

**ESSAYS ON PREFERENTIAL TRADE LIBERALISATION
AND DOMESTIC TAX POLICY:
CGE EVALUATIONS FOR THAILAND AND FOR INDIA**

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ABSTRACT

This thesis employs a computable general equilibrium modelling approach to investigate three distinctive preferential trading issues. Essay 1 seeks to estimate the extent to which customs union outcomes are sensitive to the regional market size and the degree of sectoral market imperfection, using hypothetical data. Further, Essay 1 adjusts the common external tariff rates to obtain necessarily welfare-improving outcomes for the world economy, thereby completely eliminating the trade-diversion effect under various market structure types. The results confirm that each member's welfare gain is robustly proportional to the size of the other member, and that the degree of market imperfection significantly alters the welfare outcomes as the economies of scale enhance firm productivity within the grouping. Finally, as regards a customs union with endogenous common external tariffs, union members gain less whilst the whole world gains more since non-members do not experience the welfare loss entailed by trade diversion.

Essay 2 carries out an impact analysis for certain bilateral preferential trading agreements that Thailand has reached with Japan, China, India, Australia and New Zealand. Accordingly, the model constructed in Essay 1 is extended to accommodate the Global Trade Analysis Project (GTAP) 6.0 database. It explicitly determines commodity market competition by sector; and a labour market paradigm by skill level, in order to better reflect economic reality. Among the Thai bilateral Free Trade Agreements (FTAs) entered into force thus far, in terms of the Equivalent Variation (EV) for Thailand, the Japan-Thailand Economic Partnership Agreement (JTEPA) is the best, while the Thailand-New Zealand Closer Economic Partnership Agreement (TNZCEPA) turns out to be the least beneficial FTA. However, real gains from bilateral FTAs are trivial compared to the benefits from the groupings that include the Association of South East Asian Nations (ASEAN) as a whole; moreover, unilateral trade liberalisation boosts the economy of Thailand almost as much as global free trade. On the whole, trade diversion is offset by trade creation, thus for the world economy all of the Thailand's FTAs are welfare-improving, albeit at a marginal level.

Essay 3 investigates a range of tax policy issues in India. Specifically, it estimates the welfare implications of various types of domestic tax reforms tailored to the rebalancing of government revenue after the formation of an FTA among India, China, Japan and ASEAN (i.e. ASEAN+3). Although welfare appears to be adversely affected, domestic taxes may be raised to neutralise revenue, and hence to help finance the sizable public investment on infrastructure. An income tax emerges as the most appropriate revenue-neutralising tool, since it does not hamper production and consumption as much as the other taxes considered. In contrast, a production tax appears as the least favourable choice as the FTA benefits are offset on the whole. However, once the existence of untaxable economic activity is taken into account, the most benign options measured by real output become consumption, production, income and factor input taxes, respectively. However, the introduction of a substitution elasticity between taxable and untaxable goods significantly alters the welfare outcomes. Therefore, this thesis supports the argument that the informal sector ought not to be neglected if the government is to gauge the true economic effects of domestic tax tools.

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CHAPTER 1

INTRODUCTION

1.1 Research Objectives and Methodology

The worldwide movement towards bilateral and plurilateral negotiations during the past two decades has stimulated intense public discussion on the controversial impact of regional trade liberalisation on economic growth and welfare distribution. Notwithstanding the fact that trade economists have established a succinct justification of general trade liberalisation, preferential economic integration remains controversial. As such, this study is aimed at advancing the understanding of issues surrounding preferential trading arrangements through the Computable General Equilibrium (CGE) modelling approach. Hence, this thesis is composed of three distinct essays on the topic of regional economic integration.

To begin with, the study considers the variability in Customs Union (CU) welfare results after regional size ratios and commodity market structures are altered in a hypothetical framework. Therefore, the first goal is to establish the groundwork for an empirical study of preferential trading arrangement. The base model is developed from the EcoMod model (2006) and the consistency of simulation results with trade theories is scrutinised to ensure that the model is set ready for empirical policy studies in the following chapters.

Subsequently, the second objective is to conduct a comprehensive analysis of the regional groupings between one country, Thailand, and her major trading counterparts with precise details on the production scale adjustment within sectors under imperfect competition. Indeed, it is the main objective of this thesis to predict the accurate welfare outcomes of all the Free Trade Agreements (FTAs) Thailand has concluded so far, since they are undoubtedly matters

of great public concern. Notably, the model departs from the mainstream modelling approach.¹ In order to improve the reflection of economic reality, the model firstly relaxes the assumption that production sectors in all regions operate under the same degree of market competition – e.g. perfect competition, monopolistic competition or Cournot oligopoly – as predominantly assumed in the CGE literature. Hence, a particular industry in country A could be less perfectly competitive than in country B. Additionally, the model is more flexible in that it allows for ‘asymmetric’ degrees of wage and unemployment rigidity of labour markets in different countries and of different skill levels.

Lastly, since India, one of Thailand’s trading partners, may lose from the bilateral trading arrangement with Thailand, the third objective is to contemplate a number of domestic tax options for India to maintain total tax revenue at the pre-agreement level. This is predicated on the fact that the government anticipates a huge loss in tariff revenue after the union, and is unwilling or has no capacity to sacrifice public spending for such a cause. Furthermore, the study takes into consideration the parallel presence of the untaxable informal economy, essentially not only to prove that the informal sector functions as one of the hidden drives forcing a small country’s government into the manipulation of domestic tax in the face of the considerable revenue loss after a preferential tariff removal, but also that a failure to take it into account substantially may distort the perception of the trading bloc’s economic outcomes.

Seeing that the theoretical study of preferential trading issues often yields ambiguous welfare implications even under *ceteris paribus* assumptions, this thesis utilises the theoretically consistent CGE modelling framework – within which the effects of exogenous policy shocks can be quantitatively assessed in a multi-region, multi-good and multi-factor general equilibrium setting – to pursue the above research objectives. Given the characteristics of the economy in a particular benchmark time period, the CGE model explicitly specifies the

¹ For instance, see Hertel (1998).

microeconomic foundations of the whole economy as to how economic agents rationally interact through market mechanisms under restrictive assumptions. Specifically, economic agents simultaneously and interdependently adjust to a policy change, hence the cross-sector effects are precisely observed through the ensuing shifts in demand and supply curves. This feature is imperative, since the policy impact on production efficiency and income equity can be estimated at the same time. Coupled with its flexibility in evaluating a wide range of policies using a universal framework, the static CGE study is particularly fit for the purpose of ex-ante policy appraisal, as macroeconometric models are suitable for the ex-post analysis of the dynamic response to an economic shock in aggregate terms. In other words, given solid microfoundations, the CGE approach is more useful than other alternatives in comprehensively assessing economic impacts of trade policy options on individual economic agents (e.g. the government, the household and the bank), production sectors, primary factors and regions, especially when the policies have yet to enter into force.

The history of general equilibrium modelling began with Arrow and Debreu (1954) who proposed theoretically the existence of a multi-market equilibrium in which no excess demand or supply exists. Johansen (1960) constructed a multi-sector general equilibrium model with the system of linearised equations for Norway. This modelling approach was then adopted by many researchers, both for single- and multiple-region models, including the ORANI model of the Australian economy by Dixon et al. (1982), which is developed in log differentials and is closest to the Johansen model among the recent CGE models; Dervis, de Melo and Robinson (1982) and Shoven and Whalley (1984) on the developments in levels; the Michigan Model of World Production and Trade for fiscal and trade policy analyses after the Uruguay Rounds by Deardorff and Stern (1985); and importantly the GTAP model by Hertel (1998) which has largely reproduced the success of the Australian ORANI model by creating the leading intercontinental community of CGE-based researchers, to which many contribute either by advancing the GTAP model or regularly updating the GTAP database. Although linearisation error randomly occurs when simulating a large amount of policy

change, the linearised system is widely adopted since it is relatively flexible and imposes no modification on the solution algorithm as model dimension is expanded. Nevertheless, the non-linear model has recently gained popularity since the introduction of the computer software called GAMS (General Algebraic Modeling System) with more flexibility to handle large-scale CGE models. GAMS has been used in complex models such as the IFPRI (International Food Policy Research Institute) model by Lofgren et al. (2002) and the GreenMod model by Bayar et al. (2006). Given these recent developments, the thesis constructs a non-linearised static CGE model in GAMS, then primarily uses the GTAP 6.0 database for Thailand's and India's preferential trading analyses while deriving supplementary data from external sources such as World Development Indicators (World Bank, 2007) and the online database of the United Nations Statistics Division (UNSD, 2007).

1.2 Background to the Research Problem

As regards general trade liberalisation, Ricardian theory has firmly established that international trade can be mutually beneficial when technological differences are observed across countries.² This simple, yet powerful, model with two countries, two goods and one economy-wide mobile factor input that is typically labour, is successively extended into the Ricardo-Viner model originally discussed by Viner (1931), then mathematically formalised by Jones (1971) and Mussa (1974). In this model, the incorporation of sector-specific factors, coupled with the relaxation of the constancy assumption of marginal product of labour, has simultaneously invalidated the Ricardian prediction that every individual within each economy is made better off as a result of trade liberalisation. Given that factors of production cannot move instantaneously and costlessly across industries, owners of factors specific to each economy's export sector gain while those specific to the import-competing sector lose since the variation in production mix has discrete effects on the demand for different factors

² The classic Ricardian model is first published in *On the Principles of Political Economy and Taxation* (1817).

due to sectoral dissimilarity in factor intensity. As examined by Mussa (1974), once sector-specific factors are allowed to be mobile over time, the Ricardo-Viner model will replicate the Heckscher-Ohlin equilibrium in the long run. When both countries produce two goods using two mobile factors, the Heckscher-Ohlin theorem is renowned for leading to the proof of the ‘magnification effect’ of trade in the Stolper-Samuelson theorem that a rise in the relative price of a good intensive in a particular factor will exaggeratedly shift the distribution of income in favour of that factor. As a result, the owner of the relatively abundant factor will be better off while the owner of the scarce one will lose in the face of international trade. Nevertheless, all the above influential theories unanimously propose that, at the national level, the two countries engaged in international trade will reciprocally gain from it as the world price of each country’s export good increases in relation to the import-competing one.

On the other hand, customs union theory yields more complex implications for regional welfare. Ambiguity in the consequence of a customs union on each country was introduced by Viner (1950) using the static, partial-equilibrium concepts of ‘trade creation’ and ‘trade diversion.’ While a customs union that shifts production from a higher- to a lower-cost source within the grouping is trade-creating and welfare-increasing for the union and the world as a whole; the other type that shifts production and trade from a lower-cost source outside the union to a higher-cost source within it is trade diverting and welfare-decreasing for the union and the world as a whole. This backbone of customs union theory was elaborated by Meade (1955) in a general equilibrium framework; Lipsey (1957) and Johnson (1960) on the favourable consumption effect that might ultimately increase welfare in the face of a trade-diverting customs union; and Mundell (1964) on the lucrative terms-of-trade effect that is proportionate to the pre-union tariff level. In spite of such attempts to clarify the aggregate effect of regional trade liberalisation on each economy, it has never been firmly pinpointed in theory whether preferential trading arrangement should unambiguously lead to an improved economic equilibrium.

To make matters worse, the issue becomes more convoluted when taking into consideration the existence of differences in the economic size of each country and the degree of market competition in each sector. As regards the asymmetry in size, the well-established works by Cooper and Massell (1965), Johnson (1965) and Bhagwati (1968), have demonstrated that developing countries can theoretically reach a target level of industrialisation at lower cost by specialising among themselves through regional trade integration. Nonetheless, the welfare changes for developing economies after joining a customs union can be more explicitly analysed in the context that developing countries are ‘small’ in comparison to other union counterparts and the rest of the world. This analytical aspect is of a particular interest, because developing countries in recent years have extensively altered their preferential trading arrangement strategy in favour of larger counterparts, in the midst of public concerns over the proportionately strong union effects on small members as a result of the overwhelmingly disparate economic size. Particularly, anticipation is raised amongst the group of comparatively sheltered producers that a North-South customs union will be welfare reducing. However, when focusing on net regional welfare change, Tovias (1978) has shown in a partial equilibrium model that if a preferential trade integration is to be formed between small and big economies, given that the non-member’s economy is significantly larger than the union size, the small member will unambiguously gain, the big member will definitely lose from trade diversion with no improvement in the terms of trade with the rest of the world, and the non-member economy is unaffected by the change. Nevertheless, the general equilibrium model of preferential trading that primarily focuses on the impact of the differential economic size on the welfare outcome remains to be systematically formalised, especially in consideration of another parallel customs union that can be small, identical, or large in comparison to the union at issue. Therefore, Essay 1 firstly extends the discussion in Tovias (1978) to include these additional cases, and to demonstrate that large regions may ultimately lose if trade diversion – entailed by a union with a very small region – is substantial enough to cancel out all the potential benefits, while small regions tend to gain more as the size of the other member is enlarged. More importantly, the essay endeavours to

shed light on the fact that the customs union's welfare outcomes would be non-negligibly affected when another customs union formed by the rest of the world is introduced to the model.

Besides the size issue, the second problem of preferential trading is concerned with the welfare implication of customs unions in the presence of scale economies. Corden (1972) pointed out that under imperfect competition – besides trade creation and trade diversion – there are two additional union effects to be relied on. The positive outcome is called the 'cost-reduction effect,' obtained as a group of producers capture the unionised market, then produce at lower costs of production as a result of internal scale economies. The negative outcome is called the 'trade-suppression effect,' which occurs as the newly established producer takes over the whole union market and diverts production from a lower-cost source outside the union to the higher-cost source within the union. Although Corden (1972) believes that the cost-reduction effect tends to be more significant than the trade-suppression effect, the net welfare outcome cannot be easily defined. Whilst in a partial equilibrium framework, the result largely depends on the initial level of monopolistic or oligopolistic production in each country; in a general equilibrium framework, further complications arise. For instance, we observe the sectoral demand curve shift due to the variations in income distribution and cross-sector substitution elasticities, and the endogenous preservation of the balance of payments through exchange-rate adjustment. However, it is noteworthy that Corden's cost-reduction effect is not unique to the customs union, but is also commonly observed in all kinds of trade liberalisation provided that increasing returns to scale exist. This producer's gain, however, will not be fully obtained if there is a lower bound for the number of firms, possibly due to rigorous competition policy. The negative effect of the stringency in firm population on producer's welfare is also perceived in Brander (1981), yet in a different context. Given the Cournot setting, Brander (1981) demonstrated that two symmetric monopolists located in different countries will be reciprocally inclined to generate a duopolistic competition in each other's market under free trade, but if competition policy is in place, each firm's total profit

then becomes lower in the new equilibrium as the increased competition lowers the mark-up rate. Consequently, consumers in both markets gain through lower prices. Built on these results, Bliss (1994) then further examined customs union theory under imperfect competition, using a general model of three symmetric countries, each endowed with one Cournot producer that produces an homogeneous good, given the same demand function across countries. While agreeing with the above propositions by Corden (1972) and Brander (1981), Bliss (1994) demonstrated that, if all producers survive the competition from other member countries, the union market will become more competitive and lower prices within the union will unambiguously worsen non-member's profit as it loses share in the union market. On the other hand, members' profits may equally rise or fall, depending on the 'countervailing effects' of the greater intra-union competition that reduces firms' mark-ups, and the higher intra-union market share as trade barriers are removed. However, in case some producers are driven out of business as their profits fall, the rest will prosper from the export-promotion effect, akin to the above-defined cost-reduction effect; thereby world efficiency is promoted. In any case, consumers benefit from an increase in competition.

Apart from the above impact analysis of imperfect competition with product homogeneity, monopolistic competition has progressively become one of the most discussed features in trade issues since Grubel and Lloyd (1975) pointed out the substantial amount of intra-industry trade between industrialised countries with similar economic structures. In line with Dixit and Stiglitz (1977) on the specification of monopolistic competition with heterogeneous products, Krugman (1979, 1980, 1981) convincingly showed that, given this feature, international trade enables countries to take advantage of internal scale economies, even in the absence of comparative advantage. Although Krugman's approach has been adopted by many researchers including Ethier and Horn (1984) and Saxonhouse (1993), the clear-cut analysis of the impact of monopolistic competition on the welfare outcome of customs union remains fairly uncultivated. As such, the second part of Essay 1 handles the issue of imperfect competition by contrasting the variability in customs union's welfare under perfect

competition, Cournot oligopoly and monopolistic competition. In addition, since Corden (1972), Brander (1981) and Bliss (1994) previously pointed out that the rigidity in firm population can alter producer's welfare gain, the barriers to enter and exit the market are also introduced in the end. Thus, in a highly controlled hypothetical general equilibrium setting in which regions are truly identical, the first essay endeavours to pin down the customs union's respective welfare effects on producers and consumers under different market structures, hence to confirm that under imperfect competition, union members are supposed to gain more whilst the rest of the world tends to lose to a greater extent.

In view of the afore-mentioned theoretical ambiguity in its welfare implication, the standard argument is that a customs union be handled as an empirical issue. Although, in reality the arrangement is typically far from the very definition of customs union that demands a common external tariff, as usually adopted in the theoretical framework; and also not exactly in line with the taxonomy of an FTA that requires completely free intra-union trade. Hence, the welfare results could be sectorally biased, especially when taking into consideration the disparity in the degree of market competition, among other things.

Given that the world economy is on course for regionalisation, particular interest is paid to the regional groupings among countries in Asia and the Pacific region for a number of reasons. Firstly, this set of nations includes emerging economies such as China³, India and those of Southeast Asia, which in the past several decades have experienced remarkable economic expansion. While China, India and Southeast Asia respectively represent only 4.2%, 1.5% and 2.9% of world Gross Domestic Product (GDP) in 2001 (Table 4.1, Dimaranan, 2006); China has achieved average growth of 10.6% per year during 1990-2000, although slowing to 9.6% per year during 2000-05 (Table 4.1, World Bank, 2007). In comparison with China, India has observed moderate average growth of 6% per year during 1990-2000; while expanding at the

³ Henceforth, "China" refers to the People's Republic of China (PDR), inclusive of special administrative regions (Hong Kong and Macau), yet exclusive of Taiwan.

greater annual rate of 7% during 2000-05. The same source also indicated that, among Southeast Asian countries, Vietnam has experienced the highest average annual growth of 7.9% during 1990-2000, while Cambodia on average has grown at 8.9% per year during 2000-05.

Since these countries possess great potential as the next prevailing economies in the world market, their enthusiasm for regional economic arrangement is worth elaborating, both in terms of welfare implications for individual members and the countries outside the groupings. In fact, given the dormant multilateral trade negotiations under the World Trade Organization (WTO), the East Asia Economic Caucus (EAEC) was called for by Malaysia in 1990 to encompass the Association of South East Asian Nations (ASEAN) members, China, South Korea and Japan, in response to the emerging trading blocs in Europe and the Americas. However, EAEC was strongly opposed by the United States, Australia and New Zealand, as the bloc is basically APEC (Asia-Pacific Economic Cooperation) without the above three Western nations. Although EAEC was ultimately formalised as ASEAN Plus Three in 1999, while the APEC free trade negotiation has by and large become a second priority for some members, the grouping is somewhat overshadowed by the expanding East Asia Summit (EAS) initiated in 2005, which currently involves ASEAN Plus Three with India, Australia and New Zealand. However, as the relationship between ASEAN Plus Three, EAS and APEC is complex, the negotiation is always behind schedule in comparison to the bilateral or smaller-scaled plurilateral arrangements. In particular, Thailand stands out as a good case since the country is one of the small developing countries that has been vigorously engaged in trade negotiations with a large number of countries in Asia and the Pacific region. Thus, Essay 2 accordingly undertakes the comparative static CGE analysis of preferential trading arrangements already agreed upon between Thailand and some of her trading partners, in order to clarify the circumstance of Thailand as a small developing country at the heart of the global advancement towards regionalisation, and specifically to substantiate the positive variability in welfare gain when forming a preferential trading arrangement with a larger

group of regions, thus showing the very dilemma of a small country wishing for broader integration, despite the lack of bargaining power in general.

At the same time, the interest of small countries in trade union raises another concern over public finance, since their government tax revenues tend to rely considerably on import tariffs, firstly as many import-competing producers are heavily protected, and secondly since it is the hardest type of tax to avoid in comparison to other types of taxes. As also confirmed in World Bank (Figure 4.12a, 2006), rich countries depend more on direct taxes on income and property, while poor countries are likely to rely on indirect taxes on international trade of goods and services. Precisely, as small economies are usually endowed with large informal sectors where taxation cannot apply, customs duties are more often than not their main sources of tax revenues. As such, an FTA formation may reduce national welfare, because the reduction in government welfare can potentially offset those gains in private consumption and investment, with no substantial improvement in the terms of trade with non-members to expect for when the FTA scope is comparatively negligible for the rest of the world. Hence, Essay 3 examines this feature on India which uniquely observes reduction in Equivalent Variation (EV) after trade unions with Thailand and a couple of other Asian countries (Essay 2). It focuses on the evaluation of the effectiveness of domestic tax alternatives in neutralising government revenues while maximising the benefits to individual economic agents and also to the economy as a whole. Specifically, it shows how the introduction of the informal economy alters the scope of domestic tax policy efficacy in a way that the welfare variability across tax types is narrowed down as consumers have supplementary consumption choices in the black market.

1.3 Organisation of Thesis

The thesis is organised as follows. The first essay (Chapter 2) begins with the detailed explanation of the static CGE model structure under perfect competition, along with the welfare decomposition for the hypothetical impact analysis of a small economy forming

customs unions with regions of different market sizes, with and without another parallel CU formation by the rest of the world. Subsequently, the essay additionally illustrates sectoral market structures under Cournot oligopoly and monopolistic competition in contrast with the previous perfectly competitive setting, particularly when the firm mobility constraint applies. Under these variants, the essay once again scrutinises welfare implications of the unions and importantly how to set up a necessarily welfare-improving CU by adjusting import tariffs so as not to alter bilateral trade with non-CU trading partners, given various degrees of market imperfection. Thus, it examines whether governments can collaboratively adjust their tariff rates to isolate trade diversion from the benefits of an FTA formation. Therefore, the last part of this essay is aimed at addressing the possibility of designing an FTA which could be a benign stepping stone towards global trade liberalisation. In the end, the essay tests the sensitivity of welfare results to key elasticity parameters, the exchange rate regime, the expansion of the public sector, pre-union tariffs, the benchmark size ratio of the small to the large economy and the initial size of firm population.

The second essay (Chapter 3) then turns to the empirical study of preferential trading arrangements Thailand has actually established with Japan, China, India, Australia and New Zealand. As China has been supportive of the negotiations with ASEAN as a whole, the analysis follows the actual deal, hence is implemented under the ASEAN-China framework, while the rest of Thailand's FTAs remain bilateral. After briefly explaining the CGE model structure developed from the first essay to comply with the GTAP 6.0 database, the criteria for the aggregation of region and sector, and the determination of asymmetric commodity market structure and labour market paradigm, are elaborated. Once the additional data derived from external sources along with its calibration method are described, the essay analyses the welfare outcomes of the above FTAs, and subsequently simulates a number of enlarged FTA zones that ultimately involve the world as a whole. Finally, the second essay runs sensitivity tests on the elasticity parameters not present in the first essay; the endogeneity of government transfers; and the benchmark asymmetric structures of commodity and labour markets.

Leading from Chapter 3, the final essay (Chapter 4) then builds on how India could be adversely affected by joining an FTA, principally from the viewpoint of the government. The essay thus contemplates the variability in welfare outcomes if the government is to opt for active domestic tax policies to counteract the decline in total revenue. With this respect, particular interest is paid to the variability in regional disposable income and welfare of private, public and investment sectors, as domestic taxes on consumption, output, factor input and income are consecutively increased, both in uniform and selective manners. Hence, the essay starts with a partial equilibrium analysis of the revenue-neutral trade liberalisation assuming that India is a small, net-importing country, then using Kemp and Wan's (1976) diagrammatic analytical framework, the essay extends the analysis to the revenue-neutral preferential trading arrangement assuming that India is a large net-importing economy. Subsequently, the essay disaggregates the representative household into the rich and the poor, and then it sequentially evaluates the additional imposition of taxes on income, consumption, production and factor input. The chapter ends with the incorporation of the informal untaxable economy and how this alters the welfare results in sectoral and regional terms. Lastly, Chapter 5 concludes with policy recommendations and implications for further research.

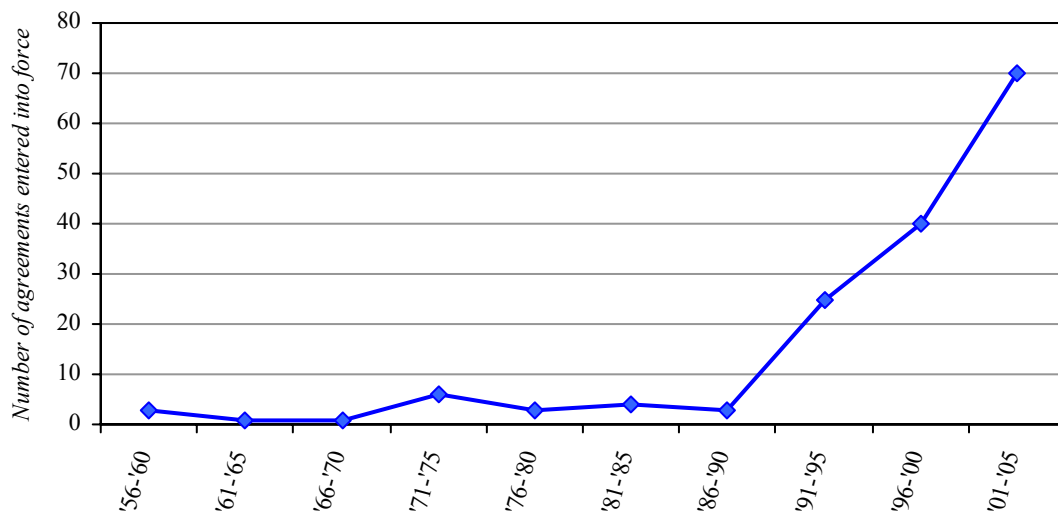
CHAPTER 2

MARKET SIZE, MARKET STRUCTURE AND WELFARE- IMPROVING REGIONAL ECONOMIC INTEGRATION

2.1 Introduction

The recent revival of interest in economic integration is propelled by the proliferation of regional Customs Unions (CUs) and Free Trade Areas (FTAs) in the world trading system since the early 1980s as a result of faltering trade negotiations under the General Agreement on Tariffs and Trade (GATT). Chart 2-1 illustrates the accelerated movement towards regional economic integration in the past few decades.

Chart 2-1: Regional Trade Agreements (RTAs) notified to the GATT/WTO and currently in force



Source: WTO database, accessed 10 February 2008 < http://www.wto.org/english/tratop_e/region_e/eif_e.xls >

Note: The number of agreements is plotted by the period of entry into force.

In order to deepen the understanding of the welfare implications of progression towards preferential trade liberalisation, Chapter 2 seeks to quantify the economic outcomes of CUs, since in comparison with other types of RTAs, the welfare changes after the formation of a

CU should be easier to interpret, as common external tariffs are imposed by union members in accordance with GATT rules. Adopting the CGE approach to the analysis of a hypothetical world economy, this study is aimed at capturing the actual causes of regional welfare changes, while maintaining model simplicity.

The theory of regional economic integration has been a subject of debate since Jacob Viner (1950) first examined the economics of the formation of a CU. Assuming constant unit costs and perfectly inelastic demand,¹ Viner (1950) refuted the assumption that discriminatory tariff removal was necessarily welfare-improving, and famously proposed the static concepts of trade creation and trade diversion in analysing the welfare effects of a CU.² In his analysis, establishment of a CU could cause welfare-increasing trade creation in some sectors but welfare-decreasing trade diversion in others. However, the analysis of possible cross-sector economic effects was ruled out due to the nature of the partial equilibrium setting. Influenced by Viner's work, many trade theorists contributed to developments of the formal analytical framework of CU formation. Among others, Meade (1955) was early in providing a complete general-equilibrium analysis of preferential trading in *The Theory of Customs Unions*. Meade's contribution included showing that, when trade creation and trade diversion were present under the assumption of flexible terms of trade, the world welfare outcomes depended on parameters such as pre-union tariffs and cross-product complementarity.

Soon afterwards, Lipsey (1957) suggested that although the concepts of trade creation and trade diversion introduced by Viner were fundamental to the understanding of how a customs union might change the pattern of world trade and production, the argument that trade diversion was always welfare-decreasing would not be valid once allowance was made for the positive consumption effects induced by lower prices of imported goods in union member

¹ The perfectly inelastic demand assumption essentially ruled out the consumption effect of CU formation. When demand is not perfectly elastic, trade diversion may be welfare-increasing. This point is illustrated later by Lipsey (1957).

² The concepts of trade creation and trade diversion are previously defined in Chapter 1 (Introduction).

countries. Thus, a trade-diverting customs union could also be beneficial to its members, and could result in higher world welfare. Johnson (1960) then elaborated on this point by explicitly defining the consumption effect – which facilitated higher trade flows for member countries and consequently increased world welfare – as another source of trade creation, thus providing a more direct link between the definitions and the welfare analysis of CUs.

Subsequently, Mundell (1964) analysed the impact of the changes in the terms-of-trade, both among CU members and between the union and the rest of the world. He showed that the higher the pre-union tariffs of other partner countries, the larger the gains to a country that joined the preferential tariff-cutting scheme. This result was critical, since it was the last piece of the puzzle that completed the basic analytical framework for the customs union issue. In consequence, the production effect, consumer effect, and terms-of-trade effect are by default regarded as the core elements of the welfare changes entailed by CU formation.

Customs union membership was once viewed as one of the more promising industrialisation strategies for developing countries. Although Cooper and Massell (1965), Johnson (1965), and Bhagwati (1968) have proved theoretically that South-South trade integration can be beneficial for member countries, when the degree of economic development is narrowly defined with regard to the scale of production at the national level, how the economic size of a CU member in relation to her counterparts and the rest of the world may affect the welfare outcomes remains to be clarified systematically. Accordingly, after briefly explaining the general CGE model design in Section 2.2, Section 2.3 addresses this question by simulating the formation of unions between regions of disparate sizes.

The early contributions to customs union theory assumed that markets were perfectly competitive. The analysis of CU formation under imperfect competition was primarily initiated by Corden (1972), Ethier and Horn (1984), Saxonhouse (1993), and Bliss (1994). Among others, Corden (1972) identified some of the complexities in a general equilibrium framework that make it difficult to generalise the economic linkages between economies of

scale, market structures and the welfare outcome of a union. Section 2.4 seeks to extend the analysis of this issue by introducing imperfectly competitive market structures to the initial CGE model.

The final issue of Chapter 2 is concerned with the negative welfare impact of CU formation on non-member economies. In this context, a seminal paper by Kemp and Wan (1976) argued that any subset of countries forming a customs union could set common external tariffs that allowed member countries to achieve higher welfare levels without lowering those of non-members. This Pareto-improving solution can be found by setting the common external tariffs at levels that do not alter trade flows between CU members and the rest of the world. Perhaps more importantly, such tariffs remove the risk that non-member countries might retaliate to the reduction of their welfare due to the formation of the customs union, and thus the risk of a ‘tariff-war.’ Accordingly, Section 2.5 focuses on how these Pareto-improving outcomes are to be achieved under various forms of imperfect competition. Subsequently, Section 2.6 tests the robustness of the model to a number of parametric changes, and then Section 2.7 summarises the key findings in this chapter.

2.2 General Model Design

The model constructed for the CU analysis in this chapter is a static, four-region, three-sector and three-factor CGE model, with production and final demand structures that are primarily developed from the single-region EcoMod model (2006).³ That CGE model consists of 1) five agents: producers, a household, a government, a bank and the rest of the world; and 2) two markets: primary factor markets and commodity markets, with an Armington aggregation that differentiates domestic outputs from imports in each region. The model is kept simple, since

³ The complete lists of parameters, variables and equations of this model are given in Appendix A2-1.

the main purpose is to identify how economic agents adjust to the CU shock in a theoretical framework. Assume that the world economy comprises four regions:⁴

$$reg = \{REG1, REG2, REG3, REG4\}.$$

Regions are completely symmetric with respect to the patterns of factor endowments, producer technologies and consumer tastes. In each region, firms are engaged in three production sectors. Of the three commodities, *SEC1* and *SEC2* are tradable (*secT*) and demanded by the private sector; while *SEC3* is non-traded (*secTN*) and consumed only by the government as a public good. The production costs are minimised subject to the nested Constant Elasticity of Substitution (CES) production function explained later in this section. Therefore, the set of all commodities is expressed as:

$$sec = \{secT, secTN\}, \text{ where:}$$

$$secT = \{SEC1, SEC2\} \text{ and } secTN = \{SEC3\}.$$

In each sector, intermediate inputs and three primary inputs: capital (*K*), labour (*L*) and land (*H*), are used to produce the final good. All the primary inputs are immobile across regions, while within regions capital and labour are mobile across production sectors (*facM*) but land is sector-specific (*facS*). To be precise, the set of all factors of production is:

$$fac = \{facM, facS\}, \text{ where:}$$

$$facM = \{K, L\} \text{ and } facS = \{H\}.$$

The household owns the primary factors. It supplies them to firms and earns rental payments in return. The household also receives income from the government in the form of transfers, namely unemployment benefits and lump-sum transfers. The household spends a part of this income on purchasing private commodities and paying direct income taxes. The remainder of the household income is then saved in the bank. Firms use intermediate inputs and purchase

⁴ At least four regions are required when analysing the customs union effects on regions with different market sizes in Section 2.3.

the services of primary factors from the household to produce value added, sell their outputs to domestic and foreign consumers, and pay ad valorem factor taxes to the government. The government collects taxes from various sources, and the government revenue net of saving is then allocated between transfers to the representative household and public good consumption. Since government saving is fixed in real terms, the government primarily spends its disposable income on unemployment benefits which are directly proportional to the level of unemployment. The level of public good consumption is passively determined as the residual of government disposable income net of transfers to the household. Since the public good (*SEC3*) is consumed solely by the government, an increase in such provision would not directly add to the household's well-being.⁵ Hence, it does not appear in the household's utility function. However, the household benefits from an increase in government revenue through the heightened factor demands from the public sector. This specification of the public sector is in line with the simplified model structure developed by EcoMod Network (2006).

Both the household and the government maximise their respective utility functions, and thus, since these are Cobb-Douglas, a constant expenditure share is allocated to each final demand commodity. The regional bank receives savings from the household, the government and the rest of the world, and then allocates a constant share to each sector in the form of investment. The macroeconomic closure rule is that the foreign savings transferred to or from the rest of the world are equal to the difference between the total values of imports and exports for each region.⁶

Next, we discuss market clearance in the CGE model. As in all 'standard' CGE models, there are two types of markets: the commodity markets (domestic and international) and the factor

⁵ Since government saving is fixed and transfers to the household are proportional to unemployment, the level of government consumption of the composite public good (*SEC3*) is derived as the residual of the tax revenue. Hence, consistent with EcoMod Network (2006), the government is modelled as a 'passive' economic agent in that the size of the public sector essentially reflects government revenue.

⁶ See Subsection 2.2.8 for the discussion of macroeconomic closure rules.

markets. With the exception of the labour market, in the perfectly competitive long-run equilibrium price flexibility ensures that supplies equal demands, so that the markets clear. In the labour market, the market clearing condition is modified to allow for unemployment.⁷

For tradable commodities, the markets are supplied by imported and domestically-produced commodities. The commodities are then purchased by production sectors as intermediate inputs, by the household as final products and by the bank as investment goods. Commodity markets contribute to government revenues by paying ad valorem commodity taxes and import tariffs. For simplicity, the possibility of trade deflection is excluded from the model,⁸ and thus only domestically-produced commodities will be exported. The market for the non-traded commodity is more simple. The public sector (*SEC3*) is modelled as that part of the government that produces an aggregate public good, which is then exclusively funded by the government. Hence, the economic activity of this sector is completely free of tax.

There exists an international market for each tradable commodity. In this market, exports and imports are traded bilaterally among regions, and the total values of exports and imports traded in the global market of each commodity will always be identical, i.e. the global markets clear.⁹

The household in each region owns the domestic endowments of primary factors – of which the total amounts are fixed – and sells them on the domestic factor markets, and production

⁷ This assumption takes us away from the neo-classical model.

⁸ Trade deflection is observed when non-members attempt to access the union market through the border of the region with lowest tariff levels, and then re-export to other union members. Supposedly, forming a union that allows for trade deflection should generally enhance the overall welfare of both member and non-member regions, since the consumption effects of tariff removal on member regions are further improved, while non-members are less negatively affected by preferential trade liberalisation. At the same time, it is analytically essential to take into account the redistributive aspect of trade deflection, as the country of final destination loses tariff revenue, while the other union member earns more revenue as a result of charging lower tariff rates on imports. However, trade deflection is not incorporated in this model because member states of a customs union share common external tariffs. Even if import tariffs against non-members are allowed to differ, the rules of origin will make certain that trade deflection is kept minimal.

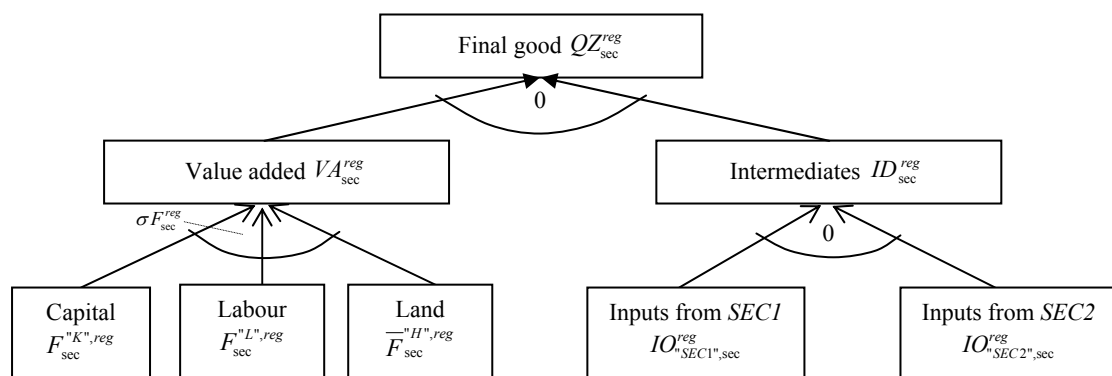
⁹ International transport costs will be introduced to the model to ensure global market clearance subsequently in Chapters 3 and 4 as the GTAP 6.0 database used in these chapters identifies the existence of international transport costs.

sectors purchase them to add value to the intermediate inputs in producing final goods. In the capital market, the model calibrates return rates to capital inputs so that all capital endowments are fully employed in each region. In the labour market, the wage is determined by labour demand, rather than being at the level that ensures full employment. The real wage is correlated with the unemployment rate, using the relationship specified by the Blanchflower and Oswald (1995) wage curve, which negatively associates the change in the unemployment rate with the adjustment in real wage. As explained in more detail in Subsection 2.2.7 the real wage is modelled as a linear function of unemployment with a negative slope. In contrast to the above two primary factors, the land market is unique in that land is not mobile across sectors. This implies that each production sector will use a fixed amount of land; so that the rental rate of land may vary across sectors.

2.2.1 Production

Each production sector sec in region reg demands factor inputs $F_{sec}^{fac,reg}$ and intermediate goods from sectors $secc$ $IO_{secc,sec}^{reg}$ to produce a final product denoted by QZ_{sec}^{reg} . The demand structure is a nested CES tree, illustrated in Figure 2-1:

Figure 2-1: Production input demand structure



The substitution elasticity in each nest is indicated below its aggregate box. At the top level of the input demand structure, there is no substitution between value added VA_{sec}^{reg} and aggregate intermediate goods ID_{sec}^{reg} (i.e. the Leontief technology). Using the quotation marks “ and ” to

denote a particular element in the sets of factors (*fac*), sectors (*sec*), or regions (*reg*), the value-added aggregate under the CES technology is made up of demands for two mobile factors (i.e. capital “*K*” and labour “*L*”) and one sector-specific factor (i.e. land “*H*”); while the intermediate aggregate nest under the Leontief technology requires fixed shares $io_{sec,sec}^{reg}$ of intermediate inputs from non-public goods (i.e., “*SEC1*” and “*SEC2*”). Note that the demand for land in each sector is exogenous and thus is specifically marked with a straight line above the variable ($\overline{F}_{sec}^{H,reg}$), whilst for simplicity, hereafter the symbol $F_{sec}^{fac,reg}$ is used when referring to factor demands in collective terms. Intermediate demand may be expressed as:

$$IO_{sec,sec}^{reg} = io_{sec,sec}^{reg} \cdot QZ_{sec}^{reg}. \quad (2-1)$$

The Value Added aggregate in each sector is modelled using CES production function so as to allow for flexible substitution at a given elasticity between primary factor inputs:

$$QZ_{sec}^{reg} = aF_{sec}^{reg} \cdot \left[\sum_{fac} \gamma F_{sec}^{fac,reg} \cdot (F_{sec}^{fac,reg})^{\rho F_{sec}^{reg}} \right]^{\frac{1}{\rho F_{sec}^{reg}}}, \quad (2-2)$$

where the value of parameter aF_{sec}^{reg} determines how efficient sector *sec* is in using primary inputs to produce the final product, $\gamma F_{sec}^{fac,reg}$ is the share parameter for each factor input, where the sum of the share parameters is unity:

$$\sum_{fac} \gamma F_{sec}^{fac,reg} = 1;$$

and ρF_{sec}^{reg} is the substitution elasticity parameter of the value-added production function. Assuming that firms minimise primary factor costs for given output levels,¹⁰ the typical demand function for factor inputs is derived as:

¹⁰ Dividing Equation (2-3) by total output, we obtain the demand function for unit factor inputs. Hence, in this model, firms simultaneously minimise their unit factor costs as well as total factor costs.

$$F_{sec}^{fac,reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac,reg}}{(1+tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac))} \right)^{\sigma F_{sec}^{reg}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac,reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1+tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)}{\sigma F_{sec}^{reg} - 1} \right) \right] \right\}}$$

(2-3)

where σF_{sec}^{reg} represents $1/(1-\rho F_{sec}^{reg})$ in Equation (2-3) as well as previously in Figure 2-1 for simplicity; $tf_{sec}^{fac,reg}$ is the ad valorem factor tax rate imposed on producers; $PFM_{sec}^{fac,reg}$ is the rate of return to each mobile factor ($facM \subset fac$) in region reg , and is the same across sectors within the same region, and $PFS_{sec}^{fac,reg}$ is the rate of return to sector-specific factor ($facS \subset fac$). The term “ $PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)$ ” thus tells the GAMS software to use the former price if the factor is mobile, and the latter one otherwise.¹¹

Given the functions for the intermediate and factor demands in Equations (2-1) and (2-3), the perfect competition assumption implies that in the long-run equilibrium firms will equate total revenues with total costs (the long-run zero-profit condition):

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1+tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)) \cdot F_{sec}^{fac,reg} + \sum_{sec c} PA_{sec c}^{reg} \cdot IO_{sec c, sec}^{reg}$$

(2-4)

where PZ_{sec}^{reg} is the producer price, and $PA_{sec c}^{reg}$ is the price of a composite commodity $sec c$.

2.2.2 Household and Government

In this model, the household consumes the tradable commodities, $SEC1$ and $SEC2$ ($secT$), while the government consumes the non-traded good, $SEC3$ ($secTN$). The household and

¹¹ See Appendix A2-1 for the definition of the dollar command (\$) in the GAMS language.

government both similarly maximise their Cobb-Douglas utility functions, subject to their budget constraints. Although the government consumes only one good, the government utility function is incorporated into this model because it is relatively effortless to further extend the model analysis later on to the case in which the government consumes many goods. With this in mind, Subsection 2.2.2.2 explains the general property of the government demand function applicable to the model that has multiple public consumption goods. Given the derived Cobb-Douglas consumption demand functions, household and government income flows are explained below.

2.2.2.1 Household

The household demand function is derived as:

$$(1 + tc_{secT}^{reg}) \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg} = \alpha HH_{secT}^{reg} \cdot CBUD^{reg}, \quad (2-5)$$

where $CBUD^{reg}$ is the consumption budget of household, spent on final goods C_{secT}^{reg} ; αHH_{secT}^{reg} is the constant expenditure share of commodity $secT$ consumption for household, the shares summing to one:

$$\sum_{secT} \alpha HH_{secT}^{reg} = 1;$$

and the commodity tax rate is denoted by tc_{secT}^{reg} . Thus, the real consumption budget level $CBUD^{reg} / PA_{secT}^{reg}$ is the key determinant of the consumption quantity of a final good $secT$. The consumption budget, on the other hand, depends on the following income balance equation, which states that the household allocates its income to consumption, savings SHH^{reg} and income tax payments TRY^{reg} :

$$INC^{reg} = CBUD^{reg} + SHH^{reg} + TRY^{reg}, \quad (2-6)$$

where the income tax payment is proportional to total household income, i.e. there is a fixed ad valorem income tax rate ty^{reg} :

$$TRY^{reg} = ty^{reg} \cdot INC^{reg} ; \quad (2-7)$$

and the household saving is a fixed proportion, denoted by mps^{reg} , of the total household income, net of the income tax payment:

$$SHH^{reg} = mps^{reg} \cdot (INC^{reg} - TRY^{reg}) . \quad (2-8)$$

As for income sources, the household receives government transfers $TRNF^{reg}$ in addition to factor incomes from the domestic production sectors:

$$INC^{reg} = \sum_{sec} \sum_{fac} \left(PFM^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac) \right) \cdot F_{sec}^{fac,reg} + TRNF^{reg} . \quad (2-9)$$

Total transfers from the government to the household, in turn, consist of unemployment benefits and other transfers:

$$TRNF^{reg} = trep^{reg} \cdot PFM^{L,reg} \cdot UNEMP^{reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg} , \quad (2-10)$$

In this equation, the government pays unemployment benefits to the household as a fixed proportion, labelled as the replacement rate $trep^{reg}$, of the household income lost from being unemployed ($PFM^{L,reg} \cdot UNEMP^{reg}$); and also transfers other lump-sum benefits which are fixed in real terms at \overline{TRO}^{reg} , e.g. income subsidies. To maintain the homogeneity of the equation, other transfers are made nominal by the multiplication of the Laspeyre consumer price index \overline{CPI}^{reg} , which is defined in the presence of endogenous taxes as:

$$\overline{CPI}^{reg} = \frac{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA_{sec}^{reg} \cdot CO_{sec}^{reg}}{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA0_{sec}^{reg} \cdot CO_{sec}^{reg}} , \quad (2-11)$$

where the value of a variable at the base year is appended with the italic number “0.” This consumer price index is chosen as the regional numéraire. Hence, it is exogenous in this

model (denoted by a ‘bar’), and all other domestic price changes are reported relative to this variable.¹²

Subsequently, Figure 2-2 summarises the income flows of the representative household.

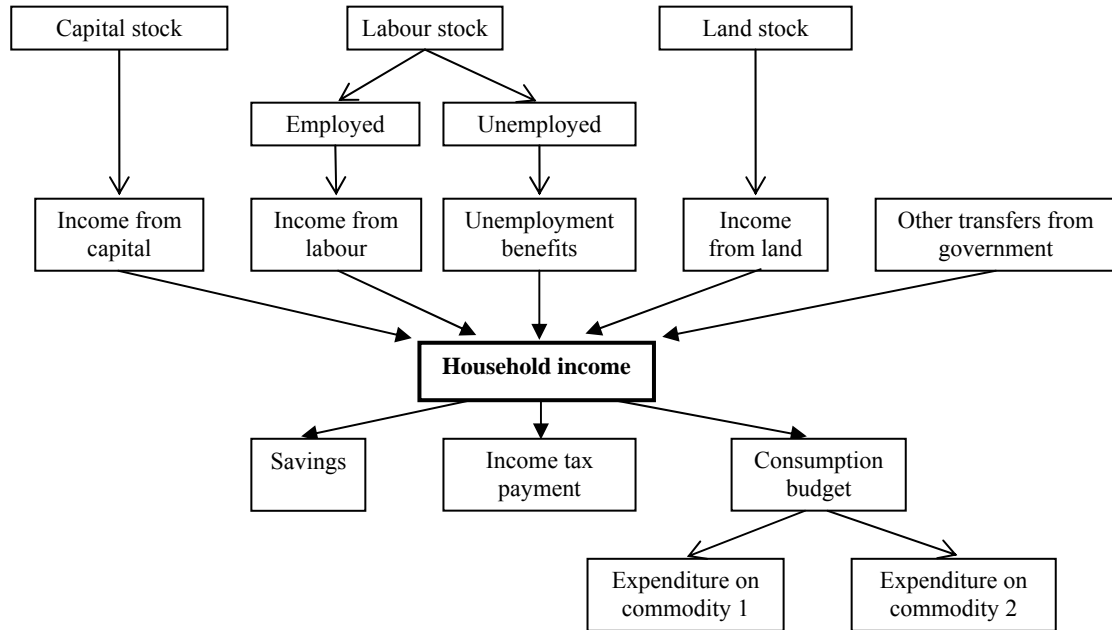


Figure 2-2: Household income flows

2.2.2.2 Government

The government purchases the non-traded public good (*SEC3*), based on the following demand function:

$$PA_{secTN}^{reg} \cdot CG_{secTN}^{reg} = \alpha CG_{secTN}^{reg} \cdot CGBUD^{reg}, \quad (2-12)$$

where $CGBUD^{reg}$ is the government budget spent on *secTN* (CG_{secTN}^{reg}); and αCG_{secTN}^{reg} is the expenditure share of commodity *secTN* consumption for government, the shares summing to one:

$$\sum_{secTN} \alpha CG_{secTN}^{reg} = 1.$$

¹² See the discussion on the specification of numéraire in Subsection 2.2.8.

Thus, the real consumption budget level $CGBUD^{reg} / PA_{secTN}^{reg}$ is the key determinant of the consumption quantity of a final good $secTN$. The consumption budget, on the other hand, depends on the following government income balance equation, which states that the government allocates its total tax revenues $TREV^{reg}$ to the consumption budget, fixed savings \overline{SG}^{reg} and total transfers to the household:

$$TREV^{reg} = CGBUD^{reg} + \overline{SG}^{reg} \cdot \overline{CPI}^{reg} + TRNF^{reg} . \quad (2-13)$$

The sources of revenue for the government are tax receipts in the forms of household income taxes (TRY^{reg}); commodity taxes (TRC^{reg}); factor usage taxes (TRF^{reg}); and import tariffs (TRM^{reg}):

$$TREV^{reg} = TRY^{reg} + TRC^{reg} + TRF^{reg} + TRM^{reg} . \quad (2-14)$$

As the household income tax is already defined in Equation (2-7), the other elements are defined as follows:

$$TRC^{reg} = \sum_{secT} tc_{secT}^{reg} \cdot C_{secT}^{reg} \cdot PA_{secT}^{reg} ; \quad (2-15)$$

$$TRF^{reg} = \sum_{sec} \sum_{fac} tf_{sec}^{fac,reg} \cdot F_{sec}^{fac,reg} \cdot PF_{sec}^{fac,reg} ; \quad (2-16)$$

$$TRM^{reg} = \sum_{secT} \sum_{regg}^{(\neq reg)} tm_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg} . \quad (2-17)$$

Note that in Equation (2-17), bilateral imports to region reg from region $regg$ are denoted by $QBM_{secT}^{reg,regg}$, while tariff revenues from these imported goods are converted to the local currency by multiplying the corresponding world prices $PWE_{secT}^{regg,reg}$ by the exchange rate EXC^{reg} . Figure 2-3 thus summarises the income flows of the government in a region:

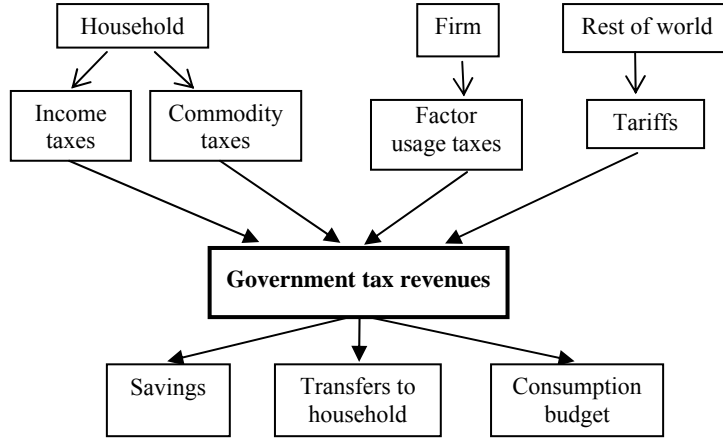


Figure 2-3: Government income flows

2.2.3 Bank

The investment bank models how outputs from production sectors are demanded for investment within a region. As this model attempts to isolate the non-traded public sector (*SEC3*) from the rest of the world in order to examine how a CU shock could affect such an isolated sector through domestic price adjustment, again, investment is not allocated to *SEC3*, which is the non-traded sector that specifically produces to meet the government's final demand. Thus, the investment demand function is expressed as:

$$PA_{secT}^{reg} \cdot I_{secT}^{reg} = \alpha_{secT}^{reg} \cdot S^{reg}, \quad (2-18)$$

where S^{reg} is the total savings in region *reg* that will be allocated to investment demands in sector *secT* (I_{secT}^{reg}); and α_{secT}^{reg} is the investment share of sector *secT* that sums up to one:

$$\sum_{secT} \alpha_{secT}^{reg} = 1.$$

The bank then collects savings from household, government and the rest of the world (the income-balance condition):

$$S^{reg} = SHH^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}, \quad (2-19)$$

while subsequently spending these savings on investment demands. In this model, foreign savings (\overline{SF}^{reg}) are fixed in real terms and denominated in local currency.

2.2.4 Rest of World

The balance of payments is essentially the zero-profit condition required to maintain the macroeconomic balance of a region. Evaluated in world currency, it defines the nominal foreign savings as equal to the total value of imports less that of exports:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg,regg} \cdot PWE_{secT}^{reg,regg} \right) + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}, \quad (2-20)$$

where $QBE_{secT}^{reg,regg}$ denotes bilateral exports of commodity $secT$ from region reg to region $regg$.

Note that in this model all regions operate a flexible exchange regime, thus their exchange rates with respect to the world currency adjust in order to stabilise the real foreign savings. As all regions are symmetric in this model,¹³ trade balances are set to be neutral.¹⁴ Hence, we have total exports equal to total imports and the foreign savings (which is in the second term on the right hand side), are fixed at zero in the benchmark year. This also implies that the sum of savings collected from the household and government will be equal to total domestic investment demands, as implied in Equations (2-18) and (2-19).

2.2.5 Domestic Commodity Markets

This section explains the market structures for commodities produced in a region. The value flow of each commodity depends on its tradability. While tradable goods are supplied to

¹³ Even if I assume products to be differentiated by country of origin, all regions can be symmetric in the sense that the Armington demand functions and their associated elasticities are universal and that products are all equivalently differentiated from each other.

¹⁴ Trade balances of the four regions in the world economy must sum up to zero. Since all regions are modelled as completely symmetric, regional trade balances are fixed to zero in order to prevent asymmetry in form of trade deficits and trade surpluses.

domestic and foreign markets, non-traded goods are produced only for the domestic market.

Figure 2-4 illustrates such flows for both cases in this model.

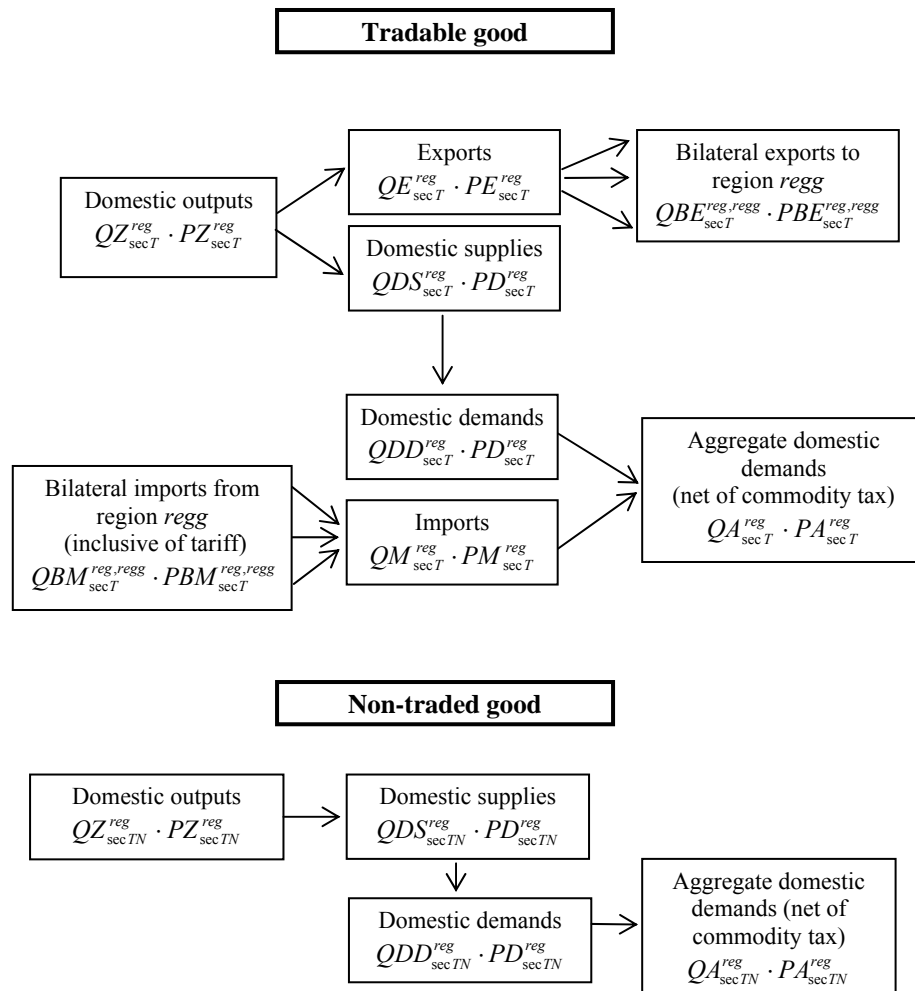


Figure 2-4: Value flows of tradable and non-traded commodities in region reg

For tradable goods, PE_{secT}^{reg} is the aggregate export price paralleling the aggregate export quantity QE_{secT}^{reg} ; $PBE_{secT}^{reg,regg}$ represents the bilateral export price paralleling the bilateral export quantity $QBE_{secT}^{reg,regg}$; PM_{secT}^{reg} is the aggregate import price paralleling the aggregate import quantity QM_{secT}^{reg} ; and $PBM_{secT}^{reg,regg}$ represents the bilateral import price paralleling the bilateral import quantity $QBM_{secT}^{reg,regg}$. As observed in Figure 2-4, direct re-exportation is not allowed in this model.

For both types of goods, PD_{sec}^{reg} denotes the price of the domestically-produced commodity supplied to the domestic market QDS_{sec}^{reg} , which equals the level demanded for domestic consumption QDD_{sec}^{reg} ; and lastly, aggregate demands are denoted by QA_{sec}^{reg} paralleling the domestic price PA_{sec}^{reg} previously introduced.

Now, to elaborate on the market structures in Figure 2-4, the relationships between the above quantities and prices with respect to tradability are explained in Subsections 2.2.5.1 and 2.2.5.2 as follows.

2.2.5.1 Tradable Commodity Markets

For tradable products, firstly, the supply value flows are summarised as follows:

$$PZ_{secT}^{reg} \cdot QZ_{secT}^{reg} = PD_{secT}^{reg} \cdot QDS_{secT}^{reg} + PE_{secT}^{reg} \cdot QE_{secT}^{reg} \quad (2-21)$$

That is, the nominal values of domestically-produced commodities are equal to the sum of those supplied to domestic and to foreign markets. Further, the values of aggregate exports are the sum of bilateral exports supplied to other regions $regg$:

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg(\neq reg)} PBE_{secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg} \quad (2-22)$$

In Figure 2-4, it is further specified that domestically-produced commodities supplied to the domestic market are equal to the quantities demanded¹⁵:

$$QDS_{secT}^{reg} = QDD_{secT}^{reg} \quad (2-23)$$

¹⁵ As with Equations (2-21) and (2-22), Equation (2-23) can also be expressed in ‘value’ terms, such that both sides are equivalent when multiplied by the market price of the domestically-produced commodity (denoted by PD_{secT}^{reg}), which in turn highlights the fact that the demand and supply of the domestically-produced good always share the same market price.

The demand side of the economy is specified as follows. In the upper level, the nominal demand for the domestic composite good QA_{secT}^{reg} equals the sum of nominal demands for domestically-produced goods QDD_{secT}^{reg} and aggregate imports QM_{secT}^{reg} .¹⁶

$$PA_{secT}^{reg} \cdot QA_{secT}^{reg} = PD_{secT}^{reg} \cdot QDD_{secT}^{reg} + PM_{secT}^{reg} \cdot QM_{secT}^{reg}. \quad (2-24)$$

The model specifies that, in the lower level of the sectoral demand structure, the values of aggregate imports should equal the sum of demands for bilateral imports from other regions $regg$ in nominal terms:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}. \quad (2-25)$$

Under perfect competition, the long-run market clearance condition holds, and prices of composite goods PA_{secT}^{reg} are determined by equating QA_{secT}^{reg} with domestic demands from the household, bank and firms¹⁷:

$$C_{secT}^{reg} + I_{secT}^{reg} + \sum_{sec} IO_{secT,sec}^{reg} = QA_{secT}^{reg}. \quad (2-26)$$

If, in tradable sector $secT$, all prices listed above are identical, we can say that exports, domestically-oriented products, and imports are homogeneous, i.e. not differentiated from each other, which is the case for the ‘supply’ side of the economy. However, on the ‘demand’ side, it is clearly observable in empirical data that ‘two-way trade’ exists.¹⁸ This phenomenon is modelled by assuming imperfect substitutability in consumption between commodities

¹⁶ The zero-profit conditions in Equations (2-24) and (2-25) apply since the respective upper- and lower-level (CES) Armington functions in Equations (2-28) and (2-32) are homogeneous of degree one (i.e. linear homogeneity). According to Euler’s theorem, for any multivariate function $Q = f(q_1, \dots, q_n)$ that is homogeneous of degree m [hence, $f(t \cdot q_1, \dots, t \cdot q_n) = t^m \cdot f(q_1, \dots, q_n)$ for any $t > 0$], $f_1 \cdot q_1 + \dots + f_n \cdot q_n = m \cdot f(q_1, \dots, q_n)$, where f_x stands for the partial differentiation of Q with respect to q_x .

¹⁷ As with Equation (2-23), Equation (2-26) can also be expressed in ‘value’ terms, such that both sides are multiplied by the Armington domestic price (PA_{secT}^{reg}).

¹⁸ In many cases some of this ‘two-way trade’ is a consequence of the aggregation of a range of goods.

produced in different countries, the ‘Armington Assumption.’¹⁹ With such product differentiation, PA_{secT}^{reg} , PD_{secT}^{reg} , PM_{secT}^{reg} and $PBM_{secT}^{reg,regg}$ in Equations (2-24) and (2-25) are allowed to deviate from each other, hence the sum of the domestically-produced quantity QDD_{secT}^{reg} and the aggregated imported quantity QM_{secT}^{reg} will no longer equal the aggregate demand QA_{secT}^{reg} ; and the sum of bilateral imports $QBM_{secT}^{reg,regg}$ will not necessarily equal the aggregate import demand QM_{secT}^{reg} . Accordingly Armington demand functions for QDD_{secT}^{reg} , QM_{secT}^{reg} and $QBM_{secT}^{reg,regg}$ need to be separately derived.

The Armington good is composited by minimising costs:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} + PD_{secT}^{reg} \cdot QDD_{secT}^{reg}, \quad (2-27)$$

subject to the CES Armington function:

$$QA_{secT}^{reg} = aA_{secT}^{reg} \cdot \left[\gamma AM_{secT}^{reg} \cdot QM_{secT}^{reg} \rho_{secT}^{reg} + \gamma AD_{secT}^{reg} \cdot QDD_{secT}^{reg} \rho_{secT}^{reg} \right]^{\frac{1}{\rho_{secT}^{reg}}}, \quad (2-28)$$

where aA_{secT}^{reg} is the efficiency parameter, γAM_{secT}^{reg} and γAD_{secT}^{reg} are the share parameters ($\gamma AM_{secT}^{reg} + \gamma AD_{secT}^{reg} = 1$) and ρ_{secT}^{reg} is the elasticity parameter for Armington composite good production. When $\sigma_{secT}^{reg} = 1/(1 - \rho_{secT}^{reg})$, Equations (2-24), (2-27) and (2-28) are solved, and the upper-level Armington demand functions are:

$$QDD_{secT}^{reg} = (aA_{secT}^{reg})^{\sigma_{secT}^{reg}-1} \cdot (\gamma AD_{secT}^{reg})^{\sigma_{secT}^{reg}} \cdot \left(\frac{PA_{secT}^{reg}}{PD_{secT}^{reg}} \right)^{\sigma_{secT}^{reg}} \cdot QA_{secT}^{reg} \quad (2-29)$$

$$QM_{secT}^{reg} = (aA_{secT}^{reg})^{\sigma_{secT}^{reg}-1} \cdot (\gamma AM_{secT}^{reg})^{\sigma_{secT}^{reg}} \cdot \left(\frac{PA_{secT}^{reg}}{PM_{secT}^{reg}} \right)^{\sigma_{secT}^{reg}} \cdot QA_{secT}^{reg}. \quad (2-30)$$

¹⁹ See Armington (1969). The compatibility of the CES differentiation of products from different sources with theoretical general equilibrium trade models are then illustrated by de Melo and Robinson (1989).

Thus, demands for domestically-produced and imported commodities are determined by the Armington aggregate demand QA_{secT}^{reg} , and their relative prices to the Armington price PA_{secT}^{reg} .

In the lower-level of the Armington demand structure, bilateral imports from different regions are also differentiated from each other. Therefore, the Armington demand function for aggregate imports can similarly be composed by minimising costs:

$$\sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}, \quad (2-31)$$

subject to the CES Armington function:

$$QM_{secT}^{reg} = aBM_{secT}^{reg} \cdot \left[\sum_{regg(\neq reg)} \gamma BM_{secT}^{reg,regg} \cdot (QBM_{secT}^{reg,regg})^{\rho BM_{secT}^{reg}} \right]^{\frac{1}{\rho BM_{secT}^{reg}}}, \quad (2-32)$$

where $aBM_{secT}^{reg,regg}$ is the efficiency parameter, $\gamma BM_{secT}^{reg,regg}$ is the share parameter:

$$\sum_{regg(\neq reg)} \gamma BM_{secT}^{reg,regg} = 1;$$

and ρBM_{secT}^{reg} is the elasticity parameter for the Armington aggregate import. When

$\sigma BM_{secT}^{reg} = 1/(1 - \rho BM_{secT}^{reg})$, the Armington demand function for bilaterally-imported goods is:

$$QBM_{secT}^{reg,regg} = (aBM_{secT}^{reg})^{\sigma BM_{secT}^{reg} - 1} \cdot (\gamma BM_{secT}^{reg,regg})^{\sigma BM_{secT}^{reg}} \cdot \left(\frac{PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma BM_{secT}^{reg}} \cdot QM_{secT}^{reg}. \quad (2-33)$$

2.2.5.2 Non-Traded Commodity Markets

For non-traded goods, the commodity flows are fairly simple. The nominal value of a non-traded commodity should be identical all through the supply chain, hence we get:

$$QZ_{secTN}^{reg} \cdot PZ_{secTN}^{reg} = QDS_{secTN}^{reg} \cdot PD_{secTN}^{reg} = QDD_{secTN}^{reg} \cdot PD_{secTN}^{reg} = QA_{secTN}^{reg} \cdot PA_{secTN}^{reg}. \quad (2-34)$$

That is to say, the value of domestic output is equal to the value of the same product supplied as well as demanded within the domestic market. Since product differentiation does not apply to the non-traded commodity, their quantities and prices are universal by sector and region:

$$QZ_{secTN}^{reg} = QDS_{secTN}^{reg} = QDD_{secTN}^{reg} = QA_{secTN}^{reg} ; \text{ and} \quad (2-35)$$

$$PZ_{secTN}^{reg} = PD_{secTN}^{reg} = PA_{secTN}^{reg} . \quad (2-36)$$

Since the non-traded good is also a public good, produced under perfect competition, the market clearance condition holds, so that domestic prices are determined by equating domestic supplies with final demands from the government:

$$CG_{secTN}^{reg} = QA_{secTN}^{reg} . \quad (2-37)$$

2.2.6 International Commodity Market

We now consider the market clearing condition in an international commodity market. The bilateral import demand for commodity $secT$ by region reg from region $regg$ should be identical to the matching export supplies from region $regg$ to region reg . Hence, the sum of sectoral export values traded in the international market must be equal to that of the import values. This property is modelled by specifying that the world price ($PWE_{secT}^{reg,regg}$) adjusts so that the international market is always cleared under perfect competition. As for the relationship between the world price and border prices, the border price of an exported good is converted into the world currency as:

$$PBE_{secT}^{reg,regg} = PWE_{secT}^{reg,regg} \cdot EXC_{secT}^{reg} . \quad (2-38)$$

Similarly, the world price is converted into the border price of an imported commodity inclusive of tariffs:²⁰

$$PBM_{secT}^{reg,regg} = (1 + tm_{secT}^{reg,regg}) \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg} . \quad (2-39)$$

2.2.7 Factor Markets

In the factor markets, the ‘standard’ assumption is that primary endowments are fully employed, so that the sum of the primary inputs demanded by production sectors is equal to the relevant endowment. However, as stated at the beginning of Section 2.2, here this property only holds for the capital market. The market clearing condition does not apply to the land market, since land is sector-specific, and these primary factor inputs are thus fixed by sector. In the labour market, the sum of factor demands equals the labour endowment less the unemployed labour. That is, this model assumes that the labour market does not necessarily clear, but that some of the unemployed labour may be supplied to production sectors when a positive policy shock is imposed on the economy (and, of course, vice versa). The labour wage is still flexible, but it does not necessarily ensure that the labour market will clear, as unemployment is endogenised and negatively associated with real wage (Blanchflower and Oswald, 1995). Following the conception of the wage curve by Blanchflower and Oswald (1995), and using the technical specification by EcoMod (2006), the wage curve is defined such that the wage curve elasticity (ω^{reg}) is -0.1 for all regions, and the downward-sloping relationship between real wage and unemployment is simplified to:²¹

$$\left(PFM^{L,reg} / PFM0^{L,reg} \right) - 1 = \omega^{reg} \cdot \left[(UNEMP^{reg} / UNEMP0^{reg}) - 1 \right]. \quad (2-40)$$

²⁰ The derivation of this price definition in accordance with the accounting identity and behavioural assumption with respect to taxes is demonstrated later in Subsection 2.3.1.

²¹ Labour’s nominal wage $PFM^{L,reg}$ is to be divided by the consumer price index CPI^{reg} to derive real wage, however, it can be abbreviated since the price index is fixed as the regional numéraire in this model.

Since variables in the benchmark year (appended with zeroes) are fixed parameters, Equation (2-40) can be rearranged as:

$$PFM^{L,reg} = \left(\frac{\omega^{reg} \cdot PFM0^{L,reg}}{UNEMPO^{reg}} \right) \cdot UNEMP^{reg} + (1 - \omega^{reg}) \cdot PFM0^{L,reg}.$$

Thus, the real wage is a *linear* function of unemployment with a negative slope.

2.2.8 Macroeconomic Closure Rules and Numéraire

2.2.8.1 Theory

2.2.8.1.1 Macroeconomic Closure Rules

In mathematical terms, all CGE models are ‘square’ economic systems in the sense that every variable must be matched with an equation. Hence, closure rules refer to the decisions on endogenous and exogenous variables based on the theoretical preferences of model builders. Since simulation outcomes can be significantly altered by the selection of closure rules (Sen, 1963), this subsection elaborates on the alternative set of closure rules and hence the justification of the choices. According to Lofgren et al. (2002), three macroeconomic balances are to be maintained through the specification of closure rules, namely the ‘external’ balance, the ‘government’ balance and the ‘savings-investment’ balance.

The ‘external’ balance can be maintained by endogenising the real exchange rate (EXC^{reg}) while fixing foreign savings (SF^{reg}). Hence, trade balances converge to zero in the new equilibrium as the real exchange rate adjusts to the proposed policy change. More explicitly, trade deficits are corrected by the depreciation of the real exchange rates that simultaneously reduce import demands and increase export supplies. The alternative external closure rule is to specify that the real exchange rate is fixed while foreign savings are flexible. Under this approach, trade deficits are not corrected and thus we observe more foreign savings (capital inflows) in the new equilibrium. Although the former situation is arguably uncommon in the

real world as trade balances are rarely zero, given that the present CGE model uses a comparative static framework, the simulation result is interpreted as a long-run equilibrium. Therefore, the endogenisation of capital flows (foreign savings) across borders can yield misleading welfare outcomes. In a dynamic CGE framework however, the latter closure would be more suitable, since regional investment volumes depend on capital inflows and thus the capital accumulation process is better captured using the fixed exchange rate approach.²²

For the ‘government’ balance, there are two closure rules discussed in Lofgren et al. (2002). The first government closure fixes tax rates, and thus government revenues ($TREV^{reg}$) are given. As government expenditures ($CGBUD^{reg}$) are not adjustable, the difference between government revenues and government expenditures (i.e. government savings SG^{reg}) is residually determined. Alternatively, tax rates can be specified as endogenous variables that adjust to the targeted levels of government savings. Since in reality, government savings can be more easily adjusted than tax rates, the former approach is common in the CGE literature. Although not preferred by Lofgren et al. (2002), another way to ‘close’ the model, according to EcoMod Network (2006), is to endogenise government expenditures while fixing tax rates and government savings. Although the three approaches alter the welfare outcomes especially in terms of the composition of production and consumption of an economy, the choice largely depends on the assumption of the government behaviour.

For the ‘saving-investment’ balance, closure rules are either savings-driven or investment-driven. The savings-driven closure specifies that regional investment (S^{reg}) is endogenous and determined by the sum of savings from the household, the government and the rest of the world. Under this approach, the household’s marginal propensity to save (mps^{reg}) is fixed, so the economy is savings-driven as investment is a residual of savings. The alternative closure

²² The implications of the external balance’s closure rules are explored in the sensitivity analysis (see Subsection 2.6.3).

is investment-driven, in which total investment is fixed and the government implements policies that generate savings to finance the targeted level of investment. As such, the household's marginal propensity to save is endogenised under this closure.

Given the three balances that must be maintained, the **Neo-Classical** closure, which is the most widely used, is the combination of the fixed foreign savings closure, the savings-driven closure, and one of the three government closures introduced above. Therefore, real investment adjusts the sum of household, government and foreign savings. On the other hand, the **Johansen** closure adopts the investment-driven closure, i.e. investment is fixed, requiring consumption to endogenously adjust as the marginal propensity to save becomes flexible.

Since both sets of closure rules assume full employment, aggregate GDP will not be affected by the choice of closure rules. The interaction between macroeconomic variables and labour demands can be additionally specified by introducing the **Keynesian** closure to the model. As a variant of structuralist CGE models,²³ labour unemployment (or total labour supply) is endogenised by specifying the real wage as exogenous. The structuralist macro models encompass the short-run elements that the level of output is determined by the level of aggregate demand as production resources are flexibly provided to generate the increase in output in response to the augmented demand (and vice versa). This approach is therefore advocated by its proponents for its reflection of structural rigidities in markets and institutions relatively specific to developing economies. Another way to incorporate unemployment to the model is to explicitly introduce the wage curve relationship between the real wage and unemployment, which is, so to speak, a 'balanced' labour market closure as both variables are endogenous while the level of labour employment adjusts to the changes in real wage with respect to the elasticity of wage curve (ω^{reg}), as explained in Subsection 2.2.7.²⁴

²³ See Taylor (1990) for the detailed description of the structuralist approach.

²⁴ The implications of the labour market clearing rules are explored in the sensitivity analysis of Chapter 3 (see Subsection 3.6.5).

2.2.8.1.2 Numéraire

The specification of the numéraire is in compliance with Walras Law that if $(n-1)$ markets in an economic model composed of n distinctive markets are in equilibrium then equilibrium in the last one will be guaranteed. For that reason, exogenising one of the nominal price variables will prevent redundancy and will allow changes in all other price variables to be measured in relation to the chosen numéraire. The required number of numéraires is an ongoing theoretical issue. While the GTAP model (Hertel, 1998), among others, specifies an international price to be the only numéraire, many models adopt multiple numéraires, that is a domestic price for each region plus an international price for the world market (for instance, the GTEM model in Pant, 2002; and the GreenMod model in Bayar et al., 2006). The latter approach is taken throughout this thesis since it is argued in Pant (2002) that there are two redundancies in the model: the first one is the market clearing conditions for regional currencies (the ‘regional budget constraint’), while the other one is the market clearing condition for international savings and investment (the ‘global budget constraint’), since the accounting identity of the global market that global trade always balances and global transfer payments always sum up to zero.

2.2.8.2 Model Specifications of Closure rules and Numéraire

As explained in Subsections 2.2.1 to 2.2.7, for the ‘external’ balance, the current model adopts the flexible exchange rate closure (fixed foreign savings), which is suitable given the static nature of the model. For the ‘government’ balance, tax rates and government savings are fixed while government consumption, and thus government expenditures, is specified as endogenously determined by the Cobb-Douglas public demand function. Since this model has only one composite public good, *SEC3*, the counterfactual public demand is then driven by the levels of domestic economic activities, as they eventually determine gross tax revenues given that tax rates are fixed. Thus, the government remains a ‘passive’ economic agent that distributes the collected tax revenues as received from the private sector. For the ‘saving-

investment' balance, the model is specified as savings-driven and real investment is determined by the target (fixed) saving rates, which is consistent with the formerly-stated external balance closure that foreign savings are exogenous. Lastly the 'labour-market' closure is subject to the wage curve definition, and thus factor prices are not completely fixed but are rigidly determined by the level of labour demand in the production function at a fixed wage curve elasticity.

As stated above, the consumer price index (CPI^{reg}) is chosen as the regional numéraire while the exchange rate of region $REGI$ (EXC^{REGI}) is fixed as the numéraire for the world market.

2.2.9 Welfare Decomposition: The Equivalent Variation (EV) Approach

This study mainly utilises the standard EV method in analysing the welfare effects of CU formation. It measures the income change induced by regional trade liberalisation, given the price in the benchmark year.²⁵ Following Varian (1992), the EV can be expressed as:

$$EV^{reg} = \frac{Y^{reg}}{WPI_{1,0}^{reg}} - Y0^{reg}, \quad (2-41)$$

where regional incomes in the benchmark year and after the proposed change are denoted by $Y0^{reg}$ and Y^{reg} , respectively. The counterfactual regional income Y^{reg} is then deflated by:

$$WPI_{1,0}^{reg} = \frac{WPI^{reg}}{WPI0^{reg}},$$

where $WPI0^{reg}$ and WPI^{reg} respectively represent the regional welfare price indices in the benchmark year and after the proposed change. Consistent with Blake (1998), these regional

²⁵ Although the economic theoretic basis for the EV presumes full employment, which does not hold in the implementation of the current model with unemployment; the method is used as the standard measure of welfare variation throughout this thesis, firstly because thus far there is no superior measure to the EV, and secondly because the gap between wage and marginal productivity of labour as a result of the unemployment specification is trivial and will not be large enough to alter the direction of welfare change in the simulation results.

welfare price indices are the geometric averages of the price indices perceived by the household, the government and the bank, weighted by their budget shares in the Cobb-Douglas form:

$$WPI^{reg} = (GPI^{reg})^{\alpha GPI^{reg}} \cdot (HPI^{reg})^{\alpha HPI^{reg}} \cdot (SPI^{reg})^{\alpha SPI^{reg}}, \quad (2-42)$$

where GPI^{reg} , HPI^{reg} and SPI^{reg} stand for consumer price indices of the government, the household and the bank respectively; while αGPI^{reg} , αHPI^{reg} and αSPI^{reg} denote the budget shares of the government, the household and the bank respectively in the regional income.

These price indices are defined as the geometric average of aggregate prices, weighted by their respective expenditure shares of the Cobb-Douglas utility function:

$$GPI^{reg} = \prod_{sec} (PA_{sec}^{reg})^{\alpha CG_{sec}^{reg}} \quad (2-43)$$

$$HPI^{reg} = \prod_{sec} [PA_{sec}^{reg} \cdot (1 + tc_{sec}^{reg})]^{\alpha HH_{sec}^{reg}} \quad (2-44)$$

$$SPI^{reg} = \prod_{sec} (PA_{sec}^{reg})^{\alpha I_{sec}^{reg}}. \quad (2-45)$$

The budget shares of the government, the household and the bank are those in the benchmark year, and necessarily sum to one ($\alpha GPI^{reg} + \alpha HPI^{reg} + \alpha SPI^{reg} = 1$). Therefore the Cobb-Douglas property holds. That is to say,

$$\alpha GPI^{reg} = \frac{CGBUD0^{reg}}{Y0^{reg}} \quad (2-46)$$

$$\alpha HPI^{reg} = \frac{CBUD0^{reg}}{Y0^{reg}} \quad (2-47)$$

$$\alpha SPI^{reg} = \frac{S0^{reg}}{Y0^{reg}}, \text{ where} \quad (2-48)$$

$$CGBUD0^{reg} + CBUD0^{reg} + S0^{reg} = Y0^{reg}. \quad (2-49)$$

From the EV definition in Equation (2-41), the EV can be decomposed into the real income effect and the consumer surplus effect. The real income effect is the nominal change in

regional income deflated by $WPI_{1,0}^{reg}$; and the consumer surplus effect shows the effect of changes in prices on welfare:

$$EV^{reg} = \underbrace{\frac{Y^{reg} - Y0^{reg}}{WPI_{1,0}^{reg}}}_{\text{real income effect}} + \underbrace{\left(\frac{1}{WPI_{1,0}^{reg}} - 1 \right) \cdot Y0^{reg}}_{\text{consumer surplus effect}}. \quad (2-50)$$

2.2.9.1 The Real Income Effect

The real income effect is decomposed into the production effect, the tax-revenue effect and the capital-inflow effect. To derive these effects, the first term is decomposed as following:

$$\begin{aligned} (Y^{reg} - Y0^{reg}) / WPI_{1,0}^{reg} &= \left[\frac{(CGBUD^{reg} + CBUD^{reg} + S^{reg})}{-(CGBUD0^{reg} + CBUD0^{reg} + S0^{reg})} \right] / WPI_{1,0}^{reg} \\ &= \underbrace{\left(\frac{\sum_{sec} \sum_{fac} \left(\frac{PFM^{fac,reg} \$ facM(fac) +}{PFS_{sec}^{fac,reg} \$ facS(fac)} \right) \cdot F_{sec}^{fac,reg}}{-\sum_{sec} \sum_{fac} \left(\frac{PFM0^{fac,reg} \$ facM(fac) +}{PFS0_{sec}^{fac,reg} \$ facS(fac)} \right) \cdot F0_{sec}^{fac,reg}} \right)}_{\text{The production effect}} / WPI_{1,0}^{reg} \\ &\quad + \underbrace{\left[(TREV^{reg} - TRY^{reg}) - (TREV0^{reg} - TRY0^{reg}) \right]}_{\text{The tax-revenue effect}} / WPI_{1,0}^{reg} \\ &\quad + \underbrace{(\overline{SF}^{reg} \cdot \overline{CPI}^{reg} - SF0^{reg} \cdot CPI0^{reg})}_{\text{The capital-inflow effect}} / WPI_{1,0}^{reg}. \end{aligned} \quad (2-51)$$

2.2.9.1.1 The Production Effect by Sector

The production effect is the change in the value-added after a shock, deflated by $WPI_{1,0}^{reg}$.

Further, we can disaggregate the production effect by sector as:

$$\frac{\sum_{fac} \left(\frac{PFM^{fac,reg} \$ facM(fac) +}{PFS_{sec}^{fac,reg} \$ facS(fac)} \right) \cdot F_{sec}^{fac,reg} - \sum_{fac} \left(\frac{PFM0^{fac,reg} \$ facM(fac) +}{PFS0_{sec}^{fac,reg} \$ facS(fac)} \right) \cdot F0_{sec}^{fac,reg}}{WPI_{1,0}^{reg}} \quad (2-52)$$

2.2.9.1.2 The Tax-revenue Effect by Type of Taxes and by Sector

Using Equation (2-14), the tax-revenue effect comprises the welfare effects of changes in commodity taxes, factor usage taxes, import tariffs and income taxes. However, the change in income tax revenues is not shown in the regional tax-revenue effect, since they are paid by the household, so that they are internally transferred and do not affect the regional income.

The commodity tax revenue effect is defined as $(TRC^{reg} - TRC0^{reg})/WPI_{1,0}^{reg}$, its effect by sector being decomposed as:

$$\frac{tc_{secT}^{reg} \left(PA_{secT}^{reg} \cdot C_{secT}^{reg} - PA0_{secT}^{reg} \cdot C0_{secT}^{reg} \right)}{WPI_{1,0}^{reg}} \quad (2-53)$$

As for the factor usage tax revenue effect, we have $(TRF^{reg} - TRF0^{reg})/WPI_{1,0}^{reg}$, and thus its effect by sector is:

$$\frac{\sum_{fac} tf_{secT}^{fac,reg} \left[\left(\frac{PFM_{secT}^{fac,reg} \$facM(fac)}{PFS_{secT}^{fac,reg} \$facS(fac)} + \right) \cdot F_{secT}^{fac,reg} - \left(\frac{PFM0_{secT}^{fac,reg} \$facM(fac)}{PFS0_{secT}^{fac,reg} \$facS(fac)} + \right) \cdot F0_{secT}^{fac,reg} \right]}{WPI_{1,0}^{reg}} \quad (2-54)$$

Since factor usage taxes are ad valorem, the factor tax revenue effect is proportionate to the production effect in Equation (2-52).

Lastly, the import tariff revenue effect is $(TRM^{reg} - TRM0^{reg})/WPI_{1,0}^{reg}$, thus we know that its effect by sector is expressed as:

$$\frac{\sum_{regg(\neq reg)} tm_{secT}^{reg,regg} \cdot \left(\frac{PWE_{secT}^{regg,reg} \cdot EXC^{reg} \cdot QBM_{secT}^{reg,regg} - PWE0_{secT}^{regg,reg} \cdot EXC0^{reg} \cdot QBM0_{secT}^{reg,regg}}{WPI_{1,0}^{reg}} \right)}{WPI_{1,0}^{reg}} \quad (2-55)$$

Note that no tax revenue effects are observed in the non-traded sector (*SEC3*), as it is assumed to be a public sector, i.e. there is no tax/tariff imposed.

2.2.9.1.3 The Capital-Inflow Effect

The regional capital-inflow effect shown as the third term of Equation (2-51) is not further decomposed. Furthermore, since foreign savings are fixed to zero, there is no capital-inflow effect in this model.

2.2.9.2 The Consumer Surplus Effect

The consumer surplus effect in the second term of Equation (2-50) can be decomposed into the effects on the government, the household and the investment bank. From Equation (2-49), we know that the consumer surplus effect is $(1/WPI_{1,0}^{reg} - 1) \cdot CGBUD0^{reg}$ for the government; $(1/WPI_{1,0}^{reg} - 1) \cdot CBUD0^{reg}$ for the household; and $(1/WPI_{1,0}^{reg} - 1) \cdot S0^{reg}$ for the investment bank. Hence, by definition, the benchmark budget constraints (i.e. $CGBUD0^{reg}$ for the government, $CBUD0^{reg}$ for the household, and $S0^{reg}$ for the bank) are key determinants of their respective consumer surplus effects.

2.3 CU Simulation Regarding Relative Market Size

Section 2.3 considers CU formation in a perfectly-competitive world economy with four regions, different in their economic sizes, although identical in their production technologies and consumer tastes. The model also specifies that the ratio of each type of factor endowment (i.e. labour, capital and land) to total factor endowment is identical across regions. Two regions (*REG1* and *REG2*) are defined as ‘small’ while the others (*REG3* and *REG4*) are defined as ‘large,’ not with respect to their *impacts* on world prices (i.e. in a traditional sense, a price change in a ‘small’ country will not affect world prices), but in terms of their *relative* economic sizes. In other words, although referred to as ‘small,’ they are not negligibly small and a CU formed between them will have some influence on the international market.

As one of the smaller regions, *REG1* considers liberalising trade with another region in order to facilitate its economic growth. First, this section explores the welfare effects of *REG1*

forming a CU with the other small region (*REG2*), and when the rest of the world (*REG3* and *REG4*) also forms another CU at the same time. Then, the second option for *REG1* is also investigated, where it forms a CU with one of the large regions (*REG3*), and where that triggers another CU formation between the rest of the world (*REG2* and *REG4*).

Prior to the analyses of simulation results in Subsection 2.3.3, Subsection 2.3.1 firstly introduces the concept of the Social Accounting Matrix (SAM) and its role in clarifying the accounting identities with respect to taxes that underlie the price definitions in the aforementioned CGE model. After elaborating on the values of benchmark variables and parameters and the price normalisation procedure, Subsection 2.3.2 then gives specific details of the policy experiments conducted in the first part of the chapter.

2.3.1 The Data

2.3.1.1 Social Accounting Matrix (SAM) and Price Definitions

The relationship between SAMs and CGE models is explicitly identified in Pyatt (1988) and McDonald (2007). A complete and consistent SAM is a square matrix that covers all transactions in an economy, and every income for an economic agent has a corresponding expenditure by another agent. The rows and columns of a SAM must be identically ordered, and by tradition, receipts of agent *i* are entered in row *i* and expenditures by agent *j* are entered in column *j*. Hence, payments to *i* by *j* is read at the point where row *i* and column *j* intersect, and a balanced SAM must have equivalent totals of the matching rows and columns. As Pyatt (1988) suggested, every economic model has a corresponding SAM, and therefore the present CGE model can be accounted for in a SAM format. Table 2-1 shows the SAM for the small regions and Table 2-2 shows that for the large ones.

Table 2-1: Social Accounting Matrix (SAM) for the small regions (REG1 and REG2)

| | 1 Commodity <i>SEC1</i> | 2 Commodity <i>SEC2</i> | 3 Commodity <i>SEC3</i> | 4 Sector <i>SEC1</i> | 5 Sector <i>SEC2</i> | 6 Sector <i>SEC3</i> | 7 Labour | 8 Capital | 9 Land | 10 Household | 11 Government | 12 Commodity taxes | 13 Labour taxes | 14 Capital taxes | 15 Land taxes | 16 Tariffs | 17 Income taxes | 18 Savings | 19 Rest of the world | TOTAL |
|-------------------------|-------------------------|-------------------------|-------------------------|----------------------|----------------------|----------------------|----------|-----------|--------|--------------|---------------|--------------------|-----------------|------------------|---------------|------------|-----------------|------------|----------------------|-------|
| 1 Commodity <i>SEC1</i> | | | | 6 | 6 | 6 | | | | 15 | | | | | | | | 2 | | 35 |
| 2 Commodity <i>SEC2</i> | | | | 6 | 6 | 6 | | | | 15 | | | | | | | | 2 | | 35 |
| 3 Commodity <i>SEC3</i> | | | | | | | | | | | 26 | | | | | | | | | 26 |
| 4 Sector <i>SEC1</i> | 23 | | | | | | | | | | | | | | | | | | 6 | 29 |
| 5 Sector <i>SEC2</i> | | 23 | | | | | | | | | | | | | | | | | 6 | 29 |
| 6 Sector <i>SEC3</i> | | | 26 | | | | | | | | | | | | | | | | | 26 |
| 7 Labour | | | | 5 | 5 | 5 | | | | | | | | | | | | | | 15 |
| 8 Capital | | | | 5 | 5 | 5 | | | | | | | | | | | | | | 15 |
| 9 Land | | | | 4 | 4 | 4 | | | | | | | | | | | | | | 12 |
| 10 Household | | | | | | | 15 | 15 | 12 | | 2 | | | | | | | | | 44 |
| 11 Government | | | | | | | | | | | | 6 | 2 | 2 | 2 | 6 | 13 | | | 31 |
| 12 Commodity taxes | 3 | 3 | | | | | | | | | | | | | | | | | | 6 |
| 13 Labour taxes | | | | 1 | 1 | | | | | | | | | | | | | | | 2 |
| 14 Capital taxes | | | | 1 | 1 | | | | | | | | | | | | | | | 2 |
| 15 Land taxes | | | | 1 | 1 | | | | | | | | | | | | | | | 2 |
| 16 Tariffs | 3 | 3 | | | | | | | | | | | | | | | | | | 6 |
| 17 Income taxes | | | | | | | | | | 13 | | | | | | | | | | 13 |
| 18 Savings | | | | | | | | | | 1 | 3 | | | | | | | | 0 | 4 |
| 19 Rest of the world | 6 | 6 | | | | | | | | | | | | | | | | | | 12 |
| TOTAL | 35 | 35 | 26 | 29 | 29 | 26 | 15 | 15 | 12 | 44 | 31 | 6 | 2 | 2 | 2 | 6 | 13 | 4 | 12 | |

Table 2-2: Social Accounting Matrix (SAM) for the large regions (REG3 and REG4)

| | 1 Commodity <i>SEC1</i> | 2 Commodity <i>SEC2</i> | 3 Commodity <i>SEC3</i> | 4 Sector <i>SEC1</i> | 5 Sector <i>SEC2</i> | 6 Sector <i>SEC3</i> | 7 Labour | 8 Capital | 9 Land | 10 Household | 11 Government | 12 Commodity taxes | 13 Labour taxes | 14 Capital taxes | 15 Land taxes | 16 Tariffs | 17 Income taxes | 18 Savings | 19 Rest of the world | TOTAL |
|-------------------------|-------------------------|-------------------------|-------------------------|----------------------|----------------------|----------------------|----------|-----------|--------|--------------|---------------|--------------------|-----------------|------------------|---------------|------------|-----------------|------------|----------------------|-------|
| 1 Commodity <i>SEC1</i> | | | | 60 | 60 | 60 | | | | 150 | | | | | | | | 20 | | 350 |
| 2 Commodity <i>SEC2</i> | | | | 60 | 60 | 60 | | | | 150 | | | | | | | | 20 | | 350 |
| 3 Commodity <i>SEC3</i> | | | | | | | | | | | 260 | | | | | | | | | 260 |
| 4 Sector <i>SEC1</i> | 230 | | | | | | | | | | | | | | | | | | 60 | 290 |
| 5 Sector <i>SEC2</i> | | 230 | | | | | | | | | | | | | | | | | 60 | 290 |
| 6 Sector <i>SEC3</i> | | | 260 | | | | | | | | | | | | | | | | | 260 |
| 7 Labour | | | | 50 | 50 | 50 | | | | | | | | | | | | | | 150 |
| 8 Capital | | | | 50 | 50 | 50 | | | | | | | | | | | | | | 150 |
| 9 Land | | | | 40 | 40 | 40 | | | | | | | | | | | | | | 120 |
| 10 Household | | | | | | | 150 | 150 | 120 | | 20 | | | | | | | | | 440 |
| 11 Government | | | | | | | | | | | | 60 | 20 | 20 | 20 | 60 | 130 | | | 310 |
| 12 Commodity taxes | 30 | 30 | | | | | | | | | | | | | | | | | | 60 |
| 13 Labour taxes | | | | 10 | 10 | | | | | | | | | | | | | | | 20 |
| 14 Capital taxes | | | | 10 | 10 | | | | | | | | | | | | | | | 20 |
| 15 Land taxes | | | | 10 | 10 | | | | | | | | | | | | | | | 20 |
| 16 Tariffs | 30 | 30 | | | | | | | | | | | | | | | | | | 60 |
| 17 Income taxes | | | | | | | | | | 130 | | | | | | | | | | 130 |
| 18 Savings | | | | | | | | | | 10 | 30 | | | | | | | | 0 | 40 |
| 19 Rest of the world | 60 | 60 | | | | | | | | | | | | | | | | | | 120 |
| TOTAL | 350 | 350 | 260 | 290 | 290 | 260 | 150 | 150 | 120 | 440 | 310 | 60 | 20 | 20 | 20 | 60 | 130 | 40 | 120 | |

These SAMs are consistent with the description of the model structure in Section 2.2 that the income-balance, zero-profit and market-clearing conditions hold for all economic transactions, i.e. the corresponding row and column totals equate. The SAMs consist of five broad categories of accounts, namely commodities, activities (by production sectors), factors, institutions (i.e. the household, the government and the bank) and trade (with the rest of the world). To explicitly identify the detailed sources of government tax revenues, tax accounts (i.e. commodity taxes, factor taxes, tariffs and income taxes) are also included.

By definition, each element in a SAM is in ‘value’ terms, i.e. the product of a price and a quantity. As CGE models are Walrasian in spirit, prices only matter in relative terms. Moreover, the accounting identities that accord with the economic logic perspective require that transaction quantities in each ‘row’ are purchased at a common single price so that all entries in the same row represent commensurate units. Therefore, the price system embedded in the present CGE model in Section 2.2 is implicitly SAM-based, since the common price for each row reflects the average revenue that should be identical to the average cost in the corresponding column. This rule implies that all prices are derived from accounting identities whether or not the data are represented as a SAM (McDonald, 2007).

To illustrate, the definition of import prices in home currency is derived as follows. Denote by $SAM(i,j)$ the entry in the i^{th} row and the j^{th} column of a SAM. Assuming that imports are not differentiated by origin, and the superscript reg is abbreviated for brevity, the import value of $secT$ in home currency can be calculated as a simple accounting identity:

$$PM_{secT} \cdot QM_{secT} = SAM(\text{"Rest of the world"}, \text{"Commodity secT"}) \\ + SAM(\text{"Tariffs"}, \text{"Commodity secT"})$$

As each SAM entry can be expressed as a price multiplied by quantity, the right-hand side of the above equation reads:

$$PM_{secT} \cdot QM_{secT} = (PWE_{secT} \cdot EXC \cdot QM_{secT}) + (tm_{secT} \cdot PWE_{secT} \cdot EXC \cdot QM_{secT}) \\ \therefore PM_{secT} = (1 + tm_{secT}) \cdot PWE_{secT} \cdot EXC$$

when tariffs are imposed at ad valorem rates. McDonald (2007) stresses that the price definition of aggregate import in this sense is the average revenue that is determined by the average cost given that the quantity is commensurate.

2.3.1.2 Description of Benchmark Variables and Parameters

In Table 2-1 and Table 2-2, benchmark data are symmetric across regions, although the values in small regions (*REG1* and *REG2*) are 10 % of those in the large regions (*REG3* and *REG4*). Capital and land endowments thus equal the aggregate of primary inputs to production sectors. However, labour endowments are the sum of those supplied to production sectors and of the unemployed labour, which are 1 unit in the small regions and 10 units in the large ones. Total government transfers to the household are \$2 in small regions and \$20 in large ones.²⁶ The replacement rate is 0.5 in all regions, thus according to Equation (2-10), 25% of the transfers is in the form of unemployment benefits.²⁷

Substitution elasticities are identical in all sectors and regions. The substitution elasticity between the three factor inputs is 0.8; while that of the Armington production function is 2 for the upper level, and 4 for the lower level.

As regards consumption and investment demands by commodity, the government only consumes commodity *SEC3*, leaving *SEC1* and *SEC2* to household consumption and investment. Household savings are \$1 in small regions and \$10 in large ones; while government savings are \$3 in small regions and \$30 in large ones. Their savings are passed on to the regional banks to purchase investment commodities. Since the symmetry requires that the balance of payments is zero for all regions, foreign savings are zero, and household plus government savings equals the aggregate of the investment demands in each region.

²⁶ Domestic values can be referred to in world currency, \$, as the benchmark exchange rates are set to one for all regions.

²⁷ The replacement rate has been defined in Equation (2-10) as the ratio of unemployment benefits to wage incomes that the household would have earned if employed.

Since products are differentiated at the border, modelled using the Armington demand function, there is cross-hauling of tradable commodities (*SEC1* and *SEC2*) in Table 2-3, where imports are read along the rows and exports are read down the columns. To maintain the symmetry, the model assumes identical two-way trade data between any pair of regions, and due to their economic sizes, small regions can only trade small volumes with the rest of the world. Large regions, on the other hand, can trade big volumes with each other.

Table 2-3: Bilateral trade values of goods (*SEC1* and *SEC2*) in world currency (\$)

| Trade values | <i>REG1</i> | <i>REG2</i> | <i>REG3</i> | <i>REG4</i> | Total |
|--------------|-------------|-------------|-------------|-------------|-------|
| <i>REG1</i> | | 2 | 2 | 2 | 6 |
| <i>REG2</i> | 2 | | 2 | 2 | 6 |
| <i>REG3</i> | 2 | 2 | | 56 | 60 |
| <i>REG4</i> | 2 | 2 | 56 | | 60 |
| Total | 6 | 6 | 60 | 60 | |

Lastly, taxation is introduced to the production and consumption of non-public goods (*SEC1* and *SEC2*). Factor usage taxes are \$1 in small regions and \$10 in large ones, while commodity tax revenues are \$3 in small regions and \$30 in large ones. Income taxes are \$13 in small regions, and \$130 in large ones. Tariff revenues, on the other hand, are summarised in Table 2-4, where each cell represents the import tariff payments by the exporting region in the column to the importing one in the row:

Table 2-4: Bilateral tariffs on tradable goods (*SEC1* and *SEC2*) in world currency (\$)

| Bilateral Tariffs | <i>REG1</i> | <i>REG2</i> | <i>REG3</i> | <i>REG4</i> | Total |
|-------------------|-------------|-------------|-------------|-------------|-------|
| <i>REG1</i> | | 1 | 1 | 1 | 3 |
| <i>REG2</i> | 1 | | 1 | 1 | 3 |
| <i>REG3</i> | 1 | 1 | | 28 | 30 |
| <i>REG4</i> | 1 | 1 | 28 | | 30 |

2.3.1.3 Price Normalisation Procedure

In conjunction with the value flows in Figure 2-4, this subsection explains how commodity prices are calibrated at the base year. The benchmark output prices in region *reg* (PZ_{sec}^{reg}) are

normalised to one. As outputs are not differentiated by destination, the prices of domestically-produced goods ($PD0_{sec}^{reg}$), aggregate exports ($PE0_{sec}^{reg}$) and bilateral exports ($PBE0_{sec}^{reg,regg}$) are also equal to one. The exchange rates are set to one, as also are the bilateral world prices ($PWE0_{sec}^{reg,regg}$). The ad valorem tariff rates drive a wedge between world and domestic import prices, therefore the domestic prices of bilateral imports from region reg in region $regg$ ($PBM0_{sec}^{regg,reg}$) is higher than one, i.e. inclusive of tariffs. Given the nested Armington function, prices are differentiated by origin, so at the lower-level aggregate import prices are calibrated from the relationship in Equation (2-25) that the values of aggregate imports are a function of total bilateral import values. More specifically, since the model calibrates aggregate import volumes to be identical to the sum of bilateral ones:

$$QM0_{sec}^{regg} = \sum_{reg} QBM0_{sec}^{regg,reg}$$

domestic aggregate import prices ($PM0_{sec}^{regg}$) are hence the ‘average’ prices of the corresponding bilateral ones, and thus higher than one. At the upper-level of the Armington function, since $PD0_{sec}^{regg} = 1$ and $PM0_{sec}^{regg} > 1$, and the Armington goods are calibrated as:

$$QA0_{sec}^{regg} = QD0_{sec}^{regg} + QM0_{sec}^{regg},$$

according to Equation (2-24) the Armington prices are then the weighted averages of the two prices: $PD0_{sec}^{regg} (=1) < PA0_{sec}^{regg} < PM0_{sec}^{regg}$.

2.3.2 Policy Experiments

The motivation behind the simulation of a small region forming CUs with either small or large regions is to pinpoint the welfare effects of CU formations with regions of different market sizes. The chapter assumes that, even though the world economy is perfectly competitive, and Heckscher-Ohlin based comparative advantage is ruled out since the model presumes symmetry in factor abundance among regions, a small region ($REGI$) may still

substantially benefit from regional trade liberalisation, because under the Armington assumption, product differentiation between domestically-produced goods and imports from other regions implicitly yields monopolistic powers to commodities from different origins. Thus, even though regions are completely symmetric, regional market expansion with Armington preferences should yield positive gains to member regions.

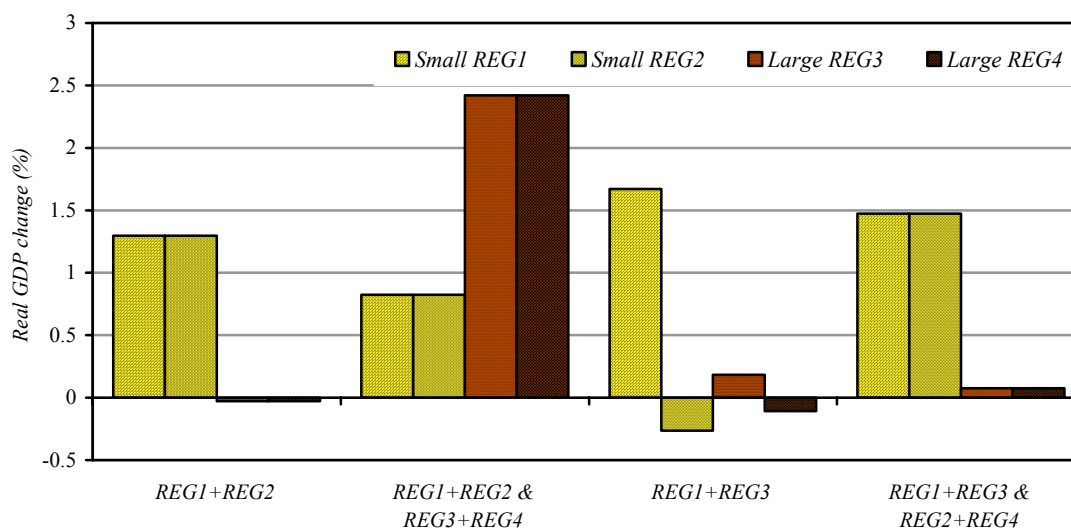
Therefore, the four policy experiments are designed as follows. The first one, labeled as “*REG1+REG2*,” is a simulation of a CU formation between two small regions. More specifically, the tariffs one small region – *REG1* – imposes on the bilateral imports from the other small region – *REG2* – are completely eliminated, and vice versa. Since *common* import tariff rates are applied to imports from all regions at the exogenous level, the tariff removal implicitly means that a customs union *with* common external tariffs is formed. The second experiment is subsequently conducted by assuming that the other two large regions (*REG3* and *REG4*) also form another CU in the presence of the previous one, henceforth referred to as “*REG1+REG2 & REG3+REG4*.” For the third one, labeled as “*REG1+REG3*,” a CU is simulated between the two regions of different sizes, i.e. the small *REG1* and the large *REG3*; and then for the last scenario, labeled as “*REG1+REG3 & REG2+REG4*,” the other two regions of different sizes (*REG2* and *REG4*) also form another CU in the presence of the “*REG1+REG3*” CU.

2.3.3 Simulation Results

The simulation results from the four CU scenarios are compared in Chart 2-2, Table 2-5, Table 2-6a and Table 2-6b. In Chart 2-2 and Table 2-5, similar adjustments are observed in the real GDP, the level of unemployment, and the volumes of imports and exports by sector. For *REG1*, these real variables respond most positively to the CU formation with a large region (*REG3*), and it is more likely that *REG1* will gain at a higher rate than *REG3*, since in relation to each region’s total trade, the small member’s dependence on trade with the large member is greater than the large member’s reliance on the small one due to the varied degrees

of production capacity constraints (see Table 2-1 to Table 2-4 for the baseline SAMs and bilateral trade and tariff data).

Chart 2-2: Relative market size simulation results (percentage changes in real GDP)



Source: Simulated by author.

Table 2-5: Percentage changes in key variables given four types of CU formations

| CU scenarios | | <i>REG1+REG2</i> | <i>REG1+REG2 REG3+REG4</i> | <i>REG1+REG3</i> | <i>REG1+REG3 REG2+REG4</i> |
|---|---------------------------------|------------------|--------------------------------|------------------|--------------------------------|
| Unemployed labour | <i>REG1</i> | -53.23% | -29.82% | -70.83% | -60.63% |
| | <i>REG2</i> | -53.23% | -29.82% | 12.67% | -60.63% |
| | <i>REG3</i> | 1.32% | -99.93% | -7.68% | -2.47% |
| | <i>REG4</i> | 1.32% | -99.93% | 5.16% | -2.47% |
| Aggregate imports QM_{secT}^{reg} | <i>REG1 (secT²⁸)</i> | 32.01% | 20.52% | 42.06% | 36.78% |
| | <i>REG2 (secT)</i> | 32.01% | 20.52% | -5.84% | 36.78% |
| | <i>REG3 (secT)</i> | -0.62% | 64.26% | 4.22% | 1.17% |
| | <i>REG4 (secT)</i> | -0.62% | 64.26% | -2.40% | 1.17% |
| Aggregate exports QE_{secT}^{reg} | <i>REG1 (secT)</i> | 33.32% | 32.02% | 38.59% | 37.88% |
| | <i>REG2 (secT)</i> | 33.32% | 32.02% | -2.49% | 37.88% |
| | <i>REG3 (secT)</i> | -0.26% | 64.80% | 4.21% | 3.32% |
| | <i>REG4 (secT)</i> | -0.26% | 64.80% | -1.01% | 3.32% |

Source: Simulated by author. Note: Numbers in bold letters are those of the regions involved in a CU formation.

²⁸ For simulation results reported in the table format, note that “secT” and “secTN” are used to indicate the welfare effects of CU formations on ‘individual’ tradable and non-traded sectors, respectively.

Table 2-6a: Terms-of-Trade (TOT) index for each region under various CU formations

| CU scenarios Terms-of-Trade index | <i>REG1+REG2</i> | <i>REG1+REG2</i> <i>REG3+REG4</i> | <i>REG1+REG3</i> | <i>REG1+REG3</i> <i>REG2+REG4</i> |
|--------------------------------------|------------------|--------------------------------------|------------------|--------------------------------------|
| <i>REG1</i> | 1.19 | 1.12 | 1.24 | 1.21 |
| <i>REG2</i> | 1.19 | 1.12 | 0.97 | 1.21 |
| <i>REG3</i> | 1.00 | 1.36 | 1.03 | 1.01 |
| <i>REG4</i> | 1.00 | 1.36 | 0.99 | 1.01 |

Source: Simulated by author. Note: Numbers in bold letters are those of the regions involved in a CU formation.

Even if the rest of the world forms another CU at the same time, *REG1* would still find “*REG1+REG3*” more beneficial than regional economic integration with the other small region (*REG2*). Not surprisingly, if *REG1* is a member of the “*REG1+REG2*” CU and faces a similar grouping by the rest of the world (the “*REG3+REG4*” CU), the welfare gains will be lowest among the four options. As for other regions, the percentage changes in real variables turn negative if they are left outside regional groupings, and the losses get bigger as the size of the CU economy grows.

In Table 2-6a, the terms-of-trade (TOT) index reported is calculated as the ratio of the Laspeyre price index of regional exports to that of imports:

$$TOT^{reg} = \left(\frac{\sum_{secT} PE_{secT}^{reg} \cdot QE_{secT}^{reg}}{\sum_{secT} PEO_{secT}^{reg} \cdot QEO_{secT}^{reg}} \right) / \left(\frac{\sum_{secT} PM_{secT}^{reg} \cdot QM_{secT}^{reg}}{\sum_{secT} PMO_{secT}^{reg} \cdot QMO_{secT}^{reg}} \right). \quad (2-56)$$

By definition, this index captures the terms-of-trade change effect for each region, which improves when $TOT^{reg} > 1$; is neutral when $TOT^{reg} = 1$; and deteriorates when $0 < TOT^{reg} < 1$. Since the terms of trade is one of the factors that cause welfare gains or losses after a CU formation, the value of the TOT index should be consistent with the simulation results observed in Chart 2-2 and Table 2-5. As predicted, Table 2-6a shows that the TOT index improves with the economic size of the regional grouping, among which small members gain more than the large ones; the terms-of-trade gains are reduced if the CU faces the formation

of another CU formation by the rest of the world; and non-members find their terms of trade progressively worsen as the CU size grows.

In essence, the differential results of the small region, *REG1*, forming a CU with the other small region, *REG2*, and with the large region, *REG3*, arise from the differences in trade shares, which is the only cross-country asymmetry reflecting the size discrepancy among the four regions. To identify the source of gains for the terms of trade in Table 2-5a, Table 2-6b further reports the percentage changes in bilateral trade volumes among the four regions.

Table 2-6b: Percentage changes in the volumes of bilateral exports of individual tradable sectors (*secT*) under various CU scenarios

| Trading partners | | <i>REG1+REG2</i> | <i>REG1+REG2</i> <i>REG3+REG4</i> | <i>REG1+REG3</i> | <i>REG1+REG3</i> <i>REG2+REG4</i> |
|-------------------|-------------------|------------------|--------------------------------------|------------------|--------------------------------------|
| Exporters | Importers | | | | |
| Small <i>REG1</i> | Small <i>REG2</i> | 140.29% | 171.44% | -22.44% | -36.43% |
| | Large <i>REG3</i> | -20.17% | -37.70% | 162.22% | 173.73% |
| | Large <i>REG4</i> | -20.17% | -37.70% | -24.01% | -23.68% |
| Small <i>REG2</i> | Small <i>REG1</i> | 140.29% | 171.44% | -15.69% | -36.43% |
| | Large <i>REG3</i> | -20.17% | -37.70% | 2.11% | -23.68% |
| | Large <i>REG4</i> | -20.17% | -37.70% | 6.13% | 173.73% |
| Large <i>REG3</i> | Small <i>REG1</i> | -15.38% | -41.61% | 179.50% | 190.94% |
| | Small <i>REG2</i> | -15.38% | -41.61% | 0.12% | -18.88% |
| | Large <i>REG4</i> | 0.82% | 72.40% | -1.90% | -2.59% |
| Large <i>REG4</i> | Small <i>REG1</i> | -15.38% | -41.61% | -17.95% | -18.88% |
| | Small <i>REG2</i> | -15.38% | -41.61% | 5.41% | 190.94% |
| | Large <i>REG3</i> | 0.82% | 72.40% | -0.63% | -2.59% |

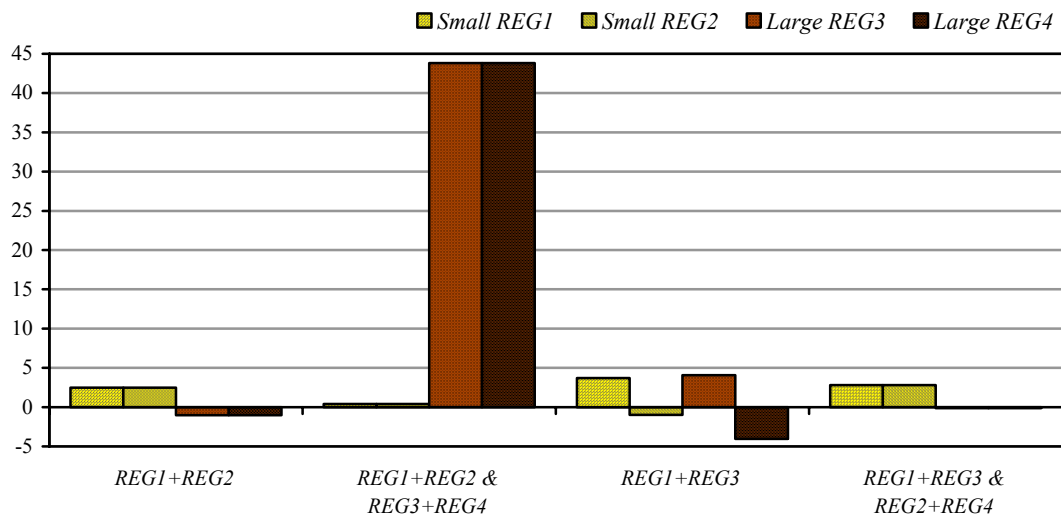
Source: Simulated by author. Note: Numbers in bold letters are those of the regions involved in a CU formation.

It is observed in Table 2-6b that initial trade shares play an important role in determining the level of welfare impact on each economy. While the “*REG1+REG2*” CU yields identical results to the two small member regions; the “*REG1+REG3*” CU affects the small and large members in a different manner. According to the benchmark trade flows reported in Table 2-3, initial trade shares of individual regions of all sizes in a small region’s total trade are completely identical. Meanwhile, each small region’s trade share in a large region’s total trade is specified to be 28 times smaller than the other large region’s share at the benchmark

year. Therefore, the small member's domestic prices and terms of trade are impacted to a greater extent than the large member's when the CU between *REG1* and *REG3* is launched, and similarly the effects on the ratios of trade to GDP of the two members become asymmetric. As the real exchange rate of the small member appreciates considerably more than that of the large counterpart, under the flexible exchange rate regime with fixed foreign savings (and thus the zero trade balance in equilibrium), bilateral trade between the two members will also be adjusted in the sense that the 'net' bilateral import volumes from the large member to the small member is positive. More to the point, as with the results in Table 2-6b that *REG1* exports more to *REG3* by 162.22% while *REG3* in return exports more to *REG1* by 179.50%.

To elaborate on the patterns of welfare changes given economic size differentials, Chart 2-3 and Table 2-7 to Table 2-10 summarise the welfare effects of four types of CU formations in terms of the decomposed EVs in world currency (\$) as defined in Subsection 2.2.9.

Chart 2-3: Relative market size simulation results (regional EVs in world currency: \$)



Source: Simulated by author.

Chart 2-3 confirms that the regional EV results are consistent with the variation in real variables and terms of trade previously discussed. Hence, if regions differ only in terms of their economic sizes, the best option for a small region (*REG1*) is to form a CU with a larger

economy, since the economic gains will be substantial enough to cancel out the potential negative effects when the rest of the world counteracts by forming another CU. The large region, on the other hand, may not find a regional grouping with a small region attractive in economic terms, as it incurs adjustment costs with little gains expected. Nevertheless, a CU between small and large regions may still be formed for political reasons.

Table 2-7: The EVs as a small region (REG1) forms a CU with another small region (REG2)

| Decomposed EVs (in world currency: \$) | | | REG1 & REG2 (small) | REG3 & REG4 (large) |
|--|--------------------|---------------------------------|---------------------|---------------------|
| Real income effect | Production effect | <i>secT</i> | 1.55 | -0.20 |
| | | <i>secTN</i> | 0.91 | -0.58 |
| | Tax revenue effect | Commodity taxes (<i>secT</i>) | 0.26 | -0.06 |
| | | Factor taxes (<i>secT</i>) | 0.33 | -0.04 |
| | | Tariffs (<i>secT</i>) | -0.85 | -0.11 |
| Consumer surplus effect | Household | -0.50 | 0.18 | |
| | Government | -0.43 | 0.16 | |
| | Bank | -0.07 | 0.02 | |
| Regional EV | | | 2.48 | -1.04 |

Source: Simulated by author.

Table 2-8: The EVs as the rest of the world forms a “REG3+REG4” CU concurrently with the “REG1+REG2” CU

| Decomposed EVs (in world currency: \$) | | | REG1 & REG2 (small) | REG3 & REG4 (large) |
|--|--------------------|---------------------------------|---------------------|---------------------|
| Real income effect | Production effect | <i>secT</i> | 1.28 | 30.71 |
| | | <i>secTN</i> | -0.30 | 14.24 |
| | Tax revenue effect | Commodity taxes (<i>secT</i>) | 0.14 | 4.83 |
| | | Factor taxes (<i>secT</i>) | 0.28 | 6.61 |
| | | Tariffs (<i>secT</i>) | -1.20 | -18.59 |
| Consumer surplus effect | Household | -0.14 | -8.78 | |
| | Government | -0.13 | -7.61 | |
| | Bank | -0.02 | -1.17 | |
| Regional EV | | | 0.40 | 43.80 |

Source: Simulated by author.

Table 2-9: The EVs as a small region (REG1) forms a CU with a large region (REG3)

| Decomposed EVs (in world currency: \$) | | | REG1 (small) | REG2 (small) | REG3 (large) | REG4 (large) |
|--|--------------------|---------------------------------|------------------------|------------------------|------------------------|------------------------|
| Real income effect | Production effect | <i>secT</i> | 1.89 | -0.20 | 1.99 | -0.79 |
| | | <i>secTN</i> | 1.55 | -0.55 | 1.75 | -2.26 |
| | Tax revenue effect | Commodity taxes (<i>secT</i>) | 0.34 | -0.06 | 0.37 | -0.25 |
| | | Factor taxes (<i>secT</i>) | 0.41 | -0.04 | 0.43 | -0.17 |
| | | Tariffs (<i>secT</i>) | -0.84 | -0.10 | -0.82 | -0.42 |
| Consumer surplus effect | Household | | -0.71 | 0.18 | -0.80 | 0.72 |
| | Government | | -0.62 | 0.15 | -0.69 | 0.62 |
| | Bank | | -0.10 | 0.02 | -0.11 | 0.10 |
| Regional EV | | | 3.71 | -1.00 | 4.07 | -4.08 |

Source: Simulated by author. Note: Numbers in bold letters are those of the regions involved in a CU formation.

Table 2-10: The EVs as the rest of the world forms a “REG2+REG4” CU concurrently with the “REG1+REG3” CU

| Decomposed EVs (in world currency: \$) | | | REG1 & REG2 (small) | REG3 & REG4 (large) |
|--|--------------------|---------------------------------|-----------------------------------|-----------------------------------|
| Real income effect | Production effect | <i>secT</i> | 1.78 | 1.22 |
| | | <i>secTN</i> | 1.03 | -0.60 |
| | Tax-revenue effect | Commodity taxes (<i>secT</i>) | 0.29 | 0.12 |
| | | Factor taxes (<i>secT</i>) | 0.38 | 0.26 |
| | | Tariffs (<i>secT</i>) | -0.98 | -1.03 |
| Consumer surplus effect | Household | | -0.56 | -0.06 |
| | Government | | -0.49 | -0.06 |
| | Bank | | -0.08 | -0.01 |
| Regional EV | | | 2.82 | -0.13 |

Source: Simulated by author.

In Subsections 2.3.3.1-2.3.3.4, the welfare effects of the four types of CU formations are separately decomposed and analysed. It is noteworthy that under all scenarios, the production effects are the biggest sources of welfare changes, since higher trade volumes facilitate production increases in the tradable sectors. Adjustments to the union between small regions are explained in Subsection 2.3.3.1; and similar mechanisms are observed in the other types of CU formations, although with certain differences in the distribution of welfare gains due to

the differences in economic sizes and thus trade shares of partner regions, as explained in Subsection 2.3.3.2 to Subsection 2.3.3.4.

2.3.3.1 The Welfare Effects of a CU Formation between Two Small Regions (“REG1+REG2”)

2.3.3.1.1 Small CU Members (REG1 and REG2)

As bilateral tariffs between members are abolished, the corresponding imports become available more cheaply, causing bilateral trade between CU members to increase by 140.3%. As a secondary effect of the regional grouping, the domestic prices of imports from non-members become higher than those from the CU counterpart, reducing imports from non-members by 15.7%.²⁹ Simultaneously, consumers in the CU countries substitute for domestically-produced commodities with imports from the other member, causing the 6.0% fall in domestic sales of the domestically-produced goods. Overall, the Armington demands in member regions increase by 4.1% due to the expansion in the private sector given the enlarged economic size. Even taking into account the 20.2% drop in export volumes to non-members, their aggregate export volumes still increase by 33.3% and domestic production thus expands.

Higher import demands from other members unanimously increase the returns to primary factors. Although, given the existence of unemployed labour, the variation in the labour wage after the shock is smaller than that for capital, owing to the higher flexibility in the labour supply since the unemployed can enter the market whenever production expands. Thus, labour employment tends to incur lower costs per production unit. Actually, capital’s rental rate rises by 10% while the labour wage increases by only 5.3%. Due to the higher factor

²⁹ The extent to which bilateral import demands increase with prices depends on the elasticity of substitution ($\sigma_{BM}^{reg}_{sect}$), as observed in Equation (2-33).

demands, the production effect, which is the biggest component of the change in regional EV, is equivalent to \$1.55 in each tradable sector. Also, note that the production effect is strengthened by the Stolper-Samuelson magnification effect that makes the factor price change higher than the variation in the parallel commodity price.

As for the production effect in the non-traded sector (*SEC3*), production factors are bid away to produce more tradable goods. As a result, production in *SEC3* falls while the price rises due to excess demand. Consequently, nominal returns to primary factors increase, although not by as much as in tradable sectors.³⁰

Equations (2-52) and (2-54) imply that the factor tax revenue effect is a fixed proportion of the production effect in the same sector. On the other hand, the tariff revenue effect is unambiguously negative as members eliminate import tariffs within the grouping, and tariff revenues received from non-members also deteriorate as imports are diverted from non-members to the union counterpart. The commodity tax revenue effect, on the other hand, depends on private and investment demands. Since returns to the primary factors owned by the household significantly increase, household income increases by 8.66%, and we observe a positive commodity tax revenue effect given the increased consumption demand. The higher household income also raises savings and eventually regional investment.

With respect to the consumer surplus effects in member regions, from the definition in Subsection 2.2.9.2, the key variable is the regional welfare price index ($WPI_{1,0}^{reg}$), which depends on the change in the Armington price. As the Armington price rises, we observe that $WPI_{1,0}^{reg} > 1$, and the consumer surplus effects on the household, the government, and the bank in member regions become negative, their values being proportionate to their respective ex-ante consumption and investment budget constraints.

³⁰ Note that the production effects on *SEC3* remain ambiguous in general. Once the fall in its production exceeds the rise in its price, the production effect may turn negative as we observe in later scenarios.

2.3.3.1.2 Large Non-Members (REG3 and REG4)

The elimination of import tariffs between CU members stimulates total demand and trade in the world market. Hence, it improves the world prices of members' exports by 5.9%. Since output prices are not differentiated by destination, non-members likewise face higher world export prices that reduce import demands by the member regions. Non-members adjust to such changes by trading more between themselves. In spite of that, the CU formation still reduces the aggregate imports of non-members, by 0.6%.³¹ This, in turn, expands domestic production by 0.1% to meet with the relatively stable domestic demands. Regarding aggregate exports, the decrease in exports to CU members lowers non-members' exports by 0.3%. Therefore, the CU formation worsens the real GDP of non-members, though this is marginal in percentage terms, as non-members are relatively large, and thus are not strongly affected by the formation of a small CU (Chart 2-2).

Inevitably, the diminishing import demands from CU members lower non-members' output prices and payments to production factors. As a result, the production effect on each tradable sector is negative. The tariff revenue also drops since import demands decline following the CU formation. As incomes in non-member regions decline, household consumption falls, and the commodity tax-revenue effect is negative. Thus, total tax revenues as well as public demand decrease. This mechanism also explains the relative negativity of the production effect on the public sector (*SEC3*) compared to the private sectors (*SEC1* and *SEC2*).

The economic contraction reduces the regional welfare price indices.³² As a consequence, the regional EVs of non-members are negative, although not strongly because the proportion of trade with the small CU members in total consumption of a large non-member region is small.

³¹ The difference in economic sizes is the reason behind such a smaller percentage change in non-member countries.

³² See Equation (2-42) for the definition of the regional welfare price index.

2.3.3.2 The Welfare Effects of CU Formation between the Two Small Regions (“*REG1+REG2*”), in the Presence of Another CU between the Two Large Regions (“*REG3+REG4*”)

2.3.3.2.1 Small CU Members (*REG1 and REG2*)

Here the economic effects of CU formation between small members given the existence of another union between the two large regions (*REG3+REG4*) are compared with those in Subsection 2.3.3.1. In general, the small regions benefit less from their union than in the previous scenario. Under this setting, bilateral imports between the members of the ‘small CU’ increase by 171.4%, much more than in Subsection 2.3.3.1, due to the fact that the small regions now face higher barriers from non-members. However, their aggregate imports rise only by 20.5%, compared to the 32.0% increase in Subsection 2.3.3.1; and aggregate exports expand only by 7.9%, since the ‘large CU’ also divert imports from small regions to their counterparts. As a result, the real income and consumer surplus effects in Table 2-8 are lower than that in Table 2-7, and the tariff revenue effect becomes more negative since the decline in tariff revenue is not only entailed by the intra-group tariff removal, but also exacerbated by the previous formation of the other CU that causes the inter-group trade to eventually drop by 41.6%. The production effect on the non-traded sector (*sec3*) is now negative, as the diminishing commodity and factor demands in the non-traded sector outweigh the moderate increase in their corresponding prices, owing to the decreased total tax revenues and the increased mobile factor prices. Since land’s rental rate, which is specific to this sector, drops by 3.2%, the adverse effect on the public sector is to be expected.

2.3.3.2.2 Large CU Members (*REG3 and REG4*)

The simulation outcomes for the large regions are comparable to those reported in Subsection 2.3.3.1 for CU members, with the magnitude accentuated by the ten-times larger market sizes. Also, in this scenario, the welfare outcomes for large regions are less affected by the

formation of the CU between the small regions, because bilateral trade with these regions is relatively small compared to their economic sizes.

2.3.3.3 The Welfare Effects of a CU Formation between Small and Large Regions (“*REG1+REG3*”)

2.3.3.3.1 Small and Large CU Members (REG1 and REG3)

As Chart 2-2, Table 2-5 and Table 2-6a show, the percentage changes in key variables for the small region (*REG1*) are approximately ten times higher than those observed in the large region (*REG3*), as its economic size and trade flows are only 10% of those in the large partner. Thus, the results generally indicate that the proportional variations in economic indicators of member regions are inversely proportionate to their ex-ante economic sizes. Given the adjustment in variables mentioned above, between the two CU members, the direction of change is generally consistent with the outcomes in Subsection 2.3.3.1 (Table 2-9). Since the increase in the regional price index is larger in the relatively smaller member, under *REG1+REG3*, the small member’s welfare gain (EV) becomes slightly lower than that of the large partner.

2.3.3.3.2 Small and Large Non-Members (REG2 and REG4)

Creation of this CU has similar welfare effects on the small and large economies outside the grouping, and the outcomes are similar to those already discussed in Subsection 2.3.3.1. Moreover, as was the case for the member regions in Subsection 2.3.3.3.1, the magnitudes of the decomposed EVs on non-members are proportionate to their economic sizes, although the discrepancies in the decomposed EVs among non-member regions are greater than those among CU members. That is to say, in absolute terms, the large region (*REG4*) is more adversely affected by the CU formation than the small one (*REG2*). This is captured in the third column (*REG1+REG3*) of Table 2-5, in that the proportional changes in real indicators for the small non-member region (*REG2*) are double those for the large non-member (*REG4*),

despite the fact that its economy is ten times smaller. Hence, while we know that the non-members (*REG2* and *REG4*) are certainly worse off as a result of trade diversion after the formation of the *REG1* and *REG3* CU, the union does enhance the trade relationship between the two non-member economies. For that reason, the absolute loss for *REG2* is smaller than that for *REG4*, since *REG2* has relatively better access to the large market in *REG4*, while *REG4* has to re-direct its trade from the large CU member to the smaller market in *REG2*.

2.3.3.4 The Welfare Effects of CU Formations between Regions of Different Sizes (“*REG1+REG3*” and “*REG2+REG4*”)

2.3.3.4.1 Small CU Members (*REG1* and *REG2*)

The regional EVs for small regions in Table 2-10 are smaller than those reported in Table 2-9. The emergence of the counteracting union certainly lessens small members’ welfare gains, since it reduces small members’ bilateral imports from countries outside the union, so that the positive union effects on prices and quantities of small regions are exacerbated.

2.3.3.4.2 Large CU Members (*REG3* and *REG4*)

In Table 2-10, the regional EVs for the large regions fall markedly due to the strong trade diversion effect. Given the benchmark elasticity of substitution between imports from members and non-members, imports from the large region outside the grouping are replaced by the relatively cheaper small union member. In this scenario, the welfare of the large regions deteriorates since they cannot expect strong trade creation from the union with a region that is 10% of their size. It was observed in Subsection 2.3.3.3 that even without the formation of the counteracting CU by the rest of the world, the agreement between regions of different sizes still has a non-negligible trade diversion effects on each large member (*REG3* or *REG4*) since they do not gain significantly more than the small partner (*REG1* or *REG2*).

The large members' decomposed EVs in Table 2-10 identify various sources of negative regional EVs. As this table shows, large members also experience considerable losses in import tariff revenues that subsequently reduce public demand. As a result, the production effect in *secTN* turns strongly negative. However, the simulation results in the fourth column of Table 2-5 and Table 2-6a indicate that the large regions still benefit moderately from the regional groupings as real variables consistently respond to the shock in a positive way.

2.4 CU Simulation Regarding Market Structure

Section 2.4 examines how different types of market structures alter the simulation results of preferential trade liberalisation. In the first scenario, this section analyses the formation of the CU between *REG1* and *REG2*, assuming perfect competition in all markets. The second scenario allows for Cournot oligopoly in homogeneous commodity markets without barriers to entry or exit; and the third assumes Cournot oligopoly with entry/exit barriers. In the fourth and fifth scenarios, the Cournot oligopoly assumption is replaced by monopolistic competition with horizontal product differentiation.

2.4.1 Imperfect Competition and CGE Modelling

Under the assumption of constant returns to scale, markets are usually perfectly competitive, and in the long-run equilibrium commodity prices are equal to average costs. Since marginal costs do not vary with the scale of production, average costs are also equal to marginal costs. On the other hand, imperfect competition is often associated with the presence of economies of scale (Harrison, Rutherford and Tarr, 1997). When production incurs fixed costs – as average costs are the sum of 'fixed' and 'variable' costs per unit of production; and marginal costs only refer to 'variable' costs per unit – average costs are greater than marginal costs and must be decreasing functions of outputs (see Appendix A2-2). There we have the internal

economies of scale, which usually imply imperfect competition as firms always have an incentive to expand their production scales.³³ Imperfect competition tends to imply welfare losses, since firms are able to set market prices above marginal costs. After trade liberalisation, overseas competition will lower domestic prices and reduce the domestic market power of Cournot oligopolistic firms (Brander, 1981). Also, under monopolistic competition, international trade simultaneously offers consumers a greater variety of products and lower prices (Krugman and Obstfeld, 2000). Francois and Roland-Holst (1997) stressed that in general the economic gains directly linked to scale economies and/or imperfect competition “may be some of the most substantial effects following from trade liberalisation.”

Following Willenbockel (2004), imperfect competition is incorporated into the model described in Section 2.2 to investigate how commodity markets operate under internal economies of scale (See Appendix A2-3 for details). In a world economy comprising four regions, only one tradable private sector (*SEC1*) is modelled as perfectly competitive, henceforth denoted by *pc*. The other tradable private sector (*SEC2*) and the non-traded public sector (*SEC3*) are imperfectly competitive, denoted by *ic*. The set of commodities is thus:

$$sec = \{pc, ic\}, \text{ where:}$$

$$pc = \{SEC1\} \text{ and } ic = \{SEC2, SEC3\}.$$

The imperfectly competitive sectors have NOF_{ic}^{reg} firms producing homogeneous commodities. Without entry barriers, the number of firms adjusts to ensure sectoral zero profits. Fixed factor inputs for each firm are denoted by $ff_{ic}^{fac,reg}$. Hence, fixed factor inputs for each sector depend solely on the number of firms. When denoting variable factor inputs for each sector by $FV_{ic}^{fac,reg}$, total factor inputs read:

³³ See Chapter 6 of *International Economics* by Krugman and Obstfeld (2000), for example, in page 119: “when increasing returns enter the trade picture, then, markets usually become imperfectly competitive,” and in page 122: “...internal economies of scale lead to a breakdown of perfect competition.”

$$F_{ic}^{fac,reg} = FV_{ic}^{fac,reg} + NOF_{ic}^{reg} \cdot ff_{ic}^{fac,reg}, \quad (2-57)$$

where variable factor demands by firms in sector ic ($FV_{ic}^{fac,reg}$) are determined by factor prices and output levels. Therefore, the CES production function in Equation (2-3) is replaced by:

$$FV_{ic}^{fac,reg} = \frac{QZ_{ic}^{reg} \cdot \left(\frac{\gamma F_{ic}^{fac,reg}}{(1 + tf_{ic}^{fac,reg}) \cdot (PFM_{ic}^{fac,reg} \$ facM(fac) + PFS_{ic}^{fac,reg} \$ facS(fac))} \right)^{\sigma_{F_{ic}^{reg}}}}{aF_{ic}^{reg} \left\{ \sum_{fac} (\gamma F_{ic}^{fac,reg})^{\sigma_{F_{ic}^{reg}}} \left[(1 + tf_{ic}^{fac,reg}) \cdot \left(\frac{PFM_{ic}^{fac,reg} \$ facM(fac)}{+ PFS_{ic}^{fac,reg} \$ facS(fac)} \right) \right]^{1 - \sigma_{F_{ic}^{reg}}} \right\}^{\frac{\sigma_{F_{ic}^{reg}}}{\sigma_{F_{ic}^{reg}} - 1}}} \quad (2-58)$$

2.4.1.1 Cournot Oligopolistic Sectors with Homogeneous Products

2.4.1.1.1 Profit Maximisation under Cournot Oligopoly

The total profits of the identical firms are expressed as:

$$\Pi = PZ \cdot qz - MC \cdot qz, \quad (2-59)$$

where PZ represents sectoral commodity prices; qz denotes output levels of firms; and MC stands for marginal costs.³⁴ Firms maximise profits with respect to output quantities, thus they produce where $\partial \Pi / \partial qz = 0$. In other words, marginal revenues read:

$$MR = \frac{\partial(PZ \cdot qz)}{\partial qz} = MC,$$

$$\therefore MR = PZ + \frac{\partial PZ}{\partial qz} \cdot qz = PZ \left(1 + \frac{\partial PZ}{\partial qz} \cdot \frac{qz}{PZ} \right) = PZ \left(1 + \frac{\partial PZ}{\partial QZ} \cdot \frac{\partial QZ}{\partial qz} \cdot \frac{qz}{PZ} \right).$$

Following Nicholson (2002), Cournot oligopoly assumes that each firm recognises that its own output decision (qz) affects market price (PZ) but not the output decisions of other firms

³⁴ For brevity, subscripts (ic) and superscripts (reg) are abbreviated here, but will be appended again later when referring to certain equations in the model.

since it is completely uninformed about other firms' policies ($\partial QZ/\partial qz = 1$). In other words, firms are myopic in that they maximise profits based on the assumption that whatever quantities rival firms choose to produce will be permanent. Hence it differs from the conjectural variations case, in which the effects of a firm's output decision on other firms are taken into account ($\partial QZ/\partial qz \neq 1$). Thus, marginal revenues may be written as:

$$MR = PZ \left(1 + \frac{\partial PZ}{\partial QZ} \cdot \frac{QZ}{PZ} \cdot \frac{qz}{QZ} \right). \quad (2-60)$$

As each firm produces the same output level, we know that $qz/QZ = 1/NOF$, therefore:

$$MR = PZ \left(1 - \frac{1}{EDM} \cdot \frac{1}{NOF} \right) = MC, \quad (2-61)$$

where EDM denotes the elasticity of demand perceived by firms:

$$EDM = - \left(\frac{\partial QZ}{QZ} / \frac{\partial PZ}{PZ} \right). \quad (2-62)$$

Using the symbol $\hat{\cdot}$ to represent the proportional change in a variable, EDM can also be expressed as $EDM = -\hat{QZ} / \hat{PZ}$. Since the mark-ups of firms equal sectoral commodity prices (PZ) less marginal costs (MC), they increase with the prices and are inversely proportional to the elasticity of demand and the number of firms:

$$MUP = PZ - MC = \frac{PZ}{EDM \cdot NOF}. \quad (2-63)$$

Hence, the following mark-up pricing equation is added to the previous model structure (explained in Section 2.2) to ensure that $MR = MC$, thus firms maximise profits under Cournot oligopoly:

$$PZ_{ic}^{reg} \cdot \left(1 - \frac{1}{EDM_{ic}^{reg} \cdot NOF_{ic}^{reg}} \right) = \sum_{fac} (1 + t_{ic}^{fac,reg}) \cdot \left(\frac{PFM_{ic}^{fac,reg} \$ fac M(fac)}{+ PFS_{ic}^{fac,reg} \$ fac S(fac)} \right) \cdot \frac{FV_{ic}^{fac,reg}}{QZ_{ic}^{reg}} + \sum_{sec} PA_{sec}^{reg} \cdot io_{sec,ic}^{reg}. \quad (2-64)$$

For each sector under oligopoly, Equation (2-64) can be interpreted as:

$$PZ - MUP = VC/QZ, \quad (2-65)$$

where VC denotes sectoral variable costs. Now, this section returns to the general property of imperfect competition. For the whole industry, the freedom of entry assumption ensures that the zero-profit condition in Equation (2-4) still holds: total revenues equal total costs, or $TR = TC$. When sectoral fixed costs are denoted by FC , Equation (2-4) can also be expressed as:

$$QZ \cdot PZ = FC + VC. \quad (2-66)$$

Dividing by sectoral outputs to derive average costs (AC):

$$PZ = FC/QZ + VC/QZ = AC. \quad (2-67)$$

Therefore, under imperfect competition with free entry and exit of firms, it is always true that $PZ = AC > MC = MR$. Moreover, from Equations (2-65) and (2-67), as sectoral profits are always zero, mark-ups will be just high enough to cover unit fixed costs, thus:

$$FC/QZ = MUP. \quad (2-68)$$

2.4.1.1.2 Perceived Price Elasticity of Demand under Cournot Oligopoly

The price elasticities of demand (EDM_{ic}^{reg}) are perceived differently in non-traded and tradable sectors, and thus are derived separately as follows.

2.4.1.1.2.a Non-Traded Sector

From Equations (2-35) and (2-37), domestic demands for non-traded goods should be equal to total outputs in each sector:

$$QZ_{secTN}^{reg} = CG_{secTN}^{reg}. \quad (2-69)$$

Take the natural logarithm of Equation (2-69) to find the expression for the perceived elasticity of demand:

$$\ln(QZ_{secTN}^{reg}) = \ln\left(\frac{\alpha CG_{secTN}^{reg} \cdot CGBUD^{reg}}{PA_{secTN}^{reg}}\right) = \ln(*). \quad (2-70)$$

Since $PA_{secTN}^{reg} = PZ_{secTN}^{reg}$, and firms have no influence on $CGBUD^{reg}$, total differentiation of Equation (2-70) yields:

$$\frac{d \ln(QZ_{secTN}^{reg})}{dQZ_{secTN}^{reg}} \cdot dQZ_{secTN}^{reg} = \frac{d \ln(*)}{dQZ_{secTN}^{reg}} \cdot dQZ_{secTN}^{reg} + \frac{d \ln(*)}{dPZ_{secTN}^{reg}} \cdot dPZ_{secTN}^{reg}, \text{ or}$$

$$\frac{dQZ_{secTN}^{reg}}{QZ_{secTN}^{reg}} = -\frac{CG_{secTN}^{reg}}{PZ_{secTN}^{reg} \cdot (*)} \cdot dPZ_{secTN}^{reg}.$$

That implies:

$$\hat{Q}Z_{secTN}^{reg} = -\frac{CG_{secTN}^{reg}}{QZ_{secTN}^{reg}} \cdot \hat{P}Z_{secTN}^{reg}. \quad (2-71)$$

Therefore, from Equation (2-62), the perceived elasticity of demand for non-traded sectors under Cournot oligopoly is:

$$EDM_{secTN}^{reg} = -\hat{Q}Z_{secTN}^{reg} / \hat{P}Z_{secTN}^{reg} = CG_{secTN}^{reg} / QZ_{secTN}^{reg}. \quad (2-72)$$

2.4.1.1.2.b Tradable Sector

This chapter further assumes that domestic firms in tradable sectors under Cournot oligopoly do not regard foreign firms as their competitors. Thus, the perceived elasticity of demand does not take into account reactions from ‘domestic’ or ‘foreign’ rival firms, just as it assumes no retaliation by domestic rivals in the same sector. In addition, from Subsection 2.2.5.1, markets are internationally integrated such that the law of one price reigns globally, and firms charge common supply prices across regional market segments. In other words, there is no differentiation between prices of domestic goods produced for the domestic market and for exports: $PZ_{secT}^{reg} = PD_{secT}^{reg} = PE_{secT}^{reg}$.

Given the above assumptions, the perceived elasticity of demand for tradable sectors is thus the weighted average of such elasticities within own and foreign markets:

$$EDM_{secT}^{reg} = \frac{QDD_{secT}^{reg}}{QZ_{secT}^{reg}} \cdot EDM_{secT}^{reg,reg} + \sum_{regg \neq reg} \frac{QBM_{secT}^{regg,reg}}{QZ_{secT}^{reg}} \cdot EDM_{secT}^{reg,regg}, \quad (2-73)$$

where $QDD_{secT}^{reg} + \sum_{regg \neq reg} QBM_{secT}^{regg,reg} = QZ_{secT}^{reg}$.

Accordingly, to find a solution for Equation (2-73), such perceived elasticities of demand within own and foreign markets are to be calculated separately.

The former elasticity ($EDM_{secT}^{reg,reg}$) is derived by log differentiating Equation (2-29):

$$Q\hat{D}D_{secT}^{reg} = \sigma A_{secT}^{reg} \cdot \hat{P}A_{secT}^{reg} - \sigma A_{secT}^{reg} \cdot \hat{P}D_{secT}^{reg} + \hat{Q}A_{secT}^{reg}. \quad (2-74)$$

Since this elasticity is defined as $EDM_{secT}^{reg,reg} = -Q\hat{D}D_{secT}^{reg} / \hat{P}D_{secT}^{reg}$, Equation (2-74) can be rewritten as follows:

$$EDM_{secT}^{reg,reg} = -\sigma A_{secT}^{reg} \cdot \frac{\hat{P}A_{secT}^{reg}}{\hat{P}D_{secT}^{reg}} + \sigma A_{secT}^{reg} - \frac{\hat{Q}A_{secT}^{reg}}{\hat{P}A_{secT}^{reg}} \cdot \frac{\hat{P}A_{secT}^{reg}}{\hat{P}D_{secT}^{reg}}. \quad (2-75)$$

Since $\hat{P}A_{secT}^{reg} / \hat{P}D_{secT}^{reg}$ reflects the share of the expenditure on domestically-produced goods

($QDD_{secT}^{reg} \cdot PD_{secT}^{reg}$) in Armington composite commodity group expenditure ($QA_{secT}^{reg} \cdot PA_{secT}^{reg}$),

or:

$$\frac{\hat{P}A_{secT}^{reg}}{\hat{P}D_{secT}^{reg}} = \frac{PD_{secT}^{reg} \cdot QDD_{secT}^{reg}}{PA_{secT}^{reg} \cdot QA_{secT}^{reg}}; \quad (2-76)$$

and by assumption, $\hat{Q}A_{secT}^{reg} / \hat{P}A_{secT}^{reg} = -1$, as firms perceive themselves to have no influences

on the aggregate group expenditure ($QA_{secT}^{reg} \cdot PA_{secT}^{reg}$) given any change in PA_{secT}^{reg} due to the

Cobb-Douglas domestic demand property; Equation (2-75) can be rewritten as:

$$\therefore EDM_{secT}^{reg,reg} = \sigma A_{secT}^{reg} - (\sigma A_{secT}^{reg} - 1) \cdot \frac{PD_{secT}^{reg} \cdot QDD_{secT}^{reg}}{PA_{secT}^{reg} \cdot QA_{secT}^{reg}}. \quad (2-77)$$

Similarly, the perceived elasticity of demand for bilateral imports from region *reg* to region *regg* ($EDM_{secT}^{reg,regg}$) in Equation (2-73) can be derived by log differentiating the following equation, in which Equation (2-30) is substituted into Equation (2-33):

$$QBM_{secT}^{regg,reg} = (aBM_{secT}^{regg})^{\sigma BM_{secT}^{regg}-1} \cdot \left(\frac{\gamma BM_{secT}^{regg,reg} \cdot PM_{secT}^{regg}}{PBM_{secT}^{regg,reg}} \right)^{\sigma BM_{secT}^{regg}} \cdot (aA_{secT}^{regg})^{\sigma A_{secT}^{regg}-1} \cdot \left(\frac{\gamma AM_{secT}^{regg} \cdot PA_{secT}^{regg}}{PM_{secT}^{regg}} \right)^{\sigma A_{secT}^{regg}} \cdot QA_{secT}^{regg}. \quad (2-78)$$

The log differentiation yields:

$$Q\hat{B}M_{secT}^{regg,reg} = (\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg}) \cdot \hat{P}M_{secT}^{regg} - \sigma BM_{secT}^{regg} \cdot \hat{P}B\hat{M}_{secT}^{regg,reg} + \sigma A_{secT}^{regg} \cdot \hat{P}A_{secT}^{regg} + \hat{Q}A_{secT}^{regg}.$$

This equation can be rephrased as following:

$$\begin{aligned} EDM_{secT}^{reg,regg} &= -\frac{Q\hat{B}M_{secT}^{regg,reg}}{\hat{P}B\hat{M}_{secT}^{regg,reg}} \\ &= \sigma BM_{secT}^{regg} - (\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg}) \frac{\hat{P}M_{secT}^{regg}}{\hat{P}B\hat{M}_{secT}^{regg,reg}} - \sigma A_{secT}^{regg} \frac{\hat{P}A_{secT}^{regg}}{\hat{P}B\hat{M}_{secT}^{regg,reg}} - \underbrace{\frac{\hat{Q}A_{secT}^{regg}}{\hat{P}A_{secT}^{regg}}}_{=-1} \frac{\hat{P}A_{secT}^{regg}}{\hat{P}B\hat{M}_{secT}^{regg,reg}} \\ &= \sigma BM_{secT}^{regg} - (\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg}) \frac{\hat{P}M_{secT}^{regg}}{\hat{P}B\hat{M}_{secT}^{regg,reg}} - (\sigma A_{secT}^{regg} - 1) \frac{\hat{P}A_{secT}^{regg}}{\hat{P}B\hat{M}_{secT}^{regg,reg}}. \end{aligned}$$

As with Equation (2-76), $\hat{P}M_{secT}^{regg} / \hat{P}B\hat{M}_{secT}^{regg,reg}$ and $\hat{P}A_{secT}^{regg} / \hat{P}B\hat{M}_{secT}^{regg,reg}$ represent the shares of imports from region *reg* in total import values and composite commodity group expenditures of region *regg*, respectively. Therefore, the perceived elasticity of demand for Cournot oligopolistic commodity group *secT* in region *regg* is expressed as:

$$\begin{aligned} \therefore EDM_{secT}^{reg,regg} &= \sigma BM_{secT}^{regg} - (\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg}) \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PM_{secT}^{regg} \cdot QM_{secT}^{regg}} \\ &\quad - (\sigma A_{secT}^{regg} - 1) \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PA_{secT}^{regg} \cdot QA_{secT}^{regg}}. \end{aligned} \quad (2-79)$$

Hence, the perceived demand elasticities in tradable sectors are derived by substituting Equation (2-77) and (2-79) into Equation (2-73):

$$\begin{aligned} \therefore EDM_{secT}^{reg} = & \frac{QDD_{secT}^{reg}}{QZ_{secT}^{reg}} \left(\sigma A_{secT}^{reg} - (\sigma A_{secT}^{reg} - 1) \frac{PD_{secT}^{reg} \cdot QDD_{secT}^{reg}}{PA_{secT}^{reg} \cdot QA_{secT}^{reg}} \right) \\ & + \sum_{\substack{regg \\ (\neq reg)}} \frac{QBM_{secT}^{regg,reg}}{QZ_{secT}^{reg}} \left(\begin{aligned} & \sigma BM_{secT}^{regg} - (\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg}) \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PM_{secT}^{regg} \cdot QM_{secT}^{regg}} \\ & - (\sigma A_{secT}^{regg} - 1) \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PA_{secT}^{regg} \cdot QA_{secT}^{regg}} \end{aligned} \right) \end{aligned} \quad (2-80)$$

2.4.1.2 Monopolistic Competition Sectors with Horizontal Heterogeneous Products

This section explains how to incorporate monopolistic competition with the Dixit-Stiglitz (1977) Love-of-Variety preferences. In monopolistically competitive sectors, consumers regard products in the same sector as perfectly substitutable, yet distinguishable. Since products from different firms are ‘heterogeneous’ by definition, they possess a certain kind of monopolistic power.

2.4.1.2.1 Intra-Industry Product Differentiation: Love-of-Variety Preference

Figure 2-5 illustrates the structure of the quantity group index of sector *SEC2* in a region. Perfectly substitutable products are heterogeneous but can be grouped into sectors, with firms using similar production technologies across varieties within a sector.

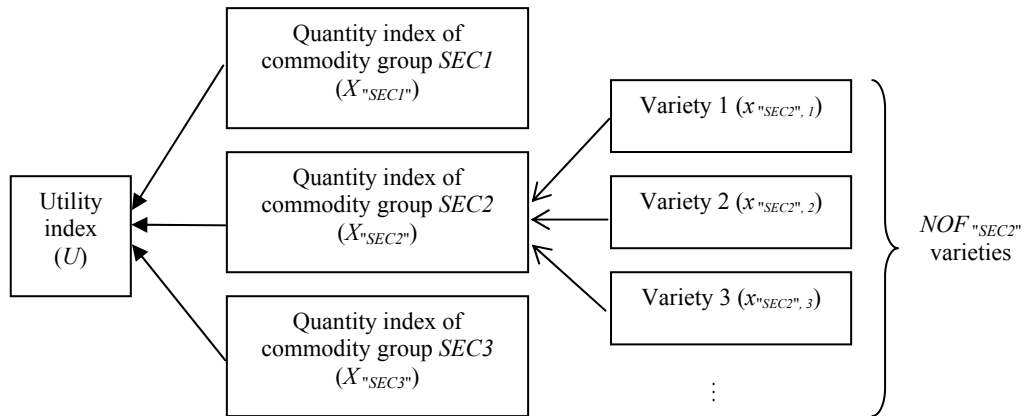


Figure 2-5: Structure of the commodity group index comprising outputs from individual firms in *SEC2*

At the upper level, consumers maximise their utility by allocating their consumption budgets across commodity groups (X_{sec}), the values of which depend entirely on their corresponding price indices (P_{sec}), according to the Cobb-Douglas demand property. At the lower stage, X_{sec} is a composite index of outputs from heterogeneous firms ($x_{sec,i}$) dual to the individual prices denoted by $p_{sec,i}$; and the number of firms in each group is denoted by NOF_{sec} , where $i = \{1, 2, \dots, NOF_{sec}\}$ is a set of individual varieties in sector *sec*.

Green (1964) argues that commodity groupings are strictly justified if:

- The product of X_{sec} and P_{sec} equals the sum of consumption expenditures on individual varieties.
- The ‘two-stage’ maximisation procedure is consistent, which means that the optimal individual commodity consumption determined by this procedure is identical to the amount which would have been purchased had utility been maximised with respect to the individual prices without any grouping.

The first requirement can be phrased as:

$$P_{sec} \cdot X_{sec} = \sum_{i=1}^{NOF_{sec}} p_{sec,i} \cdot x_{sec,i} \quad (2-81)$$

Since these varieties are perfect substitutes, individual prices and quantities are universal within a sector, and thus equation (2-81) can be re-written as:

$$P_{sec} \cdot X_{sec} = NOF_{sec} \cdot p_{sec} \cdot x_{sec} \quad (2-82)$$

As for the second requirement, the two-stage maximisation consistency is satisfied when either weak or strong separability holds. Weak separability³⁵ requires that if there are only

³⁵ The condition of the grouping is also termed as “functional separability” by Leontief (1947).

two groups in the economy, the necessary and sufficient conditions for individual quantities and prices to be grouped in terms of X_{sec} and P_{sec} , respectively are that the marginal rate of substitution between any pair of individual commodities in a group shall be independent of any quantities outside the group. Green (1964) proved that if there are more than two groups, weak separability is no longer sufficient for the grouping. Strong separability, on the other hand, satisfies the necessary and sufficient conditions for the two-stage maximisation consistency, and thus justifies the grouping, even when the number of groups is higher than two. It only requires that each group output index X_{sec} be a function that is homogeneous of degree one in its individual outputs (x_{sec}). Thus, a $\theta\%$ change in individual commodity consumption will result in an equivalent $\theta\%$ change in the commodity group index and the consumer's total expenditure, holding prices constant.

Dixit and Stiglitz (1977) meet the above requirements by specifying a homothetic utility function: $U = u(X_{SEC1}, X_{SEC2}, X_{SEC3})$, in which the quantity index is expressed as a CES function of individual quantities:

$$X_{sec} = \left[\sum_{i=1}^{NOF_{sec}} (x_{sec,i})^{\frac{\sigma LV_{sec}-1}{\sigma LV_{sec}}} \right]^{\frac{\sigma LV_{sec}}{\sigma LV_{sec}-1}}, \quad (2-83)$$

where σLV_{sec} is the elasticity of substitution between varieties within a group³⁶. As with Equation (2-82), the demand function for perfectly substitutable individual varieties in Equation (2-83) can be rewritten as:

$$X_{sec} = \left[NOF_{sec} \cdot (x_{sec})^{\frac{\sigma LV_{sec}-1}{\sigma LV_{sec}}} \right]^{\frac{\sigma LV_{sec}}{\sigma LV_{sec}-1}} = (NOF_{sec})^{\frac{\sigma LV_{sec}}{\sigma LV_{sec}-1}} \cdot x_{sec}. \quad (2-84)$$

Accordingly, the price index dual to X_{sec} can be derived as:

³⁶ As the function is homogeneous of degree one in its x_{sec} , we know that $0 < 1 - 1/\sigma LV_{sec} < 1$. Therefore, $\sigma LV_{sec} > 1$.

$$P_{\text{sec}} = \left[\sum_{i=1}^{NOF_{\text{sec}}} (p_{\text{sec},i})^{1-\sigma_{LV_{\text{sec}}}} \right]^{\frac{1}{1-\sigma_{LV_{\text{sec}}}}} = \left[NOF_{\text{sec}} (p_{\text{sec}})^{1-\sigma_{LV_{\text{sec}}}} \right]^{\frac{1}{1-\sigma_{LV_{\text{sec}}}}} = (NOF_{\text{sec}})^{\frac{1}{1-\sigma_{LV_{\text{sec}}}}} \cdot p_{\text{sec}}. \quad (2-85)$$

Thus, Equations (2-84) and (2-85) satisfy Equation (2-82), and are homogeneous of degree one in their individual outputs and prices, respectively. Subsequently, we can derive the demand function for individual variety from these two equations:

$$x_{\text{sec}} = \left(\frac{P_{\text{sec}}}{p_{\text{sec}}} \right)^{\sigma_{LV_{\text{sec}}}} \cdot X_{\text{sec}}. \quad (2-86)$$

2.4.1.2.2 Profit Maximisation by Heterogeneous Firms

As in the case of Cournot oligopoly with homogeneous products, under monopolistic competition individual firms maximise profits with respect to their output levels, thus equating marginal revenues (MR_{sec}) to marginal costs (MC_{sec}):

$$\frac{\partial}{\partial x_{\text{sec}}} (p_{\text{sec}} \cdot x_{\text{sec}} - MC_{\text{sec}} \cdot x_{\text{sec}}) = 0, \text{ that is to say :} \quad (2-87)$$

$$\frac{\partial}{\partial x_{\text{sec}}} (p_{\text{sec}} \cdot x_{\text{sec}}) = MC_{\text{sec}} = p_{\text{sec}} + \frac{\partial p_{\text{sec}}}{\partial x_{\text{sec}}} x_{\text{sec}} = p_{\text{sec}} \left(1 + \frac{\partial p_{\text{sec}}}{p_{\text{sec}}} / \frac{\partial x_{\text{sec}}}{x_{\text{sec}}} \right). \quad (2-88)$$

Marginal revenues and marginal costs thus can be expressed as:

$$MR_{\text{sec}} = MC_{\text{sec}} = p_{\text{sec}} \left(1 - \frac{1}{EDM_{\text{sec}}} \right), \quad (2-89)$$

where $EDM_{\text{sec}} = -\hat{x}_{\text{sec}} / \hat{p}_{\text{sec}}$ stands for the elasticity of demand for each variety.

2.4.1.2.3 Monopolistic Competition and Elasticity of Demand for Each Variety's Output

The model assumes that the number of firms is large enough to prevent individual firms from influencing the group's price index (P_{sec}). From Equation (2-86), we may derive the elasticity of demand for each variety as:

$$EDM_{sec} = -\frac{\hat{\partial}x_{sec}}{\hat{\partial}p_{sec}} \cdot \frac{p_{sec}}{x_{sec}} = -\frac{\partial \left(\frac{P_{sec}^{\sigma LV_{sec}} \cdot X_{sec}}{P_{sec}^{\sigma LV_{sec}}} \right)}{\partial p_{sec}} \cdot \frac{p_{sec}}{x_{sec}} = \left(\frac{P_{sec}}{P_{sec}} \right)^{\sigma LV_{sec}} \cdot \left(\frac{X_{sec}}{x_{sec}} \right) \cdot \sigma LV_{sec}. \quad (2-90)$$

From Equations (2-84) and (2-85), the elasticity of demand under monopolistic competition with product differentiation is:

$$EDM_{sec} = \sigma LV_{sec}. \quad (2-91)$$

2.4.1.2.4 Model Application

This section explains the modification of a perfectly competitive sector into a sector under monopolistic competition with heterogeneous products. Such modification is mainly concerned with consumption demands, since consumers are now assumed to prefer product variety. The market clearing condition for such a monopolistically competitive sector is:

$$QA_{ic}^{reg} = NOF_{ic}^{reg} \cdot qa_{ic}^{reg} = NOF_{ic}^{reg} \cdot \left(qaFD_{ic}^{reg} + \sum_{sec} qaIO_{ic,sec}^{reg} \right), \quad (2-92)$$

where QA_{ic}^{reg} is the composite output demand; and qa_{ic}^{reg} represents the demand for the individual variety of commodity ic , which can be decomposed into final and intermediate demands, denoted by $qaFD_{ic}^{reg}$ and $qaIO_{ic,sec}^{reg}$ respectively. From Equation (2-86), these individual demands can also be expressed as functions of group demands:

$$qaFD_{ic}^{reg} = \left(\frac{PA_{ic}^{reg}}{pa_{ic}^{reg}} \right)^{\sigma LV_{ic}^{reg}} \cdot (C_{ic}^{reg} + I_{ic}^{reg} + CG_{ic}^{reg}), \text{ and} \quad (2-93)$$

$$qaIO_{ic,sec}^{reg} = \left(\frac{PA_{ic}^{reg}}{pa_{ic}^{reg}} \right)^{\sigma LV_{ic}^{reg}} \cdot IO_{ic,sec}^{reg}, \quad (2-94)$$

where PA_{ic}^{reg} is the group price index; and pa_{ic}^{reg} represents the price of the individual variety of commodity ic . From Equation (2-85), Equations (2-93) and (2-94) are rewritten as:

$$qaFD_{ic}^{reg} = \left(NOF_{ic}^{reg} \right)^{\frac{\sigma LV_{ic}^{reg}}{1-\sigma LV_{ic}^{reg}}} \cdot \left(C_{ic}^{reg} + I_{ic}^{reg} + CG_{ic}^{reg} \right), \text{ and} \quad (2-95)$$

$$qaIO_{ic,sec}^{reg} = \left(NOF_{ic}^{reg} \right)^{\frac{\sigma LV_{ic}^{reg}}{1-\sigma LV_{ic}^{reg}}} \cdot \left(IO_{ic,sec}^{reg} \right). \quad (2-96)$$

Substituting Equations (2-95) and (2-96) into Equation (2-92) gives:

$$QA_{ic}^{reg} = \underbrace{\left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}}}_{\text{scaling vector}} \cdot \left(C_{ic}^{reg} + I_{ic}^{reg} + CG_{ic}^{reg} + \sum_{sec} IO_{ic,sec}^{reg} \right). \quad (2-97)$$

Therefore, there is a scaling effect of the Love-of-Variety preference on the group indices of final and intermediate demands, of which the magnitude depends on the size of the scaling vector in Equation (2-97).³⁷ From Equation (2-85), the group price index (PA_{ic}^{reg}) can now be expressed as:

$$PA_{ic}^{reg} = \left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg}. \quad (2-98)$$

Again, the scaling effect of monopolistic competition is observable in this equation. The nominal values of final group demands are:

$$C_{ic}^{reg} \cdot PA_{ic}^{reg} = C_{ic}^{reg} \cdot \left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg}; \quad (2-99)$$

$$I_{ic}^{reg} \cdot PA_{ic}^{reg} = I_{ic}^{reg} \cdot \left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg}; \text{ and} \quad (2-100)$$

$$CG_{ic}^{reg} \cdot PA_{ic}^{reg} = CG_{ic}^{reg} \cdot \left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg}. \quad (2-101)$$

Similarly, for intermediate inputs, the nominal values of intermediate group demands are:

$$IO_{ic,sec}^{reg} \cdot PA_{ic}^{reg} = IO_{ic,sec}^{reg} \cdot \left(NOF_{ic}^{reg} \right)^{\frac{1}{1-\sigma LV_{ic}^{reg}}} \cdot pa_{ic}^{reg}. \quad (2-102)$$

Accordingly, given Equation (2-89), the mark-up pricing equation is then re-expressed as:

³⁷ Note that since the number of firms is positive and $\sigma LV_{ic}^{reg} > 1$, the scaling vector is always positive. The model description in Section (C) of Appendix A2-3 refers to this scaling vector as AUX_{ic}^{reg} .

$$PZ_{ic}^{reg} \left(1 - \frac{1}{EDM_{ic}^{reg}} \right) = \sum_{fac} (1 + tf_{ic}^{fac,reg}) \cdot \left(\frac{PFM_{ic}^{fac,reg} \$facM(fac)}{+PFS_{ic}^{fac,reg} \$facS(fac)} \right) \cdot \frac{FV_{ic}^{fac,reg}}{QZ_{ic}^{reg}}, \quad (2-103)$$

$$+ \sum_{pc} PA_{pc}^{reg} \cdot io_{pc,ic}^{reg} + \sum_{icc} (NOF_{icc}^{reg})^{\frac{1}{1-\sigma LV_{icc}^{reg}}} \cdot pa_{icc}^{reg} \cdot io_{icc,ic}^{reg}$$

where the subscript icc stands for the set of monopolistic competition sectors alias to ic ; and the elasticity of demand for individual variety's output is fixed and equal to the elasticity of substitution between varieties, as shown in Equation (2-91).

2.4.1.3 Barriers to Entering and Exiting an Imperfectly Competitive Sector

Under imperfect competition with the economies of scale, incumbent firms have a strong incentive to prevent potential rivals from entering the market, since market prices and then the profits of these firms tend to decrease as the number of firms increases. In addition, a high ratio of fixed to variable costs could naturally become an entry barrier to new entrants.

As firm mobility is restricted (i.e. $\overline{NOF}_{ic}^{reg}$), firms in imperfectly competitive sectors are able to reap positive profits (rents). Accordingly, these newly derived firms' profits are then transferred to the representative household. Thus, the definition of household income sources formerly shown in Equation (2-9) is replaced by:

$$INC^{reg} = \left(\sum_{sec} \sum_{fac} \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \cdot F_{sec}^{fac,reg} + TRNF^{reg} \right) + \sum_{ic} PROFIT_{ic}^{reg}, \quad (2-104)$$

where the sum of sectoral profits ($PROFIT_{ic}^{reg}$) is added to the original equation. The zero-profit condition in Equation (2-4) is modified such that total revenues are equal to total costs plus sectoral profits:

$$PZ_{ic}^{reg} \cdot QZ_{ic}^{reg} = \sum_{fac} (1 + tf_{ic}^{fac,reg}) \cdot \left(\frac{PFM_{ic}^{fac,reg} \$facM(fac)}{+PFS_{ic}^{fac,reg} \$facS(fac)} \right) \cdot F_{ic}^{fac,reg} + \sum_{sec} \underbrace{PA_{sec}^{reg}}_{\otimes} \cdot IO_{sec,ic}^{reg} \quad (2-105)$$

$$+ PROFIT_{ic}^{reg},$$

where the prices of intermediate inputs (\otimes) are calculated as the group price indices

$$\left(\overline{NOF}_{sec}^{reg} \right)^{\frac{1}{1-\sigma L_{sec}^{reg}}} \cdot pa_{sec}^{reg}$$

when the intermediate inputs are purchased from monopolistically competitive markets.

Equation (2-105) can be simplified with scripts abbreviated as:

$$QZ \cdot PZ = (FC + VC) + PROFIT. \quad (2-106)$$

Divide Equation (2-106) by sectoral outputs (QZ) to find commodity prices (PZ) equal average costs plus unit profits:

$$PZ = (FC / QZ + VC / QZ) + PROFIT / QZ. \quad (2-107)$$

From Equations (2-106) and (2-107), total revenues are higher than total costs, thus prices (i.e. average revenues) are higher than average costs. Nevertheless, marginal revenues are still equal to marginal costs ($PZ - MUP = VC/QZ$) as in Equation (2-65). Therefore, with entry/exit barriers, we know that: $PZ > AC > MC = MR$. Moreover, as profits are positive, a firm's mark-up comprises fixed costs and unit profits:

$$FC/QZ + PROFIT/QZ = MUP. \quad (2-108)$$

Compared to Equation (2-68), the mark-up, which is the gap between the output price and marginal costs, is not only entailed by fixed costs, but also includes profits per unit of output.

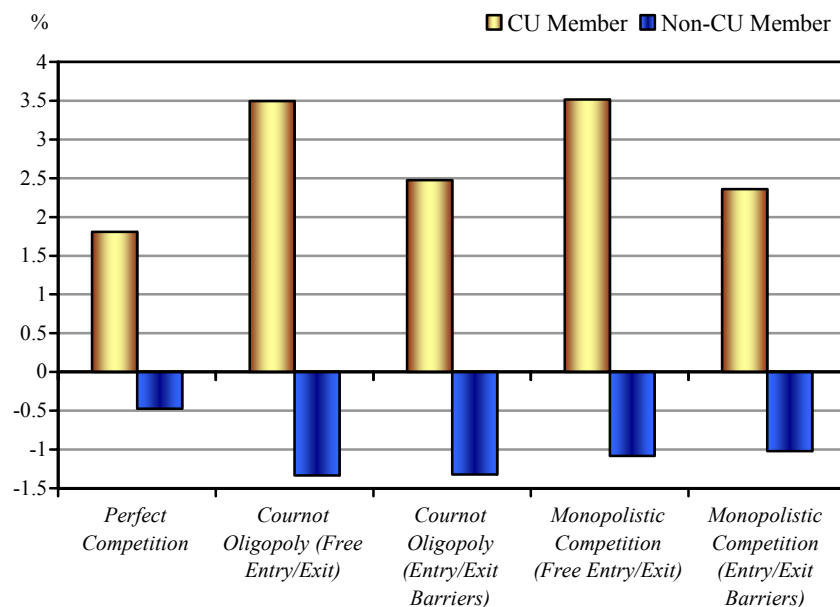
2.4.2 CU Simulation Results

In order to capture the differences in CU simulation outcomes under different market structures, this section modifies the set of data previously used in the CU simulations on regions of different market sizes (see Subsection 2.3.1 for the description of the previous data set). Since all regions are now absolutely symmetric, the value flows in regions *REG1* and *REG2* equivalently are increased by ten times, and thus the SAMs of all regions are identical to those of the large regions reported in Table 2-2. As reported in Appendix A2-4, the

bilateral trade values are \$20 and the corresponding bilateral tariff revenues are now \$10 across all trading partners; whilst the elasticity parameters are assumed to be unchanged in order to maintain the economic characteristics of the sectoral responsiveness to external shocks. Sector *SECI* remains perfectly competitive while the others are now either oligopolistic or monopolistically competitive. This specification makes it easier to make comparisons of sectoral adjustments under the different market structures.

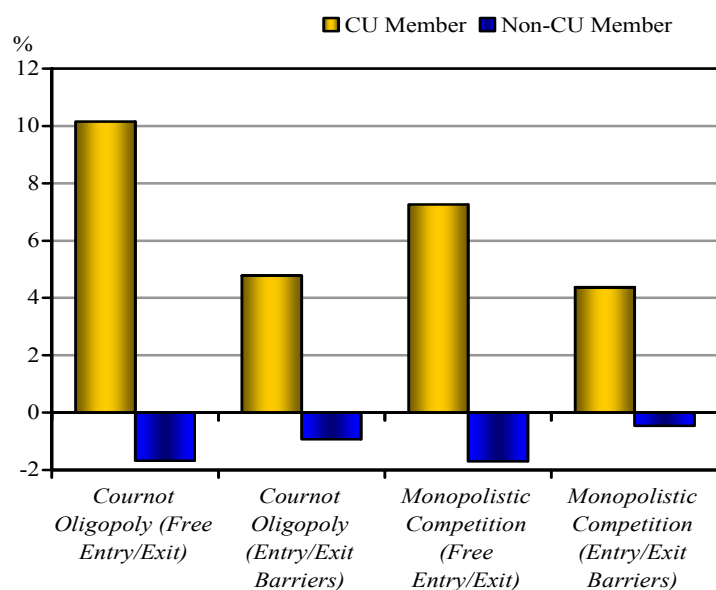
The policy experiments are set up as follows. Since the four regions are symmetric, it is not important which pair of regions are to form a CU. For simplicity it is assumed that *REG1* and *REG2* decide to eliminate import tariffs against each other. For the first experiment, all sectors in all regions are perfectly competitive. The other four experiments are conducted under imperfect competition, with and without firm mobility constraints, as explained at the beginning of Section 2.4.

Chart 2-4: Market imperfection simulation results (percentage changes in real GDP)



Source: Simulated by author.

Chart 2-5: Market imperfection simulation results (percentage changes in tradable sectors' outputs per firm)



Source: Simulated by author.

Table 2-11: Percentage changes in macroeconomic variables under different market structures

| Percentage change | | Market structures | | Perfect competition | Cournot oligopoly (free mobility) | Cournot oligopoly (barred mobility) | Monopolistic competition (free mobility) | Monopolistic competition (barred mobility) |
|--|------------|-------------------|------------|---------------------|-----------------------------------|-------------------------------------|--|--|
| | | CU member | Non-member | | | | | |
| Aggregate exports QE_{sect}^{reg} | CU member | SEC1 | | 47.53% | 46.85% | 44.58% | 47.16% | 45.89% |
| | | SEC2 | | 47.53% | 52.40% | 51.26% | 52.05% | 50.14% |
| | Non-member | SEC1 | | -4.44% | -2.96% | -2.61% | -3.14% | -3.23% |
| | | SEC2 | | -4.44% | -6.82% | -7.32% | -6.50% | -6.31% |
| Aggregate imports QM_{sect}^{reg} | CU member | SEC1 | | 46.19% | 48.09% | 46.77% | 47.92% | 46.79% |
| | | SEC2 | | 46.19% | 47.44% | 45.93% | 47.62% | 46.19% |
| | Non-member | SEC1 | | -10.28% | -11.27% | -11.63% | -10.99% | -11.11% |
| | | SEC2 | | -10.28% | -9.63% | -9.67% | -9.79% | -9.88% |

Source: Simulated by author.

The simulation results are reported in Chart 2-4, Chart 2-5, and from Table 2-11 to Table 2-16. Chart 2-4 plots the real GDP change in CU member and non-member regions, and Chart 2-5 shows the percentage change in output per firms under imperfect competition. Table 2-11

then reports the percentage changes in sectoral trade; and Table 2-12 to Table 2-16 decompose regional EVs into the real income and consumer surplus effects. Chart 2-4, Chart 2-5 and Table 2-11 suggest that CU members are better off in real terms, and that their welfare gains will more than offset the losses suffered by non-members, so that the CU shock will improve world welfare as a whole. For CU members, the real GDP increase is greater when we assume that *SEC2* (tradable) and *SEC3* (non-traded) are imperfectly competitive; and such positive effects are weakened when imperfect competition is coupled with the firm immobility constraint.

Considering first aggregate exports by sector, the ‘tradable’ imperfectly competitive sector (*SEC2*) exploits its scale economies by expanding production and increasing its exports to the global market. That, in turn, bids away production resources from the ‘non-traded’ imperfectly competitive sector (*SEC3*) and the tradable sector that is perfectly competitive (*SEC1*). Hence, in the latter, the aggregate export volume falls compared to the situation when all sectors are under perfect competition. Consequently, aggregate imports of *SEC1* under perfect competition increase more than those of the imperfectly competitive *SEC2*, and also are higher than the percentage change when the world economy is entirely perfectly competitive.

Furthermore, as shown in Chart 2-5, the percentage changes in output per firm of imperfectly competitive sectors suggest that, for CU members, an oligopolistic market structure yields higher benefits than under a monopolistically competitive one, as it enables member regions to exploit their scale economies more fully. These results are consistent with the real GDP changes reported in Chart 2-4.

For non-members, the restricted access for their goods increases their welfare losses as the introduction of increasing returns to scale further increases the detrimental trade diversion effect. As a consequence, the magnitude of the proportional change in non-members’ real variables is consistent with that observed in member regions, although the two are of opposite sign.

Table 2-12: The EVs of regions *REG1* and *REG2* forming a CU: Perfect Competition

| Decomposed EVs (in world currency: \$) | | | CU members: <i>REG1</i> & <i>REG2</i> | Non-members: <i>REG3</i> & <i>REG4</i> | |
|--|--------------------|-----------------|--|---|-------|
| Real income effect | Production effect | | <i>SEC1</i> | 22.22 | -3.48 |
| | | | <i>SEC2</i> | 22.22 | -3.48 |
| | | | <i>SEC3</i> | 11.63 | -9.82 |
| | Tax revenue effect | Commodity taxes | <i>SEC1</i> | 3.58 | -1.08 |
| | | | <i>SEC2</i> | 3.58 | -1.08 |
| | | Factor taxes | <i>SEC1</i> | 4.78 | -0.74 |
| | | | <i>SEC2</i> | 4.78 | -0.74 |
| | | Tariffs | <i>SEC1</i> | -12.87 | -1.84 |
| <i>SEC2</i> | -12.87 | | -1.84 | | |
| Consumer surplus effect | Household | | -6.74 | 3.16 | |
| | Government | | -5.84 | 2.74 | |
| | Saving-investment | | -0.90 | 0.42 | |
| Regional EV | | | 33.56 | -17.78 | |

Source: Simulated by author.

Table 2-13: The EVs of regions *REG1* and *REG2* forming a CU: Cournot oligopoly without barriers to entry/exit

| Decomposed EVs (in world currency: \$) | | | CU members: <i>REG1</i> & <i>REG2</i> | Non-members: <i>REG3</i> & <i>REG4</i> | |
|--|--------------------|-----------------|--|---|-------|
| Real income effect | Production effect | | <i>SEC1</i> | 25.29 | -3.50 |
| | | | <i>SEC2</i> | 23.57 | -4.97 |
| | | | <i>SEC3</i> | 12.48 | -9.17 |
| | Tax revenue effect | Commodity taxes | <i>SEC1</i> | 3.94 | -1.15 |
| | | | <i>SEC2</i> | 3.94 | -1.15 |
| | | Factor taxes | <i>SEC1</i> | 5.44 | -0.75 |
| | | | <i>SEC2</i> | 5.10 | -1.07 |
| | | Tariffs | <i>SEC1</i> | -12.46 | -2.05 |
| <i>SEC2</i> | -13.23 | | -1.85 | | |
| Consumer surplus effect | Household | | -5.62 | 1.96 | |
| | Government | | -4.87 | 1.70 | |
| | Saving-investment | | -0.75 | 0.26 | |
| Regional EV | | | 42.83 | -21.74 | |

Source: Simulated by author.

Table 2-14: The EVs of regions *REG1* and *REG2* forming a CU: Cournot oligopoly with barriers to entry/exit

| Decomposed EVs (in world currency: \$) | | | CU members: <i>REG1</i> & <i>REG2</i> | Non-members: <i>REG3</i> & <i>REG4</i> | |
|--|--------------------|-----------------|--|---|-------|
| Real income effect | Production effect | | <i>SEC1</i> | 23.63 | -3.44 |
| | | | <i>SEC2</i> | 27.22 | -6.15 |
| | | | <i>SEC3</i> | 18.55 | -9.30 |
| | Tax revenue effect | Commodity taxes | <i>SEC1</i> | 3.48 | -1.16 |
| | | | <i>SEC2</i> | 3.48 | -1.16 |
| | | Factor taxes | <i>SEC1</i> | 5.08 | -0.73 |
| | | | <i>SEC2</i> | 5.90 | -1.33 |
| | | Tariffs | <i>SEC1</i> | -12.50 | -2.11 |
| | | | <i>SEC2</i> | -13.43 | -1.85 |
| Consumer surplus effect | Household | | -5.19 | 2.11 | |
| | Government | | -4.50 | 1.83 | |
| | Saving-investment | | -0.69 | 0.28 | |
| Regional EV | | | 51.04 | -23.00 | |

Source: Simulated by author.

Table 2-15: The EVs of regions *REG1* and *REG2* forming a CU: monopolistic competition without barriers to entry/exit)

| Decomposed EVs (in world currency: \$) | | | CU members: <i>REG1</i> & <i>REG2</i> | Non-members: <i>REG3</i> & <i>REG4</i> | |
|--|--------------------|-----------------|--|---|-------|
| Real income effect | Production effect | | <i>SEC1</i> | 24.33 | -3.17 |
| | | | <i>SEC2</i> | 23.48 | -4.34 |
| | | | <i>SEC3</i> | 10.59 | -9.15 |
| | Tax revenue effect | Commodity taxes | <i>SEC1</i> | 3.76 | -1.08 |
| | | | <i>SEC2</i> | 3.76 | -1.08 |
| | | Factor taxes | <i>SEC1</i> | 5.23 | -0.68 |
| | | | <i>SEC2</i> | 5.10 | -0.93 |
| | | Tariffs | <i>SEC1</i> | -12.63 | -1.96 |
| | | | <i>SEC2</i> | -13.25 | -1.81 |
| Consumer surplus effect | Household | | -4.24 | 2.11 | |
| | Government | | -3.67 | 1.83 | |
| | Saving-investment | | -0.57 | 0.28 | |
| Regional EV | | | 41.90 | -19.96 | |

Source: Simulated by author.

Table 2-16: The EVs of regions *REG1* and *REG2* forming a CU: monopolistic competition with barriers to entry/exit)

| Decomposed EVs (in world currency: \$) | | | CU members: <i>REG1</i> & <i>REG2</i> | Non-members: <i>REG3</i> & <i>REG4</i> | |
|--|--------------------|-----------------|--|---|-------|
| Real income effect | Production effect | | <i>SEC1</i> | 23.30 | -3.53 |
| | | | <i>SEC2</i> | 24.23 | -5.37 |
| | | | <i>SEC3</i> | 16.17 | -9.49 |
| | Tax revenue effect | Commodity taxes | <i>SEC1</i> | 3.59 | -1.13 |
| | | | <i>SEC2</i> | 3.59 | -1.13 |
| | | Factor taxes | <i>SEC1</i> | 5.01 | -0.75 |
| | | | <i>SEC2</i> | 5.26 | -1.16 |
| | | Tariffs | <i>SEC1</i> | -12.62 | -2.02 |
| | | | <i>SEC2</i> | -13.21 | -1.84 |
| Consumer surplus effect | Household | | -5.79 | 2.53 | |
| | Government | | -5.02 | 2.19 | |
| | Saving-investment | | -0.77 | 0.34 | |
| Regional EV | | | 43.74 | -21.35 | |

Source: Simulated by author.

2.4.2.1 Perfect Competition

Table 2-12 reports the outcomes of *REG1* and *REG2* forming a CU under the assumption of universal perfect competition. The mechanism through which preferential tariff elimination alters regional welfare and real macroeconomic variables is analogous to that underlying the results reported in Table 2-5 to Table 2-7 in Subsection 2.3.3.1. The changes in key indicators have the same signs, and the differences in EV results are primarily due to the differences in economic size. Hence, the following explanation of Table 2-12 is abbreviated, although the results will be compared with those from various degrees of market competitiveness in the following subsections.

2.4.2.2 Cournot Oligopolistic Competition with Homogeneous Products in Sectors *SEC2* and *SEC3* (Free Entry/Exit)

2.4.2.2.1 CU Members (*REG1* and *REG2*)

For CU members, the expansion of trade within the grouping clearly outweighs the fall in demands for import from non-members and domestic output. Hence, as in Equation (2-80),

the perceived elasticity of demand for *SEC2* increases by 6.65%. This implies that a change in domestic price will now result in greater changes in consumption. Consequently, mark-ups in *SEC2* decline (Equation (2-63) demonstrates the negative relationship between the two variables). The lower mark-up forces 4.0% of oligopolistic firms to exit, which then reduces sectoral fixed costs.³⁸ Equation (2-68) implies that the first-hand effect of the fall in the mark-up is the profit loss, since the new mark-up no longer covers unit fixed cost. As a consequence, under the free entry and exit assumption, some firms will leave the market, allowing the unit fixed cost to fall until they equate with the ex-post mark-up level. Therefore, consistent with Horstmann and Markusen (1986), regional liberalisation will entail an exit of firms from the oligopolistic sector (*SEC2*), while the surviving firms expand their outputs (by 10.2% in this case). As a result, aggregate output is increased relative to that of the perfectly competitive sector (*SEC1*), a consequence of increasing returns to scale.

In Table 2-13, the production effect and factor tax revenue effect on *SEC2* are positive yet slightly lower than those in *SEC1*. On the other hand, since *SEC2* has lower unit costs than *SEC1*, the product becomes more affordable and we observe a stronger commodity tax revenue effect than in Table 2-12 due to an increase in final demand.

The increase in total tax revenue raises public sector demand for *SEC3* output by 0.7%. Since *SEC3* is also oligopolistic, this expansion increases factor productivity, more output per firm, and lower unit factor inputs. Since the reduction in unit factor demand is outweighed by the increase in price of the mobile factors that is additionally driven up by the demand from tradable sectors, the production effect on *SEC3* is positive. Overall, the regional EV reported in Table 2-13 is higher than that in Table 2-12, and such productivity improvement is attributable to the positive scale economy effects on the CU economies after the union.

³⁸ To avoid technical problems during the simulation process, the number of firms in this model is specified as continuous.

2.4.2.2.2 Non-Members (REG3 and REG4)

The CU formation tends to drive up the world prices of members' exports as intra-union trade is promoted. Nevertheless, since the scale economies reduce unit costs after the union, the CU export price of *SEC2* is comparatively low in the world market. Consequently, non-members perceive the imports of *SEC2* from CU members as more affordable, thus their oligopolistic exports and outputs drop by 6.8% and 0.8% respectively in aggregate terms. In contrast, the perfectly competitive sector (*SEC1*) reduces its exports by 3.0% while increasing output by 0.4%. Thus, under oligopoly, the contraction in *SEC2* has more undesirable effects on the non-member economies than in the perfect competition model. Overall, when perfect competition is replaced by oligopoly, the trade diversion effect on non-members is more accentuated. Thus, in Table 2-13, we find higher negative values of the decomposed EVs than in Table 2-12.

2.4.2.3 Cournot Oligopolistic Competition with Homogeneous Products in Sectors *SEC2* and *SEC3* (Barred Entry/Exit)

Table 2-13 and Table 2-14 show that the firm mobility assumption does not alter the signs of the decomposed EVs. In comparison to the results in Table 2-13, the exogenisation of the number of firms increases members' EV gains and non-members' losses. These outcomes are in contrast to the results reported in Chart 2-4, where the firm mobility constraint reduces the variation in real GDP of members and non-members alike. The difference is attributable to the fact that the model fixes the number of firms, which is a real variable, while endogenising firms' profit, which is a nominal one. As a consequence, the world economy becomes less affected in real terms, while being more exposed in nominal terms, since the adjustment in the number of firms after the CU formation is transformed into the variation in profits accruing to household income, making the sectoral fixed factor cost exogenous. The welfare changes for members and non-members are discussed below.

2.4.2.3.1 CU Members (REG1 and REG2)

After CU formation the mark-ups drop and, from Equation (2-108), profits decline as unit fixed factor demand is exogenised with the firm population. Consequently, output per firm does not grow as much as under the barred entry assumption.³⁹ Thus, the economies of scale are not fully taken advantage of when firm mobility is restricted, and the real effects are not as pronounced as under the free entry assumption. However, as reported in Table 2-14, the overall EVs of CU regions are still increased, and the main gains come from the oligopolistic production effect. As sectoral fixed factor demand does not adjust downward following the policy change, total factor demands by oligopolistic producers become considerably higher after the union.

2.4.2.3.2 Non-Members (REG3 and REG4)

The CU effects on non-members are similar to those previously explained in Subsection 2.4.2.2, although further accentuated by the fixing of the number of firms. In this scenario the mark-up increases with the decline in the Cournot demand elasticity as bilateral trade between CU members increases after the union. Since the number of firms is constant, each firm's profit increases with the mark-up. Thus, the rise in profits, coupled with the fall in output prices due to the lower overseas demand, results in a fall in factor demands, which explains why we see further contraction when there is no mobility of firms. In fact, Table 2-14 reports that non-members' welfare losses are mainly from the negative production effect on the Cournot sectors.

³⁹ This statement refers to the results of percentage changes in outputs per firm in Chart 2-5.

2.4.2.4 Monopolistic Competition with Heterogeneous Products in Sectors *SEC2* and *SEC3* (Free Entry/Exit)

The welfare effects of CU formation under monopolistic competition (Table 2-15) are moderate when compared with the previous results under perfect competition (Table 2-12), and under Cournot oligopoly (Table 2-13). Since the elasticity of demand is constant under monopolistic competition, firms are less endowed with price-setting power in comparison to the oligopolistic case. Nonetheless, they are not pure price takers, since consumers prefer product variety. Since monopolistic competition and Cournot oligopoly both incur fixed production costs, the magnitudes of welfare variations under monopolistic competition are closer to those under Cournot oligopoly as opposed to perfect competition. However, the mark-ups are modelled differently and the group price index is newly introduced. Under monopolistic competition, the mark-up is independent of the number of firms, but nevertheless is a function of the fixed demand elasticity and individual supply price.

Equation (2-85) implies that the group price index is proportional to the scaling vector, which is a function of the number of firms and the elasticity of substitution between product varieties. Since the number of firms must be positive, and the elasticity is higher than one, the scaling vector is always positive and inversely proportional to the number of firms. As the number of firms approaches unity, the scaling vector does the same, implying that under monopoly the group price index is equivalent to the individual price index. Under monopolistic competition, however, the number of firms is more than one, implying that the scaling vector ranges between zero and one. Thus, the relationship between the number of firms and the group price index is derived as follows. If the number of firms is higher than one, the group price index is always lower than the individual price index; hence the sum of individual outputs is lower than total demand in each sector. As the number of firms approaches infinity, the group price index falls relative to the individual index, raising total sectoral demand relative to the sum of individual firms' outputs.

2.4.2.4.1 CU Members (REG1 and REG2)

Under the monopolistic competition assumptions used here, changes in tariffs do not affect the demand elasticity, and thus the mark-up rate remains unchanged. However, the access to a larger market, the heightened international competition, and the efficiency gains due to the fall in the number of firms invariably reduce the unit fixed costs and raise the output per firm, though not as strongly as under oligopoly (as the demand elasticity is fixed). Hence the production effect on the monopolistically competitive sector (*SEC2*) is positive but lower than would be the case under oligopoly.

As the decline in the number of firms increases the scaling vector, the group price index is raised (see Equation (2-98)). Thus, final demands for commodity *SEC2* fall as consumers maximise their Cobb-Douglas utility levels. Coupled with the fixed elasticity of demand, it is generally observed that in the CU member economies the consumption of the monopolistically competitive products does not expand as strongly as under Cournot oligopoly. As a consequence, all the decomposed tax revenue effects reported in Table 2-15 are lower than those in Table 2-13. Hence, the public good demand (*SEC3*) declines more than when under oligopoly.

2.4.2.4.2 Non-Members (REG3 and REG4)

For non-member regions, the changes in real economic flows hardly differ from those observed under the oligopoly specification. However the percentage changes in unemployed labour and real GDP are lower due to the fixed demand elasticity. Since the mark-up is not affected by the shock, the entry of inefficient firms is barred. Thus, non-members experience lower negative effects than under oligopoly.

2.4.2.5 Monopolistic Competition with Heterogeneous Products in Sectors *SEC2* and *SEC3* (Barred Entry/Exit)

According to the previous EV results, the differences between the CU welfare effects with and without firm mobility restrictions under monopolistic competition are similar to those under Cournot oligopoly. The EV outcomes for member and non-member regions are likewise accentuated when the number of firm population is exogenised. Therefore, overall, the barred entry assumption yields robust and consistent welfare effects for the world economy.

2.5 Aiming At the Formation of a Necessarily Welfare-Improving CU

Building on the previous simulations in Section 2.4, Section 2.5 then explores the concept of policy-determined external tariffs developed by Kemp and Wan (1976), thus investigating the channels through which countries can set up a welfare-enhancing CU while adjusting their import tariffs against non-members so as to maintain trade, and hence welfare, with the rest of the world at the pre-CU level, and thus increasing welfare for the world as a whole. Hence, consistent with the WTO requirements, the ultimate goal is to eliminate the trade diversion that induces efficiency losses during the process. In line with the framework proposed by Waschik (2006), this chapter pursues the simulation of CU formation under three types of market structure.⁴⁰ The section uses the dataset from Section 2.4, in which *SEC1* is always under perfect competition whereas the other sectors operate under oligopoly and/or monopolistic competition. The main finding is that imperfect competition does not substantially alter the welfare implication of a grouping with endogenous external tariffs.

⁴⁰ Note that the cases of imperfect competition with free entry are not analysed in this section, since in reality, most of the imperfectly competitive sectors are subject to entry barriers for a number of reasons explained in Section 2.4.

Table 2-17: Percentage changes in bilateral imports under various market structures

| Market structures | | | | Perfect competition | Cournot oligopoly (barred mobility) | Monopolistic competition (barred mobility) |
|--|--------------------|-----------------|------|---------------------|-------------------------------------|--|
| % changes in bilateral imports | | | | | | |
| Scenario 0 (Trade creation and trade diversion) | CU member imports | From CU member | SEC1 | 187.57% | 183.54% | 185.60% |
| | | | SEC2 | 187.57% | 194.22% | 192.38% |
| | | From non-member | SEC1 | -14.38% | -12.12% | -12.87% |
| | | | SEC2 | -14.38% | -17.16% | -16.15% |
| | Non-member imports | From CU member | SEC1 | -22.50% | -24.90% | -23.97% |
| | | | SEC2 | -22.50% | -20.22% | -20.98% |
| | | From non-member | SEC1 | 15.43% | 16.43% | 16.03% |
| | | | SEC2 | 15.43% | 12.36% | 13.36% |
| Scenario 1 (No trade diversion) | CU member imports | From CU member | SEC1 | 169.95% | 167.49% | 169.23% |
| | | | SEC2 | 169.95% | 173.05% | 172.17% |
| | | From non-member | SEC1 | <i>(fixed)</i> | <i>(fixed)</i> | <i>(fixed)</i> |
| | | | SEC2 | <i>(fixed)</i> | <i>(fixed)</i> | <i>(fixed)</i> |
| | Non-member imports | From CU member | SEC1 | 0.00% | -3.08% | -1.78% |
| | | | SEC2 | 0.00% | 3.12% | 1.87% |
| | | From non-member | SEC1 | 0.00% | 1.94% | 1.11% |
| | | | SEC2 | 0.00% | -1.85% | -1.29% |
| Scenario 2 (No trade diversion; non-members fix their imports from CU members) | CU member imports | From CU member | SEC1 | 169.95% | 167.10% | 169.00% |
| | | | SEC2 | 169.95% | 172.96% | 172.13% |
| | | From non-member | SEC1 | <i>(fixed)</i> | <i>(fixed)</i> | <i>(fixed)</i> |
| | | | SEC2 | <i>(fixed)</i> | <i>(fixed)</i> | <i>(fixed)</i> |
| | Non-member imports | From CU member | SEC1 | <i>(fixed)</i> | <i>(fixed)</i> | <i>(fixed)</i> |
| | | | SEC2 | <i>(fixed)</i> | <i>(fixed)</i> | <i>(fixed)</i> |
| | | From non-member | SEC1 | 0.00% | -0.01% | 0.00% |
| | | | SEC2 | 0.00% | 0.26% | 0.00% |

Source: Simulated by author.

Table 2-18: Percentage changes in tariff rates necessary to maintain the corresponding bilateral imports at the benchmark levels

| Percentage changes in tariff rates | | Market structures | | Perfect competition | Cournot oligopoly (barred mobility) | Monopolistic competition (barred mobility) |
|---|--|-------------------|--|---------------------|-------------------------------------|--|
| | | | | | | |
| <i>Scenario 1</i> (No trade diversion) | Members' tariff rates on imports from non-members | <i>SEC1</i> | | -42.87% | -40.20% | -41.17% |
| | | <i>SEC2</i> | | -42.87% | -45.30% | -44.36% |
| <i>Scenario 2</i> (No trade diversion; non-members fix imports from members) | Members' tariff rates on imports from non-members | <i>SEC1</i> | | -42.87% | -39.82% | -40.84% |
| | | <i>SEC2</i> | | -42.87% | -45.93% | -44.63% |
| | Non- members' tariff rates on imports from members | <i>SEC1</i> | | 0.00% | -4.31% | -2.63% |
| | | <i>SEC2</i> | | 0.00% | 4.65% | 2.67% |

Source: Simulated by author.

First, the percentage changes in bilateral imports are summarised in Table 2-17. For Scenario 0, CU members only reduce import tariffs among themselves; hence the results replicate those in Section 2.4, where trade diversion is present. Then, tariffs are endogenised in Scenario 1, where CU members adjust their common external tariff rates on imports from non-members in a way that trade volumes are maintained at the benchmark levels, and the detrimental effects of trade diversion are eliminated. Lastly, in Scenario 2, non-members also endogenise their individual tariff rates on imports from CU members. Table 2-18 then shows the required adjustments in tariff rates between members and non-members, given that the initial bilateral tariff revenues are 50% of their import values in world currency (the “\$”). Finally, Table 2-19 reports the welfare implications of the above scenarios at the macroeconomic level.

Table 2-19: Welfare implications under different market structures

| | | Perfect competition | | | Cournot oligopoly (barred mobility) | | | Monopolistic competition (barred mobility) | | |
|---|-------------------------|---------------------|---------------|--------|-------------------------------------|---------------|--------|--|---------------|--------|
| | | CU member | Non-CU member | World | CU member | Non-CU member | World | CU member | Non-CU member | World |
| Scenario 0 (Trade creation and trade diversion) | Real GDP (%Δ) | 1.81% | -0.48% | 0.67% | 2.47% | -1.32% | 0.58% | 2.36% | -1.02% | 0.67% |
| | Total imports* (%Δ) | 52.94% | -9.85% | 21.54% | 53.20% | -10.24% | 21.48% | 53.33% | -10.09% | 21.62% |
| | Total exports** (%Δ) | 47.53% | -4.44% | 21.54% | 47.92% | -4.96% | 21.48% | 48.01% | -4.77% | 21.62% |
| | Regional income (%Δ) | 8.02% | -3.98% | 2.02% | 7.95% | -4.34% | 1.81% | 8.13% | -4.22% | 1.96% |
| | Equivalent Variation*** | 33.56 | -17.78 | 31.56 | 51.04 | -23.00 | 56.07 | 43.74 | -21.35 | 44.78 |
| | Real income effect | 47.04 | -24.11 | 45.86 | 61.41 | -27.22 | 68.39 | 55.33 | -26.41 | 57.84 |
| | Consumer effect | -13.48 | 6.33 | -14.30 | -10.38 | 4.22 | -12.32 | -11.59 | 5.06 | -13.05 |
| Scenario 1 (No trade diversion) | Real GDP (%Δ) | 2.00% | 0.00% | 1.00% | 2.49% | 0.03% | 1.26% | 2.40% | -0.04% | 1.18% |
| | Total imports* (%Δ) | 56.65% | 0.00% | 28.33% | 56.76% | 0.03% | 28.39% | 56.90% | -0.00% | 28.45% |
| | Total exports** (%Δ) | 56.65% | 0.00% | 28.33% | 56.77% | 0.02% | 28.39% | 56.93% | -0.03% | 28.45% |
| | Regional income (%Δ) | 7.86% | 0.00% | 3.93% | 7.77% | 0.07% | 3.92% | 7.89% | -0.03% | 3.93% |
| | Equivalent Variation*** | 32.56 | 0.00 | 65.11 | 53.71 | 1.72 | 110.85 | 43.47 | -0.02 | 86.90 |
| | Real income effect | 46.09 | 0.00 | 92.18 | 64.71 | 2.01 | 133.44 | 55.28 | -0.02 | 110.53 |
| | Consumer effect | -13.53 | 0.00 | -27.06 | -11.01 | -0.29 | -22.59 | -11.81 | -0.01 | -23.63 |
| Scenario 2 (No trade diversion; non-members fix imports from members) | Real GDP (%Δ) | 2.00% | 0.00% | 1.00% | 2.42% | 0.08% | 1.25% | 2.36% | 0.00% | 1.18% |
| | Total imports* (%Δ) | 56.65% | 0.00% | 28.33% | 56.68% | 0.04% | 28.36% | 56.85% | 0.00% | 28.43% |
| | Total exports** (%Δ) | 56.65% | 0.00% | 28.33% | 56.68% | 0.04% | 28.36% | 56.85% | 0.00% | 28.43% |
| | Regional income (%Δ) | 7.86% | 0.00% | 3.93% | 7.69% | 0.12% | 3.91% | 7.86% | 0.00% | 3.93% |
| | Equivalent Variation*** | 32.56 | 0.00 | 65.11 | 53.35 | 1.70 | 110.10 | 43.43 | 0.00 | 86.87 |
| | Real income effect | 46.09 | 0.00 | 92.18 | 64.30 | 1.98 | 132.57 | 55.24 | 0.00 | 110.48 |
| | Consumer effect | -13.53 | 0.00 | -27.06 | -10.96 | -0.28 | -22.47 | -11.81 | 0.00 | -23.61 |

Source: Simulated by author. Note: * Total import is the sum of bilateral imports, not the Armington aggregate; and ** total export is the sum of bilateral exports, not the CET aggregate. Regional income is the sum of disposable incomes of the household, the government, and the bank; and *** the Equivalent Variation consists the real income effect and consumer surplus effect, in world currency: \$.

2.5.1 Perfect Competition

In Scenario 0 each CU member increases its imports from the other member while importing less from non-members (Table 2-17). However the fall in those imports is smaller than the fall in the corresponding exports to the same non-member. This result is robust across market structures, since imports are differentiated by origin due to the Armington assumption, while exports are not distinguished by destination. At the same time, non-members increase trade among themselves, which offsets some of the loss from trade diversion. From Table 2-19 it is clear that the members' EV gains do offset the non-members' welfare losses, and the welfare effect on the world as a whole is unambiguously positive. The total trade volume grows by 21.5%, increasing the world's real GDP and gross income by 0.7% and 2.0%, respectively.

In Scenario 1 CU members keep bilateral imports from non-members at the pre-CU levels by endogenously cutting their tariff rates by 42.9%. Given perfect competition, this arrangement consequently fixes bilateral exports to non-members, keeping them completely isolated from the unfavourable trade diversion. As a result, both Scenarios 1 and 2 yield identical outcomes under perfect competition. The welfare of member economies and the world as a whole becomes higher than in Scenario 0. However, the rise in bilateral trade within the CU is smaller since members no longer replace imports from non-members with those from their partner. Nevertheless, as reported in Table 2-19, the overall imports, exports and real GDP in member regions are boosted, signifying that the avoidance of trade diversion commonly benefits all regions.⁴¹

2.5.2 Cournot Oligopoly with Barriers to Entry/Exit

The changes in bilateral imports in the Cournot oligopoly model are generally similar to those from the perfect competition model (Table 2-17). However, the magnitudes of changes under

⁴¹ Although members benefit more in real terms, the governments inevitably lose to a greater extent as tariffs against non-members are endogenised (Table 2-18). Thus, their income gains decrease in the latter two scenarios.

oligopoly (*SEC2*) are stronger than in the perfectly competitive sector (*SEC1*) because of the economies of scale and flexibility in the elasticity of demand. Hence the CU members benefit from a greater expansion in real GDP and trade compared to Subsection 2.5.1.

The trade diversion effect on *SEC2* is stronger than that in *SEC1*. Thus the CU members must set lower tariffs on *SEC2* imports than in the previous case in order to eliminate trade diversion (Scenario 1, Table 2-18). As a consequence, members' total trade flows increase by more than in Scenario 0, resulting in higher outcomes for regional EV and real GDP expansion. However income declines slightly as the governments lose more revenues due to the endogenisation of tariffs against non-members (Table 2-19).

Interestingly, once tariff endogenisation takes place (Scenario 1), the real aggregate indicators of non-members become positively affected. Under Cournot oligopoly, the demand elasticity in Cournot sectors increases in accordance with the variation in expenditure shares as total imports and demands by CU members are augmented. Thus, the higher the sensitivity to price, the more it effectively reduces mark-up rates and increases market efficiency. As a result, CU formation with external tariff endogenisation under Cournot oligopoly yields the highest welfare gains to each region and to the world as a whole among all scenarios. In particular, the gains for non-members in Scenario 2 are not as high as in Scenario 1, because the policy of maintaining non-members' imports from the CU zone prevents the CU members from making the fullest use of the increasing returns to scale.

2.5.3 Monopolistic Competition with Barriers to Entry/Exit

Sectors under Cournot oligopoly or monopolistic competition commonly share the property of scale economies, which ensures that imperfectly competitive sectors will expand proportionally more than perfectly competitive ones as the formation of a customs union of trading partners takes place. Thus, we find that the variation in trade patterns under both types of imperfectly competitive market structure is comparable. In terms of magnitude, however, monopolistic competition results in weaker effects on real variables compared to oligopoly,

because of the fixed elasticity of demand in the former. Thus, for all scenarios, we find the changes in bilateral imports and aggregate outcomes under monopolistic competition to be greater than under perfect competition but still smaller than under Cournot oligopoly. As this applies to members and non-members alike, it is not clear which type of imperfect competition is more beneficial to the world economy.

Although the world unambiguously gains after the endogenisation of CU tariffs on non-members (Scenario 1), the welfare effects for non-members remain marginally negative, firstly since the demand elasticity does not adjust to the new trade regime as under oligopoly, and hence there are no ‘oligopolistic gains,’ and secondly because imperfect competition implies greater negative effects on non-members.

If non-members also fix their bilateral imports from the grouping (Scenario 2), trade diversion is completely eliminated, although the extent of welfare improvement is not substantial, and probably less than the potential adjustment costs. Moreover, CU members gain less, and the world welfare is similarly diminished.

In summary, the welfare results illustrated in Subsections 2.5.1-2.5.3 suggest that Scenario 1 will yield the most efficient outcome for the world economy, and a substantial welfare improvement from non-members endogenising tariffs on imports from CU members is unlikely.

2.6 Sensitivity Tests

This Section examines the sensitivity of simulation results to elasticity parameters and macroeconomic closures given different types of market structure.

2.6.1 Elasticity of Substitution between Primary Factors (σF)

The sensitivity of the CU simulation results to the substitutability between capital, labour and land in the CES production function (σF) is reported in Table 2-20. In general, a 100% increase in this elasticity yields very small changes in real variables and regional EVs:

Table 2-20: The sensitivity of key variables to the substitution elasticity between primary factors (σF) in the CU simulations under different market structures (benchmark: $\sigma F = 0.8$)

| Changes in real values (%) and regional welfares | | Market structures | | Cournot oligopoly (barred mobility) | | Monopolistic competition (barred mobility) | |
|--|-------------|---------------------|------------------|-------------------------------------|------------------|--|------------------|
| | | Perfect competition | | | | | |
| | | $\sigma F = 0.4$ | $\sigma F = 0.8$ | $\sigma F = 0.4$ | $\sigma F = 0.8$ | $\sigma F = 0.4$ | $\sigma F = 0.8$ |
| Household consumption | CU members | 11.25% | 12.11% | 10.76% | 11.81% | 11.21% | 12.33% |
| | Non-members | -3.87% | -3.55% | -3.94% | -3.82% | -3.90% | -3.73% |
| Investment | CU members | 2.81% | 3.05% | 2.70% | 2.96% | 2.87% | 3.16% |
| | Non-members | -0.97% | -0.89% | -0.98% | -0.96% | -0.97% | -0.93% |
| Government consumption | CU members | -1.61% | -1.36% | -0.74% | 0.16% | -1.08% | -0.37% |
| | Non-members | -2.25% | -2.62% | -3.46% | -3.91% | -2.99% | -3.43% |
| Real GDP | CU members | 1.25% | 1.81% | 1.51% | 2.47% | 1.49% | 2.34% |
| | Non-members | -0.40% | -0.48% | -1.08% | -1.32% | -0.82% | -1.02% |
| Total imports | CU members | 52.00% | 52.94% | 51.93% | 53.20% | 52.10% | 53.33% |
| | Non-members | -10.02% | -9.85% | -10.33% | -10.24% | -10.19% | -10.09% |
| Total exports | CU members | 46.54% | 47.53% | 46.54% | 47.92% | 46.69% | 48.01% |
| | Non-members | -4.55% | -4.44% | -4.94% | -4.96% | -4.78% | -4.77% |
| Regional EV | CU members | 30.09 | 33.56 | 46.21 | 51.04 | 39.31 | 43.74 |
| | Non-members | -17.85 | -17.78 | -23.77 | -23.00 | -21.83 | -21.35 |

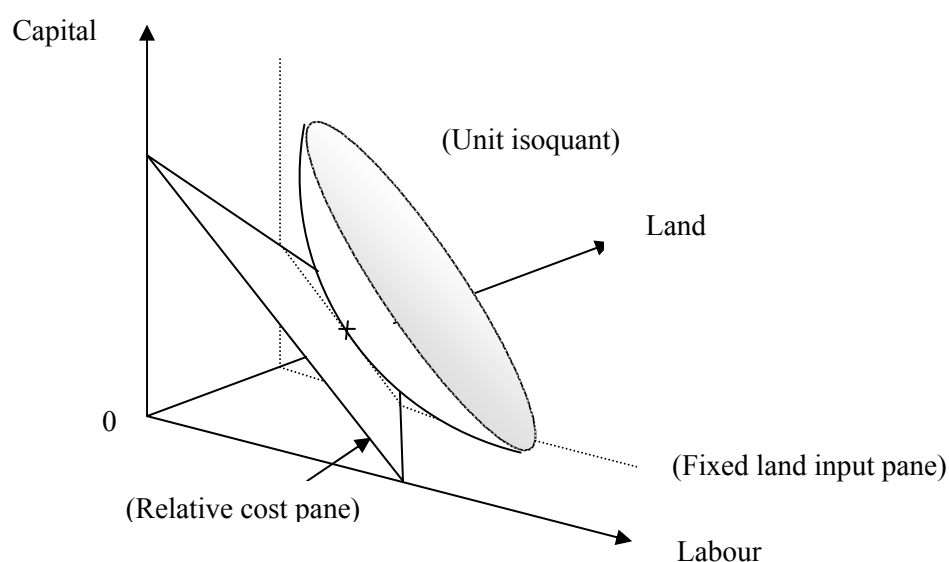
Source: Simulated by author.

World welfare gains increase with the level of σF . To explain why a higher substitution elasticity enhances the benefits arising from a CU formation, consider the unit isoquant diagram given three factor inputs in Figure 2-6.

In Figure 2-6, the relative prices of these three factors determine the three-dimensional slope of the relative cost pane. The curvature of the unit isoquant is derived from the benchmark values, and the equilibrium point is where the isoquant is tangent with the cost pane. If land is sector-specific, then the amount of land inputs to that sector is fixed, and the equilibrium

point after a change is always located on the ‘fixed land input’ pane, parallel to the capital-labour pane. Hence, when a policy shock alters the slope of the relative cost pane, the substitution elasticity determines the extent to which producers will substitute a relatively less expensive factor for another. Since the land input is fixed, even though the shift in the relative cost pane is three-dimensional, the key determinant of the equilibrium factor inputs is the relative rental rates of labour and capital. While the simulation outcomes also depend on factor intensities, in general, a change in the relative prices of these two factors of production will cause a larger change in the capital-labour ratio in the sector with the higher elasticity of substitution.

Figure 2-6: Three-dimensional unit isoquant given three factor inputs



2.6.2 Trade Elasticities (σA and σBM)

This section considers the sensitivity of welfare outcomes to Armington trade elasticities, comprising the upper-level substitution elasticity between domestic products and aggregate imports (σA); and the lower-level elasticity between imports from different origins (σBM).

Table 2-21: The sensitivity of key variables to the substitution elasticities between domestic products and imports (σA); and imports from different origins (σBM) in the CU simulations under different market structures (benchmark values: $\sigma A = 2$ and $\sigma BM = 4$)

| Market structures | | Perfect competition | | Cournot oligopoly (barred mobility) | | Monopolistic competition (barred mobility) | | | |
|-------------------------------|-------------|--|---------------|-------------------------------------|---------------|--|---------------|----------------|--------------|
| | | Changes in real values (%) and regional welfares | | $\sigma A=1.5$ | $\sigma A=2$ | $\sigma A=1.5$ | $\sigma A=2$ | $\sigma A=1.5$ | $\sigma A=2$ |
| | | $\sigma BM=3$ | $\sigma BM=4$ | $\sigma BM=3$ | $\sigma BM=4$ | $\sigma BM=3$ | $\sigma BM=4$ | | |
| Household consumption | CU members | 10.93% | 12.11% | 10.62% | 11.81% | 10.99% | 12.33% | | |
| | Non-members | -3.42% | -3.55% | -3.58% | -3.82% | -3.54% | -3.73% | | |
| Investment | CU members | 2.73% | 3.05% | 2.66% | 2.96% | 2.82% | 3.16% | | |
| | Non-members | -0.86% | -0.89% | -0.89% | -0.96% | -0.88% | -0.93% | | |
| Government consumption | CU members | -1.41% | -1.36% | -0.05% | 0.16% | -0.56% | -0.37% | | |
| | Non-members | -2.12% | -2.62% | -3.27% | -3.91% | -2.88% | -3.43% | | |
| Real GDP | CU members | 1.63% | 1.81% | 2.26% | 2.47% | 2.09% | 2.34% | | |
| | Non-members | -0.47% | -0.48% | -1.16% | -1.32% | -0.93% | -1.02% | | |
| Total imports | CU members | 37.47% | 52.94% | 37.69% | 53.20% | 37.71% | 53.33% | | |
| | Non-members | -7.70% | -9.85% | -7.97% | -10.24% | -7.87% | -10.09% | | |
| Total exports | CU members | 31.90% | 47.53% | 32.29% | 47.92% | 32.27% | 48.01% | | |
| | Non-members | -2.13% | -4.44% | -2.58% | -4.96% | -2.43% | -4.77% | | |
| Regional EV | CU members | 29.62 | 33.56 | 45.00 | 51.04 | 38.57 | 43.74 | | |
| | Non-members | -16.25 | -17.78 | -20.39 | -23.00 | -19.50 | -21.35 | | |

Source: Simulated by author.

Under each type of market structure, Table 2-21 reports the percentage changes in real values and regional EVs of members and non-members given two different sets of trade elasticities, of which the counterfactual values of σA and σBM are 75% of the benchmark ones. Higher trade elasticity considerably increases consumer demands in CU regions, and the percentage changes in total imports and exports are stronger for all regions. Total imports and exports adjust to a greater extent given higher Armington elasticities, which means that both trade creation and trade diversion effects become ‘stronger.’ Hence, CU members reap higher benefits, and non-members lose further from the proposed change. Overall, the welfare effects of preferential tariff cuttings are very sensitive to this set of parameters.

2.6.3 Macroeconomic Closure Rules for the External Balance

The sensitivity of the results to the macroeconomic closure rule is reported in Table 2-22, where the real effects of the regional grouping are reasonably robust across the exchange rate regime, while the import prices in domestic markets are directly affected by the closure rule.

Table 2-22: The sensitivity of key variables to the macroeconomic closure in the CU simulations under different market structures (benchmark: flexible exchange rate regime)

| Market structures | | Perfect competition | | Cournot oligopoly (barred mobility) | | Monopolistic competition (barred mobility) | |
|-------------------------------|----------------------|------------------------|---------------------|-------------------------------------|---------------------|--|---------------------|
| | | Flexible exchange rate | Fixed exchange rate | Flexible exchange rate | Fixed exchange rate | Flexible exchange rate | Fixed exchange rate |
| Household consumption | CU members | 12.11% | 11.62% | 11.81% | 11.25% | 12.33% | 11.75% |
| | Non-members | -3.55% | -2.99% | -3.82% | -3.32% | -3.73% | -3.18% |
| Investment | <i>Total (world)</i> | 2.16% | 2.16% | 2.00% | 1.98% | 2.23% | 2.22% |
| | CU members | 3.05% | -12.52% | 2.96% | -11.02% | 3.16% | -11.12% |
| | Non-members | -0.89% | 14.68% | -0.96% | 13.00% | -0.93% | 13.34% |
| Government consumption | CU members | -1.36% | -1.97% | 0.16% | -0.57% | -0.37% | -1.06% |
| | Non-members | -2.62% | -2.05% | -3.91% | -3.24% | -3.43% | -2.78% |
| Real GDP | CU members | 1.81% | 1.74% | 2.47% | 2.30% | 2.34% | 2.21% |
| | Non-members | -0.48% | -0.40% | -1.32% | -1.16% | -1.02% | -0.87% |
| Total imports | CU members | 52.94% | 50.44% | 53.20% | 50.86% | 53.33% | 50.97% |
| | Non-members | -9.85% | -7.57% | -10.24% | -8.16% | -10.09% | -7.96% |
| Total exports | CU members | 47.53% | 50.91% | 47.92% | 50.84% | 48.01% | 51.02% |
| | Non-members | -4.44% | -8.04% | -4.96% | -8.14% | -4.77% | -8.01% |
| Regional EV | CU members | 33.56 | 24.14 | 51.04 | 42.14 | 43.74 | 34.56 |
| | Non-members | -17.78 | -8.34 | -23.00 | -14.59 | -21.35 | -12.19 |

Source: Simulated by author.

Under the flexible exchange rate regime, CU formation leads to an appreciation of the local currency of member regions, thus they are encouraged to import more and export less than under the fixed exchange rate regime. Their foreign savings are not affected by the policy change. On the other hand, the CU members under the fixed rate regime adjust to the shock through capital outflows, so that we observe a decline in domestic savings and investment.

Consequently, the fixed exchange rate regime yields less positive effects on real variables and regional EVs of the CU members than does the flexible regime.

Under the flexible rate regime, the exchange rates of non-members tend to depreciate against the CU member currency after the formation. Hence, the welfare effects of switching between the two regimes are the opposite of those perceived in CU regions, and the capital flows from the CU economies to these regions will boost their investment demands and lessen the negative impacts of being left outside the grouping. Note that the difference in the 'domestic' investment demand increases under the two regimes can be explained by the row reporting the 'world' investment demand increase, for which the rates under different regimes are nearly identical. Therefore, the exchange rate regime is the determinant of the allocation of international investment.

Summarising, the fixed exchange rate regime tends to reduce welfare gains in the CU regions and welfare losses for non-members, which is the result of resource reallocation and changes in trade patterns and world demands for tradable goods after the policy change.

2.6.4 The Wage Curve Elasticity (ω)

Since the wage curve represents the downward-sloping relationship between unemployment and real wages, its elasticity must be negative.⁴² When the elasticity is increased, the labour market becomes less flexible in that the rise in the unemployment rate is smaller for a given fall in real wages. This explains why the 100% increase in the wage curve elasticity decreases the percentage changes in the unemployment rates by approximately 35-39%. As a consequence, the welfare effects of CU formation are weakened in all regions, but not to a marked extent, except for the government consumption, which is more sensitive to the wage curve elasticity. The reason for this is that the unemployment benefits transferred by the

⁴² The relationship between these two variables was already explained in Equation (2-40).

government to the household largely depend on this elasticity. Nonetheless, the results in Table 2-23 are generally robust against the level of the wage curve elasticity.

Table 2-23: The sensitivity of key variables to the wage curve elasticity (ω) in the CU simulations under different market structures (benchmark: $\omega = -0.1$)

| Market structures | | Perfect competition | | Cournot oligopoly (barred mobility) | | Monopolistic competition (barred mobility) | |
|------------------------|-------------|---------------------|---------------|-------------------------------------|---------------|--|---------------|
| | | $\omega=-0.1$ | $\omega=-0.2$ | $\omega=-0.1$ | $\omega=-0.2$ | $\omega=-0.1$ | $\omega=-0.2$ |
| Unemployment | CU members | -74.39% | -45.25% | -80.21% | -51.90% | -74.60% | -47.94% |
| | Non-members | 22.53% | 13.73% | 20.69% | 13.55% | 21.02% | 13.61% |
| Household consumption | CU members | 12.11% | 11.84% | 11.81% | 11.13% | 12.33% | 11.72% |
| | Non-members | -3.55% | -3.48% | -3.82% | -3.72% | -3.73% | -3.62% |
| Investment | CU members | 3.05% | 2.96% | 2.96% | 2.79% | 3.16% | 3.01% |
| | Non-members | -0.89% | -0.87% | -0.96% | -0.93% | -0.93% | -0.90% |
| Government consumption | CU members | -1.36% | -2.28% | 0.16% | -1.08% | -0.37% | -1.48% |
| | Non-members | -2.62% | -2.34% | -3.91% | -3.61% | -3.43% | -3.13% |
| Real GDP | CU members | 1.81% | 1.15% | 2.47% | 1.50% | 2.34% | 1.49% |
| | Non-members | -0.48% | -0.27% | -1.32% | -1.07% | -1.02% | -0.77% |
| Total imports | CU members | 52.94% | 52.25% | 53.20% | 52.12% | 53.33% | 52.36% |
| | Non-members | -9.85% | -9.83% | -10.24% | -10.23% | -10.09% | -10.06% |
| Total exports | CU members | 47.53% | 46.77% | 47.92% | 46.73% | 48.01% | 46.95% |
| | Non-members | -4.44% | -4.34% | -4.96% | -4.84% | -4.77% | -4.64% |
| Regional EV | CU members | 33.56 | 30.00 | 51.04 | 47.20 | 43.74 | 40.20 |
| | Non-members | -17.78 | -16.87 | -23.00 | -22.41 | -21.35 | -20.63 |

Source: Simulated by author.

2.6.5 Public Sector Expansion

To examine the sensitivity of the welfare results to the size of the government, the domestic taxes in each region (i.e., income taxes, commodity taxes and factor usage taxes) are all raised by 10%, so that the public sector is ‘neutrally’ enlarged. This gives some insight into the probable outcome of CU formation, which we would expect to reduce government tariff revenues. Thus, if the governments are to keep their public good consumptions at the pre-grouping levels, then they need to adjust their domestic tax rates accordingly.

Table 2-24: The sensitivity of key variables to a larger public sector (*SEC3*) in the CU simulations under different market structures

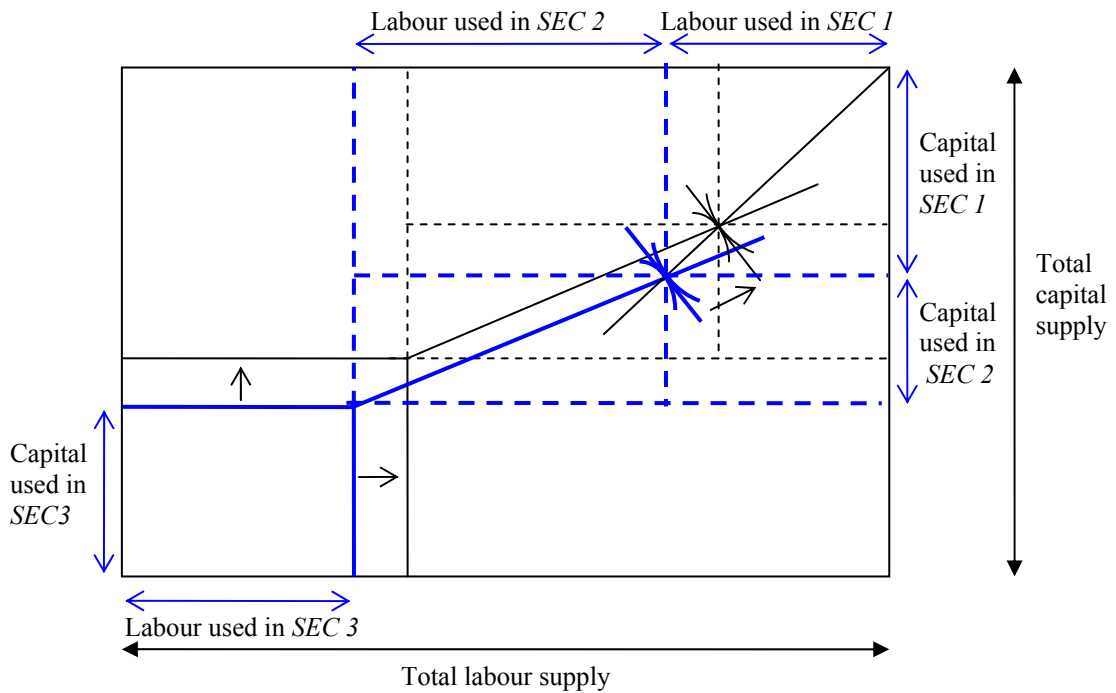
| Market structures | | Perfect competition | | Cournot oligopoly (barred mobility) | | Monopolistic competition (barred mobility) | |
|-----------------------------------|-------------|---------------------------------|--|--|--|--|--|
| | | Benchmark domestic tax rates | Domestic tax rates increased by 10% | Benchmark domestic tax rates | Domestic tax rates increased by 10% | Benchmark domestic tax rates | Domestic tax rates increased by 10% |
| Household consumption | CU members | 12.11% | 6.30% | 11.81% | 6.43% | 12.33% | 6.60% |
| | Non-members | -3.55% | -8.70% | -3.82% | -8.51% | -3.73% | -8.71% |
| Investment | CU members | 3.05% | 3.20% | 2.96% | 3.24% | 3.16% | 3.36% |
| | Non-members | -0.89% | -0.61% | -0.96% | -0.56% | -0.93% | -0.61% |
| Government consumption | CU members | -1.36% | 2.46% | 0.16% | 5.08% | -0.37% | 4.06% |
| | Non-members | -2.62% | 0.76% | -3.91% | 0.41% | -3.43% | 0.46% |
| Real GDP | CU members | 1.81% | 1.40% | 2.47% | 2.85% | 2.34% | 2.34% |
| | Non-members | -0.48% | -0.89% | -1.32% | -1.04% | -1.02% | -1.09% |
| Total imports | CU members | 52.94% | 49.54% | 53.20% | 50.75% | 53.33% | 50.36% |
| | Non-members | -9.85% | -11.78% | -10.24% | -11.63% | -10.09% | -11.76% |
| Total exports | CU members | 47.53% | 44.23% | 47.92% | 45.55% | 48.01% | 45.13% |
| | Non-members | -4.44% | -6.47% | -4.96% | -6.42% | -4.77% | -6.54% |
| Regional EV | CU members | 33.56 | 21.90 | 51.04 | 41.76 | 43.74 | 33.62 |
| | Non-members | -17.78 | -29.73 | -23.00 | -33.10 | -21.35 | -31.93 |

Source: Simulated by author.

The results in Table 2-24 show that the domestic tax raise does increase demands for public goods (*SEC3*), while also hampering production in the private sectors (*SEC1* and *SEC2*). Since factor demands in public sectors increase, such a contraction in the private sectors is aggravated as factor inputs are bid away (Figure 2-7). This crowding-out effect is clearly observable in Table 2-24, where the expansion in the public sectors not only increases government consumption while reducing household demands, but also affects the macroeconomic indicators adversely (i.e. total imports and exports, real GDPs and regional EVs). As a consequence, consumer prices fall, and a slight reduction in nominal investments allows real investments to increase with the size of the government. Note that falls in nominal investments are low because government and foreign savings are exogenous in this model.

Hence, total savings only weakly affected by the expansion, and the impact on investment is lower than that on household consumption. Hence, real investment demands may increase, but the rest of the economy inevitably faces undesirable outcomes.

Figure 2-7: Expansion of the public sector (*SEC3*) and the crowding-out effect on the other private sectors



The extent to which each region is required to adjust its domestic tax rates in order to maintain the public good provision at the pre-grouping level ranges from 1 to 3%, which is much smaller than the 10% increase reported in Table 2-24. Thus, the economic outcomes will not be as detrimental as suggested above.

Note that as the public sector expands, the positive change in real GDP remains at the same level under monopolistic competition and increases under oligopoly. The reason is that stronger market imperfection implies more positive effects on domestic consumption due to the scale economies. In nominal terms, the regional EVs improve with the degree of imperfect competition so that, for CU members, when the domestic tax rates are raised by 10%, their EVs drop by 34.74% under perfect competition; 23.14% under monopolistic competition; and

18.18% under oligopoly. Since similar outcomes are observed in non-member regions, it seems that the aggregate effects of imperfect competition are beneficial to both regional and world economies.

2.6.6 Initial Import Tariff Rates

Table 2-25: The sensitivity of key variables to the initial import tariff rates in the CU simulations under different market structures (benchmark = 50%)⁴³

| Market structures | | Perfect competition | | Cournot oligopoly (barred mobility) | | Monopolistic competition (barred mobility) | |
|-------------------------------|-------------|-------------------------|-------------------------|-------------------------------------|-------------------------|--|-------------------------|
| | | Pre-CU tariff rate: 50% | Pre-CU tariff rate: 60% | Pre-CU tariff rate: 50% | Pre-CU tariff rate: 60% | Pre-CU tariff rate: 50% | Pre-CU tariff rate: 60% |
| Household consumption | CU members | 10.25% | 12.94% | 10.01% | 12.59% | 10.37% | 13.10% |
| | Non-members | -3.02% | -3.72% | -3.24% | -4.00% | -3.17% | -3.90% |
| Investment | CU members | 2.56% | 3.24% | 2.51% | 3.16% | 2.66% | 3.36% |
| | Non-members | -0.76% | -0.93% | -0.81% | -1.00% | -0.79% | -0.97% |
| Government consumption | CU members | -0.46% | -0.61% | 1.03% | 1.21% | 0.49% | 0.57% |
| | Non-members | -2.22% | -2.78% | -3.30% | -4.14% | -2.91% | -3.64% |
| Real GDP | CU members | 1.51% | 1.89% | 2.23% | 2.73% | 2.05% | 2.56% |
| | Non-members | -0.40% | -0.50% | -1.11% | -1.38% | -0.87% | -1.08% |
| Total imports | CU members | 42.66% | 52.31% | 43.01% | 52.72% | 43.02% | 52.81% |
| | Non-members | -8.47% | -9.81% | -8.77% | -10.19% | -8.65% | -10.04% |
| Total exports | CU members | 37.96% | 46.90% | 38.44% | 47.45% | 38.42% | 47.51% |
| | Non-members | -3.77% | -4.40% | -4.20% | -4.93% | -4.04% | -4.74% |
| Regional EV | CU members | 30.08 | 37.73 | 45.27 | 55.99 | 38.78 | 48.70 |
| | Non-members | -15.12 | -18.74 | -19.38 | -24.10 | -18.13 | -22.46 |

Source: Simulated by author.

This section examines how the initial tariff rates may alter the welfare implication of CU formation. Accordingly, the benchmark Social Accounting Matrix (SAM) is modified by increasing the import tariff rates by 20%, and the SAM is re-balanced by reducing all

⁴³ In order to prevent infeasibility problems, the simulations for all scenarios are conducted by reducing the tariff rates between members by 88% in both simulations.

commodity tax rates from 25% to 19%. Table 2-25 shows that the higher initial tariff rates accentuate the trade creation and trade diversion outcomes of the regional trade liberalisation. Therefore, the welfare gains from opening up to trade (within the CU) increase with the initial tariff levels, but the region will also lose more if it is left outside the grouping. Also, the result interpretation is straightforward, since the 20% higher initial tariff rates alter the percentage changes in real variables and regional EVs by some 20-25%.

2.6.7 Initial Regional Size Ratio

This subsection focuses on the sensitivity of the market size simulation results in Section 2.3, and so investigates how the market size ratio will affect the welfare outcomes. As the initial scales of production are expanded by 400% in small regions and reduced by 30% in large ones, the market size ratio adjusts from 1:10 to 4:7, leaving the world's total outputs and the input-output structure in each region unaffected. The sensitivity results are reported in Table 2-26.

As described in Section 2.3, for a CU member, the magnitude of the welfare gains from preferential tariff cuttings largely depends on the initial economic size of its counterpart. Under the first two CU scenarios (between regions of identical sizes), as the economies of small regions are initially four times larger, the real variables in small regions are positively affected; whereas large CU regions in the second scenario are worse off as their size is reduced by 30%. A similar logic can be applied to the simulation results of CU formations between regions of different sizes. On the other hand, for a region outside the grouping, the magnitude of the welfare losses increases with the initial size of CU members, and decreases with that of the other non-member region. For example, in the first scenario (*REG1+REG2*), large non-members are notably worse off after the initial market size ratio is altered. This is not only because non-members' economies become smaller (which implies lower demand for trade), but also because the larger CU triggers stronger trade diversion effects.

Table 2-26: The sensitivity of key variables to the initial market size ratio in the CU simulations with regions of different sizes (benchmark ratio: small/large = 1/10)

| Scenarios | | REG1+REG2 | | REG1+REG2 REG3+REG4 | | REG1+REG3 | | REG1+REG3 REG2+REG4 | |
|---------------------------|------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|-----------------------------|
| | | GDP size ratio 1:10 | GDP size ratio 4:7 | GDP size ratio 1:10 | GDP size ratio 4:7 | GDP size ratio 1:10 | GDP size ratio 4:7 | GDP size ratio 1:10 | GDP size ratio 4:7 |
| Household consumption | REG1 | 8.66% | 8.94% | 4.81% | 5.59% | 11.61% | 10.32% | 9.89% | 8.37% |
| | REG2 | 8.66% | 8.94% | 4.81% | 5.59% | -2.00% | -2.33% | 9.89% | 8.37% |
| | REG3 | -0.21% | -1.37% | 16.58% | 12.24% | 1.23% | 5.80% | 0.39% | 3.02% |
| | REG4 | -0.21% | -1.37% | 16.58% | 12.24% | -0.82% | -2.75% | 0.39% | 3.02% |
| Investment | REG1 | 2.17% | 2.24% | 1.20% | 1.40% | 2.90% | 2.58% | 2.47% | 2.09% |
| | REG2 | 2.17% | 2.24% | 1.20% | 1.40% | -0.50% | -0.58% | 2.47% | 2.09% |
| | REG3 | -0.05% | -0.34% | 4.14% | 3.06% | 0.31% | 1.45% | 0.10% | 0.75% |
| | REG4 | -0.05% | -0.34% | 4.14% | 3.06% | -0.21% | -0.69% | 0.10% | 0.75% |
| Government consumption | REG1 | -0.66% | -0.42% | -4.17% | -3.44% | 0.66% | 0.27% | -0.77% | -1.55% |
| | REG2 | -0.66% | -0.42% | -4.17% | -3.44% | -1.46% | -1.70% | -0.77% | -1.55% |
| | REG3 | -0.15% | -0.99% | -2.38% | -2.19% | 0.11% | 0.07% | -0.52% | -2.19% |
| | REG4 | -0.15% | -0.99% | -2.38% | -2.19% | -0.59% | -2.02% | -0.52% | -2.19% |
| Real GDP | REG1 | 1.30% | 1.33% | 0.82% | 0.92% | 1.67% | 1.50% | 1.47% | 1.28% |
| | REG2 | 1.30% | 1.33% | 0.82% | 0.92% | -0.27% | -0.31% | 1.47% | 1.28% |
| | REG3 | -0.03% | -0.18% | 2.42% | 1.83% | 0.18% | 0.86% | 0.08% | 0.52% |
| | REG4 | -0.03% | -0.18% | 2.42% | 1.83% | -0.11% | -0.37% | 0.08% | 0.52% |
| Total imports | REG1 | 36.51% | 37.11% | 29.41% | 30.64% | 48.62% | 42.39% | 45.21% | 39.11% |
| | REG2 | 36.51% | 37.11% | 29.41% | 30.64% | -5.64% | -6.57% | 45.21% | 39.11% |
| | REG3 | -0.58% | -3.80% | 65.06% | 51.36% | 4.89% | 23.58% | 2.58% | 16.69% |
| | REG4 | -0.58% | -3.80% | 65.06% | 51.36% | -2.37% | -7.87% | 2.58% | 16.69% |
| Total exports | REG1 | 33.32% | 33.42% | 32.02% | 32.25% | 38.59% | 35.68% | 37.88% | 35.39% |
| | REG2 | 33.32% | 33.42% | 32.02% | 32.25% | -2.49% | -2.90% | 37.88% | 35.39% |
| | REG3 | -0.26% | -1.69% | 64.80% | 50.44% | 4.21% | 20.87% | 3.32% | 18.82% |
| | REG4 | -0.26% | -1.69% | 64.80% | 50.44% | -1.01% | -3.43% | 3.32% | 18.82% |
| Regional EV | REG1 | 2.48 | 10.50 | 0.40 | 3.28 | 3.71 | 12.89 | 2.82 | 8.61 |
| | REG2 | 2.48 | 10.50 | 0.40 | 3.28 | -1.00 | -4.66 | 2.82 | 8.61 |
| | REG3 | -1.04 | -4.76 | 43.80 | 22.02 | 4.07 | 12.60 | -0.13 | 2.52 |
| | REG4 | -1.04 | -4.76 | 43.80 | 22.02 | -4.08 | -4.44 | -0.13 | 2.52 |

Source: Simulated by author. Note: Numbers in bold letters are those of the regions involved in a CU formation.

It is noteworthy that the welfare of the large regions forming a CU with smaller ones in the fourth scenario is largely improved after the market size ratio modification, especially in

terms of the regional EVs. The results imply that if the size of a CU counterpart relative to the rest of the world is sufficiently small then large regions would rather maintain the status quo, since trade diversion might dominate the welfare outcomes.

2.6.8 Initial Number of Firms in Cournot Oligopolistic Sectors

This section examines the sensitivity of the FTA simulation results in Section 4 to the number of firms. This is only of concern when sectors operate under Cournot oligopoly, in which few firms compete against each other. The effects of increasing sectoral competition by 100% are compared in Table 2-27:

Table 2-27: The sensitivity of key variables to the initial number of firms (*NOF*) in Cournot oligopolistic sectors (benchmark: *NOF* = 3)

| Market structures | | Cournot oligopoly (free mobility) | | Cournot oligopoly (barred mobility) | |
|------------------------|-------------|-----------------------------------|----------------|-------------------------------------|----------------|
| | | <i>NOF</i> = 3 | <i>NOF</i> = 6 | <i>NOF</i> = 3 | <i>NOF</i> = 6 |
| Household consumption | CU members | 13.40% | 12.77% | 11.81% | 12.06% |
| | Non-members | -3.79% | -3.63% | -3.82% | -3.64% |
| Investment | CU members | 3.36% | 3.19% | 2.96% | 3.02% |
| | Non-members | -0.95% | -0.91% | -0.96% | -0.91% |
| Government consumption | CU members | 0.73% | -0.61% | 0.16% | -0.91% |
| | Non-members | -3.85% | -3.07% | -3.91% | -3.08% |
| Real GDP | CU members | 3.50% | 2.47% | 2.47% | 1.99% |
| | Non-members | -1.34% | -0.80% | -1.32% | -0.77% |
| Total imports | CU members | 54.79% | 53.71% | 53.20% | 52.98% |
| | Non-members | -10.06% | -9.92% | -10.24% | -9.98% |
| Total exports | CU members | 49.62% | 48.40% | 47.92% | 47.61% |
| | Non-members | -4.89% | -4.60% | -4.96% | -4.63% |
| Regional EV | CU members | 42.83 | 37.28 | 51.04 | 40.28 |
| | Non-members | -21.74 | -19.23 | -23.00 | -19.78 |

Source: Simulated by author.

Provided that the initial total real factor costs are kept at the same level, if an oligopolistic sector starts off with more firms then those firms face lower real fixed costs and higher real variable costs as the market becomes more ‘competitive.’ This in turn decreases the

economies of scale, and the welfare changes are reduced. The results in Table 2-27 are in general consistent with this prediction. However, in member regions, government consumption declines; and household consumption and investment with barred entry respond to the shock more positively. For the government, since higher market competition reduces tax revenues, the increase in the number of firms is unfavourable to government consumption. As for the final demands of the household and the bank, under free entry, the number of firms adjusts to keep up production efficiency after the shock, thus the sectoral zero-profit condition always holds. If this adjustment is barred, then the incumbent firms in member regions face fewer profit losses after the regional grouping.⁴⁴ That implies higher incomes of the firm owner, and household consumption and investment increase as we assume a higher initial number of firms given barred entry.

2.6.9 Substitution Elasticity between Varieties under Monopolistic Competition

Below, Table 2-28 illustrates the sensitivity of the simulation results in Section 2.4 with respect to the elasticity of substitution between varieties (σ_{LV}) in monopolistically competitive sectors.

The results in Table 2-28 indicate that a higher σ_{LV} reduces the welfare changes in real variables and regional EVs, regardless of the assumption made about firm mobility. As described in Section 2.4, σ_{LV} is specific to sectors with heterogeneous products, and equals the demand elasticity. As σ_{LV} increases, the mark-up rates drop, and the market becomes more competitive with less potential to exploit economies of scale. That is to say, the monopolistic power under monopolistic competition depends on the preference for varieties. If consumers become more flexible in substituting between varieties, the mark-up rates then inevitably drop, and thus we would expect weaker effects from regional trade liberalisation.

⁴⁴ Recall the results from Section 2.4 that under imperfect competition, firms inside the CU grouping will lose their profits as the mark-up rates fall due to higher competition from abroad.

Table 2-28: The sensitivity analysis for the elasticity of substitution between varieties in monopolistically competitive sectors (benchmark: $\sigma LV = 4$)

| Changes in real values (%) and regional welfares | | Market structures | | Monopolistic competition (free mobility) | | Monopolistic competition (barred mobility) | |
|--|-------------|-------------------|-------------|--|-----------------|--|-----------------|
| | | CU members | Non-members | $\sigma LV = 4$ | $\sigma LV = 6$ | $\sigma LV = 4$ | $\sigma LV = 6$ |
| Household consumption | CU members | | | 12.78% | 12.50% | 12.33% | 12.22% |
| | Non-members | | | -3.54% | -3.50% | -3.73% | -3.63% |
| Investment | CU members | | | 3.25% | 3.14% | 3.16% | 3.08% |
| | Non-members | | | -0.86% | -0.86% | -0.93% | -0.91% |
| Government consumption | CU members | | | -0.77% | -1.12% | -0.37% | -0.85% |
| | Non-members | | | -3.33% | -3.01% | -3.43% | -3.06% |
| Real GDP | CU members | | | 3.52% | 2.80% | 2.34% | 2.08% |
| | Non-members | | | -1.08% | -0.82% | -1.02% | -0.77% |
| Total imports | CU members | | | 54.80% | 54.01% | 53.33% | 53.11% |
| | Non-members | | | -10.01% | -9.95% | -10.09% | -9.98% |
| Total exports | CU members | | | 49.61% | 48.73% | 48.01% | 47.75% |
| | Non-members | | | -4.82% | -4.67% | -4.77% | -4.61% |
| Regional EV | CU members | | | 41.90 | 38.39 | 43.74 | 39.19 |
| | Non-members | | | -19.96 | -18.90 | -21.35 | -19.81 |

Source: Simulated by author.

From Figure 2-8, a higher level of the substitution elasticity between varieties also raises the scaling vector ($NOF^{1/(1-\sigma LV)}$), given that there must be more than one firm under monopolistic competition.

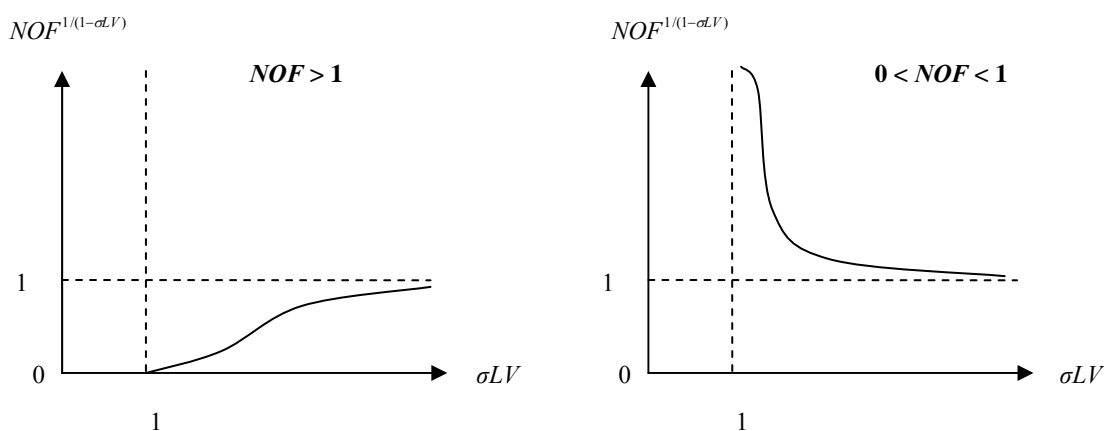


Figure 2-8: The Elasticity of Substitution between Varieties as a Determinant of the Auxiliary Scaling Vector Given the Number of Firms ($\sigma LV > 1$)

It is obvious from Equation (2-85) that an increase in the scaling vector lowers the ratio of the individual price to the group price index. From Equation (2-97), this change in turn suggests that the group quantity index should decrease in relation to the total outputs from individual firms. Therefore, higher flexibility in consumer preferences requires that monopolistically competitive producers lose some of their price-setting powers.

2.7 Summary

This chapter examines the properties of regional trade liberalisation in low-dimensional models with highly-controlled datasets. From the CU simulations between regions of different market sizes under perfect competition, it is clear that the larger the CU counterpart is, the bigger are the regional welfare gains to be expected. Thus, a large region may potentially be worse off when forming a CU with a smaller region, if the rest of the world concurrently forms another CU. As a consequence, the trade-creating effect arising from regional trade liberalisation may be strongly offset by the trade-diverting effect, measured by the reduction in trade volume and tariff revenue as relatively large economies are left outside the grouping.

The simulations of CUs among regions of identical sizes yet under various market structures suggest that the welfare effects of forming a CU in the presence of imperfect competition are stronger than those under a perfectly competitive setting. By the same token, Cournot oligopoly yields higher benefits from regional trading arrangements than monopolistic competition, due to greater procompetitive effects. As for the barriers to enter and exit the market, models with restrictive firm mobility find lower expansion of real GDP within the grouping; however, since the gains from CU formation are instead transferred to the household in the form of the augmented profits of firms, this firm immobility assumption consequently raises the estimated EVs of union counterparts.

In the experiment on the elimination of trade diversion, the endogenisation of CU members' common external tariffs on imports from non-members, with the intention of keeping the external import demands at the pre-union levels, significantly enhances regional and world

welfare under all types of market structure. Moreover, provided that members adjust their common external tariffs appropriately when forming a union, non-members will only be marginally influenced under imperfect competition and completely unaffected under perfect competition. Thus, there is no real incentive for non-members to retaliate with a counteracting trade policy so as to keep themselves isolated from this external CU shock.

Finally, the sensitivity tests have been investigated. In general, the variability in the CU welfare results in relation to the values of numerous parameters are reasonably robust and theoretically sensible. However, the specification of the exchange rate regime affects investment demand and border price in a non-negligible way, with the flexible exchange rate regime likely to be more welfare-enhancing. In addition, a bigger government tends to worsen regional welfare due to the substantial crowding-out effect, and the higher are the ex-ante tariff rates, the stronger are the magnitude of welfare effects of the regional grouping. In particular, in the simulation of CU formation between regions of disparate sizes, the sensitivity test that alters the relative market size ratio confirms that the members' welfare gains increase with the relative sizes of their counterparts. Hence, it is once again confirmed that regions always have a strong incentive to seek for a regional economic integration with larger economies in a model without endowment differences and no adjustment costs.

CHAPTER 3

THE EVALUATION OF THAILAND'S PREFERENTIAL TRADING ARRANGEMENTS WITH AUSTRALIA, NEW ZEALAND, JAPAN, CHINA AND INDIA

3.1 Introduction

Thailand has become progressively more open since the Industrial Promotion Act (IPA) was revised in 1972. Over the last quarter century, the country has kept abreast of many other developing countries, such that the economy has shifted from import-substituting to export-oriented industrialisation regimes, although the real acceleration of trade liberalisation dates back to the 1980s. In the wake of the Asian crisis in 1997, temporary import surcharges to protect vulnerable sectors were imposed, but overall tariff protection continued to decline, although certainly more slowly than in many other emerging economies such as China and India.

The current deteriorating momentum of trade liberalisation in Thailand is attributable to the lacklustre pace of the Doha Round of the World Trade Organisation (WTO), and thus the consequent attractiveness of Free Trade Agreement (FTA) initiatives in Asia and the Pacific. Effectively, bilateral and plurilateral economic partnership has grown prominent in Thai economic policy since 2001 under the Shinawatra administration. Historically, Thailand's leading trading partners are Japan, the United States, the European Union (EU), and the Association of South East Asian Nations (ASEAN), with nearly equal shares of 15-20% of total Thai trade; while trade with Australia, New Zealand, China, and India altogether account for 10% of total trade (see Table 3-1). Accordingly, since 2001, Thai FTA initiatives have issued thick and fast, involving large trading partners in East and South Asia such as China, Japan, Korea and India, and also Australia, New Zealand, Bahrain, Peru, the United States,

and European Free Trade Association (EFTA). Some of the above are supplemented by plurilateral initiatives involving all other members of ASEAN. In addition, there is also talk of the East Asia Summit (EAS), bringing together ASEAN, China, Japan, Korea, and potentially South Asia. Despite the Thai government's bold take on this matter, few initiatives have been implemented, due to domestic political controversy ignited by preferential tariff cuts in a number of sectors, namely, the fierce reaction of 'the losers.' In consequence, so far, merely five FTAs between Thailand and each of Australia, New Zealand, Japan, China, and India, have come into force, while the rest of FTA negotiations are stalled.

Table 3-1: Merchandise bilateral trade between Thailand and her FTA partners, 2001-2006

| Country | 2001-02 | | 2003-04 | | 2005-06 | |
|----------------------|----------------------------|----------------------|----------------------------|----------------------|----------------------------|----------------------|
| | Trade flows (million baht) | Share in total trade | Trade flows (million baht) | Share in total trade | Trade flows (million baht) | Share in total trade |
| <i>Exports</i> | | | | | | |
| Australia | 130,725 | 2.25% | 188,585 | 2.62% | 292,242 | 3.12% |
| New Zealand | 16,904 | 0.29% | 24,105 | 0.34% | 40,765 | 0.44% |
| Japan | 866,431 | 14.94% | 1,013,277 | 14.10% | 1,228,257 | 13.12% |
| China | 279,337 | 4.82% | 521,237 | 7.25% | 811,868 | 8.67% |
| India | 39,057 | 0.67% | 63,028 | 0.88% | 129,382 | 1.38% |
| ASEAN | 1,136,867 | 19.61% | 1,533,530 | 21.33% | 2,001,633 | 21.38% |
| Rest of World | 3,328,852 | 57.41% | 3,844,763 | 53.48% | 4,857,481 | 51.89% |
| Total exports | 5,798,173 | 100% | 7,188,525 | 100% | 9,361,628 | 100% |
| <i>Imports</i> | | | | | | |
| Australia | 124,579 | 2.26% | 154,397 | 2.22% | 260,784 | 2.71% |
| New Zealand | 17,464 | 0.32% | 18,302 | 0.26% | 22,224 | 0.23% |
| Japan | 1,252,633 | 22.68% | 1,657,017 | 23.88% | 2,025,705 | 21.04% |
| China | 376,767 | 6.82% | 580,733 | 8.37% | 964,696 | 10.02% |
| India | 63,221 | 1.14% | 82,176 | 1.18% | 112,612 | 1.17% |
| ASEAN | 913,224 | 16.53% | 1,162,443 | 16.75% | 1,767,556 | 18.36% |
| Rest of World | 2,775,964 | 50.25% | 3,284,878 | 47.33% | 4,472,015 | 46.46% |
| Total imports | 5,523,854 | 100% | 6,939,947 | 100% | 9,625,593 | 100% |

Source: Compiled by author from Customs Department of Thailand (2007).

Such a fast-paced pursuit of preferential trading arrangements naturally raises questions regarding the suitability of the government's choice of negotiating partners. By and large, it is

perceived that the Thai government approached Japan – one of the established export markets for Thailand – in order to retain market access and expand access for new product lines; while Australia, New Zealand, China and India were chosen as Thailand's other negotiating partners since they are large markets with great potential for trade expansion. Thus, if a choice of a negotiating partner is to be evaluated with respect to the importance of trade with Thailand, Table 3-1 broadly supports the argument that trade relations are enhanced by such groupings: since Thailand became vigorously engaged in FTA negotiations in 2001, the import and export shares of Thai FTA partners in total Thai trade has gradually increased, except for Japan, as the FTA between Thailand and Japan has just been signed in 2007.

However, the government may take into account other factors when seeking an FTA partner. In a comprehensive study by the Fiscal Policy Research Institute of Thailand (FPRI, 2005), 180 countries were ranked with respect to their attractiveness as FTA partners for Thailand. The index used was the weighted average of each country's attractiveness in terms of 1) relative economic size, population, and trade; 2) its leadership and role as a gateway to other countries in a particular region; 3) its abundance in natural resources; and 4) the index of economic freedom, indicative of the extent of government intervention, for instance, the granting of exclusive rights for some companies to operate in domestic markets, the scale of trade barriers, and the degree of investment and economic cooperation between Thailand and her negotiating partners. Among the five FTAs entered into force, India has the highest score; followed by China and Japan, which are equally attractive as negotiating partners; and lastly Australia and New Zealand, which are ranked in the middle range among all countries. Thus, according to FPRI (2005), the concluded FTAs may be regarded as sensible deals mainly on *political* grounds. Nevertheless, it remains very important for the government and the private sector to fully understand the potential *economic* effects of these FTAs on individual sectors and the country as a whole.

Accordingly, Chapter 3 is organised as follows. Firstly, Section 3.2 highlights a number of modifications of the model previously constructed in Chapter 2. Next, Section 3.3 explains

the treatment of the data, chiefly obtained from the GTAP 6.0 database, along with the criteria for the aggregation of data by region and sector, and the asymmetric determination of the commodity market structure (the degree of market competitiveness) and the labour market closure (the relationship between real wage and unemployment). Subsequently, Section 3.4 discusses the detailed commitments of the free trading arrangements that Thailand has reached with Australia, New Zealand, Japan, China and India, and Section 3.5 then analyses the welfare implications of these groupings through the CGE approach. Finally, Section 3.6 tests the sensitivity of the results, and Section 3.7 concludes.

3.2 General Model Structure

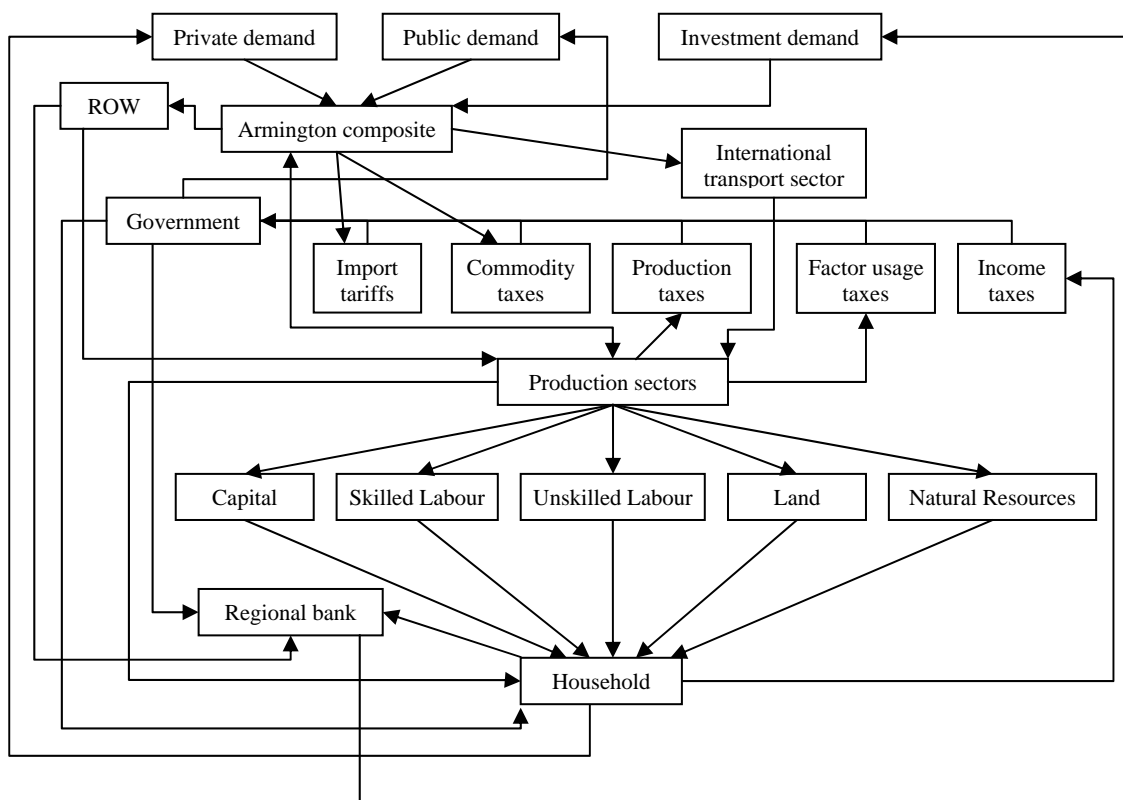


Figure 3-1: Flow of payments in the model

In Chapter 3, the model constructed in Chapter 2 is modified to reconcile with the GTAP 6.0 database, while transportation costs are treated as in the GTAP-EG model (Rutherford and Paltsev, 2000). The flow of payments within each region is shown in Figure 3-1, and

Appendix A3-1 describes the model structure in full details. In this version of the static CGE model, production is constrained by the size of factor endowments in each region, namely capital, skilled labour, unskilled labour, land, and natural resources. Capital, skilled and unskilled labour are mobile across production sectors but not across regions, whereas land and natural resources are completely immobile, so that factor returns may vary by sector. Capital, land, and natural resources are fully employed at each point of time, while there is unemployment in the labour markets in some regions due to wage rigidity. Factor costs in each sector are minimised on the assumption of Constant Elasticity of Substitution (CES) production functions, with the estimated sectoral elasticity of substitution among primary factors ranging between 0.20 to 1.68 (these parameters are taken from the GTAP 6.0 database, and are labelled as $esubva_{sec}$). Firms also demand intermediate inputs – which are Armington composites of differentiated domestically-produced and imported goods – as a fixed proportion of final output (i.e. via a Leontief production function). Firms pay factor usage taxes in proportion to factor costs as in the previous model. In addition, this model introduces production taxes on producers as a fixed proportion of the value of output, in order to reconcile the model with the GTAP 6.0 database. For perfectly competitive sectors, the final products supplied to domestic and overseas markets are differentiated by destination via Constant Elasticity of Transformation (CET) functions, with a fixed mark-up for international transport added to each traded commodity. On the other hand, there are two types of imperfectly competitive sectors. Under monopolistic competition, goods are horizontally differentiated by product variety (Krugman, 1979), and there is freedom of entry. Therefore, there are no residual profits in the long run. However, under Cournot oligopoly, goods are homogeneous and there is no freedom of entry. Hence, the firms' residual profits accrue to the capital owner, i.e. the household.

Each region has a representative household, which is endowed with the natural and labour resources, land, and capital stocks, i.e. the household receives factor incomes from the production sectors. Where unemployment exists, the household also receives benefits

proportional to the level of unemployment, in addition to other lump-sum transfers from the government. The household in turn pays income taxes as a fixed proportion of total incomes, then saves a fixed proportion of the residual income, and spends the rest on private good consumption in accordance with the nested CES utility function.

The government receives tax revenues from various sources and then spends them on 1) public good consumption with respect to its CES utility function and 2) transfers to the household. The residual is identified as government savings (or deficits when negative), which are in turn passed on to the regional bank. The regional bank receives savings from the household, government, and the rest of the world. Foreign savings transferred from the rest of the world are fixed in real terms under the assumed flexible exchange rate regime, and their value always equals net regional imports in nominal terms. The bank then spends all regional savings on investment final demands subject to a CES utility function.

In addition to the above general description of the model prepared for the analysis of the Thai FTAs, specific features newly incorporated into the model are explained below.

3.2.1 Trade: Armington and CET Functions

As in Chapter 2, regional economies are internationally linked through bilateral trade flows. Bilateral imports from different regions of goods in each given market are combined into an import composite, which is further aggregated with domestically-produced goods into a single Armington good, ultimately purchased by production and final demand sectors. The distinction between bilateral imports of the same good from different origins and between domestically-produced and aggregate import goods is again modelled through a nested Armington CES function, with trade elasticities ranging between 3.80 to 16.81 for the import aggregate; and from 1.90 to 5.20 for the final Armington good (respectively, the parameters called $esubm_{sec}$ and $esubd_{sec}$ in the GTAP 6.0 database).

On the supply side, domestic production is either sold to the domestic market or exported to foreign markets. In this chapter, producers differentiate outputs sold in domestic and overseas markets while maximising their total profits subject to the nested CET transformation function. The CET elasticities between tradable outputs supplied to domestic and the aggregate foreign market (σT_{secT}^{reg}) and between exports destined for the various overseas markets (σBE_{secT}^{reg}) are similarly specified as -2 (Bayar et al., 2006).

Figure 3-2 summarises the flow of tradable commodities $secT$ in each region.

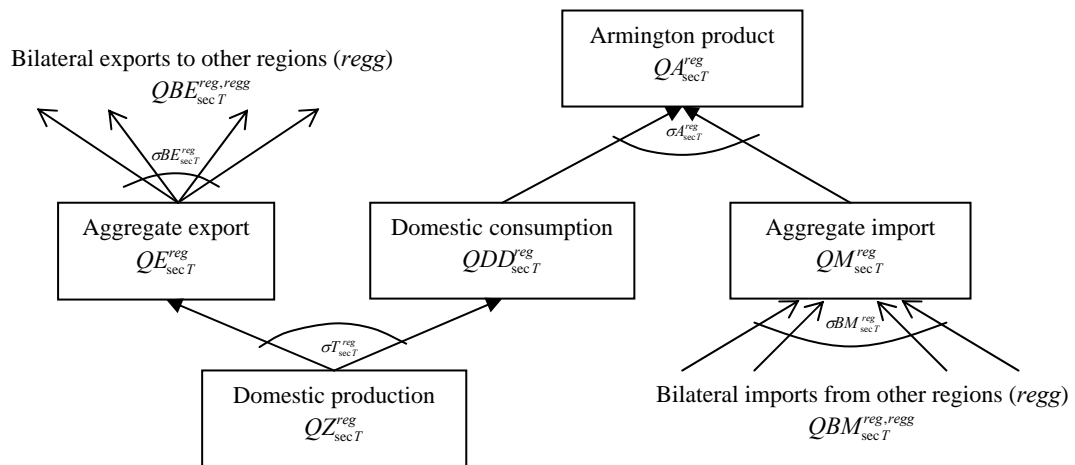


Figure 3-2: CET distributions and Armington aggregations in region reg 's tradable sectors

3.2.2 Household, Government, and Bank: CES Utility Function

There are three final demand sectors, namely private, public, and investment. Each sector purchases imported commodities (as Armington aggregates), as well as goods from domestic producers. Instead of the Cobb-Douglas functional form utilised in Chapter 2, in this chapter, final consumption products are substitutable under the CES utility function with the elasticity

of substitution of σD^{reg} (see Figure 3-3). The household, the government, and the bank share a common substitution elasticity equivalent to 1.43.¹

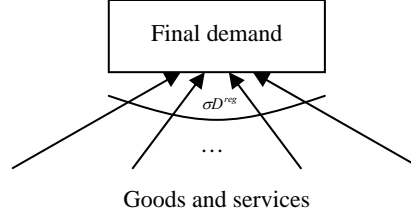


Figure 3-3: Final demand aggregation for household, government, and bank

3.2.2.1 Household

Denote by $CBUD^{reg}$ the ‘real’ disposable income (as opposed to the nominal disposable income in Chapter 2), net of income taxes and household savings, and $PCBUD^{reg}$ the household’s disposable income deflator. Given the CES distribution parameter (γHH_{sec}^{reg}) and the substitution elasticity parameter (ρD^{reg}), the household demand for each commodity (C_{sec}^{reg}) is derived by maximising the CES utility function:

$$CBUD^{reg} = \left[\sum_{sec} \gamma HH_{sec}^{reg} \cdot (C_{sec}^{reg})^{\rho D^{reg}} \right]^{\frac{1}{\rho D^{reg}}}, \quad (3-1)$$

subject to the budget constraint:

$$PCBUD^{reg} \cdot CBUD^{reg} = \sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA_{sec}^{reg} \cdot C_{sec}^{reg}, \quad (3-2)$$

where PA_{sec}^{reg} is the sectoral consumer price of each commodity, and tc_{sec}^{reg} is the ad valorem commodity tax rate.² This budget constraint requires that the household spends all its income, net of saving and income tax payment, on purchasing consumption goods. Since the elasticity

¹ This CES elasticity is derived from the GRACE model by Aaheim and Rive (2005).

² As in Equation (2-98) of Chapter 2, the sectoral consumer price of commodity mc in region reg under monopolistic competition is henceforth defined as the function of individual consumer price of each product variety: $PA_{mc<sec}^{reg} = (NOF_{mc}^{reg})^{\frac{1}{1-\sigma L_{sec}^{reg}}} \cdot pa_{mc}^{reg}$.

of substitution between final goods is defined as $\sigma D^{reg} = 1/(1 - \rho D^{reg})$, the maximisation of the household utility in Equation (3-1) yields the following household final demand function:

$$C_{sec}^{reg} = CBUD^{reg} \cdot \left[\gamma HH_{sec}^{reg} \cdot \frac{PCBUD^{reg}}{(1 + t_{sec}^{reg}) \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}} \quad (3-3)$$

3.2.2.2 Government

The government's 'real' disposable income net of savings and transfers to the representative household, denoted by $CGBUD^{reg}$, is deflated using the government's disposable income deflator, $PCGBUD^{reg}$. Given the same elasticity of substitution between products as in the case of the household (σD^{reg}), the CES distribution parameter is defined as γGV_{sec}^{reg} , and the government utility is thus optimised when:

$$CG_{sec}^{reg} = CGBUD^{reg} \cdot \left[\gamma GV_{sec}^{reg} \cdot \frac{PCGBUD^{reg}}{PA_{sec}^{reg}} \right]^{\sigma D^{reg}} \quad (3-4)$$

providing that the government spends all its income, net of saving and household transfer, on purchasing consumption goods:

$$PCGBUD^{reg} \cdot CGBUD^{reg} = \sum_{sec} PA_{sec}^{reg} \cdot CG_{sec}^{reg} \quad (3-5)$$

3.2.2.3 Bank

Given the bank's 'real' money inflow, S^{reg} , which is equivalent to its nominal inflow deflated by price PS^{reg} , the CES utility-optimising investment demand with the distribution parameter γI_{sec}^{reg} is derived as:

$$I_{sec}^{reg} = S^{reg} \cdot \left[\gamma I_{sec}^{reg} \cdot \frac{PS^{reg}}{PA_{sec}^{reg}} \right]^{\sigma D^{reg}} \quad (3-6)$$

providing that the bank spends all the saving on purchasing investment goods:

$$PS^{reg} \cdot S^{reg} = \sum_{sec} PA_{sec}^{reg} \cdot I_{sec}^{reg}. \quad (3-7)$$

3.2.3 International Transport

Transport costs function as another barrier to trade. They drive a wedge between world prices of bilateral exports and imports. Thus, producers, especially under oligopoly, may refrain from exporting to an overseas market if transport margins drive up their consumer prices in that market to a level at which they become uncompetitive in comparison with local producers.³

For that reason, transport costs are explicitly incorporated in line with the GTAP-EG model (Rutherford and Paltsev, 2000). In this model, the representative global shipping company pools a Cobb-Douglas composite of transport services from individual regions as demanded by exporters. Denote by $trsp$ the subset of sec comprising transport service sectors, producers in region reg then export their services $TRSPR_{trsp}^{reg}$ to the global shipping company at the export price of PE_{trsp}^{reg} . Thus, the values of their regional exports are constant shares $\alpha TRSPR_{trsp}^{reg}$ of the global transport service $TRSPG_{trsp}$ with the price of $PTRSPG_{trsp}$:

$$PE_{trsp}^{reg} \cdot TRSPR_{trsp}^{reg} = \alpha TRSPR_{trsp}^{reg} \cdot (PTRSPG_{trsp} \cdot TRSPG_{trsp}), \text{ and} \quad (3-8)$$

$$TRSPG_{trsp} = \sum_{reg} TRSPR_{trsp}^{reg}. \quad (3-9)$$

When commodity $secT$ is exported from region $regg$ to region reg , a price premium equivalent to:

$$\sum_{trsp} PTRSPG_{trsp} \cdot \delta_{trsp, secT}^{regg, reg}$$

³ Note that this negative effect of international transport service should be lower when a sector is perfectly or monopolistically competitive, since each and every country/region will export some quantity to each other country/region, primarily owing to the Armington configuration.

is automatically paid by its exporting destination to the global transport company, and thus consumers in region reg bear transport costs by facing a higher import price in world currency, denoted by $PWM_{secT}^{reg,regg}$:

$$PWM_{secT}^{reg,regg} = PWE_{secT}^{regg,reg} + \sum_{trsp} PTRSPG_{trsp} \cdot \delta_{trsp,secT}^{regg,reg}. \quad (3-10)$$

To determine Equation (3-10), the price premium is specified to be proportional to the parameter called $\delta_{trsp,secT}^{reg,regg}$, which is the ‘real’ international transport margin per unit of trade, calculated as a fixed fraction of benchmark bilateral trade data. Therefore, the following relationship also holds:

$$TRSPG_{trsp} = \sum_{reg} \sum_{regg} \sum_{secT} \delta_{trsp,secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}. \quad (3-11)$$

Lastly, to ensure consistency with the GTAP 6.0 database structure, transport services supplied to the international transport sector are explicitly modelled as transport margins, and thus are distinguished from other types of transport services supplied to domestic and export markets.

3.2.4 Commodity Market Structure: The Degree of Market Imperfection

Based on the specification of commodity market structures explained in Chapter 2, the model in this chapter specifies three types of market structure:

- Perfect competition,
- Cournot oligopoly with homogeneous products and entry/exit barriers, and
- Monopolistic competition under which consumers prefer product variety and firms are free to enter and exit the market.

This subsection briefly reviews the modelling of the three market structures and then describes how sectors are ‘identified’ as perfectly competitive, oligopolistic, or monopolistically competitive.

3.2.4.1 Commodity Market Structure Designs

In Chapter 2 it was assumed that all sectors were perfectly competitive, and all firms in a given sector produced homogeneous goods under constant returns to scale.⁴ Freedom of entry and exit from such sectors ensures that in the long-run there are only ‘normal’ profits, i.e. price is equal to average cost.

On the other hand, a market is likely to become imperfectly competitive when producers enjoy increasing returns to scale, since in the presence of a sizeable fixed cost, average cost exceeds marginal cost, thus average cost declines as the scale of production is increased. This type of internal economy of scale encourages firms to merge in order to benefit from the wedge between selling price and average cost. However, if firms are free to enter and exit the market, then price will converge to average costs, and the rent will eventually become zero. As firms maximise profits at the point where marginal cost equals marginal revenue (MR), with entry and exit barriers, we derive: $PZ > AC > MC = MR$; and without the barriers, this relativity becomes: $PZ = AC > MC = MR$.

Accordingly, Cournot oligopolistic sectors with restricted firm mobility, and monopolistically competitive sectors with free mobility of firms, are respectively incorporated into the current CGE model as follows.

3.2.4.1.1 Cournot Oligopoly with Firms’ Entry and Exit Barriers (Homogeneous Products)

In the standard model, Cournot oligopoly is usually associated with manufacturing and service sectors, where a small number of firms ‘compete’ in terms of quantities. In general, oligopolistic firms in each sector produce homogeneous products, and in making their decisions they assume that the other firms have myopic foresight and so will not react. They seek to maximise profits – i.e. they set marginal cost equal to marginal revenue. Also, due to

⁴ Perfectly competitive sectors may also operate under decreasing returns to scale, however, such a possibility is not strongly emphasised in this model.

the limited level of market competition, firms are usually assumed to be able to set prices. Since oligopolists price in accordance with the perceived price elasticity of demand (EDM_{sec}^{reg}) rather than total demand (Ruffin, 2003), a low elasticity of demand implies high sectoral profits ($PROFIT_{sec}^{reg}$). Additionally, in a Cournot oligopolistic sector, the number of firms is fixed (henceforth denoted by $\overline{NOF}_{sec}^{reg}$), whilst sectoral profit is endogenous.

Although the model maintains the above assumptions about Cournot oligopoly, factor prices are endogenous to each region. Production is assumed to use CES technology.⁵ Furthermore, in each region the domestic good is not a perfect substitute for imported goods, and goods originating in other regions are also imperfect substitutes for each other (i.e. the Armington assumption is made). Moreover, oligopolistic firms, while playing the standard Cournot game where firms decide on the quantities they will produce and sell in the various markets, are obliged to pay taxes on production and factor use, although they may enjoy protection in their own market via tariffs on imported equivalent goods.

Note that the above oligopolistic assumptions are mainly taken from the model developed in Chapter 2, except for the additional incorporation of production taxes (tz_{sec}^{reg}), taken from the output taxes in the GTAP 6.0 database. Hence, Equation (2-105) in Chapter 2 now becomes:

$$(1 - tz_{sec}^{reg}) \cdot PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1 + tf_{sec}^{fac,reg}) \cdot \left(\begin{array}{l} PFM_{sec}^{fac,reg} \$ facM(fac) \\ + PFS_{sec}^{fac,reg} \$ facS(fac) \end{array} \right) \cdot F_{sec}^{fac,reg} + \sum_{secc} PA_{secc}^{reg} \cdot IO_{secc,sec}^{reg} + PROFIT_{sec}^{reg}. \quad (3-12)$$

Thus, the condition still holds for all oligopolistic sectors sec in region reg that total revenue less total cost equals sectoral profit. The mark-up pricing condition for oligopolistic firms in Chapter 2, i.e. Equation (2-64), equating marginal revenue with marginal cost, is modified in accordance with the newly introduced production taxes as follows:

⁵ The detailed specification of production under imperfect competition has already been discussed in Chapter 2.

$$PZ_{\text{sec}}^{\text{reg}} \left(1 - \frac{1}{EDM_{\text{sec}}^{\text{reg}} \cdot NOF_{\text{sec}}^{\text{reg}}} \right) = \sum_{\text{fac}} (1 + t_{\text{sec}}^{\text{fac,reg}}) \cdot \left(\frac{PFM_{\text{sec}}^{\text{fac,reg}} \$\text{fac}M(\text{fac})}{+PFS_{\text{sec}}^{\text{fac,reg}} \$\text{fac}S(\text{fac})} \right) \cdot \frac{FV_{\text{sec}}^{\text{fac,reg}}}{QZ_{\text{sec}}^{\text{reg}}} \quad (3-13)$$

$$+ \sum_{\text{sec}c} PA_{\text{sec}c}^{\text{reg}} \cdot io_{\text{sec}c,\text{sec}}^{\text{reg}} + tz_{\text{sec}}^{\text{reg}} \cdot PZ_{\text{sec}}^{\text{reg}}.$$

The derivation of the perceived price elasticity of demand under Cournot oligopoly is analogous to that introduced in Chapter 2, although with a number of modifications. First, the perceived elasticity of demand for ‘non-traded’ commodities ($EDM_{\text{sec}TN \subset \text{sec}}^{\text{reg}}$) is derived by firstly taking the natural log of the market clearing condition where total supply equals the sum of final and intermediate demands:

$$QZ_{\text{sec}TN}^{\text{reg}} = C_{\text{sec}TN}^{\text{reg}} + I_{\text{sec}TN}^{\text{reg}} + CG_{\text{sec}TN}^{\text{reg}} + \sum_{\text{sec}} IO_{\text{sec}TN,\text{sec}}^{\text{reg}}.$$

In contrast with Equation (2-69) in Chapter 2, it is assumed that non-traded sectors no longer supply solely to the government. Therefore, the perceived elasticity of demand for non-traded goods is re-calculated by subsequently totally differentiating the natural log of the above market clearing condition:

$$EDM_{\text{sec}TN}^{\text{reg}} = -\hat{QZ}_{\text{sec}TN}^{\text{reg}} / \hat{PZ}_{\text{sec}TN}^{\text{reg}} = \left(C_{\text{sec}TN}^{\text{reg}} + I_{\text{sec}TN}^{\text{reg}} + CG_{\text{sec}TN}^{\text{reg}} \right) / \left(QZ_{\text{sec}TN}^{\text{reg}} - IO_{\text{sec}TN,\text{sec}TN}^{\text{reg}} \right), \quad (3-14)$$

which is comparable, but not identical, to Equation (2-72) in Chapter 2.

However, the perceived price elasticity of demand for ‘tradable’ sectors under oligopoly ($EDM_{\text{sec}T \subset \text{sec}}^{\text{reg}}$) remains the same weighted average of the demand elasticities in the domestic and foreign markets, denoted respectively by $EDM_{\text{sec}T \subset \text{sec}}^{\text{reg,reg}}$ and $EDM_{\text{sec}T \subset \text{sec}}^{\text{reg,regg}}$, as formerly indicated in Equation (2-73). The own-market demand elasticity is derived by log differentiating the Armington demand function for domestically-produced products in Equation (2-29) to derive the expression previously derived in Equation (2-75):

$$EDM_{\text{sec}T}^{\text{reg,reg}} = -\sigma A_{\text{sec}T}^{\text{reg}} \cdot \frac{\hat{P}A_{\text{sec}T}^{\text{reg}}}{\hat{P}D_{\text{sec}T}^{\text{reg}}} + \sigma A_{\text{sec}T}^{\text{reg}} - \frac{\hat{Q}A_{\text{sec}T}^{\text{reg}}}{\hat{P}A_{\text{sec}T}^{\text{reg}}} \cdot \frac{\hat{P}A_{\text{sec}T}^{\text{reg}}}{\hat{P}D_{\text{sec}T}^{\text{reg}}}.$$

As in Equation (2-76), the elasticity of the Armington price to the domestically-produced price ($\hat{P}A_{secT}^{reg} / \hat{P}D_{secT}^{reg}$) reflects the ratio of the expenditure on a domestically-produced good to total Armington expenditure. However, given the CES demand function assumed here, the elasticity of Armington demand to its own price ($\hat{Q}A_{secT}^{reg} / \hat{P}A_{secT}^{reg}$) is the negative of the elasticity of substitution between Armington composite goods in a region ($-\sigma D^{reg}$). This is because the greater the value of $-\sigma D^{reg}$, the more consumers substitute products in other sectors as the price of the Armington good increases. Hence, the perceived own-market demand elasticity in Equation (2-77) is redefined as:

$$EDM_{secT}^{reg,reg} = \sigma A_{secT}^{reg} - \left(\sigma A_{secT}^{reg} - \sigma D^{reg} \right) \cdot \frac{PD_{secT}^{reg} \cdot QDD_{secT}^{reg}}{PA_{secT}^{reg} \cdot QA_{secT}^{reg}}. \quad (3-15)$$

Similarly, the foreign-market demand elasticity ($EDM_{secT \subset sec}^{reg,regg}$) is derived by log differentiating the nested Armington demand function for imports from different origins in Equation (2-78) to obtain the following expression:

$$EDM_{secT}^{reg,regg} = \sigma BM_{secT}^{regg} - \left(\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg} \right) \frac{\hat{P}M_{secT}^{regg}}{P\hat{B}M_{secT}^{regg,reg}} - \left(\sigma A_{secT}^{regg} + \frac{\hat{Q}A_{secT}^{regg}}{\hat{P}A_{secT}^{regg}} \right) \frac{\hat{P}A_{secT}^{regg}}{P\hat{B}M_{secT}^{regg,reg}}.$$

The perceived demand elasticity in foreign markets is then:

$$EDM_{secT}^{reg,regg} = \sigma BM_{secT}^{regg} - \left(\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg} \right) \cdot \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PM_{secT}^{regg} \cdot QM_{secT}^{regg}} - \left(\sigma A_{secT}^{regg} - \sigma D^{regg} \right) \cdot \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PA_{secT}^{regg} \cdot QA_{secT}^{regg}}. \quad (3-16)$$

As a result, given the results from Equations (3-15) and (3-16), the perceived elasticity of demand for tradable sectors under Cournot oligopoly in Equation (2-80) of Chapter 2 is redefined as:

$$\begin{aligned}
EDM_{secT}^{reg} = & \frac{QDD_{secT}^{reg}}{QZ_{secT}^{reg}} \cdot \left(\sigma A_{secT}^{reg} - (\sigma A_{secT}^{reg} - \sigma D^{reg}) \cdot \frac{PD_{secT}^{reg} \cdot QDD_{secT}^{reg}}{PA_{secT}^{reg} \cdot QA_{secT}^{reg}} \right) \\
& + \sum_{\substack{regg \\ (\neq reg)}} \frac{QBM_{secT}^{regg,reg}}{QZ_{secT}^{reg}} \cdot \left(\begin{aligned} & \left(\sigma BM_{secT}^{regg} - (\sigma BM_{secT}^{regg} - \sigma A_{secT}^{regg}) \cdot \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PM_{secT}^{regg} \cdot QM_{secT}^{regg}} \right) \\ & - (\sigma A_{secT}^{regg} - \sigma D^{regg}) \cdot \frac{PBM_{secT}^{regg,reg} \cdot QBM_{secT}^{regg,reg}}{PA_{secT}^{regg} \cdot QA_{secT}^{regg}} \end{aligned} \right)
\end{aligned} \tag{3-17}$$

3.2.4.1.2 Monopolistic Competition with Free Entry and Exit of Firms (Heterogeneous Products)

Under monopolistic competition, a large number of independent firms produce commodities which are close but not perfect substitutes, differentiable in terms of their characteristics and the marketing strategy used. Firms are free to enter and exit the market, as under perfect competition, and the long-run profits will converge to zero, i.e. the profit variable in Equation (3-12) is exogenous under monopolistic competition.

As in Chapter 2, this model adopts the Dixit and Stiglitz (1977) Love-of-Variety modelling approach by expressing sectoral demand as a CES function of individual demands that is homogeneous of degree one. *Ceteris paribus*, consumer utility is an increasing function of the number of varieties. The mark-up is inversely proportional to the perceived elasticity of demand,⁶ and so the mark-up pricing condition ($MR = MC$) in Equation (3-13) becomes:

$$\begin{aligned}
PZ_{sec}^{reg} \left(1 - \frac{1}{EDM_{sec}^{reg}} \right) = & \sum_{fac} \left(1 + tf_{sec}^{fac,reg} \right) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$ fac M(fac)}{+ PFS_{sec}^{fac,reg} \$ fac S(fac)} \right) \cdot \frac{FV_{sec}^{fac,reg}}{QZ_{sec}^{reg}} \\
& + \sum_{sec c} PA_{sec c}^{reg} \cdot io_{sec c, sec}^{reg} + tz_{sec}^{reg} \cdot PZ_{sec}^{reg}
\end{aligned} \tag{3-18}$$

As the adjustment in the number of firms drives sectoral profit to zero in the long run, the mark-up of a monopolistically competitive sector is relatively low compared to that in

⁶ It is debatable whether the perceived demand elasticity under monopolistic competition exceeds that under Cournot oligopoly. While higher competition in the market under monopolistic competition implies the greater elasticity of demand; at the same time, the availability of product variety lowers the elasticity.

oligopolistic sectors with no entry and exit of firms. Given the definition of the demand function for each individual variety in Equation (2-86), the perceived demand elasticity for individual varieties is again $EDM_{sec}^{reg} = \sigma LV_{sec}^{reg}$, where σLV_{sec}^{reg} is the elasticity of substitution between product varieties within each sector. A commonly specified value for this elasticity is 4.⁷

While still based on the structure of group and individual demands in Equation (2-84), the commodity market clearing condition is now rewritten in terms of the Armington aggregated demand, i.e. it is a function of final and intermediate group demands:

$$QA_{sec}^{reg} = \left(NOF_{sec}^{reg} \right)^{\frac{1}{1-\sigma LV_{sec}^{reg}}} \cdot \left(C_{sec}^{reg} + I_{sec}^{reg} + CG_{sec}^{reg} + \sum_{sec\ c} IO_{sec,sec\ c}^{reg} \right). \quad (3-19)$$

Finally, from Equation (2-85), the Armington sectoral price is redefined as a function of the prices of individual varieties:

$$PA_{sec}^{reg} = \left(NOF_{sec}^{reg} \right)^{\frac{1}{1-\sigma LV_{sec}^{reg}}} \cdot pa_{sec}^{reg}. \quad (3-20)$$

3.2.4.2 Determination of Sectoral Market Structure: The Threshold

There are thus three types of sectoral market structures in this model, and these will be distinguished using the Herfindahl-Hirschmann Index (HHI_{sec}^{reg}) – the measure of the degree of market concentration – to determine the type of market structure. This approach was utilised by Gasiorek, Smith and Venables (1992) in assessing the economic effects of European integration under imperfectly competitive market structures. The index is defined as the sum of the squared firms' market shares in percentage ($S_{sec,i}^{reg}$), where i is the set of individual varieties in sector sec of region reg populated with NOF_{sec}^{reg} firms:

⁷ See for example the GreenMod model (Bayar et al., 2006).

$$HHI_{\text{sec}}^{\text{reg}} = \sum_i^{NOF_{\text{sec}}^{\text{reg}}} (S_{\text{sec},i}^{\text{reg}})^2. \quad (3-21)$$

The value of this index ranges between 0 and 10,000, whereby the latter represents the most extreme case, that of monopoly. The official U.S. government guideline sets its antitrust standard such that sectors with an HHI index lower than 1,000 (more than 10 equal-sized firms competing) are regarded as unconcentrated; those with an HHI higher than 1,800 (fewer than 6 equal-sized firms competing) as highly concentrated; and those in between as moderately concentrated. This chapter thus assumes that, in each region, sectors with an HHI under 100 (more than 100 equal-sized firms competing) are perfectly competitive; those with indices ranging between 100 and 1,000 are under monopolistically competitive; and the rest, with indices greater than 1,000, operate as Cournot oligopolies.⁸

3.2.5 Labour Market Closure: The Endogeneity of Unemployment and Wages

The model used in Chapter 2 assumes that the set of factor prices that ensure full employment by equating factor endowments with demands from production sectors may be found for all but the skilled and unskilled labour markets. In each of these markets, the wage is endogenously determined and is inversely proportional to the level of unemployment, which in turn is determined by labour demand within each region. To better reflect this aspect of economic reality, which may have a non-negligible economic implication for household welfare, this chapter adopts a modelling approach that allows dissimilarity in the rigidity of real wages and unemployment rates across countries and labour skill levels.

Bontout and Jean (1998) identified three labour market paradigms:

- *The Flexible Wage Approach*: a fully flexible wage ensures full employment, therefore unemployment is exogenous and fixed to zero;

⁸ Table 3-3 in Subsection 3.3.2.2 reports on the specification of commodity market structure in compliance with the above criteria, based on market concentration data from various sources.

- *The Rigid Wage Approach*: the nominal wage is bound to the consumer price index, thus the real wage is fixed and unemployment becomes endogenous;
- *The Wage Bargaining Approach*: labour wages are a consequence of complex bargaining between employers and workers, and thus both wages and unemployment levels are endogenous.

Although relevant to the labour market paradigm in advanced economies, the wage bargaining approach is comparatively data-intensive because it needs, among others, real data estimates of the probabilities of losing and finding jobs, unemployment subsidies, and the inter-temporal utilities of employed and unemployed workers. In addition, as this study focuses on the Thai economy where labour union power is not exceptionally strong, the adoption of the bargaining approach is not considered as an appropriate choice.

An alternative approach to endogenising both unemployment and the real wage of each labour type is the wage curve relationship, proposed by Blanchflower and Oswald (1995). In line with Faris (2002) and Küster et al. (2007), the real wage is a non-linear function of the level of unemployment, explicitly defined as:⁹

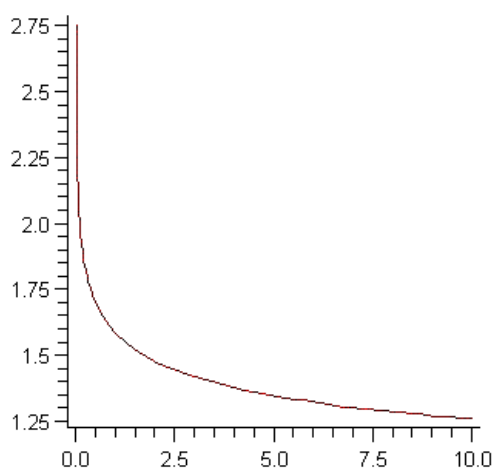
$$\frac{PFM^{flab,reg}}{PFM0^{flab,reg}} = \left(\frac{UNEMP^{flab,reg}}{UNEMPO^{flab,reg}} \right)^{\omega^{flab,reg}}, \quad (3-22)$$

where $\omega^{flab,reg}$ represents the wage curve elasticity of labour *flab*, skilled and unskilled labour (respectively denoted by “*SkLab*” and “*UnSkLab*”) in region *reg*, which is estimated to be approximately -0.1 in numerous countries (Blanchflower and Oswald, 2005). Accordingly,

⁹ Labour’s nominal wage $PFM^{flab,reg}$ is to be divided by the consumer price index CPI^{reg} to derive real wage, however, it can be abbreviated since the price index is fixed as the regional numéraire in this model.

Chart 3-1 plots a wage curve assuming that the benchmark real wage is unity and the benchmark unemployment is 100.¹⁰

Chart 3-1: Wage curve relationship between real wage and unemployment



Source: Calculated by author.

As such, these three approaches – namely the flexible wage, the rigid wage, and the wage curve approaches – are used to specify labour market structures in accordance with the characteristics of skilled and unskilled labour markets in different regions.

3.2.6 Macroeconomic Closure Rules and Numéraire

The current CGE model adopts the same macroeconomic closure rules as Subsection 2.2.8, that all economies are savings-driven with fixed foreign savings (and hence the flexible exchange rate regime). Also, the government balance is maintained by fixing tax rates and government savings, while endogenising government consumption given the CES substitution elasticity among public goods. As for the choice of numéraire, the consumer price index

¹⁰ Although the benchmark unemployment is calibrated to be different across regions and skill levels, the curvature of the graph in Chart 3-1 is marginally varied with this fixed parameter.

(CPI^{reg}) is once again chosen as the regional numéraire; whilst the exchange rate of Thailand (EXC^{THA}) becomes the international numéraire instead of $REGI$ in the previous chapter.¹¹

3.2.7 Equivalent Variation and Regional Welfare Price Indices

As in Chapter 2, the standard EV, reflecting the income change induced by regional trade integration given the price at the benchmark year, is adopted as the measure of the aggregate welfare effects of the Thai FTAs. While the utility function in Chapter 2 was assumed to be Cobb-Douglas, this chapter specifies that the utility functions of the government, the household, and the bank take the CES functional form, explicitly elaborated in Subsection 3.2.2. The reason for the modification of the demand structure being that the CES function renders more flexibility in the specification of consumption behaviour, especially in terms of substitutability of final products.

Accordingly, the consumption price indices perceived by the government (GPI^{reg}), the household (HPI^{reg}) and the bank (SPI^{reg}) as previously shown in Equation (2-43) to Equation (2-45) in Chapter 2 are now re-expressed as:

$$GPI^{reg} = \left[\sum_{sec} (\gamma_{GV}^{reg}_{sec})^{\sigma D^{reg}} \cdot (PA_{sec}^{reg})^{1-\sigma D^{reg}} \right]^{\frac{1}{1-\sigma D^{reg}}}; \quad (3-23)$$

$$HPI^{reg} = \left[\sum_{sec} (\gamma_{HH}^{reg}_{sec})^{\sigma D^{reg}} \cdot ((1 + t_{sec}^{reg}) \cdot PA_{sec}^{reg})^{1-\sigma D^{reg}} \right]^{\frac{1}{1-\sigma D^{reg}}}; \quad (3-24)$$

$$SPI^{reg} = \left[\sum_{sec} (\gamma_I^{reg}_{sec})^{\sigma D^{reg}} \cdot (PA_{sec}^{reg})^{1-\sigma D^{reg}} \right]^{\frac{1}{1-\sigma D^{reg}}}. \quad (3-25)$$

In accordance with the derivation of Equation (2-42) in Chapter 2, these price indices are subsequently weighted by their corresponding consumption budget shares in the Cobb-

¹¹ The choices of model closures and numéraire in Chapter 4 are set up in the same way. For that reason the explanation for the later set of models and policy experiments will be abbreviated.

Douglas form to obtain the regional welfare price index, which is used as the price deflator for the regional disposable income. As previously expressed in Equation (2-41) of Chapter 2, the change in the deflated regional income is hence the EV at the regional level.

3.3 The Data

The model employs the GTAP database which provides the input-output data accounting for economic linkages among sectors in a region, and also bilateral trade, transport, and various protection data that characterise economic ties among regions in the 2001 reference year (Dimaranan, 2006). Version 6.0 of the database consists of data for 87 regions and 57 sectors, which have been aggregated into 15 regions and 22 sectors in the current model. This section explains the aggregation of data by region and by sector, the determination of labour market structures, the structure of regional SAMs, and finally the derivation of data for the savings and elasticity parameters.

3.3.1 Regions: Aggregation Criteria

As noted previously, in this model, 87 regions in the GTAP database are aggregated into 15 groups:

1. Thailand (*THA*)
2. Australia (*AUS*)
3. New Zealand (*NZL*)
4. India (*IND*)
5. Japan (*JPN*)
6. China (*CHN*)¹²
7. North ASEAN (*NASN*)¹³
8. South ASEAN (*SASN*)¹⁴

¹² Region China (*CHN*) comprises China (*chn*) and Hong Kong (*hkg*).

¹³ Region North ASEAN (*NASN*) is consisted of Singapore (*sgp*) and Malaysia (*mys*).

9. Korea (*KOR*)¹⁵
10. United States (*USA*)
11. Canada (*CAN*)
12. Mexico (*MEX*)
13. United Kingdom (*UK*)
14. Rest of Europe (*XEUR*)¹⁶
15. Rest of World (*ROW*)¹⁷

Australia, New Zealand, India, Japan, and China are the countries whose bilateral FTAs with Thailand are to be analysed in this chapter. The regions left outside the groupings are broadly divided into ASEAN (excluding Thailand), Korea, the North American Free Trade Agreement (NAFTA), Europe, and the rest of the world.

Subsequently, ASEAN is further disaggregated into the North and the South, since the income disparity is clearly observable (see Chart 3-2). As the structures of factor endowments in rich and poor regions are so dissimilar, we usually find also dissimilarities in production patterns, labour market structures, and thus diversified adjustments to a change in trade policy. Since countries with significantly different economic structures tend to experience asymmetric impacts from the same trade policy change, ASEAN is accordingly split with respect to the regional income level. By the same token, Mexico is taken out of the NAFTA group. On the other hand, the rest of NAFTA (comprising USA and Canada) is further disaggregated, because the USA is engaged in FTA talks with Thailand.¹⁸ Finally, the United Kingdom is

¹⁴ Region South ASEAN (*SASN*) involves the rest of ASEAN, i.e., Indonesia (*idn*), the Philippines (*phl*), Vietnam (*vnm*), and Brunei Darussalam, Cambodia, Myanmar, and Lao PDR (*xse*).

¹⁵ Region Korea (*KOR*) exclusively refers to South Korea (*kor*).

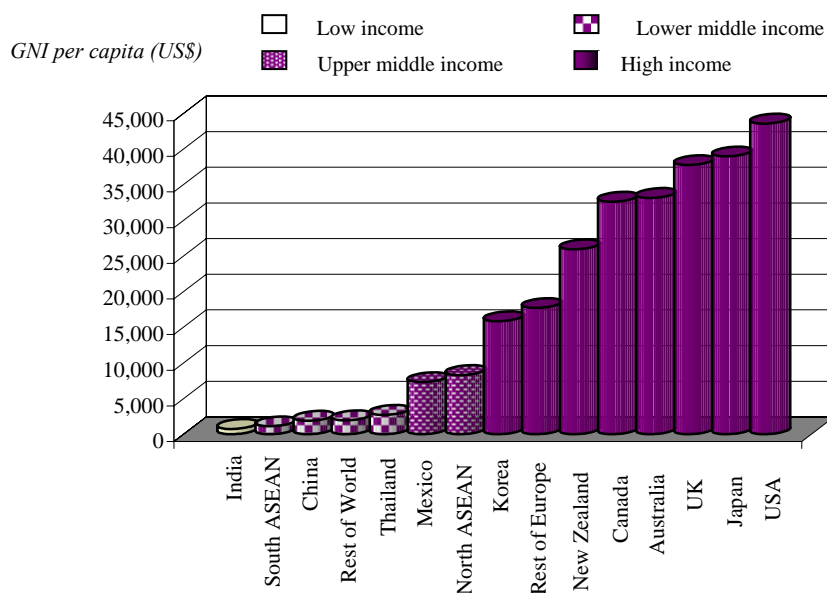
¹⁶ Region Rest of Europe (*XEUR*) includes the rest of Europe: Austria (*aut*), Belgium (*bel*), Denmark (*dnk*), Finland (*fin*), France (*fra*), Germany (*deu*), Greece (*grc*), Ireland (*irl*), Italy (*ita*), Luxembourg (*lux*), the Netherlands (*nld*), Portugal (*prt*), Spain (*esp*), Sweden (*swe*), Switzerland (*che*), Rest of EFTA (*xef*), Rest of Europe (*xer*), Albania (*alb*), Bulgaria (*bgr*), Croatia (*hrv*), Cyprus (*cyp*), Czech Republic (*cze*), Hungary (*hun*), Malta (*mlt*), Poland (*pol*), Romania (*rom*), Slovakia (*svk*), Slovenia (*svn*), Estonia (*est*), Latvia (*lva*), Lithuania (*ltu*), Russian Federation (*rus*), and Rest of Former Soviet union (*xsu*).

¹⁷ Region Rest of World includes all other regions not mentioned elsewhere.

¹⁸ However, negotiations are currently on hold, due to political instability in Thailand since 2007.

taken out of the European group, as its labour market structure is different in the sense that the UK regional wages are more flexible than those on the continent.

Chart 3-2: Gross National Income (GNI) per capita and income category by region



Source: Compiled by author from World Development Indicators, World Bank (2007). Note: The compilation of GNI per capita is based on the Atlas Method; and income categorisation is consistent with the definition by World Bank.

3.3.2 Sectors: Aggregation Criteria and Determination of Market Structure

3.3.2.1 Sectoral Aggregation: The Criteria

The GTAP 6.0 database comprises 57 sectors in each region (See Appendix A3-2). These sectors are then aggregated with respect to factor intensity and sectoral export and import shares in total trade of Thailand, since the country is placed at the focal point of this analysis as a small open economy undergoing FTA talks with her trading partners. The thresholds for sectoral clusters are as follows.

Table 3-2: Factor intensity and sectoral trade share in total trade value (net of tax and transportation cost): THAILAND

| | Trade shares | | | | Factor intensity (% of total factor input value) | | | | |
|------------------|--|--|-------------|---------------------|--|------------------|----------------|---------------|------------------|
| | Export share in total export SQE_{sec} | Import share in total import SQM_{sec} | TCI_{sec} | TCI_{sec} ranking | Land | Unskilled labour | Skilled labour | Capital | Natural resource |
| <i>Cluster 1</i> | | | | | | | | | |
| 1 pdr | 0.10% | 0.00% | 0.1 | 48 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 2 wht | 0.00% | 0.22% | 0.22 | 43 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 3 gro | 0.08% | 0.01% | 0.1 | 49 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 4 v_f | 0.55% | 0.11% | 0.65 | 33 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 5 osd | 0.01% | 0.44% | 0.46 | 40 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 6 c_b | 0.00% | 0.00% | 0 | 56 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 7 pfb | 0.01% | 0.81% | 0.82 | 30 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 8 ocr | 2.40% | 0.20% | 2.6 | 21 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 9 ctl | 0.00% | 0.04% | 0.04 | 53 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 10 oap | 0.13% | 0.40% | 0.53 | 39 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 11 rmk | 0.00% | 0.00% | 0 | 55 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| 12 wol | 0.00% | 0.07% | 0.07 | 50 | 51.43% | 41.47% | 0.04% | 7.06% | 0.00% |
| <i>Cluster 2</i> | | | | | | | | | |
| 13 frs | 0.01% | 0.16% | 0.17 | 46 | 0.00% | 33.33% | 0.03% | 57.68% | 8.95% |
| 14 fsh | 0.16% | 0.04% | 0.2 | 45 | 0.00% | 13.36% | 0.01% | 47.20% | 39.42% |
| 15 coa | 0.00% | 0.25% | 0.25 | 42 | 0.00% | 20.48% | 2.12% | 39.43% | 37.97% |
| 16 oil | 0.02% | 6.93% | 6.95 | 5 | 0.00% | 12.37% | 2.68% | 32.84% | 52.11% |
| 17 gas | 0.00% | 0.88% | 0.88 | 29 | 0.00% | 12.04% | 1.96% | 48.03% | 37.97% |
| 18 omn | 0.07% | 0.51% | 0.57 | 36 | 0.00% | 13.14% | 2.02% | 75.22% | 9.63% |
| <i>Cluster 3</i> | | | | | | | | | |
| 19 cmt | 0.01% | 0.03% | 0.03 | 54 | 0.00% | 26.92% | 4.56% | 68.52% | 0.00% |
| 20 omt | 1.36% | 0.08% | 1.44 | 25 | 0.00% | 25.74% | 4.37% | 69.89% | 0.00% |
| 21 vol | 0.11% | 0.05% | 0.17 | 47 | 0.00% | 10.30% | 2.29% | 87.41% | 0.00% |
| 22 mil | 0.11% | 0.52% | 0.63 | 34 | 0.00% | 24.90% | 3.95% | 71.15% | 0.00% |
| 23 per | 2.06% | 0.00% | 2.06 | 23 | 0.00% | 30.59% | 5.83% | 63.58% | 0.00% |
| 24 sgr | 0.69% | 0.02% | 0.71 | 32 | 0.00% | 23.50% | 5.23% | 71.27% | 0.00% |
| 25 ofd | 6.83% | 2.68% | 9.51 | 4 | 0.00% | 17.85% | 3.97% | 78.18% | 0.00% |
| 26 b_t | 0.23% | 0.35% | 0.58 | 35 | 0.00% | 19.00% | 2.84% | 78.16% | 0.00% |

Source: Compiled by author from GTAP 6.0 database, Dimaranan (2006). Note: TCI_{sec} is the Trade Concentration Index of sector sec in Thailand, and bold figures indicate sectors ranked top fifteen with respect to the level of TCI_{sec} .

Table 3-2 (Continued): Factor intensity and sectoral trade share in total trade value (net of tax and transportation cost): THAILAND

| | Trade shares | | | | Factor intensity (% of total factor input value) | | | | |
|------------------|--|--|--------------|---------------------|--|------------------|----------------|---------------|------------------|
| | Export share in total export SQE_{sec} | Import share in total import SQM_{sec} | TCI_{sec} | TCI_{sec} ranking | Land | Unskilled labour | Skilled labour | Capital | Natural resource |
| <i>Cluster 4</i> | | | | | | | | | |
| 27 tex | 3.93% | 2.50% | 6.42 | 7 | 0.00% | 28.56% | 4.46% | 66.98% | 0.00% |
| 28 wap | 3.86% | 0.21% | 4.07 | 15 | 0.00% | 34.04% | 5.04% | 60.92% | 0.00% |
| 29 lea | 2.36% | 0.53% | 2.89 | 18 | 0.00% | 20.83% | 3.20% | 75.97% | 0.00% |
| 30 lum | 2.11% | 0.54% | 2.65 | 20 | 0.00% | 29.50% | 3.83% | 66.67% | 0.00% |
| 31 ppp | 1.04% | 1.31% | 2.35 | 22 | 0.00% | 18.99% | 3.81% | 77.20% | 0.00% |
| 32 p_c | 1.25% | 0.10% | 1.35 | 26 | 0.00% | 10.02% | 2.04% | 87.94% | 0.00% |
| 33 crp | 8.94% | 10.83% | 19.77 | 3 | 0.00% | 23.47% | 5.61% | 70.92% | 0.00% |
| 34 nmm | 2.02% | 1.38% | 3.4 | 16 | 0.00% | 21.44% | 3.70% | 74.86% | 0.00% |
| 35 i_s | 0.87% | 4.10% | 4.97 | 10 | 0.00% | 27.25% | 4.51% | 68.24% | 0.00% |
| 36 nfm | 0.56% | 3.54% | 4.1 | 14 | 0.00% | 27.04% | 5.07% | 67.89% | 0.00% |
| 37 fmp | 1.45% | 1.41% | 2.86 | 19 | 0.00% | 20.38% | 3.74% | 75.88% | 0.00% |
| 38 mvh | 2.25% | 3.43% | 5.68 | 9 | 0.00% | 24.47% | 5.05% | 70.49% | 0.00% |
| 39 otn | 0.60% | 2.34% | 2.94 | 17 | 0.00% | 38.17% | 7.87% | 53.96% | 0.00% |
| 40 ele | 24.16% | 20.44% | 44.6 | 1 | 0.00% | 15.96% | 4.02% | 80.02% | 0.00% |
| 41 ome | 12.34% | 16.89% | 29.23 | 2 | 0.00% | 21.60% | 5.43% | 72.97% | 0.00% |
| 42 omf | 4.29% | 2.64% | 6.93 | 6 | 0.00% | 28.31% | 3.75% | 67.94% | 0.00% |
| <i>Cluster 5</i> | | | | | | | | | |
| 43 ely | 0.02% | 0.25% | 0.27 | 41 | 0.00% | 13.99% | 6.67% | 79.34% | 0.00% |
| 44 gdt | 0.01% | 0.06% | 0.07 | 51 | 0.00% | 9.34% | 4.46% | 86.20% | 0.00% |
| 45 wtr | 0.03% | 0.02% | 0.04 | 52 | 0.00% | 24.15% | 11.52% | 64.33% | 0.00% |
| 46 cns | 0.34% | 0.23% | 0.57 | 37 | 0.00% | 24.96% | 4.40% | 70.64% | 0.00% |
| 47 trd | 1.64% | 2.66% | 4.31 | 12 | 0.00% | 11.66% | 2.37% | 85.97% | 0.00% |
| <i>Cluster 6</i> | | | | | | | | | |
| 48 otp | 3.04% | 1.40% | 4.44 | 11 | 0.00% | 26.18% | 5.33% | 68.49% | 0.00% |
| 49 wtp | 0.45% | 0.33% | 0.78 | 31 | 0.00% | 21.70% | 4.41% | 73.89% | 0.00% |
| 50 atp | 3.24% | 1.01% | 4.25 | 13 | 0.00% | 21.59% | 4.39% | 74.01% | 0.00% |

Source: Compiled by author from GTAP 6.0 database, Dimanaran (2006). Note: TCI_{sec} is the Trade Concentration Index of sector sec in Thailand, and bold figures indicate sectors ranked top fifteen with respect to the level of TCI_{sec} .

Table 3-2 (Continued): Factor intensity and sectoral trade share in total trade value (net of tax and transportation cost): THAILAND

| | Trade shares | | | | Factor intensity (% of total factor input value) | | | | |
|------------------|--|--|-------------|---------------------|--|------------------|----------------|---------------|------------------|
| | Export share in total export SQE_{sec} | Import share in total import SQM_{sec} | TCI_{sec} | TCI_{sec} ranking | Land | Unskilled labour | Skilled labour | Capital | Natural resource |
| <i>Cluster 7</i> | | | | | | | | | |
| 51 cmn | 0.23% | 0.32% | 0.55 | 38 | 0.00% | 11.40% | 8.89% | 79.71% | 0.00% |
| 52 ofi | 0.06% | 0.14% | 0.2 | 44 | 0.00% | 15.28% | 11.91% | 72.81% | 0.00% |
| 53 isr | 0.18% | 1.13% | 1.31 | 27 | 0.00% | 29.72% | 23.16% | 47.11% | 0.00% |
| 54 obs | 2.26% | 3.79% | 6.05 | 8 | 0.00% | 18.28% | 14.25% | 67.47% | 0.00% |
| 55 ros | 1.23% | 0.76% | 2 | 24 | 0.00% | 24.33% | 18.97% | 56.70% | 0.00% |
| <i>Cluster 8</i> | | | | | | | | | |
| 56 osg | 0.31% | 0.90% | 1.21 | 28 | 0.00% | 35.14% | 54.05% | 10.81% | 0.00% |
| <i>Cluster 9</i> | | | | | | | | | |
| 57 dwe | 0.00% | 0.00% | 0 | 57 | 0.00% | 15.56% | 0.00% | 84.44% | 0.00% |

Source: Compiled by author from GTAP 6.0 database, Dimanaran (2006). Note: TCI_{sec} is the Trade Concentration Index of sector sec in Thailand, and bold figures indicate sectors ranked top fifteen with respect to the level of TCI_{sec} .

Table 3-2 reports on the sectoral data that are derived directly from the GTAP 6.0 database. Given the characteristics of Thai production sectors, sectors are bundled together if their factor intensity is clearly analogous; for example, similarly capital-intensive service sectors are aggregated as Cluster 7. As a result, initially nine clusters of commodity and service sectors are created as follows:

1. Agricultural products : pdr, wht, gro, v_f, osd, c_b, pfb, ocr, ctl, oap, rmk, wol
2. Natural-resource intensive products : frs, fsh, coa, oil, gas, omn
3. Processed agricultural products : cmt, omt, vol, mil, pcr, sgr, ofd, b_t
4. Manufacturing products : tex, wap, lea, lum, ppp, p_c, crp, nmm, i_s, nfm, fmp, mvh, otn, ele, ome, omf
5. Utility, construction, and trade : ely, gdt, wtr, cns, trd
6. Transportation services : otp, wtp, atp
7. Private services : cmn, ofi, isr, obs, ros

8. Public services : osg
 9. Dwellings : dwe¹⁹

Subsequently, sectoral trade share in regional trade value is used as the criterion to distinguish important tradable sectors from the above nine clusters. As in Table 3-2, denoting by SQE_{sec} sector sec 's export share (%) in Thailand's total export value; and similarly SQM_{sec} as sector sec 's import share (%) in Thailand's total import value, the Trade Concentration Index (TCI_{sec}) is defined as:

$$TCI_{sec} = SQE_{sec} + SQM_{sec}, \quad (3-26)$$

Where the two sectoral trade shares are derived from the GTAP database:

$$SQE_{sec} = \frac{QE0_{sec}^{THA}}{\sum_{sec c} QE0_{sec c}^{THA}} \cdot 100;$$

$$SQM_{sec} = \frac{QMO_{sec}^{THA}}{\sum_{sec c} QMO_{sec c}^{THA}} \cdot 100.$$

Since the partial differentiation of this concentration index with respect to export and import yields positive values:

$$\frac{\partial TCI_{sec}}{\partial QE0_{sec}^{THA}} = TCI_{sec} \cdot \left[1 - \frac{1}{\sum_{sec c} QE0_{sec c}^{THA}} \right] = TCI_{sec} \cdot \left[\frac{\sum_{sec c \neq sec} QE0_{sec c}^{THA}}{\sum_{sec c} QE0_{sec c}^{THA}} \right] > 0, \text{ and by symmetry,}$$

$$\frac{\partial TCI_{sec}}{\partial QMO_{sec}^{THA}} = TCI_{sec} \cdot \left[1 - \frac{1}{\sum_{sec c} QMO_{sec c}^{THA}} \right] = TCI_{sec} \cdot \left[\frac{\sum_{sec c \neq sec} QMO_{sec c}^{THA}}{\sum_{sec c} QMO_{sec c}^{THA}} \right] > 0,$$

we know that a sector recording a high TCI_{sec} is more open to trade than other sectors. As such, the index is a 'balanced' measure since it takes into account the exposure of a sector to trade, both in terms of export and import activities. Accordingly, all GTAP sectors are ranked

¹⁹ Dwellings are the only non-traded sector in the GTAP database.

with respect to this index in Table 3-2. Among the 15 top-ranked tradable sectors – specifically oil, ofd, tex, wap, crp, i_s, nfm, mvh, ele, ome, omf, trd, otp, atp, and obs – two transport sectors (otp and atp) are exempted from disaggregation, as none of Thailand’s ongoing FTA negotiations focus primarily on these sectors. Thus, the other 13 production sectors are disaggregated from their groups, and 57 sectors are consequently clustered into 22 aggregate sectors, where *DWE* (dwellings) is the only non-traded sector in this model.

1. Agricultural products (*AGR*)
2. Forestry, fishing, coal, gas, and other minerals (*NRS*)
3. Oil (*OIL*)
4. Meat, vegetable oil, dairy products, processed rice, sugar, beverage, and tobacco products (*PAGR*)
5. Other food products (*OFD*)
6. Manufacturing products (*MNF*)
7. Textiles (*TEX*)
8. Wearing apparels (*WAP*)
9. Chemical, Rubber, Plastic products (*CRP*)
10. Ferrous metals (*I_S*)
11. Other Metals (*NFM*)
12. Motor vehicles and parts (*MVH*)
13. Electronic equipment (*ELE*)
14. Other machinery and equipment (*OME*)
15. Other manufactures (*OMF*)
16. Electricity, Gas, Water, and Construction (*MSR*)
17. Trade (*TRD*)
18. Transportation services (*TRP*)
19. Communication, Financial services, Insurance, and other services (*CFI*)
20. Other business services (*OBS*)
21. Public services (*OSG*)

22. Dwellings (*DWE*)

3.3.2.2 Determination of Sectoral Market Structure

As described in Subsection 3.2.4.2, commodity market structures are determined by the level of the externally derived HHI data, except that agricultural goods (*AGR*) are produced under perfect competition in all regions.²⁰ The market concentration indices for all other sectors in each country are calculated from various national and international data sources. The data for Thailand are extracted and compiled from Table 9.2 in *Year Book of Labour Statistics 2000* published by the Department of Labour Protection and Welfare, Thailand (2001). As for Australia, the Australian Bureau of Statistics (2007) website provides the Industry Concentration Statistics for the 1998/99 financial year, showing the proportion of sales, persons employed, and industry gross products that are concentrated among the 20 largest enterprise groups in each industry. The ‘largest 20’ are further subdivided into groups of four, once again in order of their sizes. Likewise, *New Zealand Official Yearbook 1996* reports in Table 21.2 the market concentration data in 1995, as collected by Statistics New Zealand. On the other hand, the most recent Indian HHI data at the SIC 3-digit level are reported by Kambhampati and Kattuman (2003) for those medium- and large-sized firms operating in 1997.²¹ Similarly, the HHI data for Japanese industries are reported in Table 13 of Fukao and Ito (2001). Using market shares of the top 10 firms in each industry, Xiao (2005) provided in Table 1.4 and Table 1.5 the index of industry concentration for China at the 2-digit and 3-digit industry level. The market concentration indices in manufacturing sectors for Korea, Canada, and Mexico are derived from *OECD Economic Surveys* for the fiscal years of 1997,

²⁰ Agricultural sectors are commonly regarded as perfectly competitive in applied CGE models, including the Michigan model (Brown et al. (2000).

²¹ Although not explicitly reported in Kambhampati and Kattuman (2003), the actual data file is thankfully received from the first author.

2001, and 1980 respectively.²² For the USA, the HHI data of manufacturing sectors and the concentration ratios classifying service industries by the fraction of output accounted for by the largest 4, 8, 20, and 50 firms, are taken from the 2002 Economic Census organised by the U.S. Census Bureau (2007) using the North American Industry Classification System (NAICS). Finally, the concentration ratios for UK industries in 2004 are excerpted from Appendix 1 in the Office for National Statistics (2006), of which estimates are derived by calculating for the percentage of gross value added contributed by the top 5 and top 15 leading businesses in each industry.

As noted earlier, instead of the HHI, some authorities routinely publish the concentration ratios $CR(j)_{sec}^{reg}$ signifying the sum of market shares of the largest j firms operating in industry sec of region reg . Assuming that the first j firms record approximately equal market shares, the market share of each of these largest j firms is derived as $S_{sec,i \leq j}^{reg} = CR(j)_{sec}^{reg} / j$, provided that $S_{sec,i}^{reg} \geq S_{sec,(i+1)}^{reg}$ always holds. Therefore, the HHIs are accordingly approximated as:

$$HHI_{sec}^{reg} = \frac{\left(CR(j)_{sec}^{reg}\right)^2}{j} + \frac{\left(CR(k)_{sec}^{reg} - CR(j)_{sec}^{reg}\right)^2}{(k-j)} + \frac{\left(CR(l)_{sec}^{reg} - CR(k)_{sec}^{reg}\right)^2}{(l-k)} + \dots + \frac{\left(100 - CR(z)_{sec}^{reg}\right)^2}{(1,000 - z)}$$

where there are assumed to be 1,000 firms competing in each sector, and $\{j, k, l, \dots, z\}$ is the set of numbers of the largest firms, of which the concentration ratios are randomly reported.

As for the four aggregate regions consisting of numerous countries, i.e. North ASEAN (*NASN*), South ASEAN (*SASN*), Rest of Europe (*XEUR*), and Rest of World (*ROW*), it is impractical to compile the market concentration data for each and every production sector. On the premise that these regions are not as central to this study as Thailand and her FTA counterparts, the study approximates that regions in the same range of wealth level (as

²² To be precise, data of market concentration in individual countries are extracted from Table 5.2 in *OECD Economic Surveys: Korea* (2004a); Table 2.2 in *OECD Economic Surveys: Canada* (2004b); and Table 41 in *OECD Economic Surveys: Mexico* (1991/92).

Table 3-3: The degree of sectoral market competition by region

| Sector Region | AGR | NRS | OIL | PAGR | OFD | MNF | TEX | WAP | CRP | I_S | NFM | MVH | ELE | OME | OMF | MSR | TRD | TRP | CFI | OBS | OSG | DWE | |
|------------------|-----|-----|-----|------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|----|
| Thailand | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| Australia | PC | MC | MC | MC | MC | MC | PC | PC | MC | MC | PC | PC | MC | MC | PC | MC | PC | MC | CO | PC | PC | PC | PC |
| New Zealand | PC | CO | CO | CO | PC | MC | PC | PC | MC | MC | MC | MC | MC | PC | MC | MC | MC | MC | MC | MC | MC | MC | MC |
| India | PC | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO | CO |
| Japan | PC | PC | PC | MC | PC | MC | MC | PC | MC | MC | MC | MC | MC | MC | MC | MC | PC | MC | MC | MC | MC | MC | PC |
| China | PC | PC | MC | PC | PC | PC | PC | PC | PC | PC | PC | MC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| North ASEAN | PC | MC | MC | CO | CO | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC |
| South ASEAN | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| Korea | PC | MC | MC | MC | PC | MC | PC | PC | MC | MC | MC | MC | MC | PC | MC | MC | MC | MC | MC | MC | MC | MC | MC |
| USA | PC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | CO | MC | MC | PC | MC | PC | PC | PC | PC | PC | PC | PC |
| Canada | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC |
| Mexico | PC | MC | MC | CO | CO | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC | MC |
| United Kingdom | PC | MC | MC | MC | MC | MC | MC | PC | MC | MC | PC | MC | MC | MC | MC | MC | PC | MC | MC | PC | PC | PC | PC |
| Rest of Europe | PC | MC | MC | MC | MC | MC | MC | PC | MC | MC | PC | MC | MC | MC | MC | MC | PC | MC | MC | PC | PC | PC | PC |
| Rest of World | PC | PC | MC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC | PC |

Source: Compiled by author from various sources (see Subsection 3.3.2.2). Note: “PC” stands for perfectly competitive sectors ($HHI < 100$); “MC” accounts for monopolistic competitive sectors ($100 \leq HHI < 1,000$); and “CO” represents Cournot Oligopolistic sectors ($HHI \geq 1,000$). India as the only country in the low income group has the most imperfectly competitive market among all regions. Thus, it might be the case that countries with lowest income level have loose antitrust regulation. Thailand and China belong to the lower middle income group and coincidentally have similar market structures which are almost all perfectly competitive, while most markets in upper middle and high income countries are under monopolistic competition.

illustrated in Chart 3-2) tend to have a certain proximity in antitrust standard and competition policy. Therefore, the sectoral market structures of North ASEAN are assumed to replicate those of Mexico, as both are categorised as upper middle income regions. On the other hand, the geographic, political, and economic structures of South ASEAN as a lower middle income region are in keeping with those of Thailand; while the Rest of Europe shares the same HHI data with the UK; and the market concentration index for Rest of World is the simple average of the HHI data from other lower middle income countries (Thailand and China). Table 3-3 reports the designated commodity market structure given the above criteria.

Lastly, the hypothetical number of firms is calibrated in line with the ATHENA model,²³ in that the inverse of the HHI gives the number of hypothetical, equal-sized firms in each sector. Such this feature is already described in the general model structure section, in that Cournot oligopolistic sectors are populated with homogeneous firms; and that, although monopolistically competitive firms produce heterogeneous products, they have identical production functions.

3.3.3 Factors: Specification of Labour Market Structure

There are five primary factors – namely capital “*K*”, skilled labour “*SkLab*”, unskilled labour “*UnSkLab*”, land “*H*”, and natural resources “*NatRes*.” The model specifies that capital, skilled and unskilled labour are mobile domestically but not internationally, whilst land and natural resources are completely immobile (sector-specific). As described in Section 3.2.5, the current model allows the flexibility of real wage and unemployment, or the lack of it, to be varied by region. This is based on the argument that the sensitivity of the labour market and unemployment to a policy change may vary with the degree of wage rigidity; for example, the effects on the real economy may be more pronounced when wages do not adjust fully to an

²³ See Section 3.3 in de Bruijn (2006).

external shock. For that reason, the chapter accounts for the following characteristics of the skilled and unskilled labour markets in the different aggregate regions (see Table 3-4).

Table 3-4: Specifications of skilled and unskilled labour market closure rules

| Labour market (by income group) | | The flexible wage approach | The rigid wage approach | The wage curve approach |
|------------------------------------|---------------------------|---|----------------------------|---|
| Skilled labour | High income | USA New Zealand Australia Canada UK | Rest of Europe | Japan Korea |
| | Upper middle income | North ASEAN | | Mexico |
| | Lower middle income | | | Thailand South ASEAN China Rest of World |
| | Low income | | | India |
| Unskilled labour | High income | USA New Zealand Australia Canada | Rest of Europe UK | Japan Korea |
| | Upper middle income | North ASEAN | | Mexico |
| | Lower middle income | | | Thailand South ASEAN China Rest of World |
| | Low income | | | India |

Source: Compiled by author.

In general, this chapter assumes that the real wage is inversely related to the unemployment rate, so that both variables are endogenous in the majority of regions. However, it is commonly observed that in some upper-middle and high income regions the government may actively pursue policies that encourage either a flexible wage, which entails a relatively low and stable level of unemployment, or a rigid wage that inevitably brings about relatively high and fluctuating unemployment. In this model, the former types of region consist of the USA, New Zealand, Australia, Canada, and North ASEAN, whereas the Rest of Europe follows to

the rigid wage approach. To reflect the economic reality of the UK, on the other hand, the labour market is divided by skill level, so that skilled labour has a flexible wage similar to the majority of the non-European rich countries, while unskilled labour receives high unemployment benefits, similar to the Rest of Europe, such that wages become rigid and the unemployment rate remains relatively high.²⁴

3.3.4 The Simplified Social Accounting Matrix

A complete CGE model has a consistent accounting framework in the sense that every receipt must be offset by a corresponding expenditure: thus all transactions in a region can be expressed as elements of a SAM. The SAM framework of this model is consistent with the one adopted in Chapter 2 and importantly the international System of National Accounts (SNA) 1993 standard on the presentation of national income accounts set by United Nations Statistical Office (Inter-Secretariat Working Group on National Accounts, 1993). For simplicity, regional value flows derived from the GTAP database are represented in a simplified SAM format, with commodities' and activities' input-output demands explicitly identified. While the simplified regional SAM sheds light on the macroeconomic characteristics of production and trade, monetary flows between the household, the government, and the bank are not explicitly shown in the following SAMs, but will be handled later in Subsection 3.3.5.

²⁴ Another alternative is to use the rigid wage approach to model the unskilled labour market closure in lower-middle and low income countries. However, the legislative minimum wage applied to unskilled labour in these countries is basically in nominal terms, while prices and wages in the CGE model are in real terms. In addition, the non-negligible existence of the informal economic activity may effectively nullify the argument that unskilled labour wage in these countries is rigid and well-regulated by the government.

Table 3-5: Thailand's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|-----------------|----------------|----------------|-----------------|-----------------|----------------------|----------------|----------------|----------------|----------------|----------------|-----------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 0.5493 | 9.3655 | 0.5825 | 10.4972 | 2.1759 | 0.0598 | 0.0000 | | | 12.7329 |
| | M | | | | 2.4120 | 69.8117 | 19.7628 | 91.9865 | 29.2611 | 12.0461 | 0.0000 | | | 133.2937 |
| | S | | | | 1.4975 | 20.6003 | 21.3691 | 43.4669 | 31.1305 | 11.0403 | 11.5939 | | | 97.2316 |
| Activities | A | 11.0153 | | | | | | 11.0153 | | | | | 2.6291 | 13.6444 |
| | M | | 73.5131 | | | | | 73.5131 | | | | | 67.2127 | 140.7259 |
| | S | | | 89.2730 | | | | 89.2730 | | | | 4.0880 | 10.4249 | 103.7860 |
| Sub-total | | 11.0153 | 73.5131 | 89.2730 | 4.4588 | 99.7775 | 41.7143 | 319.7520 | 62.5675 | 23.1462 | 11.5939 | 4.0880 | 80.2668 | 501.4144 |
| Factors | | | | | 9.0640 | 34.1510 | 54.6334 | 97.8484 | | | | | | |
| Indirect taxes | | 0.0000 | 0.0000 | -0.0522 | 0.1215 | 6.7975 | 7.4382 | 14.3051 | | | | | | |
| Import tariffs | | 0.2053 | 5.4262 | 0.0000 | | | | 5.6315 | | | | | | |
| Import margins | | 0.0924 | 2.2102 | | | | | 2.3027 | | | | | | |
| Imports | | 1.4199 | 52.1440 | 8.0107 | | | | 61.5747 | | | | | | |
| Total | | 12.7329 | 133.2936 | 97.2315 | 13.6444 | 140.7259 | 103.7860 | 501.4143 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-6: Australia's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------------|-----------------|----------------|----------------|----------------|----------------|-------------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 1.9816 | 7.9612 | 1.3495 | 11.2923 | 3.8328 | 0.5655 | 0.0490 | | | 15.7395 |
| | M | | | | 3.1072 | 70.9855 | 53.7127 | 127.8054 | 55.8906 | 23.7860 | 2.3912 | | | 209.8733 |
| | S | | | | 4.8715 | 39.9112 | 134.6904 | 179.4731 | 155.1423 | 50.5186 | 61.7987 | | | 446.9327 |
| Activities | A | 15.1209 | | | | | | 15.1209 | | | | | 7.6564 | 22.7773 |
| | M | | 135.8025 | | | | | 135.8025 | | | | | 51.2224 | 187.0249 |
| | S | | | 432.7829 | | | | 432.7829 | | | | 5.2055 | 14.1543 | 452.1427 |
| Sub-total | | 15.1209 | 135.8025 | 432.7829 | 9.9603 | 118.8579 | 189.7526 | 902.2770 | 214.8657 | 74.8700 | 64.2389 | 5.2055 | 73.0331 | 1,334.4903 |
| Factors | | | | | 13.1217 | 63.1034 | 237.2774 | 313.5025 | | | | | | |
| Indirect taxes | | 0.0106 | 11.6482 | 1.1194 | -0.3047 | 5.0636 | 25.1127 | 42.6498 | | | | | | |
| Import tariffs | | 0.0022 | 3.1461 | 0.0000 | | | | 3.1483 | | | | | | |
| Import margins | | 0.0496 | 2.4824 | | | | | 2.5320 | | | | | | |
| Imports | | 0.5563 | 56.7940 | 13.0304 | | | | 70.3807 | | | | | | |
| Total | | 15.7395 | 209.8733 | 446.9327 | 22.7773 | 187.0249 | 452.1427 | 1,334.4903 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-7: New Zealand's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|----------------|----------------|---------------|----------------|----------------|----------------------|----------------|---------------|---------------|----------------|----------------|-----------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 0.6508 | 4.0797 | 0.3407 | 5.0712 | 0.3943 | 0.0121 | 0.0043 | | | 5.4818 |
| | M | | | | 1.0268 | 11.7091 | 8.5564 | 21.2924 | 8.0176 | 4.2856 | 0.0986 | | | 33.6942 |
| | S | | | | 2.0520 | 7.0231 | 20.5523 | 29.6274 | 20.1973 | 5.5454 | 8.3147 | | | 63.6848 |
| Activities | A | 5.1711 | | | | | | 5.1711 | | | | | 1.6918 | 6.8629 |
| | M | | 19.9139 | | | | | 19.9139 | | | | | 13.2279 | 33.1417 |
| | S | | | 58.4516 | | | | 58.4516 | | | | 1.1644 | 3.3951 | 63.0111 |
| Sub-total | | 5.1711 | 19.9139 | 58.4516 | 3.7296 | 22.8119 | 29.4493 | 139.5275 | 28.6092 | 9.8431 | 8.4176 | 1.1644 | 18.3148 | 205.8766 |
| Factors | | | | | 3.1397 | 10.0642 | 31.9383 | 45.1422 | | | | | | |
| Indirect taxes | | 0.0388 | 1.1817 | 2.0300 | -0.0064 | 0.2656 | 1.6235 | 5.1333 | | | | | | |
| Import tariffs | | 0.0003 | 0.2733 | 0.0000 | | | | 0.2736 | | | | | | |
| Import margins | | 0.0247 | 0.5844 | | | | | 0.6091 | | | | | | |
| Imports | | 0.2468 | 11.7410 | 3.2031 | | | | 15.1910 | | | | | | |
| Total | | 5.4818 | 33.6942 | 63.6848 | 6.8629 | 33.1418 | 63.0111 | 205.8766 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-8: India's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|-----------------|-----------------|-----------------|-----------------|-----------------|----------------------|-----------------|-----------------|----------------|----------------|----------------|-------------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 18.6106 | 24.8517 | 6.8093 | 50.2716 | 86.0322 | 0.7223 | 0.8681 | | | 137.8943 |
| | M | | | | 6.5378 | 129.6816 | 59.1249 | 195.3442 | 101.2848 | 48.5366 | 7.7735 | | | 352.9391 |
| | S | | | | 15.4821 | 69.2433 | 79.6502 | 164.3755 | 122.1551 | 56.8877 | 52.1444 | | | 395.5627 |
| Activities | A | 134.9327 | | | | | | 134.9327 | | | | | 3.1417 | 138.0744 |
| | M | | 285.9093 | | | | | 285.9093 | | | | | 45.5578 | 331.4671 |
| | S | | | 383.7599 | | | | 383.7599 | | | | 2.8081 | 12.4259 | 398.9939 |
| Sub-total | | 134.9327 | 285.9093 | 383.7599 | 40.6305 | 223.7765 | 145.5844 | 1,214.5933 | 309.4721 | 106.1466 | 60.7860 | 2.8081 | 61.1254 | 1,754.9316 |
| Factors | | | | | 101.9598 | 97.8715 | 241.1720 | 441.0033 | | | | | | |
| Indirect taxes | | 0.0000 | 5.9090 | 0.0000 | -4.5159 | 9.8191 | 12.2376 | 23.4498 | | | | | | |
| Import tariffs | | 0.6021 | 12.9885 | 0.0000 | | | | 13.5906 | | | | | | |
| Import margins | | 0.1800 | 2.4632 | | | | | 2.6431 | | | | | | |
| Imports | | 2.1796 | 45.6690 | 11.8028 | | | | 59.6514 | | | | | | |
| Total | | 137.8943 | 352.9390 | 395.5627 | 138.0744 | 331.4672 | 398.9940 | 1,754.9316 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-9: Japan's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|-----------------------|---|-------------------|-------------------|-------------------|----------------|-------------------|-------------------|----------------------|-------------------|-------------------|-----------------|----------------|-----------------|--------------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 8.1456 | 47.1799 | 5.7484 | 61.0738 | 27.4775 | 1.6828 | 0.2253 | | | 90.4594 |
| | M | | | | 13.4615 | 1,026.8522 | 519.4034 | 1,559.7172 | 607.5348 | 301.6870 | 7.9582 | | | 2,476.8973 |
| | S | | | | 11.6729 | 522.5113 | 1,144.3355 | 1,678.5197 | 1,699.1787 | 725.6513 | 709.8462 | | | 4,813.1959 |
| Activities | A | 71.9969 | | | | | | 71.9969 | | | | | 1.2809 | 73.2778 |
| | M | | 2,087.2483 | | | | | 2,087.2483 | | | | | 411.9499 | 2,499.1982 |
| | S | | | 4,694.0173 | | | | 4,694.0173 | | | | 14.0331 | 39.7915 | 4,747.8419 |
| Sub-total | | 71.9969 | 2,087.2483 | 4,694.0173 | 33.2800 | 1,596.5434 | 1,669.4873 | 10,152.5734 | 2,334.1910 | 1,029.0211 | 718.0297 | 14.0331 | 453.0222 | 14,700.8705 |
| Factors | | | | | 39.9828 | 673.3529 | 2,511.2107 | 3,224.5464 | | | | | | |
| Indirect taxes | | 1.3231 | 61.5511 | 34.2901 | 0.0149 | 229.3020 | 567.1439 | 893.6252 | | | | | | |
| Import tariffs | | 3.7243 | 13.3379 | 0.0000 | | | | 17.0622 | | | | | | |
| Import margins | | 1.4071 | 16.7277 | | | | | 18.1348 | | | | | | |
| Imports | | 12.0080 | 298.0321 | 84.8884 | | | | 394.9284 | | | | | | |
| Total | | 90.4594 | 2,476.8972 | 4,813.1958 | 73.2778 | 2,499.1983 | 4,747.8419 | 14,700.8705 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-10: China's simplified SAM

| | ABSORPTION MATRIX | | | | | | | FINAL DEMANDS MATRIX | | | | | Total |
|------------------|-------------------|-------------------|-------------------|-----------------|-------------------|-------------------|-------------------|----------------------|-----------------|-----------------|----------------|-----------------|-------------------|
| | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | Exports | |
| | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | 47.1588 | 108.1838 | 9.0997 | 164.4424 | 121.1458 | 6.7940 | 0.0048 | | | 292.3871 |
| | M | | | 54.6323 | 1,048.2496 | 394.3752 | 1,497.2571 | 294.7535 | 139.0984 | 0.3675 | | | 1,931.4766 |
| | S | | | 18.3501 | 229.7797 | 352.0109 | 600.1407 | 186.1046 | 310.0806 | 165.5206 | | | 1,261.8464 |
| Activities | A | 277.3103 | | | | | 277.3103 | | | | | 6.7692 | 284.0795 |
| | M | | 1,578.5627 | | | | 1,578.5627 | | | | | 376.0446 | 1,954.6073 |
| | S | | | 1,201.7297 | | | 1,201.7297 | | | | 22.2669 | 98.9474 | 1,322.9439 |
| Sub-total | 277.3103 | 1,578.5627 | 1,201.7297 | 120.1412 | 1,386.2132 | 755.4858 | 5,319.4429 | 602.0040 | 455.9730 | 165.8929 | 22.2669 | 481.7612 | 7,047.3408 |
| Factors | | | | 158.9552 | 461.9626 | 501.5940 | 1,122.5118 | | | | | | |
| Indirect taxes | 0.0000 | 0.0181 | -0.0738 | 4.9831 | 106.4315 | 65.8641 | 177.2231 | | | | | | |
| Import tariffs | 4.2592 | 28.2660 | 0.0000 | | | | 32.5252 | | | | | | |
| Import margins | 0.7779 | 13.4477 | | | | | 14.2256 | | | | | | |
| Imports | 10.0397 | 311.1820 | 60.1906 | | | | 381.4123 | | | | | | |
| Total | 292.3871 | 1,931.4765 | 1,261.8464 | 284.0795 | 1,954.6073 | 1,322.9440 | 7,047.3408 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-11: North ASEAN's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|-----------------|-----------------|---------------|-----------------|-----------------|----------------------|----------------|----------------|----------------|----------------|-----------------|-----------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 0.6364 | 2.7004 | 0.6953 | 4.0321 | 2.4133 | 0.0214 | 0.0000 | | | 6.4668 |
| | M | | | | 0.8884 | 152.1018 | 34.6905 | 187.6807 | 25.2363 | 25.1495 | 0.0001 | | | 238.0665 |
| | S | | | | 0.4537 | 31.9438 | 62.0776 | 94.4751 | 40.7019 | 16.7794 | 17.7153 | | | 169.6717 |
| Activities | A | 2.5117 | | | | | | 2.5117 | | | | | 1.7082 | 4.2198 |
| | M | | 63.8648 | | | | | 63.8648 | | | | | 191.9378 | 255.8026 |
| | S | | | 136.9609 | | | | 136.9609 | | | | 7.0486 | 43.1703 | 187.1798 |
| Sub-total | | 2.5117 | 63.8648 | 136.9609 | 1.9784 | 186.7460 | 97.4634 | 489.5252 | 68.3515 | 41.9503 | 17.7153 | 7.0486 | 236.8162 | 861.4071 |
| Factors | | | | | 2.2092 | 68.7348 | 86.7154 | 157.6594 | | | | | | |
| Indirect taxes | | 0.0847 | 1.3881 | 4.6541 | 0.0322 | 0.3218 | 3.0009 | 9.4817 | | | | | | |
| Import tariffs | | 0.5036 | 3.0871 | 0.0000 | | | | 3.5908 | | | | | | |
| Import margins | | 0.3706 | 5.8731 | | | | | 6.2437 | | | | | | |
| Imports | | 2.9963 | 163.8532 | 28.0567 | | | | 194.9062 | | | | | | |
| Total | | 6.4668 | 238.0664 | 169.6717 | 4.2198 | 255.8026 | 187.1798 | 861.4070 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-12: South ASEAN's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------------|-----------------|----------------|----------------|----------------|-----------------|-------------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 5.7276 | 27.5787 | 1.5422 | 34.8485 | 15.7814 | 0.5160 | 0.0000 | | | 51.1459 |
| | M | | | | 5.9982 | 127.8606 | 54.2337 | 188.0925 | 95.6632 | 21.0616 | 0.0001 | | | 304.8174 |
| | S | | | | 3.6056 | 46.0396 | 52.7599 | 102.4051 | 105.7719 | 47.5429 | 30.7061 | | | 286.4260 |
| Activities | A | 47.1822 | | | | | | 47.1822 | | | | | 4.7862 | 51.9685 |
| | M | | 206.9174 | | | | | 206.9174 | | | | | 116.3077 | 323.2250 |
| | S | | | 260.9105 | | | | 260.9105 | | | | 7.6353 | 9.7589 | 278.3046 |
| Sub-total | | 47.1822 | 206.9174 | 260.9105 | 15.3314 | 201.4789 | 108.5358 | 840.3561 | 217.2166 | 69.1205 | 30.7062 | 7.6353 | 130.8528 | 1,295.8874 |
| Factors | | | | | 35.1085 | 104.2441 | 154.3435 | 293.6961 | | | | | | |
| Indirect taxes | | 0.0020 | 0.1234 | 0.1862 | 1.5285 | 17.5021 | 15.4253 | 34.7676 | | | | | | |
| Import tariffs | | 0.1487 | 5.8808 | 0.0000 | | | | 6.0295 | | | | | | |
| Import margins | | 0.2842 | 4.3646 | | | | | 4.6488 | | | | | | |
| Imports | | 3.5288 | 87.5311 | 25.3293 | | | | 116.3893 | | | | | | |
| Total | | 51.1459 | 304.8173 | 286.4260 | 51.9685 | 323.2251 | 278.3046 | 1,295.8874 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-13: Korea's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|------------------|---|-------------------|-----------------|-----------------|----------------|-----------------|-----------------|----------------------|-----------------|-----------------|----------------|----------------|-----------------|-------------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 2.7652 | 21.5851 | 1.9069 | 26.2572 | 11.5064 | 0.2199 | 0.0216 | | | 38.0051 |
| | M | | | | 6.0561 | 256.9611 | 69.7173 | 332.7344 | 72.8203 | 42.1585 | 0.0673 | | | 447.7805 |
| | S | | | | 2.6594 | 69.3370 | 130.1111 | 202.1075 | 161.9001 | 64.6724 | 42.1792 | | | 470.8591 |
| Activities | A | 26.6576 | | | | | | 26.6576 | | | | | 0.5765 | 27.2342 |
| | M | | 307.7323 | | | | | 307.7323 | | | | | 158.8405 | 466.5728 |
| | S | | | 443.5643 | | | | 443.5643 | | | | 6.3589 | 17.7616 | 467.6847 |
| Sub-total | | 26.6576 | 307.7323 | 443.5643 | 11.4806 | 347.8832 | 201.7353 | 1,339.0534 | 246.2267 | 107.0508 | 42.2681 | 6.3589 | 177.1786 | 1,918.1364 |
| Factors | | | | | 16.4281 | 106.8095 | 249.8108 | 373.0484 | | | | | | |
| Indirect taxes | | 0.0040 | 2.3083 | 0.0004 | -0.6746 | 11.8802 | 16.1387 | 29.6570 | | | | | | |
| Import tariffs | | 6.7411 | 7.0579 | 0.0000 | | | | 13.7990 | | | | | | |
| Import margins | | 0.3230 | 6.5188 | | | | | 6.8418 | | | | | | |
| Imports | | 4.2792 | 124.1632 | 27.2944 | | | | 155.7368 | | | | | | |
| Total | | 38.0050 | 447.7805 | 470.8591 | 27.2342 | 466.5729 | 467.6847 | 1,918.1364 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-14: USA's simplified SAM

| | ABSORPTION MATRIX | | | | | | | FINAL DEMANDS MATRIX | | | | | Total |
|------------------|-------------------|-------------------|--------------------|-----------------|-------------------|--------------------|--------------------|----------------------|-------------------|-------------------|----------------|-----------------|--------------------|
| | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | Exports | |
| | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | 17.3956 | 111.7377 | 14.5707 | 143.7040 | 42.7386 | 1.0428 | 1.7408 | | | 189.2262 |
| | M | | | 50.0087 | 1,992.3215 | 1,145.0102 | 3,187.3404 | 1,470.4305 | 796.4590 | 228.7712 | | | 5,683.0010 |
| | S | | | 51.0923 | 1,056.7641 | 3,481.3381 | 4,589.1945 | 5,443.0977 | 1,193.1341 | 1,298.1353 | | | 12,523.5617 |
| Activities | A | 170.0151 | | | | | 170.0151 | | | | | 29.9829 | 199.9979 |
| | M | | 4,526.9972 | | | | 4,526.9972 | | | | | 638.5869 | 5,165.5841 |
| | S | | | 12,347.4362 | | | 12,347.4362 | | | | 21.4359 | 220.2423 | 12,589.1144 |
| Sub-total | 170.0151 | 4,526.9972 | 12,347.4362 | 118.4967 | 3,160.8233 | 4,640.9189 | 24,964.6874 | 6,956.2668 | 1,990.6359 | 1,528.6473 | 21.4359 | 888.8120 | 36,350.4853 |
| Factors | | | | 107.3144 | 1,811.9047 | 7,176.4027 | 9,095.6217 | | | | | | |
| Indirect taxes | 0.0000 | 30.3353 | 0.0000 | -25.8131 | 192.8561 | 771.7928 | 969.1712 | | | | | | |
| Import tariffs | 0.2179 | 19.9013 | 0.0000 | | | | 20.1192 | | | | | | |
| Import margins | 1.9524 | 38.1623 | | | | | 40.1146 | | | | | | |
| Imports | 17.0409 | 1,067.6049 | 176.1254 | | | | 1,260.7712 | | | | | | |
| Total | 189.2262 | 5,683.0010 | 12,523.5616 | 199.9979 | 5,165.5841 | 12,589.1144 | 36,350.4853 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-15: Canada's simplified SAM

| | ABSORPTION MATRIX | | | | | | | FINAL DEMANDS MATRIX | | | | | Total |
|------------------|-------------------|-----------------|-----------------|----------------|-----------------|-----------------|-------------------|----------------------|-----------------|-----------------|----------------|-----------------|-------------------|
| | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | Exports | |
| | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | 3.6145 | 12.5221 | 0.9723 | 17.1089 | 3.2181 | 0.0007 | 0.0070 | | | 20.3346 |
| | M | | | 6.0030 | 229.6872 | 76.1753 | 311.8655 | 122.8857 | 44.3375 | 1.4762 | | | 480.5650 |
| | S | | | 4.1273 | 76.0503 | 163.8235 | 244.0011 | 279.6425 | 96.2108 | 134.4639 | | | 754.3183 |
| Activities | A | 15.2549 | | | | | 15.2549 | | | | | 8.8414 | 24.0963 |
| | M | | 258.3061 | | | | 258.3061 | | | | | 224.2617 | 482.5679 |
| | S | | | 698.5502 | | | 698.5502 | | | | 7.2296 | 34.1633 | 739.9431 |
| Sub-total | 15.2549 | 258.3061 | 698.5502 | 13.7448 | 318.2596 | 240.9711 | 1,545.0867 | 405.7463 | 140.5490 | 135.9471 | 7.2296 | 267.2664 | 2,501.8252 |
| Factors | | | | 11.7616 | 140.6892 | 413.0185 | 565.4693 | | | | | | |
| Indirect taxes | 0.2641 | 14.1005 | 22.6553 | -1.4100 | 23.6190 | 85.9535 | 145.1824 | | | | | | |
| Import tariffs | 0.0627 | 2.9196 | 0.0000 | | | | 2.9823 | | | | | | |
| Import margins | 0.4594 | 5.5726 | | | | | 6.0320 | | | | | | |
| Imports | 4.2935 | 199.6662 | 33.1128 | | | | 237.0725 | | | | | | |
| Total | 20.3346 | 480.5650 | 754.3183 | 24.0963 | 482.5679 | 739.9431 | 2,501.8252 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-16: Mexico's simplified SAM

| | ABSORPTION MATRIX | | | | | | | FINAL DEMANDS MATRIX | | | | | Total |
|------------------|-------------------|-----------------|-----------------|----------------|-----------------|-----------------|-------------------|----------------------|-----------------|----------------|----------------|-----------------|-------------------|
| | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | Exports | |
| | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | 5.1031 | 20.9524 | 0.4949 | 26.5504 | 9.3335 | 0.3976 | 0.1534 | | | 36.4349 |
| | M | | | 3.6568 | 194.8044 | 67.2359 | 265.6971 | 174.6976 | 46.2394 | 7.1464 | | | 493.7804 |
| | S | | | 1.5167 | 71.2555 | 74.9951 | 147.7673 | 227.6976 | 75.1157 | 60.5932 | | | 511.1739 |
| Activities | A | 30.5781 | | | | | 30.5781 | | | | | 4.0101 | 34.5882 |
| | M | | 357.8459 | | | | 357.8459 | | | | | 150.1118 | 507.9577 |
| | S | | | 495.2136 | | | 495.2136 | | | | 3.6998 | 11.4494 | 510.3627 |
| Sub-total | 30.5781 | 357.8459 | 495.2136 | 10.2767 | 287.0123 | 142.7258 | 1,323.6524 | 411.7287 | 121.7527 | 67.8930 | 3.6998 | 165.5714 | 2,094.2979 |
| Factors | | | | 26.5909 | 200.7921 | 311.3053 | 538.6883 | | | | | | |
| Indirect taxes | 0.0000 | 0.7913 | 0.3589 | -2.2793 | 20.1533 | 56.3316 | 75.3559 | | | | | | |
| Import tariffs | 0.5688 | 6.1908 | 0.0000 | | | | 6.7596 | | | | | | |
| Import margins | 0.2172 | 3.5035 | | | | | 3.7207 | | | | | | |
| Imports | 5.0708 | 125.4489 | 15.6014 | | | | 146.1211 | | | | | | |
| Total | 36.4349 | 493.7804 | 511.1739 | 34.5882 | 507.9578 | 510.3628 | 2,094.2979 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-17: UK's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|-----------------------|---|-------------------|-----------------|-------------------|----------------|-----------------|-------------------|----------------------|-----------------|-----------------|-----------------|----------------|-----------------|-------------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 1.7604 | 16.4802 | 1.6204 | 19.8611 | 8.3706 | 0.0225 | 0.1177 | | | 28.3719 |
| | M | | | | 6.1006 | 320.7467 | 164.0008 | 490.8481 | 249.7072 | 98.3830 | 48.7264 | | | 887.6647 |
| | S | | | | 4.0403 | 161.6719 | 572.9232 | 738.6354 | 700.7653 | 140.5281 | 229.5895 | | | 1,809.5182 |
| Activities | A | 19.1379 | | | | | | 19.1379 | | | | | 1.9045 | 21.0424 |
| | M | | 568.4251 | | | | | 568.4251 | | | | | 243.0939 | 811.5190 |
| | S | | | 1,726.9150 | | | | 1,726.9150 | | | | 6.0721 | 88.0640 | 1,821.0511 |
| Sub-total | | 19.1379 | 568.4251 | 1,726.9150 | 11.9014 | 498.8988 | 738.5443 | 3,563.8226 | 958.8431 | 238.9336 | 278.4336 | 6.0721 | 333.0625 | 5,379.1674 |
| Factors | | | | | 12.6172 | 262.9714 | 900.2070 | 1,175.7955 | | | | | | |
| Indirect taxes | | 0.0000 | 14.8907 | 2.7152 | -3.4761 | 49.6489 | 182.2998 | 246.0785 | | | | | | |
| Import tariffs | | 0.3803 | 4.3409 | 0.0000 | | | | 4.7213 | | | | | | |
| Import margins | | 0.8577 | 8.6323 | | | | | 9.4900 | | | | | | |
| Imports | | 7.9960 | 291.3756 | 79.8880 | | | | 379.2595 | | | | | | |
| Total | | 28.3719 | 887.6647 | 1,809.5182 | 21.0424 | 811.5191 | 1,821.0512 | 5,379.1674 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-18: Rest of Europe's simplified SAM

| | | ABSORPTION MATRIX | | | | | | FINAL DEMANDS MATRIX | | | | | Total | |
|----------------|---|-------------------|------------|------------|------------|------------|------------|----------------------|------------|------------|------------|----------------|------------|-------------|
| | | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | | Exports |
| | | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | | 100.9391 | 205.6574 | 44.2532 | 350.8496 | 115.3619 | 3.1981 | 0.4664 | | | 469.8761 |
| | M | | | | 99.8024 | 2,622.7617 | 1,144.6370 | 3,867.2011 | 1,592.2100 | 644.5879 | 9.5897 | | | 6,113.5887 |
| | S | | | | 66.1218 | 1,238.8128 | 2,498.8660 | 3,803.8007 | 2,753.1608 | 913.9426 | 1,550.1317 | | | 9,021.0358 |
| Activities | A | 389.3266 | | | | | | 389.3266 | | | | | 48.0514 | 437.3780 |
| | M | | 3,757.7179 | | | | | 3,757.7179 | | | | | 2,136.7357 | 5,894.4535 |
| | S | | | 8,300.1429 | | | | 8,300.1429 | | | | 80.4586 | 513.5513 | 8,894.1527 |
| Sub-total | | 389.3266 | 3,757.7179 | 8,300.1429 | 266.8633 | 4,067.2319 | 3,687.7562 | 20,469.0388 | 4,460.7327 | 1,561.7286 | 1,560.1878 | 80.4586 | 2,698.3383 | 30,830.4848 |
| Factors | | | | | 177.1528 | 1,411.9438 | 4,187.8148 | 5,776.9114 | | | | | | |
| Indirect taxes | | 6.1778 | 233.1552 | 185.0211 | -6.6381 | 415.2778 | 1,018.5818 | 1,851.5755 | | | | | | |
| Import tariffs | | 3.7500 | 33.2206 | 0.0445 | | | | 37.0151 | | | | | | |
| Import margins | | 5.9260 | 74.7694 | | | | | 80.6954 | | | | | | |
| Imports | | 64.6956 | 2,014.7256 | 535.8273 | | | | 2,615.2486 | | | | | | |
| Total | | 469.8761 | 6,113.5887 | 9,021.0358 | 437.3780 | 5,894.4535 | 8,894.1527 | 30,830.4848 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

Table 3-19: Rest of World's simplified SAM

| | ABSORPTION MATRIX | | | | | | | FINAL DEMANDS MATRIX | | | | | Total |
|------------------|-------------------|-------------------|-------------------|-----------------|-------------------|-------------------|--------------------|----------------------|-----------------|-----------------|----------------|-----------------|--------------------|
| | Commodities | | | Activities | | | Sub-total | Household | Investment | Government | Export margins | Exports | |
| | A | M | S | A | M | S | | | | | | | |
| Commodities | A | | | 43.5704 | 151.2976 | 12.3584 | 207.2263 | 172.7327 | 6.8531 | 1.4208 | | | 388.2329 |
| | M | | | 53.4575 | 894.5714 | 404.1353 | 1,352.1642 | 777.6874 | 245.4122 | 8.6269 | | | 2,383.8908 |
| | S | | | 40.7907 | 396.6426 | 593.7241 | 1,031.1574 | 1,103.6686 | 358.6211 | 500.7978 | | | 2,994.2449 |
| Activities | A | 349.0496 | | | | | 349.0496 | | | | | 44.7834 | 393.8330 |
| | M | | 1,557.4976 | | | | 1,557.4976 | | | | | 669.4821 | 2,226.9797 |
| | S | | | 2,820.5338 | | | 2,820.5338 | | | | 44.9371 | 130.5415 | 2,996.0124 |
| Sub-total | 349.0496 | 1,557.4976 | 2,820.5338 | 137.8186 | 1,442.5115 | 1,010.2178 | 7,317.6289 | 2,054.0887 | 610.8864 | 510.8455 | 44.9371 | 844.8070 | 11,383.1936 |
| Factors | | | | 240.8442 | 697.8114 | 1,759.2420 | 2,697.8976 | | | | | | |
| Indirect taxes | 1.9298 | 87.4227 | 28.2254 | 15.1702 | 86.6568 | 226.5526 | 445.9575 | | | | | | |
| Import tariffs | 3.0304 | 60.8814 | 0.0053 | | | | 63.9170 | | | | | | |
| Import margins | 2.7606 | 33.4467 | | | | | 36.2073 | | | | | | |
| Imports | 31.4625 | 644.6424 | 145.4803 | | | | 821.5853 | | | | | | |
| Total | 388.2329 | 2,383.8908 | 2,994.2449 | 393.8330 | 2,226.9797 | 2,996.0124 | 11,383.1936 | | | | | | |

Source: Compiled from the GTAP 6.0 database. Note: A = Agriculture; M = Manufacturing; S = Services; values are in billion US\$; and the SAM format is based on Drud et al. (1986).

3.3.5 Disaggregation of the GTAP ‘Regional’ Household and Monetary Flows

Since the monetary flows among the household, government, and investment bank, as illustrated in Figure 3-1, are not reported in the simplified version of the SAMs above, this subsection explains the disaggregation of the ‘regional’ household in the GTAP 6.0 database, and more specifically the data sources and the calibration of the monetary sector in each region.

Although in this study, most elements in regional SAMs can be directly calibrated from the GTAP 6.0 database, the monetary flows among the government, the household and the bank require more disaggregation since GTAP only provides the data of the ‘regional’ household. In other words, domestic savings are not disaggregated into household and government savings, and government transfers to the household are not explicitly reported. Therefore, this model uses the residual approach to calibrate for the above benchmark variables. Referring to the regional SAM in Table 2-1 of Chapter 2, as we know the sum of tax receipts by the government from GTAP (row 11), which is equal to the sum of government consumption, transfers to the household and government savings (column 11); the transfers to the household in $SAM(10,11)$ ²⁵ can be residually derived once the data of government savings in $SAM(18,11)$ are obtained from external sources. Accordingly, as now we know the sum of income receipts by the household (row 10), which is identical to the sum of household consumption, income tax payments and savings (column 10); household saving in $SAM(18,10)$ can also be residually derived.

Since the SAM format is in compliance with the SNA 1993 standard, the government saving data titled, “Government Finance Deficit or Surplus, National Currency (IMF Estimates),” are derived from the United Nations Statistics Division (UNSD, 2007) online resource and subsequently converted to the assumed ‘world currency’ (US\$) using the exchange rates in

²⁵ As with Chapter 2, $SAM(10,11)$ refers to the element in the 10th row and the 11th column of the SAM.

matching years. Table 3-20 thus reports benchmark regional savings consisting of household, government, and foreign savings by region.

Table 3-20: Regional savings decomposed by source (in billion US\$)

| Region | Government savings | Household savings | Foreign savings | Regional Savings |
|----------------|--------------------|-------------------|-----------------|------------------|
| Thailand | 0.48 | 43.14 | -20.48 | 23.15 |
| Australia | -4.48 | 84.68 | -5.33 | 74.87 |
| New Zealand | -0.17 | 13.70 | -3.68 | 9.84 |
| India | -21.58 | 129.37 | -1.64 | 106.15 |
| Japan | -65.86 | 1,148.88 | -53.99 | 1,029.02 |
| China | -34.91 | 599.27 | -108.39 | 455.97 |
| North ASEAN | -2.75 | 87.41 | -42.72 | 41.95 |
| South ASEAN | -148.37 | 234.94 | -17.45 | 69.12 |
| Korea | -6.32 | 134.33 | -20.96 | 107.05 |
| USA | -318.05 | 1,918.05 | 390.64 | 1,990.64 |
| Canada | 9.20 | 162.74 | -31.39 | 140.55 |
| Mexico | -5.74 | 146.93 | -19.43 | 121.75 |
| United Kingdom | 0.47 | 188.84 | 49.62 | 238.93 |
| Rest of Europe | -123.64 | 1,768.22 | -82.85 | 1,561.73 |
| Rest of World | -203.85 | 846.69 | -31.95 | 610.89 |

Source: Government savings from UNSD database; foreign savings from GTAP 6.0 database; and household savings calculated by author as the residuals of household incomes and expenditures.

3.4 Thailand's Bilateral Free Trading Arrangements

FTA initiatives have been prevalent through the Asia-Pacific region from the beginning of the 21st century. Economic 'powerhouses' such as China, India, Japan, Korea, Australia, and New Zealand are actively involved in bilateral FTA negotiations with other countries in the region. Among ASEAN nations, Thailand positions herself at the negotiating frontier with the intention to push forward the competitive liberalisation agenda, in the hope that this positive atmosphere will help facilitate the multilateral trade negotiation process (Fiscal Policy Research Institute, 2005). At the same time, since Thailand is a small open economy with great dependence on export revenues, the government seems to have felt an urge to acquire

preferential market access to major export destinations, for fear of being left behind the current wave of (mostly bilateral) economic integration in the Asia-Pacific region.

Among Thailand's concluded bilateral FTAs, those with Australia and New Zealand have been fully in effect since 2005, while the FTA with Japan was signed later in 2007. The 'early-harvest' tariff-reducing packages with China and India came into force in 2003 and 2004, respectively.²⁶ In addition, Thailand is part of the collective ASEAN FTA's ongoing negotiations with the above five countries.²⁷ As such, Thailand's FTA commitments with these counterparts are individually summarised below, especially with respect to the de facto deals on tariff elimination and service liberalisation.

3.4.1 Thailand-Australia

The Thailand-Australia Closer Economic Relations FTA (TAFTA) came into force in January 2005. While the tariff-cutting package is reasonably comprehensive; the commitments on services and investment barely go beyond the existing GATS commitments. It is also noteworthy that, in comparison to Thailand, the Australian service markets have been relatively open since before the signing of TAFTA.

According to the Department of Trade Negotiations (Ministry of Commerce, Thailand), under TAFTA, Australia eliminated tariffs on 5,083 tariff line items, which account for 83.08% of bilateral imports from Thailand in 2003 (US\$1,934 million), on the 1st of January 2005. Furthermore, 786 items or 16.05% of Australian imports from Thailand are to be removed by 2010; and 239 sensitive tariff line items (textiles and wearing apparels) or 0.87% of current

²⁶ The 'early-harvest' package is the tariff-reducing programme preliminarily enforced before the actual signing of a preferential trading agreement. Typically, products included in the early-harvest scheme are less 'controversial' for all negotiating members.

²⁷ Negotiations on the above-mentioned plurilateral economic integration are currently ongoing under the AFTA-CER framework for ASEAN-Australia-New Zealand; and then separately between ASEAN and Japan, China, and India. Due to political tension, it is less likely that ASEAN can possibly form a single economic grouping that involves Japan and China, leave alone ASEAN+3 that includes South Korea in the negotiating circle.

trade will be phased out by 2015. Also, special safeguards on processed tuna and pineapple products are abandoned by 2008.

In terms of the liberalisation of service sectors, on the 1st of January 2005, Australia granted a preferential 100% access for Thai investors to launch businesses in her service markets, except that newspapers, media sectors, broadcasting services, banking, international airlines and airports are subject to prior approval under the Australian government's foreign investment policy.

On the other hand, Thailand has agreed to eliminate her tariffs against Australian imports under a relatively longer time span. While tariffs on 2,724 items, which account for 78.54% of bilateral imports from Australia in 2003 (US\$1,239 million), were removed in 2005 as the agreement came into force, another 2,411 items or 17.27% of Australian imports are scheduled to be eliminated by 2010. All remaining tariffs, including tariff-rate quotas, will decline to zero in 2015 or 2020, with the exception of skim milk powder and liquid milk and cream, for which the tariff-rate quotas will be eliminated in 2025.²⁸ For agricultural products subject to tariff rate quotas prior to 1 January 2005, Thailand has either eliminated the tariff and quota restrictions or will expand access for Australia over a transition period varying according to the product, before final elimination of the tariff-rate quota. Similarly, special safeguards on 23 tariff items such as pork, beef, dairy products, orange, grape and processed potatoes will be abandoned in 2015 or 2020.

As for the services commitments, Thailand has partially relaxed the limit of 49.9% foreign ownership. Hence, Australian investors are permitted to have full ownership in distribution, construction, and management consulting services; and majority ownership – up to 60% – in

²⁸ A tariff-rate quota is an ad valorem, two-tier tariff. A lower 'in-quota' tariff is applied to the first certain units of imports and a higher 'over-quota' tariff is applied to the rest. In spite of the name, the tariff-rate quota is not considered a quantitative restriction because it does not limit import quantities.

mining operations, major restaurants or hotels, tertiary education institutions in science and technology outside the capital, and maritime cargo services.

3.4.2 Thailand-New Zealand

Following TAFTA, the Thailand-New Zealand Closer Economic Partnership Agreement (TNZCEPA) entered into force in July 2005. The commitments are very similar to those under TAFTA, especially in terms of trade in goods. Negotiations on trade liberalisation in services, however, are scheduled to commence in 2008. New Zealand eliminated tariffs on 5,878 product lines, which account for roughly 85% of her import values from Thailand, on the 1st of July 2005; the rest are scheduled to become tariff-free in 2010, except for those in textiles, wearing apparels, and leather products, which must be phased out by 2015. Although trade liberalisation in services remains to be negotiated, in 2005 New Zealand agreed to extend conditional access to temporary employment for Thai chefs and traditional massage therapists.

As with the TAFTA commitments, Thailand is granted a more relaxed tariff-reduction schedule than is New Zealand. As TNZCEPA took effect in 2005, Thailand removed tariff barriers from 49% of bilateral imports from New Zealand, including important product lines for New Zealand, such as lamb's wool, products made of plastic, wood, and paper, seafood, sugar, and other processed food products. The other 10% of imports from New Zealand are scheduled to be liberalised by 2010, with exceptions for 'sensitive' tariff items for Thailand, e.g. milk and cream, beef, pork, onions, onion seeds, and so forth, which will be gradually eliminated until completely liberalised in 2015-2025. In addition, Thailand agreed to remove quotas from 18 sensitive agricultural product items, while granting progressive preferential quotas to New Zealand's imports of milk and cream products (HS 040110, 040120, 040130) until 2025; and to concentrated and sweetened milk and cream products (HS 040210), potatoes (HS 070110, 070190), onions (HS 070310, 071220), and onion seeds (HS 120991ex) until 2020, when all quotas are completely removed. However, quota impositions on strongly

sensitive items like skimmed milk remain after the signing of TNZCEPA. Similarly, special safeguards on 41 tariff items such as pork, beef, dairy products, honey, orange, grape and processed potatoes will not be abandoned until 2015 or 2020.

3.4.3 Thailand-Japan

To an extent, the Japan-Thailand Economic Partnership Agreement (JTEPA) – commenced in October 2007 after being postponed during Thailand’s political turning point – resembles those already signed between Japan and Singapore (JSEPA). In comparison with TAFTA and TNZCEPA, the coverage is less comprehensive. This is understandable in that the strong economic ties between Thailand and Japan might have caused fears that the negative list approach would harmfully affect domestic production sectors in each country. Products removed from the Japanese tariff-reduction package include rice, raw tapioca flour, products with high flour and sugar content, government-distributing rice products, raw sugar, canned pineapple, and milk products. Despite incompleteness in commitments on trade in goods, it is fair to say that liberalisation of services is advanced compared to the packages Japan has agreed with her other bilateral FTA counterparts.

Japan has agreed to abolish tariffs on 1,400 out of 2,300 agricultural and fishery products from Thailand. It immediately eliminated tariffs on prawns²⁹, tropical fruits (including durian, papaya, mango, mangosteen, and coconut), fruit wine, textiles, wearing apparels, chemical products, and jewellery. While petroleum and plastic products are to be fully liberalised in 2012, tariffs on some fishery products (excluding prawns), cat and dog food, food seasonings, wood products, footwear, and leather products will be either instantly abolished or progressively phased out until completely removed by 2017. Fruits and vegetables (excluding tropical fruits) are regarded as sensitive items, and thus their tariffs will be eliminated over a

²⁹ This commitment has significant economic meanings to Thai exporters, as prawns account for 14% of Japanese imports of fishery products from Thailand.

longer time period (due for completion in 2022). On the other hand, there are some tariff items being partially liberalised by this agreement: by 2012, tariffs on chicken and vegetable oil are reduced by 50% or less. Also, tariffs on modified tapioca flour, banana, and fresh pineapple are removed but then replaced with tariff-free quota; while molasses, pork and processed ham are to be offered tariff quotas at special tariff rates.³⁰

In terms of service liberalisation, Japan has allowed Thai companies to enter 65 service sub-sectors, and has improved GATS commitments preferentially for Thailand in 70 sub-sectors, including advertising, hotel, restaurant, health, spa, tourism, exhibition, education, printing, security, translation, business and profession, legal services, distribution, maintenance and repairs, entertainment, etc.

Thailand granted immediate elimination of tariffs on temperate fruits (e.g. apple, pear, peach, prune, berry fruits, lemon, and papaya), herring, and cod; carrot, strawberries, watermelon, and other melons are to be liberalised in 2009. Fish (excluding herring and cod) are to be liberalised by 2012, whereas tariffs on auto parts for Original Equipment Manufacturing (OEM) will be maintained until elimination in 2012 or 2014 for some sensitive engine items. In spite of being strongly opposed by domestic producers, tariffs and tariff quotas on steel products imported from Japan are promised to be eventually eliminated by 2017. As for partial liberalisation, Japanese exports of automobiles with engines exceeding 3,000 cc will receive annual tariff-reduction instalments until the tariff rates reach 60% in 2010.

With respect to service liberalisation, Thailand offered the possibility of full ownership to Japanese businessmen only in general management consulting services. Additionally, a range of 49-75% ownership is granted to Japanese companies in 13 subsectors, i.e. marketing, human resource management, production management, project management (excluding

³⁰ The terms 'tariff quota' and 'tariff-rate quota' are interchangeably employed in the literature; however, by definition, tariff quota additionally includes specific tariff (the type of tariff levied at a specific rate per physical unit).

construction), logistics, maintenance and repairs, distribution, 5-star hotels, large-scale restaurant, advertising, marinas, computer and related services, and high-level education.

3.4.4 Thailand-China and ASEAN-China

After preliminarily agreeing upon the elimination of import tariffs on 116 items of fruits and vegetables (HS 07-08) by 2003,³¹ Thailand and China subsequently extended the Thailand-China FTA to further include ASEAN as a whole. The ASEAN-China FTA is comprehensive and reciprocal in terms of commitments on goods, services, and investment.

The Early-Harvest Package (EHP) of ASEAN-China FTA covers the elimination of tariffs on agricultural items (HS 01-08) and charcoal by 2006 for China and ASEAN-6,³² while in general, CLMV³³ countries are given five more years for adjustment purposes. The EHP excludes outside-quota tariffs on milk, onion, garlic, potato, coconut, and dried longan which remain subject to WTO commitments. Subsequently, two ‘tracks’ are applied to the tariff-elimination scheme: Normal and Sensitive (inclusive of highly-sensitive items) Tracks. On the Normal Track, most of the remaining items, including industrial products, will be tariff-free by 2010 for China and ASEAN-6. On the other hand, products on the Sensitive Track (asymmetric across member countries) should not exceed 400 tariff lines (HS 6-digit) and must account for less than 10% of total imports. Most of their tariff rates will be reduced to less than 20% by 2012 and further down to 0-5% by 2015. Among the sensitive products, tariff rates of those listed as highly sensitive (fewer than 100 items) will be reduced to less than 50% within 2015.

³¹ The agreement excludes the outside-quota tariffs on onion, garlic, potato, coconut, and dried longan, which are invariably in compliance with the WTO commitments.

³² ASEAN-6 is composed of the six original members of ASEAN, i.e., Thailand, Singapore, Malaysia, The Philippines, Indonesia, and Brunei.

³³ CLMV refers to the set of countries those joined the group after the ASEAN-6 countries, i.e., Cambodia, the Lao PDR, Myanmar, and Vietnam.

Generally speaking, member countries listed some lines of automobiles and parts, rice, sugar and vegetable oil on their highly sensitive lists. Specifically, China reserved 261 items on the sensitive list, which (apart from the above highly-sensitive product lines) includes wheat, seeds, flour, coffee, pepper, tobacco, plastic products, wool, iron and steel, wood products, paper and pulp, and automobiles and parts. Similarly, Thailand specified 342 items on the sensitive list, e.g. tea, coffee, pepper, tobacco, milk, crude oil, certain farm commodities such as garlic, onions, potatoes, and tomatoes, juice, mineral water, electrical appliances, footwear, ceramic products, glass products, iron and steel, and certain types of toys.

In respect of trade in services, negotiations are delayed, since China proposed the positive-list approach, but ASEAN prefers the negative approach for investment. Nevertheless, the signing of a further agreement on service liberalisation at the 10th ASEAN-China Summit in Cebu, the Philippines on the 14th of January 2007 guaranteed that China will allow regional integration in computer services, property management, road transport, and so forth; while Thailand has promised to open her markets in business, education, tourism, and sea transport services.

3.4.5 Thailand-India and ASEAN-India

Contrary to the pattern of trade negotiation between Thailand and China in Subsection 3.4.4, the Thailand-India and ASEAN-India FTAs are negotiated simultaneously. Although the bilateral FTA has been negotiated at a faster pace, India's reluctance to grant further tariff concessions on many agricultural products has delayed the procedure as a whole. As such, not surprisingly, negotiations on services, investment, and movement of natural persons with India remain to be initiated.

With respect to the Thailand-India FTA, the Early Harvest Scheme (EHS) required that tariffs on 82 product lines including fruits, wheat, canned seafood, plastic products, jewellery, machinery parts, furniture, automobile parts, and some electrical appliances were to be annually decreased by 50, 75 and 100% of the base-year (2004) tariff rates, so that they would be fully liberalised by September 2006. Four fifths of total items are on the Normal Track,

where tariffs are eliminated over two instalments. As for the Sensitive Track involving some agricultural products, textiles, and automobiles and parts, their tariffs are scheduled to be reduced to 5% in 2015 and to 0-5% within 2018. Although, it is noteworthy that India has included rubber and related products in the Exclusion List, while Thailand has done the same with beef and textiles.

3.5 FTA Simulations

There is a public concern in Thailand over the outcomes of the concluded Thai FTAs – whose commitments on trade in goods, services, investment, and movement of natural persons were summarised in the previous section. Commonly regarded as a second-best policy for improving regional and global welfare, economists and policy makers alike anticipate inferior gains from narrower economic integration. Moreover, when all the FTA deals Thailand has separately agreed upon eventually enter into force, the ‘messiness’ arising from asymmetry in the agreements on rules of origin and customs procedures, among others, may incur non-negligible economic costs to the Thai economy. Therefore, this section scrutinises the expected outcomes of forming the ‘actual’ FTAs (TAFTA, TNZCEPA, JTEPA, ASEAN-China and Thailand-India) in comparison to the ‘counterfactual’ ones where larger free trade zones with complete sectoral coverage are formed. Finally, the ‘counterfactual’ simulation results for Thailand’s unilateral trade liberalisation; and those of global trade liberalisation are briefly compared with the above outcomes.

Trade liberalisation in agricultural and manufacturing sectors is simulated by removing tariffs in accordance with the actual commitments. While all of these sectors will be liberalised under both TAFTA and TNZCEPA, there are exclusion lists for highly sensitive products in the JTEPA, ASEAN-China and Thailand-India agreements. Tariffs on these products are to be either partially removed or kept at the benchmark Most-Favoured-Nation (MFN) rates. However, since the HS 6-digit product lines are aggregated into 22 sectors, individually removing tariffs from product lines within each sector is not possible. For that reason, all

production sectors under negotiations are completely, albeit preferentially, liberalised regardless of the de facto exclusion lists. Moreover, since the GTAP tariff data package is provided as inclusive of Non-Tariff Barriers (NTBs), the study does not explicitly impose NTBs (nor remove them in joining an FTA) due to the double-accounting issue. As NTBs are more distortionary than ad valorem tariffs, it would be of great interest to model NTBs for the future study once the two separate trade barrier accounts are properly developed. On the other hand, since there are no import tariffs on services, the intrinsic barriers to entering or exiting Cournot oligopolistic sectors are removed as the FTAs are launched. Therefore, where applicable, oligopolistic service sectors are liberalised by fixing sectoral profits while endogenising the number of firms.

To illustrate, the GAMS code for the global trade liberalisation simulation reads:

```
* Eliminate tariffs in all tradable sectors:
tm.FX(reg,regg,secT) = 0*tm0(reg,regg,secT) ;

* Fix the profit variable then free the number of firms in Cournot
* service sectors:
PROFIT.FX(reg,serv)$co(reg,serv) = PROFIT0(reg,serv) ;
NOF.LO(reg,serv)$co(reg,serv) = 0 ;
NOF.UP(reg,serv)$co(reg,serv) = +INF ;
NOF.L(reg,serv)$co(reg,serv) = NOF0(reg,serv) ;
NOF.LO(reg,serv)$co(reg,serv) = 0.000001*NOF0(reg,serv) ;
```

Simulation results are then reported in the following three subsections.

3.5.1 Thai FTAs with Australia and New Zealand

TAFTA and TNZCEPA are analysed together in Subsection 3.5.1 since not only the details of the two trade agreements but also the production patterns of Australia and New Zealand are broadly similar.

Anticipating that bilateral economic groupings will ultimately lead to broader integration, Thailand's alliance with the Australia New Zealand Closer Economic Relations Trade Agreement (ANZCERTA), henceforth 'THAILAND+2,' and ASEAN's partnership with ANZCERTA, hereafter 'ASEAN+2,' are also simulated and compared with the outcomes of the actual TAFTA and TNZCEPA agreements.

Table 3-21: Regional welfare gains after Thailand's FTA formation with Australia and New Zealand (EV in million US\$ and as percentage of the 2001 regional income)

| Region | TAFTA | | TNZCEPA | | THAILAND+2 | | ASEAN+2 | |
|------------------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>FTA member candidates</i> | | | | | | | | |
| THA | 6.81 | 0.01% | 8.31 | 0.01% | 14.64 | 0.02% | 111.54 | 0.12% |
| AUS | 97.38 | 0.03% | -1.72 | -0.00% | 118.03 | 0.03% | 224.71 | 0.06% |
| NZL | -2.73 | -0.01% | 8.31 | 0.02% | 98.57 | 0.21% | 101.67 | 0.22% |
| NASN | -0.35 | -0.00% | 1.31 | 0.00% | -3.57 | -0.00% | 1,411.30 | 1.10% |
| SASN | -3.48 | -0.00% | -1.59 | -0.00% | -12.32 | -0.00% | 1,321.62 | 0.42% |
| <i>Non-members</i> | | | | | | | | |
| IND | -2.83 | -0.00% | -0.57 | -0.00% | -5.02 | -0.00% | -99.13 | -0.02% |
| JPN | -30.43 | -0.00% | -3.01 | -0.00% | -54.25 | -0.00% | -524.10 | -0.01% |
| CHN | -11.76 | -0.00% | -1.44 | -0.00% | -37.55 | -0.00% | -335.94 | -0.03% |
| KOR | -5.45 | -0.00% | -3.46 | -0.00% | -16.43 | -0.00% | -176.42 | -0.05% |
| USA | -11.25 | -0.00% | -1.10 | -0.00% | -25.95 | -0.00% | -233.50 | -0.00% |
| CAN | -0.39 | -0.00% | -1.57 | -0.00% | -6.42 | -0.00% | 1.77 | 0.00% |
| MEX | 0.10 | 0.00% | -1.82 | -0.00% | -6.74 | -0.00% | -1.73 | -0.00% |
| UK | -8.27 | -0.00% | -5.68 | -0.00% | -28.00 | -0.00% | -94.61 | -0.01% |
| XEUR | -53.94 | -0.00% | -25.13 | -0.00% | -135.78 | -0.00% | -1,856.00 | -0.02% |
| ROW | -13.94 | -0.00% | -9.07 | -0.00% | -40.22 | -0.00% | -97.02 | -0.00% |
| World | -40.54 | -0.00% | -38.23 | -0.00% | -141.00 | -0.00% | -245.83 | -0.00% |

Source: Simulated by author. Note: Numbers in bold letters indicate welfare changes in member countries of each FTA grouping.

Table 3-21 shows the regional welfare effects – measured in terms of the EV – from Thailand forming FTAs with Australia (TAFTA); New Zealand (TNZCEPA); ANZCERTA (THAILAND+2); and also when ASEAN forms an FTA with ANZCERTA (ASEAN+2). It appears that TAFTA and TNZCEPA do not result in any significant impact on global income as the variation is close to zero in all scenarios; nevertheless, trade diversion dominates the

overall welfare outcome as the estimates of world EV losses from TAFTA and TNZCEPA are 40.54 and 38.23 million US dollars, respectively.

There is no doubt that larger economic groupings yield higher regional welfare gains to Thailand (*THA*). However, under TAFTA, Thailand gains 18% less than under TNZCEPA, perhaps because Australia (*AUS*) has an absolute advantage over Thailand due to her distinctly larger production scale in many tradable sectors. For the same reason, Australia gains more from TAFTA than does New Zealand from TNZCEPA, since Australia's lower unit costs facilitate more exports to Thailand after the trade arrangement. As a consequence, Australia may be expected to enjoy higher welfare gains than Thailand and New Zealand, even under THAILAND+2 and ASEAN+2.

In general, the levels of positive welfare changes (measured by EVs) are determined by the comparative advantages as well as the initial patterns of trade and tariffs prior to the formation of FTAs. In theory, sectors with comparative advantages would gain more from greater export opportunities that drives up export prices and thus improving the terms of trade, at the same time as inducing more efficient resource re-allocation across production sectors. Also, as examined earlier in the sensitivity analysis section in Chapter 2, the higher the protection levels prior to trade liberalisation, the greater the expected gains from it. Thus, sectors initially more protected by import duties tend to gain more in respect of the consumption effect as import prices in domestic markets are reduced, and hence higher utility levels. In addition to these gains from trade, the model also identifies the pro-competitive effect arising from trade liberalisation in sectors with imperfect competition and economies of scale (Francois and Roland-Holst, 1997). Due to this specification, more specialisation in certain goods after tariffs are eliminated reduces average costs and thus enhancing industrial performances. Consumers then enjoy cheaper products with greater quantity and variety (since imports are differentiated from domestically-produced commodities). In sum, the changes in summary statistics (EVs) are mainly caused by the changes in producer and consumer prices among sectors, and hence the changes in the structures of production and

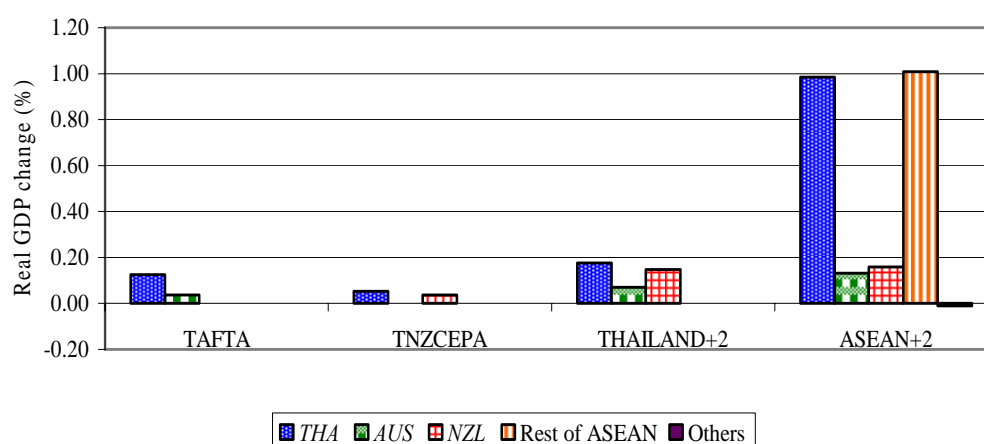
consumption incentives. As such, sector-specific adjustments to each FTA scenario will be further explored in Subsections 3.5.1.1 to 3.5.1.3.

Most countries not involved in any of the groupings are worse off, although the degree of trade diversion depends on the strength of the ex-ante economic ties with FTA members. In this respect, Japan (*JPN*), China (*CHN*), The United States (*USA*), and Europe (*UK* and *XEUR*) may expect comparatively negative effects as they have established good trade relationship with some member countries.

Conversely, several non-member regions gain marginally from the groupings, for instance, Mexico (*MEX*) from TAFTA and Canada (*CAN*) from ASEAN+2. Not only do these countries not trade much with Australia, New Zealand and ASEAN, they also have strong trade ties with the United States. Therefore, as the United States is negatively affected by TAFTA and ASEAN+2, the U.S. trade with Australia, New Zealand and ASEAN is naturally re-channelled towards Mexico and Canada, which should come as no surprise as the three countries are members of the long-established NAFTA trading bloc.

Chart 3-3 reports on the percentage changes in nominal GDP, where North and South ASEAN (*NASN* and *SASN*) are jointly referred to as 'Rest of ASEAN,' whilst all other regions not included in any of the above FTA negotiations are aggregated into one region identified as 'Others.' Once again, the economic expansion in non-member regions is barely altered, whereas member economies grow to a greater extent as the group is enlarged. In particular, the difference in New Zealand's GDP expansion rates under TNZCEPA and THAILAND+2 is noteworthy, since it manages to evade the strong trade diversion effect once its major trading partner, Australia, is included in the trade-liberalising regime.

Chart 3-3: Percentage changes in nominal GDP after Thailand's FTA formation with Australia and New Zealand



Source: Simulated by author.

Table 3-22: Welfare changes for trade indicators in Thailand after the FTA formation with Australia and New Zealand

| Welfare changes | TAFTA | TNZCEPA | THAILAND+2 | ASEAN+2 |
|-------------------------------------|--------|---------|------------|-----------|
| <i>Change in million US\$</i> | | | | |
| Gross imports from FTA partners | 361.20 | 134.37 | 478.53 | 3,952.34 |
| Gross imports from non-partners | -72.75 | -53.65 | -111.93 | -1,073.78 |
| <i>% change</i> | | | | |
| Bilateral imports from FTA partners | 19.72% | 48.99% | 23.09% | 23.20% |
| Bilateral imports from non-partners | -0.10% | -0.07% | -0.15% | -1.78% |
| Bilateral exports to FTA partners | 12.70% | 5.93% | 11.66% | 13.68% |
| Bilateral exports to non-partners | 0.07% | 0.08% | 0.16% | 0.35% |

Source: Simulated by author.

Table 3-22 also highlights the variation in trade indicators for Thailand. Under all FTA scenarios trade creation dominates trade diversion in that fewer imports from non-members are offset by those from FTA counterparts, not only because Thai imports from non-members are replaced by those produced within the FTA zones, but also because preferential trade liberalisation has created trade among member countries that would not have taken place, were it not for the reduced trade barriers. Since trade creation under TAFTA is considerably

stronger than that under TNZCEPA, Australia benefits more from the FTA with Thailand than does New Zealand in absolute terms. However, the proportional variation in Thai imports from New Zealand under TNZCEPA exceeds that from Australia under TAFTA because Thai trade with New Zealand is relatively low before the FTA signing. Consequently, TNZCEPA is estimated to increase New Zealand's exports to Thailand by 48.99%.

Table 3-23: Percentage changes in labour welfare of member countries after Thailand's FTA formation with Australia and New Zealand

| | | Real wage of unskilled labour | Real wage of skilled labour | Ratio of unskilled to skilled labour income |
|-------------------|-------------|-------------------------------|-----------------------------|---|
| TAFTA | <i>THA</i> | 0.05% | -0.11% | 0.34% |
| | <i>AUS</i> | 0.06% | 0.03% | 0.03% |
| TNZCEPA | <i>THA</i> | 0.02% | -0.04% | 0.11% |
| | <i>NZL</i> | 0.04% | -0.01% | 0.04% |
| THAILAND+2 | <i>THA</i> | 0.07% | -0.14% | 0.45% |
| | <i>AUS</i> | 0.09% | 0.03% | 0.06% |
| | <i>NZL</i> | 0.34% | 0.27% | 0.07% |
| ASEAN+2 | <i>THA</i> | 0.40% | -1.36% | 3.92% |
| | <i>AUS</i> | 0.21% | 0.08% | 0.13% |
| | <i>NZL</i> | 0.37% | 0.29% | 0.08% |
| | <i>NASN</i> | 1.39% | 0.47% | 0.92% |
| | <i>SASN</i> | 0.39% | -0.23% | 1.31% |

Source: Simulated by author.

Table 3-23 summarises the variation in the welfare of labour in member countries under the four regimes, the change in real wage implicitly reflecting the deviation of labour demand from the ex-ante level. Since Thailand (*THA*) and South ASEAN (*SASN*) are relatively abundant in unskilled-labour, the real wage of skilled labour unambiguously drops while that of the unskilled is increased once the two countries form partnerships with higher income and more skilled-labour abundant regions like Australia (*AUS*), New Zealand (*NZL*) and North ASEAN (*NASN*). On the other hand, the real wages of both types of labour in *AUS*, *NZL* and *NASN* increase since the unskilled labour in these regions is, in absolute terms, more productive than that in *THA* and *SASN*. Thus, their exports of products intensive in unskilled-

labour by and large increase after the implementation of the agreements, and accordingly, the ratio of unskilled to skilled labour income improves in all scenarios. As a consequence of the assumption that the labour markets in Thailand and South ASEAN are subject to the wage-curve relationship between the real wage and the unemployment rate, while Australia, New Zealand, and North ASEAN have flexible real wages and rigid unemployment; on average, real wages in the former group adjust by a smaller degree than in the latter group.

3.5.1.1 TAFTA

Next, the regional and sectoral welfare changes due to the formation of an FTA between Thailand and Australia (TAFTA) are discussed in greater detail.

Table 3-24: Percentage changes for various regional indicators under TAFTA

| Region | Real GDP | Private demand | Investment demand | Public demand | Regional import | Regional export | Terms of trade |
|--------------------|----------|----------------|-------------------|---------------|-----------------|-----------------|----------------|
| <i>FTA members</i> | | | | | | | |
| <i>THA</i> | 0.08% | 0.11% | 0.16% | -0.96% | 0.30% | 0.31% | 0.13% |
| <i>AUS</i> | 0.02% | 0.06% | 0.07% | -0.08% | 0.22% | 0.14% | 0.11% |
| <i>Non-members</i> | | | | | | | |
| <i>NZL</i> | -0.00% | -0.00% | -0.01% | -0.00% | -0.03% | -0.01% | -0.00% |
| Others | -0.00% | -0.00% | -0.00% | -0.00% | -0.00% | -0.00% | -0.00% |

Source: Simulated by author.

The estimated real GDP expansion rates reported in Table 3-24 suggest that Thailand and Australia gain slightly while non-members are mostly unaffected by TAFTA. Other changes in real variables, including final demands and trade flows, also indicate that TAFTA boosts regional production and trade, which consequently improves the terms of trade in member countries. Thailand's real GDP expansion is estimated to be higher than Australia's, a consequence of Thailand having higher trade barriers before the signing, and of her economy being rather small compared to her partner. Hence, the tariff revenue loss in Thailand reduces public demand by 0.96%, much higher than the 0.08% decrease than that for Australia. Although the change is small in absolute terms, New Zealand is more negatively affected by TAFTA than region 'Others,' due to her reliance on the Australian economy.

The sectoral adjustments under TAFTA are reported in Table 3-25 for Thailand, and in Table 3-26 for Australia.

Table 3-25: Percentage changes for various sectoral indicators in Thailand under TAFTA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | -0.04% | -0.08% | -0.04% | -0.12% | 0.17% | 2.10% |
| <i>NRS</i> | 0.01% | 0.04% | 0.07% | 0.01% | -0.13% | 0.34% |
| <i>OIL</i> | 0.01% | 0.03% | 0.07% | 0.00% | 1.42% | 0.07% |
| <i>PAGR</i> | 0.09% | 0.22% | 0.40% | 0.04% | 0.24% | 2.68% |
| <i>OFD</i> | 0.16% | 0.29% | 0.48% | 0.11% | 0.36% | 0.96% |
| <i>MNF</i> | 0.06% | 0.20% | 0.41% | 0.00% | 0.12% | 0.28% |
| <i>TEX</i> | 0.36% | 0.49% | 0.69% | 0.29% | 0.54% | 0.14% |
| <i>WAP</i> | 0.24% | 0.35% | 0.55% | 0.14% | 0.41% | 0.41% |
| <i>CRP</i> | 0.36% | 0.49% | 0.70% | 0.29% | 0.48% | 0.18% |
| <i>I_S</i> | 0.31% | 0.44% | 0.64% | 0.23% | 0.53% | 0.43% |
| <i>NFM</i> | 0.12% | 0.25% | 0.45% | 0.04% | 0.16% | 0.13% |
| <i>MVH</i> | 0.02% | 0.15% | 0.36% | -0.05% | 0.44% | 0.83% |
| <i>ELE</i> | -0.12% | 0.04% | 0.24% | -0.17% | -0.11% | 0.00% |
| <i>OME</i> | 1.51% | 1.65% | 1.85% | 1.44% | 1.60% | 0.50% |
| <i>OMF</i> | 0.11% | 0.24% | 0.44% | 0.03% | 0.17% | 0.25% |
| <i>MSR</i> | 0.06% | 0.21% | 0.43% | -0.01% | -0.07% | 0.15% |
| <i>TRD</i> | 0.03% | 0.25% | 0.53% | -0.02% | -0.15% | 0.20% |
| <i>TRP</i> | -0.05% | 0.13% | 0.40% | -0.14% | -0.17% | 0.08% |
| <i>CFI</i> | -0.01% | 0.10% | 0.30% | -0.11% | -0.06% | 0.04% |
| <i>OBS</i> | -0.12% | -0.01% | 0.19% | -0.21% | -0.13% | -0.02% |
| <i>OSG</i> | -0.87% | -0.96% | -0.75% | -1.16% | -0.54% | -0.63% |
| <i>DWE</i> | -0.13% | 0.04% | <i>n/a*</i> | -0.16% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

Table 3-25 shows that Thailand gains in most manufacturing sectors. Particularly, we observe outstanding output and trade expansion in processed agricultural products (*PAGR* and *OFD*), textiles and wearing apparel (*TEX* and *WAP*), chemical, rubber and plastic products (*CRP*), metal products (*I_S* and *NFM*), machinery and equipments (*OME*), and other manufacturing

products (*OMF*). On the other hand, Table 3-26 reports that Australia's agricultural products (*AGR*), motor vehicles and parts (*MVH*), electronic equipments (*ELE*) and, as with Thailand, sectors *PAGR*, *OFD*, *CRP*, *I_S*, and *OMF*, also benefit from TAFTA. The expansion of these five sectors is due to the Armington assumption that distinguishes products by country of origin. In particular, Thailand enjoys a strong expansion in sector *OME*, and does Australia in sector *OFD*. Lastly, TAFTA induces contraction in dwellings (*DWE*), the only non-traded sector, as resources are bid away by producers in tradable sectors.

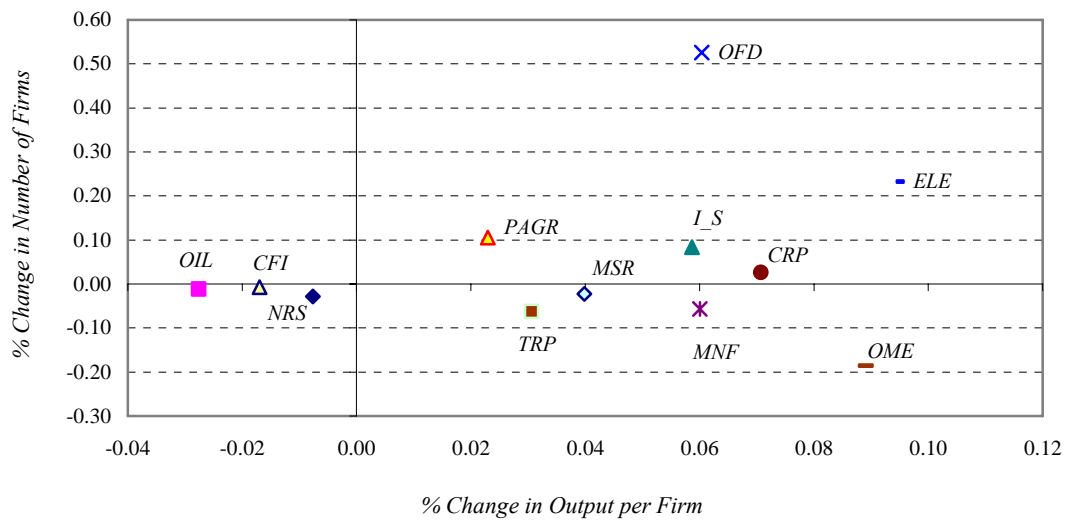
Table 3-26: Percentage changes for various sectoral indicators in Australia under TAFTA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | 0.15% | 0.19% | 0.19% | 0.19% | 0.28% | 0.31% |
| <i>NRS</i> | -0.04% | -0.05% | -0.04% | -0.05% | -0.09% | 0.19% |
| <i>OIL</i> | -0.04% | -0.05% | -0.05% | -0.05% | -0.06% | 0.06% |
| <i>PAGR</i> | 0.13% | 0.11% | 0.13% | 0.11% | 0.25% | 0.21% |
| <i>OFD</i> | 0.59% | 0.56% | 0.58% | 0.56% | 2.23% | 0.44% |
| <i>MNF</i> | 0.00% | -0.03% | -0.00% | -0.03% | 0.15% | 0.23% |
| <i>TEX</i> | -0.35% | -0.35% | -0.31% | -0.35% | -0.22% | 0.50% |
| <i>WAP</i> | -0.13% | -0.14% | -0.10% | -0.14% | 0.10% | 0.61% |
| <i>CRP</i> | 0.10% | 0.06% | 0.08% | 0.06% | 0.48% | 0.20% |
| <i>I_S</i> | 0.14% | 0.11% | 0.13% | 0.11% | 0.68% | 0.33% |
| <i>NFM</i> | -0.05% | -0.05% | -0.01% | -0.05% | -0.05% | 0.18% |
| <i>MVH</i> | 0.47% | 0.46% | 0.50% | 0.46% | 1.17% | 0.17% |
| <i>ELE</i> | 0.33% | 0.28% | 0.31% | 0.28% | 0.62% | 0.08% |
| <i>OME</i> | -0.10% | -0.14% | -0.12% | -0.14% | 0.15% | 0.36% |
| <i>OMF</i> | 0.09% | 0.08% | 0.12% | 0.08% | 0.43% | 0.30% |
| <i>MSR</i> | 0.02% | -0.00% | 0.03% | 0.00% | -0.10% | 0.12% |
| <i>TRD</i> | 0.01% | -0.00% | 0.05% | 0.00% | -0.12% | 0.13% |
| <i>TRP</i> | -0.03% | -0.05% | -0.01% | -0.05% | -0.34% | 0.13% |
| <i>CFI</i> | -0.02% | -0.03% | 0.00% | -0.03% | -0.39% | 0.13% |
| <i>OBS</i> | -0.00% | -0.02% | 0.02% | -0.01% | -0.13% | 0.13% |
| <i>OSG</i> | -0.07% | -0.09% | -0.05% | -0.09% | -0.17% | 0.08% |
| <i>DWE</i> | -0.02% | -0.03% | <i>n/a*</i> | -0.02% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: * Sector *DWE* does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector *DWE* is non-traded.

Finally, Chart 3-4 plots the percentage change in the number of firms against output per firm in Australian imperfectly competitive sectors under TAFTA.³⁴

Chart 3-4: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in Australia under TAFTA



Domestic sectors such as forestry, fishery, coal, gas, and mineral (NRS), oil (OIL) and communication, financial and insurance services (CFI), which contract under TAFTA (see Table 3-26), appear in the South-West quadrant where both the number of firms and the output per firm decrease. The output drop in this cluster of producers is attributable to the ex-ante ‘inefficacy’ arising from imperfect competition, since they were relatively highly protected before TAFTA. Whilst it comes as no surprise that firm population falls due to greater competition from abroad, the degree of inefficacy in these particular sectors is strong enough to reduce output, both at the firm and sectoral levels. On the other hand, a fraction of firms operating in sectors comparatively uncompetitive at the international level – namely transport (TRP), electricity, gas, water, and construction (MSR), some manufacturing products (MNF) and machinery and equipments (OME) – then leave the market while

³⁴ The results for Thailand are not reported here, because the estimated HHIs define that all Thai production sectors are under perfect competition.

surviving firms shift production into higher gear to benefit from the scale economies. The last group comprise sectors endowed with international competitiveness – specifically, processed agricultural products (PAGR and OFD), ferrous metals (I_S), chemical, rubber, plastic products (CRP) and electronic equipments (ELE). These sectors are estimated to grow both in terms of outputs per firm and number of firms.

3.5.1.2 TNZCEPA

The FTA between Thailand and New Zealand (TNZCEPA) is analysed as follows. In Table 3-27, we observe that Thailand and New Zealand can only gain marginally from this preferential arrangement.

Table 3-27: Percentage changes for various regional indicators under TNZCEPA

| Region | Real GDP | Private demand | Investment demand | Public demand | Regional import | Regional export | Terms of trade |
|--------------------|----------|----------------|-------------------|---------------|-----------------|-----------------|----------------|
| <i>FTA members</i> | | | | | | | |
| <i>THA</i> | 0.02% | 0.04% | 0.02% | -0.32% | 0.09% | 0.10% | 0.04% |
| <i>NZL</i> | 0.02% | 0.02% | 0.04% | -0.05% | 0.23% | 0.11% | 0.01% |
| <i>Non-members</i> | | | | | | | |
| Others | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Source: Simulated by author.

In both countries, real GDP grows merely by 0.02%, whilst private and investment demands increase by less than 0.04%. Thailand's public sector demand contracts to a greater extent as her ex-ante trade barriers are substantial especially in agricultural sectors. Trade between the two countries expands by less than one quarter of one per cent, while the terms of trade improve by only 0.04% and 0.01% in Thailand and New Zealand, respectively.

Table 3-28 and Table 3-29 report on sectoral adjustments in Thailand and New Zealand. Overall, TNZCEPA facilitates expansion in Thailand's production and exportation of processed food products (*OFD*), textiles (*TEX*), chemical, rubber, plastic products (*CRP*), metal products (*I_S* and *NFM*), and machinery and equipments (*OME*); while New Zealand

benefits from expansion particularly in agricultural produces (*AGR*), processed agricultural products (*PAGR* and *OFD*), and wearing apparels (*WAP*).

Table 3-28: Percentage changes for various sectoral indicators in Thailand under TNZCEPA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | -0.01% | -0.01% | 0.00% | -0.02% | 0.11% | 0.01% |
| <i>NRS</i> | 0.02% | 0.04% | 0.05% | 0.03% | 0.02% | 0.08% |
| <i>OIL</i> | 0.02% | 0.05% | 0.06% | 0.03% | -0.00% | 0.03% |
| <i>PAGR</i> | -0.18% | -0.14% | -0.08% | -0.20% | 0.00% | 5.49% |
| <i>OFD</i> | 0.11% | 0.15% | 0.21% | 0.09% | 0.23% | 0.54% |
| <i>MNF</i> | 0.03% | 0.08% | 0.15% | 0.01% | 0.06% | 0.02% |
| <i>TEX</i> | 0.10% | 0.14% | 0.21% | 0.07% | 0.13% | -0.02% |
| <i>WAP</i> | 0.05% | 0.08% | 0.15% | 0.02% | 0.10% | 0.57% |
| <i>CRP</i> | 0.17% | 0.21% | 0.28% | 0.15% | 0.19% | 0.01% |
| <i>I_S</i> | 0.11% | 0.15% | 0.22% | 0.08% | 0.12% | 0.05% |
| <i>NFM</i> | 0.09% | 0.13% | 0.19% | 0.06% | 0.08% | 0.06% |
| <i>MVH</i> | 0.04% | 0.09% | 0.15% | 0.02% | 0.15% | -0.03% |
| <i>ELE</i> | 0.05% | 0.10% | 0.17% | 0.03% | 0.05% | 0.03% |
| <i>OME</i> | 0.15% | 0.20% | 0.26% | 0.13% | 0.16% | 0.04% |
| <i>OMF</i> | 0.07% | 0.11% | 0.17% | 0.04% | 0.09% | -0.04% |
| <i>MSR</i> | 0.02% | 0.07% | 0.14% | -0.00% | 0.03% | -0.01% |
| <i>TRD</i> | 0.02% | 0.09% | 0.18% | 0.00% | 0.03% | -0.01% |
| <i>TRP</i> | 0.02% | 0.08% | 0.16% | -0.02% | 0.08% | -0.03% |
| <i>CFI</i> | 0.02% | 0.05% | 0.12% | -0.01% | 0.09% | -0.07% |
| <i>OBS</i> | 0.00% | 0.04% | 0.10% | -0.03% | 0.06% | -0.07% |
| <i>OSG</i> | -0.29% | -0.31% | -0.25% | -0.38% | -0.11% | -0.28% |
| <i>DWE</i> | -0.04% | 0.02% | <i>n/a*</i> | -0.05% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

The results resemble those under TAFTA, since New Zealand's economic structure and factor endowment are broadly analogous to Australia. Nonetheless, some Thai sectors adjust to TAFTA and TNZCEPA in a dissimilar manner. For instance, sector *PAGR* in Thailand contracts by 0.18% under TNZCEPA, whereas a 0.09% expansion in sectoral output was observed under TAFTA. This sheds light on the concern over the spaghetti bowl effect of multiple bilateral FTAs entering into force at different points in time, making it hard for

domestic producers to decide whether to expand production after the signing of TAFTA, given the anticipation over TNZCEPA or other FTAs that may entail contraction later on.

Table 3-29: Percentage changes for various sectoral indicators in New Zealand under TNZCEPA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | 0.17% | 0.19% | 0.20% | 0.20% | -0.01% | 0.52% |
| <i>NRS</i> | -0.06% | -0.08% | -0.07% | -0.08% | -1.44% | 0.49% |
| <i>OIL</i> | -0.08% | -0.13% | -0.12% | -0.13% | 0.21% | -0.13% |
| <i>PAGR</i> | 0.26% | 0.21% | 0.25% | 0.23% | 0.41% | 0.34% |
| <i>OFD</i> | 2.88% | 2.86% | 2.91% | 2.88% | 3.85% | -0.01% |
| <i>MNF</i> | -0.14% | -0.16% | -0.12% | -0.14% | -0.19% | 0.22% |
| <i>TEX</i> | -0.26% | -0.27% | -0.21% | -0.25% | -0.31% | 0.25% |
| <i>WAP</i> | 0.18% | 0.17% | 0.22% | 0.19% | 0.60% | 0.41% |
| <i>CRP</i> | -0.15% | -0.16% | -0.13% | -0.15% | -0.23% | 0.32% |
| <i>I_S</i> | -0.38% | -0.38% | -0.35% | -0.37% | -0.45% | 0.20% |
| <i>NFM</i> | -0.66% | -0.67% | -0.65% | -0.66% | -0.74% | 0.26% |
| <i>MVH</i> | -0.16% | -0.20% | -0.19% | -0.19% | -0.22% | 0.25% |
| <i>ELE</i> | -0.21% | -0.23% | -0.19% | -0.21% | -0.20% | 0.22% |
| <i>OME</i> | -0.43% | -0.45% | -0.39% | -0.42% | -0.45% | 0.23% |
| <i>OMF</i> | -0.23% | -0.25% | -0.22% | -0.24% | -0.36% | 0.32% |
| <i>MSR</i> | -0.03% | -0.05% | -0.01% | -0.03% | -0.22% | 0.18% |
| <i>TRD</i> | 0.01% | -0.01% | 0.04% | 0.01% | -0.18% | 0.20% |
| <i>TRP</i> | -0.12% | -0.13% | -0.09% | -0.12% | -0.55% | 0.18% |
| <i>CFI</i> | -0.02% | -0.04% | 0.00% | -0.02% | -0.21% | 0.20% |
| <i>OBS</i> | -0.01% | -0.03% | 0.01% | -0.01% | -0.20% | 0.20% |
| <i>OSG</i> | -0.04% | -0.07% | -0.02% | -0.05% | -0.22% | 0.16% |
| <i>DWE</i> | -0.00% | -0.02% | <i>n/a*</i> | -0.00% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

On the other hand, the majority of the service sectors in Thailand gain slightly from TNZCEPA. Thus, the preferential tariff elimination in agricultural and manufacturing sectors

has positive spill-over effects on service sectors, in the sense that the expansion in these sectors triggers further demands for domestic services.³⁵

Chart 3-5: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in New Zealand under TNZCEPA

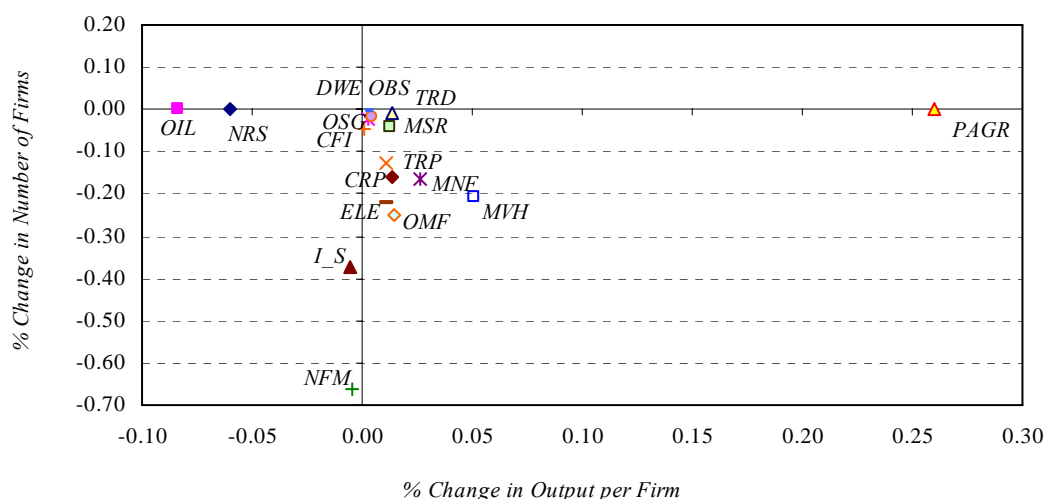


Chart 3-5 reports changes in the scale of production of firms under imperfect competition in New Zealand. Processed agricultural products (*PAGR*), as well as commodities that intensively use natural resources as primary factors (*NRS* and *OIL*), are manufactured under oligopoly in New Zealand (see Table 3-3). Therefore, firm populations are invariable, whilst outputs per firm adjust with respect to their comparative advantages over Thai imports. Precisely, since total outputs of sectors *NRS* and *OIL* drop after TNZCEPA (see Table 3-29), outputs per firm also fall respectively by 0.06% and 0.08%; whereas firms in sector *PAGR* expand by 0.26% on average, in line with the sectoral output increase reported in Table 3-29.

Since the rest of New Zealand's imperfectly competitive sectors operate under monopolistic competition and almost everyone of them is worse off after TNZCEPA, they are mostly

³⁵ Since all service firms in Thailand operate under perfect competition, the simulation of TNZCEPA does not actually include service liberalisation, i.e. the removal of oligopolistic firms' entry and exit barriers. Hence, service expansion in Thailand after TNZCEPA is chiefly attributable to the spill-over expansion effects from good sectors

plotted in the lower quadrants of the chart, where the less competitive firms exit the market and the ones that survive either expand and grow more productive under the increased pressure of international competition (e.g. sectors *MVH*, *MNF*, *OMF*, *TRP*, etc.), or decrease their output levels due to severe competition from abroad (e.g. sectors *I_S* and *NFM*).

3.5.1.3 THAILAND+2 FTA

The THAILAND+2 FTA scenario supposes that TAFTA, TNZCEPA, and ANZCERTA enter into force at the same time. Table 3-30 indicates that Thailand and New Zealand experience higher increases in real GDP, private and investment demands than Australia, probably because the better access to Australian markets granted to Thailand and New Zealand is more beneficial than that conceded to Australia in return. On the whole, the grouping's impact on the world economy is marginal. This implies that even though THAILAND+2 is more beneficial to member regions than the TAFTA or TNZCEPA, the policy influence on each region is nonetheless minimal because of the lack of trade established between Thailand and the other two countries prior to the FTA signings.

Table 3-30: Percentage changes for various regional indicators under THAILAND+2

| Region | Real GDP | Private demand | Investment demand | Public demand | Regional import | Regional export | Terms of trade | Real exchange rate |
|--------------------|----------|----------------|-------------------|---------------|-----------------|-----------------|----------------|--------------------|
| <i>FTA members</i> | | | | | | | | |
| <i>THA</i> | 0.10% | 0.15% | 0.18% | -1.27% | 0.39% | 0.40% | 0.17% | 0.08% |
| <i>AUS</i> | 0.03% | 0.10% | 0.11% | -0.22% | 0.35% | 0.33% | 0.28% | 0.01% |
| <i>NZL</i> | 0.09% | 0.15% | 0.39% | -0.10% | 0.91% | 0.26% | 0.01% | -0.63% |
| <i>Non-members</i> | | | | | | | | |
| Others | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Source: Simulated by author.

Table 3-31 compares variations in sectoral production and trade across member regions. Thailand most benefits from the expansion in machinery and equipment (*OME*), and secondarily from expansion in chemical, rubber, plastic products (*CRP*), textiles (*TEX*), ferrous metals (*I_S*), and wearing apparels (*WAP*). Thus, generally speaking, the direction of

Thailand's sectoral adjustments to THAILAND+2 is in keeping with the previous simulation results under TAFTA and TNZCEPA scenarios but with an enhanced degree of positive change.

Table 3-31: Percentage changes for various sectoral indicators in member countries under THAILAND+2

| Sector | Output | | | Export | | | Import | | |
|-------------|--------|--------|--------|--------------|--------------|--------------|--------------|--------------|--------------|
| | THA | AUS | NZL | THA | AUS | NZL | THA | AUS | NZL |
| <i>AGR</i> | -0.05% | 0.17% | -0.63% | 0.28% | 0.35% | -1.02% | 2.12% | 0.10% | 0.58% |
| <i>NRS</i> | 0.03% | 0.03% | -0.62% | -0.10% | -0.02% | -3.82% | 0.41% | 0.11% | 0.94% |
| <i>OIL</i> | 0.02% | -0.05% | 0.51% | 1.39% | 0.09% | 17.81% | 0.10% | 0.24% | 1.88% |
| <i>PAGR</i> | -0.06% | 0.13% | -0.66% | 0.27% | 0.44% | -1.09% | 7.79% | 3.75% | 2.26% |
| <i>OFD</i> | 0.25% | 0.61% | 2.60% | 0.57% | 2.32% | 3.58% | 1.49% | 0.76% | 0.28% |
| <i>MNF</i> | 0.09% | 0.02% | 0.31% | 0.18% | 0.35% | 1.17% | 0.30% | 0.42% | 0.85% |
| <i>TEX</i> | 0.44% | -0.75% | 8.96% | 0.64% | -0.12% | 16.90% | 0.11% | 1.11% | 1.75% |
| <i>WAP</i> | 0.27% | -0.45% | 14.34% | 0.49% | 0.63% | 30.36% | 0.97% | 2.04% | -0.84% |
| <i>CRP</i> | 0.52% | 0.13% | 0.86% | 0.65% | 0.70% | 1.72% | 0.19% | 0.32% | 0.66% |
| <i>I_S</i> | 0.40% | 0.20% | 0.77% | 0.63% | 0.86% | 2.08% | 0.48% | 0.68% | 0.69% |
| <i>NFM</i> | 0.20% | 0.25% | -1.08% | 0.25% | 0.28% | -1.32% | 0.19% | 0.19% | 1.62% |
| <i>MVH</i> | 0.07% | 0.66% | 0.77% | 0.59% | 1.56% | 2.61% | 0.81% | 0.12% | 1.03% |
| <i>ELE</i> | -0.06% | 0.73% | -0.88% | -0.06% | 1.18% | -1.37% | 0.03% | -0.00% | 1.13% |
| <i>OME</i> | 1.63% | 0.04% | 2.98% | 1.73% | 0.45% | 4.16% | 0.54% | 0.41% | 0.69% |
| <i>OMF</i> | 0.18% | 0.19% | 0.19% | 0.26% | 0.69% | 0.48% | 0.21% | 0.32% | 1.06% |
| <i>MSR</i> | 0.08% | 0.04% | 0.11% | -0.04% | 0.01% | -0.82% | 0.14% | 0.05% | 0.97% |
| <i>TRD</i> | 0.04% | 0.03% | 0.10% | -0.12% | -0.02% | -0.86% | 0.19% | 0.06% | 1.05% |
| <i>TRP</i> | -0.03% | 0.01% | -0.69% | -0.08% | -0.08% | -2.72% | 0.05% | 0.04% | 0.81% |
| <i>CFI</i> | 0.00% | -0.01% | -0.22% | 0.03% | -0.15% | -1.23% | -0.03% | 0.05% | 1.06% |
| <i>OBS</i> | -0.12% | 0.01% | -0.12% | -0.08% | -0.04% | -1.11% | -0.09% | 0.06% | 1.02% |
| <i>OSG</i> | -1.14% | -0.16% | -0.13% | -0.65% | -0.15% | -1.17% | -0.89% | -0.07% | 1.02% |
| <i>DWE</i> | -0.17% | -0.05% | -0.09% | <i>n/a**</i> | <i>n/a**</i> | <i>n/a**</i> | <i>n/a**</i> | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: **Output from Sector DWE is non-traded.

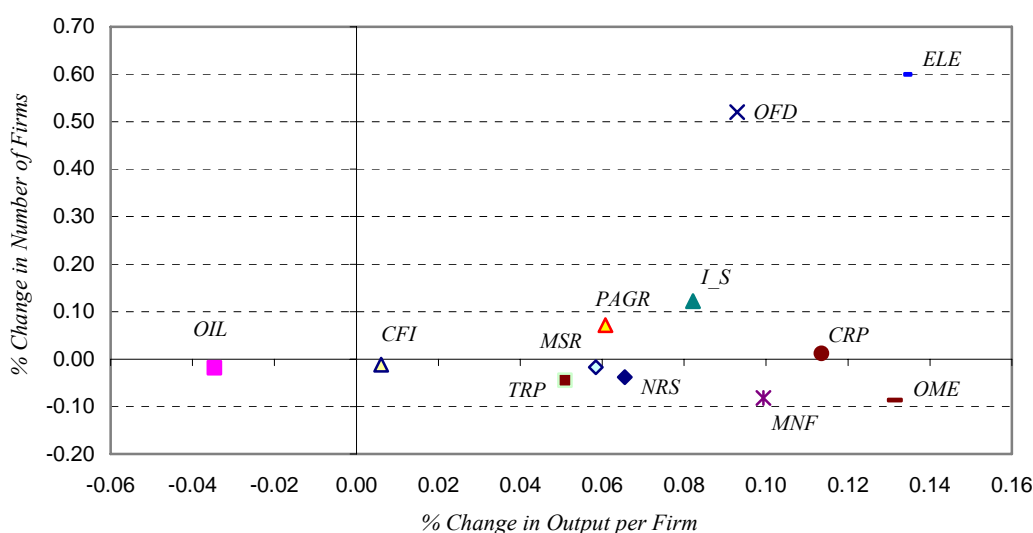
For Australia, the sources of output expansion are from processed agricultural and food products (*PAGR* and *OFD*), metal products (*I_S* and *NFM*), motor vehicles and parts (*MVH*), and electronic equipment (*ELE*), again similar to the results under TAFTA. In comparison to the other member countries, Australian exports of agricultural produces (*AGR*), processed agricultural products (*PAGR*), non-ferrous metals (*NFM*), and other manufactures (*OMF*),

expand substantially after THAILAND+2, which reflects the comparative advantage of Australia in these commodities.

Since New Zealand has strong economic ties with Australia, the simulation results for this country differ slightly from those under TNZCEPA. Although wearing apparel (*WAP*) and some food products (*OFD*) are still dominant sources of gains, once Australia is taken into consideration, agricultural produces (*AGR*) and most processed agricultural products (*PAGR*) are subject to contraction both in terms of production and exportation. Yet again, the non-traded sector, dwellings (*DWE*), is faced with contraction since productive resources are reduced as the tradable sectors are liberalised.

The proportional changes plotted in Chart 3-6 for Australia's imperfectly competitive sectors resemble those in Chart 3-4 for the TAFTA analysis, except that there forestry, fishery, coal, gas, minerals (*NRS*) was positioned in the South-West quadrant.

Chart 3-6: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in Australia under THAILAND+2

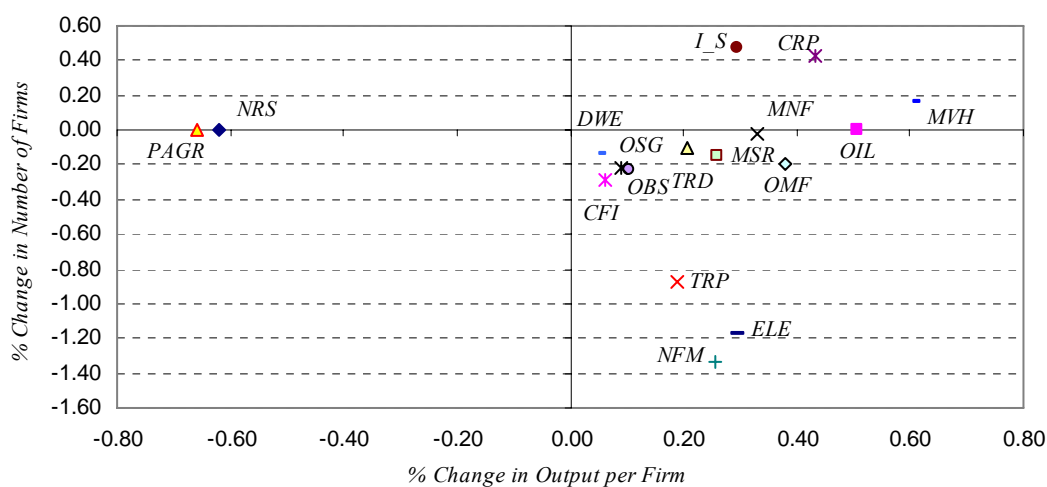


Under THAILAND+2, output per firm in this sector grows unambiguously while the variation in the number of firms is similar to that under TAFTA. As New Zealand gains access to the

grouping, the order of comparative advantages in sector *NRS* among the three countries results in sectoral expansion in Australia, due to the fact that Australia has a clear comparative advantage in this sector over New Zealand.

Finally, Chart 3-7 shows the percentage changes in production scale of New Zealand's imperfectly competitive sectors under THAILAND+2. The outcomes differ from those reported in Chart 3-5 (TNZCEPA), in which most sectors are located around the origin. In Chart 3-7, we observe more positive results on the whole as the plots are shifted toward the right hand side of the diagram. Especially, compared to the case where Australia is not involved in the agreement, sectoral and individual firm's outputs of oil (*OIL*), ferrous metals (*I_S*), chemical, rubber, plastic products (*CRP*) and motor vehicles and parts (*MVH*) have increased markedly, despite the number of firms in the latter three being expanded at the same time. This reflects the comparative advantage of New Zealand over Australia in these sectors. Conversely, in sector *PAGR* the involvement of Australia has a strong negative impact, with a notable contraction in output per firm (Chart 3-6) and by sector (Table 3-31).

Chart 3-7: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in New Zealand under THAILAND+2



3.5.2 Thai FTAs with Japan, China and India

For the next step, JTEPA, ASEAN-China and Thailand-India FTAs are analysed together in this subsection. Although we do not observe apparent proximity in the economic structures of Japan, China and India, Thai FTAs with these three nations are analogous in terms of the negotiating approaches that result in a limited coverage of commitments. Moreover, as they are all major economic figures in Asia, a comparative study of the economic effects of Thai FTAs with these nations is of an interest to policy makers. To take things further, the obtained results are contrasted with those simulated under ‘ASEAN+3,’ where ASEAN as a whole forms an ‘ideal’ FTA with Japan, China, and India.

Table 3-32: Regional welfare gains after Thailand’s FTA formation with Japan, China and India (EV in million US\$ and as percentage of 2001 regional income)

| Region | JTEPA | | ASEAN+CHINA | | THAILAND+INDIA | | ASEAN+3 | |
|------------------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|-------------------|-----------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>FTA member candidates</i> | | | | | | | | |
| THA | 1,685.49 | 1.73% | 393.76 | 0.40% | 311.70 | 0.32% | 2,144.50 | 2.20% |
| IND | -21.40 | -0.00% | -160.04 | -0.03% | -142.32 | -0.03% | 58.04 | 0.01% |
| JPN | 3,795.80 | 0.09% | -1,252.06 | -0.03% | -21.59 | -0.00% | 19,727.70 | 0.48% |
| CHN | -361.95 | -0.03% | 2,526.81 | 0.21% | -12.62 | -0.00% | 3,694.99 | 0.30% |
| NASN | -172.59 | -0.13% | 2,265.59 | 1.77% | -5.18 | -0.00% | 2,298.79 | 1.80% |
| SASN | -148.54 | -0.05% | 1,556.67 | 0.49% | -15.43 | -0.00% | 1,673.98 | 0.53% |
| <i>Non-members</i> | | | | | | | | |
| AUS | -70.61 | -0.02% | -54.23 | -0.02% | -4.81 | -0.00% | -110.37 | -0.03% |
| NZL | 1.46 | 0.00% | -3.78 | -0.01% | -1.06 | -0.00% | 0.29 | 0.00% |
| KOR | -106.10 | -0.03% | -561.00 | -0.14% | -10.19 | -0.00% | -1,577.55 | -0.40% |
| USA | -350.14 | -0.00% | -440.72 | -0.00% | -34.44 | -0.00% | -921.23 | -0.01% |
| CAN | -6.73 | -0.00% | 13.59 | 0.00% | -1.41 | -0.00% | 71.29 | 0.01% |
| MEX | -0.39 | -0.00% | 2.51 | 0.00% | 2.15 | 0.00% | -19.25 | -0.00% |
| UK | -83.45 | -0.01% | -134.33 | -0.01% | -16.15 | -0.00% | -336.22 | -0.02% |
| XEUR | -714.69 | -0.01% | -3,570.05 | -0.05% | -154.20 | -0.00% | -5,678.18 | -0.07% |
| ROW | -277.04 | -0.01% | -381.54 | -0.01% | -81.57 | -0.00% | -949.09 | -0.03% |
| World | 3,169.11 | 0.01% | 201.18 | 0.00% | -187.12 | -0.00% | 20,077.68 | 0.06% |

Source: Simulated by author. Note: Numbers in bold letters indicate welfare changes in member countries of each FTA grouping.

Table 3-32 reports the EV results from the four FTA scenarios. It is noteworthy that Thailand (*THA*) derives a welfare gain from the bilateral FTA with Japan (*JPN*) that is more than four times higher than under the assumed ASEAN+CHINA regime. Even under the ‘ideal’ ASEAN+3, Thailand’s gains are some 30% higher than under JTEPA. This result reflects the fact that Japan has been Thailand’s largest trading partner in Asia and the Pacific region. Japan, on the other hand, gains 3,795.80 million US dollars from the agreement, some 0.09% of the regional income in 2001. Overall, JTEPA increases the world income by 3,169.11 million US dollars or 0.01%, which is much larger than the results from TAFTA or TNZCEPA (see Table 3-21).

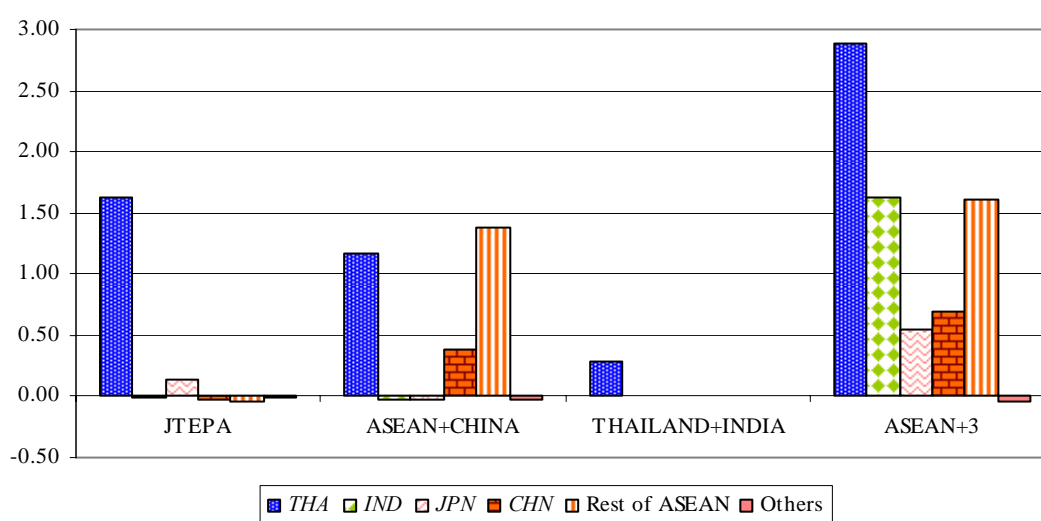
The results indicate that member countries enjoy substantial gains under ASEAN+CHINA, especially China (*CHN*), whose income is augmented by 2,526.81 million US dollars. However, the trade diversion effects on non-members such as Europe (*UK* and *XEUR*), Korea (*KOR*) and the United States (*USA*) are significant enough to counterbalance the positive impacts on member regions, resulting in a minor improvement in world welfare.

Not surprisingly, Thailand would obtain minor gains from the bilateral FTA with India (*IND*); whereas for India and the world the agreement would be slightly welfare-worsening. The primary reason for the deterioration in regional welfare is that Indian industries have been highly protected at the border. Although THAILAND + INDIA results in benefits for India through improved resource re-allocation, the tariff revenue loss reduces the government income to the extent that that it more than offsets the real gains and so decreases welfare.

Were ASEAN (*THA*, *NASN*, and *SASN*) to be successful in forming a single FTA with Japan, China and India (ASEAN+3), all members would be unequivocally better off; while non-members such as Korea, the United States and Rest of Europe would find the outcome unfavourable. In contrast, the negative impacts on Australia (*AUS*) and New Zealand (*NZL*) would be relatively small compared to other non-members, because the trade relationships between ASEAN+3 members and these two nations are not extensive. Moreover, under some FTA scenarios, non-members such as New Zealand, Canada (*CAN*) and Mexico (*MEX*) may

even marginally gain as trade with their major trading partners like Australia and the United States – also not included in the groupings – is increased after the FTA is formed. This aspect of the analysis highlights the usefulness of the general equilibrium approach in that this type of secondary trade diversion effect on non-member economies might otherwise have been overlooked.

Chart 3-8: Percentage changes in nominal GDP after Thailand’s FTA formation with Japan, China and India



Source: Simulated by author.

Chart 3-8 plots the increase in nominal GDP under the four FTA scenarios, where North and South ASEAN (*NASN* and *SASN*) are again aggregated as ‘Rest of ASEAN,’ and all other non-members are together labelled as ‘Others.’ The overall results are consistent with those in Table 3-32, except that the gross nominal output change in India after THAILAND+INDIA is positive but close to zero (0.02%). This again underlines the argument made above that the loss in tariff revenues is the main source of overall negative EV for India.

Table 3-33 reports the nominal and real changes in trade indicators for the member regions. In all cases, trade creation dominates trade diversion, and the gains grow in absolute terms as the groupings are enlarged to ASEAN+3.

Under JTEPA, bilateral trade between Thailand and Japan is boosted by approximately 25% of the base volume. Given that Thailand's ex-ante imports from Japan do not significantly differ from Japan's imports from Thailand (according to the GTAP 6.0 database), the scope for the elimination of trade barriers in the two countries should be essentially the same, despite the fact that Japanese trade barriers on major Thai agricultural exports are not removed under JTEPA. In contrast, under ASEAN+CHINA, both Thailand and South ASEAN experience greater trade impacts than China and North ASEAN, which may be expected since the former two's initial border protection is more substantial, especially given the fact that Singapore – as part of North ASEAN – imposes virtually zero tariffs on many product lines.

Table 3-33: Welfare changes for trade indicators in member countries after Thailand's FTA formation with Japan, China and India

| FTA | Region | Change in million US\$ | | % change in real volumes | | | |
|----------------|--------|---------------------------------|---------------------------------|---------------------------|---------------------------|-------------------------|-------------------------|
| | | Gross imports from FTA partners | Gross imports from non-partners | Imports from FTA partners | Imports from non-partners | Exports to FTA partners | Exports to non-partners |
| JTEPA | THA | 4,207.15 | -796.87 | 25.35% | -1.37% | 25.70% | -3.72% |
| | JPN | 5,781.69 | -998.55 | 25.70% | -0.25% | 25.35% | 0.13% |
| ASEAN+CHINA | THA | 5,141.62 | -692.20 | 24.93% | -1.37% | 19.90% | -1.65% |
| | CHN | 15,035.67 | -4,123.88 | 10.87% | -1.34% | 7.48% | 0.31% |
| | NASN | 5,169.59 | 3,178.88 | 5.45% | 1.75% | 13.45% | -2.89% |
| | SASN | 8,357.78 | -1,662.37 | 22.39% | -1.70% | 15.61% | 0.59% |
| THAILAND+INDIA | THA | 846.45 | -283.98 | 92.57% | -0.35% | 78.64% | -0.10% |
| | IND | 654.24 | -104.09 | 78.64% | -0.13% | 92.57% | -0.46% |
| ASEAN+3 | THA | 8,967.24 | -819.42 | 23.09% | -2.40% | 18.15% | -4.53% |
| | IND | 15,017.72 | -3,860.72 | 78.10% | -7.01% | 47.23% | 14.71% |
| | JPN | 19,372.86 | 4,792.81 | 10.31% | 0.96% | 17.19% | -2.11% |
| | CHN | 32,880.71 | -7,498.71 | 14.44% | -3.08% | 10.04% | 0.84% |
| | NASN | 8,362.55 | 3,330.80 | 5.66% | 2.20% | 13.52% | -4.98% |
| | SASN | 10,362.20 | -1,271.98 | 15.65% | -1.88% | 11.63% | -0.41% |

Source: Simulated by author.

By the same token, trade between Thailand and India is almost doubled under THAILAND+INDIA, reflecting their relatively minor trade relationship and their substantial

trade barriers before the arrangement. This point is also observed under ASEAN+3, as the percentage expansion in India's intra-group trade is notably higher than that perceived in other member countries.

Table 3-34: Percentage changes for labour welfare indicators in member countries after Thailand's FTA formation with Japan, China and India

| | | Unemployment rate of unskilled labour | Unemployment rate of skilled labour | Real wage of unskilled labour | Real wage of skilled labour | Ratio of unskilled to skilled labour income |
|-----------------------|-------------|---------------------------------------|-------------------------------------|-------------------------------|-----------------------------|---|
| JTEPA | <i>THA</i> | -7.84% | 7.61% | 0.82% | -0.73% | 3.32% |
| | <i>JPN</i> | -0.74% | -0.79% | 0.07% | 0.08% | -0.01% |
| ASEAN+CHINA | <i>THA</i> | -5.92% | 17.35% | 0.61% | -1.59% | 4.93% |
| | <i>CHN</i> | -2.97% | -0.58% | 0.30% | 0.06% | 0.51% |
| | <i>NASN</i> | <i>n/a*</i> | <i>n/a*</i> | 2.24% | 0.87% | 1.36% |
| | <i>SASN</i> | -5.35% | 4.34% | 0.55% | -0.42% | 2.07% |
| THAILAND+INDIA | <i>THA</i> | -2.10% | 0.41% | 0.21% | -0.04% | 0.53% |
| | <i>IND</i> | -0.08% | 0.42% | 0.01% | -0.04% | 0.11% |
| ASEAN+3 | <i>THA</i> | -13.52% | 25.88% | 1.46% | -2.28% | 8.50% |
| | <i>IND</i> | -5.30% | 4.56% | 0.55% | -0.45% | 2.11% |
| | <i>JPN</i> | -3.33% | -3.39% | 0.34% | 0.35% | -0.01% |
| | <i>CHN</i> | -6.09% | 0.37% | 0.63% | -0.04% | 1.39% |
| | <i>NASN</i> | <i>n/a*</i> | <i>n/a*</i> | 2.20% | 0.06% | 2.14% |
| | <i>SASN</i> | -5.74% | 9.31% | 0.59% | -0.89% | 3.21% |

Source: Simulated by author. Note: *North ASEAN's skilled and unskilled labour markets have fully flexible wages and rigid unemployment rates.

Finally, Table 3-34 summarises the labour welfare effects in the member regions. Since real wages in the unskilled and skilled labour markets of Thailand (*THA*), India (*IND*), Japan (*JPN*), China (*CHN*), and South ASEAN (*SASN*) are negatively associated with unemployment rates, their percentage changes are always of opposite sign. On the other hand, real wages in North ASEAN (*NASN*) are fully flexible at the same time as unemployment rates are exogenised, thus the real wage adjustment is more pronounced for the type of labour used intensively to produce commodities in which *NASN* has a comparative advantage, given that unemployment is voluntary, it does not decline with the increased labour demand. For

that reason, North ASEAN's rate of return to unskilled labour is enhanced under both ASEAN+CHINA and ASEAN+3.

Thailand experiences an improvement in the real wage of unskilled labour under all scenarios. The ex-post unskilled wage is at its highest under ASEAN+3, reflecting the strong demand for unskilled-labour intensive products from elsewhere. Since the unskilled wage variation is also considerably high under JTEPA, it is apparent that such demands mainly come from Japan, a relatively skilled-labour abundant economy. In contrast, skilled labour in Thailand is worse off under all types of FTA; hence Thailand's unskilled labour income unequivocally improves more relative to that of skilled labour.

Unskilled labour in regions such as India, China and South ASEAN benefit more from the regional groupings than does skilled labour; Japan being the only country whose skilled labour gains more from FTA formation than the unskilled, and Japan's ratio of unskilled to skilled labour income uniquely deteriorates (see Table 3-34).

3.5.2.1 JTEPA

Table 3-35 summarises the results for the partnership between Thailand and Japan (JTEPA).

Table 3-35: Percentage changes for various regional indicators under JTEPA

| Region | Real GDP | Private demand | Investment demand | Public demand | Regional import | Regional export | Terms of trade |
|--------------------|----------|----------------|-------------------|---------------|-----------------|-----------------|----------------|
| <i>FTA members</i> | | | | | | | |
| <i>THA</i> | 0.42% | 2.40% | 5.34% | -6.26% | 3.84% | 1.37% | 1.64% |
| <i>JPN</i> | 0.11% | 0.14% | 0.14% | -0.04% | 0.68% | 0.84% | 0.38% |
| <i>Non-members</i> | | | | | | | |
| <i>AUS</i> | -0.02% | -0.03% | 0.00% | -0.01% | -0.05% | -0.05% | 0.00% |
| <i>NZL</i> | -0.01% | 0.00% | 0.01% | 0.00% | -0.06% | -0.05% | 0.00% |
| <i>CHN</i> | -0.01% | -0.02% | -0.01% | -0.06% | -0.06% | -0.02% | 0.01% |
| <i>NASN</i> | -0.06% | -0.08% | -0.19% | -0.09% | -0.12% | -0.06% | 0.02% |
| <i>SASN</i> | -0.02% | -0.02% | -0.05% | -0.11% | -0.12% | -0.07% | 0.01% |
| <i>KOR</i> | -0.02% | -0.02% | -0.02% | -0.05% | -0.03% | -0.02% | 0.00% |
| Others | 0.00% | 0.00% | 0.00% | -0.01% | -0.02% | -0.01% | 0.00% |

Source: Simulated by author.

Overall, JTEPA increases the real GDP of the Thai and Japanese economies by 0.42% and 0.11%, respectively. The percentage changes in all other macroeconomic variables similarly suggest that Thailand, as a smaller economy, obtains stronger positive impacts than Japan, given the same magnitude of change in bilateral imports (see Table 3-33). Under JTEPA, regional trade is facilitated and the terms of trade with respect to all other economies are improved for both member countries. Private and investment demands are then enhanced as national incomes increase. However, the reduction in public demand is unavoidable under all FTA scenarios due to the fall in tariff revenue. Lastly, among those outside the grouping, the real GDP of Korea is that most negatively affected by JTEPA.

Table 3-36: Percentage changes for sectoral indicators in Thailand under JTEPA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|---------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | 3.08% | 6.78% | 7.18% | 6.64% | -12.04% | 28.72% |
| <i>NRS</i> | -0.45% | -0.57% | -0.26% | -0.68% | -0.82% | 1.25% |
| <i>OIL</i> | -0.75% | -1.47% | -1.17% | -1.58% | 0.08% | -1.38% |
| <i>PAGR</i> | 29.58% | 30.08% | 32.36% | 29.27% | 85.17% | 0.95% |
| <i>OFD</i> | -1.13% | -0.71% | 1.02% | -1.33% | -0.78% | 4.76% |
| <i>MNF</i> | -1.34% | -0.89% | 1.06% | -1.59% | -1.53% | 7.31% |
| <i>TEX</i> | -5.33% | -4.97% | -3.10% | -5.64% | -6.49% | 6.34% |
| <i>WAP</i> | -0.86% | -0.54% | 1.43% | -1.23% | -2.09% | 7.88% |
| <i>CRP</i> | -11.30% | -10.96% | -9.20% | -11.58% | -11.40% | 2.88% |
| <i>I_S</i> | -5.45% | -5.08% | -3.21% | -5.75% | -2.46% | 1.70% |
| <i>NFM</i> | -2.10% | -1.74% | 0.20% | -2.43% | -1.86% | -1.17% |
| <i>MVH</i> | -2.80% | -2.42% | -0.49% | -3.10% | -0.87% | 29.12% |
| <i>ELE</i> | -1.86% | -1.39% | 0.56% | -2.08% | -1.79% | 0.23% |
| <i>OME</i> | 1.83% | 2.24% | 4.26% | 1.53% | 2.19% | 4.26% |
| <i>OMF</i> | -1.55% | -1.16% | 0.79% | -1.85% | -2.14% | 3.81% |
| <i>MSR</i> | 1.26% | 1.72% | 3.89% | 0.95% | -0.28% | 2.03% |
| <i>TRD</i> | 0.11% | 0.85% | 3.51% | -0.09% | -2.02% | 2.37% |
| <i>TRP</i> | 0.29% | 0.81% | 3.47% | -0.13% | -1.46% | 1.47% |
| <i>CFI</i> | -0.05% | 0.15% | 2.13% | -0.55% | -1.52% | 1.62% |
| <i>OBS</i> | -1.01% | -0.83% | 1.13% | -1.52% | -2.17% | 1.28% |
| <i>OSG</i> | -5.57% | -6.50% | -4.66% | -7.15% | -4.52% | -3.03% |
| <i>DWE</i> | 0.54% | 1.13% | <i>n/a*</i> | 0.43% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

Table 3-36 shows Thailand's sectoral adjustments to JTEPA, while Table 3-37 reports on the corresponding results for Japan. In Thailand, processed agricultural products (*PAGR*) benefit the most from the bilateral partnership as its output and exports outstandingly grow by 29.58% and 85.17%, respectively. There is also a 3.08% expansion in the output of agricultural products (*AGR*).

Table 3-37: Percentage changes for various sectoral indicators in Japan under JTEPA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | -0.35% | -0.42% | -0.43% | -0.44% | 0.80% | -0.77% |
| <i>NRS</i> | 0.03% | 0.05% | 0.05% | 0.04% | 0.10% | 0.25% |
| <i>OIL</i> | -0.02% | -0.03% | -0.03% | -0.04% | -0.12% | 0.14% |
| <i>PAGR</i> | -1.34% | -1.45% | -1.46% | -1.50% | 0.58% | 19.55% |
| <i>OFD</i> | 0.12% | 0.15% | 0.14% | 0.08% | 4.92% | 0.64% |
| <i>MNF</i> | 0.14% | 0.13% | 0.13% | 0.08% | 0.89% | 0.05% |
| <i>TEX</i> | 0.50% | 0.45% | 0.45% | 0.40% | 1.18% | -0.03% |
| <i>WAP</i> | 0.11% | 0.14% | 0.13% | 0.06% | 1.18% | 0.21% |
| <i>CRP</i> | 0.34% | 0.31% | 0.31% | 0.26% | 1.02% | -0.27% |
| <i>I_S</i> | 0.45% | 0.38% | 0.38% | 0.34% | 1.29% | 0.00% |
| <i>NFM</i> | 0.43% | 0.40% | 0.40% | 0.36% | 0.92% | 0.10% |
| <i>MVH</i> | 1.10% | 0.90% | 0.90% | 0.84% | 1.81% | -0.15% |
| <i>ELE</i> | 0.21% | 0.19% | 0.19% | 0.15% | 0.25% | 0.05% |
| <i>OME</i> | 0.54% | 0.51% | 0.51% | 0.46% | 0.80% | 0.02% |
| <i>OMF</i> | 0.13% | 0.11% | 0.11% | 0.06% | 0.41% | 0.04% |
| <i>MSR</i> | 0.06% | 0.07% | 0.07% | 0.01% | -0.02% | 0.10% |
| <i>TRD</i> | 0.05% | 0.08% | 0.07% | -0.03% | -0.02% | 0.09% |
| <i>TRP</i> | 0.03% | 0.05% | 0.04% | -0.03% | -0.23% | 0.11% |
| <i>CFI</i> | 0.02% | 0.05% | 0.04% | -0.02% | -0.09% | 0.12% |
| <i>OBS</i> | 0.07% | 0.09% | 0.08% | 0.02% | -0.03% | 0.12% |
| <i>OSG</i> | 0.01% | 0.01% | 0.01% | -0.05% | -0.08% | 0.07% |
| <i>DWE</i> | -0.08% | 0.00% | <i>n/a*</i> | -0.08% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

Japanese production and exports, on the other hand, increase in most manufacturing sectors, especially in motor vehicles and parts (*MVH*), by 1.10% and 1.81%, respectively. Similarly, textiles (*TEX*), chemical, rubber, plastic products (*CRP*), metal products (*I_S* and *NFM*), and

machinery and equipments (*OME*) also clearly gain from JTEPA as their exports to Thailand are increased.

Chart 3-9: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in Japan under JTEPA

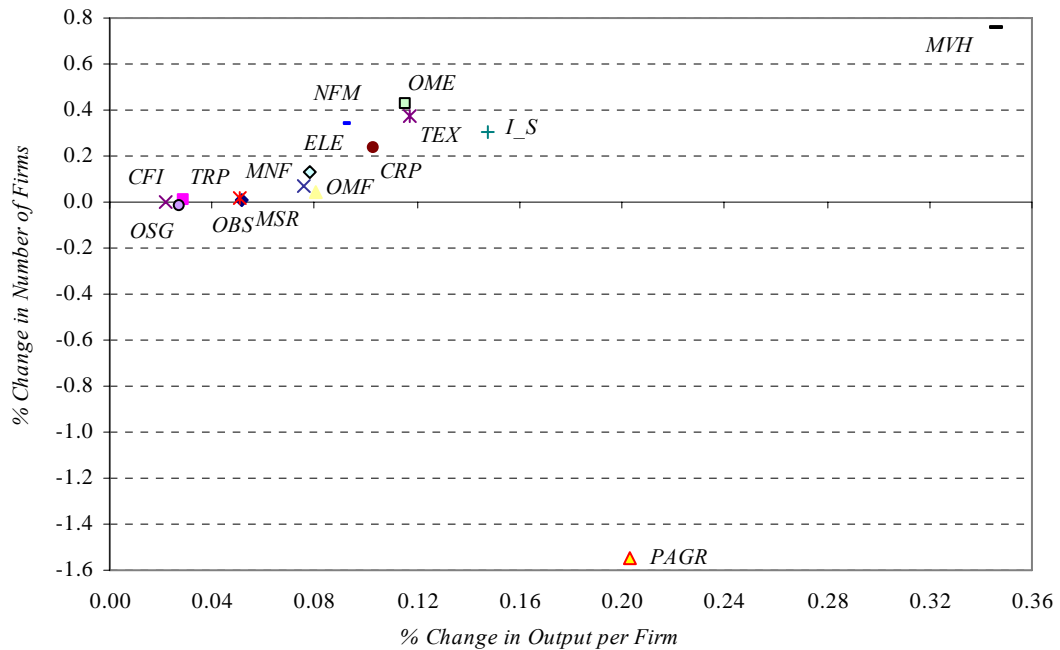


Chart 3-9 plots the changes in production of imperfectly competitive sectors in Japan. Since all of them are assumed to be operating under monopolistic competition (see Table 3-3), the number of firms population is endogenous. In most of these sectors the numbers of firms and outputs per firm are simultaneously increased, the changes in sectoral demands being reported in Table 3-37. Not surprisingly, sector *MVH* experiences the largest increases in these two indicators, reflecting its strong output expansion. On the other hand, since sector *PAGR* in Japan is at a comparative disadvantage relative to Thai exports, less efficient producers adjust to the new trade regime by merging with others or exiting the market, while the surviving ones to increase their outputs and so enjoy increasing returns to scale.

3.5.2.2 ASEAN+CHINA

This subsection reports the welfare results of the formation of an FTA between China and ASEAN. Firstly, Table 3-38 shows that the positive impacts on real GDP and final demands are strongest in North ASEAN, while Thailand and South ASEAN enjoy a relatively high increase in regional trade in comparison to other members. Given that North ASEAN's GDP is almost half of South ASEAN's, the consumer effect in North ASEAN is probably strong enough to magnify the effect of the relatively small trade change into a large impact on real GDP. Thailand and South ASEAN, on the other hand, experience sizeable trade expansions because they had imposed comparatively high trade barriers before the union. For that reason, their considerable tax revenue losses cause major reductions in public demand, in comparison to the welfare gains from the increased private and investment demands.

Table 3-38: Percentage changes for various regional indicators under ASEAN+CHINA

| Region | Real GDP | Private demand | Investment demand | Public demand | Regional import | Regional export | Terms of trade | Real exchange rate |
|--------------------|----------|----------------|-------------------|---------------|-----------------|-----------------|----------------|--------------------|
| <i>FTA members</i> | | | | | | | | |
| <i>THA</i> | 0.82% | 1.79% | 4.06% | -12.35% | 5.15% | 3.77% | 1.62% | -1.44% |
| <i>CHN</i> | 0.26% | 0.50% | 0.65% | -2.13% | 1.90% | 1.68% | 0.88% | -0.08% |
| <i>NASN</i> | 1.76% | 2.05% | 5.47% | -6.23% | 3.12% | 2.28% | 0.24% | -1.93% |
| <i>SASN</i> | 0.66% | 0.75% | 2.31% | -5.89% | 4.43% | 3.95% | 1.81% | 0.24% |
| <i>Non-members</i> | | | | | | | | |
| <i>AUS</i> | -0.01% | -0.03% | -0.02% | 0.01% | -0.03% | -0.04% | -0.04% | -0.23% |
| <i>NZL</i> | -0.04% | -0.02% | -0.04% | 0.00% | -0.36% | -0.24% | -0.01% | 0.00% |
| <i>IND</i> | -0.02% | -0.02% | -0.02% | -0.08% | -0.16% | -0.09% | -0.01% | -0.24% |
| <i>JPN</i> | -0.02% | -0.02% | -0.02% | -0.07% | -0.15% | -0.05% | 0.00% | -0.17% |
| <i>KOR</i> | -0.08% | -0.10% | -0.12% | -0.38% | -0.23% | -0.11% | -0.01% | -0.10% |
| Others | -0.02% | -0.01% | -0.02% | -0.05% | -0.05% | -0.06% | -0.02% | -0.25% |

Source: Simulated by author.

The general FTA impact on China is moderate since China is a large economy and her trade barriers are low thanks to the international competitiveness that has turned China into one of the major exporting countries nowadays. In fact, as China becomes a major economy in Asia

in terms of both the size and the expansion of its market, the ASEAN countries are keen to strengthen their economic ties with China, notwithstanding that the patterns of their factor endowments and comparative advantages are not particularly disparate. This point is clearly illustrated in Table 3-39 to Table 3-41, where the outputs of sectors such as wearing apparels (*WAP*), metal products (*I_S* and *NFM*), motor vehicles and parts (*MVH*), machinery and equipments (*OME*), and electricity, gas, water, and construction services (*MSR*) are commonly increased in all member regions.

Table 3-39: Percentage changes for various sectoral indicators in Thailand under ASEAN+CHINA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|---------|-------------------------|-----------------------|----------------|--------|--------|
| <i>AGR</i> | 1.31% | 2.81% | 3.36% | 2.43% | 11.53% | 11.39% |
| <i>NRS</i> | -0.31% | -0.22% | 0.23% | -0.53% | 0.26% | 5.17% |
| <i>OIL</i> | -0.58% | -1.01% | -0.57% | -1.32% | -1.00% | 0.68% |
| <i>PAGR</i> | -2.43% | -1.27% | 1.20% | -2.99% | -1.72% | 43.31% |
| <i>OFD</i> | -3.49% | -2.26% | 0.19% | -3.96% | -2.55% | 10.05% |
| <i>MNF</i> | 0.59% | 1.98% | 4.86% | -0.01% | 2.01% | 6.60% |
| <i>TEX</i> | -1.08% | 0.10% | 2.93% | -1.85% | 1.34% | 12.28% |
| <i>WAP</i> | 0.17% | 1.22% | 4.08% | -0.75% | -0.81% | 35.71% |
| <i>CRP</i> | 18.10% | 19.57% | 22.94% | 17.23% | 24.94% | 4.70% |
| <i>I_S</i> | 2.69% | 3.94% | 6.87% | 1.91% | 5.71% | 2.84% |
| <i>NFM</i> | 2.91% | 4.14% | 7.08% | 2.11% | 3.33% | 0.92% |
| <i>MVH</i> | 2.12% | 3.39% | 6.31% | 1.37% | 6.11% | 7.02% |
| <i>ELE</i> | 4.24% | 5.76% | 8.75% | 3.70% | 4.62% | 4.82% |
| <i>OME</i> | 4.17% | 5.51% | 8.49% | 3.45% | 4.87% | 5.25% |
| <i>OMF</i> | -3.71% | -2.53% | 0.23% | -4.43% | -4.45% | 5.45% |
| <i>MSR</i> | 1.57% | 3.03% | 6.18% | 0.86% | -1.31% | 3.59% |
| <i>TRD</i> | 0.41% | 2.60% | 6.48% | -0.06% | -3.03% | 3.93% |
| <i>TRP</i> | -0.97% | 0.67% | 4.48% | -1.94% | -5.02% | 2.44% |
| <i>CFI</i> | -0.43% | 0.52% | 3.35% | -1.45% | -2.77% | 2.45% |
| <i>OBS</i> | -2.23% | -1.33% | 1.46% | -3.25% | -3.42% | 0.72% |
| <i>OSG</i> | -11.14% | -12.29% | -9.82% | -14.00% | -8.63% | -6.72% |
| <i>DWE</i> | -0.78% | 0.87% | n/a* | -1.09% | n/a** | n/a** |

Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

Table 3-40: Percentage changes for various sectoral indicators in North and South ASEAN (excluding Thailand) under ASEAN+CHINA

| Sector | NASN | | | | | | SASN | | | | | |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
| <i>AGR</i> | -0.26% | -0.53% | -0.21% | -0.57% | -0.43% | 20.35% | 0.06% | 0.14% | 0.37% | -0.11% | 5.11% | 1.62% |
| <i>NRS</i> | -0.54% | -0.79% | -0.56% | -0.81% | -3.88% | 8.88% | 0.12% | 0.32% | 0.52% | 0.11% | -0.20% | 5.58% |
| <i>OIL</i> | -0.82% | -1.30% | -1.09% | -1.33% | -1.83% | 3.12% | -0.27% | -0.22% | -0.03% | -0.43% | -0.06% | -0.04% |
| <i>PAGR</i> | 33.63% | 30.10% | 31.93% | 29.87% | 51.35% | 20.03% | -2.05% | -1.19% | -0.11% | -2.35% | 6.92% | 57.02% |
| <i>OFD</i> | 7.88% | 6.32% | 7.65% | 6.16% | 9.67% | 6.01% | 1.55% | 2.35% | 3.48% | 1.16% | 5.15% | 3.41% |
| <i>MNF</i> | 2.01% | 0.50% | 1.23% | 0.41% | 2.56% | 4.13% | -0.34% | 0.48% | 1.72% | -0.84% | 1.91% | 8.08% |
| <i>TEX</i> | 25.73% | 20.99% | 21.61% | 20.91% | 28.22% | 6.55% | 2.62% | 3.51% | 4.79% | 2.14% | 5.69% | 5.08% |
| <i>WAP</i> | 11.46% | 8.34% | 9.25% | 8.22% | 12.01% | 5.18% | 2.82% | 3.53% | 4.81% | 2.17% | 3.50% | 10.07% |
| <i>CRP</i> | 10.96% | 9.27% | 10.34% | 9.14% | 12.92% | 2.94% | 5.28% | 6.12% | 7.43% | 4.72% | 12.82% | 2.02% |
| <i>I_S</i> | 6.70% | 3.98% | 4.37% | 3.92% | 7.43% | 5.86% | 2.05% | 3.02% | 4.29% | 1.67% | 4.70% | 2.00% |
| <i>NFM</i> | 3.00% | 0.94% | 1.32% | 0.89% | 3.09% | 3.90% | 2.60% | 3.46% | 4.74% | 2.10% | 2.64% | 3.54% |
| <i>MVH</i> | 4.27% | 2.77% | 3.79% | 2.65% | 8.55% | 2.82% | 2.13% | 2.93% | 4.20% | 1.58% | 19.21% | 3.19% |
| <i>ELE</i> | -2.45% | -4.05% | -3.42% | -4.13% | -2.43% | 0.17% | 4.57% | 5.55% | 6.86% | 4.16% | 4.65% | 2.72% |
| <i>OME</i> | 18.18% | 15.29% | 16.07% | 15.19% | 19.51% | 4.34% | 7.45% | 8.23% | 9.57% | 6.81% | 9.21% | 3.17% |
| <i>OMF</i> | 2.58% | 0.69% | 1.40% | 0.60% | 2.97% | 4.00% | 0.20% | 1.05% | 2.30% | -0.28% | 1.24% | 5.37% |
| <i>MSR</i> | 2.49% | 1.68% | 2.88% | 1.54% | -0.63% | 4.26% | 1.50% | 2.31% | 3.67% | 0.85% | 1.26% | 0.85% |
| <i>TRD</i> | -0.08% | -0.52% | 1.12% | -0.71% | -3.53% | 4.94% | 0.53% | 1.85% | 3.53% | 0.07% | -0.19% | 0.87% |
| <i>TRP</i> | -2.30% | -2.83% | -1.34% | -3.01% | -8.91% | 3.09% | 0.53% | 1.73% | 3.40% | -0.06% | 0.46% | 0.28% |
| <i>CFI</i> | -0.04% | -0.45% | 0.71% | -0.59% | -3.79% | 4.65% | -0.17% | 0.48% | 1.72% | -0.84% | -0.10% | -0.14% |
| <i>OBS</i> | -5.75% | -6.10% | -4.97% | -6.23% | -7.35% | 2.69% | -0.00% | 0.75% | 1.99% | -0.58% | -0.01% | -0.21% |
| <i>OSG</i> | -3.23% | -4.11% | -2.93% | -4.25% | -4.82% | 0.49% | -4.53% | -5.03% | -3.85% | -6.28% | -2.60% | -3.64% |
| <i>DWE</i> | -1.10% | -1.01% | <i>n/a*</i> | -1.18% | <i>n/a**</i> | <i>n/a**</i> | -1.14% | -0.05% | <i>n/a*</i> | -1.36% | <i>n/a**</i> | <i>n/a**</i> |

Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing; **Output from Sector DWE is non-traded.

Table 3-41: Percentage changes for various sectoral indicators in China under ASEAN+CHINA

| Sector | Output | Unskilled labour demand | Skilled labour demand | Capital demand | Export | Import |
|-------------|--------|-------------------------|-----------------------|----------------|--------------|--------------|
| <i>AGR</i> | 0.12% | 0.19% | 0.25% | 0.11% | 1.22% | 1.70% |
| <i>NRS</i> | 0.16% | 0.24% | 0.29% | 0.18% | 0.52% | 0.55% |
| <i>OIL</i> | 0.24% | 0.26% | 0.29% | 0.20% | -0.36% | 1.01% |
| <i>PAGR</i> | 0.29% | 0.51% | 0.79% | 0.14% | 9.78% | 8.88% |
| <i>OFD</i> | 0.17% | 0.35% | 0.62% | -0.03% | 1.07% | 1.48% |
| <i>MNF</i> | 0.47% | 0.63% | 0.94% | 0.21% | 1.72% | 1.27% |
| <i>TEX</i> | 1.03% | 1.22% | 1.53% | 0.80% | 3.46% | 2.53% |
| <i>WAP</i> | 1.36% | 1.48% | 1.80% | 1.06% | 2.39% | 9.16% |
| <i>CRP</i> | -0.99% | -0.80% | -0.50% | -1.22% | 0.52% | 4.68% |
| <i>I_S</i> | 0.48% | 0.61% | 0.92% | 0.19% | 1.68% | 0.46% |
| <i>NFM</i> | 0.50% | 0.65% | 0.96% | 0.23% | 1.37% | 0.68% |
| <i>MVH</i> | 0.55% | 0.25% | 0.35% | 0.12% | 2.49% | 0.27% |
| <i>ELE</i> | 2.81% | 3.02% | 3.33% | 2.59% | 3.68% | 1.79% |
| <i>OME</i> | 0.41% | 0.59% | 0.90% | 0.17% | 1.42% | 1.98% |
| <i>OMF</i> | 0.50% | 0.77% | 1.08% | 0.35% | 0.73% | 1.10% |
| <i>MSR</i> | 0.36% | 0.50% | 0.83% | 0.04% | 0.41% | 0.16% |
| <i>TRD</i> | 0.22% | 0.42% | 0.83% | -0.14% | 0.30% | 0.06% |
| <i>TRP</i> | 0.12% | 0.37% | 0.78% | -0.19% | -0.08% | 0.08% |
| <i>CFI</i> | 0.09% | 0.26% | 0.56% | -0.16% | 0.12% | -0.02% |
| <i>OBS</i> | -0.07% | 0.11% | 0.42% | -0.31% | 0.07% | -0.32% |
| <i>OSG</i> | -1.71% | -1.80% | -1.50% | -2.21% | -1.09% | -1.32% |
| <i>DWE</i> | -0.13% | 0.23% | <i>n/a*</i> | -0.19% | <i>n/a**</i> | <i>n/a**</i> |

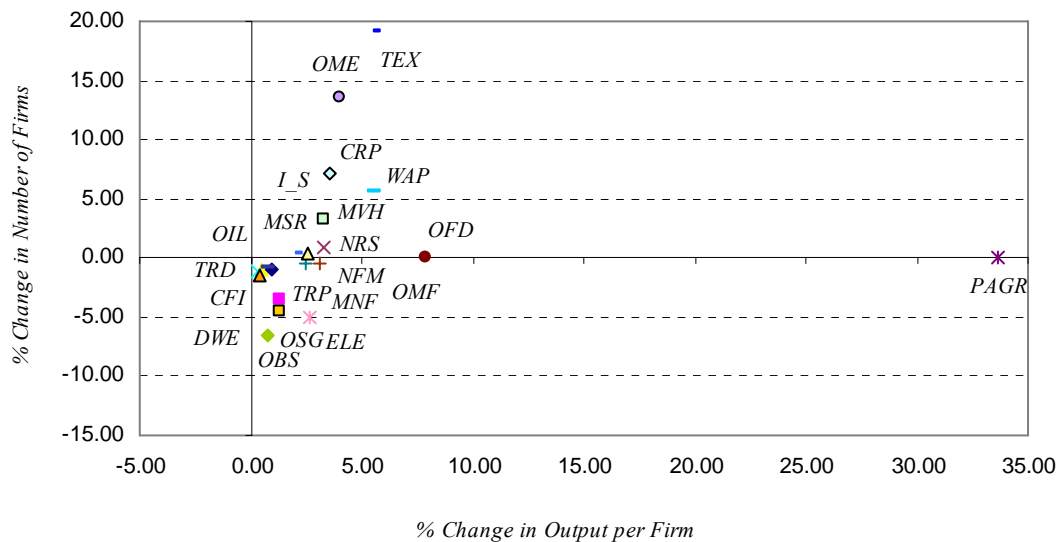
Source: Simulated by author. Note: * Sector DWE does not demand for skilled labour in the benchmark year, thus the CES production function for this sector treat this factor demand as non-existing ; **Output from Sector DWE is non-traded.

In addition, there is some similarity in the pattern of comparative advantage after the formation of ASEAN+CHINA, with Thailand becoming more specialised in chemical, rubber, and plastic products (*CRP*); North ASEAN in processed agricultural and food products (*PAGR* and *OFD*), textiles (*TEX*), and sector *CRP*; South ASEAN in sectors *OME*, *CRP* and electronic equipments (*ELE*); and China in sectors *TEX* and *ELE*. Such similar shifts in production patterns in member regions are attributable to the Armington function that differentiates products by origin and thus allowing intra-industry trade among regions; in

addition to the fact that some production sectors are under imperfect competition. As a consequence, the real gains from ASEAN+CHINA are non-zero in spite of the above-mentioned proximity.

Lastly, Chart 3-10 shows the adjustments of imperfectly competitive firms in North ASEAN.³⁶ Sectors plotted in the first quadrant are better off since they are able to compete at the international level; while those in the fourth quadrant are faced with contraction as their resources are bid away to produce more of the former group of products. Sectors *PAGR* and *OFD*, on the other hand, are located on the X axis since they are under Cournot oligopoly. The escalation in their outputs per firm is more pronounced than it would have been under monopolistic competition, as firm mobility is prohibited and the incumbent firms are able to reap more profits from their increased production activities.

Chart 3-10: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in North ASEAN under ASEAN+CHINA



³⁶ The results are only reported for North ASEAN, because sectors in Thailand and South ASEAN are all under perfect competition; also, in China, only sectors *OIL* and *MVH* are under monopolistic competition.

3.5.2.3 THAILAND+INDIA

Table 3-42 shows that the bilateral FTA between Thailand and India has weak impacts on regional and global welfare. The positive changes in the main regional indicators, including the terms of trade in Thailand and India, is predominantly less than 1%; at the same time non-members are broadly unaffected by this FTA. As with the outcomes reported in Table 3-33, India's regional export increases by a greater proportion than Thailand's, and thus we see greater improvement in her terms of trade. Nonetheless, as India is a much larger economy than Thailand, the percentage changes in its real GDP and final demands are comparatively small.

Table 3-42: Percentage changes for various regional indicators under THAILAND+INDIA

| Region | Real GDP | Private demand | Investment demand | Public demand | Regional import | Regional export | Terms of trade |
|--------------------|----------|----------------|-------------------|---------------|-----------------|-----------------|----------------|
| <i>FTA members</i> | | | | | | | |
| <i>THA</i> | 0.15% | 0.43% | 0.65% | -1.27% | 0.81% | 0.52% | 0.20% |
| <i>IND</i> | 0.03% | 0.01% | 0.11% | -0.31% | 0.59% | 0.82% | 0.42% |
| <i>Non-members</i> | | | | | | | |
| Others | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% | 0.00% |

Source: Simulated by author.

Table 3-43 reports the sectoral results for Thailand and India. In Thailand, most manufacturing sectors find the agreement beneficial. While sectors *CRP*, *I_S*, *MVH*, and *OME* expand their exports moderately (by 0.92% to 2.40%), sector *NFM* (non-ferrous metals) benefits substantially from THAILAND+INDIA as its output and exports are increased by 10.41% and 10.86%, respectively. India, on the other hand, gains predominantly from the respective 4.07% and 16.84% increases in output and exports of commodity *OFD* (food products).

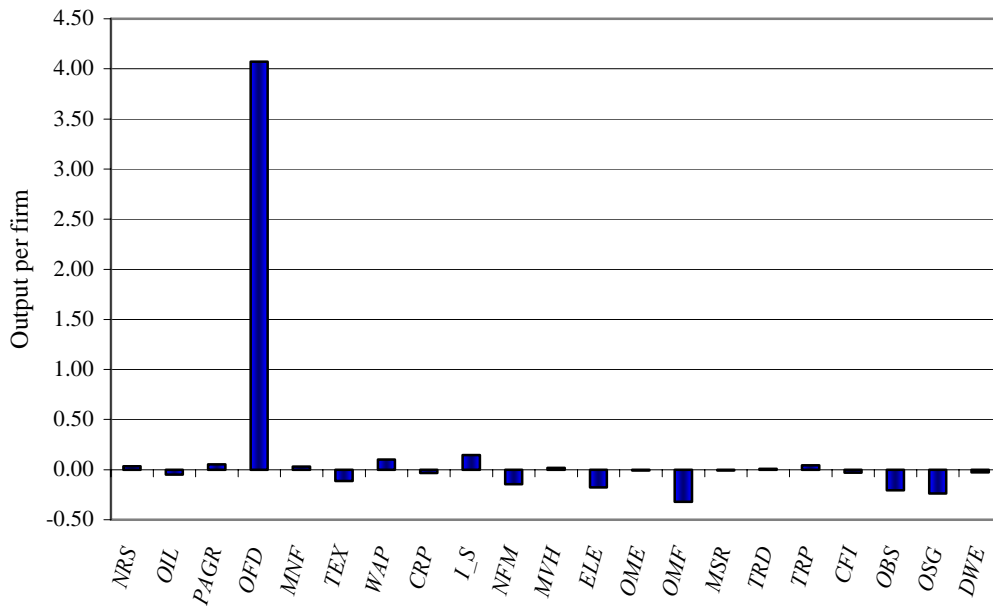
Table 3-43: Percentage changes for various sectoral indicators in member countries under THAILAND+INDIA

| Sector | Thailand | | | India | | |
|-------------|----------|--------------|--------------|--------|--------------|--------------|
| | Output | Export | Import | Output | Export | Import |
| <i>AGR</i> | 0.16% | 0.32% | 0.76% | 0.03% | -0.15% | 1.04% |
| <i>NRS</i> | -0.08% | 0.14% | 2.79% | 0.03% | 0.90% | 0.36% |
| <i>OIL</i> | -0.09% | -0.15% | 0.08% | -0.05% | -0.37% | 0.06% |
| <i>PAGR</i> | 0.17% | 0.52% | 1.28% | 0.05% | 0.16% | 1.19% |
| <i>OFD</i> | -0.32% | 1.13% | 8.77% | 4.07% | 16.84% | 1.59% |
| <i>MNF</i> | 0.07% | 0.20% | 0.92% | 0.03% | 0.49% | 0.59% |
| <i>TEX</i> | 0.15% | 0.89% | 1.35% | -0.11% | -0.14% | 3.14% |
| <i>WAP</i> | -0.12% | -0.05% | 21.15% | 0.10% | 0.15% | 3.24% |
| <i>CRP</i> | 1.17% | 1.71% | 0.60% | -0.03% | 1.14% | 0.97% |
| <i>I_S</i> | 0.63% | 1.97% | 0.72% | 0.15% | 2.67% | 0.76% |
| <i>NFM</i> | 10.41% | 10.86% | 0.75% | -0.15% | 1.72% | 0.33% |
| <i>MVH</i> | 0.89% | 2.40% | 0.44% | 0.02% | 1.69% | 3.74% |
| <i>ELE</i> | 0.01% | 0.02% | 0.24% | -0.18% | 0.67% | 1.32% |
| <i>OME</i> | 0.87% | 0.92% | 0.66% | 0.01% | 0.60% | 0.72% |
| <i>OMF</i> | 0.25% | 0.38% | 0.55% | -0.32% | -0.40% | 0.32% |
| <i>MSR</i> | 0.33% | -0.01% | 0.47% | -0.01% | -0.46% | 0.13% |
| <i>TRD</i> | 0.04% | -0.42% | 0.51% | 0.04% | -0.49% | 0.19% |
| <i>TRP</i> | -0.17% | -0.61% | 0.29% | 0.05% | -0.35% | 0.16% |
| <i>CFI</i> | 0.04% | -0.14% | 0.21% | -0.03% | -0.46% | 0.14% |
| <i>OBS</i> | -0.21% | -0.36% | 0.12% | -0.20% | -0.44% | 0.12% |
| <i>OSG</i> | -1.14% | -0.86% | -0.68% | -0.24% | -0.38% | -0.03% |
| <i>DWE</i> | -0.12% | <i>n/a**</i> | <i>n/a**</i> | -0.03% | <i>n/a**</i> | <i>n/a**</i> |

Source: Simulated by author. Note: **Output from Sector DWE is non-traded.

Chart 3-11 shows the output adjustments by individual firms in India. Except for the perfectly competitive agricultural sector (*AGR*), all Indian sectors are highly protected under the assumed Cournot oligopoly and its firm immobility constraint. As such, the firm-level results in this chart once again reflect the sectoral output changes in India previously reported in Table 3-43, such as the distinctive magnitude of gain sector *OFD* enjoys under THAILAND+INDIA.

Chart 3-11: Percentage changes in the number of firms and output per firm of imperfectly competitive sectors in India under THAILAND+INDIA



3.5.3 Broader Economic Integration

To shed more light on the prospects of Thailand’s economic integration options, Subsection 3.5.3 simulates the formation of an FTA between ASEAN and Australia, New Zealand, Japan, China, and India (ASEAN+5); Thailand’s unilateral trade liberalisation; and global trade liberalisation. As such, the real output expansion rates observed in these scenarios are contrasted with those from the previous scenarios. Specifically, Chart 3-12 to Chart 3-20 illustrates how each region is affected by the scope of the various structures of economic liberalisation.

Chart 3-12: Real GDP expansion under various FTA scenarios: THAILAND

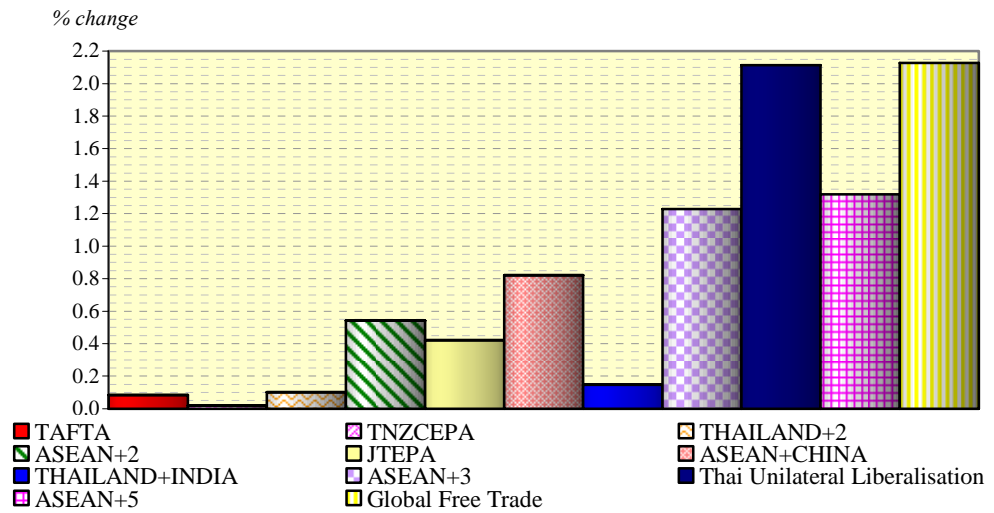


Chart 3-13: Real GDP expansion under various FTA scenarios: AUSTRALIA

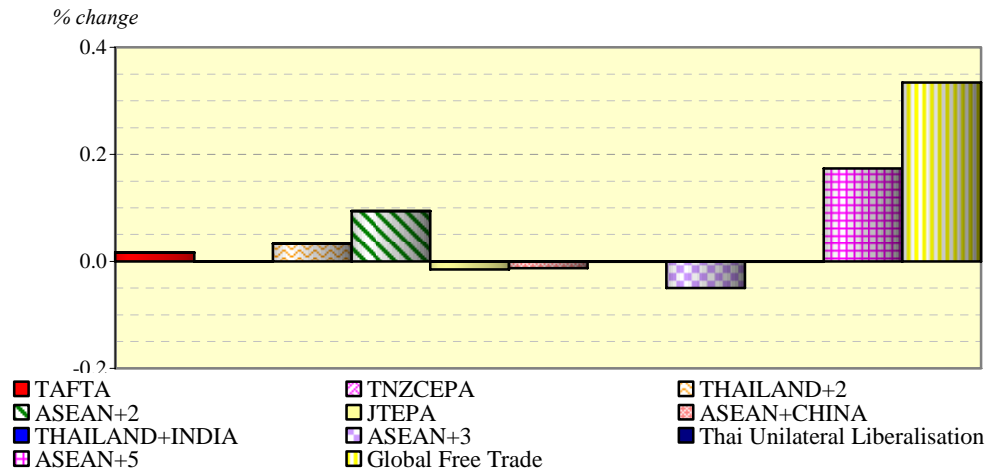


Chart 3-14: Real GDP expansion under various FTA scenarios: NEW ZEALAND

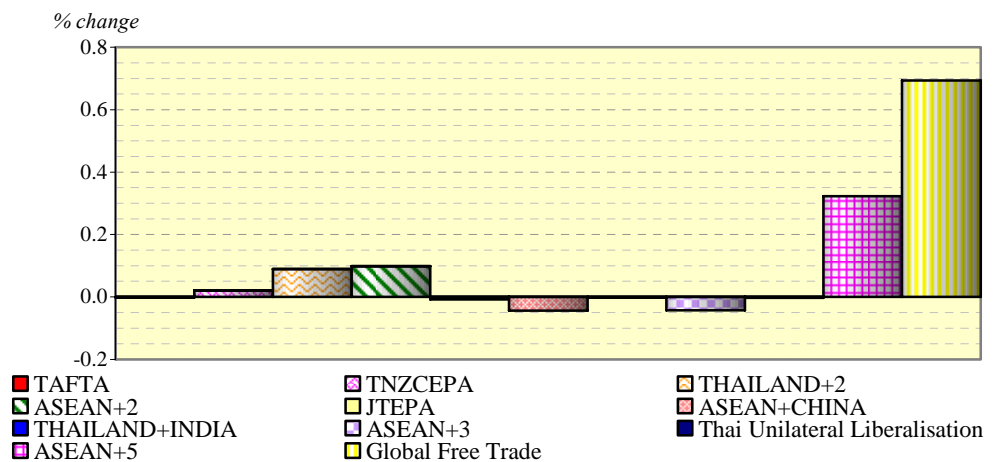


Chart 3-15: Real GDP expansion under various FTA scenarios: INDIA

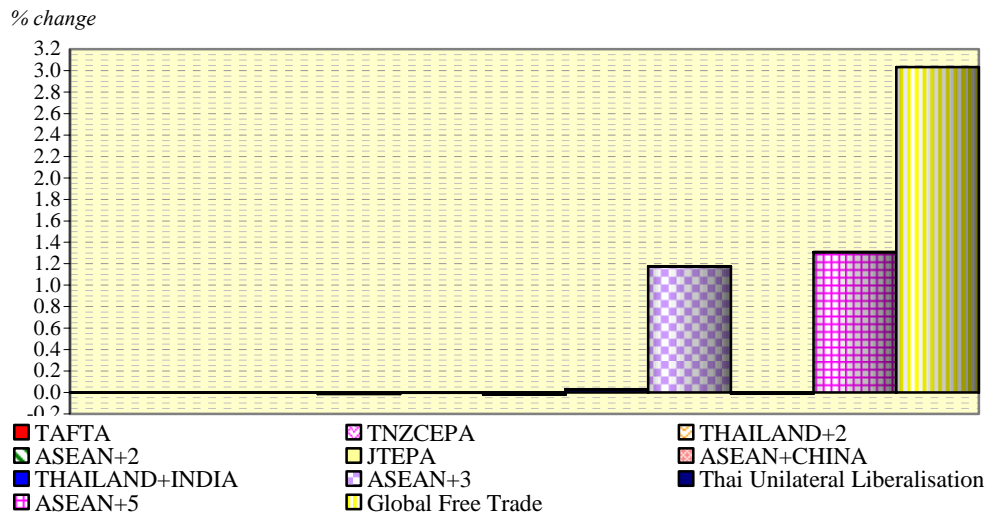


Chart 3-16: Real GDP expansion under various FTA scenarios: JAPAN

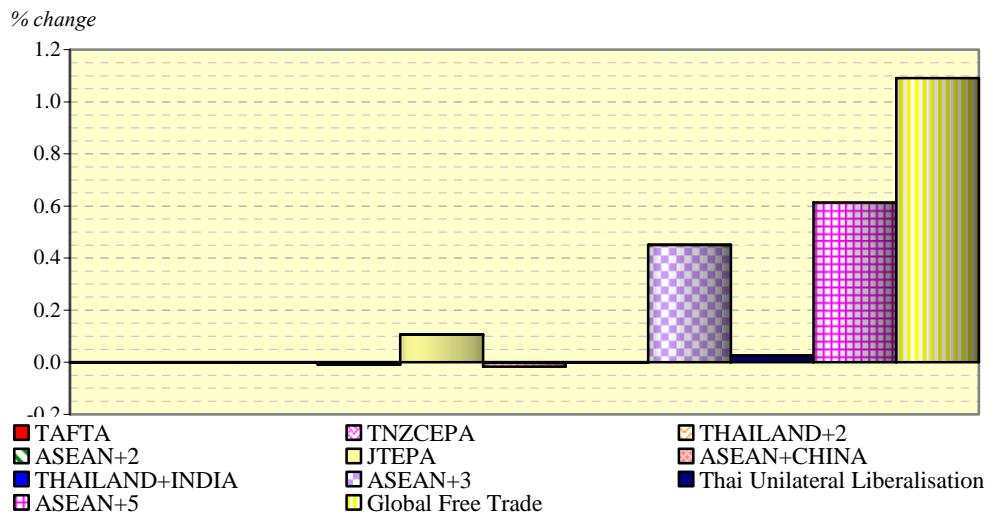


Chart 3-17: Real GDP expansion under various FTA scenarios: CHINA

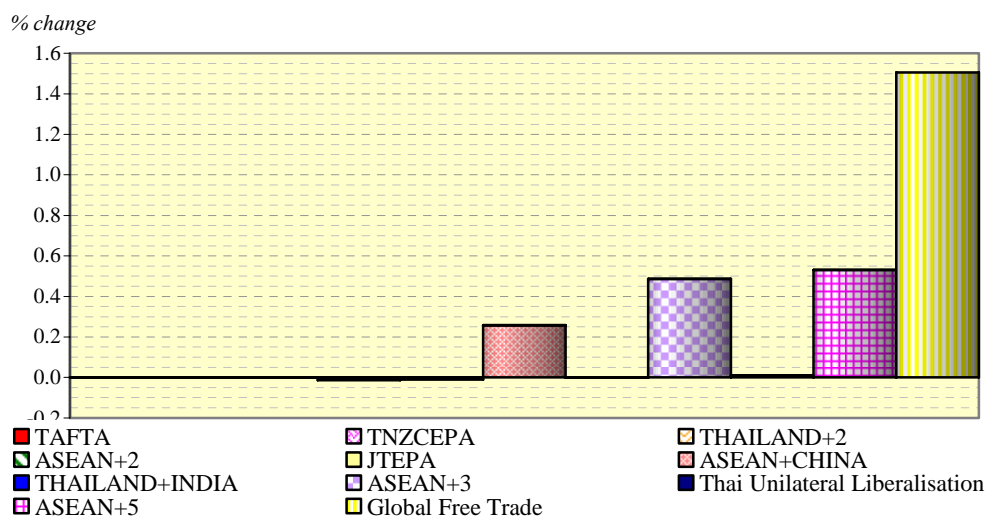


Chart 3-18: Real GDP expansion under various FTA scenarios: NORTH ASEAN

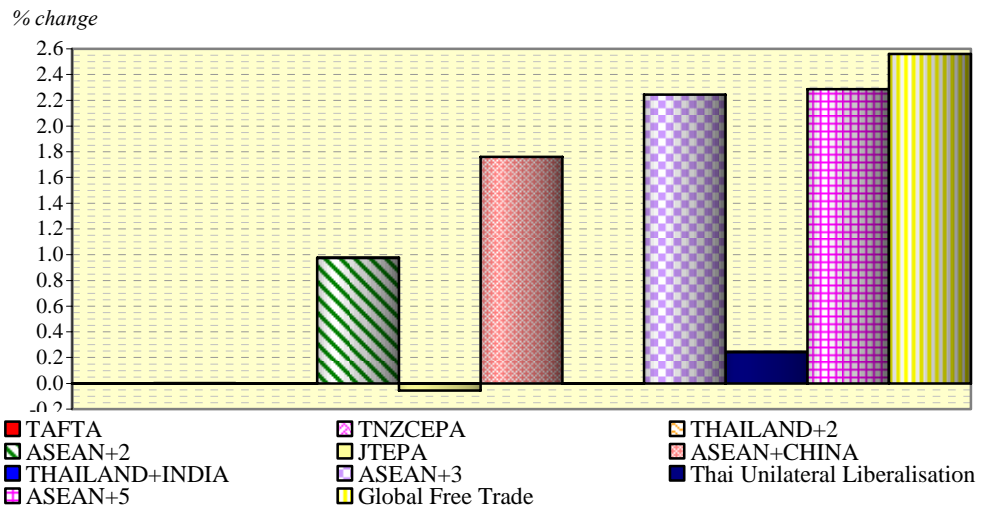


Chart 3-19: Real GDP expansion under various FTA scenarios: SOUTH ASEAN

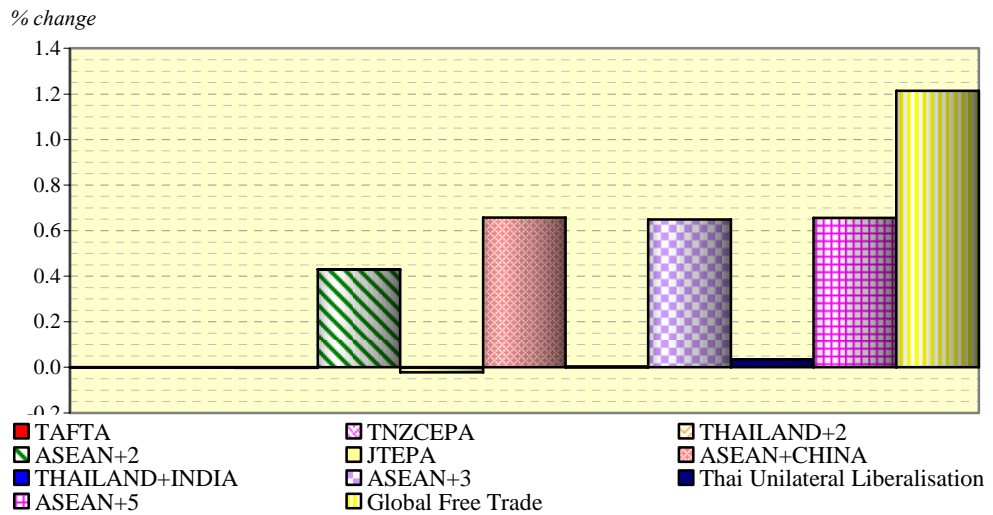
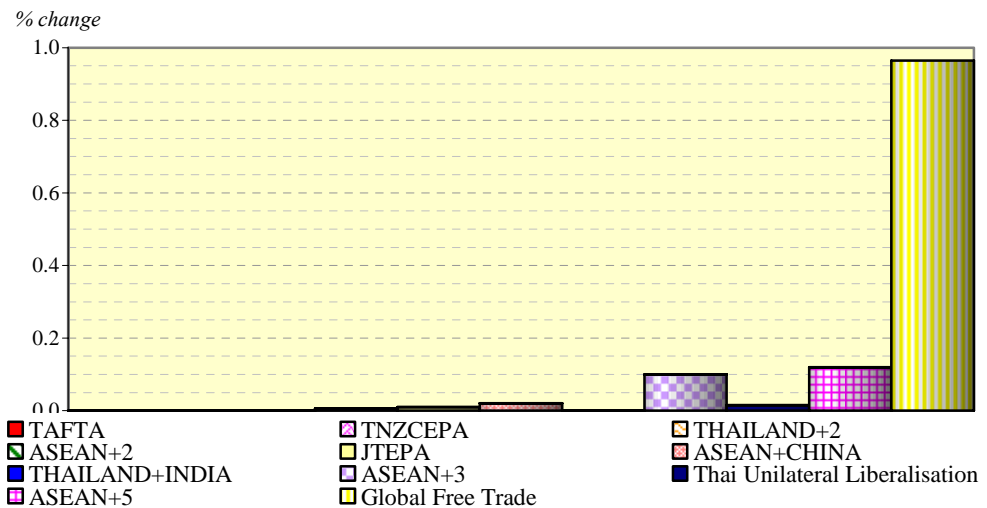


Chart 3-20: Real GDP expansion under various FTA scenarios: WORLD



It is apparent that, the expansion in real GDP is highest under global trade liberalisation. Regions generally attain more economic benefits from joining a larger free trade zone; whereas the regions left outside suffer to a greater extent not only as the trade zone expands, but also when their major trading counterparts join the grouping. Moreover, the magnitude of FTA benefits tends to vary with the ex-ante level of bilateral trade among members and also with the size of the initial trade barriers. Combined together, these welfare determinants result in Thailand gaining most from global free trade, with unilateral trade liberalisation coming next. Although Thailand clearly reaps more benefits from FTAs that involve ASEAN; among the four FTAs Thailand has bilaterally launched with Australia, New Zealand, Japan and India, the economic partnership with Japan yields the highest output expansion in the Thai economy, approximately 21 times higher than the lowest expansion, observed in the FTA between Thailand and New Zealand (TNZCEPA).

In comparison to other regions, Australia and New Zealand gain the least from global free trade and ASEAN+5, which underlines the fact that the two countries already have relatively low trade barriers. In contrast, India gains only marginally from THAILAND+INDIA, while her 3.03% real GDP expansion is the highest among all regions under global trade liberalisation, and is substantial under ASEAN+3 and ASEAN+5. This highlights both the weak economic linkages between Thailand and India and the prohibitive barriers to trade in India, where most sectors are modelled as Cournot oligopolies. Furthermore, as shown in Chart 3-16 and Chart 3-17, the real output expansion in Japan is higher than in China as the two together switch from the ASEAN+3 to ASEAN+5 regime. Hence, Japan should establish stronger trade ties with Australia and New Zealand than China. In addition, China gains almost three times more under global trade liberalisation than ASEAN+5, which can be ascribed to the a number of China's major trading partners remaining outside the ASEAN+5 grouping.

Chart 3-18 shows that, leaving aside the results that North ASEAN substantially gains from the ASEAN-plus FTAs and global trade liberalisation, the region is hardly affected by most of

the Thai bilateral FTAs, except for the 0.06% decline after JTEPA, and the 0.24% rise when Thailand unilaterally liberalises trade in goods and services. Therefore, it is safe to say that the North ASEAN economy depends considerably on trade with Japan and Thailand. As a matter of fact, trade with ASEAN accounts for roughly 20% of total Thai trade (see Table 3-1), and most of that is due to Thailand's trade with North ASEAN. In contrast, Chart 3-19 shows that South ASEAN makes only moderate gains from ASEAN FTAs and global free trade, largely because South ASEAN is less dependent on trade than the North, as indicated by the ratio of trade to GDP (GTAP 6.0 database). As for the pattern of trade, it may be observed from Chart 3-19 that ASEAN+CHINA, ASEAN+3 and ASEAN+5 result in almost identical output expansion for South ASEAN, thus exemplifying the relative importance of South ASEAN's trade with China.

Finally, Chart 3-20 illustrates the effects on the world as a whole. Not surprisingly, the world economy expands by 0.96%, significantly more than the 0.12% expansion in real GDP under ASEAN+5, the second largest economic integration scenario. ASEAN+3 comes third, as the world real GDP grows by 0.10%, while the rest of scenarios centred around Thailand and ASEAN result in positive but less than 0.02% world output expansion rates.

3.6 Sensitivity Tests

A limited number of sensitivity tests are reported in this section to shed light on the degree to which the above FTA simulation results are responsive to specific parameters and model structures. Below, the EV results of ASEAN+5 under various specifications are measured in million US dollar and as a percentage of the ex-ante income.

3.6.1 Elasticity of Substitution between Final Demands (σD)

The household, the government, and the bank are assumed to share the same elasticity of substitution between final consumption of goods and services (σD). The sensitivity of the ASEAN+5 welfare results to this elasticity is reported in Table 3-44.

It is clear from Table 3-44 that the elasticity of substitution between consumption of final goods for the household, the government, and the bank can alter the results by a large margin. Overall, greater substitutability between consumption goods improves welfare in most regions. For instance, the world EV is almost doubled and those of India and the United States even turn positive if the elasticity is tripled. The higher the elasticity, the more individuals may adjust their consumption behaviours to certain changes in regional trade policy. Yet, this cross-sectoral elasticity is not likely to be as high as in the counterfactual cases given that the Armington trade elasticities that represent the substitutability between domestically-produced and overseas products is estimated to be merely around 2 on average (GTAP 6.0 database).

Table 3-44: The sensitivity of EV results under ASEAN+5 to the elasticity of substitution between final demands of the household, the government, and the bank (benchmark value: $\sigma D^{reg} = 1.43$)

| Region | Benchmark values | | Double benchmark values | | Triple benchmark values | |
|--------------|-------------------|-----------------------|-------------------------|-----------------------|-------------------------|-----------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>THA</i> | 1,809.03 | 1.86% | 1,864.07 | 1.92% | 1,974.82 | 2.03% |
| <i>IND</i> | 3,686.81 | 1.04% | 4,561.90 | 1.29% | 5,563.19 | 1.57% |
| <i>JPN</i> | 139.23 | 0.30% | 144.05 | 0.31% | 158.03 | 0.34% |
| <i>CHN</i> | -194.22 | -0.04% | 3,486.55 | 0.73% | 2,316.95 | 0.49% |
| <i>NASN</i> | 25,486.44 | 0.62% | 32,918.76 | 0.81% | 42,477.69 | 1.04% |
| <i>SASN</i> | 4,182.72 | 0.34% | 5,615.56 | 0.46% | 6,950.54 | 0.57% |
| <i>AUS</i> | 2,325.61 | 1.82% | 2,091.09 | 1.63% | 1,772.31 | 1.38% |
| <i>NZL</i> | 1,598.73 | 0.50% | 1,781.85 | 0.56% | 2,039.64 | 0.64% |
| <i>KOR</i> | -1,831.36 | -0.46% | -1,656.67 | -0.42% | -1,552.22 | -0.39% |
| <i>USA</i> | -1,263.11 | -0.01% | -831.75 | -0.01% | 96.03 | 0.00% |
| <i>CAN</i> | 13.62 | 0.00% | 50.95 | 0.01% | 120.74 | 0.02% |
| <i>MEX</i> | -60.20 | -0.01% | -79.68 | -0.01% | -82.11 | -0.01% |
| <i>UK</i> | -560.91 | -0.04% | -566.17 | -0.04% | -486.43 | -0.03% |
| <i>XEUR</i> | -7,392.31 | -0.10% | -8,280.77 | -0.11% | -8,843.64 | -0.12% |
| <i>ROW</i> | -1,352.45 | -0.04% | -839.20 | -0.03% | -20.38 | -0.00% |
| World | 26,587.60 | 0.09% | 40,260.56 | 0.13% | 52,485.16 | 0.17% |

Source: Simulated by author.

3.6.2 Elasticity of Transformation between Products Supplied to Different Market Destinations (σT and σBE)

Table 3-45 reports on the sensitivity of the EV results to the elasticities of transformation between products supplied to domestic and overseas markets (σT), and further between those exported to different market destinations (σBE). In this table, both transformation elasticities are doubled and tripled as ASEAN, Australia, New Zealand, India, China, and Japan come together to form the ASEAN+5 FTA.

Table 3-45: The sensitivity of EV results under ASEAN+5 to the transformation elasticity between products supplied to different market destinations (benchmark values: $\sigma T = -2$; $\sigma BE = -2$)

| Region | Benchmark values | | Double benchmark values | | Triple benchmark values | |
|--------------|-------------------|-----------------------|-------------------------|-----------------------|-------------------------|-----------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>THA</i> | 1,809.03 | 1.86% | 2,364.71 | 2.43% | 2,648.86 | 2.72% |
| <i>IND</i> | 3,686.81 | 1.04% | 3,827.07 | 1.08% | 3,849.43 | 1.09% |
| <i>JPN</i> | 139.23 | 0.30% | 170.01 | 0.36% | 179.61 | 0.38% |
| <i>CHN</i> | -194.22 | -0.04% | -268.10 | -0.06% | -364.10 | -0.08% |
| <i>NASN</i> | 25,486.44 | 0.62% | 30,478.39 | 0.75% | 33,153.13 | 0.81% |
| <i>SASN</i> | 4,182.72 | 0.34% | 3,705.20 | 0.30% | 3,364.26 | 0.27% |
| <i>AUS</i> | 2,325.61 | 1.82% | 3,248.77 | 2.54% | 3,671.97 | 2.87% |
| <i>NZL</i> | 1,598.73 | 0.50% | 1,526.40 | 0.48% | 1,480.47 | 0.47% |
| <i>KOR</i> | -1,831.36 | -0.46% | -2,258.31 | -0.57% | -2,436.31 | -0.62% |
| <i>USA</i> | -1,263.11 | -0.01% | -1,891.59 | -0.02% | -2,166.14 | -0.02% |
| <i>CAN</i> | 13.62 | 0.00% | 10.68 | 0.00% | 15.74 | 0.00% |
| <i>MEX</i> | -60.20 | -0.01% | -49.52 | -0.01% | -44.46 | -0.01% |
| <i>UK</i> | -560.91 | -0.04% | -817.39 | -0.06% | -938.05 | -0.06% |
| <i>XEUR</i> | -7,392.31 | -0.10% | -10,047.91 | -0.13% | -11,356.83 | -0.15% |
| <i>ROW</i> | -1,352.45 | -0.04% | -1,874.56 | -0.06% | -2,051.60 | -0.06% |
| World | 26,587.60 | 0.09% | 28,123.84 | 0.09% | 29,005.98 | 0.09% |

Source: Simulated by author.

Overall, as the elasticities become higher, the regional welfare effects are more substantial, with both positive and negative EVs becoming higher in absolute terms. Therefore, regions that benefit from integration basically gain more with higher elasticities because they are

more able to switch exports towards the market destinations with relatively lower trade barriers. At the same time, regions that already experience welfare losses under ASEAN+5 will be even worse off as trade is shifted away from their markets. Although the extent to which these transformation elasticities change the EV results is not as extreme as in the case of the elasticity of substitution between final demands reported in Subsection 3.6.1, it is clear that these elasticities have a marked impact on the outcomes of the FTA impacts on regional economies.

3.6.3 Asymmetry of Firm Population in Each Sector across Regions

In this model, the exogenously-estimated HHI determines whether a sector in each region is modelled as perfectly competitive, monopolistically competitive or a Cournot oligopoly. As such, the number of firms is defined as the inverse of the above index, allowing the degree of market imperfection to vary by sector and region. Hence, it would be of interest to examine the sensitivity of ASEAN+5 results to the symmetry of the firm population or the lack of it. In Table 3-46, the welfare variation given the asymmetric number of firms by sector and region is compared with the symmetric case in which all sectors are deliberately and evenly populated by 27 firms, this being the simple average of the number of firms in all imperfectly competitive sectors in the world economy.

As Table 3-46 shows, the EV results are reasonably robust to changes in the initial firm population. However, regions endowed with many imperfectly competitive sectors, especially the Cournot oligopolistic ones, are comparatively more affected. Specifically, in India the regional welfare change becomes positive as the majority of Indian industries are modelled as Cournot oligopolies (see Table 3-3). Thus, the initial number of firms is one of the main determinants of the magnitude of adjustment in Cournot oligopolistic sectors. However, the overall effect of the symmetry in firm population is fairly negligible in this model.

Table 3-46: The sensitivity of EV results under ASEAN+5 to the symmetry of firm population in each sector across regions (benchmark: asymmetric number (#) of firms)

| Region | Benchmark: asymmetric # of firms | | Symmetric # of firms = 27 | |
|--------------|----------------------------------|-----------------------|---------------------------|-----------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>THA</i> | 1,809.03 | 1.86% | 1,807.18 | 1.86% |
| <i>IND</i> | 3,686.81 | 1.04% | 3,762.76 | 1.06% |
| <i>JPN</i> | 139.23 | 0.30% | 128.96 | 0.28% |
| <i>CHN</i> | -194.22 | -0.04% | 974.06 | 0.20% |
| <i>NASN</i> | 25,486.44 | 0.62% | 25,516.46 | 0.63% |
| <i>SASN</i> | 4,182.72 | 0.34% | 4,176.78 | 0.34% |
| <i>AUS</i> | 2,325.61 | 1.82% | 2,072.39 | 1.62% |
| <i>NZL</i> | 1,598.73 | 0.50% | 1,586.77 | 0.50% |
| <i>KOR</i> | -1,831.36 | -0.46% | -1,819.51 | -0.46% |
| <i>USA</i> | -1,263.11 | -0.01% | -1,230.48 | -0.01% |
| <i>CAN</i> | 13.62 | 0.00% | 12.81 | 0.00% |
| <i>MEX</i> | -60.20 | -0.01% | -53.47 | -0.01% |
| <i>UK</i> | -560.91 | -0.04% | -576.49 | -0.04% |
| <i>XEUR</i> | -7,392.31 | -0.10% | -7,605.06 | -0.10% |
| <i>ROW</i> | -1,352.45 | -0.04% | -1,446.38 | -0.05% |
| World | 26,587.60 | 0.09% | 27,306.78 | 0.09% |

Source: Simulated by author.

3.6.4 Specification of Commodity Market Structure

The sensitivity of the ASEAN+5 simulation results to commodity market structures is examined in this subsection. It aims to certify that the detailed market structure determination which allows the degree of market imperfection to differ across sectors and regions is vital when estimating the real impacts of Thai FTAs on regional and world economies. Accordingly, the benchmark EV results are compared with those when all sectors are under 1) perfect competition; 2) monopolistic competition; and 3) Cournot oligopoly. Note that as a perfectly competitive sector is changed to an imperfectly competitive one, the number of firms calibrated as the inverse of the HHI is relatively large. Also, in the monopolistic competitive case, the elasticity of substitution between product varieties within each sector is always specified as 4.

The EV results in Table 3-47 are highly responsive to the specification of commodity market structures. The world reaps the highest benefits under monopolistic competition, firstly because of the economies of scale, and secondly since firms are allowed to enter and exit the market freely under monopolistic competition, as opposed to the prohibitive firm mobility assumption under Cournot oligopoly.

Table 3-47: The sensitivity of EV results under ASEAN+5 to the specification of commodity market structure (benchmark: asymmetric market structure)

| Region | Benchmark: asymmetric market structure | | Perfect competition | | Monopolistic competition | | Cournot oligopoly | |
|--------------|--|--------------------------|----------------------|--------------------------|-----------------------------|--------------------------|----------------------|--------------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>THA</i> | 1,809.03 | 1.86% | 1,475.95 | 1.52% | 2,153.01 | 2.21% | 3,489.39 | 3.59% |
| <i>IND</i> | 3,686.81 | 1.04% | 3,101.03 | 0.88% | 3,346.11 | 0.95% | 3,194.24 | 0.90% |
| <i>JPN</i> | 139.23 | 0.30% | 213.05 | 0.45% | 254.14 | 0.54% | 214.68 | 0.46% |
| <i>CHN</i> | -194.22 | -0.04% | -48.77 | -0.01% | 1,363.89 | 0.29% | 383.33 | 0.08% |
| <i>NASN</i> | 25,486.44 | 0.62% | 19,157.57 | 0.47% | 24,874.52 | 0.61% | 34,722.18 | 0.85% |
| <i>SASN</i> | 4,182.72 | 0.34% | 3,791.64 | 0.31% | 11,838.65 | 0.97% | 2,218.66 | 0.18% |
| <i>AUS</i> | 2,325.61 | 1.82% | 2,313.08 | 1.81% | 4,287.37 | 3.35% | 3,407.42 | 2.66% |
| <i>NZL</i> | 1,598.73 | 0.50% | 1,049.41 | 0.33% | 2,236.29 | 0.71% | 1,214.21 | 0.38% |
| <i>KOR</i> | -1,831.36 | -0.46% | -1,561.18 | -0.39% | -1,958.14 | -0.50% | -2,356.36 | -0.60% |
| <i>USA</i> | -1,263.11 | -0.01% | -1,073.39 | -0.01% | -1,072.61 | -0.01% | -1,958.94 | -0.02% |
| <i>CAN</i> | 13.62 | 0.00% | 20.41 | 0.00% | -1.02 | -0.00% | 25.09 | 0.00% |
| <i>MEX</i> | -60.20 | -0.01% | -38.65 | -0.01% | -51.92 | -0.01% | 17.56 | 0.00% |
| <i>UK</i> | -560.91 | -0.04% | -523.49 | -0.04% | -679.33 | -0.05% | -899.40 | -0.06% |
| <i>XEUR</i> | -7,392.31 | -0.10% | -4,623.15 | -0.06% | -8,153.55 | -0.11% | -7,468.78 | -0.10% |
| <i>ROW</i> | -1,352.45 | -0.04% | -1,794.85 | -0.06% | -2,037.75 | -0.06% | -2,799.47 | -0.09% |
| World | 26,587.60 | 0.09% | 21,458.66 | 0.07% | 36,399.66 | 0.12% | 33,403.81 | 0.11% |

Source: Simulated by author.

Sectoral adjustment across regions results in complex aggregate welfare effects. To illustrate, although Thai production sectors are already perfectly competitive in the benchmark case, as other regions are uniformly specified as perfectly competitive, the Thai EV gain is reduced by 18.41%. Similarly, although most of the Indian industries are modelled as Cournot oligopolies in the benchmark scenario, as the whole world also shifts into Cournot oligopoly, the Indian

EV is augmented from -194.22 million US dollars to 383.33 million US dollars. In addition, substantial changes in the aggregate welfare levels of regions endowed with various types of market structures are commonly observed. Hence, the sensitivity results emphasise the importance of modelling commodity market structures to differ across regions and sectors.

3.6.5 Labour Market Closure Rules: Endogeneity of Real Wage and Unemployment

Another feature of the current CGE model is the detailed specification of a labour market paradigm, i.e. the endogeneity of the real wage and the unemployment rate. Table 3-48 contrasts the benchmark EV results with the cases when, for all labour markets, the real wage is fully flexible while unemployment is rigid (the flexible wage approach); where the real wage is rigid while unemployment is endogenous (the rigid wage approach); and where both the real wage and unemployment are flexible and associated with each other (the wage curve approach).

It may be observed from Table 3-48 that the specification of the real wage and unemployment influences regional EV outcomes to a considerable extent. In general, under an endogenous real wage with rigid unemployment, the real effects are reduced due to the full wage flexibility preventing unemployed labour from providing more or less services to production sectors, and thus the regional EVs are the smallest among the three settings. In marked contrast, when the real wage is rigid while unemployment is endogenous, the real effects are accentuated, and thus the EV results are most strongly pronounced. Not surprisingly, under the wage curve approach, where both variables are endogenous, labour markets yield outcomes in between the welfare results for each region and for the world as a whole.

In contrast to the results reported in Subsection 3.6.4, the modification of the labour market structure in other countries does not have significant spill-over effects on a region's EV. For instance, although the association of real wage and unemployment in Thailand, India, Japan and China is initially specified as subject to the wage curve relationship; once labour markets

in all other regions are modelled similarly we find that the EVs of the four countries are altered by only a small margin. In other words, the effects are more or less region-specific: because labour is not mobile across border, other regions will only be indirectly affected through trade flow adjustments.

Table 3-48: The sensitivity of EV results under ASEAN+5 to the specification of labour market closure rules (benchmark: asymmetric labour market structure)

| Region | Benchmark: asymmetric labour market structure | | The flexible wage approach | | The rigid wage approach | | The wage curve approach | |
|--------------|---|--------------------------|-------------------------------|--------------------------|----------------------------|--------------------------|----------------------------|--------------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>THA</i> | 1,809.03 | 1.86% | 1,678.59 | 1.73% | 2,170.00 | 2.23% | 1,819.72 | 1.87% |
| <i>IND</i> | 3,686.81 | 1.04% | 3,661.67 | 1.03% | 11,231.46 | 3.17% | 5,516.83 | 1.56% |
| <i>JPN</i> | 139.23 | 0.30% | 137.30 | 0.29% | 497.61 | 1.06% | 240.62 | 0.51% |
| <i>CHN</i> | -194.22 | -0.04% | -995.96 | -0.21% | 674.13 | 0.14% | -194.78 | -0.04% |
| <i>NASN</i> | 25,486.44 | 0.62% | 12,448.67 | 0.31% | 77,729.95 | 1.90% | 25,526.54 | 0.63% |
| <i>SASN</i> | 4,182.72 | 0.34% | 491.95 | 0.04% | 11,586.69 | 0.95% | 4,234.80 | 0.35% |
| <i>AUS</i> | 2,325.61 | 1.82% | 2,296.94 | 1.79% | 5,599.32 | 4.37% | 3,357.14 | 2.62% |
| <i>NZL</i> | 1,598.73 | 0.50% | 1,283.69 | 0.40% | 2,320.03 | 0.73% | 1,628.44 | 0.51% |
| <i>KOR</i> | -1,831.36 | -0.46% | -1,267.20 | -0.32% | -3,011.99 | -0.76% | -1,826.22 | -0.46% |
| <i>USA</i> | -1,263.11 | -0.01% | -1,340.24 | -0.01% | -3,362.91 | -0.03% | -1,941.69 | -0.02% |
| <i>CAN</i> | 13.62 | 0.00% | 1.98 | 0.00% | -8.31 | -0.00% | -2.49 | -0.00% |
| <i>MEX</i> | -60.20 | -0.01% | -45.12 | -0.01% | -91.13 | -0.02% | -57.11 | -0.01% |
| <i>UK</i> | -560.91 | -0.04% | -191.17 | -0.01% | -925.52 | -0.06% | -361.14 | -0.02% |
| <i>XEUR</i> | -7,392.31 | -0.10% | -1,935.47 | -0.03% | -7,110.83 | -0.09% | -3,463.70 | -0.05% |
| <i>ROW</i> | -1,352.45 | -0.04% | -812.81 | -0.03% | -1,753.65 | -0.06% | -1,216.34 | -0.04% |
| World | 26,587.60 | 0.09% | 15,412.81 | 0.05% | 95,544.86 | 0.31% | 33,260.62 | 0.11% |

Source: Simulated by author.

3.6.6 Government Closure Rules: Endogeneity of Government Transfers

Finally, in reference to Equation (2-10), the sensitivity of the government closure rule is examined by fixing total government transfers ($TRNF^{reg}$) while endogenising lump-sum transfers to the household (TRO^{reg}). Implicitly, in this alternative setting, the government always allocates the same amount of government budget to total transfers and savings, thus

the government consumption budget varies directly with total tax revenues. Since total transfers comprise unemployment benefits and other lump-sum transfers, once they are fixed, lump-sum transfers are then inversely determined by the level of unemployment in each region. Table 3-49 shows the aggregate EV results of this optional government closure rule in comparison with the benchmark setting.

Table 3-49: The sensitivity of EV results under ASEAN+5 to the government closure rule (benchmark: flexible total government transfers)

| Region | Benchmark: flexible total government transfers | | Fixed total government transfers | |
|--------------|--|-----------------------|----------------------------------|-----------------------|
| | EV (million US\$) | EV (% of 2001 income) | EV (million US\$) | EV (% of 2001 income) |
| <i>THA</i> | 1,809.03 | 1.86% | 1,805.03 | 1.85% |
| <i>IND</i> | 3,686.81 | 1.04% | 3,690.02 | 1.04% |
| <i>JPN</i> | 139.23 | 0.30% | 138.93 | 0.30% |
| <i>CHN</i> | -194.22 | -0.04% | -208.02 | -0.04% |
| <i>NASN</i> | 25,486.44 | 0.62% | 24,915.06 | 0.61% |
| <i>SASN</i> | 4,182.72 | 0.34% | 3,864.67 | 0.32% |
| <i>AUS</i> | 2,325.61 | 1.82% | 2,329.92 | 1.82% |
| <i>NZL</i> | 1,598.73 | 0.50% | 1,575.13 | 0.50% |
| <i>KOR</i> | -1,831.36 | -0.46% | -1,786.63 | -0.45% |
| <i>USA</i> | -1,263.11 | -0.01% | -1,248.84 | -0.01% |
| <i>CAN</i> | 13.62 | 0.00% | 16.13 | 0.00% |
| <i>MEX</i> | -60.20 | -0.01% | -60.38 | -0.01% |
| <i>UK</i> | -560.91 | -0.04% | -576.99 | -0.04% |
| <i>XEUR</i> | -7,392.31 | -0.10% | -7,063.24 | -0.09% |
| <i>ROW</i> | -1,352.45 | -0.04% | -1,291.42 | -0.04% |
| World | 26,587.60 | 0.09% | 26,099.37 | 0.08% |

Source: Simulated by author.

Table 3-49 shows that the results are robust to the change in the government closure rule. Generally speaking, the original closure rule is more sensible, as the government is more likely to keep the lump-sum transfers stable instead of raising them whenever the unemployment benefits drop in the face of a random positive economic shock, so as to keep total transfers flat.

3.7 Summary

The static multi-region and multi-sector CGE model used in this chapter is carefully structured with respect to the specification of factor and sectoral market structures. The flexibility of real wage and unemployment varies by region and by labour type, and the degree of market imperfection in each sector is determined by the corresponding exogenously estimated HHI.

By and large, TAFTA, TNZCEPA, JTEPA, ASEAN+CHINA and THAILAND+INDIA tend to have minor effects on the global economy, while moderately improving the welfare of member regions. FTAs universally improve their terms of trade, and trade creation commonly dominates trade diversion, with the exception that the EV of India under THAILAND+INDIA is slightly negative, probably because of the trade-diversion effect, as India's bilateral imports from Thailand are not obtained at lowest cost.

A broader economic integration definitely yields higher welfare gains to member countries, and the benefits are markedly enhanced if their major trading partners join the grouping. On the other hand, the magnitude of the negative impacts on countries excluded from a particular regional grouping depends upon their economic ties with member countries. More to the point, some non-members are even better off when their major trading counterparts are similarly left outside the trading bloc. For that reason, although by a small margin, Mexico resultantly benefits from TAFTA, ASEAN+CHINA and THAILAND+INDIA, and Canada enjoys the positive spill-over effect from ASEAN+CHINA.

At the sectoral level, FTAs usually entail contraction in dwellings (*DWE*), the only non-traded sector, since production resources are transferred to the export sectors (the reallocation effect) and commodity demands are shifted towards importing goods as they become more cheaply available after the union (the consumer effect). Among the sectors modelled as imperfectly competitive, Cournot oligopolistic firms experience stronger impacts than the monopolistically competitive firms, which is consistent with the simulation results reported in

Chapter 2. Furthermore, among sectors under monopolistic competition, sectors with a comparative advantage have incumbent firms enlarging their production scales whilst more firms enter the sector. Conversely, sectors that are not strongly competitive adjust to the new trade regime by reducing the numbers of firms at the same time as raising firms' outputs in order to make use of the increasing returns to scale. Lastly, relatively inefficient sectors reduce both output per firm and the number of firms.

Taken as a whole, among all the concluded Thai FTAs under consideration, with respect to the standard EV measure, Thailand benefits the most from JTEPA, ASEAN+CHINA, THAILAND+INDIA, TAFTA and TNZCEPA, respectively. As Australia's economy is much larger and more competitive than Thailand, the country enjoys greater trade creation under TAFTA, the simulation results showing that Australia's bilateral exports to Thailand expand to a greater extent in absolute terms than her parallel imports from the latter country. Therefore, Australia's EV is distinctly higher than Thailand's. At the sectoral level, Thailand experiences the strongest expansion in the production of machinery and equipments (*OME*), while Australia has an expansion in food products (*OFD*).

On the other hand, under TNZCEPA, New Zealand and Thailand enjoy almost the same minor levels of EVs and real output changes. In Thailand, production expansion is highest in chemical, rubber and plastic products (*CRP*), while New Zealand particularly benefits from exporting commodity *OFD*. Overall, the ex-post production pattern is analogous to TAFTA, reflecting to the proximity in economic structures of Australia and New Zealand.

Under JTEPA, Thailand's largest increase is in the production of processed agricultural products (*PAGR*), while Japan benefits from the expansion of most manufacturing sectors, especially motor vehicles and parts (*MVH*). Notwithstanding that the absolute values of Japanese imports increase by a larger degree than its exports, its EV is significantly larger than Thailand's due to the strong consumer effect that boosts the utility of the representative household and also enables the bank to invest at cheaper costs.

Subsequently, under ASEAN+CHINA, despite somewhat similar shifts in the production and trade patterns of member regions, Thailand has the greatest comparative advantage in sector *CRP*, North ASEAN in sector *PAGR*, South ASEAN in sector *OME*, and China in electronic equipments (*ELE*). Among the four members, China and North ASEAN reap considerably high EVs, while South ASEAN and Thailand are reasonably better off with the FTA. Lastly, Thailand gains more than India under THAILAND+INDIA both in absolute and proportional terms, with a substantial expansion of exports of non-ferrous metals (*NFM*). India, on the other hand, focuses on the expansion of sector *OFD*.

The sensitivity analysis results are consistent with those reported in Chapter 2, in that elasticity parameters considerably alter the policy implications. While different cross-sector substitution elasticities across final demands (σD) consistently yield positive changes to all regions, changes in the transformation elasticities (σT and σBE) exaggerate regional welfare outcomes in that FTA members make further gains while non-members experience additional losses from the integration. The sensitivity tests also show that the simulation results are robust to the benchmark firm population, and also to the government closure rule on the endogeneity of household benefits. Notwithstanding, particular attention needs to be paid to the specification of commodity market structures (the degree of market competitiveness) and labour market paradigm (the flexibility of real wage and unemployment), given that the welfare results vary with these settings in a significant way.

CHAPTER 4

REVENUE-NEUTRAL FTA FORMATION IN THE PRESENCE OF AN INFORMAL SECTOR: THE CASE OF INDIA

4.1 Introduction

The macroeconomic results from Chapter 3 indicate that, among the FTA members, India's EV has a propensity to be negative after the country forms an FTA with other countries.¹ This outcome contrasts with the positive change in the real GDP of India in all cases. The counterfactual data suggest that the fall in welfare reflects a substantial decline in tax revenue as tariffs on imports from the other FTA members go to zero.² This implies the economic dependency of low-income countries such as India³ on the customs tariff as the main source of government tax revenue, the vulnerability of domestic sectors to overseas competition. According to the WTO's Trade Policy Review of India (2002), customs duties accounted for 31.9% of the Indian gross tax revenue for the fiscal year 1992/93, but then declined following her large-scale economic reforms in the early 1990s.⁴ The GTAP 6.0 database reports that the contribution of tariffs to total tax revenue is approximately 27.5%. Thus, although free trade is theoretically optimal for a small open economy with no world market power, it may not be a practically attainable goal for India.

¹ See Table 3-32 in Chapter 3.

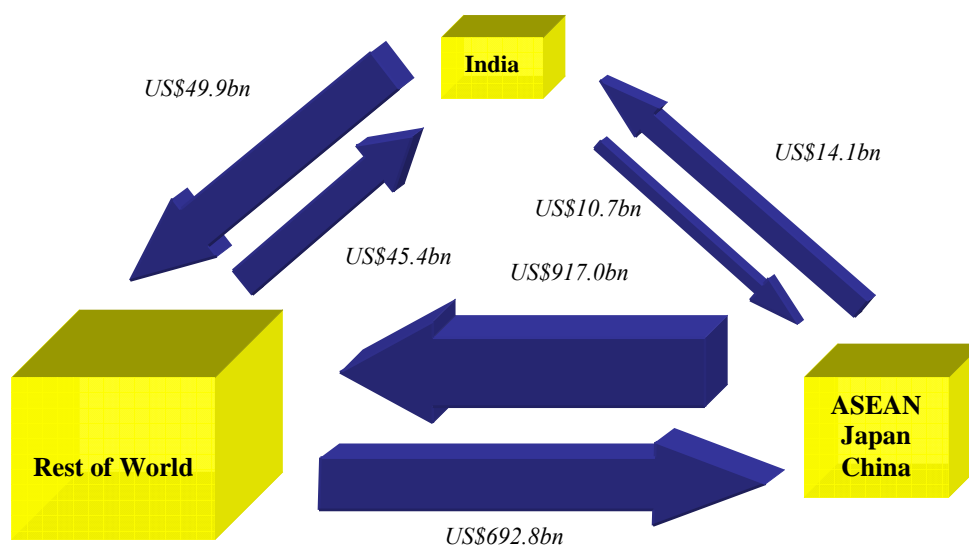
² In actuality, under the CGE approach, the net welfare loss of joining an FTA is normally not merely a consequence of lower tariff revenues but is more associated with the dominance of the trade diversion effect that adversely impacts the welfare outcomes for India. Since aiming at forming the necessarily welfare-improving CU with endogenous common external tariffs (examined earlier in Section 2.5 of Chapter 2) that completely eliminate trade diversion is probably unattainable given the current situation of international politics, it is assumed throughout this chapter that India would probably not liberalise trade in the way that ensures the absence of trade diversion, but should instead be tempted to refinance the government revenue by raising other types of domestic taxes to maintain total revenues.

³ India is categorised as a low-income country, according to Chart 3-2 in Chapter 3.

⁴ See Table III.13 in WTO (2002).

The sources of tariff revenues can be read from the global trade pattern in Chart 4-1.⁵ Taken as a whole, the immediate effect of ASEAN+3 (defined in Chapter 3 as an FTA between ASEAN, Japan, China, and India) may reduce India's tariff revenue by more than a fifth, since ASEAN, Japan and China taken together are relatively important sources of imports for India.

Chart 4-1: Trade flows between India, Rest of ASEAN+3, and Rest of World (2001)



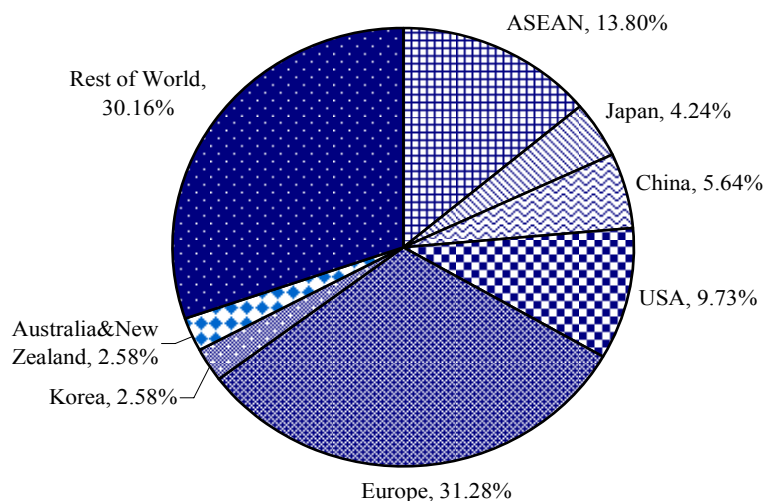
Source: Compiled from the GTAP 6.0 database.

Chart 4-2 shows the composition of Indian imports by origin. According to the GTAP 6.0 database, in 2001 India mainly imported from Europe (31.28%); and also had an important trade relationship with the ASEAN nations (13.80%). These statistics highlight the fact that the Indian government has given priority to the initiative of the ASEAN-India FTA, while at the same time pursuing trade negotiations with China and Japan. However, it is noteworthy

⁵ Trade flow values are compiled from the GTAP 6.0 database's bilateral exports net of trade taxes, subsidies, and international transport margins: *VXMD(secT,reg,regg)*.

that India has recently become diplomatically closer to China, possibly reflecting the fact that her trade with China has been growing continually since 2000.⁶

Chart 4-2: Composition of Indian imports by origin (2001)



Source: Compiled from the GTAP 6.0 database.

Given the above pattern of Indian trade and the importance of tariffs in total tax revenue, there are potential fiscal issues should India join a single preferential trading group with ASEAN, Japan and China. In reality, there are two main fiscal constraints for India. First and foremost, raising tariffs on imports from non-members to compensate for the tariff revenue loss from regional integration may be implemented only with difficulty, since India has agreed to the WTO commitment not to increase tariffs above the designated bound rates.⁷ Although there remains a de facto gap between the bound and applied rates, India has been firm in her stance of pursuing trade reform and pushing ahead with further tariff reductions in

⁶ See Table AI.4 and Table AI.5 in WTO (2007).

⁷ It is not uncommon for WTO members to have actual tariff rates that are lower than the 'bound' rates. For example, there may be a bound rate on imports of a particular good of 25%, while the de facto rate is 15%. This would mean that the de facto rate could be increased to 24.99% without violating the bound rate.

accordance with her Uruguay Round commitments, which were completed in 2005.⁸ In addition, the government has been reducing the applied MFN tariffs on non-agricultural products to meet its goal of reaching ASEAN tariff levels on these products by 2009. As a result, Indian tariff revenue has continued to decrease gradually while remaining an important source of tax revenue (WTO, 2002 and 2007).

According to WTO (2007), the second constraint for the government arises from the strong domestic needs for further public spending on infrastructure and social services as well as the pervasiveness of production and export incentives in the forms of both subsidies and tax holidays. Despite the ongoing pursuit of the 2003 Fiscal Responsibility and Budget Management (FRBM) Act, implemented for the purpose of reducing and eventually eliminating the revenue deficit through various kinds of domestic reforms by March 2009, the number of industries reserved to the public sector remains unchanged, and stated-owned enterprises still require a substantial amount of government resources. In addition, the decision in July 2006 to pause privatisation has hinted at future government support for these enterprises. Moreover, India continues to provide export assistance to producers in the form of export insurance and financing schemes through the Export-Import Bank of India, while the government has made little progress on cutting back price controls and subsidies to education, health care, and research and development. The government shows great reluctance to trim its existing public expenditures, in spite of the uncertainty about the effectiveness of these policies. This tendency is clearly demonstrated in Table I.1 of WTO (2007), which shows that the current expenditure of the central government as a percentage of GDP has been comparatively stable over the period of 2000 (13.2%) to 2007 (12.4%).

For these reasons, one natural and practical resolution of the afore-mentioned government budget issue is the manipulation of other domestic tax rates to counteract the reduction in

⁸ As of May 2007, the simple averages of the bound and applied import tariffs on all goods are 50.2% and 14.5%, respectively. See <http://stat.wto.org/CountryProfiles/IN_e.htm>.

tariff revenues after preferential trade reforms. Accordingly, in this chapter, India's domestic taxes on consumption, output, primary factor, and household income are consecutively manipulated in order to maintain real government revenue in the event of the formation of ASEAN+3.⁹ In particular, this chapter examines whether and, if so, to what extent, this sort of 'active' government budget constraint can improve regional welfare and private, public, and investment welfare levels, compared to the base case scenario, henceforth referred to as the 'passive' policy, that passes on the effects of government revenue losses to household transfers and public final demands.

An alternative strategy would be for the government to seek to maintain regional welfare, or more specifically, the welfare of the poor household, rather than its real tax revenue. However, since the EV is a function of the changes in the disposable incomes of government, bank, and households; and since bank and households in member regions tend to gain as domestic prices decline and their economies grow in real terms, it is likely that the reduction in government revenue is the source of the negative EV in India. For that reason, the rebalancing of tax revenue through the manipulation of domestic taxes can be justified, since this will improve, instead of merely maintain, the EV level, if and only if the increase in domestic tax rates does not simultaneously hamper the real side of the economy to a degree that reduces the welfare of non-governmental economic agents. This chapter thus reports on the responsiveness of the welfare of each economic agent, and also the aggregate welfare by region, to the variation in the afore-mentioned domestic taxes.

The literature on optimal taxation theory was initiated by Ramsey (1927), who argued that optimal tax rates should not distort the composition of domestic consumption, and thus should be inversely proportional to the price elasticity of demand, in other words they ought to be set at *differentiated* rates. The approach is advocated by Diamond and Mirrlees (1971) and

⁹ The real government revenue is defined in terms of the Laspeyres consumer price index, previously introduced in Equation (2-11) of Chapter 2.

extended to the case of import tariffs by Panagariya (1994). However, the underlying assumption of this theory is that goods are not substitutes but *complements*, and thus consumers will not shy away from purchasing goods with higher tax rates. Questioning the policy implications based on this assumption, Bertrand and Vanek (1971); Hatta (1977); Mitra (1994) and Chambers (1994) demonstrated that, if *substitutability* among goods prevails, the uniform attenuation of price distortions and piecemeal reforms that diminish the distortion by lowering the highest tax rate to the level of the next highest are guaranteed to be welfare-improving as they induce efficient resource re-allocation. Additionally, tax uniformity enhances the administrative simplicity and transparency that lead to an increase in government revenue and a prevention of tax evasion (Subramanian, 1994). Nonetheless, since exhaustive information on demand and cross-price elasticities is unavailable, the practical superiority of the uniform tax reform over the differential one remains an open question, since it may be difficult to identify with certainty the good(s) with the highest tax rate(s). Moreover as Dahl et al. (1994) pointed out, under the CGE framework a uniform tax may not be welfare-increasing in the presence of the existing distortionary taxation. Notwithstanding, policy recommendations by the World Bank are consistently directed towards tax uniformity reflecting the fact that the approach is advocated by policy economists on the whole (Rajaram, 1994).

Over the same period, a number of theorists endeavoured to determine the conditions that make a country better off as tariffs and other types of tax instruments are concurrently reformed. For instance, Diewert et al. (1989) specified a number of sufficient conditions for tariff reforms in a small open, multi-household economy to be welfare-improving. In this framework, commodity taxes are adopted as the instrument for income redistribution, instead of the traditional lump-sum transfers. Accordingly, Diewert et al. showed that proportional tariff reductions and reductions of extreme tariff rates will invariably improve productivity and Pareto efficiency at the same time. Abe (1995) provided a comprehensive treatment of multiple tax reforms by deriving the target rates for tariff and commodity tax reforms that

improve welfare for a small open economy with an endogenous public good. Michael et al. (1993) showed that there exists an integrated reform of import tariff and consumption tax that improves welfare while maintaining the government revenue constraint. Their results suggested that a greater uniformity of taxes will increase welfare subject to certain conditions; for example, raising the lowest consumption tax rate to the level of the second lowest, at the same time as lowering the highest tariff rate to the level of the second highest to keep constant the government revenue, will enhance welfare.

Given the theoretical predictions by the afore-mentioned authors, many attempts have been made to obtain empirical welfare implications of the simultaneous trade and domestic tax reforms. Devarajan et al. (1999) used the CGE approach to highlight the importance of Armington and transformation elasticities as key determinants of welfare results, and then argued that the econometric estimates of these trade elasticities in 60 countries indicate the improbability of trade reform being self-financing. For that reason, the government may have an incentive to compensate for such tariff revenue losses by means of domestic tax reforms. However, Anderson (1999), using the CGE technique to compute the Marginal Cost of Funds (MCF) for the Korean economy in 1963, showed that the type of revenue-neutral tax reform that simultaneously manipulates trade and consumption taxes is not necessarily welfare-enhancing. Later, Erbil (2001) extended the evaluation of revenue-neutral trade reform by generating the MCF values for import tariffs and indirect taxes in 15 countries. The results are mainly consistent with Anderson (1999) in the sense that, for 11 out of 15 countries, tariffs are less costly than indirect taxes, and thus trade reform is comparatively costly in most countries, although a minority of countries examined demonstrated the opposite outcome. Subsequently, Harrison et al. (2003) derived a generic result that the requirement for tax replacement consequently reduces the likelihood that a particular preferential trading arrangement will yield positive outcomes, as it typically imposes cross-sector distortions on the economy. More specifically, Feraboli (2007) used a dynamic CGE model to show that the arbitrary reforms of income or Value Added Tax (VAT) to counter-balance the Jordanian

government revenue loss in the face of its Association Agreement (AA) with the European Union (EU) would offset to some extent the positive outcomes, particularly in terms of private and investment demands.

Thus far, the previous theoretical analyses tell us that the welfare effects of revenue-neutral regional arrangements can be positive under certain circumstances, while the empirical studies commonly suggest that the results are more likely to be negative. Given the above results, Emran et al. (2005) introduced an informal sector into the standard model. As this sector is generally large in low- and middle-income countries, once it is incorporated, revenue-neutral trade reforms tend to reduce welfare, since the higher VAT biases production and distribution activities away from the taxable formal sector(s). Therefore, it would be of interest to evaluate the variability of FTA welfare results with counteracting domestic tax policies for a developing country in the presence of an informal sector, since the approach is relatively new, and we can foresee a non-negligible economic interaction between the formal and informal sectors during the adjustment process to the new general equilibrium.

Accordingly, Chapter 4 is organised as follows. Firstly, Section 4.2 uses theoretical general equilibrium analysis to predict the likely outcomes as domestic taxes are imposed to offset the government revenue loss in the face of a trading bloc formation. Section 4.3 explains the general model structure along with a number of modifications that distinguish the current CGE model from the one previously utilised in Chapter 3. Section 4.4 simulates the welfare effects of active domestic tax policies as India joins ASEAN+3. Section 4.5 explains how the informal economy is defined, measured, and incorporated into the current CGE framework. The variability in the welfare results is then examined in aggregate terms and also in terms of the consumption distribution of households. Finally, Section 4.6 summarises the findings of this chapter.

4.2 Theoretical General Equilibrium Analysis of Domestic Tax Policy Reforms

This section uses a simple two good general equilibrium model to provide some insight into the impacts of domestic tax reforms on consumer welfare. Relatively speaking, India may be regarded as a small country, since according to the GTAP 6.0 database, her GDP accounts for merely 1.53% of world GDP, whereas Japan and the United States respectively contribute 13.36% and 32.23%.¹⁰ However, under the CGE framework, domestic policy variation in India may affect the world market for at least some sectors. For that reason, in Subsections 4.2.1-4.2.3 we firstly develop an analytical framework for the introduction of domestic taxes in a small country, where border prices are not affected by a change in domestic tax policy. Subsequently, we shall discuss policy consequences in Subsection 4.2.4 where the country is regarded as a large economy and cross-country price effects are taken into consideration. In particular, the policy impacts on a small open economy are confirmed by simulating the domestic taxes at issue using the GAMS software in a single-region model with two identical goods that use labour and capital as primary factors, under the assumptions that the government imposes no tax distortion at the initial state, that factors are fully employed, and that world prices are fixed as a tax policy implemented by a small country would not have any effect on the international market. The theoretical predictions are discussed below.

4.2.1 An Income Tax

For a small open economy, the introduction of a tax on the income of the representative household does not have any effect on border prices, and hence does not affect domestic producer prices. Thus it does not matter for this analysis which of X and Y is exported and

¹⁰ In the GTAP 6.0 database, the nominal GDP of India is calculated as the sum of national expenditures, $\sum_{\text{gdpepend}} \text{GDPEXP}^{\text{IND}}$.

which is imported. In Figure 4-1, the pre-tax equilibrium has the household consuming quantities X_0 and Y_0 of the two goods subject to the budget constraint B_0 , giving it utility U_0 .

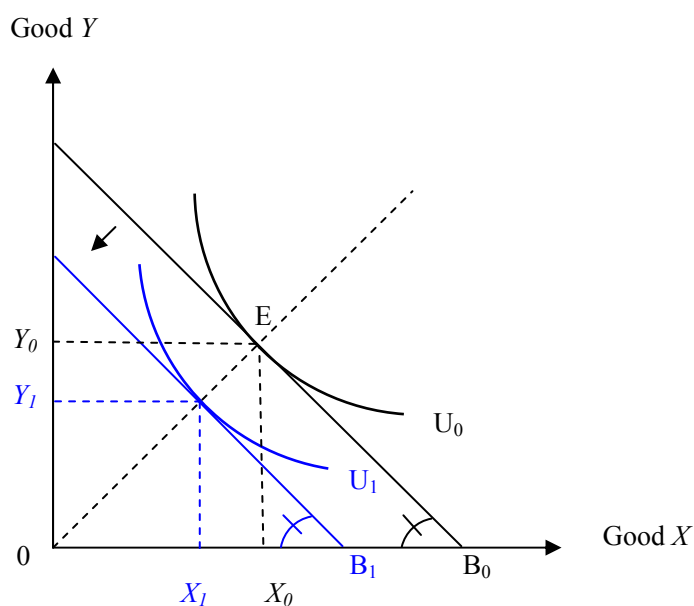


Figure 4-1: The household welfare change as an income tax is introduced

Since introducing an income tax on the household would not change the relative consumer prices of the two goods, and there are by assumption homothetic preferences, the new equilibrium must lie on the ray from the origin that passes through the initial equilibrium point. The new consumption mix is given by X_1 and Y_1 , with utility falling to U_1 under the new budget constraint B_1 . The extent to which consumer utility drops depends on the amount of tax revenue returned to the household by the government. If there are no transaction costs and the government does not spend on public good consumption but instead transfers the entire amount of income tax revenue back to the household in the form of government benefits, the level of household utility will be shifted back to the initial level (that is to say, $U_1 = U_0$).

4.2.2 A Consumption Tax

As with the income tax, if India is, by assumption, a small open economy then the imposition of a consumption tax on a good should not have any influence on the border and hence

domestic producer price of that good. Thus, once again the PPF need not be considered in this analysis.

As in Figure 4-1, introducing taxes on goods X and Y at the same ad valorem rate would not change the relative consumer prices of the two goods. Therefore, we obtain the same result as under the income tax, with the new equilibrium located on the ray from the origin that passes through the initial equilibrium point. If there are no transaction costs and the government returns the entire amount of the consumption tax revenue to the household then household consumption is unchanged. Note that in this case, household *money* income must increase, since the household still owns all the factors of production, with all factors being fully employed, and with factor prices determined by the exogenous world prices, and the household is also the recipient of the tax revenue. However, household *real* income must be unchanged, since its money income and both consumer prices have increased by the same proportion.¹¹

Suppose now that the government imposes a consumption tax only on good X . In Figure 4-2, since the consumer price of good Y is unchanged (as there is no consumption tax on good Y), the new household budget line B_2 must pass through the same point on the Y axis as before. However, if all the money income were spent on good X then the demanded quantity would be smaller. The new household budget line B_2 is tangential to indifference curve U_2 . As the ad valorem rate at which consumption tax is imposed on good X is higher than the rate commonly applied to the two goods, the biased imposition of consumption tax thus brings about more distortion to the economy, and it is likely that U_2 will turn out to be lower than U_1 .

¹¹ See Appendix A4-1 for the algebraic explanation of the adjustment of household income in *money* and *real* terms, given that both the household and the government have the Cobb-Douglas preferences.

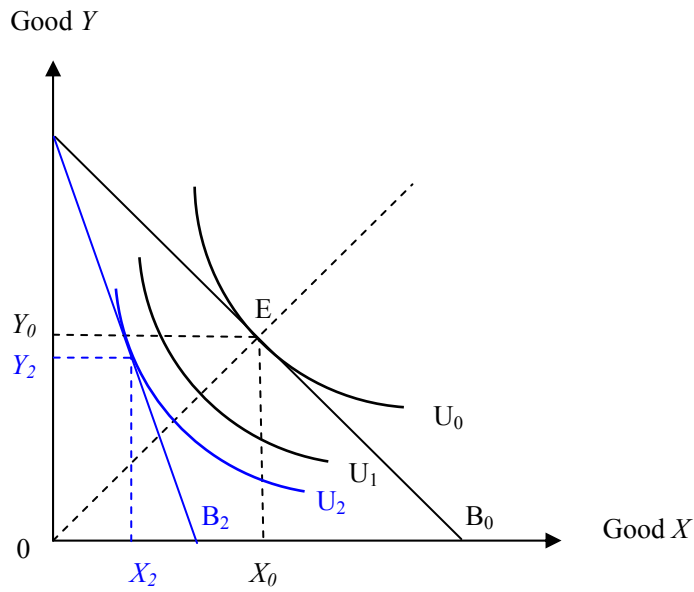


Figure 4-2: Changes in the household consumption mix when a consumption tax on good X is introduced

The tax on X reduces the household's purchasing power, i.e. its real income, and the change in relative prices leads to the household substituting good Y for good X at the margin in its consumption expenditure. In absolute terms, however, the direction and scale of change in good Y consumption depend on the elasticity of substitution.

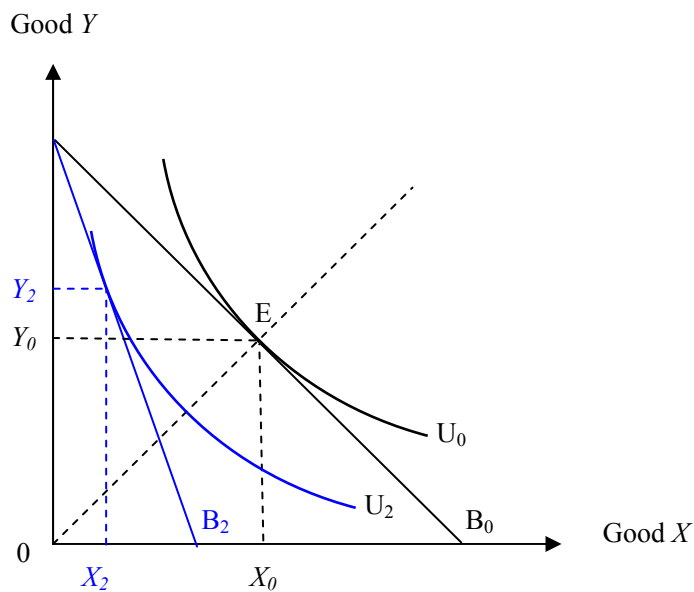


Figure 4-3: Changes in the household consumption mix when a consumption tax on good X is introduced to the household with high elasticity of substitution

When a consumption tax is imposed on good X , the effect on consumption of good Y may be decomposed into the ‘income effect’ and the ‘substitution effect.’ It is possible that the substitution effect will dominate the income effect, so that consumption of Y increases, as in Figure 4-3 above (where $Y_2 > Y_0$).

The demand equations for a CES utility function are

$$X = \frac{C}{P_X} \left(\frac{\alpha^\sigma P_X^{1-\sigma}}{\alpha^\sigma P_X^{1-\sigma} + (1-\alpha)^\sigma P_Y^{1-\sigma}} \right)$$

$$Y = \frac{C}{P_Y} \left(\frac{(1-\alpha)^\sigma P_Y^{1-\sigma}}{\alpha^\sigma P_X^{1-\sigma} + (1-\alpha)^\sigma P_Y^{1-\sigma}} \right).$$

So we want to find the derivative of Y with respect to P_X . Rewrite the Y equation as

$$Y = C \cdot (1-\alpha)^\sigma P_Y^{-\sigma} \left(\alpha^\sigma P_X^{1-\sigma} + (1-\alpha)^\sigma P_Y^{1-\sigma} \right)^{-1}.$$

Hence, we derive

$$\frac{\partial Y}{\partial P_X} = C \cdot (1-\alpha)^\sigma P_Y^{-\sigma} \left(\alpha^\sigma P_X^{1-\sigma} + (1-\alpha)^\sigma P_Y^{1-\sigma} \right)^{-2} \cdot \left\{ (\sigma-1) \left(\alpha^\sigma P_X^{-\sigma} \right) \right\}.$$

This is *positive* if $\sigma > 1$. That is, if the elasticity of substitution, σ , is sufficiently high (i.e. a relatively ‘flat’ indifference curve) then an increase in the price of X leads to an *increase* in the consumption of Y (Figure 4-3).¹² In other words, as the effect of the tax is decomposed into the income effect and the substitution effect, the more readily the household substitutes one good for the other, the more likely it is that the substitution effect (the switching at the margin from consuming X to consuming Y) will dominate the income effect. Therefore, if the utility function is Leontief ($\sigma = 0$), then the substitution effect would not exist, and thus the consumption of Y would fall as a result. The equation above also shows that when the utility

¹² As the household and government utility functions in this model are uniformly expressed in the CES form with the elasticity of substitution higher than one, an increase in the consumption of untaxed goods is particularly relevant.

function is Cobb-Douglas ($\sigma = 1$), we must have no change in the quantity of good Y that is purchased, since with the Cobb-Douglas preferences the expenditure on each good is a constant share of household money income. Since primary factors are fully employed, money income would remain at the initial level while real income drops as the imposition of a consumption tax increases the consumer price of X , and therefore household's demand for Y would not change given the assumed the Cobb-Douglas utility function.

Although the direction of change in the aggregate consumption of the two goods should not be altered by the handling of the tax revenue, in comparison with the government making a lump-sum transfer to the household, the government spending on public consumption should result in higher domestic demands in aggregate terms because the government faces no tax prejudice against X , whereas the household does. Specifically, if the government is to spend the sales tax revenue on the consumption of X and Y , then under the Cobb-Douglas preferences, the collective private and public consumption of X will descend, whilst Y will be more demanded domestically. To demonstrate this algebraically, suppose that the government applies an ad valorem sales tax of t_X on good X . Now the household maximises its utility subject to the budget constraint

$$X_t \cdot p_X \cdot (1+t_X) + Y_t \cdot p_Y = Z.$$

The Lagrangean function is

$$\Gamma = X_t^\alpha \cdot Y_t^{1-\alpha} - \lambda \cdot (X_t \cdot p_X \cdot (1+t_X) + Y_t \cdot p_Y - Z)$$

where λ is the Lagrange multiplier.

The first-order conditions are

$$\frac{\partial \Gamma}{\partial X_t} = \alpha \cdot X_t^{\alpha-1} \cdot Y_t^{1-\alpha} - \lambda \cdot p_X \cdot (1+t_X) = 0$$

$$\frac{\partial \Gamma}{\partial Y_t} = (1-\alpha) \cdot X_t^\alpha \cdot Y_t^{-\alpha} - \lambda \cdot p_Y = 0$$

$$\frac{\partial \Gamma}{\partial \lambda} = X_t \cdot p_X \cdot (1+t_X) + Y_t \cdot p_Y - Z = 0.$$

From which we obtain

$$X_t = \frac{\alpha \cdot Z}{p_X \cdot (1+t_X)}, Y_t = \frac{(1-\alpha) \cdot Z}{p_Y}.$$

The government income from the tax on good X is

$$R = X_t \cdot p_X \cdot t_X = \frac{\alpha \cdot t_X \cdot Z}{(1+t_X)}.$$

The government does not pay the tax on good X . So its utility maximising problem is

$$\text{Max } U_G = X_G^\alpha \cdot Y_G^{1-\alpha}, \text{ subject to } R = X_G \cdot p_X + Y_G \cdot p_Y$$

and the solution to that is, as before,

$$X_G = \frac{\alpha \cdot R}{p_X}, Y_G = \frac{(1-\alpha) \cdot R}{p_Y}.$$

Substituting for R gives

$$X_G = \frac{\alpha^2 \cdot Z}{p_X} \cdot \frac{t_X}{(1+t_X)}, Y_G = \frac{(1-\alpha) \cdot \alpha \cdot Z}{p_Y} \cdot \frac{t_X}{(1+t_X)}.$$

The total consumption of X is now

$$\begin{aligned} X_t + X_G &= \frac{\alpha \cdot Z}{p_X \cdot (1+t_X)} + \frac{\alpha^2 \cdot Z}{p_X} \cdot \frac{t_X}{(1+t_X)} \\ &= \frac{\alpha \cdot Z}{p_X} \cdot \frac{(1+\alpha \cdot t_X)}{(1+t_X)} < \frac{\alpha \cdot Z}{p_X} \end{aligned}$$

so that total consumption of X falls (since $\alpha < 1$).

The total consumption of Y is now

$$\begin{aligned}
 Y_t + Y_G &= \frac{(1-\alpha) \cdot Z}{p_Y} + \frac{(1-\alpha) \cdot \alpha \cdot Z}{p_Y} \cdot \frac{t_X}{(1+t_X)} \\
 &= \frac{(1-\alpha) \cdot Z}{p_Y} \cdot \left(1 + \frac{\alpha \cdot t_X}{(1+t_X)} \right)
 \end{aligned}$$

and consumption of Y increases (since $1 + \frac{\alpha \cdot t_X}{(1+t_X)} = \frac{1+(1+\alpha) \cdot t_X}{(1+t_X)} > 1$).

However, the unambiguous increase in total consumption of Y may not necessarily hold if the utility function is CES rather than Cobb-Douglas.

It is noteworthy that if the consumption preferences of the government and the household are identical then the aggregate consumption of each good is the same whether the government transfers the tax revenue back to the household or spends some or all of it on own consumption. If, however, the government and the household have different preferences then the introduction of a consumption tax would alter the consumption pattern in aggregate terms (Figure 4-4).

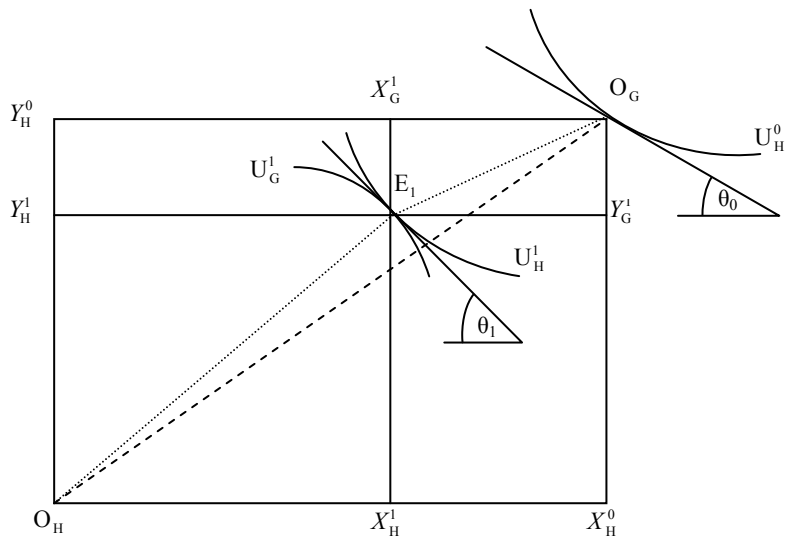


Figure 4-4: The government taxes good X and has different preferences from the household

At the initial state, the government is yet to receive tax revenue, thus the household is the only consumer in this economy. Hence, at the utility level U_H^0 , the household purchases X_H^0 and Y_H^0 at the relative price of θ_0 (i.e. P_X^0/P_Y^0). As good X is taxed, its consumer price is increased. For simplicity we assume that the government pays the same price as the household, but of course the money is reclaimed by the government as revenue, which is then spent on purchasing the two goods. If both share the same preferences, then the new consumption mix will be situated on the diagonal line $O_H O_G$, and the household consumption mix of the two goods would not be altered by the level of sales tax. If the government has different preferences to those of the household, the new equilibrium will not be on the diagonal. For Instance, if the government's preference is for a higher ratio of the X to Y than the household, as shown in Figure 4-4, the equilibrium will lie above the diagonal, for example at point E_1 . The household and government indifference curves (U_H^1 and U_G^1) are tangential since they pay the same prices for X and Y , and the new relative price of X , i.e. θ_1 , is higher than before. The household is therefore worse off because its welfare has fallen from U_H^0 to U_H^1 .

4.2.3 Production and Factor Taxes

The imposition of production and factor taxes are analysed jointly here, since both raise the average costs of production. Because a production tax decreases the prices of both primary factors and intermediate inputs¹³ as the demands for their services decline while a factor tax solely decreases primary factor prices, a tax on both factor and intermediate inputs at the equivalent ad valorem rate should have the same effect as a production tax, provided that the supply elasticities of primary factors are identical. Therefore, the two taxes would yield similar welfare impacts when both are introduced at appropriate rates to generate the same

¹³ However, note that the prices of intermediate inputs will not be affected by the introduction of a production tax if the inputs are imported by a small open economy.

level of government revenue, that is to say, the production tax would be imposed at a lower rate, owing to a broader tax base.

Since a factor or production tax on X and Y at the same ad valorem rate would not alter the relative producer prices of the two goods and the relative prices of capital and labour, and since border prices are not affected by the introduction of production or factor taxes in a small open economy; with linearly homogenous technologies and perfectly competitive factor markets (i.e. factors are fully employed due to flexible wages), the PPF would not be shifted, and the economy must remain at the original production point. However, producers' net revenues must be reduced, and so factor prices must fall. Factors will continue to be fully employed at these lower levels of payments, but if the government retains the tax revenue, then the household income must be lower, and so its consumption of both goods must fall. However, if the government returns the tax revenue to the household, then its money income will be restored, and so will the initial consumption quantities.

If the government imposes a production tax only on X , as with the consumption tax, the new equilibrium should lead to more distortion, and thus lower consumer utility further than the case in which common tax rates are levied on both goods (Figure 4-2). If a factor tax is imposed only on capital, then capital-intensive sectors would suffer from price discrimination, causing further distortionary production resource reallocation than the uniform factor tax policy, especially when the substitution elasticities of primary factors are relatively low.

4.2.4 The Large Country Case

The analysis of a large country implementing a domestic tax reform to meet the government revenue constraint is largely complicated by the uncertainty arising from the terms of trade effects as border prices are endogenous and thus responsive to a government policy change. In other words, we expect price interaction between the large country and the rest of the world. Hence, we shall not produce the same type of diagram for the large open economy;

however, the results should be reminiscent of the small country case, in that the application of a domestic tax with no sectoral bias would yield better welfare outcomes.

To be precise, consumption taxes commonly imposed at the same ad valorem rate on both goods should have similar welfare effects to an income tax on the representative household. Assuming that India is a large open economy, the proportional decrease in domestic demand leads to lower world prices of both goods X and Y , thus, although the tax hike does not strongly affect the terms of trade, it exacerbates the welfare of foreign exporters while improving that of overseas consumers. As the rest of the world is also large, and is a net importer of good X from and a net exporter of good Y to India, the corresponding adjustments in production and consumption by the rest of the world imply a higher world price for good X and a lower one for good Y . As a result, the terms of trade of India could be improved in the new equilibrium. Coupled with the higher factor prices and government transfers to the household, the welfare outcomes of the income and universal consumption tax reforms can be slightly positive for the large open economy.

Similarly, production and factor taxes imposed at the single common rate on both production sectors could be collectively explained. The proportional decrease in domestic supply heightens the world prices of both goods and the rest of the world may responsively increase its output and thus export of good Y to India, and reduce its import of good X from India. Consequently, the terms of trade of India could change adversely in the new equilibrium. Although the household still receives government transfers as in the case of income or consumption tax reform, the lower factor prices (due to lower factor demands) and the worsen terms of trade tend to yield more negative outcomes in comparison with the previous case of taxation on the demand side.

Given the above economic mechanism, if a tax is imposed on only one good, then it is likely that the terms of trade will become more distorted, and the tax reform will cause disproportional adjustments across sectors. Thus, as in the analysis in Subsections 4.2.1-4.2.3, the introduction to the economy of taxes without sectoral bias tends to yield more desirable

impacts on the representative household. However, due to the complexity in price interaction across regions, coupled with the uncertainty in the direction of change in trade volume in response to a shift in the offer curve of another country, which in turn depends on the curvature of the country's own offer curve, it is worth emphasising that the introduction of domestic taxation has exceptionally ambiguous implications on the large economy.

4.3 The Model and Benchmark Data Calibration

Section 4.3 explains new features incorporated in the computable general equilibrium model previously constructed in Chapter 3. The modified model which is described in full details in Appendix A4-2 will then be used for the fiscal analysis in Section 4.4, in which only formal economic activities are taken into account. To elaborate, the representative regional household is divided into rich and poor households, such that the income distribution effects of the revenue-neutralising FTA can be derived; and data calibration for production sectors is revised in such a way that benchmark production taxes can be directly calibrated from the GTAP 6.0 database, instead of being calculated as the residuals of total production costs as before. Since this chapter is centred on the manipulation of domestic taxes, the importance of calibrating benchmark tax rates directly from the GTAP 6.0 database must be emphasised. Finally, the detailed derivation of tax data from the GTAP 6.0 database will be clarified.

4.3.1 Household Disaggregation

In this CGE model, the set of households comprises rich and poor households:

$$hh = \{RH, PH\}^{14}$$

¹⁴ As summarised by Savard (2003), a large number of CGE literature on the income distribution and poverty analysis grow advanced in terms of the household disaggregation technique. While many modellers have disaggregated the representative household by wealth and location, this chapter simply distinguishes the two households with respect to their functions in production activities, since it focuses on public decision-making issues rather than the detailed household adjustments to multiple policy shocks.

The model assumes that the two households are identical in their CES preferences and consumption patterns at the benchmark year. The two households receive incomes from different sources. First of all, the rich household earns income from the provision of skilled labour, capital, land, and natural resource services to production sectors. In addition, firm's profits and unemployment benefits for skilled labour also accrue to this household. When the skilled and unskilled labour are respectively denoted by “*UnSkLab*” and “*SkLab*”, total income of the rich household in region *reg* reads:¹⁵

$$\begin{aligned}
 INC_{RH}^{reg} = & \left[\sum_{fac} \sum_{sec} F_{sec}^{fac,reg} \cdot \left(\frac{PFM^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right] \$[not\ SameAs(fac, "UnSkLab")] \\
 & + trep^{SkLab,reg} \cdot PFM^{SkLab,reg} \cdot UNEMP^{SkLab,reg} \\
 & + \sum_{sec} PROFIT_{sec}^{reg} \$ic_{sec}^{reg}.
 \end{aligned} \tag{4-1}$$

On the other hand, the poor household's income is earned from the provision of unskilled labour services to producers, unemployment benefits for unskilled labour, and also lump-sum income transfers by the government:

$$\begin{aligned}
 INC_{PH}^{reg} = & \left(\sum_{sec} F_{sec}^{UnSkLab,reg} \cdot PFM^{UnSkLab,reg} \right) \\
 & + trep^{UnSkLab,reg} \cdot PFM^{UnSkLab,reg} \cdot UNEMP^{UnSkLab,reg} \\
 & + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}.
 \end{aligned} \tag{4-2}$$

As described in Chapter 2, unemployment benefits in Equations (4-1) and (4-2) are derived as unemployed labour wages multiplied by the fixed replacement rates ($trep^{lab,reg}$). In addition, lump-sum income transfers which are fixed in real terms are allocated only to the poor household.

Subsequently, some part of the incomes of the two households is paid to the government as direct tax, with the rest being either saved or allocated to consumption budgets:

¹⁵ In Equation (4-1), $\$(not\ SameAs(fac, "UnSkLab"))$ tells GAMS *not* to include unskilled labour in the calculation, and $\$ic_{sec}^{reg}$ means only sectors under imperfect competition will transfer profits to the rich household.

$$INC_{hh}^{reg} = TRY_{hh}^{reg} + SHH_{hh}^{reg} + PCBUD_{hh}^{reg} \cdot CBUD_{hh}^{reg}, \quad (4-3)$$

where household saving is a fixed proportion of total income net of income tax:

$$SHH_{hh}^{reg} = mps_{hh}^{reg} \cdot (INC_{hh}^{reg} - TRY_{hh}^{reg}), \quad (4-4)$$

and private final demands are derived from the CES utility function:

$$C_{hh,sec}^{reg} = \left[\gamma_{hh,sec}^{reg} \cdot \frac{PCBUD_{hh}^{reg}}{(1 + t_{sec}^{reg}) \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}} \cdot CBUD_{hh}^{reg}. \quad (4-5)$$

Finally, total expenditure on the final consumption good by the households is equal to their respective total consumption budgets:

$$PCBUD_{hh}^{reg} \cdot CBUD_{hh}^{reg} = \sum_{sec} (1 + t_{sec}^{reg}) \cdot PA_{sec}^{reg} \cdot C_{hh,sec}^{reg}. \quad (4-6)$$

Given the above structure of household expenditure, households' income outflows are calibrated as follows. First, the benchmark data for income taxes paid by the rich and by the poor can be extracted directly from the GTAP 6.0 database.¹⁶ Denote by $gini_{hh}^{reg}$ the share of income of each household in total household income within region reg , evaluated in the benchmark year (denoted by "0"), exclusive of income tax:

$$gini_{hh}^{reg} = \frac{INC0_{hh}^{reg} - TRY0_{hh}^{reg}}{\sum_{hh} (INC0_{hh}^{reg} - TRY0_{hh}^{reg})}. \quad (4-7)$$

The sum of these parameters in each region should equal unity. Accordingly, the benchmark consumption-related data for individual households are calibrated as fixed shares of the corresponding data of the representative household in the GTAP 6.0 database. To be precise, for instance, the benchmark final demand by household is calculated as:

¹⁶ The direct derivation of income tax by household from the GTAP 6.0 database is possible, because the study takes skilled labour, capital, land, and natural resource as indicating the high-income (rich) household, and unskilled labour as indicating the low-income (poor) household.

$$CO_{hh,sec}^{reg} = gini_{hh}^{reg} \cdot (vdpm_{reg}^{sec} + vipm_{reg}^{sec}),$$

where the two vectors on the right hand side are defined in the GTAP 6.0 database as:

$vdpm_{reg}^{sec}$: Private households' domestic purchases at market prices; and

$vipm_{reg}^{sec}$: Private households' imports at market prices.

Thus, the benchmark household consumption budget is calculated as:

$$CBUD0_{hh,sec}^{reg} = \sum_{sec} (CO_{hh,sec}^{reg} + (gini_{hh}^{reg} \cdot TRCO_{sec}^{reg})). \quad (4-8)$$

Then finally, the household saving data (SHH_{hh}^{reg}) are derived as total household incomes net of income taxes and consumption budgets. Given the definition of the $gini_{hh}^{reg}$ multiplier, the proportions of incomes of rich and poor households are reported in Table 4-1:

Table 4-1: The proportion of rich and poor household incomes in total household incomes

| Region | Rich household | Poor household |
|----------------|----------------|----------------|
| Thailand | 0.72 | 0.28 |
| Australia | 0.60 | 0.40 |
| New Zealand | 0.59 | 0.41 |
| India | 0.65 | 0.35 |
| Japan | 0.56 | 0.44 |
| China | 0.55 | 0.45 |
| North ASEAN | 0.63 | 0.37 |
| South ASEAN | 0.48 | 0.53 |
| Korea | 0.60 | 0.40 |
| USA | 0.59 | 0.42 |
| Canada | 0.54 | 0.46 |
| Mexico | 0.72 | 0.28 |
| UK | 0.59 | 0.41 |
| Rest of Europe | 0.60 | 0.40 |
| Rest of World | 0.59 | 0.41 |
| World | 0.59 | 0.41 |

Source: Compiled by author from the GTAP 6.0 database.

From Table 4-1, the proportion of national income accruing to the rich household is observed to be higher than that of the poor in most regions; income disparity being especially obvious in developing countries such as Thailand, India, and Mexico.

4.3.2 Production Sectors

Production sectors are re-calibrated for the fiscal policy analysis in this chapter. The zero-profit condition for production activities requires that the value of total output equates the sum of factor costs, intermediate input costs, factor usage taxes, production taxes, and sectoral profits:

$$\begin{aligned}
 PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = & \left(\sum_{fac} (1 + tf_{sec}^{fac,reg}) \cdot \left(\begin{aligned} & PFM_{sec}^{fac,reg} \$facM(fac) \\ & + PFS_{sec}^{fac,reg} \$facS(fac) \end{aligned} \right) \cdot F_{sec}^{fac,reg} \right) + \left(\sum_{sec c} IO_{sec c, sec}^{reg} \cdot PA_{sec c}^{reg} \right) \\
 & + tz_{sec}^{reg} \cdot PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} + PROFIT_{sec}^{reg} \$ic_{sec}^{reg} .
 \end{aligned}
 \tag{4-9}$$

In this chapter, the calibration of the right hand side of the equation is altered so that instead of allocating zero values to sectoral profits and calibrating production taxes as residuals of total production costs, production tax revenues from each sector are derived directly from the GTAP 6.0 database, and accordingly profit variables are calibrated to the difference between total output values and total costs.

4.3.3 Calibration of Tax Revenues

This subsection explains how the various types of tax revenues are obtained from the GTAP 6.0 database. Region *reg* collects tariff revenues from bilateral imports from region *regg*, the revenues being the difference between the values of bilateral imports at world and domestic market prices:

$$TRBM O_{sec T}^{reg, regg} = vims_{regg, reg}^{sec T} - viws_{regg, reg}^{sec T} .$$

Consequently, total tariff revenues in region *reg* are calibrated as:

$$TRMO^{reg} = \sum_{sec \in T} \sum_{regg \substack{regg \\ (\neq reg)}} TRBMO_{sec \in T}^{reg, regg}.$$

Income taxes are calibrated by household, with the rich household deriving income from the provision of skilled labour, capital, land, and natural resource to production sectors, while the poor is endowed only with unskilled labour. If $vfm^{fac, sec, reg}$ stands for the purchases of factor fac by sector sec in region reg at market prices, and $evoa^{fac, reg}$ represents the endowment of factor fac in region reg at agents' prices, income tax revenues are calibrated as:¹⁷

$$TRYO_{RH}^{reg} = \left(\sum_{fac} \sum_{sec} (vfm^{fac, sec, reg}) - evoa^{fac, reg} \right) \$[\text{not SameAs}(fac, "UnSkLab")]$$

$$TRYO_{PH}^{reg} = \sum_{sec} (vfm^{"UnSkLab", sec, reg}) - evoa^{"UnSkLab", reg}.$$

Factor usage tax revenues are the difference between the purchase values of factor fac by sector sec in region reg at agents' and market prices:

$$TRFO_{sec}^{fac, reg} = evfa_{reg}^{fac, sec} - vfm_{reg}^{fac, sec};$$

Since consumption tax revenues are collected only from consumers, their benchmark values are calculated as the difference between private households' consumption valued at agents' and market prices:

$$TRCO_{sec}^{reg} = (vdpa_{reg}^{sec} + vipa_{reg}^{sec}) - (vdpm_{reg}^{sec} + vipm_{reg}^{sec}),$$

where the first two terms on the right hand side denote private households' purchases of domestic and imported goods at agents' prices, respectively and the second pair are the corresponding purchases at market prices. Finally, production tax revenues are calibrated to

¹⁷ It is noteworthy that strictly these are not strictly direct taxes on household incomes but are nevertheless adopted as a proxy for the revenue-rebalancing income tax policy simulations. Therefore, there are potential limitations on the implications of the counterfactual results.

the difference between total outputs of sector sec in region reg valued at market and producer prices:

$$TRZO_{sec}^{reg} = vom_{reg}^{sec} - voa_{reg}^{sec}.$$

The values of total outputs evaluated at the two prices are derived as:

$$vom_{reg}^{sec} = vdp_{reg}^{sec} + vdgm_{reg}^{sec} + \sum_{pro} vdfm_{reg}^{sec,pro} + \sum_{\substack{regg \\ (\neq reg)}} vxmd_{regg}^{sec,reg} + vst_{reg}^{sec} \$trsp(sec); \text{ and}$$

$$voa_{reg}^{sec} = \sum_{fac} evfa_{reg}^{fac,sec} + \sum_{sec\ c} (vdfa_{reg}^{sec\ c,sec} + vifa_{reg}^{sec\ c,sec}),$$

where:

$vdgm_{reg}^{sec}$ = Domestic purchases of commodity sec by the government at market prices in region reg ;

$vdfm_{reg}^{sec,pro}$ = Domestic purchases of intermediate input sec by production sector pro (i.e., sector sec inclusive of the investment sector “CGDS”) at market prices in region reg ;

$vxmd_{regg}^{sec,reg}$ = Bilateral exports of commodity sec from region reg to region $regg$ at market prices;

vst_{reg}^{sec} = Exports of international transport service sec by region reg ;

$vdfa_{reg}^{sec\ c,sec}$ = Domestic purchases of intermediate input $secc$ by production sector sec in region reg ;

$vifa_{reg}^{sec\ c,sec}$ = Imports of intermediate input $secc$ by production sector sec in region reg .

4.4 Active Domestic Tax Policies: Simulation Designs and Welfare

Results

This section discusses the simulation of a domestic tax policy introduced in order to counteract the decline in India’s tax revenue following the formation of ASEAN+3 (between ASEAN, Japan, China, and India). Imports from ASEAN, Japan and China together account

for approximately 23.7% of India's total imports (Section 4.1), and India has initiated preferential trade negotiations with this group of nations. ASEAN+3 is chosen for the analysis of Indian tax policy since the magnitude of the welfare change is much stronger, and so is the incentive for the Indian government to pursue a domestic tax reform in compensation for the tax revenue loss, than are the results from the THAILAND+INDIA grouping that has already entered into force.

Specifically, taxes on income, factor usage, consumption and production are increased in sequence, and the ensuing changes in 1) government tax revenue, 2) the utility levels of the government, the bank, and the rich and the poor households,¹⁸ and 3) regional disposable income evaluated at the ex-ante price,¹⁹ are plotted with respect to the counterfactual domestic tax rate. Subsequently, the tax rates at which total government revenue is maintained, as well as other aspects of welfare changes, are compared across tax reform scenarios.

4.4.1 Simulations of Active Income Tax Policies

In the first simulation, as ASEAN+3 is formed, the Indian government seeks to maintain its revenue by increasing the income taxes imposed on both households in the same proportion (hereafter, the 'uniform income tax reform'). An alternative, reflecting a possible concern over the effect on the poor household's welfare in the first simulation, is a discriminatory tax reform, under which a higher income tax rate is imposed only on the rich household

¹⁸ The CES utility levels of households are defined as:

$$U_{hh}^{reg} = \left\{ \sum_{sec} \gamma_{hh,sec}^{reg} \cdot (C_{hh,sec}^{reg})^{\rho D^{reg}} \right\}^{1/\rho D^{reg}},$$

which are essentially the real household budget constraints. Similarly, the CES utility levels of the government and the bank which represent their real budget constraints are, respectively,

$$UGV^{reg} = \left\{ \sum_{sec} \gamma_{g,sec}^{reg} \cdot (CG_{sec}^{reg})^{\rho D^{reg}} \right\}^{1/\rho D^{reg}}, \text{ and } UI^{reg} = \left\{ \sum_{sec} \gamma_{i,sec}^{reg} \cdot (I_{sec}^{reg})^{\rho D^{reg}} \right\}^{1/\rho D^{reg}}.$$

¹⁹ Given the definition of the Equivalent Variation (EV) in Chapter 2, this regional welfare change is actually measured by multiplying the ratio of the EV (EV^{reg}) to the benchmark regional disposable income ($Y0^{reg}$) by 100:

$$\% \Delta Y^{reg} = 100 \cdot \left(\frac{EV^{reg}}{Y0^{reg}} \right) = 100 \cdot \left(\frac{(Y^{reg} / WPI_{1,0}^{reg}) - Y0^{reg}}{Y0^{reg}} \right).$$

(henceforth, the ‘selective’ income tax reform). The welfare results from the two scenarios are reported separately in Chart 4-3 and Chart 4-4, and then compared in Table 4-2.

Chart 4-3: Increasing Indian income tax rates on all households by the same proportion (the uniform income tax reform) under ASEAN+3

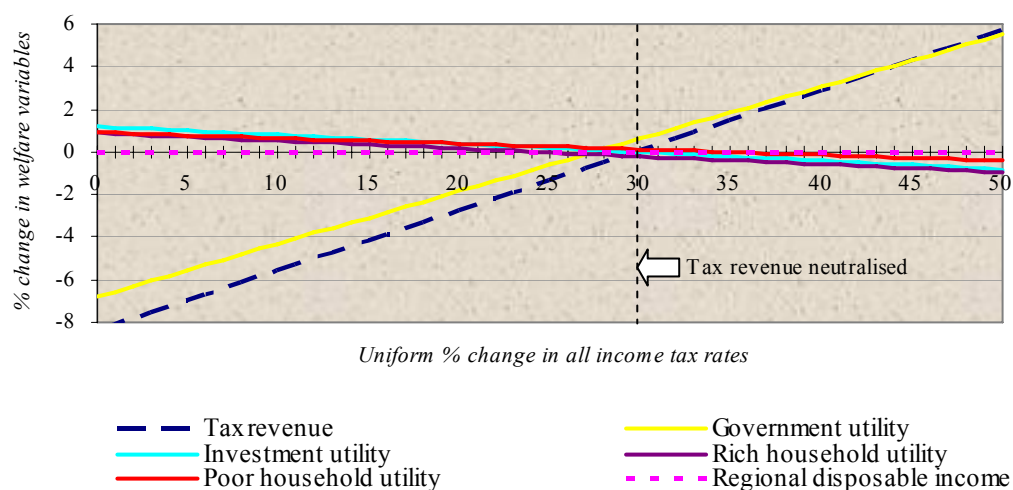


Chart 4-4: Increasing Indian income tax rates on the rich household (the selective income tax reform) under ASEAN+3

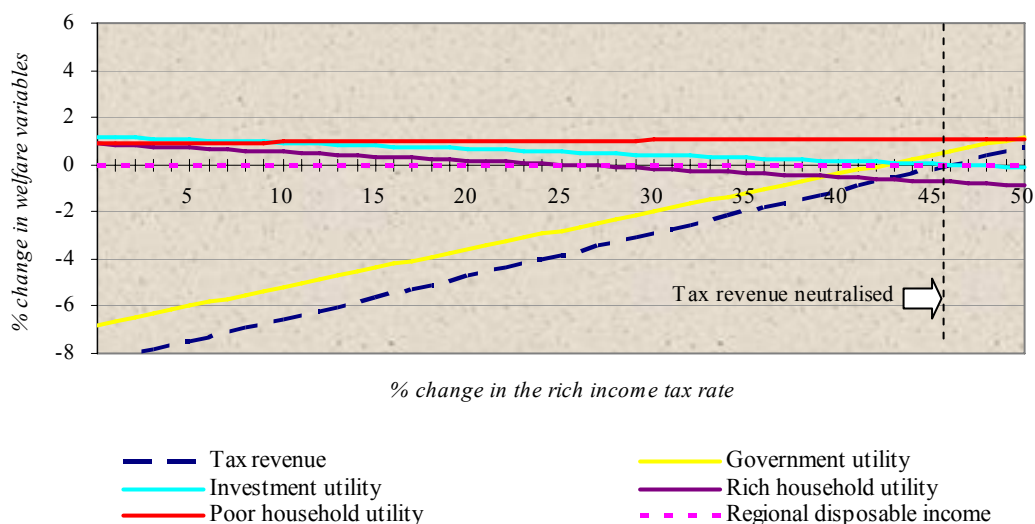


Chart 4-3 and Chart 4-4 indicate that as the household income tax is increased, tax revenue and government welfare are consistently improved in comparison with the results of the ‘standalone’ ASEAN+3 formation, i.e. ASEAN+3 without any kind of counteracting

domestic tax reform. Although such improvements are commonly observed under all types of tax reforms, tax revenue is increased at a faster rate than government welfare, as would be expected since the revenue is more directly affected by tax policy changes.

While bank welfare declines consistently under both types of income tax reform, the welfare of the rich and poor households adjust in a dissimilar manner. To elaborate, although both households are worse off under the uniform income tax reform; under the selective income tax reform, the rich household is further worse off while the poor makes a marginal gain. Therefore, at the aggregate level, albeit marginally, regional disposable income – which encompasses the utility levels of the government, the bank, and the two households – is initially improved but then worsens as the tax is further increased. Specifically, while the ‘standalone’ ASEAN+3 formation decreases India’s disposable income by 0.03%, after the introduction of an income tax reform it increases monotonically, and eventually reaches a rate (of 0.02%) at which the government revenue is rebalanced (Table 4-2).

Table 4-2: Percentage changes in welfare variables given the uniform and selective income tax reforms for government revenue neutralisation under ASEAN+3

| Welfare variables | ASEAN+3 without counteracting tax reform | ASEAN+3 with uniform income tax reform | ASEAN+3 with selective income tax reform |
|--|--|--|--|
| Income tax rates | 0% | *29.77% | **46.02% |
| Tariff revenues | -35.05% | -35.19% | -35.19% |
| Income tax revenues | 0.83% | 30.81% | 30.81% |
| Factor usage tax revenues | 1.13% | 1.21% | 1.21% |
| Consumption tax revenues | 0.76% | -0.19% | -0.19% |
| Production tax revenues | 2.98% | 2.62% | 2.62% |
| Real wage of unskilled labour | 0.56% | 0.67% | 0.67% |
| Real wage of skilled labour | -0.48% | 0.70% | 0.70% |
| Unemployment of unskilled labour | -5.41% | -6.49% | -6.49% |
| Unemployment of skilled labour | 4.98% | -6.70% | -6.70% |
| Regional unemployment | -2.93% | -6.54% | -6.54% |
| Government utility | -6.80% | 0.56% | 0.56% |
| Bank utility | 1.19% | 0.00% | 0.00% |
| Rich household utility | 0.88% | -0.21% | -0.74% |
| Poor household utility | 0.91% | 0.13% | 1.10% |
| Regional disposable income (base year price) | -0.03% | 0.02% | 0.02% |
| Real GDP | 1.12% | 1.01% | 1.01% |

Source: Simulated by author. Note: * refers to the percentage changes in income tax rates applied to both rich and poor households; while ** only shows the rate applied to the rich household, keeping the other at its initial rate of 3%.

Table 4-2 shows percentage changes in key welfare variables, first under the ‘standalone’ ASEAN+3, and then with the income tax reforms. The results suggest that, in order to maintain revenue at the ex-ante level, India can choose either to increase the income tax on the rich household by 46.02% or to tax both households by 29.77% to obtain approximately identical outcomes on most welfare variables except for household utility. This substantiates the fact that the two income tax reforms are almost indistinguishable in aggregate terms, given that this model assumes that the two households are identical in their CES utility functions and consumption patterns at the benchmark year, and thus the selective reform that

targets only the rich does not impose any greater distortion on sectoral commodity prices than the uniform reform.²⁰

In principle, the augmented income tax reduces the portion of income that households allocate to final consumption and investment via the bank. Thus, the welfare levels of the bank and the households are reduced, while total tax revenue and government welfare are increased. This crowding-out effect results in lower aggregate outputs, reflected in real GDP increasing by 1.01%, as opposed to the 1.12% increase without the reform. In contrast, the impact on regional disposable income becomes positive as the index now increases by 0.02% owing to higher factor prices driven by higher demands from the public sector.

The demand for skilled labour is increased to a greater extent than for the unskilled, as indicated by the observed increase in the augmented real wage and the reduced unemployment in the skilled labour market as the tax reform takes effect. This reflects the patterns of factor intensity in India. As illustrated in Table 4-3, two thirds of India's public demands are allocated to the purchase of commodity *OSG* (i.e. public administration, defence, education, and health) which is skilled-labour intensive. Since the second most demanded service (*MSR*) only accounts for approximately 7% of total public demand, the factor intensity of sector *OSG* is the principal determinant of welfare variation in factor markets. As a result, skilled labour benefits the most, while unskilled labour comes in second, a consequence of it being used less intensively in the production of commodity *OSG*. In aggregate terms, the revenue-neutralising income tax reform eventually improves regional disposable income, and at the same time real wages are boosted and total unemployment is reduced. The results indicate that the economic impacts of the revenue-neutralising domestic

²⁰ For that reason, if the two households have different CES preferences and consumption patterns, then selectively imposing an income tax on one of the two households would yield different welfare results from the unbiased reform. In order to incorporate this feature into the analysis, however, the detailed data of household consumption and the substitution elasticity of final consumption by household must be obtained.

tax reform on each factor owner's welfare can significantly vary with the country-specific pattern of public sector demand.

Table 4-3: The ranking of Indian public demands (million US\$), along with the corresponding factor intensities

| Rankings | Public Demands | Land | Unskilled labour | Skilled labour | Capital | Natural resource | Total |
|----------|----------------|------|------------------|----------------|---------|------------------|-------|
| 1 OSG | 40,251 | 0% | 32% | 51% | 17% | 0% | 100% |
| 2 MSR | 4,225 | 0% | 48% | 11% | 40% | 0% | 100% |
| 3 CFI | 4,200 | 0% | 20% | 15% | 65% | 0% | 100% |
| 4 OMF | 2,938 | 0% | 43% | 5% | 52% | 0% | 100% |
| 5 CRP | 2,197 | 0% | 18% | 4% | 78% | 0% | 100% |
| 6 Others | 6,975 | 15% | 35% | 4% | 44% | 1% | 100% |

Source: Compiled from the GTAP 6.0 database.

4.4.2 Simulations of Active Factor Usage Tax Policies

In these simulations taxes on production factors are increased in order to counteract the undesirable FTA effects on government revenue. First of all, India's factor taxes are collectively increased to those rates at which revenue is maintained at the initial level (henceforth, the 'uniform' factor tax reform). Then, taxes on factors owned by the rich (capital, skilled labour, land, and natural resources) and the poor (unskilled labour) are individually increased, hereafter referred to respectively as the selective 'rich-factor' tax reform and the selective 'poor-factor' tax reform,. In contrast to the proportional reforms in Subsection 4.4.1, factor tax reforms are simulated in absolute terms since India's factor tax rates are initially trivial and mostly evenly imposed on sectors and factors. The implications of the two approaches are not substantially dissimilar, but the transparency of the outcome is greatly improved as the label of the horizontal axis in the following charts can be presented in a more concise manner. The welfare results for each scenario are reported in Chart 4-5a, Chart 4-5b, Chart 4-6 and Chart 4-7, then altogether in Table 4-4.

Chart 4-5a: Increasing all Indian factor usage tax rates to a targeted rate (the uniform factor tax reform) under ASEAN+3

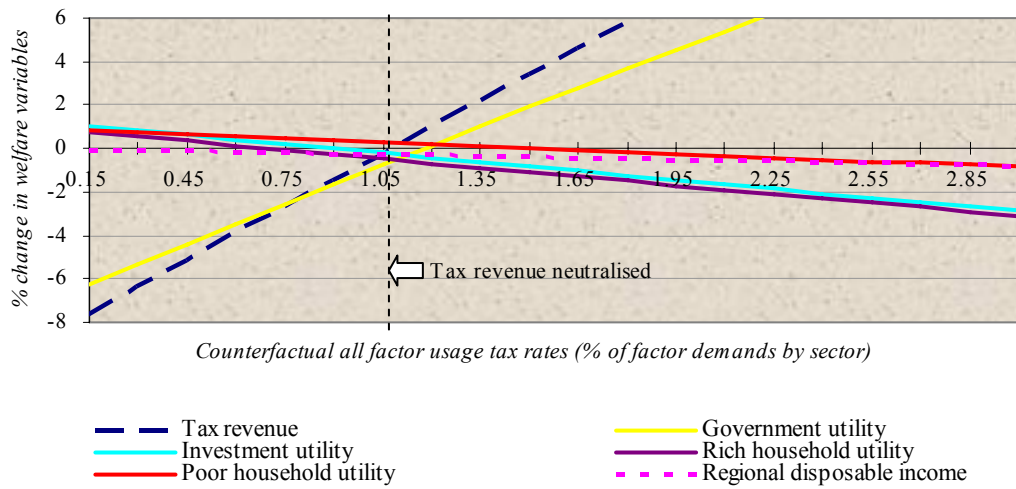


Chart 4-5b: Percentage changes in sector OSG's output and real GDP given the uniform factor tax reform under ASEAN+3

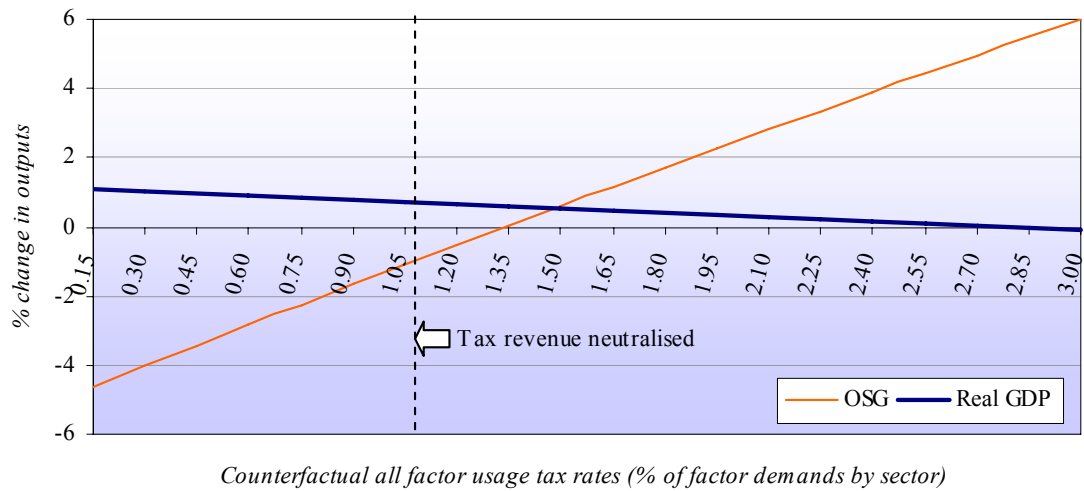


Chart 4-6: Increasing Indian tax rates on the usage of factors owned by the rich household to a targeted rate (the selective rich-factor tax reform) under ASEAN+3

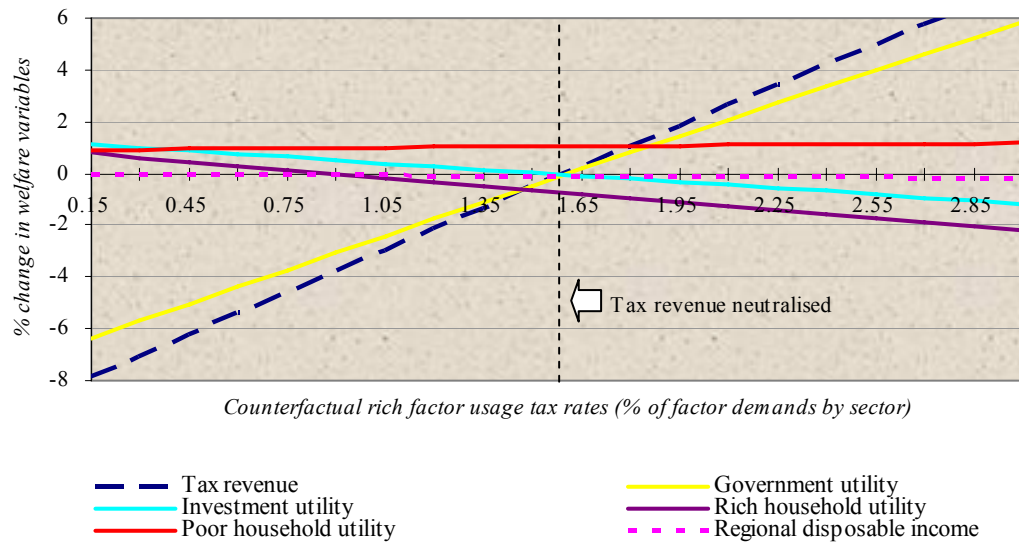
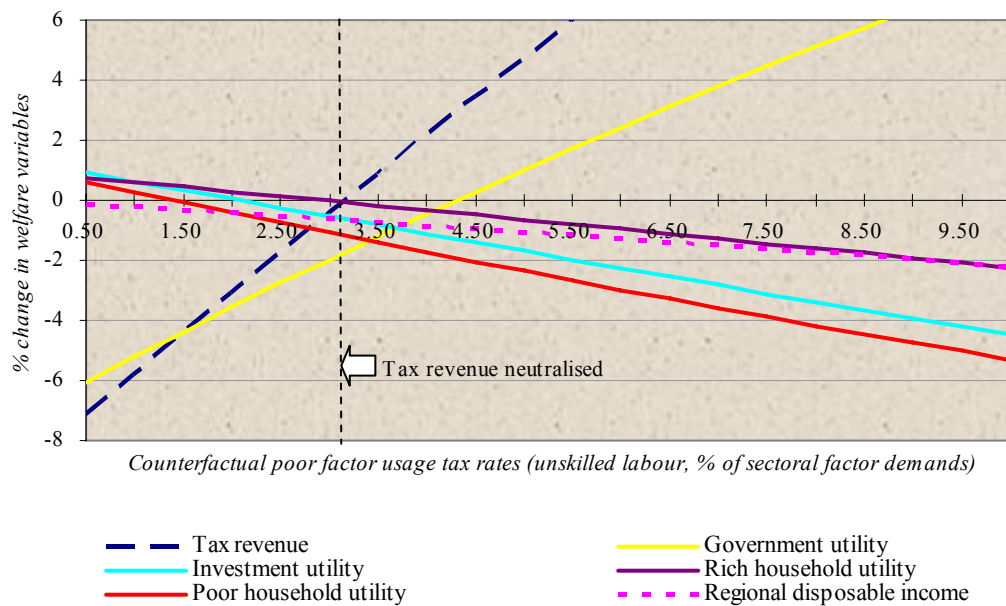


Chart 4-7: Increasing Indian tax rates on the usage of factors owned by the poor household to a targeted rate (the selective poor-factor tax reform) under ASEAN+3



There are a number of welfare results that are distinctively different from those in the income tax reforms. Firstly, although government welfare is increased with factor tax imposition, the rate of improvement is not as strong, the change in government welfare being negative especially at the point where tax revenue is rebalanced. As such, the government does not find

factor tax reforms as worth implementing as income tax reforms in Subsection 4.4.1. In aggregate terms, regional disposable income and real GDP are likewise deteriorated under all factor tax scenarios.

Table 4-4: Percentage changes in welfare variables given the uniform and selective factor usage tax reforms for government revenue neutralisation under ASEAN+3

| Welfare variables | ASEAN+3 without counteracting tax reform | ASEAN+3 with uniform factor tax reform | ASEAN+3 with selective rich-factor tax reform | ASEAN+3 with selective poor-factor tax reform |
|--|--|--|---|---|
| ⁺ Factor usage tax rates | ≈0% | *1.08% | **1.60% | ***3.16% |
| Tariff revenues | -35.05% | -35.34% | -35.24% | -35.54% |
| Income tax revenues | 0.83% | -0.30% | -0.20% | -0.53% |
| Factor usage tax revenues | 1.13% | 1,805.81% | 1,781.72% | 1,858.47% |
| Consumption tax revenues | 0.76% | -0.33% | -0.22% | -0.56% |
| Production tax revenues | 2.98% | 2.37% | 2.55% | 2.00% |
| Real wage of unskilled labour | 0.56% | 0.14% | 0.64% | -0.81% |
| Real wage of skilled labour | -0.48% | -0.01% | -0.11% | 0.18% |
| Real rent of capital | 1.61% | 0.12% | -0.25% | 0.80% |
| Unemployment of unskilled labour | -5.41% | -1.40% | -6.17% | 8.45% |
| Unemployment of skilled labour | 4.98% | 0.11% | 1.15% | -1.76% |
| Regional unemployment | -2.93% | -1.04% | -4.43% | 6.02% |
| Government utility | -6.80% | -0.59% | -0.03% | -1.75% |
| Bank utility | 1.19% | -0.24% | -0.06% | -0.63% |
| Rich household utility | 0.88% | -0.51% | -0.76% | -0.06% |
| Poor household utility | 0.91% | 0.29% | 1.05% | -1.18% |
| Regional disposable income (base year price) | -0.03% | -0.28% | -0.09% | -0.66% |
| Real GDP | 1.12% | 0.70% | 0.90% | 0.26% |

Source: Simulated by author. Note: ⁺ report on the targeted rates of factor taxes, not the percentage changes. * refer to the rates applied to all factors; ** to factors owned by the rich, and *** to those owned by the poor, while keeping the others at their initial rates.

Secondly, in contrast to the unusual results of the income tax reforms due to the identical consumption preferences of the two households, the welfare outcomes in Table 4-4 suggest that the uniform and selective factor tax reforms do not yield identical results in aggregate terms, as factor intensities differ across production sectors. One would expect the selective factor tax reforms to yield uneven effects on individual sectors, in the sense that sectors intensively employing those factors that are subject to extra taxation will be particularly

worse off, and thus the economic outcome should be more distortionary than in the uniform tax reform scenario. However, the fact that the selective rich-factor tax reform turns out to be the most favourable option of the three – which is inconsistent with the theoretical prediction in Section 4.2 – accentuates the complexity of predicting the actual outcomes of a particular set of tax reforms, especially in consideration of the terms-of-trade effect across countries.

In Table 4-4, in order to keep government revenue at the pre-FTA level, the government is assumed to raise factor tax rates to 1.08% under the uniform reform; 1.60% under the selective rich-factor reform; and 3.16% when only the unskilled labour tax is adjusted under the selective poor-factor reform. The difference in these figures represents the ‘gap’ in the scope of tax bases among individual reforms.

Under the uniform factor tax reform, production costs are evenly increased in most sectors, and real GDP is clearly reduced as a consequence. At the same time, government welfare is improved with the rise in tax revenue, although not by as much as under the income tax reforms. This reflects the stronger disincentive to the production sectors, which in turn exacerbates India’s terms of trade, as previously described in Subsection 4.2.4. To illustrate, Chart 4-5b shows that commodity *OSG* – that most demanded by the public sector (Table 4-3) – benefits significantly from the reform in terms of the change in output, while the rest of the economy contracts.²¹ As *OSG* is intensive in skilled labour, the real wage of skilled labour is improved in comparison with the ‘standalone’ ASEAN+3, whereas the real wages of other factors deteriorate. In particular, capital demand is strongly reduced; it accounts for only 17% of sector *OSG*’s factor demand, whilst representing 44% of the value of the aggregate factor endowment in India (GTAP 6.0 database). Hence, even though the welfare levels of both households are more affected than under the ‘standalone’ ASEAN+3, the rich are worse off to a greater extent, due to the substantial decline in the return to capital. The aggregate welfare

²¹ For brevity, it is not explicitly shown in Chart 4-5b that the changes in all other Indian sectoral outputs are negative and real GDP expansion is continually hampered as factor taxes are increased.

losses entailed by the uniform factor tax reform are again present, as all other types of tax revenues deteriorate (namely, consumption, production, household income, and import taxes). Thus, on the whole, the regional disposable income declines as the factor tax reform takes effect, and it is safe to say that the overall impact of the factor tax reform is more negative than under the income tax reforms.

The selective factor tax reforms generally yield similar results to the uniform reform. However, in comparison with the uniform reform, the real wages of factors owned by the rich further fall substantially, while that of the unskilled labour owned by the poor is increased under the rich-factor tax reform. In contrast, the poor-factor tax reform positively affects skilled labour and capital real prices, while exacerbating the price of the unskilled labour, again in comparison with the uniform reform. Nevertheless, the rich-factor tax reform turns out to be the most efficient choice, given India's production and trade patterns and the low substitution elasticity among factors.

4.4.3 Simulation of the Active Consumption Tax Policy

Next, Indian consumption taxes are uniformly raised to that rate that neutralises government revenue after ASEAN+3 (henceforth, the 'uniform' consumption tax reform). As was argued in Subsection 4.4.2, the uniform rate approach is preferable because India's benchmark consumption taxes in the GTAP 6.0 database are comparatively low and are imposed at similar rates across sectors. Thus, proportional and absolute reforms will yield similar welfare implications. Chart 4-8a and Chart 4-8b illustrate the different aspects of welfare changes in India under ASEAN+3 with the active consumption tax policy, and Table 4-5 contrasts the results with those from the 'standalone' ASEAN+3 simulations.

Chart 4-8a: Increasing all Indian consumption tax rates to a targeted rate (the uniform consumption tax reform) under ASEAN+3

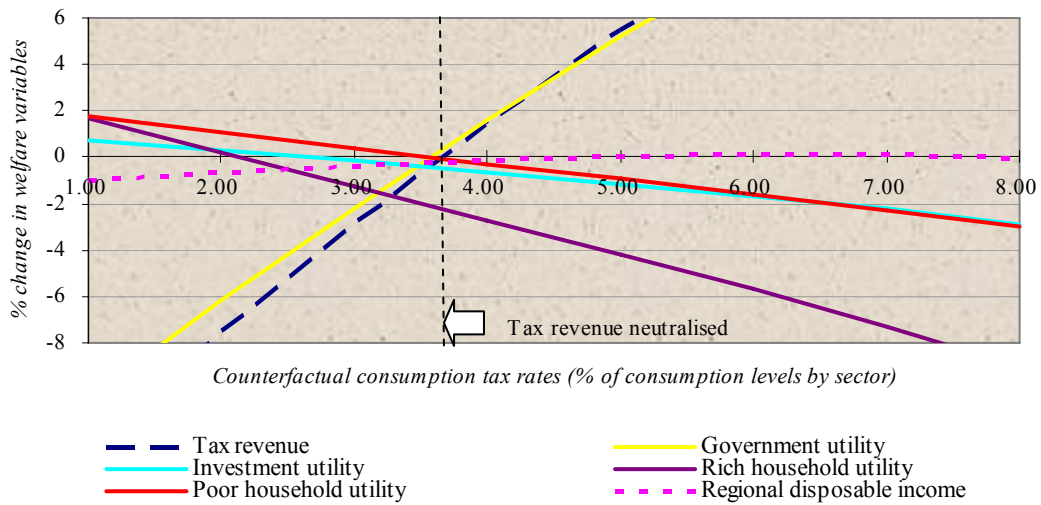
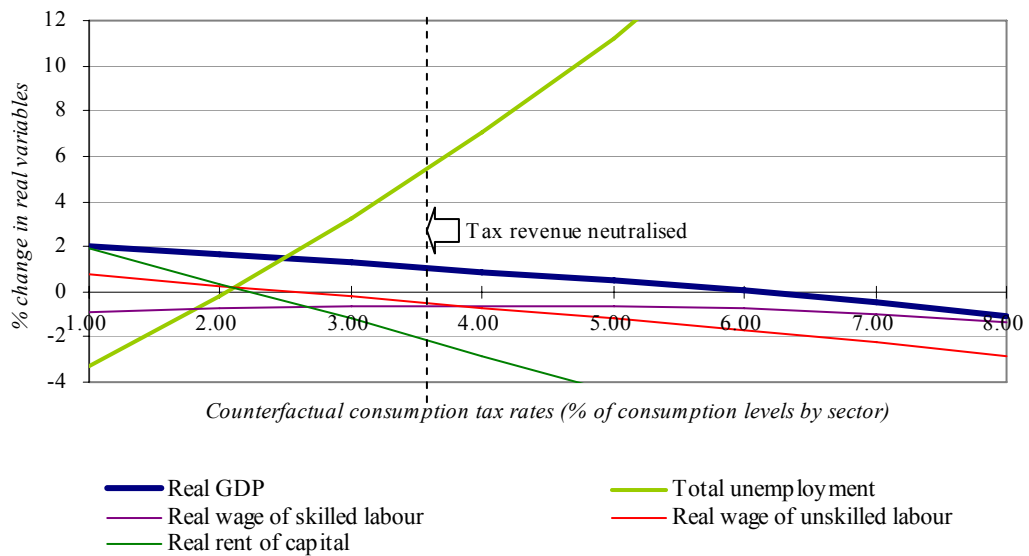


Chart 4-8b: Percentage changes in key real variables given the uniform consumption tax reform under ASEAN+3



In general, the direction of changes in the welfare variables in Chart 4-8a parallel those of the income and factor tax reforms previously simulated, except that the rich household welfare declines strongly as the consumption tax is increased. Since the uniform consumption tax reform lowers final demands in all sectors without prejudice, the demands for primary factors would also be unbiasedly affected, as all production sectors suffer the same problem of fallen

final demands. However, a disparity occurs since the government predominantly spends any additional tax revenue on specific products, such as commodity *OSG* (Table 4-3). Since capital is not used intensively in the production of these public goods, capital's real rental rate in Chart 4-8b clearly declines relative to other factors. As capital accounts for 44% of India's total factor endowment and 67% of the rich household endowment (GTAP 6.0 database), the sharp decline in capital price is the major source of welfare loss for the rich household. In addition, although initially increased as intensively used in the *OSG* production, once consumption tax becomes too heavy, skilled labour price also eventually falls. Thus, the rich household's welfare is unequivocally reduced under the consumption tax reform.

Combined together, the falls in private and investment welfare levels effectively cancel out the rise in public welfare, and consequently reduce the improvement in regional disposable income as the consumption tax is raised (Chart 4-8a). As a result, total unemployment is an increasing function of the tax rate, while real GDP is a decreasing function (Chart 4-8b). This result is consistent with the previous findings by Anderson (1999) and Erbil (2001) that a revenue-neutral tax reform that simultaneously manipulates trade and consumption taxes is not necessarily welfare-enhancing. This point is further elaborated in Table 4-5.

In Table 4-5, the revenue-neutralising outcomes are compared to the case of ASEAN+3 without the counteracting domestic tax hike. Clearly, most variables are worsened except for the welfare of the government. In particular, there is a strong negative impact on the welfare of the private sector in contrast to the effects of the uniform imposition of income and factor taxes. As a whole, the welfare of India falls almost as much as under the uniform factor tax hike. However, the positive change in real GDP is as high as under the income tax reform since the supply side is less affected by the policy shock.

Table 4-5: Percentage changes in welfare variables given the uniform consumption tax reform for government revenue neutralisation under ASEAN+3

| Welfare variables | ASEAN+3 without counteracting tax reform | ASEAN+3 with uniform consumption tax reform |
|--|--|---|
| [†] Consumption tax rates | ≈0% | 3.67% |
| Tariff revenues | -35.05% | -34.83% |
| Income tax revenues | 0.83% | -2.21% |
| Factor usage tax revenues | 1.13% | -2.31% |
| Consumption tax revenues | 0.76% | 81.07% |
| Production tax revenues | 2.98% | 1.64% |
| Real wage of unskilled labour | 0.56% | -0.53% |
| Real wage of skilled labour | -0.48% | -0.64% |
| Real rent of capital | 1.61% | -2.28% |
| Unemployment of unskilled labour | -5.41% | 5.49% |
| Unemployment of skilled labour | 4.98% | 6.63% |
| Regional unemployment | -2.93% | 5.76% |
| Government utility | -6.80% | 0.36% |
| Bank utility | 1.19% | -0.48% |
| Rich household utility | 0.88% | -2.21% |
| Poor household utility | 0.91% | -0.05% |
| Regional disposable income (base year price) | -0.03% | -0.23% |
| Real GDP | 1.12% | 1.03% |

Source: Simulated by author. Note: [†] report on the targeted rates of consumption taxes, not the percentage changes.

4.4.4 Simulations of Active Production Tax Policies

Finally, the welfare implications of production tax policies that neutralise government revenue in the face of ASEAN+3 are reported below. In contrast to the ex-ante consumption and factor tax rates, which are uniformly low for all sectors, Table 4-6 shows that India's production tax rates differ across sectors, and are mainly imposed on heavy manufacturing industries.

Table 4-6: Indian production tax rates by sector, as percentage of output values in the benchmark year (2001)

| Production sectors | Initial production tax rates (% of output values) |
|---------------------------|--|
| <i>AGR</i> | 0.00% |
| <i>NRS</i> | 0.93% |
| <i>OIL</i> | 1.21% |
| <i>PAGR</i> | 0.00% |
| <i>OFD</i> | 1.42% |
| <i>MNF</i> | 2.09% |
| <i>TEX</i> | 2.04% |
| <i>WAP</i> | 2.67% |
| <i>CRP</i> | 2.50% |
| <i>I_S</i> | 2.86% |
| <i>NFM</i> | 4.68% |
| <i>MVH</i> | 4.01% |
| <i>ELE</i> | 4.14% |
| <i>OME</i> | 4.28% |
| <i>OMF</i> | 3.99% |
| <i>MSR</i> | 2.61% |
| <i>TRD</i> | 1.51% |
| <i>TRP</i> | 4.22% |
| <i>CFI</i> | 0.85% |
| <i>OBS</i> | 2.11% |
| <i>OSG</i> | 0.41% |
| <i>DWE</i> | 0.00% |
| Simple average | 2.21% |

Source: Compiled from the GTAP 6.0 database.

Therefore, the welfare implication of the uniform ‘proportional’ production tax reform, where all tax rates are increased by the same proportion, should differ from the uniform ‘level’ production tax reform, where all are adjusted towards a targeted rate. Additionally, the selective ‘gradual’ production tax reform, where the government continuously raises the lowest production tax rates to the second lowest levels until the tax revenue is neutralised, is also simulated as an alternative reform that gradually converges taxes towards uniformity. This third reform is specifically drawn from Michael et al. (1993), in that raising the ‘lowest’

consumption tax rate to compensate for the government revenue loss after lowering the highest tariff rate will improve welfare under certain sufficient conditions. Instead of the consumption taxes, this study examines the implications of production tax reforms, as production tax rates are more diversified across sectors (Table 4-6). Accordingly, the welfare changes under the three production tax reforms are separately plotted in Chart 4-9, Chart 4-10 and Chart 4-11, and then summarised in Table 4-7 as regards macroeconomic variables, and in Table 4-8 with respect to output and mark-up by sector.

Chart 4-9: Increasing Indian production tax rates on all production sectors by the same proportion (the uniform ‘proportional’ production tax reform) under ASEAN+3

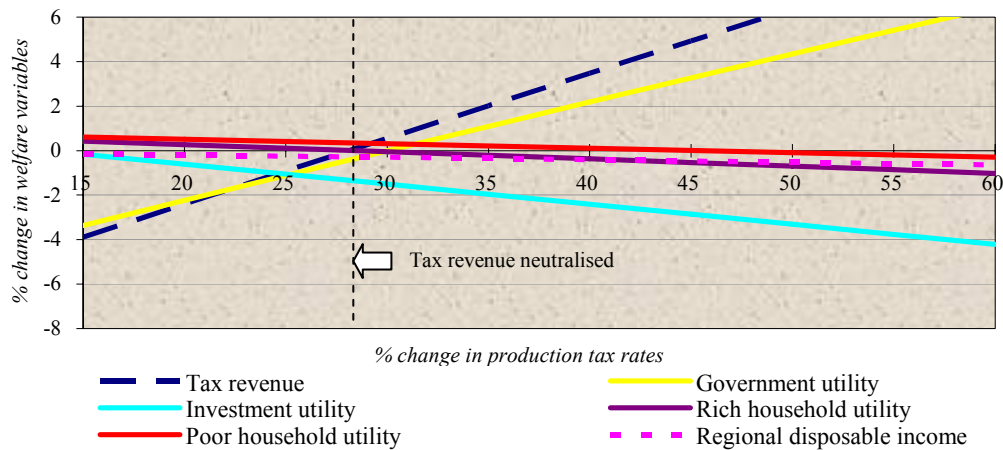


Chart 4-10: Increasing Indian production tax rates on all production sectors to a targeted rate (the uniform ‘level’ production tax reform) under ASEAN+3

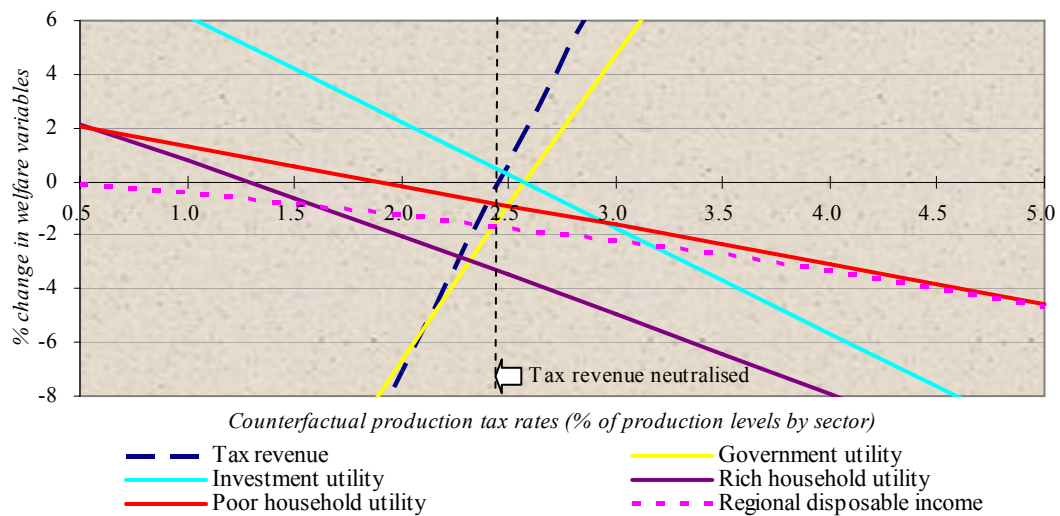
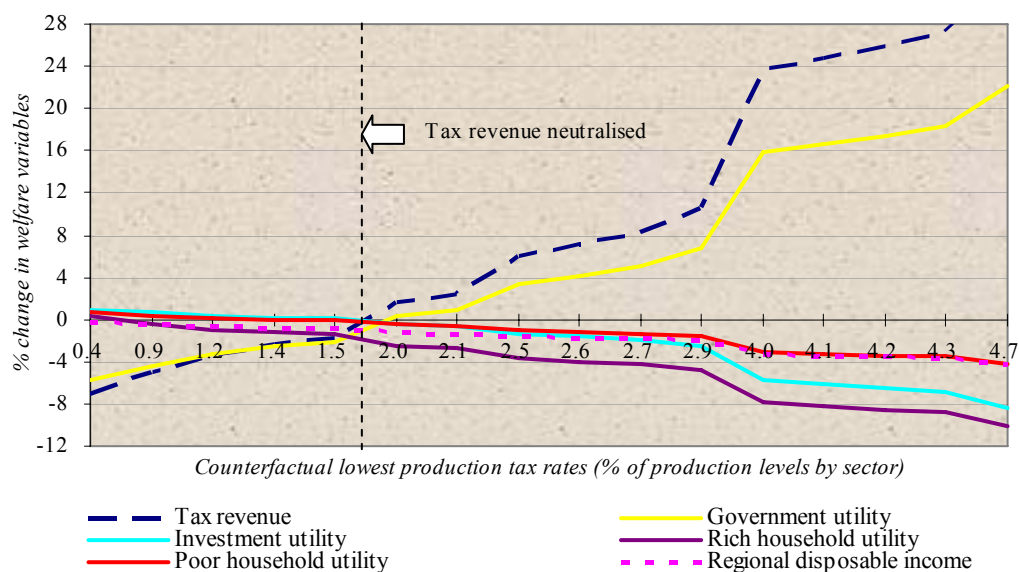


Chart 4-11: To continuously increase the lowest Indian production tax rates to the second lowest levels (the selective ‘gradual’ production tax reform) under ASEAN+3



The general direction of changes in welfare variables is similar across all reform scenarios, in that tax revenue and government welfare are augmented as the production taxes are increased, while regional income and the welfare of the regional bank and the two households decline. Output falls instantaneously as the production tax is increased, leading to reductions in real GDP, as well as in factor price, and eventually household income. At the same time, since the increased tax revenue is spent on public consumption, factors intensively used in producing public goods are better off. Hence, as with the cases in Subsections 4.4.1-4.4.3, to some extent, the increased public demand lessens the negative effects from the additional production tax. However, taken as a whole, the welfare effects are rather negative, since regional income continually falls, of which tendency is akin to factor tax reforms that directly affect the supply side of the economy.

However, Chart 4-9 to Chart 4-11 also indicate that the impact on each economic agent differs across reform types. As mentioned, the ‘proportional’ reform raises production taxes on all sectors by the same proportion, hence imposing a greater amount of taxes on sectors that are already heavily taxed. From Table 4-6, it is apparent that the heavy manufacturing sectors are worse off under this reform relative to other sectors. Given the investment and

private demand structures in India (see Appendix A4-3), we know that the investment and production tax patterns considerably overlap. As a result, the proportional reform has a more negative impact on investment more than on household consumption. This essentially explains why the percentage fall in bank welfare is always larger (Chart 4-9).

Subsequently, the uniform 'level' reform integrates the existing production taxes into a common rate, hence raising taxes on sectors relatively untaxed, and reducing them on the heavily taxed. In this sense, the level reform is the opposite of the proportional reform. As Chart 4-10 shows, the bank gains the most under this reform, especially at the point where government revenue is neutralised, because production taxes are raised on sectors with low investment and reduced on those with high investment. At the same time, the changes in welfare of the two households are inferior to that of the bank for the most part, since the uniform level reform essentially imposes higher taxes on sectors with comparatively high outputs (Table 4-7 and A4-1), which directly lowers factor prices, and eventually household incomes. As a result, the percentage change in regional disposable income is always below that under the proportional reform in Chart 4-9. On the other hand, the results under the selective 'gradual' reform (Chart 4-11) are in between those of the previous two, since the reform consecutively increases the lowest tax rate up to the second lowest level, thus resembling the level reform except that sectors with heavy production taxes do not benefit from tax reduction. Thus, this is consistent with the results from the theoretical analysis in Section 4.2, i.e. that applying the same ad valorem tax rate on all production sectors should cause the least distortion to the economy.

Table 4-7 compares welfare changes across the selected types of reform. In order to neutralise total tax revenue, the government may choose to raise production taxes equiproportionally on every sector by 28.15%; or to simultaneously converge tax rates to 2.46% of output values, which is above the initial average rate of 2.21% (Table 4-6); or to exclusively shift the rates which are initially below 1.76% up to the 1.76% level.

Table 4-7: Percentage changes in welfare variables given the uniform and selective production tax reforms for government revenue neutralisation under ASEAN+3

| Welfare variables | ASEAN+3 without tax reform | ASEAN+3 with uniform proportional production tax reform | ASEAN+3 with uniform level production tax reform | ASEAN+3 with selective gradual production tax reform |
|--|----------------------------|---|--|--|
| [†] Production tax rates | <i>n/a</i> | *28.15% | **2.46% | ***1.76% |
| Tariff revenues | -35.05% | -34.88% | -37.47% | -36.19% |
| Income tax revenues | 0.83% | 0.08% | -2.99% | -1.63% |
| Factor usage tax revenues | 1.13% | 0.36% | -3.14% | -1.56% |
| Consumption tax revenues | 0.76% | -0.48% | -2.07% | -1.06% |
| Production tax revenues | 2.98% | 30.87% | 36.59% | 33.86% |
| Real wage of unskilled labour | 0.56% | 0.20% | -0.88% | -0.34% |
| Real wage of skilled labour | -0.48% | 0.20% | -1.20% | -0.52% |
| Real rent of capital | 1.61% | 0.31% | -2.87% | -1.42% |
| Unemployment of unskilled labour | -5.41% | -1.96% | 9.27% | 3.43% |
| Unemployment of skilled labour | 4.98% | -1.98% | 12.84% | 5.40% |
| Regional unemployment | -2.93% | -1.96% | 10.12% | 3.90% |
| Government utility | -6.80% | -0.42% | -1.41% | -0.87% |
| Bank utility | 1.19% | -1.34% | 0.42% | -0.21% |
| Rich household utility | 0.88% | 0.01% | -3.34% | -2.00% |
| Poor household utility | 0.91% | 0.35% | -0.83% | -0.27% |
| Regional disposable income (base year price) | -0.03% | -0.28% | -1.67% | -1.05% |

Source: Simulated by author. Note: [†] report on both the proportional changes and targeted rates. * refers to the percentage change in production tax rates applied to all Indian sectors; ** shows their uniform targeted rate; while *** reports on the targeted rate that is second lowest among sectors, to which the lowest tax rate is to be raised.

As a production tax directly increases production costs, the three reforms yield worse welfare outcomes than under the ‘standalone’ ASEAN+3. However, among the three approaches, the proportional reform is the least welfare-decreasing. Although the bank is particularly worse off under the proportional reform, the rest of the economy gains the most under this reform, largely since it reduces unemployment by 1.96%, whereas level and gradual reforms increase unemployment by 10.12% and 3.90%, respectively. Hence, regional disposable income is least reduced under the proportional reform. This result thus supports the ‘prediction’ that applying the same proportional change on all production tax rates is generally more efficient than raising the rates in some sectors while lowering them in the others, or specifically raising production taxes against sectors those are lightly taxed in the benchmark year.

Table 4-8: Percentage changes in sectoral variables after the production tax reforms for government revenue neutralisation under ASEAN+3

| Sectors | No counteracting tax reform | | Proportional uniform production tax reform | | Level uniform production tax reform | | Gradual selective production tax reform | |
|-------------|-----------------------------|--------------------------------------|--|--------------------------------------|-------------------------------------|--------------------------------------|---|--------------------------------------|
| | Sectoral outputs | Mark-up rates (only Cournot sectors) | Sectoral outputs | Mark-up rates (only Cournot sectors) | Sectoral outputs | Mark-up rates (only Cournot sectors) | Sectoral outputs | Mark-up rates (only Cournot sectors) |
| <i>AGR</i> | -0.02% | <i>n/a*</i> | -0.06% | <i>n/a*</i> | -1.06% | <i>n/a*</i> | -0.71% | <i>n/a*</i> |
| <i>NRS</i> | 0.85% | -9.75% | 1.15% | -14.56% | -0.19% | -6.73% | 0.46% | -9.85% |
| <i>OIL</i> | 0.20% | -0.37% | 0.23% | -0.01% | -0.45% | -0.44% | 0.15% | -0.35% |
| <i>PAGR</i> | -5.31% | -11.50% | -5.34% | -11.98% | -10.44% | -10.79% | -8.89% | -11.15% |
| <i>OFD</i> | 9.30% | -5.92% | 9.24% | -6.74% | 5.79% | -4.89% | 8.08% | -5.78% |
| <i>MNF</i> | 2.29% | -3.86% | 0.31% | -4.21% | 2.01% | -3.06% | 2.13% | -4.09% |
| <i>TEX</i> | 6.81% | -6.00% | 5.36% | -6.80% | 3.19% | -3.83% | 6.44% | -6.05% |
| <i>WAP</i> | 13.93% | -1.47% | 12.19% | -1.63% | 8.83% | -1.06% | 13.00% | -1.44% |
| <i>CRP</i> | 3.11% | -6.44% | 1.73% | -6.39% | 3.58% | -6.01% | 3.86% | -6.69% |
| <i>I_S</i> | 3.79% | -2.54% | 0.05 % | -2.68% | 7.13% | -2.33% | 3.73% | -2.70% |
| <i>NFM</i> | 6.04% | -4.28% | -1.49% | -4.58% | 19.03% | -4.76% | 6.41% | -4.33% |
| <i>MVH</i> | 1.69% | -4.19% | -2.36% | -3.77% | 4.81% | -5.47% | 0.88% | -4.42% |
| <i>ELE</i> | 6.85% | -8.60% | -0.81% | -7.61% | 18.53% | -12.03% | 7.03% | -9.21% |
| <i>OME</i> | 4.09% | -7.76% | -1.35% | -6.70% | 12.33% | -11.45% | 3.92% | -8.32% |
| <i>OMF</i> | 9.45% | -3.89% | 5.01% | -3.09% | 19.54% | -5.12% | 10.65% | -3.62% |
| <i>MSR</i> | 0.34% | -0.02% | -1.27% | -0.25% | -0.47% | 0.86% | -0.46% | 0.48% |
| <i>TRD</i> | 0.98% | -0.48% | -0.05% | -0.67% | 0.17% | -0.75% | 0.74% | -0.72% |
| <i>TRP</i> | 1.75% | -1.06% | -0.69% | -1.18% | 3.39% | -0.14% | 1.46% | -0.71% |
| <i>CFI</i> | 0.75% | -0.32% | -0.09% | -0.36% | 1.11% | -1.51% | 0.74% | -0.98% |
| <i>OBS</i> | 8.69% | -5.81% | 6.90% | -6.06% | 5.50% | -3.47% | 8.49% | -5.64% |
| <i>OSG</i> | -5.00% | 2.73% | 0.03% | -0.30% | -3.47% | 0.77% | -2.05% | 0.32% |
| <i>DWE</i> | -7.53% | 6.57% | -3.12% | 2.27% | -35.25% | 29.02% | -24.61% | 17.84% |

Source: Simulated by author. Note: * sector *AGR* is operated under perfect competition, thus no variation in the mark-up rate reported.

Finally, Table 4-8 reports the sectoral impacts of individual production tax reforms. Since sector *AGR* is perfectly competitive, while the rest are modelled as Cournot oligopolies, sectors with higher outputs and lower mark-up rates gain in efficiency through becoming more competitive; while those with lower output and higher mark-up rate become more oligopolistic. The most highly protected sector – *PAGR* – is the only one that is obviously

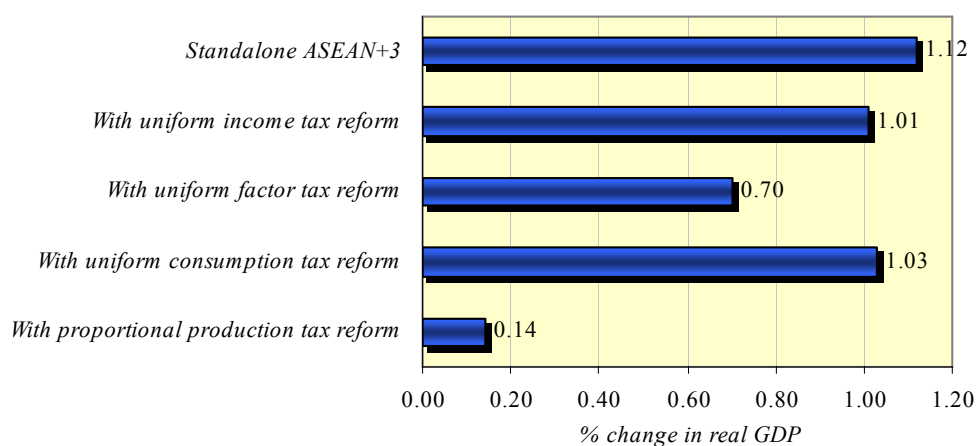
inefficient in the world market since its output and mark-up rate decline markedly after the reforms.

Under the ‘standalone’ ASEAN+3, most (few) sectors become more (less) competitive. Then, as production tax reforms are introduced, the scale of tax variation generally determines the magnitude of the impacts on sectoral output. Since we observe from Table 4-7 that the government only needs to increase production tax revenue by 30.87% to maintain its total revenue at the pre-FTA level, the proportional reform leads to the least output deviation in comparison to the other two reforms. Specifically, the output change ranges widely, between -5.34% (*PAGR*) and 12.19% (*WAP*), under the proportional reform. However, under the level reform, heavy manufacturing sectors (especially, sectors *NFM* and *OMF*) expand by more than 19% as the high tax rates are uniformly diminished to the level of 2.46%, while the dwelling sector (*DWE*) contracts significantly by -35.25%. Also, for the gradual reform, as a subset of sectors is faced with higher taxes, sector *DWE* perceives the drop in output by 24.61%, while sector *WAP* grows by 13%. Hence, by and large, Table 4-8 confirms that the proportional reform causes the smallest adjustments at the sectoral level.

4.4.5 Comparative Studies

Thus far, Subsections 4.4.1-4.4.4 have identified the welfare implications of individual revenue-neutralising reforms. This subsection compares the macroeconomic results across reform scenarios. In terms of real GDP, Chart 4-12 shows that the economic expansion of India under ASEAN+3 deteriorates as domestic taxes are introduced in order to rebalance the government revenue, and we find that all types of taxation have negative impacts on economic activities. Among the four types of domestic taxes, the imposition of consumption or income taxes – which directly affect the demand side of the economy – is less distortionary than the introduction of factor or production taxes that directly affect domestic production. This observation is consistent with the theoretical prediction in Subsection 4.2.4, in that taxing demand yields more desirable terms-of-trade effects for the Indian economy.

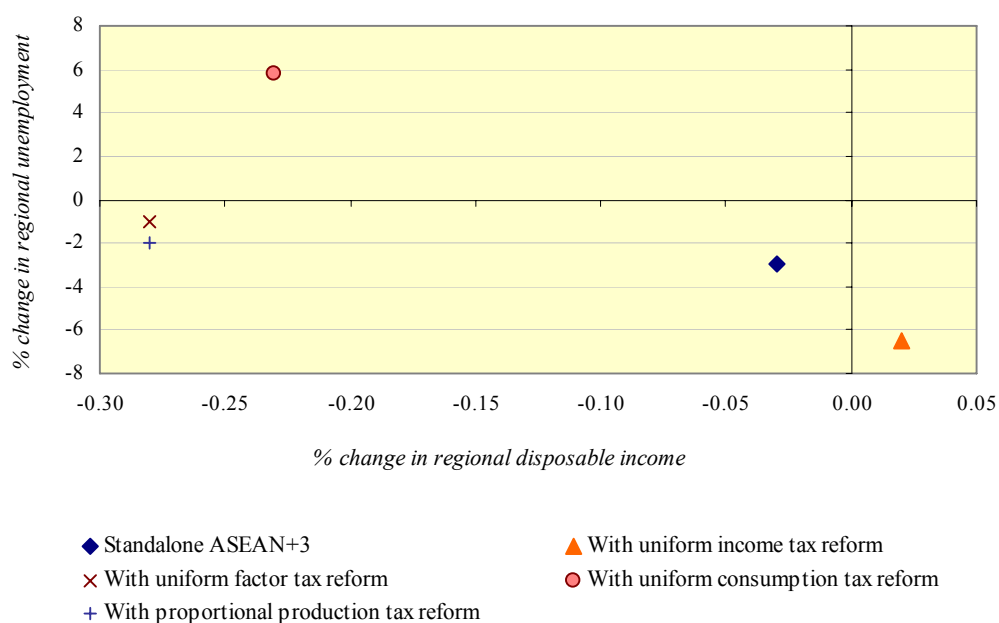
Chart 4-12: Real GDP expansion after the ASEAN+3 FTA with revenue-rebalancing tax reforms



Of the two types of taxes levied on the supply side, production taxes hamper India's economic expansion to a greater extent. It was noted in Subsection 4.2.3 that, in theory, production taxes should be less distortionary than factor taxes, since they increase the marginal cost of production as a whole, whereas factor taxes specifically increase the unit cost of primary factors, but not intermediate inputs. However, if the production tax structure in the benchmark year has already been sectorally biased in comparison with the factor tax structure, as with the case of India in the GTAP 6.0 database, factor taxes may turn out to be a more favourable policy option.

Chart 4-13 plots the percentage change in regional disposable income against unemployment, where the former variable comprises the aggregated welfare of the households, the government and the bank. Previously in this section, we observed that increasing consumption and income taxes initially enhances regional disposable income, but then worsens it as taxation becomes higher, and the crowding-out effect becomes dominant as the public sector expands. In contrast, factor and production taxes solely aggravate regional disposable income at all rates. As a result, at the point where government revenue is precisely rebalanced in Chart 4-13, the income tax turns out to be the only policy option that can improve regional income, whereas the consumption tax does not yield a significantly better impact on regional income than factor and production taxes.

Chart 4-13: Percentage changes in regional disposable income and unemployment level after the ASEAN+3 FTA with revenue-rebalancing tax reforms



As for the unemployment level, once again, it is apparent that only the income tax option can reduce labour unemployment to a greater extent than the ‘standalone’ ASEAN+3. Hence, we may conclude that the income tax appears to be an appropriate choice if India is to keep government revenue balanced in the face of the ASEAN+3 formation.

4.5 The Informal Economy and Revenue-Rebalancing Tax Policies

Given the results in Section 4.4, Section 4.5 now assumes that the informal economy exists when India implements revenue-neutralising tax reforms, once again under ASEAN+3. Despite an increasing number of studies aimed at understanding the nature and scale of the informal economy, and constructing theoretical frameworks to explain the economic linkages between formal and informal economies; the whole issue remains opaque due to problems regarding the definition and measurement of the informal sector. However, such unrecorded economic activity ought not to be overlooked in the context of the revenue-neutralising tax policy analysis, since their inclusion could alter the expected welfare outcomes, as we would

suspect that the enforcement of a domestic tax policy encourages some economic agents to shift into informal production.

The informal economy is defined in Subsection 4.5.1. Then the conventional methods usually adopted to measure the informal economy's size are overviewed, and their intrinsic problems identified. Thirdly, various ways to incorporate the informal sector into CGE models are assessed, along with a CGE model design proposed to address the revenue-neutralising problem. Finally, a number of policy simulations on the Indian economy are conducted.

4.5.1 Defining the Informal Economy

The definition of the 'informal economy' is far from standardised. Researchers use this ambiguous term in diverse contexts, depending upon their policy interests. Bearing in mind that the informal and formal parts of the economy are so inter-connected that they should not be regarded as two discrete activities, the International Labour Organisation (ILO, 1993) proposed the most widely-used, yet somewhat broad definition of the informal economy, that it consists of "units engaged in the production of goods and services with the primary objective of generating employment and income to the persons concerned." Accordingly, the System of National Accounts (SNA) conforms to this guideline by defining informal sectors in terms of the characteristics of the production units (the 'enterprise' approach), rather than the persons involved (the 'labour' approach).²² According to this definition, the informal economy may be regarded as those production units owned by households, which is particularly useful when analysing poverty issues. However, it was also acknowledged by ILO (1993) that the above definition does not capture all the dimensions of an informal economy.

²² Refer to Chapter IV, Inter-Secretariat Working Group on National Accounts (1993).

Broader definitions were proposed by Schneider (1986), Hartzenburg and Leimann (1992), and Smith (1994), where the informal economy is equated with the ‘unrecorded’ sector. However, since this definition is also somewhat imprecise in that it does not rule out illegal activities, we may find it less useful in terms of policy formulation.²³

For that reason, researchers sub-categorise the informal economy in order to cope with a variety of policy questions. In the broadest sense, Dixon (1999) defines the informal economy as comprising three socio-economic types of activities:

- Non-market economic activities (subsistence home production or voluntary community work);
- Semi-legal market activities (those kept hidden in order to evade taxes, commit benefit frauds, or avoid labour legislations);
- Illegal market activities (production and distribution of prohibited substances).

Dixon’s framework is broadly analogous to that of Bagachwa and Naho (1995), in which the above three sub-divisions are respectively labelled as ‘informal,’ ‘parallel,’ and ‘black’ markets, though the distinction drawn between the first two groups is somewhat blurred as it is based on the scale of production, rather than the type of transaction (market/non-market).

Next, a number of definitions are introduced to illustrate the extent to which the interpretation of the informal economy is diversified. Vosloo (1994) sub-categorised the informal economy both with respect to its legality (or acceptability from the social perspective) and by its position in the value chain (producer/distributor/service provider), which was useful in his analysis of the economy of South Africa. Schneider and Enste (2000) classified the informal economy by both the legality of activity and the nature of transactions (monetary/barter). In an alternative approach, Thomas (1992) proposed a continuum, with economic activities

²³ Informal activities which are illegal by nature are considered irrelevant to the tax reform analysis at issue, because the shift of production and consumption between formal and informal sectors is permanently barred as these activities cannot be ‘legalised’ and thus formally taxed. Hence, the inclusion of these activities would yield insignificant implications on the Indian economy.

falling outside the formal economy being classified as the household, informal, irregular, and criminal sectors, based on the type of transaction (market/non-market), the legality of the output itself, and the production/distribution channel.

This approach is in line with ILO (2002), where the informal economy is defined by its capability to meet certain basic employment conditions, thus implicitly indicating the co-existence of informal and formal economies along a continuum of ‘decency at work.’²⁴ This view is extrapolated in ILO (2002) to construct an expanded conceptual framework for the informal economy, taking into account the ‘employment status’ of workers (the ‘labour’ approach), to complement the ‘type of economic unit’ classification (the ‘enterprise’ approach) frequently adopted in previous studies. In this context, production and employment tend to fall on a ‘scale’ of formality (see Table 4-9).

Table 4-9: A conceptual framework: the informal economy

| | | Jobs classified by employment status | | | | | | | | |
|------------------|-----------------------------|--------------------------------------|--------|-----------|--------|----------------|-----------|--------|-------------------------------------|--------|
| | | Own-account workers | | Employers | | Family workers | Employees | | Members of producers’ co-operatives | |
| | | Informal | Formal | Informal | Formal | Informal | Informal | Formal | Informal | Formal |
| Production units | Formal sector enterprises | | X | | X | 4 | 6 | X | | X |
| | Informal sector enterprises | 1 | | 2 | | 5 | 7 | X | 9 | |
| | Households | 3 | | | | | 8 | X | | |

Source: Derived and adapted from ILO (2002). Note: Dark grey unit cells represent jobs that do not exist in the type of production unit in question; unit cells with x-marks symbolise jobs that exist by definition, though irrelevant to the main focus of the study; and white unit cells denote jobs in different segments of the informal economy.

²⁴ The seven essential securities often denied to workers in informal activities are: 1) *labour market security*: adequate employment opportunities through high levels of employment ensured by macroeconomic policies; 2) *employment security*: protection against arbitrary dismissal, regulation of hiring and firing, employment stability; 3) *job security*: the opportunity to develop a sense of occupation; 4) *work security*: protection against accidents and illness at work; 5) *skills reproduction security*: widespread opportunities to gain and retain skills, through innovation and training; 6) *income security*: provision of adequate incomes; and 7) *representation security*: protection of collective voice in the labour market.

Cells 1 and 2 refer to own-account workers (cell 1) and employers (cell 2) who have their own informal enterprises. The informal nature of their jobs follows directly from the characteristics of the enterprise they own. Cell 3 represents producers of goods for own final use by their household (for instance, subsistence farming). Cells 4 and 5 consist of contributing family workers with no contract of employment and no legal or social protection arising from the job, in formal enterprises (cell 4) or informal enterprises (cell 5). Cells 6, 7 and 8 then denote employees who have informal jobs, whether employed by formal enterprises (cell 6) or informal enterprises (cell 7) or as paid domestic workers by households (cell 8). Lastly, cell 9 shows members of informal producers' cooperatives.

The definition of the informal sector used in this chapter is a combination of the various approaches already explained above. For the purpose of the revenue-neutralising domestic tax policy analysis, the informal part of the economy – that is to be featured in the CGE framework – should exclude non-market and non-monetary transactions as well as the production and distribution of illegal outputs. It should comprise economic activities that are essentially legal in nature but kept hidden for the purpose of tax evasion and so forth. Hence, our definition encompasses the semi-legal activities in cells 1, 2, and 4 to 8 of Table 4-9.

4.5.2 Measuring the Size of the Informal Economy

The quantification of the informal economy has been conducted with varying degrees of non-compliance. Hence we always observe discrepancies in the collected data. This section overviews the three mainstream measurement methods: the direct, indirect, and model approaches, and then identifies their known issues.

4.5.2.1 The Direct Approach

The direct approach estimates the size of the informal economy through surveys, using both voluntary replies and tax audits. The monetary extent of undeclared work is clarified under this approach. The advantage of this method lies in its microeconomic nature, allowing us to

obtain a good insight into the detailed structure and geography of the informal economy. On the other hand, its downside lies in the operating costs and the deficient coverage of the direct survey on the national scale, as well as in the reliance on the willingness to reveal true information to interviewers, in the face of the potentially severe data bias since survey studies frequently have a high rate of non-response. Despite its advantages in many circumstances (in particular, the provision of information in great detail), the direct approach does not fit very well with the main purpose of this CGE study; and this, together with the inherent disadvantages that undermine the credibility of survey results; the direct approach is unlikely to be a suitable choice.

4.5.2.2 The Indirect Approach

The indirect approach is generally based on the assumption that, although individuals are inclined to conceal informal income, the data can be implicitly captured on the macroeconomic scale. As described in Annex A of the Office for National Statistics (ONS, 2005), the advantage of the indirect approach over the direct lies in its cost-efficiency, as the implementation of direct surveys is not required. Although widely used, the indirect approach has limited usefulness, as it relies heavily on rudimentary assumptions, and yields little information about informal activity in each sector as required for the multi-sector analysis.

This subsection considers the three main indirect methods as follows. Firstly, the indirect non-monetary measurement of the informal economy uses real indicators, such as the estimates of the aggregate size of small enterprises and of the labour force engaged in self-employment and second-job holding, to estimate the ‘discrepancy’ between the official and actual data observed in each category. However, this method fails to provide solid evidence that there is actual informal work in these parts of the economy. In particular, the labour force estimation is not very satisfactory, since it does not account for ‘unorganised’ types of informal job and overlooks the important fact that a person can take part in both formal and informal activities

over the same time period. The fallibility of these methods is non-trivial as they often yield contradictory results (Appendix A, ONS, 2005).

Under the indirect monetary approach, the volume of high-denomination banknote circulation; the product of money velocity and cash-deposit disparity; and the sum of monetary transactions inclusive of cheque payments, are also adopted as proxies for the size of the informal sector. However, as with the non-monetary methods discussed previously, there is no concrete theoretical justification for these proxies. To begin with, the first approach is problematic as informal work is not necessarily associated with high-denomination notes. On the contrary, small banknotes might be expected to be prevalent in informal transactions, since the informal economy is usually associated with small-scale enterprises, given that its existence is attributable to the sizeable extra marginal costs of producing in the formal sector, specifically as taxation and labour legislation are reinforced. Thus, the first approach will not be appropriate unless we define the informal economy as inclusive of illegal activities, which is incompatible with the main focus of this study. The second approach is criticised because the velocity of money in the formal and informal spheres is assumed to be identical, which is unrealistic, but nevertheless unavoidable, since it is virtually impossible to measure the velocity of money in the informal sector. Besides, it overlooks the fact that from 1/4 to 1/3 of the unreported income in the United States was paid via cheque rather than cash (Feige, 1990). The third approach relaxes the cash-only assumption, and yields higher estimates of the size of the unrecorded sector, but the other known issues associated with the indirect method remain unresolved.

In the third indirect approach, the discrepancy between expenditure and income, either by household or country, is adopted as the proxy for the size of the informal economy. Since this method is based on household and consumer surveys, it has an advantage over other indirect methods, the data being fairly reliable. However, it has the same drawbacks as the direct method. All in all, the income-expenditure discrepancy method is not likely to be a promising approach to measure the informal economy.

4.5.2.3 The Model Approach

The direct and indirect approaches discussed above are designed to estimate the size of the informal economy by taking a ‘snapshot’ of the informal economic structure while paying little attention to explaining the causes of the emergence and development of the informal economy over time. Schneider (2002) proposed a factor-analytic behavioural model – namely the Dynamic Multiple-Indicators Multiple-Causes (DYMIMIC) model – in which the structural equations explaining causal relationships between the unobserved variable (the size of the informal economy) and certain observed causal and indicator variables are specified explicitly. In brief, the interaction over time between the causal variables Z_{it} ($i = 1, 2, \dots, k$), the size of the shadow economy X_t , and the indicator variables Y_{jt} ($j = 1, 2, \dots, p$) is shown in Figure 4-5.

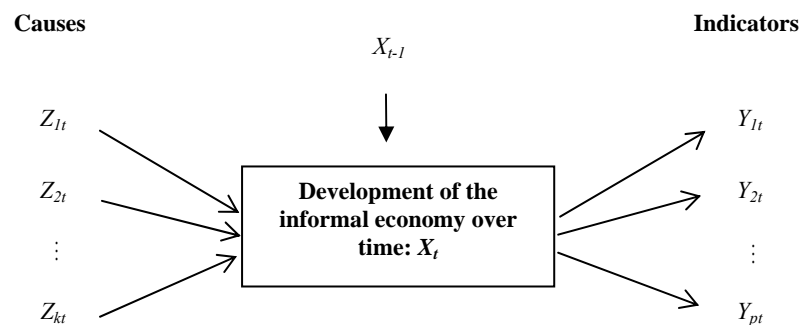


Figure 4-5: The structure of the DYMIMIC model (Schneider, 2002)

In the DYMIMIC model, Schneider identifies the causal variables (Z_{it}) as: 1) those contributing to higher marginal costs of entry to the formal sector, for instance, an increase in the tax burden, lack of social security provision, or government regulation; 2) the lack of effective detection and punishment for illegal informal economic activities; and last but not least, 3) the declining sense of ‘tax morality.’ The indicator variables (Y_{jt}) are those adjustments observed in labour, product, and money markets. Specifically, as the informal economy grows, we would expect to witness: 1) an increase in monetary transactions; 2) a rising proportion of the labour force participating in the informal economy; and 3) a decline in

primary factor demands in the formal economy. Although this model approach is probably the most comprehensive, its dynamic nature requires a vast amount of data, some of which might not be presently available in India.

4.5.3 The Informal Economy in the CGE Framework

Since analysing a fiscal policy with no regard to the existence of the informal economy can be misleading, recent CGE papers on the income distribution effects of various government policies have paid more attention to the informal element. After reviewing prior approaches that feature the informal economy in the CGE framework, the model design for the study of the revenue-neutralising tax reform will be discussed below.

4.5.3.1 Literature Review

Although economists are fully aware of the existence of the informal economy and its non-negligible influence on the outcome of a fiscal policy; CGE modellers only started to tackle this problem in the late 1990s. The underlying complications in the incorporation of the informal economy to the CGE analysis arise from the ambiguities in its definition and measurement, along with the practical issues of the scale of work to be undertaken in compiling data. Thus far, CGE models with informal sectors are constrained to be country-specific; and are predominantly designed for the purpose of analysing a fiscal policy's impact on the income distribution, rather than for the study of the simultaneous implementation of multiple tax reforms for the purpose of revenue neutralisation.

For instance, Decaluwé et al. (1999), among others, incorporated the informal economy for the study of income distribution and poverty in Africa. However, since they defined the informal economy as production units owned by households, the distinction between non-marketed subsistence production, untaxable black market production, and taxable formal market production was blurred; so that informality was not directly associated with untaxability. Similarly, Colatei and Round (2001) simulated the revenue-neutral income

redistributive reforms operated in Ghana during the 1980s and 1990s. Since the study disaggregates household with respect to socio-economic and geographic criteria, informal producers are implicitly modelled as unincorporated self-employed enterprises, and individual households are involved in both formal and informal production activities. Blake, McKay, and Morrissey (2001) explored the impact of agricultural trade liberalisation on the Ugandan economy in the presence of the informal economy. In this model, the informal households are endowed with informal non-waged labour, while formal households are endowed with both formal and informal factors of production. Once again, production sectors are not identified by their degree of formality since they hire both kinds of factors and pay production taxes; and informal households are not untaxable since they also pay income taxes. Carneiro (2003); Sinha (2003); Dorward et al. (2004); Gibson (2005); and Kiringai, Wanjala, and Mathenge (2006) also took similar approaches to the afore-mentioned studies in addressing poverty issues for Brazil, India, Malawi, Paraguay, and Kenya, respectively. While this approach is suitable for poverty analysis, it is arguable that a more explicit treatment of the interaction between formal and informal sectors is required for the study of revenue-neutralising reform.

The MIMIC model on the Dutch economy features many realistic specifications in the labour market (Graafland and Mooij, 1998).²⁵ The informal activity encompasses household production and labour supply to the black market, and thus each household allocates time between leisure, work in the formal market, and work in the informal economy. The CES utility structure of each household assumes that labour-intensive services from the formal market (C_f) and from the black market (C_b) is first combined into aggregate consumption of marketable labour-intensive services (C_l) with a substitution elasticity of 2. This aggregate is then combined with other consumption (C_k) to yield total consumption (C) with an elasticity of 1.1. Thus, C_b is a much closer substitute for C_f than C_k . Except in the black market, the

²⁵ MIMIC stands for the Micro-Macro model to analyse the Institutional Context, and is an applied general equilibrium model developed by CPB, The Hague.

housekeeping activities are modelled as a constant fraction of the time spent on leisure. Housekeeping activities yield household production that is a perfect substitute for the consumption of marketable labour-intensive services (C_l). In this context, an increase in leisure raises household production, thereby crowding out the consumption of C_l . At the same time, increasing taxes augments the consumption of C_b while lowering the overall consumption of marketable services (C_l), thus encouraging more housekeeping activities and leisure. With some differences in the demand structure, MIMIC's modelling approach is comparable to that adopted by Piggot and Whalley (2001) for the analysis of the VAT base broadening in Canada; and Patrón (2005) on education and endogenous skill formation in Uruguay, even though self-supply and housekeeping activities are not accounted for in the latter. Essentially, the virtue of MIMIC lies in the explicit association of 'informality' with 'untaxability,' which is of practical benefit in the context of tax policy studies. Nevertheless, since MIMIC is a single-region model which only incorporates VAT and income taxes while ignoring trade and production taxes, the model must be adapted for the study of simultaneous manipulation of multiple tax policies.

4.5.3.2 Model Design

The newly incorporated system of informal production and distribution activities fully described in Appendix A4-4 is similar to those used by Graafland and Mooij (1998), Piggot and Whalley (2001), and Patrón (2005). However, since the model is tailored to the efficacy analysis of domestic tax policies that exactly offset government revenue losses from preferential tariff removal, the 'untaxable' production sectors are defined as 'informal' and explicitly distinguished from those that are taxable. Both the rich and the poor households are endowed with formal and informal factors, which are supplied respectively to the formal and informal sectors. Due to their small-scale production and tax-evading nature, commodities produced in the informal sector are not internationally traded. They are demanded by informal domestic producers as informal intermediate inputs; consumed by rich and poor households

as informal final goods; and purchased by the bank as informal investment goods. However the government does not consume products from the informal sector. Thus the CES demand structure utilised thus far now applies only to the government, whereas the bank and households are represented by the newly-defined nested CES demand function illustrated in Figure 4-6.²⁶

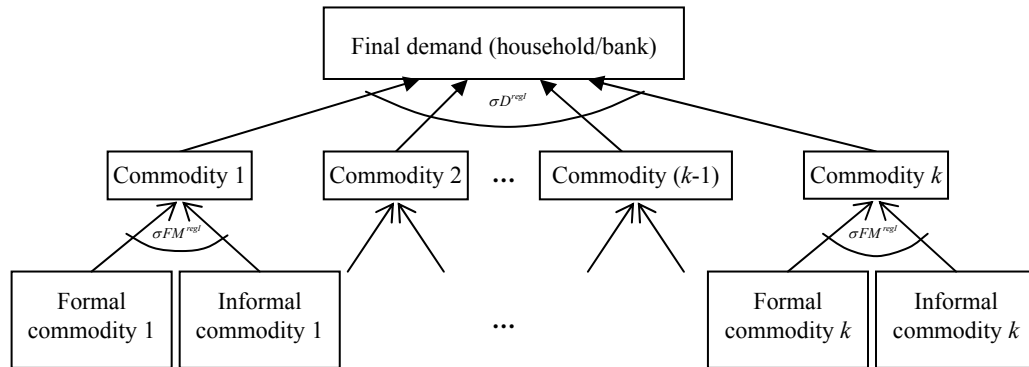


Figure 4-6: Final demand trees for the two households and the bank in the presence of informal commodities

At the top level, k types of commodities are aggregated with the common elasticity of substitution among final products denoted by σD^{regl} .²⁷ Hence the aggregate household demand is modelled as:

$$C_{sec}^{regl, hh} = \left[\gamma_{HH_{sec}^{regl, hh}} \cdot \frac{PCBUD^{regl, hh}}{PCA_{sec}^{regl, hh}} \right]^{\sigma D^{regl}} \cdot CBUD^{regl, hh}, \quad (4-10)$$

in which the price index of the aggregate demand for commodity sec by household hh in region $regl$ is the newly introduced variable $PCA_{sec}^{regl, hh}$. Thus, the household budget constraint reads:

²⁶ The earlier version of the CES demand structure is explained in Subsection 3.2.2 of Chapter 3.

²⁷ ' $regl$ ' signifies the set of regions where black markets exist ($regl \subseteq reg$). In the context of Chapter 4, it only encompasses India: $regl = \{IND\}$.

$$PCBUD^{regl, hh} \cdot CBUD^{regl, hh} = \sum_{sec} PCA_{sec}^{regl, hh} \cdot C_{sec}^{regl, hh}. \quad (4-11)$$

At the lower level, each commodity $\{1, 2, \dots, k\}$ is a CES aggregate of formal and informal products with the substitution elasticity of σFM^{regl} . Accordingly, the new set named ‘ fm ’, consisting of formal (“ FML ”) and informal (“ $IFML$ ”) commodities, is assigned to relevant parameters and variables:

$$fm = \{FML, IFML\}.$$

Thus, the lower level of the household demand function is expressed as:

$$CFM_{sec, fm}^{regl, hh} = \left[\gamma HFM_{sec, fm}^{regl, hh} \cdot \frac{PCA_{sec}^{regl, hh}}{[1 + tc_{sec}^{regl} \$(fm = "FML")]} \cdot PAFM_{sec, fm}^{regl} \right]^{\sigma FM^{regl}} \cdot C_{sec}^{regl, hh}, \quad (4-12)$$

where parameters and variables with the informal dimension are identified by the letters ‘ FM .’ The household’s demand for each commodity ($CFM_{sec, fm}^{regl, hh}$) is purchased at the corresponding sectoral market price of $PAFM_{sec, fm}^{regl}$,²⁸ with a consumption tax (tc_{sec}^{regl}) applied to formally produced commodities.²⁹ Lastly, the new parameter $\gamma HFM_{sec, fm}^{regl, hh}$ represents the consumption share of a formal or informal commodity ($CFM_{sec, fm}^{regl, hh}$) in its aggregate demand ($C_{sec}^{regl, hh}$). Paralleling Equation (4-11), the lower-level household budget constraint is specified as:

$$PCA_{sec}^{regl, hh} \cdot C_{sec}^{regl, hh} = \sum_{fm} \left[[1 + tc_{sec}^{regl} \$(fm = "FML")] \cdot PAFM_{sec, fm}^{regl} \cdot CFM_{sec, fm}^{regl, hh} \right]. \quad (4-13)$$

Similarly, the aggregate investment demand by the bank is specified as:

²⁸ For reference, the formal dimension of this new variable ($PAFM_{sec, FML}^{regl}$) is equivalent to PA_{sec}^{regl} in the previous chapters where the shadow economy did not exist.

²⁹ Accordingly, the term $\$(fm = "FML")$ means that consumption tax is to be added to Equation (4-12) only when goods are purchased from the formal sector (“ FML ”).

$$I_{sec}^{regl} = \left[\gamma I_{sec}^{regl} \cdot \frac{PS^{regl}}{PIA_{sec}^{regl}} \right]^{\sigma D^{regl}} \cdot S^{regl}, \quad (4-14)$$

where the price index of the aggregate investment demand for commodity *sec* in region *regl* is now denoted by PIA_{sec}^{regl} . Thus, the corresponding bank's budget constraint reads:

$$PS^{regl} \cdot S^{regl} = \sum_{sec} PIA_{sec}^{regl} \cdot I_{sec}^{regl}. \quad (4-15)$$

Paralleling Equations (4-12) and (4-13), the investment demand and budget constraint at the lower level are derived respectively as:

$$IFM_{sec, fm}^{regl} = \left[\gamma IFM_{sec, fm}^{regl} \cdot \frac{PIA_{sec}^{regl}}{PAFM_{sec, fm}^{regl}} \right]^{\sigma FM^{regl}} \cdot I_{sec}^{regl}; \text{ and} \quad (4-16)$$

$$PIA_{sec}^{regl} \cdot I_{sec}^{regl} = \sum_{fm} PAFM_{sec, fm}^{regl} \cdot IFM_{sec, fm}^{regl}, \quad (4-17)$$

where the investment demand for commodity *sec* by the formal and informal sectors in region *regl* ($IFM_{sec, fm}^{regl}$) and the corresponding share parameter ($\gamma IFM_{sec, fm}^{regl}$) are newly introduced.

Since the government is not involved in informal economic activities, there is no informal production and distribution of public services (*OSG*). By the same token, the government does not consume informal products. Hence, the equation that balances the sum of private, investment, public, and intermediate demands with aggregate demand in the formal and informal markets ($QAFM_{sec, fm}^{regl}$) reads:³⁰

$$\sum_{hh} CFM_{sec, fm}^{regl, hh} + IFM_{sec, fm}^{regl} + CG_{sec}^{regl} \$(fm = "FML") + \sum_{sec} IOFM_{sec, sec, fm}^{regl} = QAFM_{sec, fm}^{regl}, \quad (4-18)$$

³⁰ Once again, the formal dimension of this new variable ($QAFM_{sec, FML}^{regl}$) is equivalent to the Armington demand QA_{sec}^{regl} in the previous version where the shadow economy did not exist.

where $IOFM_{sec,sec c, fm}^{regl}$ stands for the Leontief intermediate input demand for commodity sec by formal or informal production sector $sec c$ in region $regl$, parallel with $IO_{sec,sec c}^{regl}$ from Chapter 2; while public consumption (CG_{sec}^{regl}) is only of goods sold in the formal market.³¹

As the outputs of the informal part of the economy are only produced and consumed domestically, they are non-traded. Thus, we specify that:

$$QZFM_{sec, "IFML"}^{regl} = QDSFM_{sec, "IFML"}^{regl} = QDDFM_{sec, "IFML"}^{regl} = QAFM_{sec, "IFML"}^{regl}, \quad (4-19)$$

where $QZFM_{sec, fm}^{regl}$ represents sector sec 's formal and informal outputs in region $regl$; while $QDSFM_{sec, fm}^{regl}$ and $QDDFM_{sec, fm}^{regl}$ respectively denote domestically-produced goods supplied and demanded within the same region.³² Likewise, their prices are identical:

$$PZFM_{sec, "IFML"}^{regl} = PDFM_{sec, "IFML"}^{regl} = PAFM_{sec, "IFML"}^{regl}, \quad (4-20)$$

where $PZFM_{sec, fm}^{regl}$ is the output price dual to $QZFM_{sec, fm}^{regl}$; and $PDFM_{sec, fm}^{regl}$ is the common price of domestically-produced goods ($QDSFM_{sec, fm}^{regl}$ and $QDDFM_{sec, fm}^{regl}$).³³

On the other hand, the original property is maintained in the formal part of the economy, thus supply and demand remain based on the CET and Armington functions. As a consequence the modified CET zero-profit condition for sector sec in region $regl$ reads:

³¹ Recalling Equation (2-97) in Chapter 2, the left hand side of Equation (4-18) will be multiplied by the scaling vector if sector sec is under monopolistic competition. However, the vector is not included here, first of all for the sake of simplicity, and secondly because none of the sectors in India is under monopolistic competition (Table 3-3, Chapter 3).

³² Again, $QZFM_{sec, "FML"}^{regl}$, $QDSFM_{sec, "FML"}^{regl}$, $QDDFM_{sec, "FML"}^{regl}$ newly introduced here respectively possess the same property as QZ_{sec}^{regl} , QDS_{sec}^{regl} , QDD_{sec}^{regl} in the previous version, where the black market was not taken into consideration.

³³ The same logic is applied to their parallel prices, such that $PZFM_{sec, "FML"}^{regl}$ and $PDFM_{sec, "FML"}^{regl}$ respectively possess the same property as PZ_{sec}^{regl} and PD_{sec}^{regl} in the previous version.

$$\begin{aligned}
PZFM_{sec, fm}^{regl} \cdot QZFM_{sec, fm}^{regl} &= PDFM_{sec, fm}^{regl} \cdot QDSFM_{sec, fm}^{regl} \\
&+ \left\{ \begin{aligned} &\left(PE_{sec}^{regl} \cdot QE_{sec}^{regl} \right) \$secT(sec) + \\ &\left(PE_{sec}^{regl} \cdot TRSPR_{sec}^{regl} \right) \$trsp(sec) \end{aligned} \right\} \$ (fm = "FML").
\end{aligned} \tag{4-21}$$

Implicitly, the exportation of tradable commodities ($secT$) and international transport services ($trsp$, as described in Subsection 3.2.3, Chapter 3) is not allowed in the informal sector. The market for domestic consumers clears ($QDSFM_{sec, fm}^{regl} = QDDFM_{sec, fm}^{regl}$), as in Equation (4-21), the Armington zero-profit condition for sector sec in region $regl$ requiring that aggregate demand is equal to the demands for domestic and import goods, although the latter applies solely to the distribution in the formal sector:

$$\begin{aligned}
PAFM_{sec, fm}^{regl} \cdot QAFM_{sec, fm}^{regl} &= PDFM_{sec, fm}^{regl} \cdot QDDFM_{sec, fm}^{regl} \\
&+ \left(PM_{sec}^{regl} \cdot QM_{sec}^{regl} \right) \$ (secT(sec) \cap (fm = "FML")).
\end{aligned} \tag{4-22}$$

Production in the shadow economy is assumed to be carried out on a small scale, thus implying perfect competition. Therefore, the zero-profit condition for production activities may be written as:

$$\begin{aligned}
PZFM_{sec, fm}^{regl} \cdot QZFM_{sec, fm}^{regl} &= \sum_{fac} \left[\begin{aligned} &\left(1 + t_{sec}^{fac, regl} \$ (fm = "FML") \right) \cdot \\ &\left(\begin{aligned} &PFM_{sec}^{fac, regl} \$facM(fac) \\ &+ PFS_{sec}^{fac, regl} \$facS(fac) \end{aligned} \right) \cdot FFM_{sec, fm}^{fac, regl} \end{aligned} \right] \\
&+ \sum_{sec c} IOFM_{sec c, sec, fm}^{regl} \cdot PAFM_{sec c, fm}^{regl} \\
&+ \left(t_{sec}^{regl} \cdot PZFM_{sec, fm}^{regl} \cdot QZFM_{sec, fm}^{regl} + \right) \$ (fm = "FML"), \\
&PROFIT_{sec}^{regl} \$ic(sec)
\end{aligned} \tag{4-23}$$

where $FFM_{sec, fm}^{fac, regl}$ represents the factor demands by the formal and informal sectors (as subscripted by fm), parallel with $F_{sec}^{fac, regl}$ which applies solely to the demands by the formal sector.

It should be noted that there are some limitations in the specification of labour. By definition, the informal sectors use only self-employed and waged labour. This rules out non-marketed labour services such as subsistence home production and voluntary community work, and

illegal market activities such as the production of prohibited substances. Hence, labour involved in these activities is implicitly regarded as unemployed. However, since we are focusing on the economic implication of revenue-neutralising domestic tax policies, this specification should be satisfactory, since these activities are non-taxable by their nature. A further limitation lies in the movement of labour between the formal and informal sectors, which basically depends upon the change in the proportion of formal to informal demands. Thus, the seasonal movement of unskilled labour into formal manufacturing sectors during the dry season while otherwise working in informal agricultural sectors is not modelled. Lastly, the complex nature of labour supply, in that a person can simultaneously work full time in the formal sector while holding an informal part-time job, is not precisely accounted for. Nevertheless, since we do not define the unit of labour input as a person but rather as the value added to the final output, this issue is automatically taken care of in the CGE framework.

As for each household's income, the model specifies that informal income is received from informally providing labour services to informal production sectors. Then, denoted by $INCFI^{regl, hh}$, the household income inclusive of that from informal sources, the household's income-balance condition is modified to:

$$INCFI^{regl, hh} = TRY^{regl, hh} + SHH^{regl, hh} + PCBUD^{regl, hh} \cdot CBUD^{regl, hh}. \quad (4-24)$$

Income tax is exclusively imposed on 'formal' income ($INC^{regl, hh}$),

$$TRY^{regl, hh} = ty^{regl, hh} \cdot INC^{regl, hh}. \quad (4-25)$$

4.5.4 Tax Policy Simulation in the Presence of the Informal Sector

Compiling data on the informal economy is difficult since, as noted earlier, all the measurement methods contain inaccuracies. In the CGE context, the data on the informal sector should ideally be comprehensive and on a national scale, with sectoral details which are compatible with our model design. In practice, Subsection 4.5.4.1 re-calibrates the CGE

model using the informal data estimated by Unni (2001), and Subsection 4.5.4.2 then simulates the revenue-neutralising reform taking into account the informal economy.

4.5.4.1 Model Calibration

Despite the serious constraints on data availability, a number of SAMs have been constructed for India (Sarkar and Subbarao, 1981; Sarkar and Panda, 1986; Janvry and Subbarao, 1986; Subbarao, 1993; Storm, 1997; Sinha et al., 2003; and Pradhan et al., 2006). As these Indian SAMs are constructed and updated regularly by the same set of researchers for the analysis of policy impacts on income distribution across households, household income is classified in great detail, although not explicitly with regard to taxability. Hence, this model adopts the informal data estimates from Unni (2001) and specifies that the share of the informal sector in GDP is proxied by the share of the unorganised sector in Net Domestic Product (NDP) from the National Accounts Statistics. Although the definition of the unorganised sector is based on the legal status of the enterprise rather than on its taxability, it is assumed that the two criteria are reasonably correlated.

It should be noted that this method of estimating and including informal activities ‘in addition’ to the SAM data provided by GTAP conflicts with the definition of the standard SNA production boundary that informal activities are already ‘included’ in the economic system (Dimaranan, 2006). Although this approach entails structural biases in the simulation results, the method is chosen for a number of reasons. Firstly, the common occurrence of underestimation of the informal sector in official statistics is widely recognised (Charmes, 1998; Kulshreshtha, 2004). Secondly, the comparability of the present model results with the former ones where only formal activities are accounted for, will be lost if the benchmark formal sector is re-calibrated to become smaller, because then domestic taxes are imposed on a smaller base and thus all benchmark tax rates will become higher, implying a completely different tax structure. Finally, since neither calibration approaches (i.e., adding informal activities on top of the GTAP statistics or extracting them from the dataset) could yield a

strictly accurate reflection of the Indian economy, and since the study originally aims at offering an insight into how the incorporation of the informal economy can alter the former policy implications, the adopted method should be qualified to suit the primary purpose of the current research.

Once the production sectors from Table 7 of Unni (2001) are mapped with those in the current model, the ratio of informal to formal GDP by sector (mul_{sec}^{regI}) is calculated. Subsequently, the informal intermediate, private, and investment demands for each commodity are similarly calibrated in compliance with the respective formal demands originally taken from the GTAP 6.0 database. Thus we derive:

$$IOFM_{sec,sec c,"IFML"}^{regI} = mul_{sec}^{regI} \cdot IOFM_{sec,sec c,"FML"}^{regI}$$

$$CFM_{sec,"IFML"}^{regI, hh} = mul_{sec}^{regI} \cdot CFM_{sec,"FML"}^{regI, hh}$$

$$IFM_{sec,"IFML"}^{regI} = mul_{sec}^{regI} \cdot IFM_{sec,"FML"}^{regI}$$

The benchmark informal demand for commodity sec can now be derived as:

$$QAFM_{sec,"IFML"}^{regI} = \sum_{sec c} IOFM_{sec,sec c,"IFML"}^{regI} + \sum_{hh} CFM_{sec,"IFML"}^{regI, hh} + IFM_{sec,"IFML"}^{regI}$$

Since informal commodities are not internationally tradable, this aggregate demand should be equal to the corresponding domestic output ($QZFM_{sec,"IFML"}^{regI}$), which in turn determines the total informal labour demand as the residual of informal intermediate demands:

$$FIO_{sec}^{regI} = QZFM_{sec,"IFML"}^{regI} - \sum_{sec c} IOFM_{sec c,sec,"IFML"}^{regI}$$

The ratios of unskilled to skilled labour demanded by informal producers are calibrated to be consistent with those previously observed in the corresponding formal sectors:

$$FFM_{sec,"IFML"}^{lab, regI} = \frac{FFM_{sec,"FML"}^{lab, regI}}{\sum_{lab} FFM_{sec,"FML"}^{lab, regI}} \cdot FIO_{sec}^{regI}$$

Since household income, now derived as $INCFIO^{regl, hh}$, takes into account the additional labour supply to the informal market, household saving is re-calibrated as the residual of income and expenditure:

$$SHHO^{regl, hh} = INCFIO^{regl, hh} - TRYO^{regl, hh} - CBUDO^{regl, hh},$$

Where the household consumption budget is also re-calculated as inclusive of informal consumption:

$$CBUDO^{regl, hh} = \sum_{sec} \left(\sum_{fm} CFMO_{sec, fm}^{regl, hh} + tc_{sec}^{regl} \cdot CFMO_{sec, "FML"}^{regl, hh} \right).$$

Finally, the elasticity of substitution between formal and informal goods (σFM) for the bank and households is universally set to 2, as in Graafland and Mooij (1998).

4.5.4.2 Simulation Results

To help our understanding of the effects of introducing the informal economy into the model, we simulate the uniform ‘level’ tax reforms intended to compensate for the Indian government revenue loss after ASEAN+3 is formed, both with and without tax evasion.³⁴ Since the calibration in Subsection 4.5.4.1 assumes that the GTAP 6.0 database overlooks the existence of the informal sector, the benchmark Indian GDP is more than doubled when the informal economy is incorporated.³⁵ Since the initial economic sizes with and without the informal sector are not the same, the comparison of welfare impacts in proportional terms is not suitable for this particular type of analysis. Consequently, in Table 4-10, welfare changes are reported in the world currency (US\$), whilst price changes are shown in proportional terms since their benchmark values are uniformly unity.

³⁴ For simplicity, the ASEAN+3 FTA simulation in the presence of the informal economy is defined as tariff cuts in agricultural and manufacturing sectors among member nations, while service liberalisation in terms of competition advocacy is abbreviated.

³⁵ Precisely, Table 7 in Unni (2001) suggests that the informal sector contributes approximately 60.5% to GDP.

It is also noteworthy that the simulated tax rates required to keep government revenue balanced barely differ across tax types. For instance, under consumption tax reforms, tax rates (tc_{sec}^{IND}) are raised to 0.035 without, and 0.033 with the informal sector.³⁶ Hence, we can rest assured that the model imposes nearly the same degree of tax policy change on the economy with and without the informal market, and the results in Table 4-10 are hence mostly caused by the adjustment between formal and informal sectors.

4.5.4.2.1 Overall Results

The results are summarised in Table 4-10 in terms of both relative and absolute changes. The absolute changes in three categories of real variables, i.e. final demands, labour demands and total output (also referred to as the real GDP), are reported in commensurate units which are defined as the values divided by the corresponding prices in each row of a regional SAM (see Table 2-1 in Chapter 2 for the basic SAM structure). As a consequence, while we may compare the counterfactual changes in the real variables of the same kind, it is not meaningful to compare the absolute changes in, for instance, final and factor demands. Although the percentage changes in real variables are more commonly reported in the CGE literature, the absolute measure is utilised here because the study is focused on the comparability of these variable changes with and without the informal sector. More specifically, reporting the results in percentage terms might be misleading, given the fact that the benchmark volumes of the real variables at the regional level become larger when including the informal activities on top of the initial data from GTAP.

As a whole, the introduction of the informal economy alters welfare outcomes in a non-negligible way. Welfare is reduced given income and factor tax reforms and improved given

³⁶ Similarly, the respective revenue-neutralising targeted tax rates before and after the incorporation of the non-taxable black market are 0.040 and 0.041 for income tax ($ty^{IND,hh}$); 0.0106 and 0.0105 for factor tax ($tf_{sec}^{fac,IND}$); and 0.024 and 0.023 for production tax (tz_{sec}^{IND}).

consumption and production tax reforms. As a consequence, we observe a smaller gap between the outcomes of the best and the worst tax policies.

In general, the beneficial tariff-cutting effect that shifts production from the informal to formal sector, outweighs the unfavourable effect of increasing domestic taxes which consequently replaces production in the formal sector with that from the informal sector. The former effect is particularly enhanced under consumption and production tax reforms, as the formal sector grows markedly in real terms. Presumably, as the informal sector is brought into existence, consumers can adjust their final demands in accordance with the new tax regime in a more flexible manner, since households and the bank can now substitute between formal and informal consumption with the elasticity of σFM^{regl} , as specified in Equations (4-12) and (4-16). Consequently, the consumption tax reform yields the highest real gains, as the policy is most directly influenced by the afore-mentioned adjustment in final demand. In the same way, the production tax reform turns out to be the second best, while income and factor tax reforms are least welfare-enhancing. Accordingly, India's revenue-neutralising domestic tax reforms, in the presence of the untaxable sector, are individually discussed as follows.

4.5.4.2.1.1 ASEAN+3 with the Revenue-Neutralising Income Tax Increase ($ty^{IND, hh}$)

In the presence of the informal sector, tariff cuts stimulate expansion in the formal sector, which takes production resources from the informal sector. In particular, the partial trade liberalisation eliminates the economic distortion, thereby enabling India to gain from trade creation and the improvement in its terms of trade. At the same time, the higher domestic tax tends to lower these gains so causing an opposite shift in the direction of the informal economy. Although the former is stronger than the latter, since the revenue-neutralising income tax reform in the presence of the informal sector leads to positive outcomes as a whole, policy efficacy drops relative to the outcome when there is no informal economy. As the informal real GDP change is unequivocally negative, the reallocation of primary factors towards informal production sectors in consequence of the income tax reform is not as efficient as the shift in demand towards formal consumption caused by tariff removal.

4.5.4.2.1.2 ASEAN+3 with the Revenue-Neutralising Factor Tax Increase ($tf_{sec}^{fac, "IND"}$)

Akin to the results under the income tax reform, real gains from tariff removal exceed the losses from factor tax increases, since macroeconomic variables such as employment and real GDP adjust positively to the new tax regime. However, factor taxes are evidently inferior to an income tax in terms of policy efficacy, as observed in Section 4.4, in that they hamper real production more directly. Nonetheless, in the presence of the untaxable black market, not only does that production expand more in the formal sector than the contraction in the informal one, but that contraction is also fairly minor, implying a smaller fall in production after the incorporation of the informal economy compared with that under the income tax reform. In principle the factor tax should result in greater efficiency in the presence of the informal economy, as it is more directly associated with the substitution between formal and informal consumption. On the other hand, since regional welfare in India declines slightly, the imposition of factor taxes does restrict domestic demand; however, preferential trade liberalisation nevertheless stimulates production, especially for the overseas markets within the regional grouping.

4.5.4.2.1.3 ASEAN+3 with the Revenue-Neutralising Consumption Tax Increase (tc_{sec}^{IND})

In contrast with the income and factor tax reforms, given ASEAN+3 with the consumption tax reform, India's welfare is improved after the untaxable economy is incorporated into the model. Specifically, it is apparent from Table 4-10 that changes in real GDP, skilled and unskilled labour employment, real factor prices, and regional welfare are all positive. While ASEAN+3 leads to expansion in the formal sector akin to the previous two cases, an increase in the consumption tax turns out to be more beneficial with the informal sector included, because households have consumption alternatives those are not subject to taxation, and thus they can substitute between the two in response to the new tax regime. Consequently, although the consumption tax reform encourages the household to shift demand towards informal commodities, consumption by rich and poor households does not decline greatly

with the introduction of the informal sector, and macroeconomic variables are clearly improved on the whole.

4.5.4.2.1.4 ASEAN+3 with the Revenue-Neutralising Production Tax Increase ($tz_{\text{sec}}^{\text{IND}}$)

As was the case without the untaxable sector, the production tax option yields the least favourable welfare changes among the four domestic taxes, particularly in terms of real wages, consumption demand, employment, and disposable income. However, the incorporation of the black market noticeably increases India's welfare, with the real GDP increasing by 7.25 billion units, more than twice the output change in the absence of the informal economy. An increase in the production tax shifts production resources from the formal sector, and the ensuing reduction in formal supply further stimulates formal import demand, which has already been boosted by the partial tariff removal under ASEAN+3. With the regional bank able to substitute flexibly between formal and informal investment, formal investment from abroad is significantly increased. As a consequence, most variables respond positively to the new tax regime once the informal sector is taken into consideration.

Table 4-10: ASEAN+3 with revenue-neutralising uniform tax raises

| | ASEAN+3 with revenue-neutralising uniform income tax raise ($ty^{IND, hh}$) | | ASEAN+3 with revenue-neutralising uniform factor tax raise ($tf_{sec}^{fac, IND}$) | | ASEAN+3 with revenue-neutralising uniform consumption tax raise (tc_{sec}^{IND}) | | ASEAN+3 with revenue-neutralising uniform production tax raise (tz_{sec}^{IND}) | |
|-------------------------------------|---|----------------------|--|----------------------|--|----------------------|---|----------------------|
| | Without informal sector | With informal sector | Without informal sector | With informal sector | Without informal sector | With informal sector | Without informal sector | With informal sector |
| | <i>% change</i> | | | | | | | |
| Real wage of unskilled labour | 0.86% | 0.17% | 0.17% | 0.02% | -0.46% | -0.23% | -0.90% | -0.39% |
| Real wage of skilled labour | 0.85% | 0.23% | 0.11% | 0.02% | -0.26% | -0.17% | -0.93% | -0.49% |
| Real rent of capital | 2.46% | 2.30% | 0.89% | 0.94% | 0.09% | 1.16% | -1.04% | 0.54% |
| | <i>Absolute change (billion units)</i> | | | | | | | |
| Rich household consumption | 0.80 | 1.13 | -0.32 | -0.74 | -2.81 | -2.85 | -3.99 | -4.28 |
| Formal rich household consumption | 0.80 | 1.92 | -0.32 | 0.12 | -2.81 | -1.98 | -3.99 | -4.03 |
| Informal rich household consumption | 0 | -0.79 | 0 | -0.86 | 0 | -0.87 | 0 | -0.25 |
| Poor household consumption | 0.51 | 0.13 | 0.37 | 0.18 | -0.71 | -0.72 | -1.36 | -1.12 |
| Formal poor household consumption | 0.51 | 0.88 | 0.37 | 0.26 | -0.71 | -0.79 | -1.36 | -1.78 |
| Informal poor household consumption | 0 | -0.75 | 0 | -0.09 | 0 | 0.07 | 0 | 0.66 |
| Government consumption | 0.25 | -0.10 | -0.41 | -0.51 | -0.07 | -0.18 | -1.15 | -1.05 |
| Bank consumption | 0.08 | -0.65 | -0.28 | 0.19 | -0.30 | 0.53 | 0.83 | 2.46 |
| Formal bank consumption | 0.08 | 0.05 | -0.28 | -0.14 | -0.30 | 0.45 | 0.83 | 3.34 |
| Informal bank consumption | 0 | -0.70 | 0 | 0.33 | 0 | 0.08 | 0 | -0.87 |

Source: Simulated by author

Table 4-10 (Continued): ASEAN+3 with revenue-neutralising uniform tax raises

| | ASEAN+3 with revenue-neutralising uniform income tax raise ($ty^{IND,hi}$) | | ASEAN+3 with revenue-neutralising uniform factor tax raise ($tf_{sec}^{fac,IND}$) | | ASEAN+3 with revenue-neutralising uniform consumption tax raise (tc_{sec}^{IND}) | | ASEAN+3 with revenue-neutralising uniform production tax raise (tz_{sec}^{IND}) | |
|---|--|----------------------|---|----------------------|--|----------------------|---|----------------------|
| | Without informal sector | With informal sector | Without informal sector | With informal sector | Without informal sector | With informal sector | Without informal sector | With informal sector |
| | <i>Absolute change (billion units)</i> | | | | | | | |
| Unskilled labour employment | 1.39 | 0.28 | 0.28 | 0.03 | -0.80 | -0.39 | -1.59 | -0.67 |
| Formal unskilled labour employment | 1.39 | 2.13 | 0.28 | 0.57 | -0.80 | 0.07 | -1.59 | -0.36 |
| Informal unskilled labour employment | 0 | -1.85 | 0 | -0.54 | 0 | -0.46 | 0 | -0.32 |
| Skilled labour employment | 0.43 | 0.12 | 0.06 | 0.01 | -0.14 | -0.09 | -0.52 | -0.27 |
| Formal skilled labour employment | 0.43 | 0.51 | 0.06 | 0.08 | -0.14 | 0.16 | -0.52 | -0.12 |
| Informal skilled labour employment | 0 | -0.39 | 0 | -0.07 | 0 | -0.25 | 0 | -0.15 |
| Real GDP | 9.00 | 6.70 | 5.00 | 4.85 | 6.42 | 8.53 | 3.32 | 7.25 |
| Formal real GDP | 9.00 | 11.77 | 5.00 | 6.38 | 6.42 | 11.69 | 3.32 | 9.86 |
| Informal real GDP | 0 | -5.07 | 0 | -1.53 | 0 | -3.17 | 0 | -2.61 |
| | <i>Absolute change (billion US\$)</i> | | | | | | | |
| Regional welfare (disposable income) | 2.28 | 0.82 | -0.18 | -0.51 | -5.70 | -4.38 | -9.20 | -7.27 |
| Rich household utility | 0.70 | 1.02 | -0.43 | -0.87 | -2.02 | -1.81 | -4.14 | -4.49 |
| Poor household utility | 0.45 | 0.06 | 0.32 | 0.11 | -0.26 | -0.15 | -1.43 | -1.23 |
| Government utility | 0.25 | -0.10 | -0.42 | -0.51 | -0.08 | -0.18 | -1.16 | -1.07 |
| Bank utility | 0.07 | -0.66 | -0.29 | 0.19 | -0.31 | 0.52 | 0.80 | 2.40 |

Source: Simulated by author.

4.5.4.2.2 Household Consumption: The Cross-Sector Distribution Effect

In addition to the aggregate outcomes reported in Subsection 4.5.4.2.1, the following charts give a further insight into the economic effects of the revenue-neutralising tax policies on the distribution of household's consumption budget across commodity groups. As with Table 4-10, all results are reported in absolute terms since the benchmark economic sizes with and without the informal sector are not identical. Also, for simplicity, commodities for which consumption levels adjust by less than 5 million units, both in formal and informal markets, are omitted from the charts.

Chart 4-14a: Variation in the Indian rich household's consumption distribution under ASEAN+3 with the uniform income tax increase

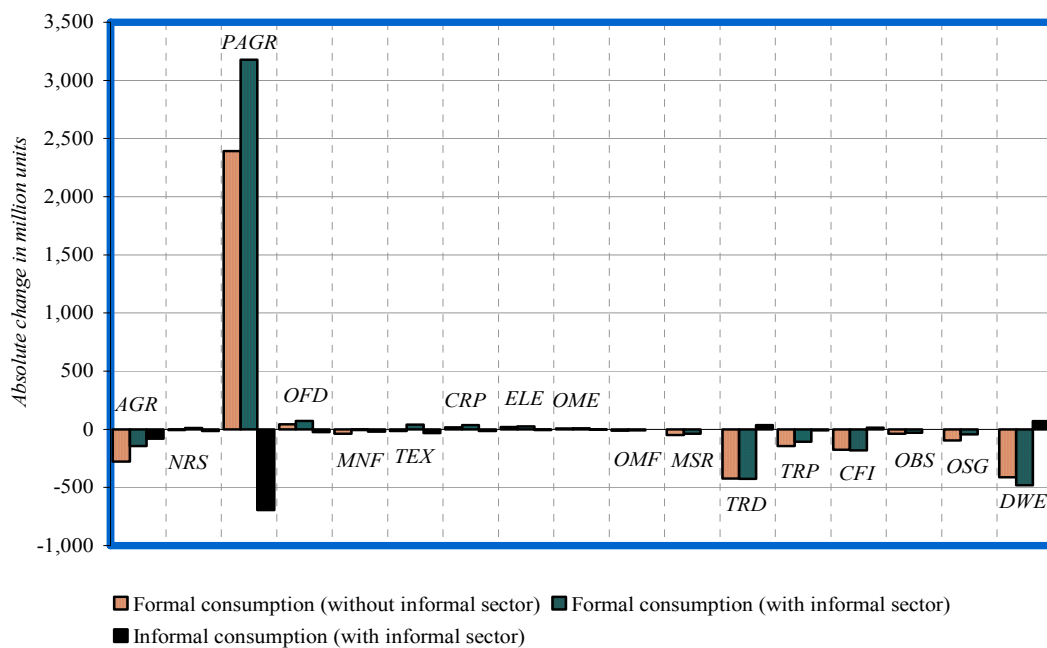


Chart 4-14a indicates that the rich household in India demands more manufacturing products and less agricultural and service goods under ASEAN+3 with the income tax reform. This tendency is particularly strong in sector *PAGR* (i.e. processed agricultural products), in which the consumer effect of ASEAN+3 prevails, and domestic output is strongly replaced by cheaper imports from other ASEAN+3 member countries, namely ASEAN, Japan, and China.

This is further elaborated in Chart 4-14b, where the change in aggregate imports of commodity *PAGR* is comparatively high, while production in both the formal and the informal sectors markedly fall. Since unskilled labour, which accounts for 54.33% of the benchmark total factor input to sector *PAGR*, belongs to the poor household, that group may potentially disapprove the new tax regime. However, according to the GTAP 6.0 database, the amount of unskilled labour demanded by sector *PAGR* accounts for only 5.03% of the total unskilled labour endowment, and only 3.60% of the total factor endowment is allocated to this sector. Although the poor would find the policy less favourable than would the rich, since unskilled labour demand increases in aggregate terms (Table 4-10), the welfare of the poor household is not exacerbated by the reform, and the government should be able to put this into practice.

Chart 4-14b: Absolute changes in Indian aggregate imports, formal and informal outputs under ASEAN+3 with the uniform income tax increase (in the presence of the shadow economy)

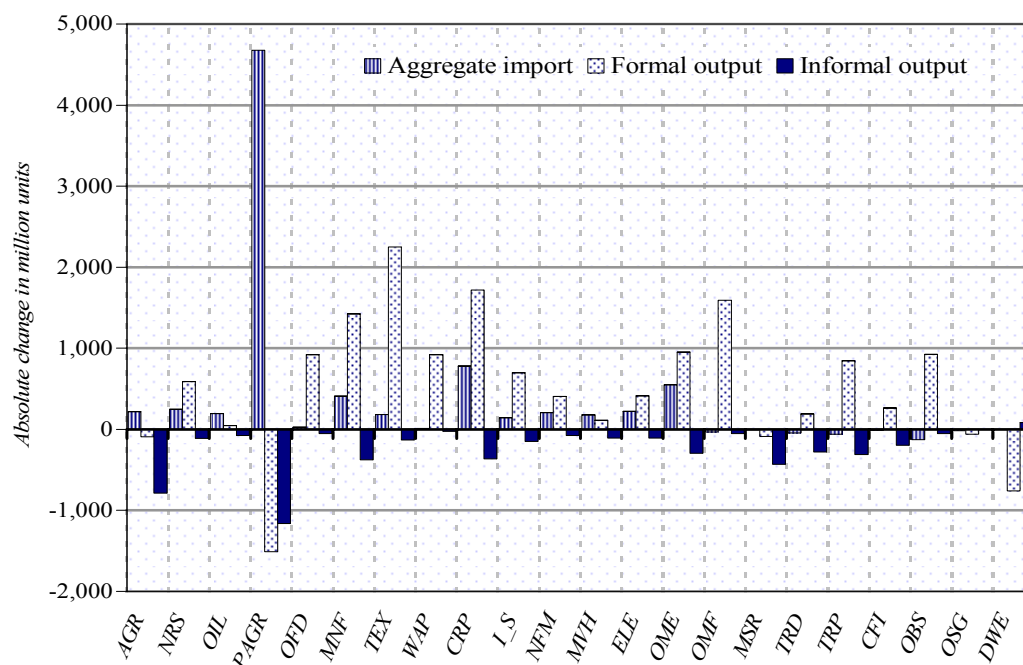
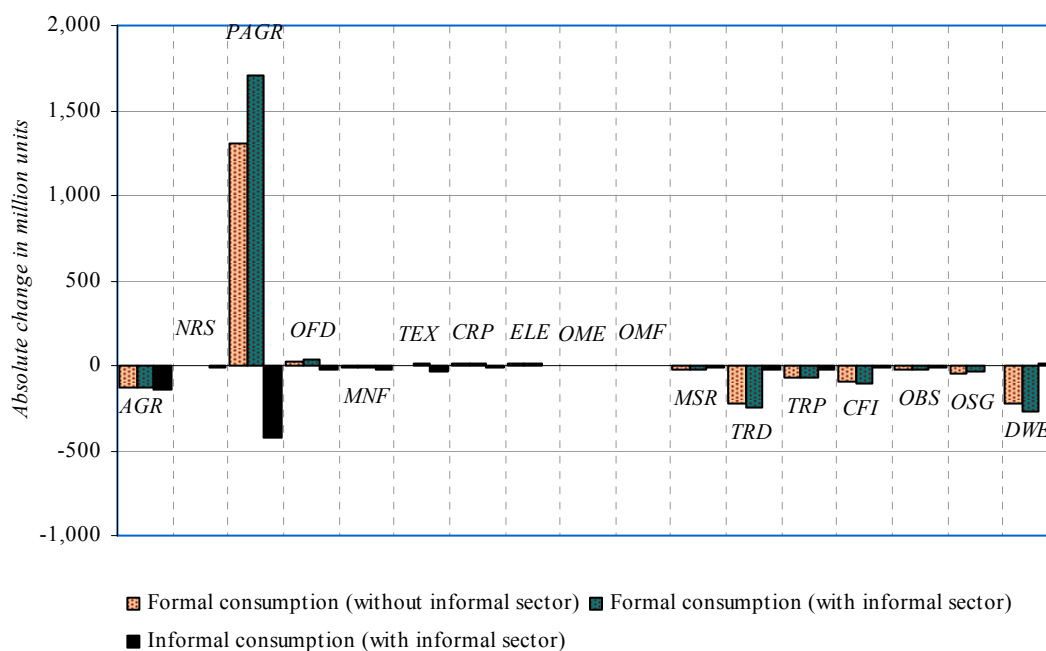


Chart 4-14a indicates that the direction of change in formal consumption with and without the black market is by and large the same. However, the consumption of informal manufacturing products tends to be replaced by the formal equivalent; while agricultural and service goods

adjust in the opposite direction. As noted earlier, such substitution should depend upon the positive impact of partial tariff removal under ASEAN+3 in relation to the negative effect of income tax increase on each sector. In consequence, the rich household shifts demands toward formal manufacturing goods because the consumer effect of ASEAN+3 is dominant in these sectors. On the other hand, agricultural and service goods benefit from ASEAN+3 to a lesser extent, as formal consumption falls both with and without the informal economy (Chart 4-14a), and aggregate imports barely expand in the agricultural sector while declining moderately, if at all, in the service sector (Chart 4-14b). The consumption of the formal version of these commodities is replaced with products from the informal sector.

Chart 4-15: Variation in the Indian poor household's consumption distribution under ASEAN+3 with the uniform income tax increase



The results for the poor household, which are broadly similar, are illustrated in Chart 4-15. The poor also consume more manufactured goods and less agricultural and service products after the policy change; and consumption of commodity *PAGR* noticeably increases. However, since the poor only receives incomes from unskilled labour services and government transfers, their consumption level should be distinctly lower than that of the rich

in general. Also, as aggregate production of *PAGR* – which is intensive in unskilled labour – drops markedly after the shock (Chart 4-14b), the income of the poor household is not increased as much as that of the rich. Therefore, the magnitude of change in consumption demand, hence the scale of the Y axis in Chart 4-15 turns out to be roughly half of the change in Chart 4-14a.

Finally, Chart 4-16 to Chart 4-21 show the impacts of ASEAN+3, coupled with the other three types of revenue-neutralising domestic tax reforms, on the cross-sector distribution of the rich and the poor households' final demands. In general, it is apparent that the direction of change in each commodity's consumption level is fairly robust across types of domestic tax policies, while the magnitude of change basically depends on the channel through which each tax type affects household consumption.

Chart 4-16: Variation in the Indian rich household's consumption distribution under ASEAN+3 with the uniform factor tax increase

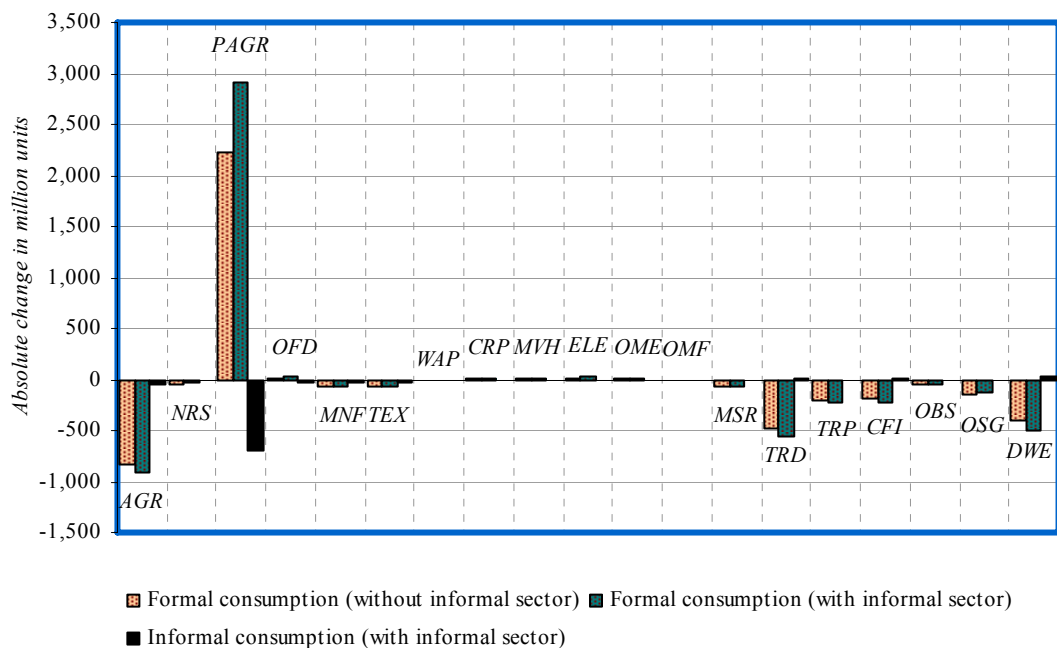


Chart 4-17: Variation in the Indian poor household's consumption distribution under ASEAN+3 with the uniform factor tax increase

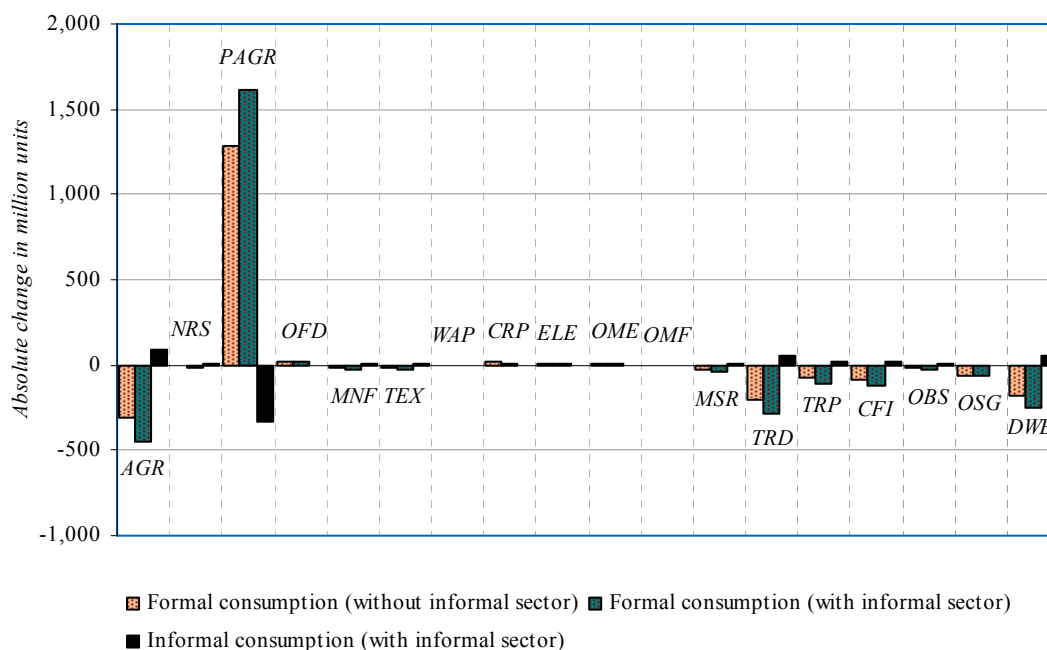


Chart 4-18: Variation in the Indian rich household's consumption distribution under ASEAN+3 with the uniform consumption tax increase

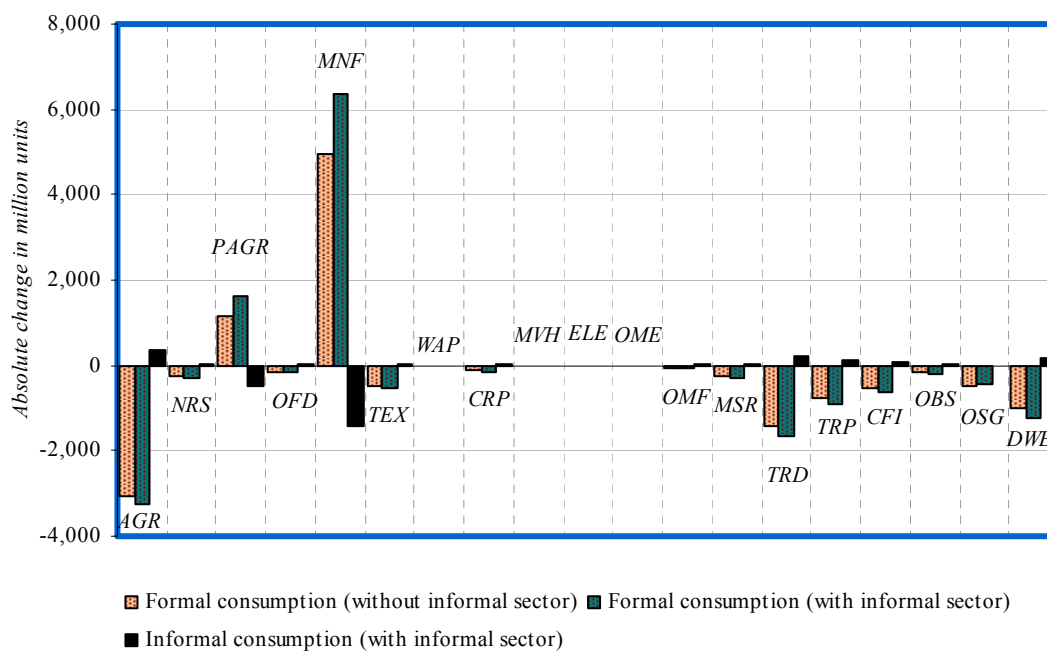


Chart 4-19: Variation in the Indian poor household's consumption distribution under ASEAN+3 with the uniform consumption tax increase

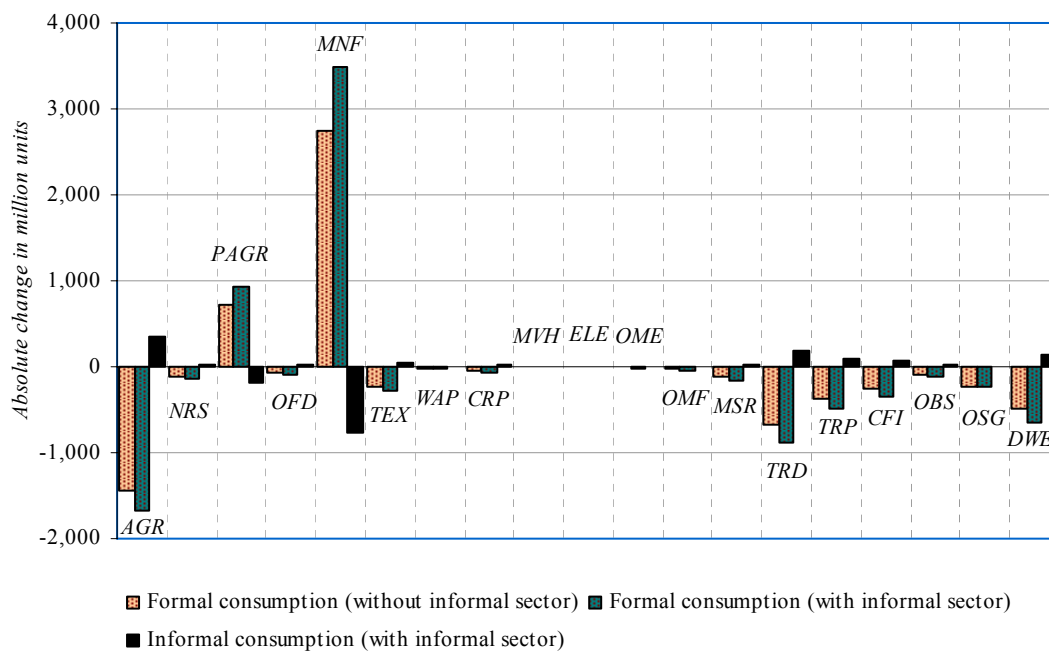


Chart 4-20: Variation in the Indian rich household's consumption distribution under ASEAN+3 with the uniform production tax increase

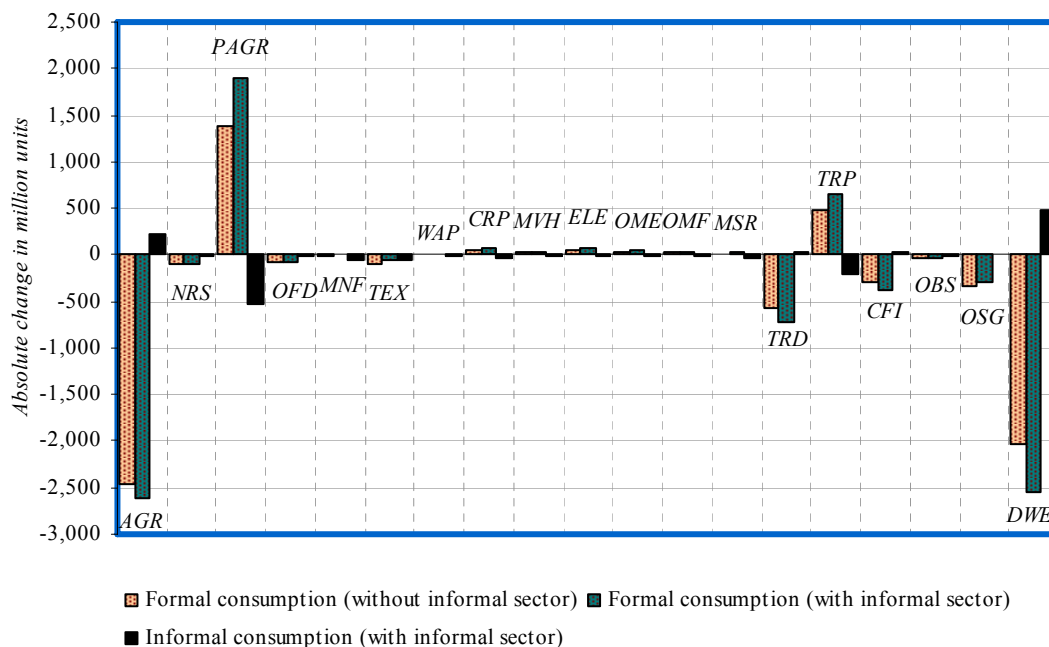
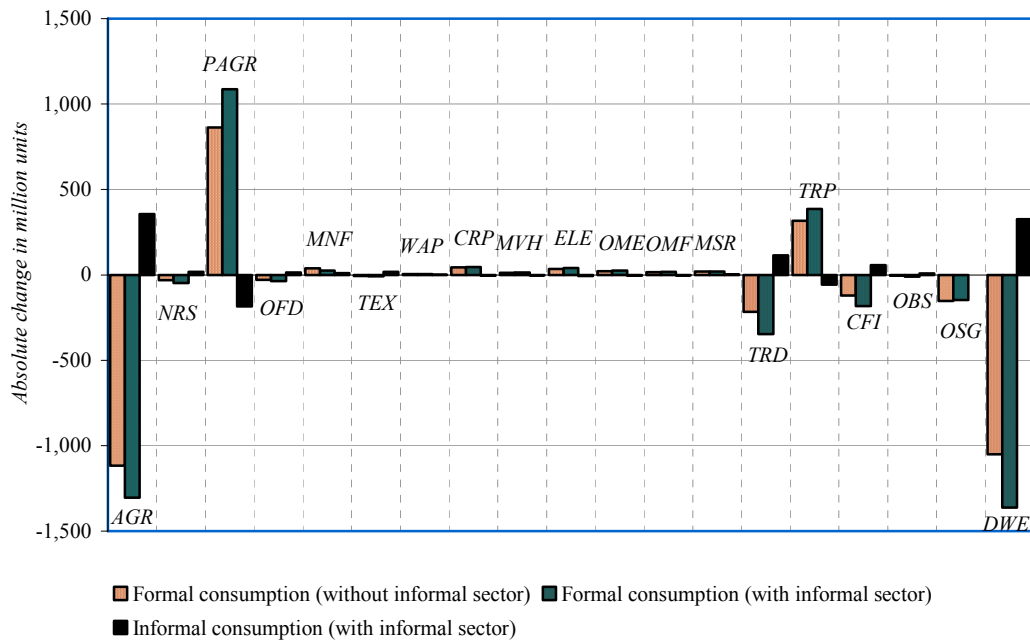


Chart 4-21: Variation in the Indian poor household's consumption distribution under ASEAN+3 with the uniform production tax increase



4.6 Summary

In this chapter, four types of reform to India's domestic tax structure in order to neutralise government revenue under ASEAN+3 have been scrutinised. To recapitulate, the motivation of this study derives from the observation that the Indian government anticipates revenue losses after the preferential trade liberalisation, since import tariffs are one of the major sources of government revenue. If India abides by its WTO commitment not to increase tariffs against other countries outside the grouping, and demand for public spending is consistently high, it is plausible that the government will be induced to change its domestic taxes in order to rebalance its budget. Accordingly, Chapter 4 begins with the analysis of the welfare impacts of individual domestic taxes in a theoretical general equilibrium framework where each country produces only two goods. Firstly, assuming that India is a small country in the world market, the model predicts that there should be no difference in the welfare implications of the four domestic taxes, as long as they are levied on the whole economy without prejudice. However, India would find taxation of goods (i.e. production and consumption taxes) or primary factors (i.e. factor tax) less acceptable than the income tax

since both bias the pattern of demand of domestic economic agents. Hence, we may presume that the broader is the tax base, the less distortionary is the tax policy.

However, if India becomes a large economy, any change in domestic demand and supply induced by a policy reform would lead to changes in world prices (the so-called terms-of-trade effect) and some ambiguity in the net welfare impact of the four tax reforms may be anticipated. Since the rest of the world is also a large economy, the price interaction between the two large economies further complicates the net welfare outcome. However, consumer-related taxes tend to yield better results than producer-related ones.

Chapter 4 subsequently analyses the empirical results of the revenue-neutral ASEAN+3 formation using the CGE approach. As a domestic tax is introduced, the increased public demand especially benefits skilled labour, which is most intensively used in the production of India's public goods. An income tax appears to be the best revenue-neutralising policy for India, as measured by the effects on both real GDP and regional disposable income. Hence, consistent with the theoretical model, imposing a tax on household income seemingly distorts real demand to the least extent. More to the point, the model predicts that an income tax selectively levied on the rich household will yield the same welfare outcome in aggregate terms as an income tax neutrally imposed on the two household types. This is attributable to the fact that the initial income tax structure of India, according to the GTAP 6.0 database, is not biased across households. Thus, the 'selective' income tax reform is the most appropriate policy alternative if the government is to ensure that the poor household benefits from the revenue-neutral ASEAN+3 without reducing the net welfare gain of the country.

Secondly, consumption taxes turn out to be the second-best policy option; given that India's real GDP increases by almost as much as under the income tax reform. However, consumption taxes are less beneficial in terms of regional disposable income, because they have a narrower tax base than an income tax in that they directly and solely reduce private consumption, whereas an income tax reduces expenditures and savings of households neutrally.

Thirdly, factor taxes appear to be the third-best policy tool, since while the regional disposable income falls by nearly as much as under the consumption tax reform, real GDP declines to a stronger extent. Thus, consistent with the prediction in Subsection 4.2.4, factor taxes are more welfare-decreasing since they have a direct negative impact on real production. However, it is noteworthy that levying taxes selectively on factors owned by the rich household is a superior option in aggregate terms, being slightly better than imposing taxes uniformly on all types of factors. This contradicts the prediction in Section 4.2 that an unbiased tax imposition should yield the most desirable welfare outcome. Indeed, the results reflect complications in pinpointing the likely outcomes of individual tax policies in the real world, where cross-sector price interactions may be expected to be complex and somewhat dependent on the economic structure in the initial year.

Finally, production taxes are shown to be the worst choice for India, because the initial production tax structure is comparatively strongly biased across sectors (Table 4-6). Among the three types of production tax reforms, the one that augments tax rates on all sectors by the same proportion gives the best welfare outcome. Since this type of reform effectively increases taxes in a more balanced way, it is once again in keeping with the former prediction that the economy reaps the highest benefits from a 'uniform' tax imposition.

Once the study takes into consideration the existence of the informal economy, which is basically untaxable, the welfare results are greatly altered, since consumers are assumed to switch consumption between formal and informal goods. Accordingly, consumption and production taxes – which are more directly related with the elasticity of substitution between formal and informal commodity demands – lead to a greater increase in output; whereas income and factor taxes yield lower gains in the presence of the informal economy. However, since the extent of the demand shift between formal and informal consumption depends upon the elasticity of substitution, which is externally estimated, it remains an empirical issue whether the same relativity is likely to be replicated for other countries.

CHAPTER 5

CONCLUSIONS

The main conclusions of this thesis are structured as follows. Firstly, Section 5.1 commences with the overview of the results – in respect of the similarities and differences between the predicted and actual outcomes, along with some key policy implications – and then Section 5.2 concludes with the outline of the limitations and areas for future research.

5.1 Overview of the Results and Policy Implications

This set of essays addresses a number of critical issues concerning the effects of preferential trading arrangements on economic welfare, by means of the static computable general equilibrium modelling approach. They explicitly call attention to various characteristics of individual markets that bring about idiosyncratic counterfactual adjustments across types of primary factors, production sectors, and economic regions after a proposed policy change.

Given that CGE models are often criticised for the complexity of the equation system that leads to a lack of clarity of simulation outcomes (Panagariya and Duttagupta, 2001), the first essay initially focuses on the discrepancy in regional economic size, as to how it affects the simulation results of a customs union. It shows that, in a hypothetical framework with a highly controlled dataset, a small region has every incentive to gain preferential market access to a large economy. As observed from the results, the degrees by which trade creation dominates trade diversion, and the customs union improves the terms of trade with the rest of the world, are higher as the scope of the economic integration expands. This is consistent with Brown, Deardorff and Stern (2003), as their CGE model has shown that “the welfare gains from multilateral trade liberalisation are therefore considerably greater than the gains from preferential trading arrangements and more uniformly positive for all countries.” Furthermore, the small region perceives stronger union impacts on domestic production and

consumption in relation to the large one, which would appear to be reasonable, given that the small partner accounts for a very small share of the large region's total trade.

Additionally, suppose that regions outside the union concurrently form another grouping, thereby the world comprises two economic blocs, in each of which members trade freely among themselves while facing substantial inter-bloc trade barriers. Given this circumstance, the gains from the union is proportional to the collective size of other members, at the same time as being inversely proportional to the size of the other grouping. While general equilibrium models of Vanek (1965), Kemp (1969) and Lipsey (1970), and partial equilibrium models of Tovias (1978) and Schiff (1996) reckoned that small members would gain while large ones would lose from a customs union; this study suggests that under the CGE framework, goods supplied from (to) different origins (destinations) are treated as heterogeneous, and thus trade diversion becomes moderate (Konan and Maskus, 1997). As a result, small and large members may both gain from the union, although the introduction of the concurrent formation of another trading bloc by the rest of the world would strongly worsen the welfare of the large member. Therefore, this thesis offered a concise and comprehensive approach to the analysis of the differential country size effect on the welfare outcome of preferential trade integration, and is in line with other studies using the CGE technique, e.g. Kose and Riezman (2000) and Perroni and Whalley (2003).

Although from the results, we can rest assured that it is unequivocally more beneficial for small countries to ally themselves with relatively large economies; political reality has it that the negotiation is prone to failure, by reason of the disparity in the bargaining power and area of interest, on top of the fact that large regions have no real economic motivation to form a union with small countries. Hence, small economies may be advised to negotiate progressively with regions of parallel sizes, while simultaneously lowering tariffs on imports from non-members. This ensures that the union does not trigger retaliation from the rest of the world and thus regional trade liberalisation can ultimately be expanded to the broadest extent. Particularly, as regards the design of a customs union that minimises trade diversion, the

results from the first essay advocate that the reduction of common external tariffs against the rest of the world should be more than sufficient to prevent non-members from adjusting their tariffs against the union or forming another trading bloc in response. In addition, the simulation results suggested that this tendency holds true across various types of market structures, among which the Cournot oligopolistic setting yields the highest welfare gains for union members and non-members alike.

As the first essay shows, the scope of scale economies is a positive determinant of the magnitude of welfare change after a customs union. This point is consistent with Francois and Roland-Holst (1997) and de Bruijn (2006), in that the effects of incorporating scale economies and imperfect competition – such as the decline of market power and the expansion of output in quantity and product variety – are substantial. According to Francois and Roland-Holst (1997), “it is clear that the constant returns, perfect competition paradigm suppresses a number of potentially powerful mechanisms linking trade policy with industry performance.” Hence, regions populated with relatively imperfectly competitive firms tend to reap greater benefits from trade liberalisation, and the gain is further advanced if the government decides concurrently to press forward the competition policy that enables firms to enter or exit the market without constraint. Moreover, we derive further policy implication from the first essay that, in order to enjoy the benefit of preferential trading arrangements to the fullest, the government is recommended to uphold the flexible exchange rate regime and not to compensate for the import tariff revenue loss by raising domestic taxes. Lastly, the sensitivity test confirms that the welfare gains from a regional grouping are proportionate to the extent of tariff removal.

While the policy implication of the first essay is straightforward and generally in keeping with trade theory, the prime concern of this thesis regards the actual application of the CGE analytical framework to the issues of preferential trading arrangements in small developing countries such as Thailand. For that reason, the second essay reconciles the previous model in the first essay with the GTAP 6.0 database. It pays particular attention to the labour market

closure that differs across skill levels of labour and regions; and importantly, the discrepancy in the degree of market competition across production sectors and regions, in order to advance the reflection of economic reality. Thus far, there are numerous multi-region CGE models specifically developed for the ex-ante studies of the economic effects of trade liberalisation. Among which, the most widely recognised one is the standard GTAP model characterised by constant returns to scale and perfect competition (Hertel, 1998); whilst the General Equilibrium Model for Asia's Trade (GEMAT) by Asian Development Bank (2006) and the MIRAGE model by The Centre d'Etudes Prospectives et d'Informations Internationales (CEPII)¹ have recently taken into account the complex features of product differentiation and imperfect competition. Although CGE modellers tend to make the strong assumption that commodity and labour market structures are homogeneous across regions, sectors and skill levels; this CGE model has contributed to the literature by assuming instead that markets can be 'imperfect' and 'heterogeneous' at the same time.

Using the above-mentioned model, the second essay conducts the comparative analysis of the PTAs Thailand has in point of fact concluded with Japan (JTEPA), China (ASEAN+CHINA), India (THAILAND+INDIA), Australia (TAFTA) and New Zealand (TNZCEPA). Although most other studies have focused on ASEAN-based PTA scenarios² – a sensible choice as Thailand's PTAs were initiated mostly for political rather than economic reasons (Sally, 2007) – it is imperative to comprehensively understand the welfare effects of the above five Thai PTAs, both at the sectoral and regional levels.

Since official statistics have revealed that Thai industries are predominantly operated under perfect competition, in accordance with the simulation outcomes from the first essay, it is predicted that Thailand almost certainly expects less welfare gains from TAFTA, TNZCEPA,

¹ See Decreux and Valin (2007) for the description of the updated MIRAGE model.

² For example, see Urata and Kiyota (2003); Mohanty, Pohit and Roy (2004); Gilbert, Scollay and Bora (2004); Cheong (2005); Bhir and Fouquin (2006); McDonald, Robinson and Thierfelder (2007) and Francois and Wignaraja (2008) for recent studies of ASEAN-based FTAs using the CGE approach.

JTEPA, ASEAN+CHINA, and THAILAND+INDIA, in comparison with other types of imperfectly competitive market structures, namely, Cournot oligopoly with firm mobility barriers, or monopolistic competition without them. Besides, in reality, most of the above Thai FTAs are negotiated among nations regarded as ‘small’ in relation to the rest of the world; and FTA commitments concluded – even on the bilateral basis – are normally not comprehensive as they involve extensive lists of sensitive and highly sensitive product lines not subject to tariff removal. Therefore, not surprisingly, the scale of welfare improvement perceived by FTA counterparts in the second essay turns out to be positive yet negligible in real terms, at the same time as non-members and the world as a whole are mostly unaffected by the proposed trade policy change. Hence, albeit the fact that Thailand has vigorously advocated each and every form of trade liberalisation and opted for the flexible exchange rate regime since the 1997 Asian Financial Crisis, the simulation results from the second essay has implied that it is certainly necessary for Thailand to involve herself in FTA negotiations of a larger scale, if the country is to benefit from free trade in a substantial way. More to the point, trade creation is actually most enhanced and trade diversion is most diminished when Thailand allies herself with large economies with sizeable capacity to trade such as Japan and China under JTEPA and ASEAN+CHINA. This contrasts with the less expected benefits on the Thai economy under the bilateral FTA with India, TAFTA with Australia, and TNZCEPA with New Zealand.

Another concern is raised over the direction of output adjustment in each production sector after manifold preferential trade policy shocks. To be precise, except for the non-traded sector that typically contracts after the shock, the change in production pattern of the tradable sector apparently differs across types of FTAs. For instance, the production of processed agricultural goods (*PAGR*) in Thailand expands by almost 30% under JTEPA, moderately rises under THAILAND+INDIA and TAFTA, but contracts under TNZCEPA and ASEAN+CHINA. This type of sectoral discrepancy unavoidably incurs adjustment costs to the economy, which may not be trivial in cumulative terms. Given the fact that the rules of origin have already

complicated the combined welfare effects of FTAs concurrently in force, confusion can be minimised if the Thai government discloses the roadmap of the country's FTA negotiations to the public prior to the actual signings, and attempts to amalgamate the rules of origin across the existing FTAs.

The third essay moves the discussion to the means of government revenue neutralisation in the event of the trading bloc formation. In this case, India is chosen as an instance of a region that is worse off in terms of EV after joining an FTA. Hence, it is in addressing the efficiency of domestic policy choices that this essay seeks to make a contribution. Nonetheless, on the whole, the policy implication is not straightforward, because the efficacy of each revenue-rebalancing domestic tax policy is varied with the size of the informal economy, which is untaxable by definition. If tax evasion is prevalent in some sectors, introducing a domestic tax primarily on these sectors will entail policy inefficacy, compared with imposing a new tax on domestic sectors with more formal activities. In addition, the value of the elasticity of substitution between final demands for formal and informal goods plays a major role in the simulation results. High substitution elasticity implies more flexibility for consumers to shift to informal good consumption, and hence policy efficacy is ambiguous unless we obtain an accurate estimate of this elasticity. As such, it is difficult to identify exactly which tax policy is best for the maintenance of government revenue balance. However, the simulation results in the third essay are seemingly in keeping with those derived from the first essay, in that the ensuing expansion of the public sector normally hampers the positive changes in real GDP and EV after the launching of an FTA. For that reason, the government is advised not to manipulate the domestic tax policy unless the level of government spending is seriously in difficulty as a result of preferential tariff removal.

5.2 Limitations and Extensions for Future Research

Thus far, this thesis has examined numerous aspects of preferential trading arrangements and their effects on commodity and primary factor markets, rich and poor households, and overall

welfare of individual regions and the world as a whole. Whilst the CGE analysis is carefully conducted and the modelling approach is in tune with economic reality, the limitations of this research are chiefly attributable to the intrinsic characteristics of CGE models. Although it can be laborious trying to resolve some technical issues, it is reckoned that a number of model improvements with respect to the precision of the predictions of trade policy outcomes can certainly be achieved.

The first set of limitations is concerned with the modelling of trade policy measures. As trade and protection data in this thesis are simply derived from the GTAP 6.0 database, the study has reconciled the CGE model with the GTAP specification in that Non-Tariff Barriers (NTBs) including quota restrictions are not explicitly modelled but instead transformed into tariff-equivalent protections, which in actuality partially account for customs tariffs on imports. As such, in order to examine the direct impact of quota removal on the economy, quota restrictions ought to be incorporated into the current CGE model in its original forms. This point is firmly justified since trade theory has resolutely vindicated the argument that quota restrictions yield different welfare effects on income distribution from import tariffs and tend to be more distortionary in general. Besides, this specific type of policy modelling should be applicable to a wide range of empirical FTA analyses, since FTA negotiations commonly include either the reduction or removal of quota restrictions. Although, it is noteworthy that the GTAP data on border protection will no longer be relevant as this feature is taken into account, and it requires a certain amount of effort on the redefinition and hence the recalibration of the benchmark border protection data in order that they become exclusive of quota restrictions.

In addition to the above limitation in the incorporation of trade quota to the existing model, it is also the case that under the CGE framework, the quantification of various qualitative FTA commitments which are embraced by negotiating partners on a regular basis – for instance, the rules of origin and the reciprocal facilitation in government procurement, customs procedure, paperless trading, Foreign Direct Investment (FDI) and numerous kinds of

technical assistance – is extremely difficult, if not impossible. At the same time, trade economists recognise the long-term benefits of the afore-mentioned commitments, especially in terms of trade and real output expansion. For that reason, greater efforts on future research in this area are duly required for the advancement of the current understanding on the economic consequences of those FTA commitments which are normally unquantifiable. In particular, the FTA commitment on FDI facilitation should be regarded as one of the most prioritised research topics, as its economic benefits are likely to be fairly substantial in the long run. Accordingly, in order to address the FTA effect on FDI, there are a number of modifications to be made. First of all, multinational firms will be brought into existence, since capital is no longer identified as a region-specific production factor. As a result, the earlier assumption that foreign savings and international capital flows are exogenous should become invalidated. Hence, the explicit modelling of multinational firms and cross-country investment demands the restructuring of the monetary market which remains primitive in most CGE models. Importantly, firms should be allowed to allocate directly profits to overseas investment, instead of investing through the representative regional bank, which basically fixes the amount of foreign saving while concentrating on domestic investment. Concurrently, steps toward the dynamic CGE modelling will soon be imperative, due to the fact that capital accumulation greatly accounts for the long-term benefits of FDI promotion within a trading bloc.

Another alternative for the current CGE model enhancement is to incorporate the heterogeneous firm assumption proposed by Melitz (2003) which essentially states that strong firms are comparatively capable of exportation while incompetent ones tend to supply mostly towards the domestic market. Intuitively, this feature may be explored through the re-specification of the CES production function so that it additionally includes the efficiency parameter which is heterogeneous across individual firms. Since the modification obviously requires a colossal amount of data calibration at the firm level, it is doubtful whether the idea is practical. Nevertheless, on the modelling end, the problem is worth attention in

consideration of the fact that even the production functions of firms under monopolistic competition with heterogeneous products themselves are not truly heterogeneous, leaving alone those under perfect and Cournot oligopoly. Therefore, there is scope for improvement in the modelling of heterogeneous firms within individual sectors.

Some other modelling issues for future research include the enrichment of the structure of the informal sector, which was strictly defined as the untaxable economy in the present version, in combination with the refinement of its relationship with the formal economy. Specifically, to improve the flexibility of the model in terms of its responsiveness to a policy change, the consumer demand function may be redefined in order that leisure is also included in the bundle of consumption options, or informal labour may be remodelled to explicitly account for the second-job holding. Alternatively, the modelling of the informal economy may be extended to the income distribution analysis which perhaps requires that the household is to be further disaggregated in accordance with profession, income and geography. Lastly, the inclusion and calibration of the informal sector in other developing countries which are expected to have a sizable degree of tax evasion similar to India may be implemented and compared with the previous simulation outcomes for the Indian economy.

The second set of limitations is mainly associated with the data constraint. To a certain extent, most CGE models suffer from the accuracy issue concerning the estimation of parameters and variables in the benchmark year, which are collected from various external resources and may not be strictly consistent due to inconsistent data compilation methods. Besides, it remains doubtful whether we can take the data which are simply calibrated at a random point as if the economy must be in equilibrium. Thus, in future research we may endeavour to enhance data consistency by estimating initial values for a number of countries of interest using data from relatively updated and reliable sources.

The remainder of the limitations are concerned with the sensitivity analysis of CGE models. Although the scale and complexity of the CGE modelling system require that the selection of functional forms and closure rules is transparent, simple and straightforward on the whole,

there is no proper facility to substantiate that they are appropriately chosen for specific types of economies. Coupled with the fact that the determinants of welfare gains from individual FTAs are vaguely articulated for the CGE framework, we may further supplement the findings in this thesis with some relevant results from econometric models specifically designed for the afore-mentioned purposes. However, this line of extension ought to be conducted after the FTAs under consideration have taken effect for a certain amount of time.

APPENDICES

Appendix to Chapter 2

Appendix A2-1: Technical Specifications of the CGE Model Designed for Market Size Simulations

Notations:

- Regions (*reg* or *regg*) are endowed with sectors/goods (*sec* or *secc*), of which the subset *secT* is tradable and the subset *secTN* is non-tradable. Sectors demand primary factors (*fac*), of which the subset *facM* is mobile domestically but not internationally, and the subset *facS* is sector-specific.
- Following the GAMS syntax, double quotation marks (" and ") are used to denote a particular element in one of the sets of factors (*fac*), sectors (*sec*) or regions (*reg*). Hence, “ $PFM^{L,reg}$ ” represents the price of the mobile factor ‘labour’ in region *reg*.
- In some equation blocks, particular parameters (variables) are appended with the dollar options (\$), used in GAMS to identify conditions for these parameters (variables) to be incorporated into the model. If the conditions are not met, then the parameters (variables) will be set to zero. For example, “ $PFM^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac)$ ” tells GAMS to use the former price if the factor is mobile, and the latter price otherwise. Furthermore, “ $\$SameAs(fac, "L")$ ” specifies that the preceding parameters (variables) are to be used only when the element of the factor set (*fac*) is ‘labour.’
- Benchmark values of variables are indicated by appending the number ‘0’. These variables are endogenous in general but their benchmark values may be used in defining other equations such as the wage curve and the consumer price index.

- For simplicity, all factor demands are referred to as $F_{sec}^{fac,reg}$, with ‘fixed’ sector-specific factor demands identified by a ‘bar’ over the factor name (i.e. $\overline{F}_{sec}^{fac,reg}$).

Parameters

| | |
|--------------------------------|---|
| $\alpha_{HH_{sec}}^{reg}$ | Households’ Cobb-Douglas commodity budget shares |
| $\alpha_{CG_{sec}}^{reg}$ | Government’s Cobb-Douglas commodity budget shares |
| $\alpha_{I_{sec}}^{reg}$ | Bank’s Cobb-Douglas commodity budget shares |
| $io_{sec,sec}^{reg}$ | Leontief intermediate demand coefficients |
| $\sigma_{F_{sec}}^{reg}$ | CES substitution elasticity of the value-added production function |
| $a_{F_{sec}}^{reg}$ | CES efficiency parameters of the value-added production function |
| $\gamma_{F_{sec}}^{fac,reg}$ | CES share parameters of factors in the value-added production function |
| $\sigma_{A_{sec}}^{reg}$ | Substitution elasticity of the upper-level Armington function |
| $a_{A_{sec}}^{reg}$ | Efficiency parameters of the upper-level Armington function |
| $\gamma_{AM_{sec}}^{reg}$ | Share parameters of imports in the upper-level Armington function |
| $\gamma_{AD_{sec}}^{reg}$ | Share parameters of domestically-produced goods in the upper-level Armington function |
| $\sigma_{BM_{sec}}^{reg}$ | Substitution elasticity of the lower-level Armington function |
| $a_{BM_{sec}}^{reg}$ | Efficiency parameters of the lower-level Armington function |
| $\gamma_{BM_{sec}}^{reg,regg}$ | Share parameters of bilateral imports in the lower-level Armington function |
| ω^{reg} | Wage curve elasticity |
| $trep^{reg}$ | Replacement rates |
| mps^{reg} | Households’ marginal propensity to save |
| ty^{reg} | Income tax rates |
| tc_{sec}^{reg} | Commodity tax rates |
| $tf_{sec}^{fac,reg}$ | Factor tax rates |
| $tm_{sec}^{reg,regg}$ | Import tariff rates |

Exogenous variables

| | |
|---------------------------------|--|
| $\overline{FS}^{fac,reg}$ | Factor endowments (by region) |
| $\overline{F}_{sec}^{facS,reg}$ | Sector-specific factor demands (by sector) |
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |

Endogenous variables

| | |
|------------------------|--|
| $PFM^{fac,reg}$ | Mobile factor prices |
| $PFS_{sec}^{fac,reg}$ | Sector-specific factor prices |
| PA_{sec}^{reg} | Armington composite commodity prices |
| PZ_{sec}^{reg} | Output prices |
| PD_{sec}^{reg} | Prices of domestically-produced goods delivered to the home market |
| PM_{sec}^{reg} | Import prices in home currency |
| PE_{sec}^{reg} | Export prices in home currency |
| $PBM_{sec}^{reg,regg}$ | Prices of bilateral imports by region <i>reg</i> from region <i>regg</i> in home currency |
| $PBE_{sec}^{reg,regg}$ | Prices of bilateral exports from region <i>reg</i> to region <i>regg</i> in home currency |
| $PWE_{sec}^{reg,regg}$ | Prices of bilateral exports from region <i>reg</i> to region <i>regg</i> in world currency |
| EXC^{reg} | Exchange rates |
| $F_{sec}^{facM,reg}$ | Mobile factor demands |
| QA_{sec}^{reg} | Armington composite commodity quantities |
| QZ_{sec}^{reg} | Output quantities |
| QDS_{sec}^{reg} | Quantities of domestically-produced goods supplied to the home market |
| QDD_{sec}^{reg} | Quantities of domestically-produced goods demanded by the home market |
| QM_{sec}^{reg} | Import volumes |
| QE_{sec}^{reg} | Export volumes |
| $QBM_{sec}^{reg,regg}$ | Bilateral import volumes by region <i>reg</i> from region <i>regg</i> |
| $QBE_{sec}^{reg,regg}$ | Bilateral export volumes from region <i>reg</i> to region <i>regg</i> |

| | |
|------------------|---|
| INC^{reg} | Household income |
| $TREV^{reg}$ | Total tax revenue |
| S^{reg} | Total savings |
| $CBUD^{reg}$ | Household consumption budget |
| C_{sec}^{reg} | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{reg}$ | Unemployed labour |

Numéraires

| | |
|-------------------------|---------------------------------|
| \overline{CPI}^{reg} | Laspeyre consumer price indices |
| \overline{EXC}^{REG1} | Exchange rate of region $REG1$ |

Equations

Firms' CES factor demands:

$$F_{sec}^{fac,reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac,reg}}{(1 + t_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac))} \right)^{\sigma F_{sec}^{reg}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac,reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1 + t_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac)}{PFM_{sec}^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac)} \right)^{1 - \sigma F_{sec}^{reg}} \right] \right\}^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}}$$

Firms' zero-profit conditions:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1 + t_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac)) \cdot F_{sec}^{fac,reg} + \sum_{sec c} PA_{sec c}^{reg} \cdot (io_{sec c, sec}^{reg} \cdot QZ_{sec}^{reg})$$

Households' Cobb-Douglas commodity demands:

$$(1 + t_{\text{sec}T}^{\text{reg}}) \cdot PA_{\text{sec}T}^{\text{reg}} \cdot C_{\text{sec}T}^{\text{reg}} = \alpha HH_{\text{sec}T}^{\text{reg}} \cdot CBUD^{\text{reg}}$$

Government's Cobb-Douglas commodity demands:

$$PA_{\text{sec}TN}^{\text{reg}} \cdot CG_{\text{sec}TN}^{\text{reg}} = \alpha CG_{\text{sec}TN}^{\text{reg}} \cdot \underbrace{\left(TREV^{\text{reg}} - TRNF^{\text{reg}} - \overline{SG}^{\text{reg}} \cdot \overline{CPI}^{\text{reg}} \right)}_{\text{Government budget: } CGBUD^{\text{reg}}}$$

Bank's Cobb-Douglas commodity demands:

$$PA_{\text{sec}T}^{\text{reg}} \cdot I_{\text{sec}T}^{\text{reg}} = \alpha I_{\text{sec}T}^{\text{reg}} \cdot S^{\text{reg}}$$

Homogeneous commodity supply to domestic and overseas markets:

$$PZ_{\text{sec}}^{\text{reg}} \cdot QZ_{\text{sec}}^{\text{reg}} = PD_{\text{sec}}^{\text{reg}} \cdot QDS_{\text{sec}}^{\text{reg}} + \left(PE_{\text{sec}}^{\text{reg}} \cdot QE_{\text{sec}}^{\text{reg}} \right) \$\text{sec}T(\text{sec})$$

$$PE_{\text{sec}T}^{\text{reg}} \cdot QE_{\text{sec}T}^{\text{reg}} = \sum_{\text{regg} (\neq \text{reg})} PBE_{\text{sec}T}^{\text{reg}, \text{regg}} \cdot QBE_{\text{sec}T}^{\text{reg}, \text{regg}}$$

$$PZ_{\text{sec}T}^{\text{reg}} = PD_{\text{sec}T}^{\text{reg}} = PE_{\text{sec}T}^{\text{reg}} = PBE_{\text{sec}T}^{\text{reg}, \text{regg}}$$

$$QDS_{\text{sec}TN}^{\text{reg}} = QZ_{\text{sec}TN}^{\text{reg}}$$

Upper-level Armington functions:

Domestically-produced commodity demands:

$$QDD_{\text{sec}}^{\text{reg}} = \left[\left(a_{\text{sec}}^{\text{reg}} \right)^{\sigma_{\text{sec}}^{\text{reg}} - 1} \cdot \left(\frac{\gamma AD_{\text{sec}}^{\text{reg}} \cdot PA_{\text{sec}}^{\text{reg}}}{PD_{\text{sec}}^{\text{reg}}} \right)^{\sigma_{\text{sec}}^{\text{reg}}} \cdot QA_{\text{sec}}^{\text{reg}} \right] \$\text{sec}T(\text{sec}) + \left[QA_{\text{sec}}^{\text{reg}} \right] \$\text{sec}TN(\text{sec})$$

Aggregate import demands:

$$QM_{\text{sec}T}^{\text{reg}} = \left(a_{\text{sec}T}^{\text{reg}} \right)^{\sigma_{\text{sec}T}^{\text{reg}} - 1} \cdot \left(\frac{\gamma AM_{\text{sec}T}^{\text{reg}} \cdot PA_{\text{sec}T}^{\text{reg}}}{PM_{\text{sec}T}^{\text{reg}}} \right)^{\sigma_{\text{sec}T}^{\text{reg}}} \cdot QA_{\text{sec}T}^{\text{reg}}$$

Balancing conditions for upper-level Armington demands:

$$PA_{\text{sec}}^{\text{reg}} \cdot QA_{\text{sec}}^{\text{reg}} = PD_{\text{sec}}^{\text{reg}} \cdot QDD_{\text{sec}}^{\text{reg}} + \left(PM_{\text{sec}}^{\text{reg}} \cdot QM_{\text{sec}}^{\text{reg}} \right) \$\text{sec}T(\text{sec})$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg,regg} = \left(aBM_{secT}^{reg} \right)^{\sigma_{secT}^{reg} - 1} \cdot \left(\frac{\gamma BM_{secT}^{reg,regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma_{secT}^{reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} = \overline{FS}^{fac,reg} - UNEMP^{reg} \$(fac = "L")$$

Armington commodity markets:

$$\left(C_{sec}^{reg} + I_{sec}^{reg} + \sum_{sec c} io_{sec,sec c}^{reg} \cdot QZ_{sec c}^{reg} \right) \$secT(sec) + CG_{sec}^{reg} \$secTN(sec) = QA_{sec}^{reg}$$

Domestically-produced commodity supply and demand:

$$QDS_{sec}^{reg} = QDD_{sec}^{reg}$$

Bilateral trade:

$$QBE_{secT}^{reg,regg} = QBM_{secT}^{regg,reg}$$

Balance of payments:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg,regg} \cdot PWE_{secT}^{reg,regg} \right) + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}$$

Wage curve:

$$\frac{PFM^{L,reg}}{PFM0^{L,reg}} - 1 = \omega^{reg} \cdot \left[\left(\frac{UNEMP^{reg}}{UNEMPO^{reg}} \right) - 1 \right]$$

Household income:

$$INC^{reg} = \sum_{sec} \sum_{fac} \left(PFM^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac) \right) \cdot F_{sec}^{fac,reg} + TRNF^{reg}$$

Household consumption budget:

$$CBUD^{reg} = (1 - ty^{reg}) \cdot INC^{reg} - SHH^{reg}$$

Household savings:

$$SHH^{reg} = mps^{reg} \cdot \left[(1 - ty^{reg}) \cdot INC^{reg} \right]$$

Total savings:

$$S^{reg} = SHH^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}$$

Government tax revenue:

$$TRFV^{reg} = \underbrace{ty^{reg} \cdot INC^{reg}}_{\text{Income taxes: } TRY^{reg}} + \sum_{secT} \underbrace{tc_{secT}^{reg} \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg}}_{\text{Commodity taxes: } TRC^{reg}} + \sum_{secT} \sum_{regg(\neq reg)} \underbrace{tm_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg} \cdot QBM_{secT}^{reg,regg}}_{\text{Import tariffs: } TRM^{reg}} + \underbrace{\sum_{sec} \sum_{fac} tf_{sec}^{fac,reg} \cdot \left(PFM^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac) \right) \cdot F_{sec}^{fac,reg}}_{\text{Factor taxes: } TRF^{reg}}$$

Government's transfer to the household:

$$TRNF^{reg} = trep^{reg} \cdot PFM^{L,reg} \cdot UNEMP^{reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index:

$$\overline{CPI}^{reg} = \frac{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA_{sec}^{reg} \cdot C0_{sec}^{reg}}{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA0_{sec}^{reg} \cdot C0_{sec}^{reg}}$$

Bilateral export price:

$$PBE_{secT}^{reg,regg} = PWE_{secT}^{reg,regg} \cdot EXC^{reg}$$

Bilateral import price:

$$PBM_{secT}^{reg,regg} = (1 + tm_{secT}^{reg,regg}) \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg}$$

Appendix A2-2: If $MC(X) < AC(X)$ then $AC(X)$ is a Decreasing Function of X .

Let the total cost function of X be $C(X)$.

Then the marginal cost function is $MC(X) = \frac{dC(X)}{d(X)}$,

and the average cost function is $AC(X) = \frac{C(X)}{X}$.

The derivative of $AC(X)$ with respect to X is:

$$\frac{dAC(X)}{dX} = \frac{d}{dX} \left(\frac{C(X)}{X} \right) = \frac{X \left(\frac{dC(X)}{dX} \right) - C(X)}{X^2}.$$

This will be negative if $X \left(\frac{dC(X)}{dX} \right) - C(X) < 0$, that is if $\frac{dC(X)}{dX} - \frac{C(X)}{X} < 0$.

Therefore, $AC(X)$ is a decreasing function of X if marginal cost is less than average cost, i.e. $MC(X) < AC(X)$.

Appendix A2-3: Technical Specifications of the CGE Model Designed for Market Structure Simulations

Regions (*reg* or *regg*) are endowed with sectors/goods (*sec* or *secc*), of which the subset *secT* is tradable and the subset *secTN* is non-tradable (as in Appendix A2-1). In addition, *pc* stands for the perfectly competitive subset of sectors, and *ic* for the imperfectly competitive sector. As with Appendix A2-1, sectors demand primary factors (*fac*), of which *facM* is mobile domestically but not internationally, and *facS* is sector-specific.

(A) Cournot Oligopoly with Homogeneous Goods (Free Firm Mobility)

This model is based upon the perfectly competitive model specified in Appendix A2-1, but has additional oligopolistic features, which are shown in bold type below.

Parameters

| | |
|------------------------------|---|
| $\alpha_{sec}^{HH,reg}$ | Households' Cobb-Douglas commodity budget shares |
| $\alpha_{sec}^{CG,reg}$ | Government's Cobb-Douglas commodity budget shares |
| $\alpha_{sec}^{I,reg}$ | Bank's Cobb-Douglas commodity budget shares |
| $i_{sec,sec}^{reg}$ | Leontief intermediate demand coefficients |
| $\sigma_{sec}^{F,reg}$ | CES substitution elasticity of the value-added production function |
| $a_{sec}^{F,reg}$ | CES efficiency parameters of the value-added production function |
| $\gamma_{sec}^{fac,reg}$ | CES share parameters of factors in the value-added production function |
| $\sigma_{sec}^{A,reg}$ | Substitution elasticity of the upper-level Armington function |
| $a_{sec}^{A,reg}$ | Efficiency parameters of the upper-level Armington function |
| $\gamma_{sec}^{AM,reg}$ | Share parameters of imports in the upper-level Armington function |
| $\gamma_{sec}^{AD,reg}$ | Share parameters of domestically-produced goods in the upper-level Armington function |
| $\sigma_{sec}^{BM,reg}$ | Substitution elasticity of the lower-level Armington function |
| $a_{sec}^{BM,reg}$ | Efficiency parameters of the lower-level Armington function |
| $\gamma_{sec}^{BM,reg,regg}$ | Share parameters of bilateral imports in the lower-level Armington function |
| ω^{reg} | Wage curve elasticity |
| $trep^{reg}$ | Replacement rates |
| mps^{reg} | Households' marginal propensity to save |
| ty^{reg} | Income tax rates |
| tc_{sec}^{reg} | Commodity tax rates |
| $tf_{sec}^{fac,reg}$ | Factor tax rates |
| $tm_{sec}^{reg,regg}$ | Import tariff rates |
| $ff_{sec}^{fac,reg}$ | Fixed factor inputs demanded by each firm in Cournot sector <i>sec</i> |

Exogenous variables

| | |
|---------------------------------|--|
| $\overline{FS}^{fac,reg}$ | Factor endowments (by region) |
| $\overline{F}_{sec}^{facS,reg}$ | Sector-specific factor demands (by sector) |
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |

Endogenous variables

| | |
|-----------------------------------|--|
| $\overline{PFM}^{fac,reg}$ | Mobile factor prices |
| $\overline{PFS}_{sec}^{fac,reg}$ | Sector-specific factor prices |
| $\overline{PA}_{sec}^{reg}$ | Armington composite commodity prices |
| $\overline{PZ}_{sec}^{reg}$ | Output prices |
| $\overline{PD}_{sec}^{reg}$ | Prices of domestically-produced goods delivered to the home market |
| $\overline{PM}_{sec}^{reg}$ | Import prices in home currency |
| $\overline{PE}_{sec}^{reg}$ | Export prices in home currency |
| $\overline{PBM}_{sec}^{reg,regg}$ | Prices of bilateral imports by region <i>reg</i> from region <i>regg</i> in home currency |
| $\overline{PBE}_{sec}^{reg,regg}$ | Prices of bilateral exports from region <i>reg</i> to region <i>regg</i> in home currency |
| $\overline{PWE}_{sec}^{reg,regg}$ | Prices of bilateral exports from region <i>reg</i> to region <i>regg</i> in world currency |
| \overline{EXC}^{reg} | Exchange rates |
| $\overline{F}_{sec}^{facM,reg}$ | Mobile factor demands |
| $\overline{QA}_{sec}^{reg}$ | Armington composite commodity quantities |
| $\overline{QZ}_{sec}^{reg}$ | Output quantities |
| $\overline{QDS}_{sec}^{reg}$ | Quantities of domestically-produced goods supplied to the home market |
| $\overline{QDD}_{sec}^{reg}$ | Quantities of domestically-produced goods demanded by the home market |
| $\overline{QM}_{sec}^{reg}$ | Import volumes |
| $\overline{QE}_{sec}^{reg}$ | Export volumes |
| $\overline{QBM}_{sec}^{reg,regg}$ | Bilateral import volumes by region <i>reg</i> from region <i>regg</i> |

| | |
|-------------------------|---|
| $QBE_{sec}^{reg, regg}$ | Bilateral export volumes from region reg to region $regg$ |
| INC^{reg} | Household income |
| $TREV^{reg}$ | Total tax revenue |
| S^{reg} | Total savings |
| $CBUD^{reg}$ | Household consumption budget |
| C_{sec}^{reg} | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{reg}$ | Unemployed labour |
| EDM_{sec}^{reg} | Price elasticity of demand for Cournot commodities |
| NOF_{sec}^{reg} | Number of firms in Cournot sectors |

Numéraires

| | |
|-------------------------|---------------------------------|
| \overline{CPI}^{reg} | Laspeyre consumer price indices |
| \overline{EXC}^{REG1} | Exchange rate of region $REG1$ |

Equations

Firms' CES factor demands:

$$F_{sec}^{fac, reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac, reg}}{(1 + tf_{sec}^{fac, reg}) \cdot (PFM_{sec}^{fac, reg} \$ facM(fac) + PFS_{sec}^{fac, reg} \$ facS(fac))} \right)^{\sigma F_{sec}^{reg}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac, reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1 + tf_{sec}^{fac, reg}) \cdot \left(\frac{PFM_{sec}^{fac, reg} \$ facM(fac)}{+ PFS_{sec}^{fac, reg} \$ facS(fac)} \right) \right]^{1 - \sigma F_{sec}^{reg}} \right\}^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}} + (ff_{sec}^{fac, reg} \cdot NOF_{sec}^{reg}) \$ ic(sec)$$

Firms' zero-profit conditions:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} \left(1 + t_{sec}^{fac,reg}\right) \cdot \left(PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)\right) \cdot F_{sec}^{fac,reg} \\ + \sum_{sec\ c} PA_{sec\ c}^{reg} \cdot \left(io_{sec\ c,sec}^{reg} \cdot QZ_{sec}^{reg}\right)$$

Cournot firms' price-markup conditions:

$$PZ_{ic}^{reg} \cdot \left(1 - \frac{1}{EDM_{ic}^{reg} \cdot NOF_{ic}^{reg}}\right) = \sum_{fac} \left\{ \begin{array}{l} \left(1 + t_{ic}^{fac,reg}\right) \times \left(\begin{array}{l} PFM_{ic}^{fac,reg} \$facM(fac) \\ + PFS_{ic}^{fac,reg} \$facS(fac) \end{array} \right) \\ \times \frac{F_{ic}^{fac,reg} - (ff_{ic}^{fac,reg} \cdot NOF_{ic}^{reg})}{QZ_{ic}^{reg}} \end{array} \right\} + \sum_{sec} PA_{sec}^{reg} \cdot io_{sec,ic}^{reg}$$

Cournot price elasticity of demand:

$$EDM_{ic}^{reg} = \left\{ \begin{array}{l} \frac{QDD_{ic}^{reg}}{QZ_{ic}^{reg}} \left(\sigma A_{ic}^{reg} - (\sigma A_{ic}^{reg} - 1) \frac{PD_{ic}^{reg} \cdot QDD_{ic}^{reg}}{PA_{ic}^{reg} \cdot QA_{ic}^{reg}} \right) \\ + \sum_{\substack{regg \\ (\neq reg)}} \frac{QBM_{ic}^{regg,reg}}{QZ_{ic}^{reg}} \left(\begin{array}{l} \sigma BM_{ic}^{regg} - \frac{PBM_{ic}^{regg,reg} \cdot QBM_{ic}^{regg,reg}}{PM_{ic}^{regg} \cdot QM_{ic}^{regg}} \\ (\sigma BM_{ic}^{regg} - \sigma A_{ic}^{regg}) \\ - \frac{PBM_{ic}^{regg,reg} \cdot QBM_{ic}^{regg,reg}}{PA_{ic}^{regg} \cdot QA_{ic}^{regg}} \cdot (\sigma A_{ic}^{regg} - 1) \end{array} \right) \end{array} \right\} \$ (QM0_{ic}^{reg} \neq 0) \\ + \frac{CG_{ic}^{reg}}{QZ_{ic}^{reg}} \$ (QM0_{ic}^{reg} = 0)$$

Households' Cobb-Douglas commodity demands:

$$(1 + t_{secT}^{reg}) \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg} = \alpha HH_{secT}^{reg} \cdot CBUD^{reg}$$

Government's Cobb-Douglas commodity demands:

$$PA_{secTN}^{reg} \cdot CG_{secTN}^{reg} = \alpha CG_{secTN}^{reg} \cdot \underbrace{\left(TREV^{reg} - TRNF^{reg} - \overline{SG}^{reg} \cdot \overline{CPI}^{reg} \right)}_{\text{Government budget: } CGBUD^{reg}}$$

Bank's Cobb-Douglas commodity demands:

$$PA_{secT}^{reg} \cdot I_{secT}^{reg} = \alpha I_{secT}^{reg} \cdot S^{reg}$$

Homogeneous commodity supply to domestic and overseas markets:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = PD_{sec}^{reg} \cdot QDS_{sec}^{reg} + \left(PE_{sec}^{reg} \cdot QE_{sec}^{reg} \right) \$secT(sec)$$

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg(\neq reg)} PBE_{secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

$$PZ_{secT}^{reg} = PD_{secT}^{reg} = PE_{secT}^{reg} = PBE_{secT}^{reg,regg}$$

$$QDS_{secTN}^{reg} = QZ_{secTN}^{reg}$$

Upper-level Armington functions:

Domestically-produced commodity demands:

$$QDD_{sec}^{reg} = \left[\left(aA_{sec}^{reg} \right)^{\sigma A_{sec}^{reg} - 1} \cdot \left(\frac{\gamma AD_{sec}^{reg} \cdot PA_{sec}^{reg}}{PD_{sec}^{reg}} \right)^{\sigma A_{sec}^{reg}} \cdot QA_{sec}^{reg} \right] \$secT(sec) + \left[QA_{sec}^{reg} \right] \$secTN(sec)$$

Aggregate import demands:

$$QM_{secT}^{reg} = \left(aA_{secT}^{reg} \right)^{\sigma A_{secT}^{reg} - 1} \cdot \left(\frac{\gamma AM_{secT}^{reg} \cdot PA_{secT}^{reg}}{PM_{secT}^{reg}} \right)^{\sigma A_{secT}^{reg}} \cdot QA_{secT}^{reg}$$

Balancing conditions for upper-level Armington demands:

$$PA_{sec}^{reg} \cdot QA_{sec}^{reg} = PD_{sec}^{reg} \cdot QDD_{sec}^{reg} + \left(PM_{sec}^{reg} \cdot QM_{sec}^{reg} \right) \$secT(sec)$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg,regg} = \left(aBM_{secT}^{reg} \right)^{\sigma BM_{secT}^{reg} - 1} \cdot \left(\frac{\gamma BM_{secT}^{reg,regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma BM_{secT}^{reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} = \overline{FS}^{fac,reg} - UNEMP^{reg} \$(fac = "L")$$

Armington commodity markets:

$$\left(C_{sec}^{reg} + I_{sec}^{reg} + \sum_{sec c} i_{sec,secc}^{reg} \cdot QZ_{secc}^{reg} \right) \$secT(sec) + CG_{sec}^{reg} \$secTN(sec) = QA_{sec}^{reg}$$

Domestically-produced commodity supply and demand:

$$QDS_{sec}^{reg} = QDD_{sec}^{reg}$$

Bilateral trade:

$$QBE_{secT}^{reg,regg} = QBM_{secT}^{regg,reg}$$

Balance of payments:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg,regg} \cdot PWE_{secT}^{reg,regg} \right) + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}$$

Wage curve:

$$\frac{PFM^{L,reg}}{PFM0^{L,reg}} - 1 = \omega^{reg} \cdot \left[\left(\frac{UNEMP^{reg}}{UNEMPO^{reg}} \right) - 1 \right]$$

Household income:

$$INC^{reg} = \sum_{sec} \sum_{fac} \left(PFM^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac) \right) \cdot F_{sec}^{fac,reg} + TRNF^{reg}$$

Household consumption budget:

$$CBUD^{reg} = (1 - ty^{reg}) \cdot INC^{reg} - SHH^{reg}$$

Household savings:

$$SHH^{reg} = mps^{reg} \cdot \left[(1 - ty^{reg}) \cdot INC^{reg} \right]$$

Total savings:

$$S^{reg} = SHH^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}$$

Government tax revenue:

$$\begin{aligned} TREV^{reg} &= \underbrace{ty^{reg} \cdot INC^{reg}}_{\text{Income taxes: } TRY^{reg}} + \sum_{secT} \underbrace{tc_{secT}^{reg} \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg}}_{\text{Commodity taxes: } TRC^{reg}} \\ &+ \sum_{secT} \sum_{regg (\neq reg)} \underbrace{tm_{secT}^{reg, regg} \cdot PWE_{secT}^{regg, reg} \cdot EXC^{reg} \cdot QBM_{secT}^{reg, regg}}_{\text{Import tariffs: } TRM^{reg}} \\ &+ \sum_{sec} \sum_{fac} \underbrace{tf_{sec}^{fac, reg} \cdot (PFM_{sec}^{fac, reg} \$ facM(fac) + PFS_{sec}^{fac, reg} \$ facS(fac)) \cdot F_{sec}^{fac, reg}}_{\text{Factor taxes: } TRF^{reg}} \end{aligned}$$

Government's transfer to the household:

$$TRNF^{reg} = trep^{reg} \cdot PFM^{L, reg} \cdot UNEMP^{reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index:

$$\overline{CPI}^{reg} = \frac{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA_{sec}^{reg} \cdot C0_{sec}^{reg}}{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA0_{sec}^{reg} \cdot C0_{sec}^{reg}}$$

Bilateral export price:

$$PBE_{secT}^{reg, regg} = PWE_{secT}^{reg, regg} \cdot EXC^{reg}$$

Bilateral import price:

$$PBM_{secT}^{reg, regg} = (1 + tm_{secT}^{reg, regg}) \cdot PWE_{secT}^{regg, reg} \cdot EXC^{reg}$$

(B) Cournot Oligopoly with Homogeneous Goods (Barred Firm Mobility)

The firm immobility constraint is applied by fixing the number of firms at the same time as endogenising the profit variable. Additional features to the former Cournot model, which assumed free entry and exit of firms, are indicated in bold.

Parameters

| | |
|--------------------------------|---|
| $\alpha_{HH}^{reg}_{sec}$ | Households' Cobb-Douglas commodity budget shares |
| $\alpha_{CG}^{reg}_{sec}$ | Government's Cobb-Douglas commodity budget shares |
| $\alpha_{I}^{reg}_{sec}$ | Bank's Cobb-Douglas commodity budget shares |
| $io_{sec,sec}^{reg}$ | Leontief intermediate demand coefficients |
| $\sigma_{F}^{reg}_{sec}$ | CES substitution elasticity of the value-added production function |
| $a_{F}^{reg}_{sec}$ | CES efficiency parameters of the value-added production function |
| $\gamma_{F}^{fac,reg}_{sec}$ | CES share parameters of factors in the value-added production function |
| $\sigma_{A}^{reg}_{sec}$ | Substitution elasticity of the upper-level Armington function |
| $a_{A}^{reg}_{sec}$ | Efficiency parameters of the upper-level Armington function |
| $\gamma_{AM}^{reg}_{sec}$ | Share parameters of imports in the upper-level Armington function |
| $\gamma_{AD}^{reg}_{sec}$ | Share parameters of domestically-produced goods in the upper-level Armington function |
| $\sigma_{BM}^{reg}_{sec}$ | Substitution elasticity of the lower-level Armington function |
| $a_{BM}^{reg}_{sec}$ | Efficiency parameters of the lower-level Armington function |
| $\gamma_{BM}^{reg,regg}_{sec}$ | Share parameters of bilateral imports in the lower-level Armington function |
| ω^{reg} | Wage curve elasticity |
| $trep^{reg}$ | Replacement rates |
| mps^{reg} | Households' marginal propensity to save |
| ty^{reg} | Income tax rates |
| tc_{sec}^{reg} | Commodity tax rates |
| $tf_{sec}^{fac,reg}$ | Factor tax rates |
| $tm_{sec}^{reg,regg}$ | Import tariff rates |
| $ff_{sec}^{fac,reg}$ | Fixed factor inputs demanded by each firm in Cournot sector <i>sec</i> |

Exogenous variables

| | |
|--------------------------------|--|
| $\overline{FS}^{fac,reg}$ | Factor endowments (by region) |
| $\overline{F}_{sec}^{fac,reg}$ | Sector-specific factor demands (by sector) |

| | |
|------------------------------|--|
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |
| $\overline{NOF}_{sec}^{reg}$ | Number of firms in Cournot sectors |

Endogenous variables

| | |
|------------------------|--|
| $PFM^{fac,reg}$ | Mobile factor prices |
| $PFS_{sec}^{fac,reg}$ | Sector-specific factor prices |
| PA_{sec}^{reg} | Armington composite commodity prices |
| PZ_{sec}^{reg} | Output prices |
| PD_{sec}^{reg} | Prices of domestically-produced goods delivered to the home market |
| PM_{sec}^{reg} | Import prices in home currency |
| PE_{sec}^{reg} | Export prices in home currency |
| $PBM_{sec}^{reg,regg}$ | Prices of bilateral imports by region <i>reg</i> from region <i>regg</i> in home currency |
| $PBE_{sec}^{reg,regg}$ | Prices of bilateral exports from region <i>reg</i> to region <i>regg</i> in home currency |
| $PWE_{sec}^{reg,regg}$ | Prices of bilateral exports from region <i>reg</i> to region <i>regg</i> in world currency |
| EXC^{reg} | Exchange rates |
| $F_{sec}^{facM,reg}$ | Mobile factor demands |
| QA_{sec}^{reg} | Armington composite commodity quantities |
| QZ_{sec}^{reg} | Output quantities |
| QDS_{sec}^{reg} | Quantities of domestically-produced goods supplied to the home market |
| QDD_{sec}^{reg} | Quantities of domestically-produced goods demanded by the home market |
| QM_{sec}^{reg} | Import volumes |
| QE_{sec}^{reg} | Export volumes |
| $QBM_{sec}^{reg,regg}$ | Bilateral import volumes by region <i>reg</i> from region <i>regg</i> |
| $QBE_{sec}^{reg,regg}$ | Bilateral export volumes from region <i>reg</i> to region <i>regg</i> |
| INC^{reg} | Household income |
| $TREV^{reg}$ | Total tax revenue |

| | |
|----------------------|--|
| S^{reg} | Total savings |
| $CBUD^{reg}$ | Household consumption budget |
| C_{sec}^{reg} | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{reg}$ | Unemployed labour |
| EDM_{sec}^{reg} | Price elasticity of demand for Cournot commodities |
| $PROFIT_{sec}^{reg}$ | Sectoral profits under Cournot oligopoly |

Numéraires

| | |
|-------------------------|-------------------------------------|
| \overline{CPI}^{reg} | Laspeyre consumer price indices |
| \overline{EXC}^{REG1} | Exchange rate of region <i>REG1</i> |

Equations

Firms' CES factor demands:

$$F_{sec}^{fac,reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac,reg}}{(1 + tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac))} \right)^{\sigma F_{sec}^{reg}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac,reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1 + tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+ PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right]^{1 - \sigma F_{sec}^{reg}} \right\}^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}}$$

$$+ \left(ff_{sec}^{fac,reg} \cdot \overline{NOF}_{sec}^{reg} \right) \$ic(sec)$$

Firms' zero-profit conditions:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1 + tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)) \cdot F_{sec}^{fac,reg}$$

$$+ \sum_{sec c} PA_{sec c}^{reg} \cdot (io_{sec c, sec}^{reg} \cdot QZ_{sec}^{reg}) + PROFIT_{sec}^{reg} \$ic(sec)$$

Cournot firms' price-markup conditions:

$$PZ_{ic}^{reg} \cdot \left(1 - \frac{1}{EDM_{ic}^{reg} \cdot \overline{NOF}_{ic}^{reg}} \right) = \sum_{fac} \left\{ \begin{array}{l} \left(1 + t f_{ic}^{fac,reg} \right) \times \left(\frac{PFM_{ic}^{fac,reg} \cdot \$facM(fac)}{+ PFS_{ic}^{fac,reg} \cdot \$facS(fac)} \right) \\ F_{ic}^{fac,reg} - \left(\overline{ff}_{ic}^{fac,reg} \cdot \overline{NOF}_{ic}^{reg} \right) \\ \times \frac{QZ_{ic}^{reg}}{QZ_{ic}^{reg}} \end{array} \right\} + \sum_{sec} PA_{sec}^{reg} \cdot io_{sec,ic}^{reg}$$

Cournot price elasticity of demand:

$$EDM_{ic}^{reg} = \left\{ \begin{array}{l} \frac{QDD_{ic}^{reg}}{QZ_{ic}^{reg}} \left(\sigma A_{ic}^{reg} - (\sigma A_{ic}^{reg} - 1) \frac{PD_{ic}^{reg} \cdot QDD_{ic}^{reg}}{PA_{ic}^{reg} \cdot QA_{ic}^{reg}} \right) \\ + \sum_{\substack{regg \\ (\neq reg)}} \frac{QBM_{ic}^{regg,reg}}{QZ_{ic}^{reg}} \left(\begin{array}{l} \sigma BM_{ic}^{regg} - \frac{PBM_{ic}^{regg,reg} \cdot QBM_{ic}^{regg,reg}}{PM_{ic}^{regg} \cdot QM_{ic}^{regg}} \\ (\sigma BM_{ic}^{regg} - \sigma A_{ic}^{regg}) \\ - \frac{PBM_{ic}^{regg,reg} \cdot QBM_{ic}^{regg,reg}}{PA_{ic}^{regg} \cdot QA_{ic}^{regg}} \cdot (\sigma A_{ic}^{regg} - 1) \end{array} \right) \end{array} \right\} \$ (QM0_{ic}^{reg} \neq 0)$$

$$+ \frac{CG_{ic}^{reg}}{QZ_{ic}^{reg}} \$ (QM0_{ic}^{reg} = 0)$$

Households' Cobb-Douglas commodity demands:

$$(1 + t c_{secT}^{reg}) \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg} = \alpha HH_{secT}^{reg} \cdot CBUD^{reg}$$

Government's Cobb-Douglas commodity demands:

$$PA_{secTN}^{reg} \cdot CG_{secTN}^{reg} = \alpha CG_{secTN}^{reg} \cdot \underbrace{\left(TREV^{reg} - TRNF^{reg} - \overline{SG}^{reg} \cdot \overline{CPI}^{reg} \right)}_{\text{Government budget: } CGBUD^{reg}}$$

Bank's Cobb-Douglas commodity demands:

$$PA_{secT}^{reg} \cdot I_{secT}^{reg} = \alpha I_{secT}^{reg} \cdot S^{reg}$$

Homogeneous commodity supplies to domestic and overseas markets:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = PD_{sec}^{reg} \cdot QDS_{sec}^{reg} + \left(PE_{sec}^{reg} \cdot QE_{sec}^{reg} \right) \$ secT(sec)$$

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg(\neq reg)} PBE_{secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

$$PZ_{secT}^{reg} = PD_{secT}^{reg} = PE_{secT}^{reg} = PBE_{secT}^{reg,regg}$$

$$QDS_{secTN}^{reg} = QZ_{secTN}^{reg}$$

Upper-level Armington functions:

Domestically-produced commodity demands:

$$QDD_{sec}^{reg} = \left[\left(aA_{sec}^{reg} \right)^{\sigma A_{sec}^{reg} - 1} \cdot \left(\frac{\gamma AD_{sec}^{reg} \cdot PA_{sec}^{reg}}{PD_{sec}^{reg}} \right)^{\sigma A_{sec}^{reg}} \cdot QA_{sec}^{reg} \right] \$secT(sec) + \left[QA_{sec}^{reg} \right] \$secTN(sec)$$

Aggregate import demands:

$$QM_{secT}^{reg} = \left(aA_{secT}^{reg} \right)^{\sigma A_{secT}^{reg} - 1} \cdot \left(\frac{\gamma AM_{secT}^{reg} \cdot PA_{secT}^{reg}}{PM_{secT}^{reg}} \right)^{\sigma A_{secT}^{reg}} \cdot QA_{secT}^{reg}$$

Balancing conditions for upper-level Armington demands:

$$PA_{sec}^{reg} \cdot QA_{sec}^{reg} = PD_{sec}^{reg} \cdot QDD_{sec}^{reg} + \left(PM_{sec}^{reg} \cdot QM_{sec}^{reg} \right) \$secT(sec)$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg,regg} = \left(aBM_{secT}^{reg} \right)^{\sigma BM_{secT}^{reg} - 1} \cdot \left(\frac{\gamma BM_{secT}^{reg,regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma BM_{secT}^{reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} = \overline{FS}^{fac,reg} - UNEMP^{reg} \$(fac = "L")$$

Armington commodity markets:

$$\left(C_{\text{sec}}^{\text{reg}} + I_{\text{sec}}^{\text{reg}} + \sum_{\text{sec}c} i o_{\text{sec,secc}}^{\text{reg}} \cdot QZ_{\text{secc}}^{\text{reg}} \right) \$ \text{sec}T(\text{sec}) + CG_{\text{sec}}^{\text{reg}} \$ \text{sec}TN(\text{sec}) = QA_{\text{sec}}^{\text{reg}}$$

Domestically-produced commodity supply and demand:

$$QDS_{\text{sec}}^{\text{reg}} = QDD_{\text{sec}}^{\text{reg}}$$

Bilateral trade:

$$QBE_{\text{sec}T}^{\text{reg,regg}} = QBM_{\text{sec}T}^{\text{regg,reg}}$$

Balance of payments:

$$\sum_{\text{sec}T} \sum_{\text{regg}(\neq \text{reg})} QBM_{\text{sec}T}^{\text{reg,regg}} \cdot PWE_{\text{sec}T}^{\text{regg,reg}} = \left(\sum_{\text{sec}T} \sum_{\text{regg}(\neq \text{reg})} QBE_{\text{sec}T}^{\text{reg,regg}} \cdot PWE_{\text{sec}T}^{\text{regg,reg}} \right) + \frac{\overline{SF}^{\text{reg}} \cdot \overline{CPI}^{\text{reg}}}{EXC^{\text{reg}}}$$

Wage curve:

$$\frac{PFM^{L,\text{reg}}}{PFM^{L,\text{reg}}} - 1 = \omega^{\text{reg}} \cdot \left[\left(\frac{UNEMP^{\text{reg}}}{UNEMPO^{\text{reg}}} \right) - 1 \right]$$

Household income:

$$INC^{\text{reg}} = \sum_{\text{sec}} \sum_{\text{fac}} \left(\frac{PFM^{\text{fac,reg}} \$ \text{fac}M(\text{fac})}{+PFS_{\text{sec}}^{\text{fac,reg}} \$ \text{fac}S(\text{fac})} \right) \cdot F_{\text{sec}}^{\text{fac,reg}} + TRNF^{\text{reg}} + \sum_{\text{sec}} PROFIT_{\text{sec}}^{\text{reg}} \$ \text{ic}(\text{sec})$$

Household consumption budget:

$$CBUD^{\text{reg}} = (1 - t_y^{\text{reg}}) \cdot INC^{\text{reg}} - SHH^{\text{reg}}$$

Household savings:

$$SHH^{\text{reg}} = mps^{\text{reg}} \cdot \left[(1 - t_y^{\text{reg}}) \cdot INC^{\text{reg}} \right]$$

Total savings:

$$S^{\text{reg}} = SHH^{\text{reg}} + (\overline{SG}^{\text{reg}} + \overline{SF}^{\text{reg}}) \cdot \overline{CPI}^{\text{reg}}$$

Government tax revenue:

$$\begin{aligned}
TREV^{reg} &= \underbrace{ty^{reg} \cdot INC^{reg}}_{\text{Income taxes: } TRY^{reg}} + \sum_{secT} \underbrace{tc_{secT}^{reg} \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg}}_{\text{Commodity taxes: } TRC^{reg}} \\
&+ \sum_{secT} \sum_{regg (\neq reg)} \underbrace{tm_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg} \cdot QBM_{secT}^{reg,regg}}_{\text{Import tariffs: } TRM^{reg}} \\
&+ \sum_{sec} \sum_{fac} \underbrace{tf_{sec}^{fac,reg} \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)) \cdot F_{sec}^{fac,reg}}_{\text{Factor taxes: } TRF^{reg}}
\end{aligned}$$

Government's transfer to the household:

$$TRNF^{reg} = trep^{reg} \cdot PFM^{L,reg} \cdot UNEMP^{reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index:

$$\overline{CPI}^{reg} = \frac{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA_{sec}^{reg} \cdot C0_{sec}^{reg}}{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot PA0_{sec}^{reg} \cdot C0_{sec}^{reg}}$$

Bilateral export price:

$$PBE_{secT}^{reg,regg} = PWE_{secT}^{reg,regg} \cdot EXC^{reg}$$

Bilateral import price:

$$PBM_{secT}^{reg,regg} = (1 + tm_{secT}^{reg,regg}) \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg}$$

(C) Monopolistic Competition with Heterogeneous Goods (Free Firm Mobility)

In Equation (2-98) of Chapter 2, the Armington group price index under monopolistic competition (PA_{sec}^{reg}) is the product of the price of the individual variety (pa_{sec}^{reg}) and the scaling vector (hereafter AUX_{sec}^{reg}). However, since the GAMS syntax does not distinguish between capital and small letters, for simplicity, in the following model, $AUX_{sec}^{reg} \cdot PA_{sec}^{reg}$ refers to the Armington group price index both under perfect competition and monopolistic competition. The scaling vector elements are set equal to one for perfect competition sectors, and as a function of the number of firms in monopolistic competition sectors. Modifications to the perfectly competitive model discussed in Appendix A2-1 are shown in bold letters.

Note that the application of the assumption of barred firm mobility to the monopolistically competitive case is not reported as the modifications are simply a repetition of the Cournot case in Subsection (B) of this appendix.

Parameters

| | |
|------------------------------|---|
| $\alpha_{HH}^{reg}_{sec}$ | Households' Cobb-Douglas commodity budget shares |
| $\alpha_{CG}^{reg}_{sec}$ | Government's Cobb-Douglas commodity budget shares |
| $\alpha_I^{reg}_{sec}$ | Bank's Cobb-Douglas commodity budget shares |
| $i\omega_{sec,sec}^{reg}$ | Leontief intermediate demand coefficients |
| σF_{sec}^{reg} | CES substitution elasticity of the value-added production function |
| aF_{sec}^{reg} | CES efficiency parameters of the value-added production function |
| $\gamma F_{sec}^{fac,reg}$ | CES share parameters of factors in the value-added production function |
| σA_{sec}^{reg} | Substitution elasticity of the upper-level Armington function |
| aA_{sec}^{reg} | Efficiency parameters of the upper-level Armington function |
| γAM_{sec}^{reg} | Share parameters of imports in the upper-level Armington function |
| γAD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level Armington function |
| σBM_{sec}^{reg} | Substitution elasticity of the lower-level Armington function |
| aBM_{sec}^{reg} | Efficiency parameters of the lower-level Armington function |
| $\gamma BM_{sec}^{reg,regg}$ | Share parameters of bilateral imports in the lower-level Armington function |
| ω^{reg} | Wage curve elasticity |
| $trep^{reg}$ | Replacement rates |
| mps^{reg} | Households' marginal propensity to save |
| ty^{reg} | Income tax rates |
| tC_{sec}^{reg} | Commodity tax rates |
| $tf_{sec}^{fac,reg}$ | Factor tax rates |
| $tm_{sec}^{reg,regg}$ | Import tariff rates |

| | |
|---------------------------------|--|
| $\overline{ff}_{sec}^{fac,reg}$ | Fixed factor inputs demanded by each firm in monopolistically competitive sector sec |
| σLV_{sec}^{reg} | Substitution elasticity between product varieties in monopolistically competitive sector sec |

Exogenous variables

| | |
|--------------------------------|--|
| $\overline{FS}^{fac,reg}$ | Factor endowments (by region) |
| $\overline{F}_{sec}^{fac,reg}$ | Sector-specific factor demands (by sector) |
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |

Endogenous variables

| | |
|------------------------|--|
| $PFM^{fac,reg}$ | Mobile factor prices |
| $PFS_{sec}^{fac,reg}$ | Sector-specific factor prices |
| PA_{sec}^{reg} | Armington composite commodity prices |
| PZ_{sec}^{reg} | Output prices |
| PD_{sec}^{reg} | Prices of domestically-produced goods delivered to the home market |
| PM_{sec}^{reg} | Import prices in home currency |
| PE_{sec}^{reg} | Export prices in home currency |
| $PBM_{sec}^{reg,regg}$ | Prices of bilateral imports by region reg from region $regg$ in home currency |
| $PBE_{sec}^{reg,regg}$ | Prices of bilateral exports from region reg to region $regg$ in home currency |
| $PWE_{sec}^{reg,regg}$ | Prices of bilateral exports from region reg to region $regg$ in world currency |
| EXC^{reg} | Exchange rates |
| $F_{sec}^{facM,reg}$ | Mobile factor demands |
| QA_{sec}^{reg} | Armington composite commodity quantities |
| QZ_{sec}^{reg} | Output quantities |
| QDS_{sec}^{reg} | Quantities of domestically-produced goods supplied to the home market |

| | |
|-------------------------|---|
| QDD_{sec}^{reg} | Quantities of domestically-produced goods demanded by the home market |
| QM_{sec}^{reg} | Import volumes |
| QE_{sec}^{reg} | Export volumes |
| $QBM_{sec}^{reg,regg}$ | Bilateral import volumes by region reg from region $regg$ |
| $QBE_{sec}^{reg,regg}$ | Bilateral export volumes from region reg to region $regg$ |
| INC^{reg} | Household income |
| $TREV^{reg}$ | Total tax revenue |
| S^{reg} | Total savings |
| $CBUD^{reg}$ | Household consumption budget |
| C_{sec}^{reg} | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{reg}$ | Unemployed labour |
| EDM_{sec}^{reg} | Price elasticity of demand under monopolistic competition |
| NOF_{sec}^{reg} | Number of firms in sectors under monopolistic competition |
| AUX_{sec}^{reg} | Scaling vectors |
| <i>Numéraires</i> | |
| \overline{CPI}^{reg} | Laspeyre consumer price indices |
| \overline{EXC}^{REG1} | Exchange rate of region $REG1$ |

Equations

Firms' CES factor demands:

$$F_{sec}^{fac,reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac,reg}}{(1+tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac))} \right)^{\sigma F_{sec}^{reg}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac,reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1+tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right]^{1-\sigma F_{sec}^{reg}} \right\}^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg}-1}} + (ff_{sec}^{fac,reg} \cdot NOF_{sec}^{reg}) \$ic(sec)}$$

Firms' zero-profit conditions:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1+tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac)) \cdot F_{sec}^{fac,reg} + \sum_{secc} AUX_{secc}^{reg} \cdot PA_{secc}^{reg} \cdot (io_{secc,sec}^{reg} \cdot QZ_{sec}^{reg})$$

Monopolistically competitive firms' price-markup conditions:

$$PZ_{ic}^{reg} \cdot \left(1 - \frac{1}{EDM_{ic}^{reg}} \right) = \sum_{fac} \left\{ \frac{\left((1+tf_{ic}^{fac,reg}) \times \left(\frac{PFM_{ic}^{fac,reg} \$facM(fac)}{+PFS_{ic}^{fac,reg} \$facS(fac)} \right) \right)}{F_{ic}^{fac,reg} - (ff_{ic}^{fac,reg} \cdot NOF_{ic}^{reg})} \right\} + \sum_{sec} AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot io_{sec,ic}^{reg}$$

Monopolistically competitive price elasticity of demand:

$$EDM_{ic}^{reg} = \sigma LV_{ic}^{reg}$$

Scaling vectors for sectors both under perfect and monopolistic competition:

$$AUX_{sec}^{reg} = 1\$pc(sec) + NOF_{sec}^{reg} \frac{1}{1-\sigma LV_{sec}^{reg}} \$ic(sec)$$

Household's Cobb-Douglas commodity demands:

$$(1+tc_{secT}^{reg}) \cdot AUX_{secT}^{reg} \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg} = \alpha HH_{secT}^{reg} \cdot CBUD_{secT}^{reg}$$

Government's Cobb-Douglas commodity demands:

$$AUX_{secTN}^{reg} \cdot PA_{secTN}^{reg} \cdot CG_{secTN}^{reg} = \alpha CG_{secTN}^{reg} \cdot \underbrace{\left(TREV_{secTN}^{reg} - TRNF_{secTN}^{reg} - \overline{SG}^{reg} \cdot \overline{CPI}^{reg} \right)}_{\text{Government budget: } CGBUD^{reg}}$$

Bank's Cobb-Douglas commodity demands:

$$AUX_{secT}^{reg} \cdot PA_{secT}^{reg} \cdot I_{secT}^{reg} = \alpha I_{secT}^{reg} \cdot S^{reg}$$

Homogeneous commodity supply to domestic and overseas markets:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = PD_{sec}^{reg} \cdot QDS_{sec}^{reg} + \left(PE_{sec}^{reg} \cdot QE_{sec}^{reg} \right) \$secT(sec)$$

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg (\neq reg)} PBE_{secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

$$PZ_{secT}^{reg} = PD_{secT}^{reg} = PE_{secT}^{reg} = PBE_{secT}^{reg,regg}$$

$$QDS_{secTN}^{reg} = QZ_{secTN}^{reg}$$

Upper-level Armington functions:

Domestically-produced commodity demands:

$$QDD_{sec}^{reg} = \left[\left(aA_{sec}^{reg} \right)^{\sigma A_{sec}^{reg} - 1} \cdot \left(\frac{\gamma AD_{sec}^{reg} \cdot PA_{sec}^{reg}}{PD_{sec}^{reg}} \right)^{\sigma A_{sec}^{reg}} \cdot QA_{sec}^{reg} \right] \$secT(sec) + \left[QA_{sec}^{reg} \right] \$secTN(sec)$$

Aggregate import demands:

$$QM_{secT}^{reg} = \left(aA_{secT}^{reg} \right)^{\sigma A_{secT}^{reg} - 1} \cdot \left(\frac{\gamma AM_{secT}^{reg} \cdot PA_{secT}^{reg}}{PM_{secT}^{reg}} \right)^{\sigma A_{secT}^{reg}} \cdot QA_{secT}^{reg}$$

Balancing conditions for upper-level Armington demands:

$$PA_{sec}^{reg} \cdot QA_{sec}^{reg} = PD_{sec}^{reg} \cdot QDD_{sec}^{reg} + \left(PM_{sec}^{reg} \cdot QM_{sec}^{reg} \right) \$secT(sec)$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg,regg} = \left(aBM_{secT}^{reg} \right)^{\sigma_{secT}^{BM,reg} - 1} \cdot \left(\frac{\gamma BM_{secT}^{reg,regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma_{secT}^{BM,reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} = \overline{FS}^{fac,reg} - UNEMP^{reg} \$(fac = "L")$$

Armington commodity markets:

$$AUX_{sec}^{reg} \cdot \left\{ \left(C_{sec}^{reg} + I_{sec}^{reg} + \sum_{sec c} io_{sec,sec c}^{reg} \cdot QZ_{sec c}^{reg} \right) \$secT(sec) + CG_{sec}^{reg} \$secTN(sec) \right\} = QA_{sec}^{reg}$$

Domestically-produced commodity supply and demand:

$$QDS_{sec}^{reg} = QDD_{sec}^{reg}$$

Bilateral trade:

$$QBE_{secT}^{reg,regg} = QBM_{secT}^{regg,reg}$$

Balance of payments:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,reg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg,regg} \cdot PWE_{secT}^{reg,regg} \right) + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}$$

Wage curve:

$$\frac{PFM^{L,reg}}{PFMO^{L,reg}} - 1 = \omega^{reg} \cdot \left[\left(\frac{UNEMP^{reg}}{UNEMPO^{reg}} \right) - 1 \right]$$

Household income:

$$INC^{reg} = \sum_{sec} \sum_{fac} \left(PFM^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac) \right) \cdot F_{sec}^{fac,reg} + TRNF^{reg}$$

Household consumption budget:

$$CBUD^{reg} = (1 - ty^{reg}) \cdot INC^{reg} - SHH^{reg}$$

Household savings:

$$SHH^{reg} = mps^{reg} \cdot \left[(1 - ty^{reg}) \cdot INC^{reg} \right]$$

Total savings:

$$S^{reg} = SHH^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}$$

Government tax revenue:

$$\begin{aligned} TREV^{reg} &= \underbrace{ty^{reg} \cdot INC^{reg}}_{\text{Income taxes: } TRY^{reg}} + \underbrace{\sum_{secT} tc_{secT}^{reg} \cdot AUX_{secT}^{reg} \cdot PA_{secT}^{reg} \cdot C_{secT}^{reg}}_{\text{Commodity taxes: } TRC^{reg}} \\ &+ \underbrace{\sum_{secT} \sum_{regg (\neq reg)} tm_{secT}^{reg,regg} \cdot PWE_{secT}^{regg,regg} \cdot EXC_{secT}^{reg} \cdot QBM_{secT}^{reg,regg}}_{\text{Import tariffs: } TRM^{reg}} \\ &+ \underbrace{\sum_{sec} \sum_{fac} tf_{sec}^{fac,reg} \cdot \left(PFM^{fac,reg} \$ facM(fac) + PFS_{sec}^{fac,reg} \$ facS(fac) \right) \cdot F_{sec}^{fac,reg}}_{\text{Factor taxes: } TRF^{reg}} \end{aligned}$$

Government's transfer to the household:

$$TRNF^{reg} = trep^{reg} \cdot PFM^{L,reg} \cdot UNEMP^{reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index:

$$\overline{CPI}^{reg} = \frac{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CO_{sec}^{reg}}{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CO_{sec}^{reg}}$$

Bilateral export price:

$$PBE_{secT}^{reg,regg} = PWE_{secT}^{reg,regg} \cdot EXC_{secT}^{reg}$$

Bilateral import price:

$$PBM_{secT}^{reg,regg} = (1 + tm_{secT}^{reg,regg}) \cdot PWE_{secT}^{regg,reg} \cdot EXC^{reg}$$

Appendix A2-4: Value Flows in the CGE Model Designed for Market Structure Simulations

(A) Bilateral Trade Values of Goods (*SEC1* and *SEC2*) in World Currency (\$)

| Trade values | REG1 | REG2 | REG3 | REG4 | Total |
|--------------|------|------|------|------|-------|
| REG1 | | 20 | 20 | 20 | 60 |
| REG2 | 20 | | 20 | 20 | 60 |
| REG3 | 20 | 20 | | 20 | 60 |
| REG4 | 20 | 20 | 20 | | 60 |
| Total | 60 | 60 | 60 | 60 | |

Note: Imports are read on the rows whilst exports are read on the columns.

(B) Bilateral Tariffs on Tradable Goods (*SEC1* and *SEC2*) in World Currency (\$)

| Bilateral Tariffs | REG1 | REG2 | REG3 | REG4 | Total |
|-------------------|------|------|------|------|-------|
| REG1 | | 10 | 10 | 10 | 30 |
| REG2 | 10 | | 10 | 10 | 30 |
| REG3 | 10 | 10 | | 10 | 30 |
| REG4 | 10 | 10 | 10 | | 30 |

Note: Imports are read on the rows whilst exports are read on the columns.

Appendix to Chapter 3

Appendix A3-1: Technical Specifications of the CGE Model Designed for Thai FTA Simulations

The nested CET functions; the CES demand functions for the household, the government and the bank; international transport margins and production taxes are added to the base model in

Chapter 2. As with Subsection (C) of Appendix A2-3, $AUX_{sec}^{reg} \cdot PA_{sec}^{reg}$ refers to the Armington group price index, where the scaling vector AUX_{sec}^{reg} is a function of the number of firms under monopolistic competition, and is equal to one under both perfect competition and Cournot oligopoly.

Setsⁱ

| | |
|-----------------------|-------------------------|
| $reg, regg$ | Regions |
| $sec, secc$ | Production sectors |
| $secT (\subset sec)$ | Tradable sectors |
| $secTN (\subset sec)$ | Non-traded sectors |
| $trsp (\subset sec)$ | Transport sectors |
| fac | Primary factors |
| $facM (\subset fac)$ | Mobile factors |
| $facS (\subset fac)$ | Sector-specific factors |
| $flab (\subset fac)$ | Labour |

The model allows individual sectors in all regions to have independent market structures. Therefore, the sets identifying the degrees of market competition have both regional and sectoral dimensions, i.e.:

| | |
|---|--------------------------|
| pc_{sec}^{reg} | Perfect competition |
| ic_{sec}^{reg} | Imperfect competition |
| $co_{sec}^{reg} (\subset ic_{sec}^{reg})$ | Cournot oligopoly |
| $mc_{sec}^{reg} (\subset ic_{sec}^{reg})$ | Monopolistic competition |

ⁱ As with the standard set theory, $A \subset B$ means that A is a subset of B.

Individual labour markets in all regions have independent closure rules which depend on the flexibility of wages and unemployment. Thus, the sets identifying the labour market closure rules have both regional and skill-level dimensions, i.e.:

| | |
|---------------------|----------------------------|
| flx_{reg}^{flab} | The flexible wage approach |
| rgd_{reg}^{flab} | The rigid wage approach |
| $wcrv_{reg}^{flab}$ | The wage curve approach |

Parameters

| | |
|------------------------------|---|
| σD^{reg} | CES substitution elasticity of final demand functions |
| γHH_{sec}^{reg} | CES share parameters of household consumption |
| γGV_{sec}^{reg} | CES share parameters of government consumption |
| γI_{sec}^{reg} | CES share parameters of bank investment |
| $io_{sec,sec c}^{reg}$ | Leontief intermediate demand coefficients |
| σF_{sec}^{reg} | CES substitution elasticity of the value-added production function |
| aF_{sec}^{reg} | CES efficiency parameters of the value-added production function |
| $\gamma F_{sec}^{fac,reg}$ | CES share parameters of factors in the value-added production function |
| σA_{sec}^{reg} | Substitution elasticity of the upper-level Armington function |
| aA_{sec}^{reg} | Efficiency parameters of the upper-level Armington function |
| γAM_{sec}^{reg} | Share parameters of imports in the upper-level Armington function |
| γAD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level Armington function |
| σBM_{sec}^{reg} | Substitution elasticity of the lower-level Armington function |
| aBM_{sec}^{reg} | Efficiency parameters of the lower-level Armington function |
| $\gamma BM_{sec}^{reg,regg}$ | Share parameters of bilateral imports in the lower-level Armington function |
| σT_{sec}^{reg} | Transformation elasticity of the upper-level CET function |
| aT_{sec}^{reg} | Efficiency parameters of the upper-level CET function |

| | |
|-----------------------------------|--|
| γTE_{sec}^{reg} | Share parameters of exports in the upper-level CET function |
| γTD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level CET function |
| σBE_{sec}^{reg} | Transformation elasticity of the lower-level CET function |
| aBE_{sec}^{reg} | Efficiency parameters of the lower-level CET function |
| $\gamma BE_{sec}^{reg, regg}$ | Share parameters of bilateral exports in the lower-level CET function |
| $\omega^{fac, reg}$ | Wage curve elasticity |
| $trep^{fac, reg}$ | Replacement rates |
| mps^{reg} | Households' marginal propensity to save |
| ty^{reg} | Income tax rates |
| tc_{sec}^{reg} | Commodity tax rates |
| $tf_{sec}^{fac, reg}$ | Factor tax rates |
| t_{sec}^{reg} | Production tax rates |
| $tm_{sec}^{reg, regg}$ | Import tariff rates |
| $ff_{sec}^{fac, reg}$ | Fixed factor inputs demanded by each firm in imperfectly competitive sector <i>sec</i> |
| σLV_{sec}^{reg} | Substitution elasticity between product varieties in monopolistically competitive sectors |
| $\alpha TRSPR_{sec}^{reg}$ | Shares of international transport services provided by region <i>reg</i> |
| $\delta_{sec, sec c}^{reg, regg}$ | International transport margin (<i>sec</i>) per unit of export goods <i>sec c</i> from region <i>reg</i> to region <i>regg</i> |

Exogenous variables

| | |
|---------------------------------|--|
| $\overline{FS}^{fac, reg}$ | Factor endowments (by region) |
| $\overline{F}_{sec}^{fac, reg}$ | Sector-specific factor demands (by sector) |
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |

| | |
|--|---|
| $\overline{NOF}_{sec}^{reg} \co_{sec}^{reg} | Number of firms in Cournot sectors |
| $\overline{PROFIT}_{sec}^{reg} \mc_{sec}^{reg} | Sectoral profits under monopolistic competition |
| $\overline{UNEMP}_{reg}^{flab} \flx_{reg}^{flab} | Unemployment under the flexible wage assumption |

Endogenous variables

| | |
|------------------------|---|
| $PCBUD^{reg}$ | Household consumption budget deflator |
| $PCGBUD^{reg}$ | Government consumption budget deflator |
| PS^{reg} | Bank investment budget deflator |
| $PFM^{fac,reg}$ | Mobile factor prices |
| $PFS_{sec}^{fac,reg}$ | Sector-specific factor prices |
| PA_{sec}^{reg} | Armington composite commodity prices |
| PZ_{sec}^{reg} | Output prices |
| PD_{sec}^{reg} | Prices of domestically-produced goods delivered to the home market |
| PM_{sec}^{reg} | Import prices in home currency |
| PE_{sec}^{reg} | Export prices in home currency |
| $PBM_{sec}^{reg,regg}$ | Prices of bilateral imports by <i>reg</i> from <i>regg</i> (home currency) |
| $PBE_{sec}^{reg,regg}$ | Prices of bilateral exports from <i>reg</i> to <i>regg</i> (home currency) |
| $PWM_{sec}^{reg,regg}$ | Prices of bilateral imports by <i>reg</i> from <i>regg</i> (world currency) |
| $PWE_{sec}^{reg,regg}$ | Prices of bilateral exports from <i>reg</i> to <i>regg</i> (world currency) |
| EXC^{reg} | Exchange rates |
| $F_{sec}^{facM,reg}$ | Mobile factor demands |
| QA_{sec}^{reg} | Armington composite commodity quantities |
| QZ_{sec}^{reg} | Output quantities |
| QDS_{sec}^{reg} | Quantities of domestically-produced goods supplied to home market |
| QDD_{sec}^{reg} | Quantities of domestically-produced goods demanded by home market |
| QM_{sec}^{reg} | Import volumes |
| QE_{sec}^{reg} | Export volumes |
| $QBM_{sec}^{reg,regg}$ | Bilateral import volumes by region <i>reg</i> from region <i>regg</i> |

| | |
|---------------------------------------|---|
| $QBE_{sec}^{reg, regg}$ | Bilateral export volumes from region reg to region $regg$ |
| INC^{reg} | Household income |
| $TREV^{reg}$ | Total tax revenue |
| S^{reg} | Total savings |
| $CBUD^{reg}$ | Household consumption budget |
| $CGBUD^{reg}$ | Government consumption budget |
| C_{sec}^{reg} | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{fac, reg}$ | Unemployed labour |
| EDM_{sec}^{reg} | Price elasticity of demand for imperfectly competitive commodities |
| $NOF_{sec}^{reg} \$mc_{sec}^{reg}$ | Number of firms in monopolistically competitive sectors |
| $PROFIT_{sec}^{reg} \$co_{sec}^{reg}$ | Sectoral profits under Cournot oligopoly |
| AUX_{sec}^{reg} | Scaling vectors |
| $PTRSPG_{sec}$ | Prices of global transport services |
| $TRSPG_{sec}$ | Quantities of global transport services |
| $TRSPR_{sec}^{reg}$ | Quantities of international transport services provided by region reg |
| Numéraires | |
| \overline{CPI}^{reg} | Laspeyre consumer price indices |
| $\overline{EXC}^{"THA"}$ | Exchange rate of Thailand |

Equations

Firms' CES factor demands:

$$F_{sec}^{fac,reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac,reg}}{(1+tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac))} \right)^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac,reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1+tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right]^{1-\sigma F_{sec}^{reg}} \right\}^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}} + \left(\overline{ff}_{sec}^{fac,reg} \cdot \overline{NOF}_{sec}^{reg} \right) \$co_{sec}^{reg} + \left(\overline{ff}_{sec}^{fac,reg} \cdot \overline{NOF}_{sec}^{reg} \right) \$mc_{sec}^{reg}$$

Firms' zero-profit conditions:

$$(1-tz_{sec}^{reg}) \cdot PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1+tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \cdot F_{sec}^{fac,reg} + \sum_{sec\ c} AUX_{sec\ c}^{reg} \cdot PA_{sec\ c}^{reg} \cdot (io_{sec\ c,sec}^{reg} \cdot QZ_{sec}^{reg}) + PROFIT_{sec}^{reg} \$co_{sec}^{reg} + \overline{PROFIT}_{sec}^{reg} \$mc_{sec}^{reg}$$

Imperfectly competitive firms' mark-up pricing conditions $\$ic_{sec}^{reg}$:

$$PZ_{sec}^{reg} \cdot \left\{ 1 - \left[\frac{1}{EDM_{sec}^{reg} \cdot \overline{NOF}_{sec}^{reg}} \right] \$co_{sec}^{reg} + \left[\frac{1}{EDM_{sec}^{reg}} \right] \$mc_{sec}^{reg} \right\} = \sum_{fac} \left\{ \left((1+tf_{sec}^{fac,reg}) \times \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right) \cdot F_{sec}^{fac,reg} - \left(\overline{ff}_{sec}^{fac,reg} \cdot \left(\frac{\overline{NOF}_{sec}^{reg} \$co_{sec}^{reg}}{+ \overline{NOF}_{sec}^{reg} \$mc_{sec}^{reg}} \right) \right) \right\} \times \frac{1}{QZ_{sec}^{reg}} + \sum_{sec\ c} AUX_{sec\ c}^{reg} \cdot PA_{sec\ c}^{reg} \cdot io_{sec\ c,sec}^{reg} + tz_{sec}^{reg} \cdot PZ_{sec}^{reg}$$

Imperfectly competitive price elasticity of demand $\$ic_{sec}^{reg}$: ii

$$EDM_{sec}^{reg} = \left\{ \begin{array}{l} \frac{QDD_{sec}^{reg}}{QZ_{sec}^{reg}} \left(\sigma A_{sec}^{reg} - (\sigma A_{sec}^{reg} - \sigma D^{reg}) \frac{PD_{sec}^{reg} \cdot QDD_{sec}^{reg}}{PA_{sec}^{reg} \cdot QA_{sec}^{reg}} \right) \\ + \sum_{\substack{regg \\ (\neq reg)}} \frac{QBM_{sec}^{regg,reg}}{QZ_{sec}^{reg}} \left(\begin{array}{l} \sigma BM_{sec}^{regg} - (\sigma BM_{sec}^{regg} - \sigma A_{sec}^{regg}) \\ \cdot \frac{PBM_{sec}^{regg,reg} \cdot QBM_{sec}^{regg,reg}}{PM_{sec}^{regg} \cdot QM_{sec}^{regg}} \\ - (\sigma A_{sec}^{regg} - \sigma D^{regg}) \\ \cdot \frac{PBM_{sec}^{regg,reg} \cdot QBM_{sec}^{regg,reg}}{PA_{sec}^{regg} \cdot QA_{sec}^{regg}} \end{array} \right) \end{array} \right\} \$(\text{sec}T(\text{sec}) \cap co_{sec}^{reg}) \\ + \left(\frac{C_{sec}^{reg} + CG_{sec}^{reg} + I_{sec}^{reg}}{QZ_{sec}^{reg} \cdot (1 - io_{sec,sec}^{reg})} \right) \$(\text{sec}TN(\text{sec}) \cap co_{sec}^{reg}) + (\sigma LV_{sec}^{reg}) \$mc_{sec}^{reg}$$

Scaling vectors:

$$AUX_{sec}^{reg} = 1\$ \left(pc_{sec}^{reg} \cup co_{sec}^{reg} \right) + \left(NOF_{sec}^{reg} \frac{1}{1 - \sigma LV_{sec}^{reg}} \right) \$mc_{sec}^{reg}$$

Households' CES private demands:

$$C_{sec}^{reg} = CBUD_{sec}^{reg} \cdot \left[\gamma HH_{sec}^{reg} \cdot \frac{PCBUD_{sec}^{reg}}{(1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}}$$

Households' budget constraints:

$$PCBUD_{sec}^{reg} \cdot CBUD_{sec}^{reg} = \sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot C_{sec}^{reg}$$

Government's CES public demands:

$$CG_{sec}^{reg} = CGBUD_{sec}^{reg} \cdot \left[\gamma GV_{sec}^{reg} \cdot \frac{PCGBUD_{sec}^{reg}}{AUX_{sec}^{reg} \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}}$$

ⁱⁱ Henceforth, for brevity, the symbol indicating the union of sets A and B: $A \cup B = \{x \mid x \text{ is an element of A and B}\}$, and that representing the intersection of sets A and B: $A \cap B = \{x \mid x \text{ is an element of A or B}\}$ are adopted to illustrate the asymmetric handlings of sectors, factors and regions in Chapter 3, and also later in Chapter 4.

Government's budget constraints:

$$PCGBUD^{reg} \cdot CGBUD^{reg} = \sum_{sec} AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CG_{sec}^{reg}$$

Bank's CES investment demands:

$$I_{sec}^{reg} = S^{reg} \cdot \left[\gamma I_{sec}^{reg} \cdot \frac{PS^{reg}}{AUX_{sec}^{reg} \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}}$$

Bank's budget constraints:

$$PS^{reg} \cdot S^{reg} = \sum_{sec} AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot I_{sec}^{reg}$$

Upper-level CET functions:

Domestically-produced good supply (1) $\$ \{ \text{not} [\text{sec}T(\text{sec}) \cap (co_{sec}^{reg} \cup \text{trsp}(\text{sec}))] \}$:

$$QDS_{sec}^{reg} = \left[\left(aT_{sec}^{reg} \right)^{\sigma T_{sec}^{reg} - 1} \cdot \left(\frac{\gamma TD_{sec}^{reg} \cdot PZ_{sec}^{reg}}{PD_{sec}^{reg}} \right)^{\sigma T_{sec}^{reg}} \cdot QZ_{sec}^{reg} \right]$$

$$\$ \{ \text{sec}T(\text{sec}) \cap [\text{not} (co_{sec}^{reg} \cup \text{trsp}(\text{sec}))] \}$$

$$+ [QZ_{sec}^{reg}] \$ \text{sec}TN(\text{sec})$$

Domestically-produced good supply (2) $\$ [\text{sec}T(\text{sec}) \cap (co_{sec}^{reg} \cup \text{trsp}(\text{sec}))]$:

$$PD_{sec}^{reg} = PZ_{sec}^{reg}$$

Aggregate export supply (1) $\$ \{ \text{sec}T(\text{sec}) \cap [\text{not} (co_{sec}^{reg} \cup \text{trsp}(\text{sec}))] \}$:

$$QE_{sec}^{reg} = \left(aT_{sec}^{reg} \right)^{\sigma T_{sec}^{reg} - 1} \cdot \left(\frac{\gamma TE_{sec}^{reg} \cdot PZ_{sec}^{reg}}{PE_{sec}^{reg}} \right)^{\sigma T_{sec}^{reg}} \cdot QZ_{sec}^{reg}$$

Aggregate export supply (2) $\$ [\text{sec}T(\text{sec}) \cap (co_{sec}^{reg} \cup \text{trsp}(\text{sec}))]$:

$$PE_{sec}^{reg} = PZ_{sec}^{reg}$$

Balancing conditions for upper-level CET supplies:

$$PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = PD_{sec}^{reg} \cdot QDS_{sec}^{reg} + \left(PE_{sec}^{reg} \cdot QE_{sec}^{reg} \right) \$secT(sec) \\ + \left(PE_{sec}^{reg} \cdot TRSPR_{sec}^{reg} \right) \$trsp(sec)$$

Lower-level CET functions:

Bilateral export supply (1) \$(not \$co_{secT}^{reg}\$):

$$QBE_{secT}^{reg,regg} = \left(aBE_{secT}^{reg} \right)^{\sigma BE_{secT}^{reg}-1} \cdot \left(\frac{\gamma BE_{secT}^{reg,regg} \cdot PE_{secT}^{reg}}{PBE_{secT}^{reg,regg}} \right)^{\sigma BE_{secT}^{reg}} \cdot QE_{secT}^{reg}$$

Bilateral export supply (2) \$co_{secT}^{reg}\$:

$$PBE_{secT}^{reg,regg} = PE_{secT}^{reg}$$

Balancing conditions for bilateral export supply:

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg (\neq reg)} PBE_{secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

Upper-level Armington functions:

Domestically-produced commodity demands:

$$QDD_{sec}^{reg} = \left[\left(aA_{sec}^{reg} \right)^{\sigma A_{sec}^{reg}-1} \cdot \left(\frac{\gamma AD_{sec}^{reg} \cdot PA_{sec}^{reg}}{PD_{sec}^{reg}} \right)^{\sigma A_{sec}^{reg}} \cdot QA_{sec}^{reg} \right] \$secT(sec) + \left[QA_{sec}^{reg} \right] \$secTN(sec)$$

Aggregate import demands:

$$QM_{secT}^{reg} = \left(aA_{secT}^{reg} \right)^{\sigma A_{secT}^{reg}-1} \cdot \left(\frac{\gamma AM_{secT}^{reg} \cdot PA_{secT}^{reg}}{PM_{secT}^{reg}} \right)^{\sigma A_{secT}^{reg}} \cdot QA_{secT}^{reg}$$

Balancing conditions for upper-level Armington demands:

$$PA_{sec}^{reg} \cdot QA_{sec}^{reg} = PD_{sec}^{reg} \cdot QDD_{sec}^{reg} + \left(PM_{sec}^{reg} \cdot QM_{sec}^{reg} \right) \$secT(sec)$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg,regg} = \left(aBM_{secT}^{reg} \right)^{\sigma BM_{secT}^{reg} - 1} \cdot \left(\frac{\gamma BM_{secT}^{reg,regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma BM_{secT}^{reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} = \overline{FS}^{fac,reg} - UNEMP^{fac,reg} \$flab(fac)$$

Armington commodity markets:

$$AUX_{sec}^{reg} \cdot \left(C_{sec}^{reg} + CG_{sec}^{reg} + I_{sec}^{reg} + \sum_{sec c} io_{sec,secc}^{reg} \cdot QZ_{secc}^{reg} \right) = QA_{sec}^{reg}$$

Domestically-produced commodity supply and demand:

$$QDS_{sec}^{reg} = QDD_{sec}^{reg}$$

Bilateral trade:

$$QBE_{secT}^{reg,regg} = QBM_{secT}^{regg,reg}$$

Balance of payments:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg,regg} \cdot PWM_{secT}^{reg,regg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg,regg} \cdot PWE_{secT}^{reg,regg} \right) + \sum_{trsp} TRSPR_{trsp}^{reg} \cdot PTRSPG_{trsp} + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}$$

Wage curve and rigid wage approaches $\{ \text{not } flx_{reg}^{flab} \}$:

$$\frac{PFM_{flab,reg}}{PFM0_{flab,reg}} = 1 \$rgd_{reg}^{flab} + \left[\left(\frac{UNEMP_{flab,reg}}{UNEMPO_{flab,reg}} \right)^{\omega_{flab,reg}} \right] \$wcrv_{reg}^{flab}$$

Household income:

$$INC^{reg} = \sum_{sec} \sum_{fac} \left(\frac{PFM_{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \cdot F_{sec}^{fac,reg} + TRNF^{reg} + \sum_{sec} \left(\frac{PROFIT_{sec}^{reg} \$co_{sec}^{reg}}{+PROFIT_{sec}^{reg} \$mc_{sec}^{reg}} \right)$$

Household consumption budget:

$$PCBUD^{reg} \cdot CBUD^{reg} = (1 - ty^{reg}) \cdot INC^{reg} - SHH^{reg}$$

Household savings:

$$SHH^{reg} = mps^{reg} \cdot \left[(1 - ty^{reg}) \cdot INC^{reg} \right]$$

Total savings:

$$PS^{reg} \cdot S^{reg} = SHH^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}$$

Government tax revenue:

$$\begin{aligned} TREV^{reg} &= \underbrace{ty^{reg} \cdot INC^{reg}}_{\text{Income taxes: } TRY^{reg}} + \underbrace{\sum_{sec} tc_{sec}^{reg} \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot C_{sec}^{reg}}_{\text{Commodity taxes: } TRC^{reg}} \\ &+ \underbrace{\sum_{sec} tz_{sec}^{reg} \cdot PZ_{sec}^{reg} \cdot QZ_{sec}^{reg}}_{\text{Production taxes: } TRZ^{reg}} \\ &+ \underbrace{\sum_{secT} \sum_{regg(\neq reg)} tm_{secT}^{reg,regg} \cdot PWM_{secT}^{reg,regg} \cdot EXC_{secT}^{reg} \cdot QBM_{secT}^{reg,regg}}_{\text{Import tariffs: } TRM^{reg}} \\ &+ \underbrace{\sum_{sec} \sum_{fac} tf_{sec}^{fac,reg} \cdot \left(PFM_{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac) \right) \cdot F_{sec}^{fac,reg}}_{\text{Factor taxes: } TRF^{reg}} \end{aligned}$$

Government consumption budget:

$$PCGBUD^{reg} \cdot CGBUD^{reg} = TREV^{reg} - TRNF^{reg} - \overline{SG}^{reg} \cdot \overline{CPI}^{reg}$$

Government's transfer to the household:

$$TRNF^{reg} = \sum_{flab} trep^{flab,reg} \cdot PFM^{flab,reg} \cdot UNEMP^{flab,reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index:

$$\overline{CPI}^{reg} = \frac{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CO_{sec}^{reg}}{\sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CO_{sec}^{reg}}$$

Bilateral export price (home currency):

$$PBE_{secT}^{reg,regg} = PWE_{secT}^{reg,regg} \cdot EXC^{reg}$$

Bilateral import price (home currency):

$$PBM_{secT}^{reg,regg} = (1 + tm_{secT}^{reg,regg}) \cdot PWM_{secT}^{reg,regg} \cdot EXC^{reg}$$

Bilateral import price (world currency):

$$PWM_{secT}^{reg,regg} = PWE_{secT}^{regg,reg} + \sum_{trsp} PTRSPG_{trsp} \cdot \delta_{trsp,secT}^{regg,reg}$$

Shares of international transport services provided to the global transport sector:

$$PE_{trsp}^{reg} \cdot TRSPR_{trsp}^{reg} = \alpha TRSPR_{trsp}^{reg} \cdot (PTRSPG_{trsp} \cdot TRSPG_{trsp})$$

Balancing conditions for the global transport sector:

$$TRSPG_{trsp} = \sum_{reg} TRSPR_{trsp}^{reg}$$

International transport margins as constant shares of bilateral export volumes:

$$TRSPG_{trsp} = \sum_{reg} \sum_{regg} \sum_{secT} \delta_{trsp,secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

Appendix A3-2: Production Sectors in GTAP 6.0 Database

| Code | Sector description | Code | Sector description |
|--------|--|--------|---|
| 1 pdr | paddy rice | 30 lum | wood products |
| 2 wht | wheat | 31 ppp | paper products, publishing |
| 3 gro | cereal grains, n.e.c. | 32 p_c | petroleum, coal products |
| 4 v_f | vegetables, fruit, nuts | 33 crp | chemical, rubber, plastic products |
| 5 osd | oil seeds | 34 nmm | mineral products, n.e.c. |
| 6 c_b | sugar cane, sugar beet | 35 i_s | ferrous metals |
| 7 pfb | plant-based fibres | 36 nfm | metals, n.e.c. |
| 8 ocr | crops n.e.c | 37 fmp | metal products |
| 9 ctl | bovine cattle, sheep and goats, horses | 38 mvh | motor vehicles and parts |
| 10 oap | animal products, n.e.c. | 39 otn | transport equipment, n.e.c. |
| 11 rmk | raw milk | 40 ele | electronic equipment |
| 12 wol | wool, silk-worm cocoons | 41 ome | machinery and equipment |
| 13 frs | forestry | 42 omf | manufactures, n.e.c. |
| 14 fsh | fishing | 43 ely | electricity |
| 15 coa | coal | 44 gdt | gas manufacture, distribution |
| 16 oil | oil | 45 wtr | water |
| 17 gas | gas | 46 cns | construction |
| 18 omn | minerals n.e.c. | 47 trd | trade |
| 19 cmt | bovine meat products | 48 otp | transport, n.e.c. |
| 20 omt | meat products, n.e.c. | 49 wtp | water transport |
| 21 vol | vegetables oils and fats | 50 atp | air transport |
| 22 mil | dairy products | 51 cmn | communication |
| 23 pcr | processed rice | 52 ofi | financial services, n.e.c. |
| 24 sgr | sugar cane, sugar beet | 53 isr | insurance |
| 25 ofd | food products, n.e.c. | 54 obs | business services, n.e.c. |
| 26 b_t | beverages and tobacco products | 55 ros | recreational and other services |
| 27 tex | textiles | 56 osg | public admin., defence, education, health |
| 28 wap | wearing apparel | 57 dwe | dwellings |
| 29 lea | leather products | | |

Note: "n.e.c." stands for "not elsewhere classified" as defined by GTAP.

Appendix to Chapter 4

Appendix A4-1: Two-Good Small Open Economy with the Same Ad Valorem Sales Tax Imposed on Both Goods (with the Cobb-Douglas Preferences)

Let the border prices be p_X and p_Y .

Assume a common ad valorem tax t on goods X and Y so that the household faces prices

$p_X(1+t)$ and $p_Y(1+t)$, and consumes quantities X_t and Y_t .

Let the utility function be Cobb-Douglas

$$U_H = X_t^\alpha \cdot Y_t^{1-\alpha}$$

and let the initial household money income be Z .

The household maximises its utility subject to the budget constraint

$$X_t \cdot p_X \cdot (1+t) + Y_t \cdot p_Y \cdot (1+t) = Z.$$

The Lagrangean function is

$$\Gamma = X_t^\alpha \cdot Y_t^{1-\alpha} - \lambda \cdot (X_t \cdot p_X \cdot (1+t) + Y_t \cdot p_Y \cdot (1+t) - Z),$$

where λ is the Lagrange multiplier.

The first-order conditions are

$$\frac{\partial \Gamma}{\partial X_t} = \alpha \cdot X_t^{\alpha-1} \cdot Y_t^{1-\alpha} - \lambda \cdot p_X \cdot (1+t) = 0$$

$$\frac{\partial \Gamma}{\partial Y_t} = (1-\alpha) \cdot X_t^\alpha \cdot Y_t^{-\alpha} - \lambda \cdot p_Y \cdot (1+t) = 0$$

$$\frac{\partial \Gamma}{\partial \lambda} = X_t \cdot p_X \cdot (1+t) + Y_t \cdot p_Y \cdot (1+t) - Z = 0.$$

From which we obtainⁱⁱⁱ

$$X_t = \frac{\alpha \cdot Z}{p_X \cdot (1+t)}, \quad Y_t = \frac{(1-\alpha) \cdot Z}{p_Y \cdot (1+t)},$$

ⁱⁱⁱ Take the ratios of the left and right hand terms in the first two conditions to get Y as a function of X , and then substitute into the 3rd equation to get X .

that is to say, with a given *money* income, the imposition of a common ad valorem consumption tax on the two goods ($t > 0$) results in the household consuming less of both goods – its *real* income has fallen – and consumption of the two goods falls in the same proportion. Note that if $t = 0$, we have

$$X_0 = \alpha \cdot Z / p_X, Y_0 = (1 - \alpha) \cdot Z / p_Y.$$

The government income from the taxes is

$$R = X_t \cdot p_X \cdot t + Y_t \cdot p_Y \cdot t$$

In the simplest version of this analysis the government income ‘disappears’ – we don’t ‘know’ what the government has done with it. However, for our purposes we need to make some assumption about what the government does with the revenue, and the most simple assumption is that it uses the revenue to purchase goods X and Y . For simplicity we shall assume that the government has the same preferences (utility function) as the household. (If the government has different preferences then things will become more complicated.)

So the government utility function is

$$U_G = X_G^\alpha \cdot Y_G^{1-\alpha}$$

where X_G and Y_G are the quantities purchased by the government. The government’s utility maximising problem is

$$\max U_G = X_G^\alpha \cdot Y_G^{1-\alpha} \text{ subject to } R = X_G \cdot p_X + Y_G \cdot p_Y.$$

The government’s Lagrangean function is^{iv}

^{iv} The government does not pay the tax.

$$\Gamma_G = X_G^\alpha \cdot Y_G^{1-\alpha} - \mu \cdot (X_G \cdot p_X + Y_G \cdot p_Y - R).$$

The first-order conditions are

$$\frac{\partial \Gamma_G}{\partial X_G} = \alpha \cdot X_G^{\alpha-1} \cdot Y_G^{1-\alpha} - \mu \cdot p_X = 0$$

$$\frac{\partial \Gamma_G}{\partial Y_G} = (1-\alpha) \cdot X_G^\alpha \cdot Y_G^{-\alpha} - \mu \cdot p_Y = 0$$

$$\frac{\partial \Gamma_G}{\partial \mu} = X_G \cdot p_X + Y_G \cdot p_Y - R = 0.$$

from which we obtain

$$X_G = \frac{\alpha \cdot R}{p_X}, Y_G = \frac{(1-\alpha) \cdot R}{p_Y},$$

where R is given by the revenue from the taxes on household consumption of the two goods,

i.e.

$$R = X_t \cdot p_X \cdot t + Y_t \cdot p_Y \cdot t.$$

Substituting for X_t and Y_t gives

$$R = \frac{\alpha \cdot Z}{p_X \cdot (1+t)} \cdot p_X \cdot t + \frac{(1-\alpha) \cdot Z}{p_Y \cdot (1+t)} \cdot p_Y \cdot t = \left(\frac{t}{1+t} \right) \cdot Z.$$

We can now obtain X_G and Y_G by substituting for R :

$$X_G = \frac{\alpha}{p_X} \left(\frac{t}{1+t} \right) \cdot Z, Y_G = \frac{(1-\alpha)}{p_Y} \left(\frac{t}{1+t} \right) \cdot Z.$$

Thus the total consumption of X is

$$X_t + X_G = \frac{\alpha}{p_X} \left(\frac{1}{1+t} \right) \cdot Z + \frac{\alpha}{p_X} \left(\frac{t}{1+t} \right) \cdot Z = \frac{\alpha}{p_X} \cdot Z,$$

which is of course the household consumption of X when there is no tax on either good. An equivalent result holds for good Y .

Suppose that the government decides to return the tax revenue to the household. The household now has a total *money* income given by its initial money income (nothing has happened that changes that money income) and the transfer from the government. So now its money income, M , is given by $M = Z + R$. But we know that $R = X_t \cdot p_X \cdot t + Y_t \cdot p_Y \cdot t$ so that the optimisation problem for the household is to maximise

$$U_H = X_M^\alpha \cdot Y_M^{1-\alpha}$$

subject to the constraint

$$X_M \cdot p_X \cdot (1+t) + Y_M \cdot p_Y \cdot (1+t) = Z + R = Z + (X_t \cdot p_X \cdot t + Y_t \cdot p_Y \cdot t).$$

But we can rewrite the above constraint as

$$X_M \cdot p_X \cdot (1+t) + Y_M \cdot p_Y \cdot (1+t) - (X_t \cdot p_X \cdot t + Y_t \cdot p_Y \cdot t) = Z$$

which simplifies to

$$X_M \cdot p_X + Y_M \cdot p_Y = Z.$$

That is, we have the same problem as in the case where the government does not impose a tax on either good. Thus, $X_M = X_0 = \alpha \cdot Z / p_X$, $Y_M = Y_0 = (1-\alpha) \cdot Z / p_Y$.

Therefore, the *money* prices of both goods increase by a proportion t but the *money* income of the household has also increased by a proportion t , so that the *real* income of the household is unchanged. This result would hold for any homothetic utility function, not just for the Cobb-Douglas function. It does rely on the assumption that the same ad valorem tax rate is applied to both goods.

Appendix A4-2: Technical Specifications of the CGE Model Designed for India's Government Revenue Rebalancing Simulations

Notations:

- As in the Appendices for previous model versions, $AUX_{sec}^{reg} \cdot PA_{sec}^{reg}$ refers to the Armington group price index, where the scaling vector AUX_{sec}^{reg} is a function of the number of firms under monopolistic competition, and is equal to one under perfect competition and Cournot oligopoly.
- The representative household is disaggregated into the rich and the poor households in order to clarify the disparity in the welfare impacts of domestic tax policies on households given different income sources.

Sets

One-Dimensional Sets:

| | |
|-----------------------|-------------------------|
| $reg, regg$ | Regions |
| $sec, secc$ | Production sectors |
| $secT (\subset sec)$ | Tradable sectors |
| $secTN (\subset sec)$ | Non-traded sectors |
| $trsp (\subset sec)$ | Transport sectors |
| fac | Primary factors |
| $facM (\subset fac)$ | Mobile factors |
| $facS (\subset fac)$ | Sector-specific factors |
| $flab (\subset fac)$ | Labour |
| hh | Households |

Two-Dimensional Sets:

| | |
|--|----------------------------|
| pc_{sec}^{reg} | Perfect competition |
| ic_{sec}^{reg} | Imperfect competition |
| $co_{sec}^{reg} \left(\subset ic_{sec}^{reg} \right)$ | Cournot oligopoly |
| $mc_{sec}^{reg} \left(\subset ic_{sec}^{reg} \right)$ | Monopolistic competition |
| flx_{reg}^{flab} | The flexible wage approach |
| rgd_{reg}^{flab} | The rigid wage approach |
| $wcrv_{reg}^{flab}$ | The wage curve approach |

Parameters

| | |
|----------------------------|---|
| σD^{reg} | CES substitution elasticity of final demand functions |
| $\gamma HH_{hh,sec}^{reg}$ | CES share parameters of household consumption |
| γGV_{sec}^{reg} | CES share parameters of government consumption |
| γI_{sec}^{reg} | CES share parameters of bank investment |
| $io_{sec,sec c}^{reg}$ | Leontief intermediate demand coefficients |
| σF_{sec}^{reg} | CES substitution elasticity of the value-added production function |
| aF_{sec}^{reg} | CES efficiency parameters of the value-added production function |
| $\gamma F_{sec}^{fac,reg}$ | CES share parameters of factors in the value-added production function |
| σA_{sec}^{reg} | Substitution elasticity of the upper-level Armington function |
| aA_{sec}^{reg} | Efficiency parameters of the upper-level Armington function |
| γAM_{sec}^{reg} | Share parameters of imports in the upper-level Armington function |
| γAD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level Armington function |
| σBM_{sec}^{reg} | Substitution elasticity of the lower-level Armington function |
| aBM_{sec}^{reg} | Efficiency parameters of the lower-level Armington function |

| | |
|-------------------------------|---|
| $\gamma BM_{sec}^{reg,regg}$ | Share parameters of bilateral imports in the lower-level Armington function |
| σT_{sec}^{reg} | Transformation elasticity of the upper-level CET function |
| aT_{sec}^{reg} | Efficiency parameters of the upper-level CET function |
| γTE_{sec}^{reg} | Share parameters of exports in the upper-level CET function |
| γTD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level CET function |
| σBE_{sec}^{reg} | Transformation elasticity of the lower-level CET function |
| aBE_{sec}^{reg} | Efficiency parameters of the lower-level CET function |
| $\gamma BE_{sec}^{reg,regg}$ | Share parameters of bilateral exports in the lower-level CET function |
| $\omega^{fac,reg}$ | Wage curve elasticity |
| $trep^{fac,reg}$ | Replacement rates |
| mps_{hh}^{reg} | Households' marginal propensity to save |
| τ_{hh}^{reg} | Income tax rates |
| τ_{sec}^{reg} | Commodity tax rates |
| $\tau_{sec}^{fac,reg}$ | Factor tax rates |
| τ_{sec}^{reg} | Production tax rates |
| $tm_{sec}^{reg,regg}$ | Import tariff rates |
| $ff_{sec}^{fac,reg}$ | Fixed factor inputs demanded by each firm in imperfectly competitive sector <i>sec</i> |
| σLV_{sec}^{reg} | Substitution elasticity between product varieties in monopolistically competitive sectors |
| $\alpha TRSPR_{sec}^{reg}$ | Shares of international transport services provided by region <i>reg</i> |
| $\delta_{sec,sec}^{reg,regg}$ | International transport margin (<i>sec</i>) per unit of export goods <i>secc</i> from region <i>reg</i> to region <i>regg</i> |

Exogenous variables

| | |
|---------------------------|-------------------------------|
| $\overline{FS}^{fac,reg}$ | Factor endowments (by region) |
|---------------------------|-------------------------------|

| | |
|--|--|
| $\overline{F}_{sec}^{facS,reg}$ | Sector-specific factor demands (by sector) |
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |
| $\overline{NOF}_{sec}^{reg} \co_{sec}^{reg} | Number of firms in Cournot sectors |
| $\overline{PROFIT}_{sec}^{reg} \mc_{sec}^{reg} | Sectoral profits under monopolistic competition |
| $\overline{UNEMP}_{reg}^{flab} \flx_{reg}^{flab} | Unemployment under the flexible wage assumption |

Endogenous variables

| | |
|-----------------------------------|---|
| $\overline{PCBUD}_{hh}^{reg}$ | Household consumption budget deflator |
| \overline{PCGBUD}^{reg} | Government consumption budget deflator |
| \overline{PS}^{reg} | Bank investment budget deflator |
| $\overline{PFM}^{fac,reg}$ | Mobile factor prices |
| $\overline{PFS}_{sec}^{fac,reg}$ | Sector-specific factor prices |
| $\overline{PA}_{sec}^{reg}$ | Armington composite commodity prices |
| $\overline{PZ}_{sec}^{reg}$ | Output prices |
| $\overline{PD}_{sec}^{reg}$ | Prices of domestically-produced goods delivered to the home market |
| $\overline{PM}_{sec}^{reg}$ | Import prices in home currency |
| $\overline{PE}_{sec}^{reg}$ | Export prices in home currency |
| $\overline{PBM}_{sec}^{reg,regg}$ | Prices of bilateral imports by <i>reg</i> from <i>regg</i> (home currency) |
| $\overline{PBE}_{sec}^{reg,regg}$ | Prices of bilateral exports from <i>reg</i> to <i>regg</i> (home currency) |
| $\overline{PWM}_{sec}^{reg,regg}$ | Prices of bilateral imports by <i>reg</i> from <i>regg</i> (world currency) |
| $\overline{PWE}_{sec}^{reg,regg}$ | Prices of bilateral exports from <i>reg</i> to <i>regg</i> (world currency) |
| \overline{EXC}^{reg} | Exchange rates |
| $\overline{F}_{sec}^{facM,reg}$ | Mobile factor demands |
| $\overline{QA}_{sec}^{reg}$ | Armington composite commodity quantities |
| $\overline{QZ}_{sec}^{reg}$ | Output quantities |

| | |
|---------------------------------------|---|
| QDS_{sec}^{reg} | Quantities of domestically-produced goods supplied to home market |
| QDD_{sec}^{reg} | Quantities of domestically-produced goods demanded by home market |
| QM_{sec}^{reg} | Import volumes |
| QE_{sec}^{reg} | Export volumes |
| $QBM_{sec}^{reg,regg}$ | Bilateral import volumes by region reg from region $regg$ |
| $QBE_{sec}^{reg,regg}$ | Bilateral export volumes from region reg to region $regg$ |
| INC_{hh}^{reg} | Household income |
| $TREV^{reg}$ | Total tax revenue |
| S^{reg} | Total savings |
| $CBUD_{hh}^{reg}$ | Household consumption budget |
| $CGBUD^{reg}$ | Government consumption budget |
| $C_{hh,sec}^{reg}$ | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH_{hh}^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{fac,reg}$ | Unemployed labour |
| EDM_{sec}^{reg} | Price elasticity of demand for imperfectly competitive commodities |
| $NOF_{sec}^{reg} \$mc_{sec}^{reg}$ | Number of firms in monopolistically competitive sectors |
| $PROFIT_{sec}^{reg} \$co_{sec}^{reg}$ | Sectoral profits under Cournot oligopoly |
| AUX_{sec}^{reg} | Scaling vectors |
| $PTRSPG_{sec}$ | Prices of global transport services |
| $TRSPG_{sec}$ | Quantities of global transport services |
| $TRSPR_{sec}^{reg}$ | Quantities of international transport services provided by region reg |
| Numéraires | |
| \overline{CPI}^{reg} | Laspeyre consumer price indices |

\overline{EXC}^{THA}

Exchange rate of Thailand

Equations

Firms' CES factor demands:

$$F_{sec}^{fac,reg} = \frac{QZ_{sec}^{reg} \cdot \left(\frac{\gamma F_{sec}^{fac,reg}}{(1+tf_{sec}^{fac,reg}) \cdot (PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac))} \right)^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}}{aF_{sec}^{reg} \cdot \left\{ \sum_{fac} (\gamma F_{sec}^{fac,reg})^{\sigma F_{sec}^{reg}} \cdot \left[(1+tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right]^{1-\sigma F_{sec}^{reg}} \right\}^{\frac{\sigma F_{sec}^{reg}}{\sigma F_{sec}^{reg} - 1}}}$$

$$+ \left(\overline{ff}_{sec}^{fac,reg} \cdot \overline{NOF}_{sec}^{reg} \right) \$co_{sec}^{reg} + \left(\overline{ff}_{sec}^{fac,reg} \cdot \overline{NOF}_{sec}^{reg} \right) \$mc_{sec}^{reg}$$

Firms' zero-profit conditions:

$$(1-tz_{sec}^{reg}) \cdot PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} = \sum_{fac} (1+tf_{sec}^{fac,reg}) \cdot \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \cdot F_{sec}^{fac,reg}$$

$$+ \sum_{sec,c} AUX_{sec,c}^{reg} \cdot PA_{sec,c}^{reg} \cdot (io_{sec,c,sec}^{reg} \cdot QZ_{sec}^{reg})$$

$$+ PROFIT_{sec}^{reg} \$co_{sec}^{reg} + \overline{PROFIT}_{sec}^{reg} \$mc_{sec}^{reg}$$

Imperfectly competitive firms' mark-up pricing conditions $\$ic_{sec}^{reg}$:

$$PZ_{sec}^{reg} \cdot \left\{ 1 - \left[\frac{1}{EDM_{sec}^{reg} \cdot \overline{NOF}_{sec}^{reg}} \right] \$co_{sec}^{reg} + \left[\frac{1}{EDM_{sec}^{reg}} \right] \$mc_{sec}^{reg} \right\} = \sum_{fac} \left\{ \left((1+tf_{sec}^{fac,reg}) \times \left(\frac{PFM_{sec}^{fac,reg} \$facM(fac)}{+PFS_{sec}^{fac,reg} \$facS(fac)} \right) \right) \cdot F_{sec}^{fac,reg} - \left(\overline{ff}_{sec}^{fac,reg} \cdot \left(\frac{\overline{NOF}_{sec}^{reg} \$co_{sec}^{reg}}{+ \overline{NOF}_{sec}^{reg} \$mc_{sec}^{reg}} \right) \right) \right\}$$

$$\times \frac{QZ_{sec}^{reg}}{QZ_{sec}^{reg}} + \sum_{sec,c} AUX_{sec,c}^{reg} \cdot PA_{sec,c}^{reg} \cdot io_{sec,c,sec}^{reg} + tz_{sec}^{reg} \cdot PZ_{sec}^{reg}$$

Imperfectly competitive price elasticity of demand $\$ic_{sec}^{reg}$:

$$EDM_{sec}^{reg} = \left\{ \begin{array}{l} \frac{QDD_{sec}^{reg}}{QZ_{sec}^{reg}} \left(\sigma A_{sec}^{reg} - (\sigma A_{sec}^{reg} - \sigma D^{reg}) \frac{PD_{sec}^{reg} \cdot QDD_{sec}^{reg}}{PA_{sec}^{reg} \cdot QA_{sec}^{reg}} \right) \\ + \sum_{\substack{regg \\ (\neq reg)}} \frac{QBM_{sec}^{regg,reg}}{QZ_{sec}^{reg}} \left(\begin{array}{l} \sigma BM_{sec}^{regg} - (\sigma BM_{sec}^{regg} - \sigma A_{sec}^{regg}) \\ \cdot \frac{PBM_{sec}^{regg,reg} \cdot QBM_{sec}^{regg,reg}}{PM_{sec}^{regg} \cdot QM_{sec}^{regg}} \\ - (\sigma A_{sec}^{regg} - \sigma D^{regg}) \\ \cdot \frac{PBM_{sec}^{regg,reg} \cdot QBM_{sec}^{regg,reg}}{PA_{sec}^{regg} \cdot QA_{sec}^{regg}} \end{array} \right) \end{array} \right\} \$(\text{sec}T(\text{sec}) \cap co_{sec}^{reg})$$

$$+ \left(\frac{\sum_{hh} C_{hh,sec}^{reg} + CG_{sec}^{reg} + I_{sec}^{reg}}{QZ_{sec}^{reg} \cdot (1 - io_{sec,sec}^{reg})} \right) \$(\text{sec}TN(\text{sec}) \cap co_{sec}^{reg}) + (\sigma LV_{sec}^{reg}) \$mc_{sec}^{reg}$$

Scaling vectors:

$$AUX_{sec}^{reg} = 1 \$ (pc_{sec}^{reg} \cup co_{sec}^{reg}) + \left(NOF_{sec}^{reg} \frac{1}{1 - \sigma LV_{sec}^{reg}} \right) \$mc_{sec}^{reg}$$

Households' CES private demands:

$$C_{hh,sec}^{reg} = CBUD_{hh}^{reg} \cdot \left[\gamma HH_{hh,sec}^{reg} \cdot \frac{PCBUD_{hh}^{reg}}{(1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}}$$

Households' budget constraints:

$$PCBUD_{hh}^{reg} \cdot CBUD_{hh}^{reg} = \sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot C_{hh,sec}^{reg}$$

Government's CES public demands:

$$CG_{sec}^{reg} = CGBUD_{sec}^{reg} \cdot \left[\gamma GV_{sec}^{reg} \cdot \frac{PCGBUD_{sec}^{reg}}{AUX_{sec}^{reg} \cdot PA_{sec}^{reg}} \right]^{\sigma D^{reg}}$$

Government's budget constraints:

$$PCGBUD_{sec}^{reg} \cdot CGBUD_{sec}^{reg} = \sum_{sec} AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CG_{sec}^{reg}$$

Bank's CES investment demands:

$$I_{\text{sec}}^{\text{reg}} = S^{\text{reg}} \cdot \left[\gamma I_{\text{sec}}^{\text{reg}} \cdot \frac{PS^{\text{reg}}}{AUX_{\text{sec}}^{\text{reg}} \cdot PA_{\text{sec}}^{\text{reg}}} \right]^{\sigma D^{\text{reg}}}$$

Bank's budget constraints:

$$PS^{\text{reg}} \cdot S^{\text{reg}} = \sum_{\text{sec}} AUX_{\text{sec}}^{\text{reg}} \cdot PA_{\text{sec}}^{\text{reg}} \cdot I_{\text{sec}}^{\text{reg}}$$

Upper-level CET functions:

Domestically-produced good supply (1) $\$ \left\{ \text{not} \left[\text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec})) \right] \right\}$:

$$QDS_{\text{sec}}^{\text{reg}} = \left[\left(aT_{\text{sec}}^{\text{reg}} \right)^{\sigma T_{\text{sec}}^{\text{reg}} - 1} \cdot \left(\frac{\gamma TD_{\text{sec}}^{\text{reg}} \cdot PZ_{\text{sec}}^{\text{reg}}}{PD_{\text{sec}}^{\text{reg}}} \right)^{\sigma T_{\text{sec}}^{\text{reg}}} \cdot QZ_{\text{sec}}^{\text{reg}} \right]$$

$$\$ \left\{ \text{sec}T(\text{sec}) \cap \left[\text{not} (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec})) \right] \right\}$$

$$+ \left[QZ_{\text{sec}}^{\text{reg}} \right] \$ \text{sec}TN(\text{sec})$$

Domestically-produced good supply (2) $\$ \left[\text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec})) \right]$:

$$PD_{\text{sec}}^{\text{reg}} = PZ_{\text{sec}}^{\text{reg}}$$

Aggregate export supply (1) $\$ \left\{ \text{sec}T(\text{sec}) \cap \left[\text{not} (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec})) \right] \right\}$:

$$QE_{\text{sec}}^{\text{reg}} = \left(aT_{\text{sec}}^{\text{reg}} \right)^{\sigma T_{\text{sec}}^{\text{reg}} - 1} \cdot \left(\frac{\gamma TE_{\text{sec}}^{\text{reg}} \cdot PZ_{\text{sec}}^{\text{reg}}}{PE_{\text{sec}}^{\text{reg}}} \right)^{\sigma T_{\text{sec}}^{\text{reg}}} \cdot QZ_{\text{sec}}^{\text{reg}}$$

Aggregate export supply (2) $\$ \left[\text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec})) \right]$:

$$PE_{\text{sec}}^{\text{reg}} = PZ_{\text{sec}}^{\text{reg}}$$

Balancing conditions for upper-level CET supplies:

$$PD_{\text{sec}}^{\text{reg}} \cdot QZ_{\text{sec}}^{\text{reg}} = PD_{\text{sec}}^{\text{reg}} \cdot QDS_{\text{sec}}^{\text{reg}} + \left(PE_{\text{sec}}^{\text{reg}} \cdot QE_{\text{sec}}^{\text{reg}} \right) \$ \text{sec}T(\text{sec})$$

$$+ \left(PE_{\text{sec}}^{\text{reg}} \cdot TRSPR_{\text{sec}}^{\text{reg}} \right) \$ \text{trsp}(\text{sec})$$

Lower-level CET functions:

Bilateral export supply (1) \$(not \$co_{secT}^{reg}\$):

$$QBE_{secT}^{reg,regg} = (aBE_{secT}^{reg})^{\sigma BE_{secT}^{reg}-1} \cdot \left(\frac{\gamma BE_{secT}^{reg,regg} \cdot PE_{secT}^{reg}}{PBE_{secT}^{reg,regg}} \right)^{\sigma BE_{secT}^{reg}} \cdot QE_{secT}^{reg}$$

Bilateral export supply (2) \$co_{secT}^{reg}\$:

$$PBE_{secT}^{reg,regg} = PE_{secT}^{reg}$$

Balancing conditions for bilateral export supply:

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg (\neq reg)} PBE_{secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

Upper-level Armington functions:

Domestically-produced commodity demands:

$$QDD_{sec}^{reg} = \left[(aA_{sec}^{reg})^{\sigma A_{sec}^{reg}-1} \cdot \left(\frac{\gamma AD_{sec}^{reg} \cdot PA_{sec}^{reg}}{PD_{sec}^{reg}} \right)^{\sigma A_{sec}^{reg}} \cdot QA_{sec}^{reg} \right] \$secT(sec) + [QA_{sec}^{reg}] \$secTN(sec)$$

Aggregate import demands:

$$QM_{secT}^{reg} = (aA_{secT}^{reg})^{\sigma A_{secT}^{reg}-1} \cdot \left(\frac{\gamma AM_{secT}^{reg} \cdot PA_{secT}^{reg}}{PM_{secT}^{reg}} \right)^{\sigma A_{secT}^{reg}} \cdot QA_{secT}^{reg}$$

Balancing conditions for upper-level Armington demands:

$$PA_{sec}^{reg} \cdot QA_{sec}^{reg} = PD_{sec}^{reg} \cdot QDD_{sec}^{reg} + (PM_{sec}^{reg} \cdot QM_{sec}^{reg}) \$secT(sec)$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg,regg} = (aBM_{secT}^{reg})^{\sigma BM_{secT}^{reg}-1} \cdot \left(\frac{\gamma BM_{secT}^{reg,regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg,regg}} \right)^{\sigma BM_{secT}^{reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg(\neq reg)} PBM_{secT}^{reg,regg} \cdot QBM_{secT}^{reg,regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} = \overline{FS}^{fac,reg} - UNEMP^{fac,reg} \$flab(fac)$$

Armington commodity markets:

$$AUX_{sec}^{reg} \cdot \left(\sum_{hh} C_{hh,sec}^{reg} + CG_{sec}^{reg} + I_{sec}^{reg} + \sum_{sec c} io_{sec,secc}^{reg} \cdot QZ_{secc}^{reg} \right) = QA_{sec}^{reg}$$

Domestically-produced commodity supply and demand:

$$QDS_{sec}^{reg} = QDD_{sec}^{reg}$$

Bilateral trade:

$$QBE_{secT}^{reg,regg} = QBM_{secT}^{regg,reg}$$

Balance of payments:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg,regg} \cdot PWM_{secT}^{reg,regg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg,regg} \cdot PWE_{secT}^{reg,regg} \right) + \sum_{trsp} TRSPR_{trsp}^{reg} \cdot PTRSPG_{trsp} + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}$$

Wage curve and rigid wage approaches $\{\text{not } flx_{reg}^{flab}\}$:

$$\frac{PFM_{flab,reg}}{PFMO_{flab,reg}} = 1 \$rgd_{reg}^{flab} + \left[\left(\frac{UNEMP_{flab,reg}}{UNEMPO_{flab,reg}} \right)^{\omega_{flab,reg}} \right] \$wcrv_{reg}^{flab}$$

Rich household income:

$$\begin{aligned}
INC_{RH}^{reg} &= \left[\sum_{fac} \sum_{sec} F_{sec}^{fac,reg} \cdot \left(PFM_{sec}^{fac,reg} \$facM(fac) \right) \right. \\
&\quad \left. + PFS_{sec}^{fac,reg} \$facS(fac) \right] \$[not\ SameAs(fac, "UnSkLab")] \\
&\quad + trep^{SkLab,reg} \cdot PFM^{SkLab,reg} \cdot UNEMP^{SkLab,reg} \\
&\quad + \sum_{sec} \left(\frac{PROFIT_{sec}^{reg} \$co_{sec}^{reg}}{+PROFIT_{sec}^{reg} \$mc_{sec}^{reg}} \right)
\end{aligned}$$

Poor household income:

$$\begin{aligned}
INC_{PH}^{reg} &= \left(\sum_{sec} F_{sec}^{UnSkLab,reg} \cdot PFM^{UnSkLab,reg} \right) \\
&\quad + trep^{UnSkLab,reg} \cdot PFM^{UnSkLab,reg} \cdot UNEMP^{UnSkLab,reg} \\
&\quad + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}
\end{aligned}$$

Household consumption budget:

$$PCBUD_{hh}^{reg} \cdot CBUD_{hh}^{reg} = (1 - ty_{hh}^{reg}) \cdot INC_{hh}^{reg} - SHH_{hh}^{reg}$$

Household savings:

$$SHH_{hh}^{reg} = mps_{hh}^{reg} \cdot \left[(1 - ty_{hh}^{reg}) \cdot INC_{hh}^{reg} \right]$$

Total savings:

$$PS^{reg} \cdot S^{reg} = \sum_{hh} SHH_{hh}^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}$$

Government tax revenue:

$$\begin{aligned}
TREV^{reg} &= \underbrace{\sum_{hh} ty_{hh}^{reg} \cdot INC_{hh}^{reg}}_{\text{Income taxes: } TRY^{reg}} + \underbrace{\sum_{hh} \sum_{sec} tc_{sec}^{reg} \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot C_{sec}^{reg, hh}}_{\text{Commodity taxes: } TRC^{reg}} \\
&\quad + \underbrace{\sum_{sec} tz_{sec}^{reg} \cdot PZ_{sec}^{reg} \cdot QZ_{sec}^{reg}}_{\text{Production taxes: } TRZ^{reg}} \\
&\quad + \underbrace{\sum_{secT} \sum_{regg(\neq reg)} tm_{secT}^{reg, regg} \cdot PWM_{secT}^{reg, regg} \cdot EXC_{secT}^{reg} \cdot QBM_{secT}^{reg, regg}}_{\text{Import tariffs: } TRM^{reg}} \\
&\quad + \underbrace{\sum_{sec} \sum_{fac} tf_{sec}^{fac,reg} \cdot \left(PFM_{sec}^{fac,reg} \$facM(fac) + PFS_{sec}^{fac,reg} \$facS(fac) \right) \cdot F_{sec}^{fac,reg}}_{\text{Factor taxes: } TRF^{reg}}
\end{aligned}$$

Government consumption budget:

$$PCGBUD^{reg} \cdot CGBUD^{reg} = TREV^{reg} - TRNF^{reg} - \overline{SG}^{reg} \cdot \overline{CPI}^{reg}$$

Government's transfer to the household:

$$TRNF^{reg} = \sum_{flab} trep^{flab,reg} \cdot PFM^{flab,reg} \cdot UNEMP^{flab,reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index:

$$\overline{CPI}^{reg} = \frac{\sum_{hh} \sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CO_{hh,sec}^{reg}}{\sum_{hh} \sum_{sec} (1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot CO_{hh,sec}^{reg}}$$

Bilateral export price (home currency):

$$PBE_{secT}^{reg,regg} = PWE_{secT}^{reg,regg} \cdot EXC^{reg}$$

Bilateral import price (home currency):

$$PBM_{secT}^{reg,regg} = (1 + tm_{secT}^{reg,regg}) \cdot PWM_{secT}^{reg,regg} \cdot EXC^{reg}$$

Bilateral import price (world currency):

$$PWM_{secT}^{reg,regg} = PWE_{secT}^{regg,reg} + \sum_{trsp} PTRSPG_{trsp} \cdot \delta_{trsp,secT}^{regg,reg}$$

Shares of international transport services provided to the global transport sector:

$$PE_{trsp}^{reg} \cdot TRSPR_{trsp}^{reg} = \alpha TRSPR_{trsp}^{reg} \cdot (PTRSPG_{trsp} \cdot TRSPG_{trsp})$$

Balancing conditions for the global transport sector:

$$TRSPG_{trsp} = \sum_{reg} TRSPR_{trsp}^{reg}$$

International transport margins as constant shares of bilateral export volumes:

$$TRSPG_{trsp} = \sum_{reg} \sum_{regg} \sum_{secT} \delta_{trsp,secT}^{reg,regg} \cdot QBE_{secT}^{reg,regg}$$

Appendix A4-3: India's Benchmark Investment and Household Consumption Demands, Aggregate Import and Export, and Output by Sector (Billion US\$)

| Production Sectors | Investment demand | Household consumption demand | Aggregate Import | Aggregate export | Output |
|--------------------|-------------------|------------------------------|------------------|------------------|--------|
| <i>AGR</i> | 0.72 | 86.03 | 2.18 | 3.14 | 138.07 |
| <i>NRS</i> | 0.00 | 8.28 | 2.51 | 1.33 | 19.50 |
| <i>OIL</i> | 0.00 | 0.00 | 9.06 | 0.00 | 3.62 |
| <i>PAGR</i> | 0.00 | 38.19 | 1.82 | 1.46 | 40.34 |
| <i>OFD</i> | 0.00 | 7.04 | 0.21 | 2.29 | 10.06 |
| <i>MNF</i> | 6.51 | 15.08 | 5.07 | 6.66 | 72.99 |
| <i>TEX</i> | 0.02 | 16.33 | 0.95 | 7.44 | 34.73 |
| <i>WAP</i> | 0.00 | 1.06 | 0.07 | 5.53 | 6.60 |
| <i>CRP</i> | 1.84 | 5.16 | 6.48 | 6.39 | 50.67 |
| <i>L_S</i> | 1.38 | 0.00 | 1.29 | 1.50 | 22.38 |
| <i>NFM</i> | 0.00 | 0.00 | 3.27 | 0.68 | 7.46 |
| <i>MVH</i> | 7.54 | 0.49 | 0.77 | 0.62 | 10.54 |
| <i>ELE</i> | 6.44 | 1.27 | 3.19 | 0.89 | 6.84 |
| <i>OME</i> | 21.07 | 0.88 | 6.36 | 3.27 | 28.96 |
| <i>OMF</i> | 3.75 | 1.59 | 4.62 | 7.50 | 16.78 |
| <i>MSR</i> | 49.87 | 6.81 | 0.11 | 0.03 | 99.24 |
| <i>TRD</i> | 4.27 | 37.20 | 2.20 | 2.38 | 83.83 |
| <i>TRP</i> | 2.75 | 21.61 | 2.93 | 2.35 | 68.55 |
| <i>CFI</i> | 0.00 | 13.80 | 1.02 | 0.62 | 52.04 |
| <i>OBS</i> | 0.00 | 5.29 | 4.96 | 6.28 | 15.80 |
| <i>OSG</i> | 0.00 | 13.08 | 0.58 | 0.76 | 54.97 |
| <i>DWE</i> | 0.00 | 24.36 | 0.00 | 0.00 | 24.57 |

Source: Calibrated from GTAP 6.0 database.

Appendix A4-4: Technical Specifications of the CGE Model Designed for India's Government Revenue Rebalancing Simulations (with the Informal Economy)

This appendix uses the same notation as Appendix A4-2, the only substantial modification being the incorporation of the informal economy, specifically defined as untaxed.

One-Dimensional Sets:

| | |
|-----------------------|--------------------------------------|
| $reg, regg$ | Regions |
| $regF (\subset reg)$ | Regions without the informal economy |
| $regI (\subset reg)$ | Regions with the informal economy |
| $sec, secc$ | Production sectors |
| $secT (\subset sec)$ | Tradable sectors |
| $secTN (\subset sec)$ | Non-traded sectors |
| $trsp (\subset sec)$ | Transport sectors |
| fac | Primary factors |
| $facM (\subset fac)$ | Mobile factors |
| $facS (\subset fac)$ | Sector-specific factors |
| $flab (\subset fac)$ | Labour |
| hh | Households |
| fn | Formality of economic activities |

Two-Dimensional Sets:

| | |
|---|----------------------------|
| pc_{sec}^{reg} | Perfect competition |
| ic_{sec}^{reg} | Imperfect competition |
| $co_{sec}^{reg} (\subset ic_{sec}^{reg})$ | Cournot oligopoly |
| $mc_{sec}^{reg} (\subset ic_{sec}^{reg})$ | Monopolistic competition |
| flx_{reg}^{flab} | The flexible wage approach |
| rgd_{reg}^{flab} | The rigid wage approach |
| $wcrv_{reg}^{flab}$ | The wage curve approach |

Parameters

| | |
|------------------------------|---|
| σD^{reg} | CES substitution elasticity of final demand functions |
| $\gamma HH_{hh,sec}^{reg}$ | CES share parameters of household consumption |
| γGV_{sec}^{reg} | CES share parameters of government consumption |
| γI_{sec}^{reg} | CES share parameters of bank investment |
| $io_{sec,sec,c}^{reg}$ | Leontief intermediate demand coefficients |
| σF_{sec}^{reg} | CES substitution elasticity of the value-added production function |
| aF_{sec}^{reg} | CES efficiency parameters of the value-added production function |
| $\gamma F_{sec}^{fac,reg}$ | CES share parameters of factors in the value-added production function |
| σA_{sec}^{reg} | Substitution elasticity of the upper-level Armington function |
| aA_{sec}^{reg} | Efficiency parameters of the upper-level Armington function |
| γAM_{sec}^{reg} | Share parameters of imports in the upper-level Armington function |
| γAD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level Armington function |
| σBM_{sec}^{reg} | Substitution elasticity of the lower-level Armington function |
| aBM_{sec}^{reg} | Efficiency parameters of the lower-level Armington function |
| $\gamma BM_{sec}^{reg,regg}$ | Share parameters of bilateral imports in the lower-level Armington function |
| σT_{sec}^{reg} | Transformation elasticity of the upper-level CET function |
| aT_{sec}^{reg} | Efficiency parameters of the upper-level CET function |
| γTE_{sec}^{reg} | Share parameters of exports in the upper-level CET function |
| γTD_{sec}^{reg} | Share parameters of domestically-produced goods in the upper-level CET function |
| σBE_{sec}^{reg} | Transformation elasticity of the lower-level CET function |
| aBE_{sec}^{reg} | Efficiency parameters of the lower-level CET function |
| $\gamma BE_{sec}^{reg,regg}$ | Share parameters of bilateral exports in the lower-level CET function |
| $\omega^{fac,reg}$ | Wage curve elasticity |

| | |
|---------------------------------|---|
| $trep^{fac,reg}$ | Replacement rates |
| mps_{hh}^{reg} | Households' marginal propensity to save |
| ty_{hh}^{reg} | Income tax rates |
| tc_{sec}^{reg} | Commodity tax rates |
| $tf_{sec}^{fac,reg}$ | Factor tax rates |
| t_{sec}^{reg} | Production tax rates |
| $tm_{sec}^{reg,regg}$ | Import tariff rates |
| $ff_{sec}^{fac,reg}$ | Fixed factor inputs demanded by each firm in imperfectly competitive sector sec |
| σLV_{sec}^{reg} | Substitution elasticity between product varieties in monopolistically competitive sectors |
| $\alpha TRSPR_{sec}^{reg}$ | Shares of international transport services provided by region reg |
| $\delta_{sec,secc}^{reg,regg}$ | International transport margin (sec) per unit of export goods $secc$ from region reg to region $regg$ |
| σFM^{reg} | Substitution elasticity between formal & informal goods |
| $\gamma HFM_{sec,fm}^{reg,hh}$ | Share parameters of household consumption between formal & informal goods |
| $\gamma IFM_{sec,fm}^{reg}$ | Share parameters of bank investment between formal & informal goods |
| $\gamma FFM_{sec,fm}^{fac,reg}$ | Share parameters of factor demands by formal & informal firms |
| $a FFM_{sec,fm}^{reg}$ | Efficiency parameters of factor demands by formal & informal firms |
| $io FM_{sec,fm}^{reg,secc}$ | Formal and informal intermediate inputs provided respectively to formal & informal firms |

Exogenous variables

| | |
|--------------------------------|--|
| $\overline{FS}^{fac,reg}$ | Factor endowments (by region) |
| $\overline{F}_{sec}^{fac,reg}$ | Sector-specific factor demands (by sector) |
| \overline{TRO}^{reg} | Government's lump-sum transfers to the household |

| | |
|--|---|
| \overline{SG}^{reg} | Government savings |
| \overline{SF}^{reg} | Foreign savings |
| $\overline{NOF}_{sec}^{reg} \ \co_{sec}^{reg} | Number of firms in Cournot sectors |
| $\overline{PROFIT}_{sec}^{reg} \ \mc_{sec}^{reg} | Sectoral profits under monopolistic competition |
| $\overline{UNEMP}_{reg}^{flab} \ \flx_{reg}^{flab} | Unemployment under the flexible wage assumption |

Endogenous variables

| | |
|------------------------|---|
| $PCBUD_{hh}^{reg}$ | Household consumption budget deflator |
| $PCGBUD^{reg}$ | Government consumption budget deflator |
| PS^{reg} | Bank investment budget deflator |
| $PFM^{fac,reg}$ | Mobile factor prices |
| $PFS_{sec}^{fac,reg}$ | Sector-specific factor prices |
| PA_{sec}^{reg} | Armington composite commodity prices |
| PZ_{sec}^{reg} | Output prices |
| PD_{sec}^{reg} | Prices of domestically-produced goods delivered to the home market |
| PM_{sec}^{reg} | Import prices in home currency |
| PE_{sec}^{reg} | Export prices in home currency |
| $PBM_{sec}^{reg,regg}$ | Prices of bilateral imports by <i>reg</i> from <i>regg</i> (home currency) |
| $PBE_{sec}^{reg,regg}$ | Prices of bilateral exports from <i>reg</i> to <i>regg</i> (home currency) |
| $PWM_{sec}^{reg,regg}$ | Prices of bilateral imports by <i>reg</i> from <i>regg</i> (world currency) |
| $PWE_{sec}^{reg,regg}$ | Prices of bilateral exports from <i>reg</i> to <i>regg</i> (world currency) |
| EXC^{reg} | Exchange rates |
| $F_{sec}^{facM,reg}$ | Mobile factor demands |
| QA_{sec}^{reg} | Armington composite commodity quantities |
| QZ_{sec}^{reg} | Output quantities |
| QDS_{sec}^{reg} | Quantities of domestically-produced goods supplied to home market |
| QDD_{sec}^{reg} | Quantities of domestically-produced goods demanded by home market |

| | |
|---------------------------------------|---|
| QM_{sec}^{reg} | Import volumes |
| QE_{sec}^{reg} | Export volumes |
| $QBM_{sec}^{reg,regg}$ | Bilateral import volumes by region reg from region $regg$ |
| $QBE_{sec}^{reg,regg}$ | Bilateral export volumes from region reg to region $regg$ |
| INC_{hh}^{reg} | Household income (only from formal sources) |
| $TREV^{reg}$ | Total tax revenue |
| S^{reg} | Total savings |
| $CBUD_{hh}^{reg}$ | Household consumption budget |
| $CGBUD^{reg}$ | Government consumption budget |
| $C_{hh,sec}^{reg}$ | Households' consumption demands |
| CG_{sec}^{reg} | Government's consumption demands |
| I_{sec}^{reg} | Bank's investment demands |
| SHH_{hh}^{reg} | Household savings |
| $TRNF^{reg}$ | Government's total transfers to the household |
| $UNEMP^{fac,reg}$ | Unemployed labour |
| EDM_{sec}^{reg} | Price elasticity of demand for imperfectly competitive commodities |
| $NOF_{sec}^{reg} \$mc_{sec}^{reg}$ | Number of firms in monopolistically competitive sectors |
| $PROFIT_{sec}^{reg} \$co_{sec}^{reg}$ | Sectoral profits under Cournot oligopoly |
| AUX_{sec}^{reg} | Scaling vectors |
| $PTRSPG_{sec}$ | Prices of global transport services |
| $TRSPG_{sec}$ | Quantities of global transport services |
| $TRSPR_{sec}^{reg}$ | Quantities of international transport services provided by region reg |
| $PCA_{sec}^{reg,hh}$ | Prices of aggregate consumption goods for households |
| PIA_{sec}^{reg} | Prices of aggregate investment goods for the bank |
| $CFM_{sec,fm}^{reg,hh}$ | Household consumption of formal and informal goods |
| $IFM_{sec,fm}^{reg}$ | Bank investment on formal and informal goods |
| $PAFM_{sec,fm}^{reg}$ | Formal and informal Armington composite commodity prices |

| | |
|-----------------------------|--|
| $PZFM_{sec, fm}^{reg}$ | Formal and informal output prices |
| $PDFM_{sec, fm}^{reg}$ | Formal and informal prices of domestically-produced goods delivered to the home market |
| $QAFM_{sec, fm}^{reg}$ | Formal and informal Armington composite commodity quantities |
| $QZFM_{sec, fm}^{reg}$ | Formal and informal output quantities |
| $QDSFM_{sec, fm}^{reg}$ | Formal and informal quantities of domestically-produced goods supplied to home market |
| $QDDFM_{sec, fm}^{reg}$ | Formal and informal quantities of domestically-produced goods demanded by home market |
| $FFM_{sec, fm}^{facM, reg}$ | Formal and informal mobile factor demands |
| $AUXFM_{sec, fm}^{reg}$ | Scaling vectors for formal and informal goods |
| $INCFI^{reg, hh}$ | Households' incomes inclusive of those from informal sources |

Numéraires

| | |
|------------------------|---------------------------------|
| \overline{CPI}^{reg} | Laspeyre consumer price indices |
| \overline{EXC}^{THA} | Exchange rate of Thailand |

Equations

Firms' CES factor demands in $regF$:

$$F_{sec}^{fac, regF} = \frac{QZ_{sec}^{regF} \cdot \left(\frac{\gamma F_{sec}^{fac, regF}}{(1 + tf_{sec}^{fac, regF}) \cdot (PFM_{sec}^{fac, regF} \$facM(fac) + PFS_{sec}^{fac, regF} \$facS(fac))} \right)^{\sigma F_{sec}^{regF}}}{aF_{sec}^{regF} \cdot \left[\sum_{fac} \left[\left(\gamma F_{sec}^{fac, regF} \right)^{\sigma F_{sec}^{regF}} \cdot (1 + tf_{sec}^{fac, regF})^{1 - \sigma F_{sec}^{regF}} \cdot \left(PFM_{sec}^{fac, regF} \$facM(fac) + PFS_{sec}^{fac, regF} \$facS(fac) \right)^{1 - \sigma F_{sec}^{regF}} \right]^{\frac{\sigma F_{sec}^{regF}}{\sigma F_{sec}^{regF} - 1}} \right]} + \left(ff_{sec}^{fac, regF} \cdot \overline{NOF}_{sec}^{regF} \right) \$co_{sec}^{regF} + \left(ff_{sec}^{fac, regF} \cdot NOF_{sec}^{regF} \right) \$mc_{sec}^{regF}$$

Firms' CES factor demands in $regI$:

$$\begin{aligned}
 FFM_{sec, fm}^{fac, regI} &= \frac{QZFM_{sec, fm}^{regI} \cdot \left(\frac{\gamma FFM_{sec, fm}^{fac, regI}}{(1 + t_{sec}^{fac, regI} \$ (fm = "FML"))) \cdot \left(\frac{PFM_{sec}^{fac, regI} \$ facM(fac)}{+ PFS_{sec}^{fac, regI} \$ facS(fac)} \right)^{\sigma_{sec}^{regI}} \right)}{a FFM_{sec, fm}^{regI} \left\{ \sum_{fac} \left[\left(\gamma FFM_{sec, fm}^{fac, regI} \right)^{\sigma_{sec}^{regI}} \cdot (1 + t_{sec}^{fac, regI} \$ (fm = "FML"))^{1 - \sigma_{sec}^{regI}} \right]^{\frac{\sigma_{sec}^{regI}}{\sigma_{sec}^{regI} - 1}} \cdot \left(\frac{PFM_{sec}^{fac, regI} \$ facM(fac)}{+ PFS_{sec}^{fac, regI} \$ facS(fac)} \right)^{1 - \sigma_{sec}^{regI}} \right\}} \\
 &+ \left(ff_{sec}^{fac, regI} \cdot \overline{NOF}_{sec}^{regI} \right) \$ (co_{sec}^{regI} \cap (fm = "FML")) \\
 &+ \left(ff_{sec}^{fac, regI} \cdot \overline{NOF}_{sec}^{regI} \right) \$ (mc_{sec}^{regI} \cap (fm = "FML"))
 \end{aligned}$$

Firms' zero-profit conditions in $regF$:

$$\begin{aligned}
 (1 - t_{sec}^{regF}) \cdot PZ_{sec}^{regF} \cdot QZ_{sec}^{regF} &= \sum_{fac} (1 + t_{sec}^{fac, regF}) \cdot \left(\frac{PFM_{sec}^{fac, regF} \$ facM(fac)}{+ PFS_{sec}^{fac, regF} \$ facS(fac)} \right) \cdot F_{sec}^{fac, regF} \\
 &+ \sum_{sec c} AUX_{sec c}^{regF} \cdot PA_{sec c}^{regF} \cdot (io_{sec c, sec}^{regF} \cdot QZ_{sec}^{regF}) \\
 &+ PROFIT_{sec}^{regF} \$ co_{sec}^{regF} + \overline{PROFIT}_{sec}^{regF} \$ mc_{sec}^{regF}
 \end{aligned}$$

Firms' zero-profit conditions in $regI$:

$$\begin{aligned}
 (1 - t_{sec}^{regI} \$ (fm = "FML")) \cdot PZFM_{sec, fm}^{regI} \cdot QZFM_{sec, fm}^{regI} &= \sum_{fac} (1 + t_{sec}^{fac, regI} \$ (fm = "FML")) \cdot \left(\frac{PFM_{sec}^{fac, regI} \$ facM(fac)}{+ PFS_{sec}^{fac, regI} \$ facS(fac)} \right) \cdot FFM_{sec, fm}^{fac, regI} \\
 &+ \sum_{sec c} AUXFM_{sec c, fm}^{regI} \cdot PAFM_{sec c, fm}^{regI} \cdot (ioFM_{sec c, sec, fm}^{regI} \cdot QZFM_{sec, fm}^{regI}) \\
 &+ PROFIT_{sec}^{regI} \$ (co_{sec}^{regI} \cap (fm = "FML")) + \overline{PROFIT}_{sec}^{regI} \$ (mc_{sec}^{regI} \cap (fm = "FML"))
 \end{aligned}$$

Imperfectly competitive firms' mark-up pricing conditions in $regF$ Sic_{sec}^{reg} :

$$PZ_{sec}^{regF} \cdot \left\{ 1 - \left[\left(\frac{1}{EDM_{sec}^{regF} \cdot NOF_{sec}^{regF}} \right) \$co_{sec}^{regF} \right] + \left(\frac{1}{EDM_{sec}^{regF}} \right) \$mc_{sec}^{regF} \right\} = \sum_{fac} \left\{ \left(1 + tf_{sec}^{fac,regF} \right) \times \left(\frac{PFM_{sec}^{fac,regF} \$facM(fac)}{+PFS_{sec}^{fac,regF} \$facS(fac)} \right) - \left(\frac{NOF_{sec}^{regF} \$co_{sec}^{regF}}{+NOF_{sec}^{regF} \$mc_{sec}^{regF}} \right) \right\} \times \frac{1}{QZ_{sec}^{regF}} + \sum_{sec c} AUX_{sec c}^{regF} \cdot PA_{sec c}^{regF} \cdot io_{sec c,sec}^{regF} + tz_{sec}^{regF} \cdot PZ_{sec}^{regF}$$

Imperfectly competitive firms' mark-up pricing conditions in $regI$ Sic_{sec}^{reg} :

$$PZFM_{sec, "FML"}^{regI} \cdot \left\{ 1 - \left[\left(\frac{1}{EDM_{sec}^{regI} \cdot NOF_{sec}^{regI}} \right) \$co_{sec}^{regI} \right] + \left(\frac{1}{EDM_{sec}^{regI}} \right) \$mc_{sec}^{regI} \right\} = \sum_{fac} \left\{ \left(1 + tf_{sec}^{fac,regI} \right) \cdot \left(\frac{PFM_{sec}^{fac,regI} \$facM(fac)}{+PFS_{sec}^{fac,regI} \$facS(fac)} \right) - \left(\frac{NOF_{sec}^{regI} \$co_{sec}^{regI}}{+NOF_{sec}^{regI} \$mc_{sec}^{regI}} \right) \right\} \times \frac{1}{QZFM_{sec, "FML"}^{regI}} + \sum_{sec c} AUXFM_{sec c, "FML"}^{regI} \cdot PAFM_{sec c, "FML"}^{regI} \cdot ioFM_{sec c, sec, "FML"}^{regI} + tz_{sec}^{regI} \cdot PZFM_{sec, "FML"}^{regI}$$

Imperfectly competitive price elasticity of demand in $regF$ Sic_{sec}^{reg} :

$$EDM_{sec}^{regF} = \left\{ \frac{QDD_{sec}^{regF}}{QZ_{sec}^{regF}} \left(\sigma A_{sec}^{regF} - (\sigma A_{sec}^{regF} - \sigma D^{regF}) \frac{PD_{sec}^{regF} \cdot QDD_{sec}^{regF}}{PA_{sec}^{regF} \cdot QA_{sec}^{regF}} \right) + \sum_{regg (\neq regF)} \frac{QBM_{sec}^{regg, regF}}{QZ_{sec}^{regF}} \left(\frac{\sigma BM_{sec}^{regg} - (\sigma BM_{sec}^{regg} - \sigma A_{sec}^{regg}) \cdot \frac{PBM_{sec}^{regg, regF} \cdot QBM_{sec}^{regg, regF}}{PM_{sec}^{regg} \cdot QM_{sec}^{regg}}}{- (\sigma A_{sec}^{regg} - \sigma D^{regg}) \cdot \frac{PBM_{sec}^{regg, regF} \cdot QBM_{sec}^{regg, regF}}{\left((PA_{sec}^{regg} \cdot QA_{sec}^{regg}) \$regF(regg) + (PAFM_{sec, "FML"}^{regg} \cdot QAFM_{sec, "FML"}^{regg}) \$regI(regg) \right)}} \right) \right\} \cdot \left(\begin{matrix} secT(sec) \\ \cap co_{sec}^{regF} \end{matrix} \right) + \left(\frac{\sum_{hh} C_{hh, sec}^{regF} + CG_{sec}^{regF} + I_{sec}^{regF}}{QZ_{sec}^{regF} \cdot (1 - io_{sec, sec}^{regF})} \right) \cdot \left(\begin{matrix} secTN(sec) \cap co_{sec}^{regF} \\ + (\sigma LV_{sec}^{regF}) \$mc_{sec}^{regF} \end{matrix} \right)$$

Imperfectly competitive price elasticity of demand in $regI$ $\$ic_{sec}^{reg}$:

$$EDM_{sec}^{regI} = \left\{ \begin{array}{l} \frac{QDDFM_{sec,"FML"}^{regI}}{QZFM_{sec,"FML"}^{regI}} \left(\frac{\sigma A_{sec}^{regI} - (\sigma A_{sec}^{regI} - \sigma D^{regI})}{\frac{PDFM_{sec,"FML"}^{regI} \cdot QDDFM_{sec,"FML"}^{regI}}{PAFM_{sec,"FML"}^{regI} \cdot QAFM_{sec,"FML"}^{regI}}} \right) \\ \\ \left(\frac{\sigma BM_{sec}^{regg} - (\sigma BM_{sec}^{regg} - \sigma A_{sec}^{regg})}{\frac{PBM_{sec}^{regg,regI} \cdot QBM_{sec}^{regg,regI}}{PM_{sec}^{regg} \cdot QM_{sec}^{regg}}} - (\sigma A_{sec}^{regg} - \sigma D^{regg}) \right) \\ \\ \left(\frac{PBM_{sec}^{regg,regI} \cdot QBM_{sec}^{regg,regI}}{\left((PA_{sec}^{regg} \cdot QA_{sec}^{regg}) \$regF(regg) + (PAFM_{sec,"FML"}^{regg} \cdot QAFM_{sec,"FML"}^{regg}) \$regI(regg) \right)} \right) \end{array} \right\} \$ \left(\begin{array}{l} \text{sec}T(\text{sec}) \\ \cap co_{sec}^{regI} \end{array} \right)$$

$$+ \sum_{\substack{regg \\ (\neq regI)}} \frac{QBM_{sec}^{regg,regI}}{QZFM_{sec,"FML"}^{regI}} \left(\frac{\sigma A_{sec}^{regg} - \sigma D^{regg}}{\left((PA_{sec}^{regg} \cdot QA_{sec}^{regg}) \$regF(regg) + (PAFM_{sec,"FML"}^{regg} \cdot QAFM_{sec,"FML"}^{regg}) \$regI(regg) \right)} \right)$$

$$+ \left(\frac{\sum_{hh} CFM_{sec,"FML"}^{regI, hh} + CG_{sec}^{regI} + IFM_{sec,"FML"}^{regI}}{QZFM_{sec,"FML"}^{regI} \cdot (1 - ioFM_{sec,sec,"FML"}^{regI})} \right) \$ \left(\text{sec}TN(\text{sec}) \cap co_{sec}^{regI} \right) + (\sigma LV_{sec}^{regI}) \$mc_{sec}^{regI}$$

Scaling vectors $\$mc_{sec}^{reg}$:^v

$$AUX_{sec}^{reg} \$regF(reg) + AUXFM_{sec,"FML"}^{reg} \$regI(reg) = NOF_{sec}^{reg} \frac{1}{1 - \sigma LV_{sec}^{reg}}$$

Households' CES upper-level private demands:

$$C_{hh,sec}^{reg} = CBUD_{hh}^{reg} \cdot \left[\frac{\gamma HH_{hh,sec}^{reg} \cdot PCBUD_{hh}^{reg}}{\left((1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \right) \$regF(reg) + PCA_{hh,sec}^{reg} \$regI(reg)} \right]^{\sigma D^{reg}}$$

Households' upper-level budget constraints:

$$PCBUD_{hh}^{reg} \cdot CBUD_{hh}^{reg} = \sum_{sec} \left[\left((1 + tc_{sec}^{reg}) \cdot AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \right) \$regF(reg) \right. \\ \left. + PCA_{hh,sec}^{reg} \$regI(reg) \right] \cdot C_{hh,sec}^{reg}$$

^v The scaling vectors of sectors that are informal and/or under perfect competition and Cournot oligopoly are calibrated and set to unity, and hence are not included in this equation.

Households' CES lower-level private demands (only in $regI$):

$$CFM_{sec, fm}^{regI, hh} = C_{sec}^{regI, hh} \cdot \left[\frac{\gamma HFM_{sec, fm}^{regI, hh} \cdot PCA_{sec}^{regI, hh}}{\left(1 + tc_{sec}^{regI} \$(fm = "FML")\right) \cdot AUXFM_{sec, fm}^{regI} \cdot PAFM_{sec, fm}^{regI}} \right]^{\sigma FM^{regI}}$$

Households' lower-level budget constraints (only in $regI$):

$$PCA_{sec}^{regI, hh} \cdot C_{sec}^{regI, hh} = \sum_{fm} \left[\left(1 + tc_{sec}^{regI} \$(fm = "FML")\right) \cdot AUXFM_{sec, fm}^{regI} \cdot PAFM_{sec, fm}^{regI} \cdot CFM_{sec, fm}^{regI, hh} \right]$$

Government's CES public demands:

$$CG_{sec}^{reg} = CGBUD^{reg} \cdot \left[\frac{\gamma GV_{sec}^{reg} \cdot PCGBUD^{reg}}{AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \$regF(reg) + AUXFM_{sec, "FML"}^{reg} \cdot PAFM_{sec, "FML"}^{reg} \$regI(reg)} \right]^{\sigma D^{reg}}$$

Government's budget constraint:

$$PCGBUD^{reg} \cdot CGBUD^{reg} = \sum_{sec} \left[\left(\begin{aligned} &AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \$regF(reg) \\ &+ AUXFM_{sec, "FML"}^{reg} \cdot PAFM_{sec, "FML"}^{reg} \$regI(reg) \end{aligned} \right) \cdot CG_{sec}^{reg} \right]$$

Bank's CES upper-level investment demands:

$$I_{sec}^{reg} = S^{reg} \cdot \left[\frac{\gamma I_{sec}^{reg} \cdot PS^{reg}}{AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \$regF(reg) + PIA_{sec}^{reg} \$regI(reg)} \right]^{\sigma D^{reg}}$$

Bank's upper-level budget constraints:

$$PS^{reg} \cdot S^{reg} = \sum_{sec} \left[\left(AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \$regF(reg) + PIA_{sec}^{reg} \$regI(reg) \right) \cdot I_{sec}^{reg} \right]$$

Bank's CES lower-level investment demands (only in $regI$):

$$IFM_{sec, fm}^{regI} = \left[\frac{\gamma IFM_{sec, fm}^{regI} \cdot PIA_{sec}^{regI}}{AUXFM_{sec, fm}^{regI} \cdot PAFM_{sec, fm}^{regI}} \right]^{\sigma FM^{regI}} \cdot I_{sec}^{regI}$$

Bank's lower-level budget constraints (only in $regI$):

$$PIA_{sec}^{regI} \cdot I_{sec}^{regI} = \sum_{fm} AUXFM_{sec, fm}^{regI} \cdot PAFM_{sec, fm}^{regI} \cdot IFM_{sec, fm}^{regI}$$

Upper-level CET functions:

Domestically-produced good supply in *regF* (1) $\{ \text{not} [\text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}F} \cup \text{trsp}(\text{sec}))] \}$:

$$QDS_{\text{sec}}^{\text{reg}F} = \left[\left(aT_{\text{sec}}^{\text{reg}F} \right)^{\sigma_{\text{sec}}^{\text{reg}F} - 1} \cdot \left(\frac{\gamma TD_{\text{sec}}^{\text{reg}F} \cdot PZ_{\text{sec}}^{\text{reg}F}}{PD_{\text{sec}}^{\text{reg}F}} \right)^{\sigma_{\text{sec}}^{\text{reg}F}} \cdot QZ_{\text{sec}}^{\text{reg}F} \right]$$

$$\{ \text{sec}T(\text{sec}) \cap [\text{not} (co_{\text{sec}}^{\text{reg}F} \cup \text{trsp}(\text{sec}))] \}$$

$$+ [QZ_{\text{sec}}^{\text{reg}F}] \{ \text{sec}TN(\text{sec}) \}$$

Domestically-produced good supply in *regF* (2) $\{ \text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}F} \cup \text{trsp}(\text{sec})) \}$:

$$PD_{\text{sec}}^{\text{reg}F} = PZ_{\text{sec}}^{\text{reg}F}$$

Domestically-produced good supply in *regI* (1) $\{ \text{not} [\text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}I} \cup \text{trsp}(\text{sec})) \cap (fm = "FML")] \}$:

$$QDSFM_{\text{sec},fm}^{\text{reg}I} = \left[\left(aT_{\text{sec}}^{\text{reg}I} \right)^{\sigma_{\text{sec}}^{\text{reg}I} - 1} \cdot \left(\frac{\gamma TD_{\text{sec}}^{\text{reg}I} \cdot PZFM_{\text{sec},fm}^{\text{reg}I}}{PDFM_{\text{sec},fm}^{\text{reg}I}} \right)^{\sigma_{\text{sec}}^{\text{reg}I}} \cdot QZFM_{\text{sec},fm}^{\text{reg}I} \right]$$

$$\{ \text{sec}T(\text{sec}) \cap [\text{not} (co_{\text{sec}}^{\text{reg}I} \cup \text{trsp}(\text{sec}))] \cap (fm = "FML") \}$$

$$+ [QZFM_{\text{sec},fm}^{\text{reg}I}] \{ \text{sec}TN(\text{sec}) \cup [\text{sec}T(\text{sec}) \cap (fm = "IFML")] \}$$

Domestically-produced good supply in *regI* (2) $\{ \text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}I} \cup \text{trsp}(\text{sec})) \}$:

$$PDFM_{\text{sec}, "FML"}^{\text{reg}I} = PZFM_{\text{sec}, "FML"}^{\text{reg}I}$$

Aggregate export supply (1) $\{ \text{sec}T(\text{sec}) \cap [\text{not} (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec}))] \}$:

$$QE_{\text{sec}}^{\text{reg}} = \left(aT_{\text{sec}}^{\text{reg}} \right)^{\sigma_{\text{sec}}^{\text{reg}} - 1} \cdot \left(\frac{\gamma TE_{\text{sec}}^{\text{reg}} \cdot (PZ_{\text{sec}}^{\text{reg}} \$regF(\text{reg}) + PZFM_{\text{sec}, "FML"}^{\text{reg}} \$regI(\text{reg}))}{PE_{\text{sec}}^{\text{reg}}} \right)^{\sigma_{\text{sec}}^{\text{reg}}}$$

$$\cdot (QZ_{\text{sec}}^{\text{reg}} \$regF(\text{reg}) + QZFM_{\text{sec}, "FML"}^{\text{reg}} \$regI(\text{reg}))$$

Aggregate export supply (2) $\{ \text{sec}T(\text{sec}) \cap (co_{\text{sec}}^{\text{reg}} \cup \text{trsp}(\text{sec})) \}$:

$$PE_{\text{sec}}^{\text{reg}} = PZ_{\text{sec}}^{\text{reg}} \$regF(\text{reg}) + PZFM_{\text{sec}, "FML"}^{\text{reg}} \$regI(\text{reg})$$

Balancing conditions for upper-level CET supplies in $regF$:

$$PZ_{sec}^{regF} \cdot QZ_{sec}^{regF} = PD_{sec}^{regF} \cdot QDS_{sec}^{regF} + \left(PE_{sec}^{regF} \cdot QE_{sec}^{regF} \right) \$secT(sec) \\ + \left(PE_{sec}^{regF} \cdot TRSPR_{sec}^{regF} \right) \$trsp(sec)$$

Balancing conditions for upper-level CET supplies in $regI$:

$$PZFM_{sec, fm}^{regI} \cdot QZFM_{sec, fm}^{regI} = PDFM_{sec, fm}^{regI} \cdot QDSFM_{sec, fm}^{regI} \\ + \left\{ \begin{array}{l} \left(PE_{sec}^{regI} \cdot QE_{sec}^{regI} \right) \$secT(sec) + \\ \left(PE_{sec}^{regI} \cdot TRSPR_{sec}^{regI} \right) \$trsp(sec) \end{array} \right\} \$(fm = "FML").$$

Lower-level CET functions:

Bilateral export supply (1) $\$(not\ co_{secT}^{reg})$:

$$QBE_{secT}^{reg, regg} = \left(aBE_{secT}^{reg} \right)^{\sigma BE_{secT}^{reg} - 1} \cdot \left(\frac{\gamma BE_{secT}^{reg, regg} \cdot PE_{secT}^{reg}}{PBE_{secT}^{reg, regg}} \right)^{\sigma BE_{secT}^{reg}} \cdot QE_{secT}^{reg}$$

Bilateral export supply (2) $\$co_{secT}^{reg}$:

$$PBE_{secT}^{reg, regg} = PE_{secT}^{reg}$$

Balancing conditions for bilateral export supply:

$$PE_{secT}^{reg} \cdot QE_{secT}^{reg} = \sum_{regg (\neq reg)} PBE_{secT}^{reg, regg} \cdot QBE_{secT}^{reg, regg}$$

Upper-level Armington functions:

Domestically-produced commodity demands in $regF$:

$$QDD_{sec}^{regF} = \left[\left(aA_{sec}^{regF} \right)^{\sigma A_{sec}^{regF} - 1} \cdot \left(\frac{\gamma AD_{sec}^{regF} \cdot PA_{sec}^{regF}}{PD_{sec}^{regF}} \right)^{\sigma A_{sec}^{regF}} \cdot QA_{sec}^{regF} \right] \$secT(sec) \\ + \left[QA_{sec}^{regF} \right] \$secTN(sec)$$

Domestically-produced commodity demands in $regI$:

$$QDDFM_{sec, fm}^{regI} = \left[\left(aA_{sec}^{regI} \right)^{\sigma A_{sec}^{regI} - 1} \cdot \left(\frac{\gamma AD_{sec}^{regI} \cdot PAFM_{sec, fm}^{regI}}{PDFM_{sec, fm}^{regI}} \right)^{\sigma A_{sec}^{regI}} \cdot QAFM_{sec, fm}^{regI} \right]$$

$$\$[\text{sec}T(\text{sec}) \cap (fm = "FML")]$$

$$+ [QAFM_{sec, fm}^{regI}] \$[\text{sec}TN(\text{sec}) \cup (fm = "IFML")]$$

Aggregate import demands:

$$QM_{secT}^{reg} = \left(aA_{secT}^{reg} \right)^{\sigma A_{secT}^{reg} - 1} \cdot \left(\frac{\gamma AM_{secT}^{reg} \cdot \left(PA_{secT}^{reg} \$regF(reg) + PAFM_{secT, "FML"}^{reg} \$regI(reg) \right)}{PM_{secT}^{reg}} \right)^{\sigma A_{secT}^{reg}}$$

$$\cdot \left(QA_{secT}^{reg} \$regF(reg) + QAFM_{secT, "FML"}^{reg} \$regI(reg) \right)$$

Balancing conditions for upper-level Armington demands in $regF$:

$$PA_{sec}^{regF} \cdot QA_{sec}^{regF} = PD_{sec}^{regF} \cdot QDD_{sec}^{regF} + \left(PM_{sec}^{regF} \cdot QM_{sec}^{regF} \right) \$\text{sec}T(\text{sec})$$

Balancing conditions for upper-level Armington demands in $regI$:

$$PAFM_{sec, fm}^{regI} \cdot QAFM_{sec, fm}^{regI} = PDFM_{sec, fm}^{regI} \cdot QDDFM_{sec, fm}^{regI}$$

$$+ \left(PM_{sec}^{regI} \cdot QM_{sec}^{regI} \right) \$[\text{sec}T(\text{sec}) \cap (fm = "FML")]$$

Lower-level Armington functions:

Bilateral import demands:

$$QBM_{secT}^{reg, regg} = \left(aBM_{secT}^{reg} \right)^{\sigma BM_{secT}^{reg} - 1} \cdot \left(\frac{\gamma BM_{secT}^{reg, regg} \cdot PM_{secT}^{reg}}{PBM_{secT}^{reg, regg}} \right)^{\sigma BM_{secT}^{reg}} \cdot QM_{secT}^{reg}$$

Balancing conditions for bilateral import demands:

$$PM_{secT}^{reg} \cdot QM_{secT}^{reg} = \sum_{regg (\neq reg)} PBM_{secT}^{reg, regg} \cdot QBM_{secT}^{reg, regg}$$

Market-clearing conditions:

Factor markets $\$facM(fac)$:

$$\sum_{sec} F_{sec}^{fac,reg} \$regF(reg) + \sum_{fm} \sum_{sec} FFM_{sec,fm}^{fac,reg} \$regI(reg) = \overline{FS}^{fac,reg} - UNEMP^{fac,reg} \$flab(fac)$$

Armington commodity markets in $regF$:

$$AUX_{sec}^{regF} \cdot \left(\sum_{hh} C_{hh,sec}^{regF} + CG_{sec}^{regF} + I_{sec}^{regF} + \sum_{sec\ c} io_{sec,secc}^{regF} \cdot QZ_{secc}^{regF} \right) = QA_{sec}^{regF}$$

Armington commodity markets in $regI$:

$$AUXFM_{sec,fm}^{regI} \cdot \left(\sum_{hh} CFM_{sec,fm}^{regI, hh} + CG_{sec}^{regI} \$(fm = "FML") \right. \\ \left. + IFM_{sec,fm}^{regI} + \sum_{sec\ c} ioFM_{sec,sec\ c, fm}^{regI} \cdot QZFM_{sec\ c, fm}^{regI} \right) = QAFM_{sec, fm}^{regI}$$

Domestically-produced commodity supply and demand in $regF$:

$$QDS_{sec}^{regF} = QDD_{sec}^{regF}$$

Domestically-produced commodity supply and demand in $regI$:

$$QDSFM_{sec, fm}^{regI} = QDDFM_{sec, fm}^{regI}$$

Bilateral trade:

$$QBE_{secT}^{reg, regg} = QBM_{secT}^{regg, reg}$$

Balance of payments:

$$\sum_{secT} \sum_{regg(\neq reg)} QBM_{secT}^{reg, regg} \cdot PWM_{secT}^{reg, regg} = \left(\sum_{secT} \sum_{regg(\neq reg)} QBE_{secT}^{reg, regg} \cdot PWE_{secT}^{reg, regg} \right) \\ + \sum_{irsp} TRSPR_{irsp}^{reg} \cdot PTRSPG_{irsp} + \frac{\overline{SF}^{reg} \cdot \overline{CPI}^{reg}}{EXC^{reg}}$$

Wage curve and rigid wage approaches $\{ \text{not } flx_{reg}^{flab} \}$:

$$\frac{PFM_{flab, reg}^{flab, reg}}{PFM0_{flab, reg}^{flab, reg}} = 1 \$rgd_{reg}^{flab} + \left[\left(\frac{UNEMP_{flab, reg}^{flab, reg}}{UNEMP0_{flab, reg}^{flab, reg}} \right)^{\omega_{flab, reg}^{flab, reg}} \right] \$wcrv_{reg}^{flab}$$

Rich household income (only from formal sources):

$$\begin{aligned}
 INC_{RH}^{reg} &= \left[\sum_{fac} \sum_{sec} \left(\begin{aligned} &F_{sec}^{fac,reg} \$regF(reg) + \\ &FFM_{sec,FML}^{fac,reg} \$regI(reg) \end{aligned} \right) \cdot \left(\begin{aligned} &PFM_{sec}^{fac,reg} \$facM(fac) \\ &+ PFS_{sec}^{fac,reg} \$facS(fac) \end{aligned} \right) \right] \\
 &\$[\text{not SameAs}(fac, "UnSkLab")] \\
 &+ trep^{SkLab,reg} \cdot PFM^{SkLab,reg} \cdot UNEMP^{SkLab,reg} \\
 &+ \sum_{sec} \left(PROFIT_{sec}^{reg} \$co_{sec}^{reg} + \overline{PROFIT}_{sec}^{reg} \$mc_{sec}^{reg} \right)
 \end{aligned}$$

Poor household income (only from formal sources):

$$\begin{aligned}
 INC_{PH}^{reg} &= \left(\sum_{sec} \left(\begin{aligned} &F_{sec}^{UnSkLab,reg} \$regF(reg) + \\ &FFM_{sec,FML}^{UnSkLab,reg} \$regI(reg) \end{aligned} \right) \cdot PFM^{UnSkLab,reg} \right) \\
 &+ trep^{UnSkLab,reg} \cdot PFM^{UnSkLab,reg} \cdot UNEMP^{UnSkLab,reg} \\
 &+ \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}
 \end{aligned}$$

Rich household income (also from informal sources):

$$\begin{aligned}
 INCFI_{RH}^{regI} &= \left[\sum_{fm} \sum_{fac} \sum_{sec} FFM_{sec,fm}^{fac,regI} \cdot \left(\begin{aligned} &PFM_{sec}^{fac,regI} \$facM(fac) \\ &+ PFS_{sec}^{fac,regI} \$facS(fac) \end{aligned} \right) \right] \\
 &\$[\text{not SameAs}(fac, "UnSkLab")] \\
 &+ trep^{SkLab,regI} \cdot PFM^{SkLab,regI} \cdot UNEMP^{SkLab,regI} \\
 &+ \sum_{sec} \left(PROFIT_{sec}^{regI} \$co_{sec}^{regI} + \overline{PROFIT}_{sec}^{regI} \$mc_{sec}^{regI} \right)
 \end{aligned}$$

Poor household income (also from informal sources):

$$\begin{aligned}
 INCFI_{PH}^{regI} &= \left(\sum_{fm} \sum_{sec} FFM_{sec,fm}^{UnSkLab,regI} \cdot PFM^{UnSkLab,regI} \right) \\
 &+ trep^{UnSkLab,regI} \cdot PFM^{UnSkLab,regI} \cdot UNEMP^{UnSkLab,regI} \\
 &+ \overline{TRO}^{regI} \cdot \overline{CPI}^{regI}
 \end{aligned}$$

Household consumption budget:

$$PCBUD_{hh}^{reg} \cdot CBUD_{hh}^{reg} = \left(INC_{hh}^{reg} \$regF(reg) + INCFI_{hh}^{reg} \$regI(reg) \right) - t_{hh}^{reg} \cdot INC_{hh}^{reg} - SHH_{hh}^{reg}$$

Household savings:

$$SHH_{hh}^{reg} = mps_{hh}^{reg} \cdot \left[\left(INC_{hh}^{reg} \$regF(reg) + INCFI_{hh}^{reg} \$regI(reg) \right) - ty_{hh}^{reg} \cdot INC_{hh}^{reg} \right]$$

Total savings:

$$PS^{reg} \cdot S^{reg} = \sum_{hh} SHH_{hh}^{reg} + (\overline{SG}^{reg} + \overline{SF}^{reg}) \cdot \overline{CPI}^{reg}$$

Government tax revenue:

$$\begin{aligned} TREV^{reg} = & \sum_{hh} \underbrace{ty_{hh}^{reg} \cdot INC_{hh}^{reg}}_{\text{Income taxes: } TRY^{reg}} + \underbrace{\sum_{hh} \sum_{sec} tc_{sec}^{reg} \cdot \left(\begin{aligned} & AUX_{sec}^{reg} \cdot PA_{sec}^{reg} \cdot C_{sec}^{reg, hh} \$regF(reg) + \\ & AUXFM_{sec, "FML"}^{reg} \cdot PAFM_{sec, "FML"}^{reg} \cdot CFM_{sec, "FML"}^{reg, hh} \$regI(reg) \end{aligned} \right)}_{\text{Commodity taxes: } TRC^{reg}} \\ & + \underbrace{\sum_{sec} tz_{sec}^{reg} \cdot \left(\begin{aligned} & PZ_{sec}^{reg} \cdot QZ_{sec}^{reg} \$regF(reg) + \\ & PZFM_{sec, "FML"}^{reg} \cdot QZFM_{sec, "FML"}^{reg} \$regI(reg) \end{aligned} \right)}_{\text{Production taxes: } TRZ^{reg}} \\ & + \sum_{secT} \sum_{regg (\neq reg)} \underbrace{tm_{secT}^{reg, regg} \cdot PWM_{secT}^{reg, regg} \cdot EXC^{reg} \cdot QBM_{secT}^{reg, regg}}_{\text{Import tariffs: } TRM^{reg}} \\ & + \underbrace{\sum_{sec} \sum_{fac} tf_{sec}^{fac, reg} \cdot \left(\begin{aligned} & PFM_{sec}^{fac, reg} \$facM(fac) \\ & + PFS_{sec}^{fac, reg} \$facS(fac) \end{aligned} \right) \cdot \left(\begin{aligned} & F_{sec}^{fac, reg} \$regF(reg) + \\ & FFM_{sec, "FML"}^{fac, reg} \$regI(reg) \end{aligned} \right)}_{\text{Factor taxes: } TRF^{reg}} \end{aligned}$$

Government consumption budget:

$$PCGBUD^{reg} \cdot CGBUD^{reg} = TREV^{reg} - TRNF^{reg} - \overline{SG}^{reg} \cdot \overline{CPI}^{reg}$$

Government's transfer to the household:

$$TRNF^{reg} = \sum_{flab} trep^{flab, reg} \cdot PFM^{flab, reg} \cdot UNEMP^{flab, reg} + \overline{TRO}^{reg} \cdot \overline{CPI}^{reg}$$

Laspeyre consumer price index in $regF$:

$$\overline{CPI}^{regF} = \frac{\sum_{hh} \sum_{sec} (1 + tc_{sec}^{regF}) \cdot AUX_{sec}^{regF} \cdot PA_{sec}^{regF} \cdot C0_{hh, sec}^{regF}}{\sum_{hh} \sum_{sec} (1 + tc_{sec}^{regF}) \cdot AUX0_{sec}^{regF} \cdot PA0_{sec}^{regF} \cdot C0_{hh, sec}^{regF}}$$

Laspeyre consumer price index in *regI*:

$$\overline{CPI}^{regI} = \frac{\sum_{fm} \sum_{hh} \sum_{sec} (1 + tc_{sec}^{regI} \$ (fm = "FML")) \cdot AUXFM_{sec, fm}^{regI} \cdot PAFM_{sec, fm}^{regI} \cdot CFM0_{sec, fm}^{regI, hh}}{\sum_{fm} \sum_{hh} \sum_{sec} (1 + tc_{sec}^{regI} \$ (fm = "FML")) \cdot AUXFM0_{sec, fm}^{regI} \cdot PAFM0_{sec, fm}^{regI} \cdot CFM0_{sec, fm}^{regI, hh}}$$

Bilateral export price (home currency):

$$PBE_{secT}^{reg, regg} = PWE_{secT}^{reg, regg} \cdot EXC^{reg}$$

Bilateral import price (home currency):

$$PBM_{secT}^{reg, regg} = (1 + tm_{secT}^{reg, regg}) \cdot PWM_{secT}^{reg, regg} \cdot EXC^{reg}$$

Bilateral import price (world currency):

$$PWM_{secT}^{reg, regg} = PWE_{secT}^{regg, reg} + \sum_{trsp} PTRSPG_{trsp} \cdot \delta_{trsp, secT}^{regg, reg}$$

Shares of international transport services provided to the global transport sector:

$$PE_{trsp}^{reg} \cdot TRSPR_{trsp}^{reg} = \alpha TRSPR_{trsp}^{reg} \cdot (PTRSPG_{trsp} \cdot TRSPG_{trsp})$$

Balancing conditions for the global transport sector:

$$TRSPG_{trsp} = \sum_{reg} TRSPR_{trsp}^{reg}$$

International transport margins as constant shares of bilateral export volumes:

$$TRSPG_{trsp} = \sum_{reg} \sum_{regg} \sum_{secT} \delta_{trsp, secT}^{reg, regg} \cdot QBE_{secT}^{reg, regg}$$

($\neq reg$)

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