Essays on Exchange Rate Volatility and Current Account Adjustments

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Dedicated to my parents

for their boundless love and infinite sacrifice.

Abstract

This thesis empirically assesses exchange rate volatility given the choice of exchange rate regimes and the responses of current account components (trade balance and net investment income flows) to exchange rate fluctuations across countries.

Chapter 1 presents the general motivations of this thesis, followed by the research aims and methodology. The structure of thesis is then outlined.

Chapter 2 investigates exchange rate volatility given the choice of exchange rate regimes. By assessing a large currency-pair sample over 1999M1-2006M12, bilateral exchange rate volatility increases with the degree of the flexibility of the exchange rate regime combinations. Currency network effects (*i.e.* pegs sharing the same anchor would benefit lower exchange rate volatility) are significant, with the structural variables also being controlled. Relative to the both-free-floating pairs, the marginal volatility-stabilising effects are identical across the anchors (networks) and hence the network effect increases with the network size. Managed floats are shown to track the US dollar, which consequently increases the effective size of the USD network relative to the others. Structural factors, such as larger cycle asymmetry, lower bilateral trade openness, larger economy size and *per capita* land resources, are associated with greater bilateral exchange rate volatility. Inflation conditions significantly undermine the network effects. Moreover, the volatility-stabilising effects increases with the peg network size under the arithmetic multilateral exchange rate volatility measure but not under the trade-weighted measure, indicating the competing rationales for the choice of anchors (networks).

Chapter 3 assesses the trade balance adjustments in response to exchange rate fluctuations across countries. By estimating fixed-effects regressions covering 96 countries from 1993 to 2006, trade balance exhibits significant responses for the contemporaneous and the subsequent one year, particularly for the Industrial and Emerging Market groups. The J-curve dynamics become more evident after exports and imports are examined separately. There are clear asymmetric patterns between the Industrial and developing economies. The latter group tends to have larger and more instant adjustments both on trade balance and between tradable and nontradable sectors than the former. Moreover, the Industrial economies on average show symmetric long-run and short-run responses to depreciations and appreciations. However, the Emerging Market economies' trade balance tend to respond faster to depreciations than to appreciations. Relative to the moderate degree of fluctuations, large exchange rate changes for developing economies are associated with the inverse dynamics of the normal cases. Other factor variables, such as the terms of trade and domestic income variables exhibit explanatory power as expected in the literature.

By taking fixed-effects regressions over a similar sample to Chapter 3, Chapter 4 examines the changes of net investment incomes in response to exchange rate fluctuations across countries with different foreign currency lending positions. Given the initial net capital outflow, depreciations (appreciations) are associated with net investment income improvements (deteriorations) for the Industrial economies, most of which have positive positions of foreign currency exposure (FXE), *i.e.* foreign currency assets exceed liabilities. An inverse case applies for the developing economies of which most possess negative positions of FXE. Given the changes of exchange rate, the degree of this valuation effect increases with the imbalance position of FXE particularly among the Industrial and Emerging Market economies. Further investigations show that this is mainly driven by the adjustments of foreign currency components in the two groups' external balance sheets. For the other developing economies, there are insignificant valuation effects conditioning on the FXE positions that are mainly driven by the overall net foreign borrowing positions. The initial captial outflow proxied by the lagged current account position tends to have insignificant effects on the net investment income flows across the countries.

Combing the trade balance dynamics and the valuation effects, the overall current account adjustments are mainly driven by the trade balance across the economies. Given similar long-run quantitative effects of exchange rate fluctuations between the Industrial and Emerging Market economies, the latter group exhibits faster and larger short-run trade balance and current account responses than the former. The valuation effects are insignificant in the overall current account adjustments. Nevertheless, the valuation effects tend to counteract the trade balance adjustments for the Emerging Market economies given an exchange rate change, while those two channels work in the same direction for the Industrial economies. These asymmetries further indicate the importance of country's external portfolio dynamics.

Chapter 5 summarises the main findings, followed by the discussions about implications and possible future research.

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CHAPTER 1

Introduction

1.1 Motivation

1.1.1 Exchange Rate Volatility and Exchange Rate Regimes

Explaining the determinants of exchange rate volatility is not exclusively attracting the pedagogical interests but is important for policy interventions of balancing an economy's internal and external sectors. By the considering exchange rate as the general price ratio for a pair of economies, *i.e.* the consumption-based exchange rate, the sources of variations can be traced from tradable and nontradable sectors. There have been extensive studies both in theory and practice following this approach to characterise exchange rate behaviour. In particular, with the increasing trend of market integration, many studies attempt to explain the geographical price differentials across goods markets (Rogoff, 1996; Taylor and Taylor, 2004) or the return rate differentials across capital markets (Engel, 2011; Sarno et al., forthcoming). Some studies also explore the interactions between the sectors separated by tradability (Samuelson, 1994) or market types (Dornbusch, 1976). Later developments in micro-founded general equilibrium techniques attempt to synthesise those styled effects (Obstfeld and Rogoff, 1995a; Ghironi and Melitz, 2005; Bergin et al., 2006).

The evolution of understanding exchange rate volatility also richly benefits from the long-living debates and experiences from the international currency arrangements (Frankel, 2010a; Bordo et al., 2010). Generally, a credibly pegged exchange rate regime for a small economy that is highly integrated and largely synchronised with the anchor economy could establish price stability (Ghosh et al., 2002) and facilitate goods (Frankel and Rose, 2002) and financial market (Aghion et al., 2009) integrations. On the other hand, a free floating regime for a small economy fully exposed to international trade and captial movements could absorb external shocks (Broda, 2004) and allow independent monetary policies (Shambaugh, 2004) to accommodate internal volatilities (Obstfeld and Rogoff, 1995b). In recent decades, countries are scattered over richer degrees of goods and financial market integration and facing more complex international economic scenarios (Obstfeld et al., 2005), resulting in more varieties of internal stabilisation policies and exchange rate regime flexibilities (Williamson, 2002; Calvo and Mishkin, 2003; Farhi and Werning, 2012). The choice and performance of exchange rate regimes hence still remains open for investigations (Frankel, 2003; Tavlas et al., 2008).

1.1.2 Current Account Adjustments: Trade Balance and Net Investment Income

Exchange rate shocks can be regarded as one source of current account adjustments, particularly for a small economy that needs balancing the internal fundamentals and large exposure to the external shocks (Sachs et al., 1996; Frankel, 2005). Given a limited extent of international capital movements as happened in the past, trade income is the major concern for a country's growth and stabilisation objectives on the external sectors (McKinnon, 1981). Following the intuition of a small economy open to trade, world income and expenditures could be regarded to be stable and the price competitiveness of domestic exports relative to imports is captured by the exchange rate fluctuations. Hence the elasticity approach applies for the demand and supply analyses that finally determine the trade balance. Later analyses by constructing micro-founded structural models that help identify specific shocks or detailed channels under tractable economic structures also yield similar styled effects in the reduced-form expressions (Backus et al., 1994; Ghironi and Melitz, 2005).

Generally, the adjustment of trade balance to exchange rate fluctuations is believed to have a J-curve dynamics relying on the faster transmission of price than quantity adjustments. For instance, a depreciation will firstly increase the import price and hence expenditure relative to exports, *i.e.* a trade balance deterioration, but will eventually promote exports and discourage imports, *i.e.* a trade balance improvement. There have been intensive studies both empirically documenting the detailed stages of adjustments (Goldstein and Khan, 1985; Bahmani-Oskooee and Ratha, 2004) and theoretically modelling the specific economic structures (Backus et al., 1994; Senhadji, 1998). With the increasing availability of disaggregate data, empirical studies are able to examine the adjustments across industries and time frequencies. Many anomalies have been found at specific disaggregation levels and hence motivate further investigations (Bahmani-Oskooee and Hegerty, 2007).

On the other hand, there has been a surge of cross-boarder asset holdings since the 1990s (Lane and Milesi-Ferretti, 2007). The fast growing international captial flows occasionally bring developing economies (mainly emerging market economies) and even recently developed economies into crises and the aftermath recessions (Mishkin, 2007; Reinhart and Reinhart, 2010), particularly for those with persistent and large current account deficits (Edwards, 2004b). Empirical studies suggest that the dominant proportion of developing economies' external liabilities are denominated in foreign currencies, while a substantial proportion of foreign liabilities on the Industrial economies' balance sheet are denominated in domestic currency (Eichengreen et al., 2003; Lane and Shambaugh, 2010a). This asymmetry would generate significantly different external portfolio dynamics through the balance sheet channel, *i.e.* the valuation effects (Tille and van Wincoop, 2010; Devereux and Sutherland, 2010).

A typical example for the valuation effects can be explained via the currency crises lessons from some emerging market economies (Kaminsky and Reinhart, 1999; Calvo et al., 2006b). When a large and unexpected negative shock induces the sudden stop of net captial inflows, current account deficits would be no longer sustained and domestic currency also collapses. Consequently, the outstanding net foreign liability position as well as the interest rate payments would rise substantially in domestic currency value if the dominant proportion of existing liabilities are foreign currency denominated. This would further trigger domestic banking crises and aggravate the contractionary effects (Frankel, 2005; Calvo et al., 2008). Some case studies on developed economies during the normal periods also suggest exchange rate fluctuation can generate valuation gains from net external lending position (Gourinchas and Rey, 2005, 2007). Accordingly, empirical studies on the valuation effects across countries needs further systematic investigations.

1.2 Aims and Methodologies

All of the analyses in this thesis aim at empirical contributions to the literature. Chapter 2 focuses on the volatility of exchange rates given the alternative choices of regimes. Previous studies on exchange rate volatility under exchange rate regimes usually compare the multilateral rates across the economies (Hau, 2002), resulting in less degrees of freedom as well as the heterogeneity of country-specific multilateral weightings. Some studies use richer bilateral exchange rate samples to explore other structural variables in determining the volatility (Bayoumi and Eichengreen, 1998; Devereux and Lane, 2003), leaving out the exchange rate regime effects. There are also some studies comparing the bilateral exchange rate only against the major anchor for each economy (Klein and Shambaugh, 2008; Bleaney and Francisco, 2010).

Following the bilateral approach (Bayoumi and Eichengreen, 1998; Devereux and Lane, 2003), Chapter 2 compares exchange rate volatility across the pairs of 88 currencies over the period 1999M1-2006M12. By controlling the structural variables, the bilateral exchange rate volatility is assessed given the choice of exchange rate regimes. Furthermore, pegs (and managed floats) are distinguished by their (quasi-)anchors so that the volatility-stabilising effects can be assessed across different currency networks. The results hence will mainly contribute to empirically documenting the currency network effects across the anchors and the covariance structure of bilateral exchange rate across currency pairs.

Chapter 3 focuses on the adjustments of the trade balance in response to exchange rate fluctuations. There have been extensive studies and recent research has relied heavily on disaggregated data for single country studies, which help identify the sector-specific story of delayed adjustments (Bahmani-Oskooee and Ratha, 2004; Bahmani-Oskooee and Hegerty, 2010). However, this ignores the systematic differences across countries.

Using the fixed-effects regressions with a reduced-form gravity-type specification that are prevailing in the previous studies (Bahmani-Oskooee and Hegerty, 2007, 2010), Chapter 3 empirically investigates a panel of 96 countries over 1993-2006. Countries are classified into five groups according to their rule-of-thumb economic characteristics (*i.e.* the Industrial, Financial, Oil Exporting, Emerging Market, and Other Developing groups). Two alternative scaling variables indicating the relationships between tradable and nontradable sectors are employed as well. Given each group's J-curve pattern, two potential asymmetries of trade balance adjustments at the aggregate levels are explored for the response to exchange rate changes: the directions (appreciations and depreciations) and the magnitude (large and moderate fluctuations). The results hence will mainly contribute to empirically characterising the asymmetric patterns of trade balance adjustments between developed and developing country groups.

Chapter 4 focuses on the adjustments of net property income flows in response to exchange rate fluctuations. Many relevant studies both in theory (Blanchard et al., 2005; Tille and van Wincoop, 2010; Devereux and Sutherland, 2010) and practice (Gourinchas and Rey, 2007; Lane and Shambaugh, 2010c) aim to explain the dynamics of the *overall stock* of net foreign asset positions. Some also extend the analyses to domestic (internal) balance sheet fluctuations (Céspedes et al., 2004). There are also studies based on the portfolio approach investigating the global imbalance issues (Obstfeld and Rogoff, 2005). None of them explores the dynamics of the net investment income flows in response to exchange rate fluctuations, *viz.* the valuation effects on the net property incomes.

By employing the reduced-form fixed-effects regressions over a similar sample to

Chapter 3, Chapter 4 empirically investigates the net investment income flows in response to exchange rate fluctuation given the initial position of net captial inflow across the country groups. By controlling the positions (lending and borrowing) and further the levels of foreign currency exposure, valuation effects are contrasted between the Industrial and developing groups. Further decompositions into the adjustments of net foreign currency shares and the overall external borrowing positions are conditioned to assess the sources of valuation effects between the Industrial and developing economies. Combining the adjustments of trade balance and net investment components, current account adjustments in response to exchange rate changes are finally explored using similar specifications. The results hence will contribute to empirically documenting the quantitative extent of valuation effects in the net investment income flows and contrasting the different adjustments patterns in current account components in response to exchange rate shocks between the Industrial and developing groups.

1.3 Thesis Outline

The thesis is organised as follows. Chapter 2 encompasses the analyses of exchange rate volatility under the choice of exchange rate regimes. A survey of literature will be presented to sketch out the evolutionary thoughts on exchange rate determinants and the debates about the choice, performance, and classification of exchange rate regimes. Following the discussions on empirical specification, the baseline results then provide consistent results for the structural variables appearing in the existing literatures and also show that exchange rate volatility increases with exchange rate regime flexibility.

The currency network effects will be firstly identified from the lower bilateral volatilities between those pegs having the same anchor than those with other regime combinations. Further analyses by using refined regime combination variables will uncover the result that relative to the both-independent-floats pairs, the *ceteris paribus* marginal volatility-stabilising effects for the same-currency-network pegs will be similar across the anchors (networks). Hence the overall stabilisation effects depend on the size of the network, *i.e.* the number of pegs simultaneously pegging to the anchor. By comparing the bilateral exchange rate volatility of managed floats across the networks, there is clear evidence of tracking-the-US-dollar behaviour. Hence a representative managed float regime can be regarded as a quasi-USD peg. Consequently, this can increase the effectiveness of the USD network relative to the others.

Some further discussions about the network effects and the choice of regimes are also presented. For instance, in addition to those variables characterising the cycle and shock asymmetries between the pair of economies, higher inflation conditions indicating worse monetary regimes are shown to undermine the network effects. Moreover, joining in a particular currency network may not be necessarily the sole objective of minimising the multilateral exchange rate volatility (*i.e.* the arithmetic average measure). One can show that the volatility-stabilising effects are insignificantly different across the networks' size under the trade-weighted measure. Possible implications are presented at the end of the chapter.

Chapter 3 assesses trade balance adjustments in response to exchange rate changes across country groups. A review of literature will firstly summarise theoretical discussions from the elasticity approach to the later structural models. Some recent empirical works are surveyed based on the increasing availability of disaggregated level data and the advances of time series techniques. Following the discussions on the empirical specifications and country group classification, the baseline results comparable to existing literatures are presented to show the stylised adjustments. Generally, the trade balance exhibits significantly negative correlations with exchange rate appreciations for the Industrial and Emerging Market economies for the current and subsequent years. Separating export and import flows helps yield a clearer gradual adjustments.

The asymmetric patterns of trade balance adjustments between developed and developing economies can be particularly observed between the Industrial and Emerging Market groups' results. The trade balance of the latter group generally shows larger and more instant responses to exchange rate fluctuations than the former. The comparisons using alternative wealth scaling variables also indicate that exchange rate fluctuations tend to induce a larger immediate change of nontradable sectors for the developing than developed economies. Moreover, the Industrial group is shown to have symmetric adjustments over the appreciation and depreciation domains, while developing economies' trade balance responds faster to depreciations than appreciations. Relative to the moderate fluctuation cases, large real exchange rate fluctuations for developing economies are shown to be associated with a larger immediate and a subsequent reversal responses of trade balance. Some further checks on these patterns by using alternative specifications are also discussed.

Chapter 4 investigates the valuation effects on the net investment income flows. The structural equation inspiring the empirical specification for this study is firstly discussed, followed by a survey of literature on countries' external asset stock dynamics to provide a more complete discussion. The baseline results present the styled asymmetry of foreign currency exposure (FXE) position between developed and developing groups: given the initial net captial inflow, appreciation improves net investment income flows significantly for latter groups of economies but insignificantly for former.

By contrasting the Industrial economies with the developing economy groups, the existence of valuation effects is firstly examined by conditioning on the *sign* of foreign currency exposure (*i.e.* positive/negative position), yielding significant results over the negative domain. Further conditioning on the *level* of FXE positions reveals significant captial return rates among the Industrial and Emerging Market economies. Hence the valuation effects increases with the degree of imbalance on the net foreign currency borrowing positions. However, exchange rate fluctuations tend to generate insignificant effects through the FXE channel for the other developing groups. The decomposition of FXE further suggests that the significant valuation effects among the Industrial and Emerging Market economies are mainly from the foreign currency share changes in their external balance sheet components, while the changes of FXE for the other developing economies tend to be driven by the overall amount of external borrowings over the sample period.

Given the asymmetric implication of the valuation channel particularly between the Industrial and Emerging Market economies, the current account adjustments in response to exchange rate fluctuations are examined between the two groups at the end of the chapter. The dynamic patterns of current account adjustments are shown to be mostly driven by the trade balance. Given that the long-run difference between the Emerging Market and Industrial groups tend to be insignificant, the responses of the trade and current account balance for the former group are more instant and volatile than the latter. Although the valuation effects tend to be insignificant in the overall current account adjustments, its influence on the net investment income flows will offset the trade balance responses given the exchange rate changes for the Emerging Market economies, which is significantly different from the Industrial group.

Chapter 5 finally summarises the major findings. Further discussions mainly focuses on the implications from the results and possible extensions for future research.

CHAPTER 2

Currency Networks and Exchange Rate Volatilities

2.1 Introduction

The empirical determinants of exchange rate volatility have attracted much research interests because economic theory suggests that exchange rate movements matter for policy interventions (*e.g.* Mussa, 1986; Baxter and Stockman, 1989; Frankel, 2003). Discussions on the choice and performance of exchange rate regimes generally follow the paradigm of the optimum currency area (OCA) literature and the Trilemma theories. In general, a currency peg under perfect capital mobility would remove domestic monetary independence as the inflation is anchored to the foreign anchor economy. Many empirical investigations have been undertaken on the relevant issues. In assessing the macroeconomic performance of output (Levy Yeyati and Sturzenegger, 2003), monetary independence (Shambaugh, 2004), and responses to terms of trade shocks (Broda, 2004), studies tend to conclude with a preference for the floating regime for relatively larger and domestic-oriented economies. On the other side, by evaluating the performance the trade boosting effect (Rose, 2000), the growth (Aghion et al., 2009), the credibility cost (Aizenman and Glick, 2008), studies favour a peg regime for a highly regionally integrated or a small external-depended economy. Moreover, richer combinations of the degree of trade and financial integration and other economic scenarios would force stabilisation policy to acquire a more complicated synchronisation of economic conditions and international policy coordination, leading to the debates about the intermediate regimes. (Obstfeld et al., 1995; Williamson, 2002; Frankel, 2005).

This chapter investigates exchange rate volatility given the choice of exchange rate regimes. In addition to the degree of flexibility, this chapter further examines the effect of the choice of anchors for pegs and quasi-anchors for managed floats. This issue has not been examined in previous studies. The main contributions to the empirical findings are that a) the results confirm the existence of currency network effects (*i.e.* pegs share the same anchor would benefit lower exchange rate volatility) after structural variables are controlled; b) the marginal effect of volatility-stabilising effects is identical across currency networks (anchors) so that the network effects would be mainly determined by the network size; c) in addition to a series of structural variables, domestic price instabilities (inflations) substantially undermines the network effect; d) managed floats track the US dollar; e) Inflation undermines the network effects; f) the volatility-stabilising effects do not increase with the network size under trade-weighted multilateral exchange rate volatility measure.

Previous studies on exchange rate volatility mainly focus on the bilateral rates of a currency against its anchor currencies, leaving out effects of exchange rate regime interaction across the currency pairs and the issue of the choice of anchors. Hau (2002) examines the volatilities of real effective exchange rates for 48 countries with 36-months rolling-window observations over 1980M1-1998M12 and finds that real exchange rate volatility is negatively correlated with the international trade openness, and that fixed regimes have negative correlation with the bilateral volatility for OECD countries. Klein and Shambaugh (2008) empirically examine the *de facto* pegs' dynamics and their effects on both bilateral and multilateral exchange rate volatilities. The results suggest that pegs can obtain lower volatility both for bilateral and multilateral exchange rates and there exist some additional lower multilateral volatility benefits other than pure gains from bilateral anchors. Bleaney and Francisco (2010) assess the volatility of the bilateral exchange rate against USD and CHF under detailed exchange rate regimes according to the IMF classification across 139 countries over 1990-2006. They find that the volatility of the nominal bilateral exchange rates against USD increases with the flexibility of the IMF exchange rate regime, and similar results can be shown for the real bilateral rates, with the exception of crawling pegs and crawling bands. Moreover, compared with the volatilities against USD, the exchange volatilities against CHF have less effects. This suggests the evaluation of the bilateral rates of a currency against a non-anchor currency essentially entails the joint effects of the bilateral rates between the currency and its anchor currency and between the anchor currency and the non-anchor currency.

Some other empirical studies suggest that exchange rate volatility tends to be determined by structural variables without distinguishing the choice of regimes. Bayoumi and Eichengreen (1998) examine nominal bilateral exchange rate volatilities for 21 industrial countries over from the 1960s to 1980s and suggest that bilateral trade openness has negative correlation while the economy size and asymmetric shocks have positive correlations. Devereux and Lane (2003) examined nominal bilateral exchange rate volatilities over the period between 1991M1 and 2000M12 for a larger sample of country pairs. They showed that, in the presence of standard OCA variables, external debts (denominated in foreign currencies) reduce bilateral exchange rate fluctuations particularly for developing economies relative to creditor economies. However, for industrial economies, OCA variables generally dominate the explanation.

This chapter follows the bilateral approach as Bayoumi and Eichengreen (1998) and Devereux and Lane (2003). Compared with the bilateral approach, the multilateral exchange rate used in empirical studies is usually subject to country-specific weightings. This generates the concerns that cross-country differences in exchange rate volatility could either result from the bilateral rates or different weightings. Moreover, if we were analysing the *level* of the real exchange rate, there would be only N-1 independent bilateral rates between N countries. In the case of bilateral volatilities, the variance between a currency pair i and j would be calculated against the third currency k. Hence the degree of freedom would be extended to N(N-1)/2 pairs in the covariance matrix of currency pairs. The empirical results in this chapter will then contribute to the quantitative structure of the covariance.

This chapter is organised as follows. Section 2.2 explores the literature covering exchange rate determinants, choice and classification of exchange rate regimes and discussions on vehicle currencies. Section 2.3 examines the relationship between bilateral exchange rate volatility and currency network effects. The main analysis begins with testing the volatility-stabilising effects of pegs without distinguishing the anchors. Further investigations differentiate anchors and relax the assumption that the both-pegging effect is twice as large as single-pegging. By later using double-fixed effect dummies in controlling for many potential structural variables, special attention is focused on inflations. Robustness checks are conducted by examining the endogeneity issues, exact frequency measures and basket pegs. Section 2.4 examines the currency network effects on the volatility measures for the trade-weighted and arithmetic-weighted multilateral exchange rates. Section 2.5 concludes.

2.2 Literature Review

2.2.1 Exchange Rate Determinant Models

The consumption-based bilateral real exchange rate between country i and j can be written as $Q^i_j = S^i_j \frac{P_j}{P_i}$, where S^i_j denotes the nominal price currency j in units of currency i, thus a rise indicates the appreciation of currency j; P represents domestic consumption price level, which is assumed to be a function of the prices for a given basket of goods, *i.e.* $P = P(\omega)$ where ω is the index of goods in the basket. Dornbusch (1987b) summarises that the absolute Purchasing Power Parity (PPP)[1] requires the two countries' general price levels have the same homogeneous functional form. Under the Law of One Price[2], *i.e.* $Q^i_j = 1$ for $\forall\omega$, the nominal exchange rate can then

[1]The origin of PPP can be traced backed to the studies on usury by the Spanish Salamanca School around the sixteenth century, and further developments involve the discussions from the bullionist to the classical economists in the following eras, as shown by Holmes (1967), and Officer (1982), and for a comprehensive historical description of foreign exchange, see Einzig (1962).

[2]See reviews on the Law of One Price by Houthakker (1978) and Sarno and Taylor (2002).

be determined by $S_j^i = \frac{P_i}{P_j}$. In the relative PPP version[3], a nominal appreciation of currency j is associated with one-to-one inflation in economy i or deflation in j: $\hat{S}_j^i = \hat{P}_i - \hat{P}_j$, where $\hat{X}$ represents the percentage changes of X from its initial level.

Assume that the price index is a geometric average of the prices for tradable and non-tradable goods and the two countries' price weightings are identical. The bilateral real exchange rate can be written as $Q_j^i = \left(S_j^i \frac{P_{j,T}}{P_{i,T}}\right)\left(\frac{P_{j,NT}/P_{j,T}}{P_{i,NT}/P_{i,T}}\right)^{\eta}$, where the last termis the two countries' price ratio of nontradables goods divided by their price ratio for tradable goods. If the Law of One Price applies for tradable goods (or they adjust faster than the nontradables), *i.e.* $S_j^i \frac{P_{i,T}}{P_{j,T}} = 1$, the real exchange rate will then be determined by the price differential of the non-tradables. This Salter (1959) - Swan (1956) type model, featured by the separation between the internal and external equilibrium conditions for an economy, facilitates the theoretical analysis synthesising different sources and dynamic patterns of price fluctuations (see surveys by Taylor, 1995; Froot and Rogoff, 1995), identified from empirical studies (*e.g.* studies based on disaggregated data by Gregorio et al., 1994; Engel, 1999).

The Balassa (1964)-Samuelson (1964) effect, that addresses the different price movements between tradable and non-tradable goods due to the productivity differentials and wage equalisation, formalises an important source of long-run bilateral real exchange rates of deviating from PPP (Asea and Corden, 1994; Samuelson, 1994). Many models of exchange rate determination thereafter incorporate this feature into richer frameworks (*e.g.* Dornbusch et al., 1977; Rogoff, 1992) and it also attracts extensive empirical investigations (see a survey in Choudhri and Khan, 2005).

Given the linkage between the exchange rate and the general price level, theories applying the monetary approach to the balance of payments further re-interpret exchange rate movements as asset-pricing changes[4], and the short-run dynamics of the exchange rate are then associated with the money supply and the forward expectation

[3] See relevant discussions on the post-war periods by Cassel (1918), Pigou (1922), Haberler (1944, 1945), Young (1947), and Officer (1978), and modern surveys by Rogoff (1996), and Taylor and Taylor (2004).

[4] For discussions on the interest rate parity, see Stein (1965), Aliber (1973), and Frenkel and Levich (1975).

of inflation (Dornbusch, 1976; Frenkel, 1976). With the assumption of PPP, bilateral exchange rate is then linked to the cross-country differentials of inflation, money supply and output (Mundell, 1968).

Assuming that all the goods are tradeble for simplicity, the monetary approach introduces the money market condition which is consistent with the quantity theory of money[5], *i.e.* $MV = PY$, where M is desired money supply; V is the velocity of money circulation, which can be expressed in terms of other variables[6]; Y is the aggregate real output. Thus the real exchange rate in percentage-deviation form can be written as $\hat{Q}^i_j = \hat{S}^i_j + \left(\hat{M}_i - \hat{M}_j\right) + \left(\hat{V}_i - \hat{V}_j\right) - \left(\hat{Y}_i - \hat{Y}_j\right)$, *i.e.* the dynamics of the nominal price differentials can result from the monetary variables and real output.

Empirically, Meese and Rogoff (1983) summarise that the structural variables from various monetary models mainly include the pairwise differentials of money supply, output, short-term interest rate, expected long-run inflation, and the cumulated trade balance. However, these structural models tend to have poor out-sample forecasting performance relative to the random walk. This may be due to the difficulties either/both of the empirical measurement or the failure of the modelling strategy.

With the advances in macroeconomic modelling (see a comprehensive survey by Goodfriend and King, 1997), exchange rate determination models are enriched by rigid and explicit frameworks particularly with consumer preference, firm pricing behaviours and intertemporal optimisations. Stockman (1987) and Obstfeld and Stockman (1985) reviewed the developments during the 1980s. In those intertemporal general equilibrium frameworks (*e.g.* Stockman, 1980; Lucas, 1982; Mussa, 1982; Obstfeld, 1982; and Hodrick, 1989), the exchange rate (price differential) is interpreted as an endogenous variable, mostly with the assumption of rational expectations and saddle path stability. Although these models suggest various source of exchange rate dynamics, they are still challenged by empirical studies that show a poor forecasting performance (*e.g.* see discussions by Meese and Rose, 1991).

[5] See detailed discussions on the quantity theory of money by Friedman (2008).

[6] *e.g.* some functions of the interest rate differentials through the money demand equations as mentioned above.

Obstfeld and Rogoff (1995a, 2000a) established a seminal theoretical framework (the *Redux* model) that further launches *New Open Economy Macroeconomics* and induces a vast emergence of discussions until present. Lane (2001) provides an influential survey that summaries the brief origination and the developments across the topics. A distinct feature of this model is that it introduces the monopolistic competition settings[7] into the previous intertemporal framework with explicit microfoundations of consumer-producer behaviour. This facilitates rigorous analysis of the dynamics of exchange rates and other macroeconomic variables interacted with policy interventions.

The stylised dynamics of the exchange rate in both the long run and the short run for the *Redux* model utilise the relative-PPP equation (Lane, 2001). Together with the money-in-the-utility function[8] and the consumer-producer economy (no explicit firm sector), the real money balance is then associated with the substitution between money holding and consumption and with nominal interest rates. Hence changes in bilateral exchange rates are linked to the differential changes in the money growth and consumption between the two countries. Accordingly, a short-run jump of the exchange rate equal to the long-run PPP would result from an unexpected permanent monetary shock, leaving the relative consumption level unchanged. This is in contrast to the *overshooting* model and generates implausibly smooth fluctuations in the exchange rate.

Subsequently, various modified models aim to generate more volatile and persistent exchange rate variations. Corsetti and Pesenti (2001), aiming to address the transmission mechanism of fiscal and monetary policy, distinguish the substitutions between domestically produced and foreign goods, and introduce the monopolistic competition structure in the labour market. The exchange rate behaviour under an unexpected permanent shock then has more persistent fluctuations, because of a larger nominal

[7]The advances of monopolistic competition modelling, originating from Chamberlin (1950, 1953, 1960) and remarkably developed by Dixit and Stiglitz (1977, 1979, 1993), facilitates the synthesis of this type of framework, *e.g.* for macroeconomics, see Hart (1982); for nominal rigidities, see Blanchard and Kiyotaki (1987) and Ball and Romer (1989); and for earlier attempts in open macroeconomics see Svensson and van Wijnbergen (1989).

[8]General discussions on this type of utility can be found by Sidrauski (1967) and Feenstra (1986).

wage rigidity and larger exposure to the world market (see also Chari et al., 2002).

Following the *Pricing-To-Market* (PTM) literatures[9], Betts and Devereux (1996, 2000) present a model that allows a fraction of exporting firms to have the power of discriminating between domestic and foreign markets with local-currency pricing. This results in disconnected prices between the two separated markets. The fraction of PTM firms enters the exchange rate determinant equation and hence yields larger and persistent volatility than the standard model. In contrast to focusing on the tradable sector, Hau (2000) emphasises that the presence of non-tradable goods tends to limit the capability of price adjustments for tradable goods after an unexpected permanent monetary shock, resulting in larger nominal exchange rate fluctuations than the price level (Cavallo and Ghironi, 2002; Rogoff, 2002).

In parallel to these advances, developments in trade theory enable detailed trading patterns to be illustrated. Some recent models fo exchange rate determination combine those patterns into macroeconomic models, aiming to match the empirical observations from disaggregated data (*e.g.* Gregorio et al., 1994; Burstein et al., 2005; Betts and Kehoe, 2008). Dornbusch et al. (1977) build a two-country framework with Ricardian comparative advantage trading over a continuum of goods. A further extension to a many-country world is developed by Eaton and Kortum (2002) who employ a probabilistic setting. Bravo-Ortega and di Giovanni (2005b) then combine these features into an exchange rate model where the volatility of the exchange rate is driven by the productivity differential of the tradable sector, and the interaction terms between the productivity differential and consumption basket. The trade cost matters in these models as well in the way that it enters the firm's pricing behaviours.

Krugman (1979, 1980) introduces the monopolistic competition framework into the trade literature. Melitz (2003) launches the studies on intra-industry trade with firm heterogeneities. One of the distinct features of this model is that the tradability of goods is driven by the productivity realisation from a *ex post* distribution, thus

[9] *e.g.* see relevant theoretical discussions by Dornbusch (1987a), Krugman (1987), and Atkeson and Burstein (2008), and empirical studies by Bergin and Feenstra (2001) and Bergin and Glick (2007).

the consumer basket can vary endogenously over the time. Another feature is that the number of varieties of goods in a stationary equilibrium[10] is determined by the expected profitability of selling more existing goods versus the fixed entry cost of introducing a new product. This is consistent with the Chamberlinian monopolistic competition.[11]

Ghironi and Melitz (2005) utilised the Melitz (2003) set-up so that firms in a two-country world endogenously decide to export given their productivity realisation. Tradability and hence the price and consumption will determined accordingly. By using simulated results, the authors show that if the productivity shocks for the two countries are small but have positive spillovers and are highly auto-correlated, the model can generate a higher cross-country correlation for consumption than for real output. The real exchange rate shows lower volatility than the real data, and the authors attribute this to the flexible price setting. On the other hand, Bergin et al. (2006) and Bergin and Glick (2007) use a similar modelling strategy with a two-country static world to emphases the influence of the endogenous tradability decisions on the re-allocation of consumption and hence the price changes. This provides a new detailed channel of the Balassa-Samuelson effect.

2.2.2 Exchange Rate Regimes

The evolution of those analytical models mentioned above does not encompass the complete range of exchange rate volatility studies. In general, exchange rate fluctuations can be considered as the asymmetric movements of a vector of fundamental variables between geographical regions, and hence economic regions with more similar fundamental conditions tend to exhibit smaller exchange rate volatility. This inspires the practical arguments of optimally adopting common currency, namely the Optimal Currency Area theory (Mundell, 1968). Hence exchange rate volatility can be directly influenced for various policy objectives and extensive studies have shown that choice of the exchange rate regimes exhibits significant impacts on exchange rate volatility as

[10] see a detailed and general discussion by Hopenhayn (1992).
[11] See discussions by Bishop (1967), and Bilbiie et al. (2008).

well as other macroeconomic variables. (Mussa, 1986; Ghosh et al., 2002; Rogoff et al., 2004; Frankel, 2010a)

There have been numerous and long-lasting debates on the choice and consequence of exchange rate regimes. These discussions evolve with the modelling techniques[12] as well as policy practises[13], ranging from the post-War period[14], particularly the Bretton Woods period[15], to the modern era for both industrial economies (Bordo et al., 2010) and developing economies (Frankel, 2010a). Many of the lessons are particularly obtained from regional or global crises periods.[16]

With the development of these studies, there also exist debates about the empirical classification schemes based on the *ex post* observations. (Bubula and Ötker-Robe, 2002; Levy Yeyati and Sturzenegger, 2005; Reinhart and Rogoff, 2004; Shambaugh, 2004) The following two sections are presenting relevant discussions.

2.2.2.1 Choice and Performance of Exchange Rate Regimes

A currency peg is at one pole of the exchange rate regime spectrum. Following the Optimal Currency Area (OCA) theory, it is optimal to share the same currency among some individual economies if they have highly integrated economic fundamentals, such as large openness to external trade with the region, small asymmetry of business cycle shocks, perfect counter-cyclical production factor mobility, mature political and institutional systems, and efficient financial markets that are capable to absorb shocks.[17]

Recent empirical evidence suggests that those factors, as well as the choice of exchange rate regimes, tend to be significantly associated with exchange rate volatility. For instance, Bayoumi and Eichengreen (1998) examine nominal bilateral exchange rate volatilities for 21 industrial countries over three decades (1960s-1980s) and sug-

[12] *e.g.* Dornbusch (1989).

[13] *e.g.* McKinnon (1981), Frankel (1999), and Ball and Mazumder (2011).

[14] The discussions can be traced back to even earlier periods, *e.g.* see discussions by Yeager (1976), McCloskey and Zecher (1976), Cowen (1997), and Williamson (2002).

[15] See detailed surveys by Bordo and Eichengreen (1993) and Bordo et al. (2011)

[16] *e.g.* see surveys for the Euro zone and its histories by Eichengreen (1993) and Feldstein (2011), and those for the developing economies by Sachs et al. (1996) and Frankel (2005).

[17] See Mundell (1961) and McKinnon (1963), and recent reviews by Dellas and Tavlas (2009) and Frankel (2010a).

gest that bilateral trade openness has a negative correlation while the economy size and asymmetric shocks have positive correlations. Devereux and Lane (2003) examine nominal bilateral exchange rate volatilities from January 1991 to December 2000 for a larger sample of country pairs. They showed that, in the presence of standard OCA variables, external debts (denominated in foreign currencies) reduce bilateral exchange rate fluctuations particularly for developing economies relative to creditor economies. However, for industrial economies, OCA variables generally dominate the explanation. Klein and Shambaugh (2008) showed that currency pegging tends to significant lower volatility than floating. Bleaney and Francisco (2010) found a lower bilateral exchange rate volatilities for the more rigid exchange rate regimes.

One of the advantages for a fixed exchange rate regime is that it eliminates "unwanted" nominal variations (such as the transaction costs and exchange rate risk) and promotes trade and financial markets' integration that ultimately facilitate growth (*e.g.* Rose and Engel, 2002). In particular, a fixed exchange rate regime could eliminate nominal shocks that otherwise may have depreciated/appreciated the domestic currency and induced real economic influences under floating regimes.

Some earlier studies can be found from Mussa (1986) who suggested that the commitment of fixed rates tends to help stabilising nominal and real fluctuations. On the other hand, Baxter and Stockman (1989) investigated two example countries (Canada and Ireland) that switched their exchange rate regimes later than 1973 and found no difference between fixed and floating regimes for those macroeconomic variables' correlations.

Recent structural econometric studies by Rose (2000) and Frankel and Rose (2002) show that currency unions, particularly for the Euro zone, tend to have significantly positive effects of increasing trade and reducing exchange rate volatility. These further improve the income of the member countries. By assessing 95 disaggregated commodity prices, Parsley and Wei (2001) show a empirical evidence in supporting the negative relationship between exchange rate volatility and market integration. Bravo-Ortega and di Giovanni (2005b) show a theoretical role of a fixed exchange rate as a trade cost. Aghion et al. (2009) employ a panel of 79 countries over 1960-2000 and show that exchange rate uncertainty represented by volatility tends to have a negative effect on economic growth after controlled for credit constraints.

Another advantage of adopting a fixed exchange rate regime is that it provides a way of establishing an inflation anchor. This has been shown useful particularly, after some emerging market economic crises, to re-establish domestic policy disciplines and enhance their currencies' credibilities[18] (Melvin, 1985; Ghosh et al., 2000; Alesina et al., 2002). Two types of fixed rate are widely discussed: the dollarisation regime under which domestic transactions and commercial banks' deposits accept settlements in a foreign currency such as US dollar (*e.g.* Alesina and Barro, 2001), and the currency board regime [19] under which the currency board is legally required to hold reserve assets in fixed exchange ratio for the amount of domestic currency that has been issued.[20]

Despite the benefits of volatility-stabilising effects, the literature has sought to explain the rarity of fixed exchange rate regimes - economies can be very vulnerable in response to large real shocks (*e.g.* Aizenman and Glick, 2008). Dooley et al. (2004) propose that the Bretton Woods system provides a successful export-led growth strategy but economies that enter and exit the strategy should be capable of balancing the development purposes as well as the shocks from the international capital market. Bordo and Eichengreen (1993) reviewed the Bretton Woods system and point to the crucial balance for policy between maintaining the balance of payments equilibrium and providing domestic monetary liquidity and credibility.

Eichengreen (1993) reviewed three unification attempts for the Euro zone (ERM) up to the early 1990s. Although higher market integration and greater price stability are achieved, the heterogeneities between member countries are still large enough and hence require the autonomous fiscal and monetary policies. Froot and Rogoff (1991) examined the convergence process of EMU economies and concluded that disinflation

[18] in the sense as Barro and Gordon 1983

[19] For an historical aspect, see a review by Schwartz (1993).

[20] *e.g.* see detailed case studies for Argentina economy by Della Paolera and Taylor (2001), Russian by Hanke et al. (1993), and other economies by Williamson (1995).

effects were achieved while the real exchange rate target seemed to be implausible due to the higher debt ratios.

The collapse of a peg regime is usually triggered by large international capital speculations such that extremely volatile exchange rate fluctuations and economic contractions are usually observed (*e.g.* Krugman, 2000). The typical experiences in the recent decades for developing economies is that real shocks can be amplified via the balance sheet effect and can finally destroy a peg and economic growth. In particular, many developing economies are unable to issue foreign liabilities in domestic currency so that large exchange rate depreciation triggers the explosion of leverage and puts the country into insolvency (*e.g.* Hausmann et al., 2001; Calvo et al., 2006a).

Calvo et al. (2003) suggested that dollarisation may help re-establish the credibility and hence manage to avoid international capital outflows. However, this generates the currency mismatch problems on countries' external balance sheets. When the net foreign capital inflow suddenly stops, which is usually accompanied by falls in domestic economic additivity and growth, the credit market is no longer sustainable and depreciation may shrink the net asset wealth substantially.[21] Frankel (2005) surveyed emerging market crises and suggested that those large devaluations associated with contractionary effects may not be mainly through the faster pass-through channel but the worsening balance sheets because of the substantially increased value of foreign currency denominated liabilities. This will disrupt the domestic credit market and trigger banking crises (Kaminsky and Reinhart, 1999).

Schmitt-Grohé and Uribe (2001) developed a dynamic general equilibrium model and calibrated it for the Mexico economy. They suggest that, relative to other monetary stabilising strategies, the dollarisation cost may be higher. Taylor (2001) extended the Taylor-rule policy into alternative stylised DSGE models with explicit terms for the exchange rate and its lag. Most of the results show only small improvements in the

[21] On the other hand, Calvo (2006) also suggests that during the bank run crises, foreign reserve could serve as the instruments for the Lender of Last Resort for monetary authority to avoid excessive exchange volatility from interest rate spikes. Hence a pegged regime with other policy mix may become a better choice.

volatility-reducing effect. This opens the question about what is the optimal monetary responses to exchange rate fluctuations. Cook (2004) also shows that fixed exchange rate policy can generate more stability than an interest rate target.

The superiority of a floating exchange rate over fixed regimes generally follow the Trilemma principle that independent monetary policies for accommodating domestic shocks are ineffective simultaneously with both perfect international capital mobility and fixed exchange rate regimes (Friedman, 1953; Fleming, 1962; Mundell, 1963; Poole, 1970). Mussa (1976) suggested that exchange rate fluctuation can be considered as the result of monetary incrustations so that it reflects the long-run inflation differentials while the short-run adjustments would work through the interest rate differentials.[22] Obstfeld et al. (2005) empirically tested interest rate differentials over 130 years from the Gold Period until 2000 and concluded that pegs tightly followed monetary policy of their anchoring economies while the interest rate differential linkage for non-pegs was weakening over the years.

Broda (2001, 2004) adopt the VAR analyses on real exchange rate, terms of trade, output, and inflation variables for a panel of developing economies over 1973–1996. The results generally support the idea that flexible exchange rate regimes are more capable of absorbing external shocks from terms of trade than pegs so that the output responses are smoother.

With the evolving debates on the external policy objectives between growth and stabilisation(McKinnon, 1981; Sachs et al., 1996; Hahm et al., 2012), practices of choosing the "intermediate" regimes emerged aiming for comprising the benefits and costs from the two "corner solutions", such as soft pegs, target zones, and managed floats (Frankel, 1999). Williamson (2001) reviewed the growth experiences on East Asian countries and proposes the BBC (Basket, Band, and Crawl) type regimes. The basket refers to the trade-weighted exchange rate stabilisation. The Band would allow the exchange rate flexibility sufficiently enough to a) avoid defending speculations on

[22] Reinterpretations for the Gold Standard system by monetary approach can be found by McCloskey and Zecher (1976).

short-run disequilibrium, b) conduct domestic countercyclical monetary policy, and c) accommodate capital flows. The Crawl enables the exchange rate to move to long-run equilibrium governed by inflation differentials and the Balassa-Samuelson effect. On the other side, adopting the BBC regime should take account of country-specific characteristics and may need regional coordinated policies across.

Savvides (1990) found that exchange rate volatility is consistent with the OCA theories, and positively correlated with exchange rate regime flexibility. Ogawa and Ito (2002) proposed a coordinated regional currency system that comprises country-specific tradable goods baskets. Having reviewed the two-folded influences of different regimes, Goldstein (2002) proposes that managed floats could be incorporated with inflation targeting disciplines. Hence on the one side, managed floating has no explicit target so that it can mitigate the currency mismatch problems as pegs. On the other hand, it allows wider fluctuations that would avoid the one-way bet market speculations.

However, experiences from currency crises and aftermath periods suggest that only those regimes at the two poles of the spectrum, particularly hard pegs, may be the optimal choice. Eichengreen (1994) concluded that the convergence process for EMU, by narrowing the band of a target zone, may not be better than "a single jump" adjustment. Obstfeld and Rogoff (1995b) suggest that inflation anchoring by the exchange rate for those developing economies in the long-run may suffer crises, as the nominal rigidity under the fixed exchange rate could not accommodate large negative trade shocks and monetary policy can be effective only under perfect capital control. Those problems mean that a peg is not credible. Technically, monetary authority should be prepared for a sharp increase in interest rate which is harmful in the long-term as the borrowing cost and liability increases.

Fischer (2001) suggest that the weak credibility of intermediate regimes would finally lead to the choice of hard pegs and there seems to be a trend that choice of regimes would tend toward the polarised solutions. On the other side, Masson (2001) empirically assessed the regime transitions by utilising Markov transition process modelling and found that all intermediate regimes tend to be stable. Frankel (2003) also pointed out that the corner hypothesis may be due to the sudden emergence of independent economies that had been in the Soviet Union. Bleaney and Francisco (2005) found that soft pegs and floats are generally similar while only hard pegs show lower inflation. Utilising continuous stochastic modelling techniques, Krugman and Miller (1992) showed in theory that, given a target zone's credibility, the market can provide self-reinforcing effects and tolerate a wide range of disequilibrium variations. However, infinite defending will be needed when the credibility is undermined.

2.2.2.2 Exchange Rate Classifications

After the 1990s, an increasing number of studies aiming to evaluate the performance of exchange rate regimes have noticed that countries that claimed to conduct one regime may actually behave differently. As discussed before, on the one side, frequent realignments of limited-fluctuation regimes can undermine the commitment credibility for a monetary authority and hence the price stabilisation fails. On the other side, free floats for those small open economies with potential concerns such as faster pass-through, balance sheet mismatch and export-growth contraction would generate incentives for implicit interventions in the foreign exchange market.

These concerns are observed by empirical studies (*e.g.* Ghosh et al., 2002; Frankel and Wei, 2008) and lead to the distinctions between the *de jure* and *de facto* classification schemes. The former type represents what the country claims, which were collected and published by the IMF *Annual Report on Exchange Arrangements and Exchange Restrictions* (AREAER) until 1998. Three categories are generally defined: the Pegged regimes including pegs to a single currency[23] as well as a weighted basket, the Limited Flexibility regimes that are EMU currencies or those pegs with a maximum fluctuation boundary, and the Flexible regimes including managed and independently floats.

This classification has a wide coverage of country panels and provides the potential anchors for pegged regimes. Ghosh et al. (1997) employed this classification and

[23] Anchor currencies are mainly US dollar, French franc, and others such as Deutsch Mark, Indian rupee, South African rand etc.

evaluated the economic performance across 136 countries over 1960-1990. The results suggest that pegs are associated with lower inflation but larger real growth volatility. By using the criteria of more than one parity changes (par value or weights), the "frequent-adjuster" pegs are distinguished from "infrequent" ones to proxy the difference between *de jure* and *de facto* commitments. The results suggest no much difference in inflation anchoring effects relative to non-pegs.

A *de facto* classification scheme has been introduced by IMF[24] since 1999, aiming to clarify the actual combination of exchange rate and monetary regimes. As shown in Table 2-1, there are 8 categories generally ordered by the increasing flexibility of exchange rate movements relative to the potential anchors and some selective indicators. Bubula and Ötker-Robe (2002) followed the same methodology and extended the sample back to 1990.[25] After investigating the regime transition matrix by Markov chain technique over a panel of countries from 1990 to 2001, the authors reject the corner hypotheses and suggest that intermediate regimes tend to be stable. Later studies using more than one exchange rate regime classifications usually use this scheme as the benchmark results.

In parallel to the IMF method, some literatures also propose alternative classification schemes, mainly based on the *ex post* performance of exchange rates together with some selective macroeconomic variables. Levy Yeyati and Sturzenegger (2005) statistically clusterised regimes based on the volatility of monthly exchange rate (σ_e) and its changes ($\sigma_{\Delta e}$) and intervention pressure (σ_{IP}). The bilateral nominal exchange rates in the calculation is against the legal anchors or the lowest volatility. The monthly changes is measured as the absolute value of percentage changes within the calendar year. The intervention pressure is defined as the changes of net reserve in dollars relative to domestic monetary base in dollars, $IP = \frac{\Delta NetDollarReserve_t}{MoneyBaseInDollar_{t-1}}$. Following Eichengreen et al. (1994) and Edwards (2004b), this can be regarded as the intensity

[24]Official definition can be found at `http://www.imf.org/external/np/mfd/er/index.asp`.

[25]Bubula and Ötker-Robe (2002) further refined the IMF classification into 13 categories that can distinguish between a) dollarisation and currency union, b) forward- (pre-announced) and backward-looking pegs and crawling bands, and c) tighly (intensively-monitored) and other managed floats. See p15 of Bubula and Ötker-Robe (2002).

Table 2-1. IMF *De Facto* Exchange Rate Regime Classification

Exchange Rate Regime	Description
Exchange Arrangements with No Separate Legal Tender	The currency of another country circulates as the sole legal tender (formal dollarisation), or the member belongs to a monetary or currency union in which the same legal tender is shared by the members of the union.
Currency Board Arrangements	A monetary regime based on an explicit legislative commitment to exchange domestic currency for a specified foreign currency at a fixed exchange rate, combined with restrictions on the issuing authority to ensure the fulfilment of its legal obligation.
Conventional Fixed Peg Arrangements	The country pegs its currency within margins of ±1percent or less *vis-à-vis* another currency; a cooperative arrangement, such as the ERM II; or a basket of currencies, where the basket is formed from the currencies of major trading or financial partners and weights reflect the geographical distribution of trade, services, or capital flows.
Pegged Exchange Rates within Horizontal Bands	The value of the currency is maintained within certain margins of fluctuation of more than ±1percent around a fixed central rate or the margin between the maximum and minimum value of the exchange rate exceeds 2 percent.
Crawling Pegs	The currency is adjusted periodically in small amounts at a fixed rate or in response to changes in selective quantitative indicators, such as past inflation differentials *vis-à-vis* major trading partners, differentials between the inflation target and expected inflation in major trading partners.
Exchange Rates within Crawling Bands	The currency is maintained within certain fluctuation margins of at least ±1percent around a central rate —or the margin between the maximum and minimum value of the exchange rate exceeds 2 percent —and the central rate or margins are adjusted periodically at a fixed rate or in response to changes in selective quantitative indicators.
Managed Floating with No Predetermined Path for the Exchange Rate	The monetary authority attempts to influence the exchange rate without having a specific exchange rate path or target. Indicators for managing the rate are broadly judgemental (*e.g.*, balance of payments position, international reserves, parallel market developments), and adjustments may not be automatic. Intervention may be direct or indirect.
Independently Floating	The exchange rate is market-determined, with any official foreign exchange market intervention aimed at moderating the rate of change and preventing undue fluctuations in the exchange rate, rather than at establishing a level for it.

of intervention against speculative attacks. Based on the behavioural similarity of the three volatility measures as show in Table 2-2, five categories are finally obtained.

Table 2-2. Behavioural Criteria for LYS Classification

Exchange Rate Regime	σ_e	$\sigma_{\Delta e}$	σ_{IP}
Inconclusive	Low	Low	Low
Flexible	High	High	Low
Dirty Float	High	High	High
Crawling Peg	High	Low	High
Fixed	Low	Low	High

Source: Levy Yeyati and Sturzenegger (2005).

Following this work, Levy Yeyati and Sturzenegger (2003) and Levy Yeyati et al. (2010) evaluate the impact of exchange rate regimes on economic performances after the post-Bretton Woods period. The main results suggest that for developing economies, a more rigid regime is associated with slower growth and higher output volatility while the impact of the regimes on real economic growth is insignificant for industrial economies. Moreover, the interactions between regimes and fundamentals tend to be stable over the years and consistent with theories concerning the OCA theory and Trilemma, as well as the political costs of abandoning seigniorage.

Reinhart and Rogoff (2004) incorporate both internal documents and broad economic performances into their classification method that crucially based on the market-determined exchange rates.[26] This methods is proposed to reflect the underlying real shocks. For instance, using Australia as the benchmark example of reflecting TOT shocks, the authors show that many *de jure* pegs' exchange rates appear over-smoothed than the real shocks. Moreover, the official rate tends to show consistent levels with the market rates in the long-run, suggesting that the market interactions with the fundamentals and monetary policies can be captured by the premium.

As a result, the classification scheme uses parallel rates with 5-years-rolling-window to verify the claimed regime for an economy in an given year. It provides 14 categories as shown in Table 2-3. A notable category is the last one where countries experienced either 12-month inflation rate higher than 40 percent or monthly inflation above 50 percent (*i.e.* hyperinflation).

Rogoff et al. (2004) and Husain et al. (2005) employed this classification scheme to assess the durability and the performance of exchange rate regimes. The results suggest that the inflation anchoring effects for pegs tend to be significant for developing economies with small exposure to international capital market. For financially developed economies, floating regimes serve well for both inflation and growth. For the emerging market countries, it seems neutral for the tendency of adopting exchange rate regimes and the duration of exchange rate regimes was declining over the years. Moreover, the bipolar view tends to be rejected.

[26]Detailed chronologies and supplementary documents can be found at `http://www.carmenreinhart.com/research/publications-by-topic/exchange-rates-and-dollarization/`.

Table 2-3. RR Exchange Rate Regime Classification

Fine Grid Exchange Rate Regime	Coding
No Separate Legal Tender	1
Pre-Announced Peg or Currency Board Arrangement	2
Pre-Announced Horizontal Band that is Narrower than or Equal to ±2%	3
De Facto Peg	4
Pre-Announced Crawling Peg	5
Pre-Announced Crawling Band that is Narrower than or Equal to ±2%	6
De Facto Crawling Peg	7
De Facto Crawling Band that is Narrower than or Equal to ±2%	8
Pre-Announced Crawling Band that is Wider than ±2%	9
De Facto Crawling Band that is Narrower than or Equal to ±5%	10
Non-Crawling Band that is Narrower than or Equal to ±2%	11
Managed Floating	12
Freely Floating	13
Freely Falling (Includes Hyperfloat)	14

Source: Reinhart and Rogoff (2004)

Shambaugh (2004) develops a classification scheme inspired by the empirical evidence of Obstfeld and Rogoff (1995b). The central definition is that the annual regime will be recognized as a peg if the bilateral exchange rate stays within a band ±2% throughout the whole year, with the allowance of one time change of the central rate.[27] Moreover, the JS classification selects the potential anchor as a currency has been pegged to or a major industrial currency that an economy has strong economic relationship with. The potential anchors are explicitly recorded in the dataset.

Based solely on the *ex post* volatility, this classification scheme sharpens the Trilemma effects that pegs tend to follow their anchors' monetary policies (interest rate differentials) tighter than non-pegs, *e.g.* Shambaugh (2004) and Obstfeld et al. (2005). Klein and Shambaugh (2008) empirically examined pegs' dynamics and their effects on both bilateral and multilateral exchange rate volatilities for 125 countries over 1973-2004. The results suggest that pegs can obtain lower volatility relative to their anchors than non-pegs. There exist some additional lower multilateral volatility benefits other than pure gains from bilateral anchors. Moreover, the expected persistency of either pegs or non-pegs tends to be greater as long as the economy continues staying in that regime longer or with breaks as less as possible.

Although those prevailing classifications are respectively proposed in enhancing one

[27] Technically, the band is defined in the log-changes form with the threshold ±0.2, which is equivalent to 22 percent.

or more aspects relative to the official (IMF) scheme, disagreements between them are substantial. An intuitive observation is that most of them are based on volatility measures and hence can be sensitive to large changes in exchange rate or other informative variables. For instance, the LYS method does not adjust such cases as the CFA devaluation in 1994 while RR using rolling-window and JS allowing one-time adjustment attempt to compromise the result.

Moreover, some of the methods selectively utilise informative macroeconomic variables, which would be more likely to be distinguished from others. For instance, the LYS method utilises the reserve stock data to measure the peg-defending pressure. This variable may comprise valuation changes that are not reflecting the actual management activities of the monetary authority. Moreover, the interaction between domestic monetary base and reserve may not be properly justified particularly around crisis periods (*e.g.* Dominguez, 2012; Aizenman and Ito, 2012). Another example would be the RR method that employs the parallel market rates. This may introduce systematic uncertainties from the disconnections between theories and market realities (*e.g.* Obstfeld and Rogoff, 2000b; Wagner, 2012; Sarno et al., forthcoming).

Bleaney and Francisco (2007) examined the above classifications over the common sample for 74 developing economies from 1985 to 2000 and concluded that the disagreements tend to be substantial and exhibit no tendency of vanish over the time. This indicates that the performance evaluation results would be determined by which scheme is used. Eichengreen and Razo-Garcia (2011) conduct Mixed-Probit models over the alternative schemes and show that disarrangements are more often observed a) among the emerging market and developing economies than among richer economies, b) among those economies more financially-opened but with lower reserve levels, and c) in volatile periods involving crises. Tavlas et al. (2008) reviewed a larger collection of classification methods and concluded that the large disagreements in terms of both methodology and outcomes reflect the lack of consensus in exchange rate determinant knowledges. The interactions between monetary policies (*e.g.* interest rates) and exchange rate regimes across countries are still open for exploring the consolidate definition for the "optimal" choices.

2.2.3 Currency Networks

The discussions above suggest that the bilateral exchange rates of a currency against a non-anchor currency reflect the joint effects of the bilateral rates between the currency and its anchor currency and between the anchor currency and the non-anchor currency. This effects can be indicated from a few empirical studies. Klein and Shambaugh (2008) suggest that there exist some additional lower multilateral volatility benefits other than pure gains from bilateral anchors. Bleaney and Francisco (2010) compared the exchange rate volatility reduction effect against USD and against CHF, for which IMF pegs tend to have less effects.

There are also a few studies aiming to explain the possible reasons that some currencies are more popular than the others. Those vehicle currency theories provide a potential interpretation of the choice of anchor currency and its network size. For instance, Krugman (1980) adopts the triangular transaction framework to illustrate that the choice of vehicle currency aims to reduce the total transaction cost, and an economically dominant currency is more likely to be the vehicle currency. Matsuyama et al. (1993), using a two-countries two-currencies random matching model, show that currency adoption in the international exchange may attain multiple equilibria that depend on the two economies' integration. The monetary authority's policy that affects the inflation tax on the currency will be important for the choice of vehicle currency. Rey (2001) develops a three-countries model with trade and financial intermediate sectors. The model generates multiple equilibria that depend on trade patterns and currency market intensities. A dominant vehicle currency will be used if trade between the other two minor economies are relatively small and closely related, *i.e.* either the transaction cost of using the vehicle currency is dominantly low, or the market intensity of the vehicle currency is large. Devereux and Shi (2013) develop a vehicle currency model under a dynamic general equilibrium framework. By imposing the "trading posts" that determine the transaction cost of using currencies, there exist incentives for adopting some vehicle currencies to improve the overall efficiency. The model also highlights the choice of balancing among monetary policy(inflation), economy size, and the number of currency members.

Empirically, by using 24-country trade-invoicing data, Goldberg and Tille (2008) compare the role of vehicle currencies of USD and Euro. They show that the exporting country's relative size and the composition of the export basket both matter for adopting the two major currencies for international invoicing. USD are more likely to be adopted since it tends to have lower transaction cost in the world financial market. It is also preferred when the industry of the exporting countries tend to be more homogeneous and closely competitive since it is easier for the competitors to contrast their relative prices. Meissner and Oomes (2009) suggest that there exist peg network externalities that, given that some small economies are credibly pegging to the same anchor currency, the network can be self-reinforced by attracting the other local and closely related economies to join in so as to encourage the trade of the member countries. The degree of synchronisation of the nominal output and price movements with a potential anchor currency tends to increase the propensity of pegging to it while larger country size tends to discourage pegging.

2.3 Currency Networks and Bilateral Exchange Rate Volatilities

2.3.1 Empirical Methodology and Data Description

The bilateral exchange rate volatility for a given pair of economies is assumed as a function of economic structural factors together with the regime variables. The structural control variables in principle follow the OCA theory and most exchange rate determinant models mentioned above. Moreover, they are consistent with the few empirical studies on bilateral exchange rate volatilities such as Bayoumi and Eichengreen (1998), Devereux and Lane (2003), and Bleaney and Tian (2012). The empirical cross-sectional regressions are specified as follows

$$VLT_{ij} = \alpha + \beta X_{ij} + \gamma Regime_{ij} + \epsilon_{ij} \quad (2.1)$$

where VLT_{ij} represents the bilateral volatility of the currency pair i and j; X_{ij} includes a list of control varaibles; $Regime_{ij}$ is a vector of regime frequency variables for the currency pair; ϵ_{ij} is a random error term.

2.3.1.1 Bilateral Volatility

The dependent variable is a measure of the bilateral exchange rate volatility between the currencies i and j, defined as the standard deviation of the monthly logarithmic changes of the bilateral rates:

$$VLT_{ij} = STDEV(d \ln BiEXR_{ij}) \quad (2.2)$$

The bilateral exchange rate data covers 1999M1-2006M12[28] from the IMF International Financial Statistics (IFS). As shown in Table 2-4, the data consist of 3415 bilateral exchange rate volatilities for 88 countries. 72% of the observations relate to pairs of Developing countries, 2% to pairs of Industrial economies, and the remaining 26% involve one from each group. The Industrial and developing groups are defined according to the IMF definition.

Table 2-4. Descriptive Statistics for Nominal Bilateral Exchange Rate Volatility

	Excl. High Inflation			Incl. High Inflation		
	Obs.	Mean	Stdev	Obs.	Mean	Stdev
Ind with Ind	66	0.0259	0.0069	66	0.0259	0.0069
Dev with Ind	887	0.0321	0.0135	959	0.0338	0.0147
Dev with Dev	2462	0.0317	0.0179	2856	0.0350	0.0194
Dev with World	3349	0.0318	0.0169	3815	0.0347	0.0183
World with World	3415	0.0317	0.0167	3881	0.0345	0.0182

[1] Ind is the indicator variable for the Industrial economies and Dev for the developing economies. World includes all countries.

It can be seen from Table 2-4 that the nominal bilateral exchange rate volatility between the Industrial economy currencies is lower and less dispersed than between the

[28] The sample starting date matches the launch of Euro.

developing economies. The concentrated lower volatility can also be seen from the Dev with Ind pairs compared with the Dev with Dev group. Due to the dominant number of developing economies, the general patterns of the bilateral volatility in Dev with Dev group are very similar to the pairs of Dev with World and World with World. Those developing economy currency pairs ever having high inflation rates (greater than 40% in any year during the sample period) tend to be associated with greater volatility.

2.3.1.2 Control Variables

A vector of control variables is employed to capture the non-regime determinants of bilateral exchange rate volatility as mentioned at the beginning of Section 2.3.1. In particular, there are three variables following the empirical tradition of the OCA theory: trade dependency, the asymmetry of economic cycles, and the economy size. Another three variables are utilised to capture shocks of terms-of-trade, inflation, and *per capita* income across the currency pairs, suggested by literatures. Detailed definitions and discussion are presented as follows.

Land Area *per capita* is defined as the logarithmic ratio of land area to population, averaged over the pair of currencies i and j. An economy with a larger value has more land *per capita* and is more likely to specialise in primary products and thus to experience larger terms-of-trade shocks (Chen and Rogoff, 2003; Cashin et al., 2004).

Bilateral Trade is the pair-averaged logarithmic transformation of one plus the bilateral trade relative to GDP for i and j. The trade and GDP data are from IMF *Direction of Trade Statistics* and *World Development Indication* (WDI) database respectively. Various theoretical and empirical studies indicate the correlation of trade with exchange rate volatility (Hau, 2002; Bergin et al., 2006; Bravo-Ortega and di Giovanni, 2005b). Following the OCA theory, bilateral trade is expected to be negatively correlated with the exchange rate volatilities.

Cycle Asymmetry is measured by the standard deviation of the difference between the annual logarithmic GDP growth of country i and j. The GDP series is from the WDI database covering period 1995-2005. Following the OCA theory, bilateral exchange rate volatility would be expected to increase with the degree of shock asymmetries (Bayoumi and Eichengreen, 1998; Devereux and Lane, 2003).

Economic Size is constructed by taking the pair average of logarithmic GDP, using the data in the year of 2000 from WDI. Larger economies are expected to have greater exchange rate volatility as there are *ceteris paribus* more opportunities for internal trade (McKinnon, 1963; Devereux and Lane, 2003).

Inflation tends to be associated with greater exchange rate volatility, because of its effect on equilibrium nominal exchange rates. Even if the pair of currencies have similar inflation rates, a greater exchange rate instability can result from larger price fluctuations due to high inflation (Dornbusch and Fischer, 1993; Frankel, 2003). Nevertheless, inflation has been neglected in previous empirical studies of bilateral volatility (Bleaney and Tian, 2012), although it has been shown to be a significant determinant of real effective exchange rate volatility (Bleaney and Francisco, 2010). Two inflation variables are employed: the pair average of inflation and the inflation differential between the pair of currencies. Inflation for each economy is the annual percentage changes in the consumer price index over the years 1999-2006. The rates are then averaged or differenced within each currency pair accordingly.

GDP *per capita* is a pair-average of the logarithmic terms for the currency pair in the year 2000. This aims to capture the effect of different productivity levels. Its sign are expected to be ambiguous. Dummy variables for the cases where either/both of the two countries is/are an industrial economy/-ies are also included. These variables are included in order to reduce possible omitted variables bias in the regressions.[29]

2.3.1.3 Regime Variables

Two alternative exchange rate regime classification schemes are employed. One is the IMF’s official *de facto* classification system that has been in force since 1999 and consists of eight types of regimes indexed generally by increasing flexibility of the exchange rate movements against the anchor currency (basket): no legal tender, currency

[29] The external debt and other financial variables in spirit of Devereux and Lane (2003) tend to be insignificant and hence are omitted.

board, conventional pegs, horizontal pegs, crawling pegs, crawling bands, managed floats and independent floats. The first six groups are pooled as IMF Pegs, with no differentiation between those tightness of commitments. An important reminder for the IMF' s definition of a peg is that occasional adjustments of the level of the exchange rate are permitted. Basket anchors are further separated from single-currency pegs in Section 2.2.2. The last two are receptively defined as IMF Managed Floats and IMF Independent Floats.[30]

The alternative classification scheme is by Shambaugh (2004). This classification is binary, and hence the regime for a given currency in a given year is defined either as a JS Peg or as a JS non-peg. A JS Peg requires the range of exchange rate variations not exceed ±2% throughout the calendar year, with the exception case for one larger variation in a single month but with zero changes in the other eleven months. JS Pegs are somewhat less frequent than the IMF classification, but there exist observations which are pegs according to Shambaugh but non-pegs according to the IMF.[31]

The regime variables (Peg, Managed Float, and Independent Float) of a currency pair is defined as the average of the two currencies' corresponding regime frequencies, *i.e.* the ratio of the total episode length being classified as a certain regime relative to the total length of the sample period.

$$\begin{aligned} Regime_{ij} &= \frac{Regime_i + Regime_j}{2} \\ &\text{where } Regime \in \{Peg, ManagedFloat, IndependentFloat\} \\ &\text{and } \sum_{Regime} Regime = 1 \text{ for } i, j \end{aligned} \tag{2.3}$$

Accordingly, for a given pair of currencies i and j, if currency i spent 20% of the sample period as a peg, 60% as a managed float and the rest as an independent float while

30 A grateful thank is given to Harald Anderson of the IMF for supplying the data set.

31 Other alternative regime classifications are those of Levy Yeyati and Sturzenegger (2005) and Reinhart and Rogoff (2004). The former has been criticized for treating big devaluations (*e.g.* of the CFA franc in 1994) as brief episodes of floating. The latter is unusual in using parallel-market exchange rates; perhaps in part for this reason it is rather an outlier, with a low correlation with other classifications. See Bleaney and Francisco (2007) and Tavlas et al. (2008), and detailed discussions in Section 2.2.2.

currency j is always an independent float, the Peg_{ij} and $Managed\,Float_{ij}$ will be 0.1 and 0.3 respectively. The $Independent\,Float_{ij}$ variable, which takes the value 0.6, will be excluded from the regressions as the reference base. The peg variables are further subdivided by different anchor currencies, following the same method.

Table 2-5 presents the descriptive statistics of the positively-valued JS Peg variables across the economy groups. It can be seen that developing economies constitute the majority of JS pegs and JS USD pegs. Over 75% of JS Peg observations tend to be USD pegs, suggesting the leading anchor currency position of USD. No Industrial economies are categorised as JS USD pegs. Compared with the average volatilities with those corresponding groups in Table 2-4, there tends to be currency-stabilising effects for JS Pegs and the JS USD Pegs exhibit second-order lower average volatility than the JS Pegs under moderate inflations.

Table 2-5. Descriptive Statistics for Bilateral JS Pegs

	Dev with Ind		Dev with World		World with World			
	No. of Positive Values	Weighted Average Volatility	No. of Positive Values	Weighted Average Volatility	No. of Positive Values	Mean of Positive Values	Weighted Average Volatility	
JS Pegs	477	0.0281	2189	0.0263	2210	0.4745	0.0262	Exclude
JS USD Pegs	300	0.0286	1663	0.0253	1663	0.4496	0.0253	High Inflation
JS Pegs	509	0.0295	2463	0.0290	2484	0.4626	0.0290	Include
JS USD Pegs	324	0.0301	1901	0.0286	1901	0.4363	0.0286	High Inflation

[1] Variables are defined as in Equation 2.3.

Table 2-6 shows the general patterns of the positively-valued IMF peg variables. It is obvious that there are more developing economies that have been categorised as pegs under IMF classification than the JS scheme.[32] This is because the JS classification scheme not only restricts the volatility range but requires infrequent devaluations for a peg as well. The proportion of the USD pegs to all pegs is even higher than the JS scheme, at about 80%. The IMF pegs on average exhibit lower level volatilities than the whole sample average shown in Table 2-4, and the USD pegs generally have the similar mean value as all pegs. Those pairs with managed floats generally show second-order larger bilateral volatilities than the whole sample average.

[32] In the data, Iceland Króna is the only Industrial economy currency occasionally classified as IMF pegs during the sample period but it is never regarded as a JS peg.

Table 2-6. Descriptive Statistics for Bilateral IMF Pegs

	Dev with Ind		Dev with World		World with World			
	No. of Positive Values	Weighted Average Volatility	No. of Positive Values	Weighted Average Volatility	No. of Positive Values	Mean of Positive Values	Weighted Average Volatility	
IMF Pegs	657	0.0284	2870	0.0278	2891	0.4906	0.0277	Exclude
IMF USD Pegs	468	0.0295	2327	0.0271	2327	0.4134	0.0271	High
Managed Floats	481	0.0348	2376	0.0334	2387	0.4045	0.0334	Inflation
IMF Pegs	699	0.0299	3243	0.0307	3264	0.4887	0.0306	Include
IMF USD Pegs	504	0.0313	2669	0.0307	2669	0.4160	0.0307	High
Managed Floats	531	0.0368	2755	0.0366	2766	0.4045	0.0366	Inflation

[1] Variables are defined as in Equation 2.3.

An implicit assumption of this specification is that the overall effect on both currencies of being in a regime will be twice as large as for a single currency. This would be implausible for identifying the peg network effects, as the currency-stabilising effects may require both currencies pegging to the same anchor. To distinguish these cases, two regime variables are constructed as follows

$$Both\,Regime_{ij} = Regime_i Regime_j \tag{2.4}$$

$$Either\,Regime_{ij} = 1 - (1 - Regime_i)(1 - Regime_j) \tag{2.5}$$

$$\text{where } Regime \in \{Peg, ManagedFloat, IndependentFloat\}$$

$$\text{and } \sum_{Regime} Regime = 1 \text{ for } i, j$$

. Accordingly, the $Both\,Peg_{ij}$ variable will be non-zero if neither Peg_i nor Peg_j is zero and it will be one only if both Peg_i and Peg_j are one. More generally, this definition captures the intuition that the given the average spell of peg for a pair of currencies, the network effect will attain its maximum magnitude once both the currencies are pegging.[33] The $Either\,Peg_{ij}$ variable will be one if either Peg_i or Peg_j is one. This captures the tendency that at least one currency is a peg during the sample period.

Note that the sum of these two variables $Both\,Regime_{ij}$ and $Either\,Regime_{ij}$ is twice the original pair regime variable $Regime_{ij}$. If they both enter the regressions and yield the similar coefficients, the simpler specification with the original regime variables will be adequate. If the currency networks are important, the $Both\,Peg_{ij}$

[33] *i.e.* given a certain value of Peg_{ij}, $Both\,Peg_{ij}$ will be maximised when $Peg_i = Peg_j$.

variable for a particular anchor currency (*e.g.* $Both\,USD\,Peg_{ij}$)would exhibit a much larger coefficient than $Either\,Regime_{ij}$ (*i.e.* $Either\,USD\,Peg_{ij}$).

2.3.1.4 Currency Unions

The bilateral approach will be implausible when members of a currency union exhibit the same bilateral volatility against the same anchor currency while each possesses different economic characteristics. Hence in this chapter currency unions (Euro, CFA, and ECD zones) are treated as single units so that each individual (i and j) is a currency rather than a country. The union-level variables are calculated as either the sum or the GDP-weighted average of the constituent countries' values, as appropriate.

2.3.1.5 Episodes of High Inflation

The sample period covers the Great Moderation periods when global financial markets were rapidly integrated and many macroeconomic variables exhibit significant stability across the regions (Lane and Milesi-Ferretti, 2010). However, economic turbulences causing destructively large fluctuations and ultimately disrupting long-run growth still emerge particularly among the developing economies (Frankel, 2003; Obstfeld, 2009). As discussed above, a significant feature can be high-inflation episodes (*e.g.* Reinhart and Rogoff, 2004; Frankel, 2005). Except for the baseline line results, the regressions presented in the following sections exclude all cases where any annual inflation in one of the currency pair exceeds 40% during the sample period. As shown in the next section, the results are in fact very similar if these observations are included.

2.3.2 Baseline Results

The analyses begin with the basic regressions under the two exchange rate regime classification schemes. Table 2-7 presents the baseline results including the control variables and simple IMF regime variables. Three control variables following the OCA theory behave much as expected. The positive coefficient for $Cycle\,Asymmetry$ has greater significance than the other two, suggesting that the asymmetry of the economic cycle between the two currencies notably enlarges bilateral exchange rate volatility. The bilateral trade dependency shows negative coefficients across the regressions, suggesting that greater economic inter-dependency tend to be associated with smaller general price differences. The economy size of the currency pair is positively correlated with the bilateral exchange rate volatility, suggesting that larger economy pairs tend to tolerate a wider range of the exchange rate movements.

Table 2-7. Bilateral Exchange Rate Volatility: IMF Baseline Results

	Excl. High Inflation			Incl. High Inflation		
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area p.c.	0.00359	0.00321	0.00333	0.00375	0.00380	0.00396
	(18.21)***	(15.93)***	(17.09)***	(18.72)***	(19.03)***	(20.29)***
Trade	-0.07597	-0.07433	-0.02768	-0.07059	-0.06797	-0.02477
	(-4.69)***	(-4.51)***	(-2.83)***	(-4.78)***	(-4.57)***	(-2.49)**
Cycle Asymmetry	0.19958	0.18090	0.19328	0.18850	0.17137	0.18210
	(20.72)***	(17.62)***	(19.23)***	(19.98)***	(17.13)***	(18.49)***
Size	0.00122	0.00071	0.00095	0.00102	0.00036	0.00056
	(15.41)***	(8.30)***	(11.46)***	(12.60)***	(4.19)***	(6.54)***
Inflation Average	0.00283	0.00255	0.00267	0.00220	0.00186	0.00194
	(24.75)***	(22.92)***	(24.78)***	(20.42)***	(18.95)***	(19.64)***
Inflation Differential	0.00056	0.00070	0.00069	0.00016	0.00032	0.00032
	(7.06)***	(9.41)***	(9.63)***	(2.50)**	(5.38)***	(5.26)***
GDP p.c.	0.00313	0.00399	0.00411	0.00208	0.00403	0.00408
	(12.41)***	(15.15)***	(16.11)***	(8.53)***	(15.32)***	(15.77)***
Ind with Dev	-0.00116	-0.00568	-0.00536	-0.00082	-0.00579	-0.00554
	(-1.92)*	(-8.62)***	(-8.64)***	(-1.35)	(-8.67)***	(-8.65)***
Ind with Ind	-0.00684	-0.01571	-0.01530	-0.00670	-0.01638	-0.01605
	(-5.57)***	(-11.77)***	(-11.33)***	(-5.56)***	(-12.01)***	(-11.49)***
IMF Peg		-0.01562	-0.00766		-0.01654	-0.00885
		(-15.57)***	(-7.13)***		(-16.26)***	(-7.81)***
IMF USD Peg			-0.01214			-0.01143
			(-13.23)***			(-12.11)***
Managed Float		-0.01133	-0.01183		-0.00395	-0.00420
		(-10.30)***	(-11.06)***		(-3.58)***	(-3.88)***
USD Dummy			-0.01497			-0.01306
			(-11.69)***			(-9.91)***
Euro Dummy			-0.00721			-0.00546
			(-6.50)***			(-4.68)***
Constant	-0.06103	-0.03258	-0.04525	-0.03705	-0.00987	-0.01977
	(-15.34)***	(-7.45)***	(-10.35)***	(-9.20)***	(-2.25)**	(-4.46)***
Obs.	3415	3415	3415	3881	3881	3881
RMSE	0.0115	0.0111	0.0106	0.0125	0.0120	0.0116
R^2	0.53	0.57	0.60	0.53	0.57	0.59
p-values of tests						
Joint Regimes		0.00	0.00		0.00	0.00
Peg = MF		0.00	0.00		0.00	0.00
USD Peg = MF			0.00			0.00

[1] The dependent variable is nominal bilateral exchange rate volatility as defined in Equation 2.2.
[2] White heteroscedasticity robust t-statistics are presented in the parentheses.
[3] RMSE is the root mean square error of the regression.
[4] Asterisks, ***, **, *, denote the significance level at 1%, 5% and 10% respectively.
[5] Members of the same currency unions have been aggregated as single economies.
[6] High-inflation is defined as >40% in any year during the sample period.
[7] The USD and Euro Dummies take the value of one if the bilateral rate is against USD and Euro respectively.
[8] The Joint Regimes test represents the joint significance test for all regime variables (Pegs, USD Pegs, and Managed Floats).
[9] The USD Peg = MF test represents the test for Peg + USD Peg = Managed Floats.

The other control variables generally have consistent results across the specifications. Land area *per capita* has a highly significant positive coefficient. This may suggest that economy pairs with richer natural resources tend to experience more volatile terms-of-trade shocks. The positive coefficient of GDP per capita suggests that wealthier economy pairs tend to tolerate higher volatilities. On the other hand, the negative coefficients for *Ind with Ind* and *Dev with Ind* dummies indicate particular lower bilateral exchange rate volatilities for the Industrial economy currencies. These may suggest that Industrial economies may intrinsically have greater stabilities or that most economies may generally have particular considerations on the bilateral rates against major currencies.

The pair average inflation exhibit the largest explanatory power among all the variables. The positive coefficients across the regressions suggest that inflation enlarges the range of the bilateral exchange rate movements. The significantly positive coefficient for the *Inflation Differential* also indicates that monetary regime differences widens the bilateral volatility, though the magnitude is smaller. It can be seen that the inclusion of those currency pairs ever experiencing annual inflation higher than 40% would not change the results very much.

It can be shown that those currency pairs with IMF pegs and managed floats generally have lower bilateral exchange rate volatilities than those with both independent floats. Once the simple regime variables are introduced into the regressions, the joint significant tests confirm that the coefficients are statistically different from zero. The *Peg* variable shows a highly significant negative coefficient, suggesting that the more frequently both currencies are recognised as IMF pegs, the greater volatility reduction effect there tends to be. By taking the result in Column 2 for instance, if both the currencies are pegged throughout the whole sample period 1999-2006, their bilateral exchange rate volatility will be lowered by 0.156 relative to the both independent float pairs. The significantly negative coefficient for the *Managed Floats* variable indicates similar results and the equivalence test suggests that the volatility reduction effects are between pairs with peg(s) and managed float(s) are quantitatively different.

The negative coefficient of the IMF *Peg* variable remains significant when the IMF *USD Peg* variable is added into the regressions, though the magnitude of the coefficient is nearly halved. Moreover, the significantly negative coefficient for the *USD Peg* variable exhibits much larger magnitude than the *Peg* variable. These suggest that the volatility stabilising effects may mainly come from peg networks among which the most prevailing USD network tend to have the lowest volatility. Specifically, for a given number of currencies, the larger is the fraction of all bilateral exchange rates pegging to the same anchor (*i.e.* a more popular anchor), the lower will be the average volatility for that anchor (*i.e.* larger network effect). As shown in Column 3, those currency pairs with both USD peg tend to have lower bilateral exchange rate volatility by 0.0126 than those pegging to other currencies. Moreover, both the *USD Dummy* and *Euro Dummy* have negative coefficients, suggesting that most currency tend to be particularly stabilised against USD and Euro.

Table 2-8 presents the baseline regressions with JS peg variables. Instead of examining pegs from the currency pairs only against the potential anchor currency as Klein and Shambaugh (2008), the regressions in the table are estimated over all possible bilateral pairs. It can be seen that the control variables are generally consistent with the IMF results in Table 2-7 and the general performance of the regressions in terms of R^2 and standard deviation are roughly the same. The cycle asymmetry still shows the largest explanatory power among the variables consistent with the OCA theory. Larger bilateral trade tends to be associated with more stabilised bilateral exchange rates. The economy size of the pair has a positive coefficient. Both the two dummies related to Industrial currencies exhibit significantly negative coefficients. Land Area and GDP *p.c.* are positively correlated with bilateral exchange rate volatility. Inflation tends to disconnect the price co-movements for the pair of currencies, preserving roughly the same effects as the corresponding regressions in Table 2-7.

Since the JS classification only distinguish pegs from non-pegs, the reference category will be the currency pair with both non-pegs. The negative coefficient for the JS *Peg* variable (Column 1 & 4) is significant when it is the only peg variable included

Table 2-8. Bilateral Exchange Rate Volatility: JS Baseline Results

	Excl. High Inflation			Incl. High Inflation		
	(1)	(2)	(3)	(4)	(5)	(6)
Land Area p.c.	0.00362	0.00365	0.00346	0.00376	0.00383	0.00393
	(18.39)***	(18.93)***	(17.43)***	(18.85)***	(19.34)***	(19.47)***
Trade	-0.07608	-0.02986	-0.02868	-0.07042	-0.02812	-0.02586
	(-4.63)***	(-3.05)***	(-2.95)***	(-4.70)***	(-2.74)***	(-2.57)**
Cycle Asymmetry	0.19114	0.19970	0.19727	0.17835	0.18347	0.18326
	(19.22)***	(20.63)***	(20.04)***	(18.22)***	(19.08)***	(18.92)***
Size	0.00115	0.00143	0.00130	0.00094	0.00115	0.00093
	(14.34)***	(18.02)***	(15.84)***	(11.43)***	(13.93)***	(10.94)***
Inflation Average	0.00255	0.00267	0.00275	0.00197	0.00203	0.00199
	(21.26)***	(22.27)***	(23.20)***	(17.91)***	(18.00)***	(18.20)***
Inflation Differential	0.00065	0.00060	0.00059	0.00026	0.00023	0.00027
	(8.09)***	(7.61)***	(7.55)***	(3.92)***	(3.46)***	(4.09)***
GDP p.c.	0.00313	0.00297	0.00320	0.00221	0.00204	0.00284
	(12.56)***	(11.88)***	(12.15)***	(9.28)***	(8.50)***	(10.80)***
Ind with Dev	-0.00195	-0.00132	-0.00229	-0.00181	-0.00118	-0.00245
	(-3.21)***	(-2.28)**	(-3.83)***	(-2.95)***	(-2.00)**	(-4.00)***
Ind with Ind	-0.00829	-0.00726	-0.01034	-0.00850	-0.00745	-0.01054
	(-6.78)***	(-5.63)***	(-7.74)***	(-7.07)***	(-5.79)***	(-7.68)***
JS Peg	-0.00434	0.00397	0.00142	-0.00507	0.00075	0.00104
	(-5.40)***	(3.52)***	(1.16)	(-6.17)***	(0.64)	(0.81)
JS USD Peg		-0.01126	-0.01151		-0.00791	-0.00890
		(-9.23)***	(-9.24)***		(-6.19)***	(-6.74)***
IMF Peg in			-0.00384			-0.00443
JS NonPegs			(-7.12)***			(-7.75)***
IMF MF in			-0.00336			-0.00005
JS NonPegs			(-5.59)***			(-0.08)
USD Dummy		-0.01556	-0.01545		-0.01418	-0.01367
		(-11.70)***	(-11.95)***		(-10.30)***	(-10.21)***
Euro Dummy		-0.00625	-0.00650		-0.00448	-0.00472
		(-5.57)***	(-5.82)***		(-3.77)***	(-4.06)***
Constant	-0.05486	-0.06739	-0.05957	-0.03126	-0.04003	-0.03242
	(-13.19)***	(-15.93)***	(-13.71)***	(-7.48)***	(-9.32)***	(-7.41)***
Obs.	3415	3415	3415	3881	3881	3881
RMSE	0.0114	0.0111	0.0110	0.0124	0.0122	0.0121
R^2	0.54	0.57	0.57	0.54	0.55	0.56
p-values of tests						
Joint Regimes		0.00	0.00		0.00	0.00

[1] *IMF Peg in JS NonPegs* and *IMF MF in JS NonPegs* are defined as Equation 2.6.
[2] The Joint Regimes test represents the joint significant test for the JS Peg and JS USD Peg variables.
[3] See notes to Table 2-7

in the regression. This suggests that a currency pair tends to have lower bilateral exchange rate volatility if they spend more time as JS pegs. However, the coefficient becomes positive when the JS *USD Peg* is added to the regression and exhibits significantly negative coefficient. This indicates peg network effects that the stabilised volatility is mainly from the currency pair with both pegging to the same anchor. The more frequently a pair of currencies are pegged to USD, the less bilateral exchange rate volatility they tend to exhibit relative to both JS non-pegs.

The results in Column 2 & 5 suggest that the volatility reduction effect under the JS classification appears weaker than the IMF. This may result from the difference of the reference category, since the IMF classification generally allows more flexible pegs and also distinguishes managed floats from independent floats. To further adjust the JS regressions with similar reference group, two more variables are constructed to capture the IMF pegs and managed floats in the JS non-peg respectively:

$$\begin{aligned} &IMF\,Regime\,in\,JS\,NonPegs_{ij} = IMF\,Regime_{ij} \times (1 - JS\,Peg_{ij}) \\ &\text{where } Regime \in \{Peg, Managed\,Float\} \end{aligned} \tag{2.6}$$

It can be seen from Column 3 & 6 that the positive coefficient on the JS *Peg* variable loses significance once the two variables are added into the regressions, suggesting that the anomalies in Column 2 & 5 are weakened after the reference category are adjusted similar to both IMF independent float pairs. The coefficients for the two new variables are both negative, suggesting those more flexible IMF pegs and managed floats in the JS non-pegs indeed exhibit volatility stabilising effects. The *USD Peg* variable still shows significantly negative, preserving similar magnitude as before.

2.3.3 Currency Networks

The baseline results suggest that a currency pair tends to have lower bilateral exchange rate volatility if both economies stay in pegs, and those pairs with USD pegs tend to have even lower bilateral exchange rate volatilities than the other non-USD pegs. This may result from the network effects that more currencies pegged to the same anchor would result in lower bilateral volatilities among them than with others. Moreover, managed floats tend to exhibit the stabilising effect with the magnitude between USD pegs and other pegs given all the other factors controlled. This suggests that they may have particular concern on USD than other currencies. This section attempts to identify those currency networks.

2.3.3.1 Peg Networks

As discussed before, the simple peg variables used in the baseline results are bilaterally averaged, which may raise the concern that currency pairs with both pegs may not reduce the bilateral exchange rate volatility twice as much as those with only one currency pegging. If both currencies are pegging to different anchor currencies, the bilateral exchange rate volatility is also expected to be different from those with both pegging to the same currency. Accordingly, two variables *Either Peg* and *Both Pegs* are constructed following Equation 2.4 to relax the assumption that the stabilising effect is doubled for both pegs relative to a single peg. Moreover, to further investigate the anchor currencies in addition to USD, the *Both Same NonUSD Peg* variable is introduced into the regressions together with *Either USD Peg* and *Both USD Peg*, aiming to capture the fraction of times for both currencies pegging to the same non-USD anchor.

The summary statistics of those peg variables are presented in Table 2-9. It can be seen from the number of observations that Non-USD pegs are much less than USD pegs. Since the potential anchor currency in the JS classification are mainly USD and Euro, a *Both Euro Pegs* variable is added to contrast the components of non-USD peg observations. It is obvious that the Euro pegs constitute almost all the non-USD pegs under both the IMF and JS classifications and they tend to have larger stabilising effects than USD pegs.[34] The number of IMF non-USD pegs is more than JS non-USD pegs and a greater average volatility can be observed for both currencies pegged to the same anchor under the IMF classification than the JS method. This reflects the relatively tight criteria of classifying pegs by the JS method that directly bases on the *ex post* bilateral exchange rate volatility. Moreover, one can infer from the positive-valued mean values that non-USD peggers tend to exhibit longer time than USD pegs during the sample period. The high inflation condition only influence the spell of USD pegs and generally preserve the proportion of both USD pegs to both pegs.

Table 2-10 presents the results employing the peg network variables, differentiating the both-pegging from single-pegging effects under the two classification methods. Generally, the performance of regressions in terms of R^2 and standard deviation are similar to the baseline results. The coefficients for the control variables remain the

[34] For the IMF classification, there is a single pair of currencies both pegging to Indian Rupee: the Nepalese Rupee and Sri Lanka Rupee, of which the latter currency is never regarded as a JS peg during the sample period.

Table 2-9. Descriptive Statistics for Bilateral Peg Network Variables

	IMF Classification			JS Classification			
	No. of Positive Values	Mean of Positive Values	Weighted Average Volatility	No. of Positive Values	Mean of Positive Values	Weighted Average Volatility	
Either Peg	2891	0.7831	0.0290	2210	0.8088	0.0275	
Either USD Peg	2327	0.7148	0.0283	1663	0.8055	0.0267	Exclude
Both Pegs	1199	0.4777	0.0229	536	0.5783	0.0190	High
Both USD Pegs	612	0.4258	0.0191	260	0.6001	0.0139	Inflation
Both NonUSD Pegs	46	0.6100	0.0126	28	0.4583	0.0074	
Both Euro Pegs	45	0.6177	0.0125	28	0.4583	0.0074	
Both IF	555	0.5313	0.0386	536	0.5783	0.0190	
Either Peg	3264	0.7808	0.0318	2484	0.7928	0.0302	
Either USD Peg	2669	0.7168	0.0317	1901	0.7831	0.0298	Include
Both Pegs	1349	0.4755	0.0261	595	0.5527	0.0217	High
Both USD Pegs	720	0.4267	0.0244	303	0.5622	0.0182	Inflation
Both NonUSD Pegs	46	0.6100	0.0126	28	0.4583	0.0074	
Both Euro Pegs	45	0.6177	0.0125	28	0.4583	0.0074	
Both IF	655	0.5085	0.0403	595	0.5527	0.0217	

same in terms of both magnitude and significance level.

Column 1 & 3 presents the regressions using alternative peg network variables comparable to baseline results. The negative coefficients of the *Either Peg* variable under both the IMF and JS classifications suggests that the bilateral exchange rate volatility would be lower if at least one currency of a pair is pegged rather than both are independent floats. The *Both Pegs* variable exhibits much larger negative coefficients, by about 36 % under the IMF and even larger under the JS classification. This indicates the assumption that the currency network effects are largely from both currencies' pegging. Moreover, it can be calculated that the sum of the coefficients for those two variables are roughly larger in magnitude than the *Peg* variable in the baseline results under both the IMF[35] and JS [36] classifications. This also indicates the volatility stabilising networks function much more effectively for a both-pegs pair than a single-peg one.

Column 2, 4, & 5 further examine the peg networks by differentiating the anchor currencies. Similarly to the baseline regressions, the additional effects of the USD peggers' network are captured by the *Either USD* and *Both USD Pegs* variables. A *Both Same NonUSD Peg* variable is introduced into the regressions to capture all the

[35] *i.e.* -0.00677-0.00924=-0.01601 from Column 1 in Table 2-10 is larger in magnitude than -0.1562 from Column 2 in Table 2-7

[36] *i.e.* -0.00097-0.00487=-0.00584 from Column 3 in Table 2-10 is larger in magnitude than -0.00434 from Column 1 in Table 2-8

Table 2-10. Nominal Bilateral Exchange Rate Volatility and Peg Networks

	IMF Classification		JS Classification		
	(1)	(2)	(3)	(4)	(5)
Land Area p.c.	0.00320	0.00333	0.00360	0.00364	0.00340
	(15.90)***	(17.38)***	(18.36)***	(19.20)***	(17.65)***
Trade	-0.07525	-0.02143	-0.07617	-0.02070	-0.01918
	(-4.51)***	(-2.31)**	(-4.59)***	(-2.26)**	(-2.11)**
Cycle Asymmetry	0.18124	0.19358	0.19240	0.20070	0.19916
	(17.67)***	(19.46)***	(19.37)***	(20.83)***	(20.15)***
Size	0.00071	0.00096	0.00115	0.00142	0.00116
	(8.36)***	(11.72)***	(14.44)***	(18.18)***	(14.28)***
Inflation Average	0.00255	0.00268	0.00258	0.00272	0.00287
	(22.89)***	(24.95)***	(21.44)***	(22.82)***	(24.69)***
Inflation Differential	0.00070	0.00069	0.00062	0.00055	0.00050
	(9.35)***	(9.55)***	(7.70)***	(7.02)***	(6.47)***
GDP p.c.	0.00398	0.00410	0.00313	0.00296	0.00361
	(15.11)***	(16.29)***	(12.58)***	(12.06)***	(13.91)***
Ind with Dev	-0.00570	-0.00535	-0.00195	-0.00123	-0.00306
	(-8.66)***	(-8.88)***	(-3.20)***	(-2.18)**	(-5.23)***
Ind with Ind	-0.01544	-0.01523	-0.00816	-0.00720	-0.01237
	(-11.62)***	(-11.76)***	(-6.68)***	(-5.81)***	(-9.42)***
Either Peg	-0.00677	-0.00359	-0.00097	0.00248	0.00330
	(-11.04)***	(-5.53)***	(-1.89)*	(3.89)***	(4.76)***
Either USD Peg		-0.00438		-0.00419	-0.00471
		(-8.37)***		(-6.50)***	(-7.31)***
Both Pegs	-0.00924	-0.00125	-0.00487	0.00515	-0.00219
	(-11.83)***	(-1.77)*	(-5.02)***	(5.38)***	(-1.86)*
Both USD Pegs		-0.01418		-0.01618	-0.01617
		(-14.42)***		(-12.13)***	(-12.14)***
Both Same NonUSD Pegs		-0.01819		-0.02939	-0.02972
		(-13.37)***		(-11.36)***	(-11.88)***
IMF Pegs in JS NonPegs					-0.00717
					(-11.32)***
IMF MF in JS NonPegs					-0.00458
					(-7.58)***
Managed Float	-0.01129	-0.01173			
	(-10.28)***	(-11.02)***			
USD Dummy		-0.01190		-0.01308	-0.01324
		(-8.35)***		(-9.24)***	(-9.60)***
Either USD Peg ×		-0.01104		-0.01262	-0.01043
USD Dummy		(-4.71)***		(-5.16)***	(-4.37)***
Euro Dummy		-0.00730		-0.00633	-0.00682
		(-6.75)***		(-5.75)***	(-6.35)***
Constant	-0.03321	-0.04645	-0.05560	-0.06783	-0.05504
	(-7.59)***	(-10.67)***	(-13.38)***	(-16.12)***	(-12.76)***
Obs.	3415	3415	3415	3415	3415
RMSE	0.0110	0.0103	0.0114	0.0109	0.0107
R^2	0.57	0.62	0.54	0.58	0.60
p-values of tests					
Joint Pegs	0.00	0.00	0.00	0.00	0.00
USD = Same NonUSD		0.79		0.00	0.00

[1] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[2] The Joint Pegs test represents the joint significance test for all peg variables (Both Pegs, Both USD Pegs, Either Peg, and Either USD Peg).
[3] The USD = Same NonUSD test represents the test for Either USD Peg + Both USD Pegs = Both Same Non-USD Pegs.
[4] See notes to Table 2-7.

pairs that are pegged to the same non-USD anchors. Consequently, the coefficient for the *Both Pegs* variable would indicate the network effect of a pair pegging to different anchors and the *Either Peg* variable would be the reference group as a single non-USD peg pair.

It can be seen that once the peg network effects is refined by groups of anchors, the negative coefficients of the *Either Peg* and *Both Pegs* variables become much smaller both in magnitude and significance level. The coefficient for the *Either Peg* variable is nearly halved in magnitude under the IMF classification (Column 2) and it even becomes positive under the JS classification (Column 4 & 5). This suggests that the volatility stabilising effect is substantially reduced once the largest peg network (*i.e.* USD) is "conditioned out".

The coefficient for the *Both Peg* variable is substantially reduced in magnitude, supporting the assumption that currency network effects rely mostly on pegging to the same anchor. For the IMF classification result (Column 2), the coefficient retains significantly negative. Quantitatively, the coefficient indicates that those pairs pegging to different anchors tend to have lower bilateral exchange rate volatility than both independent floats by about 0.00484 (-0.00359-0.00125). For the JS classification, it can be calculated that even after the reference group is adjusted similarly to the IMF both-independent-floats pairs (Column 5), a pair of different-anchors pegs still shows insignificantly larger volatility.[37]

The bilateral exchange rate volatilities tend to be significantly reduced through the USD peg network. The negative coefficients of the *Either USD Peg* variable across the regressions suggest that there exist additional volatility stabilising effects for a single-USD-peg pair than a single-non-USD-peg. Even for the JS classification results, it can be shown that a currency pair with a single-USD-peg on average tend to have significantly lower bilateral volatility than a neither-peg pair.[38] The coefficient for

[37] *i.e.* the sum of the coefficients 0.00330-0.00219 = 0.00111 is insignificantly different from zero with the p-value 0.39.

[38] *e.g.* In Column 5, the sum of the coefficients 0.00330-0.00471= -0.00141 is significantly different from zero with the p-value 0.02.

Both USD Peg variable is significantly negative across the regressions with much larger magnitude, suggesting that there are strong network effects for the USD peg network. Moreover, the negative coefficients for the *USD Dummy* is still significant after the USD pegs are controlled by an additional variable. This suggests that all the economies may have particular considerations of stabilising against USD.

It can be shown that the volatility stabilising effect for a both non-USD pegs pair is no smaller than a both USD pegs. The significantly negative coefficients for the *Both Same NonUSD Pegs* variable across the regressions suggests that a both-pegs pair with the same non-USD anchor are associated with additional lower bilateral volatility than those pegging to different anchors. Moreover, by aggregating the overall incremental effects for the both USD pegs (*i.e.* the sum of *Either USD Peg* and *Both USD Pegs*), it can be seen that the marginal volatility stabilising effect for a non-USD peg network is similar in magnitude to the USD network under the IMF classficiation[39] but significantly larger under the JS classification[40]. This suggests that the *ceteris paribus* lower bilateral volatilities for USD pegs than non-USD pegs are entirely through former network's larger size. In other words, it is the dominant number of USD pegs that contributes to the more stabilised bilateral volatility for USD than the other anchor currencies, despite of the USD network members' overall lower marginal bilateral network effects.

Table 2-11 provides illustrative examples for peg networks in stabilising bilateral exchange rate volatility under different combinations of regime pairs. The calculations exploit the corresponding coefficients in Column 2 & 4 of Table 2-10 for the IMF and JS classifications respectively and assume each scenario as a Dev with Dev currency pair constantly staying in the corresponding regimes throughout the sample period. Since the JS classification is only binary, the results for mange floats and independent floats are not differentiated. In contrast to the statistical differences as discussed in the

[39] As as shown in Column 2, the test of USD (-0.00438-0.01418=0.01856) = Same Non USD (-0.01819) can not be rejected

[40] *e.g.* In Column 5, the test of USD (-0.00471-0.01617=0.02088) = Same NonUSD (-0.02972) is significantly rejected

above paragraphs, these illustrative examples only indicates the point estimate effects.

Table 2-11. Illustrative Examples of Peg Network Effects

Regime Combinations	IMF Classification Aggregate Effects	IMF Classification Stabilisation Ranking	JS Classification Aggregate Effects	JS Classification Stabilisation Ranking
Both USD Peg	-0.02340	1	-0.01279	2
Both Same NonUSD Peg	-0.02303	2	-0.02604	1
USD Peg with NonUSD Peg	-0.00922	6	0.00337	10
USD Peg with MF	-0.01384	3	-0.00183	3
NonUSD Peg with MF	-0.00946	5	0.00237	8
MF vs. MF	-0.01173	4	0	5
USD Peg with IF	-0.00797	7	-0.00183	3
NonUSD Peg vs. IF	-0.00359	9	0.00237	8
MF with IF	-0.00587	8	0	5
IF with IF	0	10	0	5

[1] Each calculation assumes an representative Dev with Dev pair of currencies always staying in the corresponding regime combination throughout the sample period.
[2] The example uses the coefficients in Column 2 of Table 2-10 for the IMF classification and Column 4 for the JS classification.
[3] The JS classification by definition would not distinguish managed floats from independent floats.
[4] The stabilisation rankings only indicates the results of point estimates without considering the statistical differences.

It is obvious that those pairs with both currencies pegging to the same anchor currency exhibit the lowest bilateral exchange rate volatilities among all regime combinations, suggesting strong currency network effects. A USD peg tends to show larger stabilising effects than a non-USD peg when they are matched with a non-peg, suggesting the former network's dominant size. Interestingly, the IMF results suggests that managed floats tends to have stronger stabilising effects than non-USD pegs but weaker than a USD peg.

2.3.3.2 Managed Floats and USD Network

There has been studies suggesting that managed floats substantially stabilise their exchange rates as "soft" pegs.(Calvo and Reinhart, 2002) This leads to an intuitive question about identifying their potential anchor currencies. By controlling the structural variables, our previous results suggest that managed floats tend to exhibit systematic patterns in reducing bilateral exchange rate volatility: an representative currency of managed floats tends to exhibit lower bilateral volitionality with a USD peg than NonUSD. To further investigate this issue, several managed float variables are added following similar ideas of assessing peg networks. The regime variables described as "X

with Y” are defined as follows:

$$\begin{aligned} RegimeX\,with\,RegimeY_{ij} &= RegimeX_i RegimeY_j + RegimeY_i RegimeX_j \\ \text{where } RegimeX,\, Y &\in \{Peg, ManagedFloat, IndependentFloat\} \end{aligned} \tag{2.7}$$

Thus a regime variable will take the value of one if the currency pair i and j will stay in the corresponding regime combination throughout the sample period. The indication for its coefficient will then represent similar ideas to Table 2-11, *i.e.* the volatility stabilising effect for that combination relative to the both-independent-floats pairs. Moreover, those peg variables are refined for USD and NonUSD anchors as well and a *Diff. Anchors Pegs* variable defined as

$$Diff.\,Anchors\,Pegs_{ij} = Both\,Pegs_{ij} - Both\,USD\,Pegs_{ij} - Both\,Same\,NonUSD\,Pegs_{ij} \tag{2.8}$$

Table 2-12 presents the network effects for managed floats. It can be seen that the volatility stabilising effects across all regime combinations are very similar as shown the illustrative example in Table 2-11. Those currency pairs pegging to the same anchor currency on average exhibit the lowest *ceteris paribus* bilateral exchange rate volatility. Further statistical tests also suggest that the marginal stabilising effects are indifferent between the anchors (USD and Non-USD) for the those both-the-same-anchor pegs. Among the other combinations, a USD peg tends to have uniformly lower volatility than a non-USD peg. These jointly suggest that the USD peg network effects largely benefit from its dominant size.

It can be shown that the managed float network behaves very similarly to the USD peg network. The negative coefficient for the *USD Peg with MF* variable is more than twice in magnitude of *NonUSD Peg with MF* across the regressions and the statistical tests also significantly reject the quantitative indifference. This suggests that the bilateral exchange rate fluctuations for a managed float is particularly reduced relative the USD pegs. The coefficient for the *Both Managed Floats* variable lies between the former two variables, suggesting that the volatility stabilising effects among the managed

Table 2-12. Managed Floats and USD Network

	(1)	(2)	(3)
Land Area p.c.	0.00332	0.00333	0.00334
	(17.35)***	(17.47)***	(17.51)***
Trade	-0.02735	-0.02033	-0.01735
	(-2.67)***	(-2.18)**	(-1.93)*
Cycle Asymmetry	0.19250	0.19240	0.19241
	(19.47)***	(19.44)***	(19.47)***
Size	0.00096	0.00096	0.00096
	(11.82)***	(11.78)***	(11.82)***
Inflation Average	0.00267	0.00267	0.00268
	(24.89)***	(24.93)***	(25.01)***
Inflation Differential	0.00070	0.00070	0.00069
	(9.70)***	(9.71)***	(9.62)***
GDP p.c.	0.00409	0.00408	0.00409
	(16.25)***	(16.22)***	(16.28)***
Dev with Ind	-0.00567	-0.00556	-0.00558
	(-9.30)***	(-9.14)***	(-9.17)***
Ind with Ind	-0.01383	-0.01455	-0.01440
	(-10.03)***	(-11.28)***	(-11.38)***
Both USD Pegs	-0.02222	-0.02162	-0.02150
	(-17.51)***	(-17.03)***	(-16.76)***
Both Same NonUSD Pegs	-0.02213	-0.02146	-0.02139
	(-15.25)***	(-14.78)***	(-14.59)***
Diff. Anchors Pegs	-0.00796	-0.00733	-0.00721
	(-7.51)***	(-6.90)***	(-6.69)***
USD Peg with IF	-0.00597	-0.00497	-0.00500
	(-6.34)***	(-5.24)***	(-5.11)***
NonUSD Peg with IF	-0.00387	-0.00361	-0.00294
	(-3.74)***	(-3.52)***	(-2.84)***
Both Managed Floats	-0.01020	-0.00959	-0.00946
	(-7.62)***	(-7.15)***	(-7.00)***
USD Peg with MF	-0.01486	-0.01430	-0.01416
	(-13.43)***	(-12.91)***	(-12.61)***
NonUSD Peg with MF	-0.00680	-0.00613	-0.00608
	(-6.08)***	(-5.45)***	(-5.33)***
MF with IF	-0.00445	-0.00377	-0.00373
	(-4.19)***	(-3.51)***	(-3.35)***
USD Dummy	-0.01507	-0.00759	-0.00791
	(-11.35)***	(-4.84)***	(-5.03)***
USD Peg×USD Dummy		-0.01636	-0.01609
		(-6.45)***	(-6.31)***
MF × USD Dummy		-0.00944	-0.00913
		(-2.90)***	(-2.80)***
Euro Dummy	-0.00728	-0.00727	-0.00631
	(-6.90)***	(-7.00)***	(-3.35)***
Euro Peg×Euro Dummy			-0.01855
			(-6.39)***
MF × Euro Dummy			0.00170
			(0.75)
Constant	-0.04746	-0.04773	-0.04797
	(-10.79)***	(-10.84)***	(-10.90)***
Obs.	3415	3415	3415
RMSE	0.0103	0.0103	0.0103
R^2	0.62	0.62	0.63
p-values of tests			
Joint Regimes	0.00	0.00	0.00
Both Same Anchor	0.95	0.91	0.94
MF with USD=NonUSD	0.00	0.00	0.00
Diff Anchors = Both MF	0.06	0.06	0.06

[1] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[2] The regime combination variables are defined as Equation 2.7 and 2.8.
[3] The Joint Regimes test represents the joint significance test for all regime combination variables.
[4] The Both Same Anchor test represents the test for Both USD Pegs = Both Same Non-USD Pegs.
[5] The MF with USD=NonUSD test represents the test for USD Peg with MF = NonUSD with MF
[6] The Diff Anchors = Both MF test represents the test for Diff. Anchors Pegs = Both Managed Floats
[7] See notes to Table 2-7.

floats may also benefit from the USD peg network. This can be inferred as well from the coefficient for the *MF with IF* variable, as it also lies between the *USD Peg with IF* and *NonUSD Peg with IF* variables.

Column 2 & 3 further examines the bilateral exchange rates particularly against USD and Euro relative to the other potential anchor currencies for managed floats. It can be seen that negative coefficients for both *USD* and *Euro* dummies are always significant, suggesting that all currencies may treat these two currencies as particular stabilising anchors relative to the others. Moreover, after controlling the pegs and managed floats (Column 3), one can show that the coefficients for the two dummies are statistically similar with the p-value 0.50, suggesting similar magnitude stabilisation effects against the anchors.

USD and Euro Pegs exhibit the lowest bilateral volatility against the two currencies as expected. It can be seen that except for the USD pegs, managed floats exhibit significantly lower bilateral volatility against USD than the others (non-USD pegs and USD-floats). However, when the bilateral rates are calculated against the Euro, managed floats behave insignificantly different from other non-pegs. These provide clear contrasts that managed floats tend to track USD. Intuitively, managed floats may then be considered as quasi-USD-pegs and hence contribute further to the effective size of the USD network.

2.3.4 Further Issues

2.3.4.1 Inflation and Peg Networks

There is some evidence that price-stabilising-oriented monetary policies may utilise the lower inflation of the anchor currency as domestic inflation anchor via pegging (*e.g.* Broda, 2006; Frankel, 2010a; Ball and Mazumder, 2011). Consequently, a positive correlation between exchange rate volatility with inflation is expected with the increasing rigidity of pegs. On the other hand, high inflation tends to undermine the credibility of a peg and may trigger occasional devaluations (Obstfeld and Rogoff, 1995b; Shambaugh, 2004; Frankel, 2005). This implies that the volatility stabilizing effects of a particular peg network could be offset by the inflation of the members.

To further investigate the latter effect, some interaction variables between the same-anchor-pegs and inflation are constructed. The variable capturing the same-anchor-pegs is defined as

$$Both\,Same\,Pegs_{ij} = Both\,USD\,Pegs_{ij} + Both\,Same\,NonUSD\,Pegs_{ij} \qquad (2.9)$$

If inflation undermines the peg network effects, a positive coefficient would be expected. Moreover, we utilise the double-fixed-effects variables (*i.e.* fixed effects respectively for currency i and j) to simplify the specifications as Lane and Milesi-Ferretti (2008). Hence all the regime and other control variables constructed as the bilateral average would be absorbed by the fixed-effects dummies. However, those variables that are specific to each currency pair will be retained including the *Both Same Pegs* and its interaction with inflation variables, *Cycle Asymmetry*, and *Trade* variables.

Table 2-13 presents the double-fixed-effects results under both the IMF and JS classifications. The left panel (Column 1-6) employs the nominal exchange rate volatility as the dependent variable as before. The right panel (Column 7-12) uses the real exchange rate volatility constructed similarly to the nominal volatility by Equation 2.2. The real exchange rate is calculated from the CPI-adjusted nominal bilateral rates against USD, taken the log-differenced form. The sample size becomes smaller as some countries are dropped due to the unavailability of monthly consumer price index data from the IMF IFS database.[41]

It can be seen that the coefficient on the *Cycle Asymmetry* variable is always significantly positive across the regressions but negative for the *Trade* variable. This yields similar implications as before that bilateral exchange rate volatility increases with idiosyncratic cycles while decreases with the trade dependence. The R^2 improves substantially as expected, since numerous fixed-effects dummies have entered the re-

[41] The network effects for bilateral real exchange rate volatility exhibit very similar patterns once the regressions employ the same specifications as in previous sections. Only the double fixed regression results are shown to avoid redundancy.

Table 2-13. Inflation and Peg Networks: Double Fixed Effect Regressions

	Nominal Exchange Rate Volatility						Real Exchange Rate Volatilty					
	IMF Classification			JS Classification			IMF Classification			JS Classification		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Trade	-0.04685	-0.04564	-0.04544	-0.04314	-0.04060	-0.04040	-0.04160	-0.04202	-0.04155	-0.04037	-0.04000	-0.03911
	(-4.66)***	(-4.20)***	(-4.30)***	(-4.29)***	(-3.68)***	(-3.71)***	(-4.42)***	(-4.45)***	(-4.40)***	(-4.34)***	(-4.33)***	(-4.20)***
Cycle Assymetry	0.05723	0.06096	0.06170	0.06276	0.06106	0.06094	0.06487	0.06642	0.06680	0.06803	0.06612	0.06665
	(4.02)***	(4.26)***	(4.40)***	(4.42)***	(4.29)***	(4.32)***	(3.93)***	(3.98)***	(4.00)***	(4.04)***	(3.95)***	(4.00)***
Both Same Pegs	-0.01015	-0.01455	-0.01466	-0.01284	-0.01793	-0.01973	-0.00881	-0.01206	-0.01215	-0.00908	-0.01445	-0.01713
	(-17.47)***	(-17.29)***	(-17.85)***	(-20.58)***	(-17.43)***	(-18.33)***	(-14.13)***	(-12.06)***	(-11.74)***	(-11.27)***	(-12.40)***	(-13.02)***
Inflation Average ×		0.00123	0.00046		0.00193	0.00113		0.00085	0.00045		0.00190	0.00103
Both Same Pegs		(7.73)***	(1.73)*		(6.84)***	(3.46)***		(3.30)***	(1.81)*		(6.71)***	(3.61)***
Inflation Differential ×			0.00064			0.00118			0.00035			0.00150
Both Same Pegs			(4.21)***			(5.09)***			(1.20)			(4.93)***
Obs.	3415	3415	3415	3415	3415	3415	2943	2943	2943	2943	2943	2943
RMSE	0.0044	0.0043	0.0043	0.0044	0.0043	0.0043	0.0047	0.0047	0.0047	0.0048	0.0047	0.0047
R^2	0.93	0.94	0.94	0.94	0.94	0.94	0.93	0.93	0.93	0.92	0.92	0.93

[1] Double fixed effect dummies for both currencies are included in the regressions.
[2] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[3] The *Both Same Pegs* variable is defined as Equation 2.9.
[4] See Notes to Table 2-7.

gressions. The results for real exchange rate volatility are very similar to the corresponding regressions using nominal rate volatility.

Column 1 shows the baseline result from the IMF classification. The significantly negative coefficient of the *Both Same Pegs* variable suggest that those pegging-to-the-same-anchor pairs on average have lower bilateral volatility than other regime combinations by about 0.01015. This magnitude is comparable to the previous results. Once the inflation variable is added in Column 2, the coefficient for the *Both Same Pegs* variable would imply the average stabilising effect with zero pair inflation. It is obvious that the negative coefficient -0.01455 in magnitude is larger than Column 1 and the coefficients for the interaction variable is significantly positive. This suggests that inflation tends to undermine the average network effects. One could calculated that the volatility stabilising effects can be completely offset if there is an 11.83(=0.01455/0.00123) percent annual average inflation for a currency pair within the same network.

A similar conclusion can be inferred under the JS classification as well. In Column 5, a slightly larger coefficient (-0.01793) than the IMF result is shown for the *Both Same Pegs* variable, indicating a larger network effects. On the other side, the interaction variables also appears to have larger positive coefficient (0.00193), implying a faster elimination speed of increasing inflations. One can hence calculate that the offsetting threshold is about 9.29% *p.a.* for a both-network-members pair.

The results in previous sections suggest that both the pair average and differentials of inflation tend to significantly enlarge the bilateral volatilities. Following the similar idea, Column 3 & 5 further enrich the specifications by introducing the interactions between the *Both Same Pegs* and *Inflation Differential* variables. It can be seen that the coefficient are significantly positive across most regressions, suggesting again that pairwise price stabilisation are strongly associated with exchange rate volatilities. Moreover, the positive coefficient of the interaction variable for average inflation still remain significant, suggesting similar implications discussed above.

2.3.4.2 Endogeneity Issues

A potential endogeneity concern on some of the economic structure variables are explored in this section. There are studies investigating whether exchange rate volatility discourages trade flows, though often with ambiguous results (*e.g.* Clark et al., 2004). Moreover, if the output is largely affected by volatility, our *Cycle Asymmetry* variable would then be potentially endogenous as well. One could expect that the overall results are less likely to change, since the large cross-country heterogeneities would be enough to dominate the second-order effects generated from each individual's potential endogenous influences. (*e.g.* **?**). Nevertheless, a series of instrument variables (including pair-averaged land area p.c., common language, common colony, landlockness, GDP size and its squared term, GDP p.c., and logarithmic bilateral distance and its squared term)[42] are employed to capture the potential endogeneity problems for the $Trade$ and *Cycle Asymmetry* variables, following existing literatures (Hau, 2002; Devereux and Lane, 2003; **?**).

Table 2-14 presents the two-stage least-square results[43] in a specification comparable to previous results. The regime variables in Column 1 & 2 are consistent with peg network regressions shown in Table 2-10 and those in Column 3 follow Table 2-12. It can be seen that those instrument regressions present stronger effects for bilateral trade and asymmetric cycles variables while they tend to have lower explanatory power in terms of lower R^2 and larger $RMSE$ than the previous results. The negative coefficients for $Dev\,and\,Ind$ and $Ind\,with\,Ind$ become smaller both in magnitude and significant levels.

It can be seen that the stylised network effects are the same as before. Those pairs with the same peg anchor tends to have the most stabilised bilateral exchange rate volatility. The USD network mainly benefits from its dominant size so that a

[42]The data source is from Andrew Rose's website: `http://faculty.haas.berkeley.edu/arose/RecRes.htm`.

[43]Some highly similar results can be found for the IV-GMM method following Devereux and Lane (2003). Also, other regressions using those more "exogenous" variables (such as Log-distance, common language and colonies, and landlockness) to directly replace the two variables are implemented following Bleaney and Francisco (2010) and yield similar conclusions.

Table 2-14. 2SLS Checks for Trade and Cycle Asymmetry

	IMF Class. (1)	JS Class. (2)		Managed Float (3)
Trade	-0.07914	-0.16316		-0.08343
	(-1.67)*	(-3.60)***		(-1.78)*
Cycle Asymmetry	0.64652	0.52140		0.63459
	(5.72)***	(4.99)***		(5.71)***
Land Area p.c.	0.00292	0.00274		0.00291
	(11.13)***	(10.62)***		(11.22)***
Size	0.00168	0.00168		0.00166
	(9.19)***	(10.30)***		(9.24)***
Inflation Average	0.00294	0.00324		0.00293
	(17.35)***	(16.64)***		(17.51)***
Inflation Differential	-0.00008	-0.00011		-0.00006
	(-0.38)	(-0.51)		(-0.30)
GDP p.c.	0.00429	0.00410		0.00428
	(11.92)***	(12.80)***		(12.04)***
Dev with Ind	-0.00126	-0.00036		-0.00160
	(-0.98)	(-0.32)		(-1.28)
Ind with Ind	-0.00517	-0.00555		-0.00420
	(-1.86)*	(-2.25)**		(-1.45)
Either Peg	0.00057	0.00639	Both USD Pegs	-0.01747
	(0.39)	(4.18)***		(-7.99)***
Either USD Peg	-0.00638	-0.00546	Both Same	-0.01623
	(-6.67)***	(-5.79)***	NonUSD Pegs	(-5.33)***
Both Pegs	0.00226	-0.00059	Diff. Anchors	-0.00168
	(1.69)*	(-0.38)	Pegs	(-0.70)
Both USD Pegs	-0.01533	-0.01593	USD Peg	-0.00330
	(-12.49)***	(-9.79)***	with IF	(-1.90)*
Both Same	-0.02026	-0.03029	NonUSD Peg	0.00060
NonUSD Pegs	(-8.59)***	(-9.35)***	with IF	(0.28)
Managed Floats	-0.00713		Both MF	-0.00590
	(-3.77)***			(-2.68)***
IMF Peg		-0.00705	USD Peg	-0.00963
in JS NonPeg		(-8.27)***	with MF	(-4.49)***
IMF MF		-0.00418	NonUSD Peg	-0.00051
in JS NonPeg		(-5.04)***	with MF	(-0.21)
			MF with IF	-0.00159
				(-0.80)
USD Dummy	-0.01485	-0.01126		-0.01463
	(-5.76)***	(-4.65)***		(-5.71)***
Euro Dummy	-0.00913	-0.00850		-0.00907
	(-6.06)***	(-6.48)***		(-6.18)***
Contant	-0.10409	-0.09994		-0.10384
	(-7.70)***	(-7.84)***		(-7.68)***
Obs.	3330	3330		3330
RMSE	0.0139	0.0128		0.0138
R^2	0.31	0.42		0.32
p-values of tests				
Joint Regime	0.00	0.00		0.00
USD = Same NonUSD	0.54	0.01		0.60

[1] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[2] Trade and Cycle Asymmetry are endogenous variables instrumented by land area p.c., logarithmic distance and its squared term, common language, common colony, bilateral averaged landlockness, GDP size and its squared term, and GDP p.c. as discussed in the text.
[3] Regime variables and additional tests in Column 1 & 2 are consistent with definitions of Table 2-10 and those in Column 3 follow Table 2-12.
[4] See notes to Table 2-7.

USD peg on average always tends to have lower volatility than a non-USD peg when they are matched with the other regimes. Managed floats behaves as members of the USD network. For those pairs with non-USD pegs and with different anchors, the instrument regressions suggest smaller peg network effects under the IMF classification so that the networks are not significantly stronger in stabilising bilateral volatilities than both-independent-float pairs. This contrasts the size effect of the USD network even sharper, as the tests still suggest quantitative indifference of the stabilising effects between both-USD-pegs pairs and both-same-non-USD-pegs pairs.

2.3.4.3 Basket Pegs and Exact Frequency Measures

There exist a few currencies with the experiences of basket pegging regimes (*e.g.* see a survey by Frankel, 1999), under which the anchors are more than one. This contradicts the assumption of the JS classification that only one potential anchor is targeted. Consequently, we utilise the information from the IMF classification to adjust the values of previous regime variables and create a new category for basket pegs. A summary of relevant economies in the sample is listed in Table 2-15. It can be seen that generally all of the basket pegs were classified as conventional pegs.

Table 2-15. Summary Statistics for Basket Pegs

IMF Code	Name	JS Anchor Currency	IMF BP Value	Previous Classification	Previous Peg Value
181	Malta	EUR	0.83	Peg	1
616	Botswana	ZAR	0.83	Peg	1
618	Burundi	USD	0.067	Peg	0.067
672	Libya	USD	1	Peg	1
686	Morocco	EUR	1	Peg	1
718	Seychelles	USD	0.6	Peg	1
819	Fiji	USD	1	Peg	1
846	Vanuatu	USD	1	Peg	1
862	Samoa	NZD	1	Peg	1

Column 1 of Table 2-16 presents the result after the adjustments for basket pegs. It can been seen that those new basket variables do not change the network effects as mentioned before. On the other hand, one can show that the bilateral exchange rate volatility for basket pegs behave differently from other regimes. The joint significant tests suggest that those pairs with basket pegs are associated with lower volatility than both-independent-floats. Moreover, the volatility stabilising effects tend to be similar for a basket peg matched with a USD peg relative to a Non-USD peg. Those pairs with both-basket-pegs on average exhibit smaller stabilising effects than both-same-anchor pegs. These are consistent with the expectations that different currencies may not share identical pegging anchors.

The regime variables used above are constructed mostly from the multiplication of the two frequency variables respectively for the pair of currencies. Although this measure is easy to calculate as it only requires the series independently from each individual, an implausible complication would emerge when currencies switch the regimes frequently. A "mismatch" problem would arise in the sense that the two currencies with both half of their times staying in pegs may not be necessarily pegging at the same time. To the extreme case, one of them can stay for the first half of the sample period while the other does the second half, implying that the multiplication of the two frequency variables over-estimates the tendency. Hence it is worth to check the robustness of using the pair-averaged frequency variables as a proxy for the exact regime pair frequencies.

Column 2 of Table 2-16 replicates the basket peg adjusted regressions with exact frequency variables. For each currency pair, a time panel of regime combination variables are created and then averaged so that each variable would indicate the exact proportion of quarters the pair of currencies spent in that combination relative to the whole sample period. For instance, if the $Both\, USD\, Pegs$ variables takes the value of 0.5, this means both the currencies are simultaneous USD pegs over half lengths of the sample period. The summary statistics suggest that all the correlations of the regime combination variables under the exact measure with the approximated ones are above 97%. This results in the facts that regressions using exact frequency measures are highly similar to those using approximated variables.[44]

[44] The exact measures for the previous specifications (*i.e.* those without distinguishing basket pegs) are constructed as well and all leads to highly similar results due to the consistently approximated values.

Table 2-16. Basket Pegs and Exact Frequency Measures

	Approximate Frequency (1)	Exact Frequency (2)
Land Area p.c.	0.00330	0.00331
	(17.44)***	(17.46)***
Trade	-0.01604	-0.01583
	(-1.73)*	(-1.71)*
Cycle Asymmetry	0.19122	0.19109
	(19.27)***	(19.27)***
Size	0.00105	0.00105
	(12.65)***	(12.61)***
Inflation Average	0.00272	0.00272
	(25.56)***	(25.48)***
Inflation Differential	0.00070	0.00071
	(9.89)***	(9.93)***
GDP p.c.	0.00406	0.00405
	(16.21)***	(16.20)***
Dev with Ind	-0.00576	-0.00575
	(-9.49)***	(-9.46)***
Ind with Ind	-0.01499	-0.01505
	(-11.58)***	(-11.64)***
Both USD Pegs	-0.02434	-0.02429
	(-18.76)***	(-18.73)***
Both Same NonUSD Pegs	-0.02333	-0.02331
	(-12.68)***	(-12.81)***
Diff. Anchors Pegs	-0.00580	-0.00581
	(-5.05)***	(-5.08)***
USD Peg with IF	-0.00486	-0.00497
	(-5.01)***	(-5.19)***
NonUSD Peg with IF	-0.00262	-0.00262
	(-2.34)**	(-2.37)**
Both Managed Floats	-0.00960	-0.00938
	(-7.15)***	(-6.99)***
USD Peg with MF	-0.01477	-0.01499
	(-13.01)***	(-13.35)***
NonUSD Peg with MF	-0.00541	-0.00566
	(-4.51)***	(-4.76)***
MF with IF	-0.00381	-0.00395
	(-3.54)***	(-3.77)***
Both Basket Pegs	-0.01363	-0.01354
	(-6.88)***	(-6.80)***
USD Peg with BP	-0.00895	-0.00901
	(-7.06)***	(-7.13)***
NonUSD Peg with BP	-0.01048	-0.01053
	(-6.91)***	(-7.01)***
MF with BP	-0.00814	-0.00832
	(-6.03)***	(-6.23)***
IF with BP	-0.00475	-0.00484
	(-3.99)***	(-4.12)***
USD Dummy	-0.00768	-0.00773
	(-4.54)***	(-4.56)***
USD Peg ×	-0.01859	-0.01852
USD Dummy	(-7.13)***	(-7.10)***
Managed Float ×	-0.00965	-0.00955
USD Dummy	(-2.88)***	(-2.85)***
Basket Peg ×	-0.00275	-0.00270
USD Dummy	(-1.17)	(-1.15)
Duro Dummy	-0.00747	-0.00746
	(-7.13)***	(-7.11)***
Constant	-0.05252	-0.05221
	(-11.65)***	(-11.59)***
Obs.	3415	3415
RMSE	0.0102	0.0102
R^2	0.63	0.63
p-values of tests		
Joint Regimes	0.00	0.00
Joint BP	0.00	0.00
USD = NonUSD	0.58	0.59
BP with USD = NonUSD	0.29	0.29
IF with BP = MF	0.37	0.39

[1] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[2] The regime combination variables for Approximated Frequency (Column 1) are consistent with previous regressions (defined as Equation 2.7 and 2.8).
[3] Exact frequency variables are calculated by accounting the exact fraction of times staying in the corresponding regime combinations throughout the sample period.
[4] The Joint BP test represents the joint significant test for all regime variable related to basket pegs
[5] The BP with USD = NonUSD represents the test for USD Peg with BP = NonUSD Peg with BP
[6] The IF with BP = MF test represents the test for BP with IF = MF with IF.
[5] See notes to Table 2-7 and 2-12.

2.4 Peg Networks and Multilateral Exchange Rate Volatilities

The results from previous sections suggest significant currency network effects in reducing bilateral exchange rate volatility within pairs of currencies. Given other conditions the same, the larger is the network size, the more benefits will be spilled over among the network members. This leads to an immediate expectation that any economy has incentives to join in the largest currency network to obtain the minimal multilateral exchange rate volatility, since it is more likely to be matched with the same network member. It is straight forward that a *de facto* independently floating currency would show little intention of stabilising (some of) its multilateral volatilities. However, a Non-USD peg, basket peg, or managed float would not necessarily have greater multilateral volatility than a USD peg network member, since there could be the rationale to shed particular attentions on the volatilities against one or more mainly-interacted economies.

Accordingly, if one constructs a currency's multilateral exchange rate as the arithmetic average of its all bilateral rates, the multilateral volatility will be negatively correlated with the size of the currency network. However, if an economy has a particular concern on its cross-boarder interactions with some of the major partners, the peg network size effect would become insignificant by using alternative weightings of calculating the multilateral exchange rate measure. An intuitive criterion would be trade-oriented currency stabilisation (*e.g.* Meissner and Oomes, 2009), so that some small currency networks may exist because of the particularly large trade between the members.

2.4.1 Empirical Methodologies

Following similar specifications as previous sections, the cross-sectional regressions for multilateral volatility measures would include the regime variables and some control variables similarly as Equation 2.1.[45] Each observation represents an individual currency and all the volatility measures are taken in the logarithmic form. The control variables include the period average of Inflation, logarithmic GDP size, logarithmic trade-weighted distance[46] and a dummy for Industrial economies.

Two types of multilateral exchange rate measures are constructed, with the volatility is defined as the standard deviation of the two log-differenced measures.[47] The first type is constructed as the arithmetic average across the log-differenced bilateral exchange rates.

$$\ln VLT_i^{Arithmetic} = \ln STDEV\left(\sum_{j\in N_i} \frac{1}{N_i} d\ln BiEXR_{ij}\right) \tag{2.10}$$

, where $STDEV$ stands for standard deviation; N_i represents the number of partner currencies j in the i' basket, and $BiEXR_{ij}$ is the price of currency j per unit of i. Since all the partner currencies j have identical weighting, it is expected that the peg network effect would be significant for this measure. Specifically, if the $USD\,Peg$ variable are employed to contrast with Non-USD pegs and other regimes, a negative coefficient would be expected.

The second type is defined as the trade-weighted average of the log-differenced bilateral exchange rates.

$$\begin{gathered} \ln VLT_i^{Trade} = \ln STDEV\left(\sum_j w_{ij}^{2002} d\ln BiEXR_{ij}\right) \\ \text{where } w_{ij}^{2002} = \frac{Trade_{ij}^{2002}}{\sum_{j\in N_i} Trade_{ij}^{2002}} \end{gathered} \tag{2.11}$$

This definition proxies the standard deviation of log-differenced nominal effective exchange rate (NEER) index. The bilateral trade (imports plus exports) weightings for

[45]See Section 2.3.1 on Page 32

[46]The bilateral trade uses the observations in the year 2002 as the trade-weighted exchange rate, and the bilateral distance employs the CEPII's distances measure (`http://www.cepii.fr`).

[47]Technically, some base-year level (*e.g.* in this case is 2002M12) of the bilateral exchange rates would be needed to be normalised upon but will be offset in the differenced form.

currency i with its partner j is constructed as the proportion of trade between i and j relative to i's total trade with the world in the year of 2002. Due to the consistency of trading baskets, if a partner j for currency i has any missing observations for the bilateral trade or exchange rate throughout the sample period, it will be dropped from i's basket. If the total number of i's missing partners is greater than a quarter of the total countries of the dataset,[48] the multilateral exchange rate index of currency i would be set missing.

Since the IFS database provides NEER series, the third volatility measure is then constructed from this index as a comparable reference

$$\ln VLT_i^{IMF} = \ln STDEV\left(d \ln NEER_j^{IMF}\right) \tag{2.12}$$

. Generally, this measure is expected to cover a smaller sample of currencies and may use alternative measures to calculate the NEER index.[49]

Table 2-17 presents the summary statistics for the three multilateral exchange rate volatility measures. It can be seen that the arithmetic-averaged index generally exhibits greater volatility than trade-weighted measures. This may indicate that trade-oriented currency stabilising attracts greater attention than simple network spill-overs.[50] Similarly to the case of bilateral exchange rate volatility, the Industrial economies tend to have lower multilateral volatility than the world average, and the cross-country difference of volatility level among them are also less than among developing economies. Higher inflation tends to be associated with larger volatility particularly for developing economies. The sample size for the IFS NEER series is smaller than the trade-weighted indices as expected but roughly exhibit similar patterns relative to the arithmetic-averaged index.

[48]There is no significant difference of choosing the missing number of trade partners as half or a quarter. See also discussions on Section 3.6.1.

[49]For instance, the index utilises period-average exchange rate data for a selected basket of partners and is published under the country's approval. See the IMF's introduction http://www.esds.ac.uk/international/support/user_guides/imf/Introduction.pdf.

[50]The number of currencies covered by the two calculated indices is slightly more than the bilateral sample, because some incomplete bilateral trade data have been allowed missing in the multilateral basket.

Table 2-17. Descriptive Statistics for Nominal Multilateral Exchange Rate Volatilities

	Industrial Economies			World			
	Obs	Mean	Stdev	Obs	Mean	Stdev	
$VLT_i^{Arithmetic}$	12	0.0210	0.0050	97	0.0216	0.0136	Exclude
VLT_i^{Trade}	12	0.0172	0.0057	97	0.0200	0.0149	High
VLT_i^{IMF}	12	0.0146	0.0051	56	0.0176	0.0110	Inflation
$VLT_i^{Arithmetic}$	12	0.0210	0.0050	106	0.0269	0.0357	Include
VLT_i^{Trade}	12	0.0172	0.0057	106	0.0257	0.0367	High
VLT_i^{IMF}	12	0.0146	0.0051	60	0.0185	0.0116	Inflation

The regime variables follow the same definition as in previous sections, representing the proportion of time staying in a certain regime relative to the sample period length. Table 2-18 provides the summary statistics under the IMF and JS classifications. Similarly as before, the IMF classification allows more pegs than the JS method and there this no Industrial currencies as USD pegs in the latter scheme. It can be seen that over 67% of pegs are recognised as USD network members. Pegs tend to exhibit lower multilateral volatility for all measures particularly under the JS classification. USD pegs tends to have lower volatility than other pegs only for the arithmetic-weighted measure. Managed floats and independent floats on average tend to show greater volatilities for all multilateral exchange rate measures.

Table 2-18. Descriptive Statistics for Regime Variables

	Obs. of Positive Values	Mean of Positive Values	Corresponding Arithmetic Volatility	Corresponding Trade Weighed Volatility	Corresponding IFS NEER Volatility	Obs. in IFS NEER
IMF Peg	58	0.6977	0.0176	0.0146	0.0124	33
IMF USD Peg	40	0.6642	0.0174	0.0166	0.0139	22
IMF MF	46	0.6428	0.0230	0.0227	0.0206	23
IMF IF	39	0.6915	0.0261	0.0252	0.0218	24
JS Peg	40	0.7583	0.0146	0.0116	0.0094	19
JS USD Peg	27	0.7531	0.0132	0.0124	0.0100	11
JS NonPeg	77	0.8658	0.0248	0.0239	0.0206	46

2.4.2 Baseline Results

Table 2-19 presents the baseline results for multilateral exchange rate volatility under the IMF classification. Together with the control variables, three regime variables are added to contrast the USD peg network, managed floats, and independent floats, with the omitting reference group as the non-USD pegs. The dependent variables are the alternative volatility measures in the logarithmic form.

It can be seen that the coefficients for the control variables generally exhibit the expected signs. Specifically, the *Land Area p.c.* variable, used as the proxy for cross-country heterogeneity of terms-of-trade volatility, shows significantly positive coefficients across all the regressions. This is consistent with many empirical studies on multilateral exchange rate variations that is positively associated with terms-of-trade shocks particularly for developing economies (*e.g.* Broda, 2004; Hausmann et al., 2006). Hence the richer is an economy's primary resources than the others, the larger proportion of its exchange rates are exposed to volatile terms-of-trade shocks. The coefficient for the Industrial currency dummy is significantly negative, indicating lower exchange rate volatilities for richer economies. On the other hand, the coefficients for the GDP size is insignificantly positive for most cases except the last column. This indicates the positive correlation of larger exchange rate variations with larger internal trade between nontradable and tradable sectors suggested by literatures (Hau, 2002; Bergin et al., 2006).

The insignificant coefficient for the *Trade Weighted Distance* variable is positive (though insignificant) in the regressions for trade-weighted volatilities, suggesting a positive correlation of exchange rate volatility with trade "remoteness" as expected by literatures (*e.g.* Bravo-Ortega and di Giovanni, 2005a). However, the coefficients are insignificantly negative for the regressions on the arithmetic-averaged volatility measure. This suggests that the volatility-stabilising effects from the peg network tends to be stronger when the natural conditions of the trade-oriented stabilising concern are weakened. The *Inflation Average* variable exhibits significantly positive coefficients across the regressions, suggesting that various currency-stabilising objects can be undermined by high inflation scenarios, suggested by literatures (*e.g.* Bleaney and Francisco, 2010).

It can be been that the coefficient for the *USD Peg* variable is significantly negative when the multilateral rate is measured as the arithmetic average (Column 1 & 4). This is consistent with the results in the previous sections that the USD pegs that form the largest peg network tend to have the lowest volatilities than the non-USD

Table 2-19. Multilateral Exchange Rate Volatilities: IMF Baseline Results

	Exclude High Inflation			Include High Inflation		
	Arithmetic Average (1)	Trade Weighted (2)	IFS NEER (3)	Arithmetic Average (4)	Trade Weighted (5)	IFS NEER (6)
USD Peg	-0.35768	-0.03524	0.00440	-0.27683	0.07791	0.03395
	(-2.41)**	(-0.18)	(0.02)	(-1.98)*	(0.41)	(0.18)
Managed Float	-0.08969	0.42038	0.33435	0.13638	0.67897	0.37762
	(-0.63)	(2.67)***	(1.96)*	(1.04)	(4.37)***	(2.09)**
Independent Float	0.27434	0.79009	0.91822	0.48233	1.04667	0.98977
	(1.97)*	(5.27)***	(5.75)***	(3.15)***	(6.14)***	(5.70)***
Land Area p.c.	0.09207	0.13645	0.08340	0.10407	0.14746	0.06400
	(2.27)**	(2.90)***	(2.78)***	(2.75)***	(3.45)***	(1.94)*
GDP	0.04098	0.06059	0.01729	0.00737	0.02271	-0.01074
	(1.60)	(1.88)*	(0.62)	(0.27)	(0.70)	(-0.32)
Inflation Average	0.04994	0.05347	0.05980	0.01160	0.01221	0.04480
	(3.42)***	(3.25)***	(5.05)***	(9.40)***	(8.82)***	(3.73)***
Trade-Weighed	-0.02924	0.03338	0.10675	-0.03284	0.01397	0.11026
Distance	(-0.47)	(0.51)	(1.52)	(-0.55)	(0.21)	(1.57)
Ind Dummy	-0.27008	-0.51223	-0.51944	-0.37207	-0.63230	-0.47922
	(-1.82)*	(-3.18)***	(-3.42)***	(-2.45)**	(-3.88)***	(-3.04)***
Constant	-4.50623	-5.84534	-5.76113	-3.53625	-4.65271	-5.17684
	(-5.31)***	(-6.30)***	(-6.03)***	(-4.56)***	(-5.40)***	(-4.89)***
Obs.	97	97	56	106	106	60
RMSE	0.3919	0.4919	0.3273	0.4420	0.5355	0.3669
R^2	0.47	0.52	0.73	0.55	0.57	0.68
p-values of tests						
Join Regime	0.00	0.00	0.00	0.00	0.00	0.00

[1] The dependent variables are nominal multilateral exchange rate volatility measures (defined in Equation 2.10, 2.11, and 2.12), taken in the logarithmic form.
[2] High-inflation is defined as >40% in any year during the sample period.
[3] The Joint Regimes test represents the joint significance test for all regime variables.
[4] See notes to Table 2-7

pegs, and the network effect is weakened when high-inflation experiences are included. However, the coefficient becomes insignificant when the multilateral rate is measured as trade-weighted averages (Column 2,3,5, & 6). This suggests that when the currency-stabilising objectives is trade-oriented, the larger USD peg group exhibits no significant network effects than the other smaller non-USD peg groups.

Managed floats have been shown to particularly track USD rates so that the bilateral volatility-stabilising effects lie between the USD and other currency networks. In Column 1, the coefficient is insignificant for the arithmetic multilateral volatility measure. This suggests an insignificantly larger currency-stabilising effect than non-USD pegs when all the bilateral rates of a managed float is evaluated simultaneously.[51]

[51] Strictly, there is a subtle difference between the average of all bilateral volatilities ($\sum_{j \in N_i} \frac{1}{N_i} STDEV(d \ln BiEXR_{ij})$) and the volatility of averaged bilateral rates (Equation 2.10) if the bilateral shocks are not independent of each other, since the former measure evaluates all the bilateral fluctuations *jointly* for each instant of time. Nevertheless, the results using the latter measure are very similar to the former and hence are omitted. Similar cases apply for the trade-weighted measures as well and hence the interpretations between the weighted volatility and the volatility of weighted rates are not distinguished in the text.

The coefficient in Column 4 is also insignificant but becomes positive, suggesting again that the network effects is undermined by inflation. Once the multilateral rate is measured as the trade-weighted average (Column 2, 3, 5, & 6), the coefficient is always significantly positive, indicating larger volatility than pegs.

The coefficient for independent floats is always significantly positive and the magnitude becomes larger when the trade-weighted average multilateral rate is used. This is consistent with the expectation that *de facto* floats would not have particular intentions of stabilising exchange rates against one or more anchors and hence exhibit larger volatilities under some of alternative weighting schemes than pegs.

Table 2-20 presents the stylised results under the JS classification. It can be seen that the general performance of the regressions are very similar to the results under the IMF classification in terms of the R^2 and standard deviations. Two regime varaibles *USD Peg* and *NonPeg* are added into the regressions so that the reference category is JS non-USD pegs. Some additional variables are further introduced (Column 2, 4 , & 6) for further comparisons as in the bilateral results. The coefficients for the control variables such as *Land Area p.c.*, *Ind Dummy* and *Inflation Average* only exhibit second-order changes. The positive coefficient for the *GDP* variable become slightly more significant while the trade remoteness measure tends to be still insignificant.

Similar results for the network effects can be concluded as well under the JS classification. USD pegs only exhibit significantly additional volatility-stabilising effects than non-USD pegs when all the bilateral volatilities are equally weighted (Column 1 & 2). For trade-weighted measures, there is insignificant difference between different peg networks (Column 4-6). For the JS non-pegs, the coefficient tends to be always positive, and it becomes significant for trade-weighted measures. This suggests that non-pegs generally have larger multilateral exchange rate volatility under the JS classification as well.

As discussed in the bilateral results, pegs under the JS classification is generally more tight than the IMF classification. It can be seen from Column 2, 4, & 6 that the coefficients for the two additional variables are all negative, suggesting that the among

Table 2-20. Multilateral Exchange Rate Volatilities: JS Baseline Results

	Arithmetic Average		Trade-Weighted		IFS NEER	
	(1)	(2)	(3)	(4)	(5)	(6)
USD Peg	-0.52601	-0.51330	-0.15638	-0.13968	0.17209	0.05373
	(-4.08)***	(-3.98)***	(-0.89)	(-0.78)	(0.86)	(0.27)
NonPeg	0.04623	0.24417	0.49180	0.76542	0.69244	0.96269
	(0.29)	(1.53)	(2.72)***	(4.50)***	(4.77)***	(6.02)***
IMF Peg in		-0.36788		-0.61697		-0.87589
JS NonPeg		(-1.57)		(-2.02)**		(-3.50)***
IMF MF in		-0.26324		-0.27835		-0.56811
JS NonPeg		(-2.08)**		(-2.08)**		(-3.89)***
Land Area p.c.	0.09172	0.08782	0.13677	0.13798	0.08342	0.08343
	(2.58)**	(2.37)**	(3.50)***	(3.14)***	(2.45)**	(2.85)***
GDP	0.05164	0.04442	0.07649	0.06429	0.02014	0.01600
	(2.15)**	(1.81)*	(2.43)**	(2.07)**	(0.66)	(0.59)
Inflation Average	0.04438	0.04511	0.05244	0.05083	0.05345	0.05849
	(3.23)***	(3.08)***	(3.40)***	(3.02)***	(5.02)***	(5.54)***
Trade Weithed	0.01850	-0.00981	0.10595	0.06184	0.17579	0.09246
Distance	(0.32)	(-0.18)	(1.42)	(0.93)	(2.13)**	(1.27)
Ind Dummy	-0.13001	-0.27319	-0.30138	-0.50179	-0.12832	-0.48973
	(-0.85)	(-1.92)*	(-1.93)*	(-3.28)***	(-0.85)	(-3.26)***
Constant	-5.11936	-4.72606	-6.81647	-6.14078	-6.59140	-5.65100
	(-6.28)***	(-5.96)***	(-7.33)***	(-6.96)***	(-6.63)***	(-5.73)***
Obs.	97	97	97	97	56	56
RMSE	0.3844	0.3774	0.5014	0.4839	0.3871	0.3283
R2	0.49	0.52	0.50	0.54	0.62	0.74
p-values of tests						
Join Regime	0.00	0.00	0.00	0.00	0.00	0.00
IMF Peg = NonPeg		0.65		0.67		0.75
IMF MF = NonPeg		0.91		0.01		0.04

[1] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[2] The Joint Regimes test represents the joint significance test for all regime variables.
[3] The IMF Peg = NonPeg test represents the test IMF Peg in JS NonPeg + NonPeg = 0.
[4] The MF = NonPeg test represents the test IMF MF in JS NonPeg + NonPeg = 0.
[5] See notes to Table 2-19.

the JS non-pegs, those currencies classified as IMF pegs and managed floats generally have smaller multilateral volatility than the rest non-pegs. Particularly under the trade-weighted measures, the coefficient for the *IMF peg in JS nonPeg* variable becomes highly significant and larger in magnitude than the regression for the arithmetic measure. One can calculate that those IMF pegs exhibit statistically similar volatility-stabilising effects as the reference group (JS non-USD pegs) across the regressions.[52] On the other hand, those IMF managed floats in the JS non-pegs category on average exhibits the volatility-stabilising effects still larger than pegs.[53]

[52] *e.g.* in Column 4, the sum of the coefficients for the *NonPeg* (0.76542) and *IMF peg in JS nonPeg* (-0.61697) variables is statistically indifferent from zero (0.014845) at the p-value 0.67.

[53] *e.g.* in Column 4, the sum of the coefficients (0.76542-0.27835 = 0.48707) is statistically different from zero at the p-value 0.01.

2.4.3 Peg Network Size

The results in the previous section suggests that USD pegs tend to have larger volatility-stabilising effects than other pegs when the multilateral exchange rate is measured as the arithmetic average of bilateral ones. This could result either from the larger peg network size (as suggested by the bilateral results) or hard pegging that all the same network members within the basket simultaneously have smaller bilateral variations. To further confirm the former effects, an effective peg network variable is constructed as follows:

$$\mathit{Effective\,Peg\,Network}_i = Peg_i^{Anchor} \times \left(\sum_{j \in N_i} \mathbf{1}\{Peg_{j,2002}^{Anchor=1}\} - 2 \right) \tag{2.13}$$

, where Peg_i^{Anchor} is the proportion of time currency i staying as a peg to the currency $Anchor$; N_i is the number of i's partner currencies; the indicator function $\mathbf{1}\{Peg_{j,2002}^{Anchor} = 1\}$ takes the value of one if currency i's partner j is in the same peg network in the year of 2002 and hence the sum of j calculates the total size of network. This peg network size is subtracted by two so that the network only contains the pair of peg and anchor are will be assumed to have zero effective network effects. Intuitively, the larger value is the variable, the longer time the currency i tends to stay in a larger peg network. Hence a negative coefficient would be expected for the regressions under the arithmetic volatility measure.

Table 2-21 presents the results for the peg network effects for alternative multilateral exchange rate volatility measures. It can be seen that the coefficient for the *Effective Peg Network* variable is significantly negative for the arithmetic measure results under both the IMF and JS classifications (Column 1 & 4). This confirms the network effects that larger effective peg network size is associated with greater volatility-stabilising effects when the bilateral rates are equally weighted. However, when the trade-weighted multilateral measures are used in the rest columns, the coefficient looses significance entirely. Those non-peg regime variables exhibits positive coefficients particularly for trade-weighted measures, similarly as before.

Table 2-21. Peg Networks and Multilateral Exchange Rate Volatilities

	IMF Classification			JS Classification		
	Arithmetic Average (1)	Trade Weighted (2)	IFS NEER (3)	Arithmetic Average (4)	Trade Weighted (5)	IFS NEER (6)
Effective Peg	-0.00975	-0.00113	0.00014	-0.01383	-0.00409	0.00168
Network	(-1.99)**	(-0.20)	(0.02)	(-2.86)***	(-0.82)	(0.27)
Managed Float	-0.19430	0.40380	0.33648			
	(-0.97)	(2.03)**	(1.48)			
Independent Float	0.17119	0.77356	0.92035			
	(0.87)	(4.02)***	(4.08)***			
NonPeg				0.13433	0.72423	0.98284
				(0.60)	(3.64)***	(4.56)***
IMF MF in				-0.36797	-0.61670	-0.87589
JS NonPeg				(-1.57)	(-2.02)**	(-3.50)***
IMF IF in				-0.26517	-0.27859	-0.56811
JS Nonpeg				(-2.09)**	(-2.08)**	(-3.89)***
Land Area p.c.	0.09132	0.13645	0.08340	0.08763	0.13790	0.08343
	(2.25)**	(2.90)***	(2.78)***	(2.37)**	(3.13)***	(2.85)***
GDP	0.04069	0.06066	0.01729	0.04366	0.06431	0.01600
	(1.58)	(1.88)*	(0.62)	(1.77)*	(2.07)**	(0.59)
Inflation Average	0.05005	0.05350	0.05980	0.04520	0.05091	0.05849
	(3.44)***	(3.24)***	(5.05)***	(3.09)***	(3.02)***	(5.54)***
Trade-Weighted	-0.04100	0.03315	0.10675	-0.02197	0.06010	0.09246
Disntance	(-0.66)	(0.52)	(1.52)	(-0.40)	(0.93)	(1.27)
Ind Dummy	-0.26534	-0.51226	-0.51944	-0.26576	-0.50081	-0.48973
	(-1.76)*	(-3.17)***	(-3.42)***	(-1.84)*	(-3.27)***	(-3.26)***
Constant	-4.30153	-5.82879	-5.76326	-4.49748	-6.08646	-5.67115
	(-5.27)***	(-6.52)***	(-6.21)***	(-5.78)***	(-7.02)***	(-5.91)***
Obs.	97	97	56	97	97	56
RMSE	0.3942	0.4919	0.3273	0.3801	0.4839	0.3283
R^2	0.47	0.52	0.73	0.51	0.54	0.74
p-values of tests						
Join Regimes	0.00	0.00	0.00	0.00	0.00	0.00

[1] Currencies with ever high-inflation (>40% p.a.) during the sample period are excluded.
[2] The Joint Regimes test represents the joint significance test for all regime variables.
[3] See notes to Table 2-19.

It is worth noting that the insignificance of the effective peg network size for the trade-weighted measures does not necessarily imply the absence of network effects. Rather, the results in Table 2-21 suggest that the choice of anchor currency and hence the network may dependent on several competing rationales. On the one hand, a currency pegging to the anchor with more peripheries is more likely to be matched with the same network member and hence benefit lower bilateral volatility (*i.e.* pure network effect). On the other hand, if the anchor currency is dominantly demanded by a smaller group of minor economies for some specific reasons, such as the intra-regional trade, then a smaller network would be preferred. This matches the observations that the trade remoteness measure exhibits negative coefficients for the arithmetic average regressions (Column 1 & 4), suggesting the substitution effects between trade- and size-orientations. Nevertheless, the coefficient is insignificant.

Another intuitive evidence can be shown for the two prevailing networks of USD and Euro. Taking the year of 2002 for instance, the sum of the bilateral trade values with the Euro zone for all the Euro pegs is about 8.08 times as large as the USD pegs. Conversely, the sum of all the bilateral trade with the US for all the USD pegs is only about 1.16 times of the Euro pegs. This suggests the disincentives for those Euro pegs to choose the larger USD network. One may not attribute the entire trade value discrepancy to simple regime effects. Table 2-22 in Appendix (page 75) provides stylised cross-country regressions for the log-ratio of bilateral trade with US relative to Euro Zone by including some prevailing explanatory variables in the gravity-type models. It can be seen that the tendency mentioned above are consistent with the larger negative coefficients for Euro pegs.

2.5 Conclusion

Using bilateral exchange rate volatilities covering 88 currencies over 1999M1-2006M12, this chapter has examined currency network effects across various regime combinations and anchors, with a series of structural variables using as controls. When two currencies are simultaneously stabilising against the same anchor currency, they can inherit lower bilateral exchange rate volatilities than other pairs that are not belonging to the same currency network.

Relative to the both-free-floating pairs, USD pegs *ceteris paribus* exhibit the lowest volatility against the rest world while other currency peg networks on average exhibit smaller magnitude of the volatility-stabilising effect. When the regime combinations are further contrasting the-same-anchor pegs with different-anchors pegs, the volatility-stabilising effect for the latter group vanishes. This suggests that the externality benefits from pegs are entirely through the network effects. Moreover, by comparing among the-same-anchor pegs, there tends to be insignificantly different magnitudes of the volatility-stabilising effects across different anchors. This suggests that the effects of peg is common to most currency anchors and hence the overall effects will be determined by the network size.

Managed floats have been shown to track the US dollar. Specifically, managed floats are associated with significantly lower bilateral exchange rate volatilities against USD pegs than non-USD pegs. Moreover, their bilateral volatilities against USD is also *ceteris paribus* lower than against EUR. These suggest that by implicitly controlling the bilateral exchange rate against the USD, a managed float can benefit lower volatilities from the most popular currency network. Since managed floats behave similarly to a quasi-USD-peg, the effective size of the USD network is enlarged. In addition, this USD-tracking behaviour may indicate channels of the "fear of floating" concerns *à la* Calvo and Reinhart (2002).

The results for bilateral exchange rate volatility suggest that the currency network effect significantly benefits from the size, assuming that all pairs of currencies are randomly matched. However, choice of anchors may not necessarily collapse to the unique equilibrium where all the pegged currencies have the same anchor. A peg could minimise the opportunity costs of smoothing *some* weighted bilateral exchange rates jointly. By comparing the trade-weighted with the arithmetic-weighted multilateral exchange rate volatilities, the network size effect tends to be only significant under the latter measure. This result is consistent with the literatures that pegs tend to choose the anchors that have the largest intra-network trade (**?**Meissner and Oomes, 2009).

The currency networks may indicate the rarity of basket pegs as in practice. A peg to a single anchor is more transparent and easier to conduct than an a weighted basket that may need careful design. Joining in a large network would directly benefit from the volatility-stabilising effect for a large number of potential trading partners while specific weightings may compromise asymmetric fluctuations from different currency networks. Thus single-currency peg may be a better choice if a weighted-basket is the *ceteris paribus* alternative. Moreover, one could assume a similar scenario where the international currency system would either result in a dominant currency network or a number of similar basket pegs. Thus the US dollar, which served as the global reserve and anchor currency from the Bretton-Woods, can be the path-dependent equilibrium that is observed today. As the reserve and private investment portfolios become more and more diversified, a declining position of the US dollar will be expected but its largest network effects may provide extra force for surviving (*e.g.* Jeanne, 2012).

If a peg suffers substantial inflation differentials relative to its anchor, it is under the pressure of parity adjustments. The results confirm that inflation significantly undermine the network effects across currency pairs. A 10% pair-average annual inflation rate would entirely offset the largest network effects, particularly if the pair of currencies have equal inflation rates.

Moreover, structural variables exhibit significant explanatory power. The results for the OCA variables are generally consistent with the literatures. The bilateral trade openness ratio is negatively correlated with exchange rate volatility, while the asymmetric shocks and economy size of the economy pair have positive correlations. Lower land area *p.c.* indicating less specialisation in natural resources trade tends to be associated with smaller exchange rate volatility. Among different economy groups, the Industrial economies generally reveal intrinsic lower nominal bilateral exchange rate volatility than developing economies. Currencies of developing economies exhibit lower volatility for the bilateral exchange rate against industrial currencies. Generally, all currencies have significantly lower volatilities against major anchor currencies particularly for the US dollar and Euro. These in all suggest that solid monetary policy may help stabilising volatilities while shocks in fundamentals still influence the exchange rate fluctuations as expected.

2.6 Appendix

Table 2-22. Cross-Country Comparison of Bilateral Trade with US relative Euro Zone

	(1)	(2)	(3)	(4)	(5)
USD Peg	0.66292	0.2118	0.58817	0.10102	0.12088
	-1.45	-0.82	-1.24	-0.39	-0.47
EURO Peg	-1.9954	-0.3725	-2.1072	-0.5091	-0.3921
	(-6.98)***	(-1.20)	(-6.91)***	(-1.81)*	(-1.50)
Distance		-1.2696		-1.2857	-1.3699
		(-15.57)***		(-16.02)***	(-12.36)***
Common Border					0.00054
					0
Common Language					0.02753
					-0.08
Ever Colony					0.38735
					-1.09
GDPpc			0.12346	0.17351	0.1568
			-1.38	(3.39)***	(2.67)***
Constant	-0.5558	0.16363	-1.4963	-1.149	-0.8803
	(-2.64)***	-1.4	(-2.29)**	(-2.77)***	(-1.82)*
Obs.	92	92	92	92	92
RMSE	1.4765	0.8474	1.4735	0.8121	0.8082
R^2	0.21	0.74	0.22	0.77	0.78
p-values of tests					
USD = Euro	0.00	0.15	0.00	0.11	0.16

[1] Regressions aim to contrast stylised patterns of bilateral trade for USD and Euro pegs mentioned on page 72.
[2] Sample includes those currencies appearing in 2-21.
[2] The dependent variable is $\ln\left(Trade^i_{US}\middle/Trade^i_{Euro\ Zone}\right)$ for each currency i.
[3] Distance is $\ln\left(Distance^i_{US}\middle/Distance^i_{Euro\ Zone}\right)$ where distance to Euro Zone is trade-weighted.
[4] Common Border, Common Language, Ever Colony are the difference of the bilateral dummies with US and with Euro Zone, where the dummy for Euro Zone will take the value of one if currency i meets the condition with any member in the Euro Zone. Trade agreements with US and with Euro Zone, and other possible triangular characteristics may differ across host countries, which have not been captured.
[5] The USD = Euro test represents the test for $USD\,Peg = EURO\,Peg$.

CHAPTER 3

Trade Balance and Exchange Rate Fluctuations

3.1 Introduction

The response of an economy's trade balance to its currency depreciation is traditionally believed to follow a J-curve, i.e. domestic currency depreciation will initially result in an immediate deterioration in the trade balance due to the larger import expenditure than the revenue of export, but eventually improves the trade balance in the long-run. This will happen if there is delayed adjustment of trade flows to relative price changes and the demand and supply elasticities in both export and import sectors follow a certain pattern, namely the Bickerdike-Robinson-Metzler condition or more particularly the Marshall-Lerner condition (Harberger, 1957; Krugman et al., 1987; Bahmani-Oskooee and Ratha, 2004).

There has been a long tradition of the relevant studies (Goldstein and Khan, 1985; Bahmani-Oskooee and Ratha, 2004) as the speed and extent of trade balance response for a given exchange rate shock may convey policy implications. In particular, the misalignment of exchange rates for a given disequilibrium of fundamentals constantly attracts researchers' attentions (Clark and MacDonald, 1998; Isard, 2007; Imbs and Mejean, 2009; Lane and Milesi-Ferretti, 2011). Recent works have been utilising developments in time series technique to assess more refined level of trade data, which may help identify those particular industries that may benefit from depreciations. Many of those studies confirm the delayed adjustment story, but heterogeneities of the adjustment speed can be obtained whenever refined level data are available, *e.g.* see a survey by Bahmani-Oskooee and Hegerty (2007).

However, those studies overwhelmingly rely on disaggregated data for individual economies, ignoring the systematic patterns across the countries. Moreover, a stylised observation, as suggested by Crucini and Davis (2013), indicates that those macroeconomic studies using aggregate flows and matched with the observed exchange rate volatilities tend to find a much smaller elasticity of substitution between domestic and foreign goods than trade literatures.

On the other hand, many studies tend to suggest different patterns of external balance adjustments among different country groups. Generally, industrial economies tend to have smoother economic fluctuations and hence are more likely to have positive correlations between depreciation and trade balance improvements, while developing economies tend to have less solid macroeconomic fundamentals and less mature institutions, resulting in procyclical and more volatile behaviour in macroeconomic variables during certain periods of time (Frankel, 2010a). In particular, the production side of some small open developing economies can be subject to the resource curse (Frankel, 2010b) so that their external balances and economic volatility (and even political instability) are substantially correlated with the commodity (e.g. oil) price booms and busts (Matsuyama, 1992; Sachs and Warner, 2001; Aguiar and Gopinath, 2007). Experiences from the emerging market crises may also result in a different story from the J-curve, as large devaluations and real economic contractionary effects are stylised observations (Frankel, 2005; Calvo et al., 2006b). Moreover, the pass-through effect may be larger for developing economies which limits the flexibility of gradual adjustments (Campa and Goldberg, 2005).

This chapter aims to assess the trade balance adjustments in response to real exchange rate fluctuations across country groups. A reduced-form fixed-effects regression with the specification comparable to existing literatures (Bahmani-Oskooee and Hegerty, 2007) is undertaken on a panel covering 96 countries from 1992 to 2006. Generally, the trade balance tends to have significantly negative responses to appreciation for the contemporaneous and the subsequent year, particularly for the Industrial and Emerging Market groups. The short-run dynamics are more significant when one separates exports and imports among the Industrial economies. The major contributions to the empirical findings are the asymmetric dynamic patterns between the Industrial and developing (particularly the Emerging Market) economies, including that a) the developing economy groups tend to have larger and more instant trade balance responses than the Industrial group; b) the Industrial group exhibits symmetric short-run and long-run trade balance reposes to appreciations and depreciations; c) given similar long-run effects, depreciations tend to induce larger and faster short-run trade balance adjustments than appreciations for the Emerging Market economies; d) for developing economies, large exchange rate fluctuations (*e.g.* depreciation) tend to be associated with a significant immediate response (improvement) as well as a subsequent reversal adjustment (deterioration), *i.e.* an inverse J-curve.

The remaining sections are organised as follows. Section 3.2 presents literature reviews respectively from the theoretical and empirical perspective. Section 3.3 specifies the empirical methodology and data issues. Countries are classified into five groups according to their rule-of-thumb characteristics in their international economic activities. The econometric results are presented in Section 3.4. Starting with the baseline regressions on the aggregate trade balance adjustments, two alternative scaling variables are employed to further compare the tradable and nontradable sectors' responses to shocks. The dynamics of the imports and exports are further separated to explore the J-curve dynamics. Two potential asymmetries on the aggregate variables are then assessed across the county groups: the asymmetric responses to real depreciations and appreciations, and the asymmetries over the large magnitude volatilities of exchange rate fluctuations. Some further robustness checks are attempted in the final subsection. Section 3.5 concludes.

3.2 Literature Review

3.2.1 Theoretical Considerations

A reduced-form expression for the trade balance may help the justification. Suppose a small open economy i is trading with the rest of the world w. The superscripts denote the trade flow origin while the subscript represents the destination. The trade balance of country i in domestic currency can be written as $TB = X_w^i - M_i^w = \Pi_w^i Y_w^i - P_i^w C_i^w$, one can have

$$\widetilde{TB} = \mu_X(\widetilde{\Pi}_w^i + \widetilde{Y}_w^i) - \mu_M(\widetilde{P}_i^w + \widetilde{C}_i^w) \tag{3.1}$$

, where $\mu_X = \frac{\bar{X}_w^i}{\bar{X}_w^i + \bar{M}_i^w} = 1 - \mu_M$ is the steady-state proportion of export values relative to the trade balance. Π indicates the producer's price while P represents the consumer's price.

Earlier models for small open economies under the perfect competition world assume price-taker behaviour with elasticity of supply and demand curves. For instance, define their log-linear forms by $\widetilde{Y}_w^i = \eta^i \widetilde{\Pi}_w^i$ and $\widetilde{C}_w^i = -\eta_w(\widetilde{\Pi}_w^i + \widetilde{Q}_w^i)$ for the economy's exporting sectors and $\widetilde{Y}_i^w = \eta^w \widetilde{\Pi}_i^w$ and $\widetilde{C}_i^w = -\eta_i(\widetilde{\Pi}_i^w - \widetilde{Q}_w^i)$ for importing sectors, where the linear coefficients can be considered as the elasticities of supply and demand respectively[1] and Q_w^i is the exchange rate and a rise indicates appreciation of currency i. Then given the market-clearing condition, the percentage change in trade balance in response to the rate of appreciations can be written as $\widetilde{TB} = -\left[\mu_X \frac{(\eta^i+1)\eta_w}{\eta^i+\eta_w} + \mu_M \frac{(\eta_i-1)\eta^w}{\eta^w+\eta_i}\right] \widetilde{Q}_w^i$

It is then obvious that depreciation would improve the trade balance provided that the square bracket is a positive number. If the log-linearisation is around a balanced trade steady-state[2], $\mu_x \approx \mu_M$, this term would be purely determined by the demand and supply elasticities. Hence depreciation would improve trade balance in the long-run given $\frac{(\eta^i+1)\eta_w}{\eta^i+\eta_w} + \frac{(\eta_i-1)\eta^w}{\eta^w+\eta_i}\widetilde{Q}_w^i > 0$, which is known as *the Bickerdike-Robinson-Metzler*

[1] Conventional derivations using elasticity approach follow similar procedures, though the term log-linearisation is not used, *e.g.* see p62-p69 of Stern (2007).

[2] Technically, it is assumed that the trade is not exactly balanced, as is almost always the case in the empirical data, see also Gourinchas and Rey (2005).

condition. If the supply elasticities are further assumed to be infinite, *i.e.* η^i, $\eta^w \to \infty$, the condition degenerates to $\eta_i + \eta_w > 1$, namely *the Marshall-Lerner condition*.

The trade balance responses to given exchange rate shocks can then be interpreted as the dynamics of those variables interacting with the long-run and short-run elasticity conditions. If the export sector is assumed to have slower responses (the price is stickier or the volume of trade flows has a slower response) than the import sector, an unexpected depreciation would then immediately raise domestic import prices and hence expenditure. This results in a short-run positive correlation between appreciation and trade balance improvement. However, in the long run, the increased spending on imports will be offset by the reduced demand while exports will be encouraged due to the more competitive price. Under the BRM condition, depreciation of domestic currency will eventually result in an improvement for the trade balance.

Magee (1973) descriptively enriches the dynamics of the elasticity approach above with currency contract behaviour. Many studies at the same time try to seek empirical evidence and theoretical frameworks (*e.g.* Junz and Rhomberg, 1973; Miles, 1979; Levin, 1983; Himarios, 1985).

Later developments in structural models provide more rigid theoretical specifications than the elasticity approach. To give an illustrative example, suppose the economy is monopolistic competitive and a given country i's demand structure is in the CES form with a variety-scaling parameter, i.e. $C_i = \left(n_i^{i\,\frac{1}{\sigma}} C_i^{i\,\frac{\sigma-1}{\sigma}} + n_i^{w\,\frac{1}{\sigma}} C_i^{w\,\frac{\sigma-1}{\sigma}}\right)^{\frac{\sigma}{\sigma-1}}$, where $C_i^j \equiv \left(N_i^{j\,-\frac{1}{\sigma}} \int_{\Omega_i^j} c^{\frac{\sigma-1}{\sigma}} d\omega\right)^{\frac{\sigma}{\sigma-1}}$ is the aggregator and $n_i^j = \frac{N_i^j}{\sum_j N_i^j}$ $(j = i, w)$ is the variety produced by country j and consumed by country i in proportion to i's total consumption basket.[3] The prices are assumed in real terms and the elasticity of substitution is assumed identical across countries.

Then the trade balance be expressed as $TB = P_w^i n_w^i (\frac{P_w^i}{P_w})^{-\sigma} I_w - P_i^w n_i^w (\frac{P_i^w}{P_i})^{-\sigma} I_i$, where the second equality is directly from the demand function under CES property.

[3] See detailed discussions about this variety variables by Benassy (1996).

After log-linearisation around the steady-state, the equation can be written as

$$\widetilde{TB} = (\sigma - 1)(\widetilde{n_i^{w\,\frac{1}{1-\sigma}} P_i^w} - \widetilde{n_w^{i\,\frac{1}{1-\sigma}} P_w^i}) - (\sigma - 1)(\widetilde{P}_w - \widetilde{P}_i) + (\widetilde{I}_w - \widetilde{I}_i) \tag{3.2}$$

The coefficients of the first two components both contain the demand elasticity of substitution. Alternative preference structures (*e.g.* translog) can yield more complicated but empirically comprehensive coefficients (Feenstra, 2003). When dynamics are introduced in the micro-founded general equilibrium framework, the coefficient can entail a combination of some deep parameters: the elasticity of substitution and inter-temporal elasticity (Chari et al., 2000).

The first component indicates the terms of trade , which is expected to be positively correlated with the trade balance following the Keynesian view, namely the Harberger (1957)-Laursen-Metzler (1950) (HLM) Effect. The original idea suggests that if in equilibrium the wealth can be measured by the terms of trade, then deterioration of the terms of trade would imply a fall in income (and hence wealth). Accordingly, given the investment and government sectors unchanged, the reduction of savings will correspond to the trade balance deterioration.

The dynamics of the HLM effect can determined by the source of shocks and the structure of the economies (Obstfeld, 1982; Svensson and Razin, 1983). In particular, it occurs if there is a temporary terms of trade shock and domestic consumers would temporarily finance the consumption through international capital market. If the terms of trade shock is expected to be permanent, a negative correlation could appear since consumption tends to be reduced immediately, *i.e.* higher savings and trade surplus (Mendoza, 1995). Moreover, the revealed terms of trade shock will also be determined by the subsequent substitution adjustments (Backus et al., 1994; Cashin and McDermott, 1998).

The second component is the appreciation of consumption-based real effective exchange rate for the country i. The last component can be considered as the excessive demand / expenditure allocation of the world relative to country i on the importing goods, and is expected to be positively correlated with trade surplus. Most literatures provide these standard results. For instance, monetary shocks (and hence devaluation) in the *Redux* model under sticky price setting suggest short-run trade balance improvement (current account improvement). This is due to the wealth-increasing effect and is consistent with the consumption-smoothing view (Obstfeld and Rogoff, 1995a) but the responses tend to be too fast. To introduce more persistent and volatile behaviour for exchange rates, many literatures utilise staggered price settings together with more specific channels developed in macroeconomics, such as intermediate goods and variable elasticity preferences (Bergin and Feenstra, 2000, 2001; Lombardo, 2002).

With no changes of the tradable varieties, the terms of trade changes will be always in proportion to the real effective exchange rate, since the pass-through effect is perfect (Obstfeld and Rogoff, 2000a). However, recent literatures contributing to examine the stickiness interacted with nontradable sectors (Hau, 2000, 2002) and with firm entry decisions and changes in the varieties of the representative basket (Bergin and Glick, 2007; Ghironi and Melitz, 2005, 2007; Naknoi, 2008) confirm that the models with imperfect pass-through and variation of variety tend to match the findings.

Moreover, to explain the pass-through dynamics, theoretical studies consider sources of the firms' pricing-to-market behaviour and trade impediments. An earlier survey is presented by Goldberg and Knetter (1997). Devereux and Engel (2001, 2003) model that exporters tend to prefer the currency with the greatest stability. When the monetary variation is similar across the countries, local currency pricing is preferred, while producer currency pricing can exist if the monetary stability is identical. Burstein et al. (2003) introduce an intermediate distribution service (nontradable) sector into the modelling framework and suggest that the distributional cost for tradable goods may have explanatory power for firm's pricing-to-the-market behaviour. Atkeson and Burstein (2007, 2008) utilise recent developments in trade models to distinguish the imperfect competition effect from the trade cost by introducing the mark-up as a function of market shares.

3.2.2 Empirical Studies

The response of the trade balance to exchange rate changes have been extensively examined in empirical literature in the past decades. Goldstein and Khan (1985) provide a comprehensive survey of the earlier attemptsand conclude that there exist a positive correlation between devaluation and trade balance improvement. The short-run responses including pass-through and quantity adjustment may take from quarters to years for developed economies. The short-run dynamics differ with the characteristics such as composition of trading baskets and other economic and institutional structures are different. Nevertheless, data availability is a constant issue when the examination is extended to the global view, particularly for developing economies.

Advances in time series analysis (Engle and Granger, 1987) and improvements in the quality of data facilitate empirical studies to examine the exact shape of short-run dynamics and long-run relations (Bahmani-Oskooee, 1985, 1989; Noland, 1989; Krugman et al., 1987; Krugman, 1989). Numerous studies of testing the J-curve effect then follow the timing-evolutionary intuition and hence employ time-series techniques. As shown in the survey by Bahmani-Oskooee and Ratha (2004), most of them use the gravity-type reduced-form specifications, based on annual to quarterly trade data and the short-run coefficients are assessed from country-aggregate level to industrial specific of a particular host (and mostly industrial) economy. The conclusions tend to be plausible for gradual adjustments of trade balance in response to exchange rate changes but are subject to some anomalies for the J shape.

More recent studies utilise the new development of cointegration approach for multivariate time series analysis (Sims, 1980; Johansen and Juselius, 1990; Pesaran and Shin, 1998). As surveyed by Bahmani-Oskooee and Hegerty (2010), many of the studies investigate the bilateral trade between a (mainly developing) host economy against trading partners (mainly industrial economies). For instance, Onafowora (2003) utilises a vector error correction model to test the relationship between the trade balance and the real exchange rate for 3 ASEAN economies (Thailand, Malaysia, and Indonesia)respectively against US and Japan. By studying the generalised impulse response function, a long-run Marshall-Lerner condition and short-run J-curve are perceived. Similarly, Hacker and Hatemi-J (2004) show the general impulse response functions for the bilateral trade of Czech Republic, Hungary, and Poland against Germany tend to suggest J-curve effects. Narayan (2006) finds both long- and short-run negative relationships between depreciation of China's real exchange rate against US dollar and its bilateral trade balance improvements. The impulse response function result suggests particularly volatile adjustments of trade balance in response to one standard-deviation-sized shock of exchange rate during the first 20 months. Bahmani-Oskooee and Wang (2008) and Bahmani-Oskooee and Bolhasani (2011) investigate the bilateral trade of US respectively against China and Canada by using commodity/industrial level data. The results suggest that a fractions number of industries depict J-curve dynamics.

Crucini and Davis (2013) address that fact that the empirical elasticity of substitution between home and foreign goods tends to be smaller in macroeconomic models than trade literatures (Ruhl, 2008), mainly because the former literature focus on the observed high volatility of the real exchange rate. Studies on the pass-through effects also provide deeper findings of international price transmissions, which may help explaining the observed smaller trade balance responses. Taylor (2000) suggests that the speed of pass-through is smaller for more stable monetary regimes. Campa and Goldberg (2005) provide cross-country evidence for 23 OECD economies and find the differences between the dock price and the retail price, and between the full pass-through of raw material goods and the partial pass-through of manufacture goods. Frankel et al. (2012) use the import prices of selective 8 goods over 76 capital cities and show a general decline of the pass-through coefficient for the 1990s, particularly for developing economies. Wage increases have a negative influence on the pass-through, which tends to suggest the distributional cost perhaps via the Balassa-Samuelson effect.

Recent trade literatures tend to follow the pricing-to-market theory in explaining slower pass-through, mainly relying on disaggregated exporters' data for industrial economies (Berman et al., 2012). Firms with higher productivity and larger market shares are more likely to respond to exchange rate shocks by pricing-to-market behaviour. This tends to be particularly significant for higher import intensity (Amiti et al., 2012). Drozd and Nosal (2012) suggest that exporters have to build up marketing capital to be matched and bargain with the retailers in the destination country so that the short-run pricing-to-market effects are smaller than the long-run. Engel and Wang (2011) suggest that the stocks of durable goods tend to be sluggish in response to price shocks. Crucini and Davis (2013) propose that the local distribution service of imported goods may need specific non-traded capital that has slow adjustments.

3.3 Empirical Methodology

This chapter aims to assess the trade balance adjustments in response to real exchange rate fluctuations across country groups by conducting fixed-effects regressions for 96 countries over 1993-2006. The structural dynamics of prices and quantities would not be the aim, and the trade balance variables are in the value sense. The empirical model begins with the standard gravity-type specification in the reduced form as many analyses for individual economies and industries (Bahmani-Oskooee and Ratha, 2004; Bahmani-Oskooee and Hegerty, 2010):

$$dTB = \sum_{s=1}^{n} \beta_{it-s} d\ln REER_{it-s} + \gamma X_{it} + \delta D_{it} + \epsilon_{it} \tag{3.3}$$

where dependent variable is trade balance, scaled by the total value of trade and GDP respectively. The major variables of interest are log-changes of the consumption-based real exchange rate with lags. X includes a set of economy's characteristic variables that covers terms of trade, GDP size, *etc.*; D represents the fixed effect dummies. The data include as many economies as the WDI database permits. Summary statistics of variables can be found in Section 3.6.2 in the Appendix.

3.3.1 Trade Balance

The dependent variable is defined as the change in an economy's trade balance scaled by wealth measures: total value of trade (exports plus imports) and overall GDP size. These two measures are consistent with some theoretical considerations on the cyclical dynamics of current account Caballero et al. (2008) and empirical J-curve traditions Rose and Yellen (1989); Senhadji (1998). For a given exchange rate shock, changes in trade balance position relative to the total value of trade would indicate the tradable sector adjustments while changes in the GDP ratio would imply the responses of overall economies (nontradable and tradable sectors).

An alternative measure appearing in the empirical literature is the log-change of the ratio of export value to imports, which indicates a balanced trade when the ratio is equal to unity (Bahmani-Oskooee and Ratha, 2004). As shown in the previous section, this is quantitatively similar to using the import values as the scaling variable, which is indirectly linked to the literatures and facilitate the interpretations only when the consumer's taste parameters are assumed equal and both tradable and nontradable goods are assumed separable across countries. Moreover, later discussions will show that the results tend to have no much difference from using the trade balance scaled by total value of trade.

3.3.2 The Effective Exchange Rate

The first group of explanatory variables are the changes in the logarithmic real effective exchange rate (REER) with lags. A rise in the level (or a positive number in its first order difference) is defined as the appreciation of the currency against the rest world. As discussed in the previous sections, the J-curve effect in theory implies a significant positive coefficient at the instant of unexpected change of exchange rate variable but a series of negative coefficients on its lags. Empirically, this roughly corresponds to the result that some/all of the coefficients for those annual exchange rate variables are negative. For the contemporaneous variable, the expected sign of the coefficient tends to be ambiguous since the short-run rigidities may not necessarily last for over one year (Goldstein and Khan, 1985; Campa and Goldberg, 2005).

Since the lagged exchange rate variables capture the delayed adjustments in both tradable and nontradable sectors provided that the pass-through is imperfect and the short-run quantity adjustments gradually occur, their coefficients are expected to be negative or insignificant after some years. The order of lags is set at 2. This is because on the one side, the data are relatively scarce (1991-2006 annually) and many of the economies have even poorer data completeness. On the other hand, empirical studies in general suggest that the adjustment period across countries can reach over 1-3 years (Goldstein and Khan, 1985; Bahmani-Oskooee and Ratha, 2004) and studies based on monthly/quarterly time-series for particular industries /economies show the spell of dynamics varies from quarters up to 2 years, *e.g.* Narayan (2006) and Hacker and Hatemi-J (2004). Some of them using annual data also suggest that most industries have less than 2 years of significant lags (Bahmani-Oskooee and Bolhasani, 2011). Moreover, studies on long-run PPP suggest that the half-live convergence tend to be 3-6 year or even shorter (Rogoff, 1996; Frankel et al., 2012).

To exploit the data availability, the REER variable is a synthesis between the calculated series by using the IMF monthly exchange rate data and some existing REER series in the WDI database (See Section 3.6.1 in the Appendix for details). The REER for an economy by definition is constructed as the geometric trade-weighted average of its bilateral real exchange rates. The basket of trading partners is fixed at the year of 2002 according to the IMF DOT database. The bilateral trade weightings for each year are defined as the bilateral imports plus exports. The corresponding nominal bilateral exchange rates are defined as foreign currency price per unit of domestic currency, constructed from each country's nominal exchange rate against the USD. The series then are normalised on 2002M12 and adjusted by the inflation differentials to form the index of real bilateral exchange rate variable. The inflation rate for each country is the first-order difference of logarithmic CPI. Both nominal exchange rate and CPI data are the end-of-period monthly series from the IMF IFS database. Once the monthly

REER series is constructed, the annual series is correspondingly its period average.

3.3.3 Other Control Variables

The second group of regressors includes each individual economy's characteristic variables: the logarithmic changes of the terms of trade and real GDP. The latter variable is standard in the J-curve specifications as a proxy for demand conditions (Bahmani-Oskooee, 1985; Rose and Yellen, 1989). On the other hand, this variable also captures those unobserved effects that correlate with the real size of the economy. The GDP data is from WDI database under constant 2000 US dollar measurement.

The terms of trade variable is employed to capture the contemporaneous structural changes in trade and macroeconomic conditions. On the one hand, studies have shown that the terms of trade shocks are typically exogenous for developing economies, and the responses of the output and price variations tend to be more smoothed for those with greater flexibilities of exchange rate regimes (Broda, 2004). Moreover, economies (mostly developing economies) exposed to a larger commodity trade tend to be subject to more volatile real shocks (Cashin et al., 2004). On the other hand, the terms of trade adjustments tend to indicate the structural adjustments in response to an economy's trade patterns. For instance, studies on the international business cycles suggest that shocks to the terms of trade through various channels can yield different reactions on the trade balance (Svensson and Razin, 1983; Backus et al., 1994). Some studies also suggest that economic reforms such as free trade agreements and also be captured by the changes of the terms of trade and hence trade balance adjustments (Anderson and Yotov, 2011). The data for the terms of trade are from WDI database with the series name "net barter terms of trade" index, in log-differences.

The last group of variables are fixed effect dummies: country fixed-effect and year dummies. The former variables are used to control for each individual economy's intrinsic properties, e.g., the long-run positions in demographic and geographic conditions, the long-run economic positions relative to the rest world such as a constant world demand and supply factors affecting the trade responses of the economy, and other factors that shift the trade balance constantly in proportion to the one of the other's. The year dummies are used to control the global cycles that are common to all the economies among the groups.

3.3.4 Country Groups

Five groups are categorised according to the economies' general perspectives of international economic activities. See a detailed list in Section 3.6.4 in the Appendix. Oil Exporting economies are firstly selected according to the IMF definition of fuel exporting countries. As reviewed by Sachs (2007) and Frankel (2010b), those economies heavily rely on their natural resource earnings but are subject to extremely volatile external shocks relative to their small size of economy. At the same time, domestic fiscal and exchange rate policies related to the oil earnings are playing a substantial role in economic stabilisation and long-run growth strategies. However, empirical findings suggest that they may fail to perform as well as other emerging market economies during the past decades and are often involved in economic crises and institutional instabilities.

Financial Economies are then labelled according to the list of small financial-offshore economies by Lane and Milesi-Ferretti (2008, 2010). These economies, usually small in population size and on the periphery of a major economy, provide massive international financial services that can intermediate multinational firms to maximise their profits by taking regulation arbitrage or can complement financial and investment transactions for an emerging market economy under international capital controls. As a result, the driving force of the movements in those economies' external balance position may be substantially attributed to their financial trading partners. Above all, data incompleteness is a severe problem for both this and the previous group.

The selection of Emerging Market economies follows the list by Morgan Stanley Capital International. These economies tend to have sound growth performance during the last decades and are mostly in the progress of economic reform and being integrated in global goods and financial markets. However, experiences suggest that they are exposed to both considerable external and internal shocks, and their weak fundamentals and procyclical policies may aggravate fluctuations during the crises. Empirical findings of short-run dynamics tend to be ambiguous. On the one hand, the pass-through effect may be larger for developing economies than industrial economies, which suggest higher short-run elasticities (Campa and Goldberg, 2005). On the other hand, the procyclical patterns of the macroeconomic variables, particularly the contractionary effect that combines sharp devaluations and trade deficit reductions can be observed in the aftermath of crises (Shatz and Tarr, 2000; Frankel, 2005). Moreover, a stylised effect in the external balance adjustment after the late 1990s for emerging market and oil exporting economies is the substantial accumulation of trade surplus and foreign exchange reserves, accompanied by managed exchange rates with occasional large devaluations (Aizenman and Lee, 2007; Lane and Milesi-Ferretti, 2007).

Advanced Economies are the industrial economies listed by IMF documents. Literatures of empirical J-curves tend to show most supportive results for this group (Bahmani-Oskooee and Ratha, 2004). The remaining economies are finally grouped as Other Developing Economies. As discussed in the previous sections, the empirical evidence for this group tends to be implausible, showing either insignificant results or a complex short-run dynamics. Most of these economies are less exposed to the world market than the previous groups, and are subject to poor economic performance and sometimes involved in institutional instabilities. Some are also exposed to commodity price volatilities or the influence of international aid inflows (Lensink and Morrissey, 2000; Pallage and Robe, 2001).

3.4 Empirical Results

3.4.1 Baseline Regression Results

3.4.1.1 Trade Balance

The analyses start with the baseline regressions on the two alternative trade balance variables across the groups. Year dummies are included and the standard-errors are clustered at the individual economy level. As discussed in the last section, the number of economies for the Financial and Oil Exporting groups is small relative to the time length, which may violate the requirements of fixed-effect estimation. Moreover, these two groups are small economies (most with the population less than two million) largely exposed to volatile global oil price and financial capital movements. Hence the regressions over the entire sample excluding the two groups are conducted as well in examining the performance of the overall sample.

The results in Table 3-1 use the dependent variable as the changes in the ratio of trade balance to the value of tradable goods and services. It can be seen that the explanatory variables roughly contribute significantly to most of the regressions except those for the Financial group, suggesting the latter group's distinct exposure to external shocks as well as the data issues. The annual growth of the domestic income (real GDP) tends to be negatively correlated with the trade balance improvement for all the regressions, consistent with the expectation that an increase of domestic income tends to boost imports relative to exports. Take the coefficient in Column 1 for instance, one additional percent growth in domestic real GDP tends to aggravate the tradable goods scaled trade balance deterioration by 0.4 percent.

The coefficient appears to be larger when the Financial and Oil Exporting economies are excluded from the overall sample regression. Moreover, the group-wise regressions for the two groups (Column 4 & 5) exhibit insignificant coefficients. These may suggest their larger tradable sector volatilities associated with domestic income changes than the other groups, which is consistent with their relatively small size and large exposure of external sectors. The Industrial group exhibits similar coefficients to the overall sample while the Emerging Market group appears a larger and more significant negative correlation. The Other Developing economies tend to have negative correlation but insignificant.

It can be seen that an improvement in the terms of trade is positively correlated with the trade balance improvements for the overall sample regressions (Column 1 & 2). This is consistent with the sign of HLM effects. As discussed in previous sections, the

Table 3-1. Baseline Regressions on $d\frac{TB}{(X+M)}$

	Whole	Whole Excl. Fin & Oil	Industrial	Financial	Oil	EM	Other Dev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dlnREER	-0.122	-0.089	-0.039	-0.029	-0.129	-0.203	-0.047
	(-2.42)**	(-1.90)*	(-0.88)	(-0.15)	(-0.83)	(-4.64)***	(-0.77)
dlnREER(-1)	-0.043	-0.038	-0.107	0.045	-0.056	-0.029	-0.018
	(-1.80)*	(-2.12)**	(-4.03)***	(0.22)	(-2.24)*	(-0.78)	(-0.82)
dlnREER(-2)	0.019	-0.007	-0.042	-0.029	0.062	0.027	-0.008
	(0.79)	(-0.37)	(-1.14)	(-0.27)	(1.02)	(0.98)	(-0.33)
dlnTOT	0.233	0.153	0.243	0.015	0.313	0.144	0.130
	(5.12)***	(3.55)***	(3.93)***	(0.10)	(3.33)***	(2.28)**	(2.46)**
dlnGDP	-0.386	-0.451	-0.434	-0.311	-0.129	-0.627	-0.288
	(-3.07)***	(-3.42)***	(-5.05)***	(-1.06)	(-0.66)	(-3.04)***	(-1.59)
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367
R^2 Overall	0.18	0.14	0.38	0.13	0.51	0.37	0.13
R^2 Within	0.25	0.2	0.39	0.16	0.57	0.45	0.17
R^2 Between	0.04	0.01	0.36	0.00	0.02	0.02	0.00
RMSE	0.051	0.042	0.018	0.057	0.089	0.035	0.055
p-values of tests							
Joint dlnREER	0.000	0.000	0.000	0.991	0.181	0.001	0.113
No Effect	0.000	0.000	0.000	0.951	0.488	0.001	0.087

[1] Robust t-statistics (clustering at individual economy level) are presented in the parentheses.
[3] RMSE is the root mean square error of the regression.
[4] Asterisks, ***, **, *, denote the significance level at 1%, 5% and 10% respectively.
[8] The Joint dlnREER test represents the joint significance test for all exchange rate variables (the contemporaneous and lag variables).
[9] The No Effects test represents the test for the sum of exchange rate varaibles' coeffcients equal to zero.

(temporary) deterioration of the terms of trade indicates domestic income declining and results in ceteris paribus trade balance deterioration since the reduction of consumption tends to be smoothed over the subsequent periods. By comparing among the group-wise regressions, it can be seen that the trade balance for the Oil Exporting economies tends to have the largest terms of trade sensitivity, suggesting their large exposure to the volatile prices of their tradable sectors. The Industrial, Emerging Market and Other Developing economies exhibit positive group-wise coefficients with the magnitudes of the former group appearing larger than the latter two.

The coefficients of real exchange rate variables reveal the gradual responses of the trade balance. For the overall sample average (Column 1 & 2), one percent annual average depreciation against the world tends to accelerate the trade balance improvements by 0.09-0.12 percent of the tradable sector size during the same year, and an additional 0.04 percent improvements can be obtained one year later. The second period lag of the exchange rate variables appears insignificant across the regressions, suggesting the major trade adjustment procedure may last for no longer than two years.

Two additional tests for exchange rate variables are conducted for all the regressions and shown at the last two rows in Table 3-1. The first is a joint significance test on all the three exchange rate variables, and the second attempts to test whether exchange rate fluctuations have zero cumulative effect on the trade balance improvements over the current and subsequent two years. It can be seen that for the overall sample regressions, the exchange rate variables are jointly significant and the cumulative influences quantitatively mentioned in the above paragraph present a non-zero quantity in statistical sense.

For the Industrial group (Column 3), only the coefficient for the first-order lag exchange rate variable is significant. This suggests that the major adjustments of trade balance scaled by tradable sector size may significantly occur one year later, though there is an insignificant negative coefficient for the contemporaneous appreciation variable. For the Emerging Market group, only the coefficient of the contemporaneous variable is significant and its magnitude tends to be larger than the Industrial group. This may imply that the trade balance variations for the emerging market economies tend to be more instant and sensitive to the exchange rate fluctuations, so that the major adjustments would be accomplished within 2 years. This may be consistent with traditional view that the pass-through coefficient is larger for them. Both of the above two groups have the joint significance of all exchange rate variables, and the net influences are quantitatively different from zero.

For the Other Developing economies, none of the exchange rate variables are significant, though the coefficients appear negative. These suggest that those economies' trade balance changes may lack responsiveness to the real exchange rate changes or the overall adjustments in the tradable sectors could be completed within a year. The joint significant test confirms the insignificance level over 10 percent and the net zero cumulative effect test cannot be rejected at 5 percent level. These may indicate the weak tendency of trade balance responses. For the Oil Exporting economies, only the first lag of exchange rate tends to be significant, but both the joint significance and net cumulative effect tests suggest that there is little linkage between the trade balance changes and exchange rate fluctuations.

It can be shown that the results in Table 3-1 are also quantitatively comparable to the J-curve literatures using an alternative measures for the trade balance, the log-difference of the ratio of export to imports (*e.g.* Bahmani-Oskooee and Ratha, 2004). Theoretically, it can be shown that around the balanced trade, the dependent variable of Table 3-1, the changes in trade balance relative to the trade value, is quantitatively similar to half of the log-differenced ratio.[4] Moreover, it can be seen in Table 3-23 in Appendix that the resulting coefficients are doubled in magnitude relative to those in Table 3-1 and the t-statistics remain almost the same as expected.

Rather than measuring the trade relative to the tradable sector size, an alternative scaling variable scaled by the total economy size is employed in Table 3-2. Comparisons between the corresponding coefficients for the same specification but under the two measures would convey the structural adjustments between tradable and nontradable sectors. Given the explanatory variables unchanged, the resulting difference of the corresponding coefficients may imply two sources of variations, the long-run rescaling effect and the short-run adjustments of tradable sectors relative to the overall economy. The rescaling effect expects that, *ceteris paribus*, the ratio of the corresponding coefficients between Table 3-2 and Table 3-1 should be consistent with the long-run ratio of the two scaling variables (*i.e.* the ratio of trade value to GDP, or the trade openness). In other words, under pure rescaling effect, the coefficients in Table 3-1 multiplied by the group average trade openness should be equal to the corresponding coefficients in Table 3-2.

As shown in Table 3-3, the group-wise trade openness are mostly less than unity except for the Financial group, suggesting that the coefficients in Table 3-1 tend to be larger than those in Table 3-2 except for the Financial group. For instance, the

[4] Define d as the differential operator, one can rewrite the two variables into: $d\frac{X-M}{X+M} = \frac{1}{(X+M)^2}\Big[(X+M)d(X-M)-(X-M)d(X+M) = 2\frac{MdX-XdM}{(X+M)^2}\Big]$ and $d\ln\frac{X}{M} = \frac{dX}{X} - \frac{dM}{M} = \frac{MdX-XdM}{(MX)} \geq 4\frac{MdX-XdM}{(X+M)^2}$ where the last inequality is from the Cauchy-Schwarz inequality and the equality holds when $M = X$ which indicates the balanced trade.

Table 3-2. Baseline Regressions on $d\frac{TB}{GDP}$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dlnREER	-0.057	-0.038	-0.047	-0.096	-0.008	-0.079	-0.013
	(-2.34)**	(-1.87)*	(-1.90)*	(-0.48)	(-0.07)	(-2.87)**	(-0.44)
dlnREER(-1)	-0.019	-0.019	-0.054	0.104	-0.038	-0.028	-0.003
	(-0.96)	(-1.70)*	(-2.77)**	(0.39)	(-1.10)	(-1.59)	(-0.20)
dlnREER(-2)	0.040	-0.004	-0.012	-0.097	0.162	0.019	-0.006
	(1.30)	(-0.33)	(-0.62)	(-0.93)	(1.24)	(1.01)	(-0.40)
dlnTOT	0.153	0.099	0.174	-0.079	0.017	0.101	0.084
	(4.41)***	(3.26)***	(2.68)**	(-0.38)	(0.14)	(2.53)**	(2.29)**
dlnGDP	-0.019	-0.214	-0.179	-0.314	0.447	-0.495	-0.041
	(-0.09)	(-1.84)*	(-1.79)*	(-1.18)	(1.83)	(-2.86)**	(-0.28)
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367
R^2 Overall	0.10	0.09	0.37	0.11	0.32	0.34	0.11
R^2 Within	0.10	0.13	0.37	0.14	0.36	0.44	0.11
R^2 Between	0.10	0.03	0.37	0.00	0.04	0.04	0.18
RMSE	0.051	0.031	0.012	0.071	0.11	0.023	0.041
p-values of tests							
Joint dlnREER	0.007	0.058	0.000	0.829	0.513	0.046	0.934
No Effect	0.282	0.011	0.001	0.723	0.485	0.023	0.523

[1] See notes to Table 3-1

total value of trade for the whole sample average exhibits the size as about 80 percent of GDP, suggesting that the coefficients in column 1 of Table 3-1 should be about 1.24 (=1/0.8095) times as large as the corresponding ones in Table 3-2. Moreover, the average changes of the openness ratio, indicating the growth differences between the two scaling variables over the years, are around 2%, which is expected to exert ignorable effects. Hence, deviations of the ratio between the corresponding coefficients from Table 3-3 can be regarded as the structural adjustments between tradable and nontradable sectors.[5]

Table 3-3. Trade Openness Across Country Groups

	Whole	Whole Excl. Fin&Oil	Industrial	Financial	Oil	Emerging Market	Other Developing
Openness	0.8095	0.7008	0.6653	1.6106	0.8654	0.6781	0.7387
dOpenness	0.0169	0.0148	0.0153	0.0173	0.0262	0.022	0.0124

It can be seen that the results in Table 3-2 generally exhibit similar regression performances particularly for the standard deviations (RMSEs) to Table 3-1. Since the pure rescaling effect would assume that the tradable sector size varying in stable

[5] One should note that these comparisons only rely on the point estimates, without constructing rigorous statistics.

proportions to GDP, the standard deviations would have been expected to exhibit similar rescaling effect mentioned above. Moreover, the between-R square shows slightly improvement across the regressions. These tend to support the presence of structural adjustments between tradable and nontradable sectors.

The annual GDP growth in the whole sample regressions (Column 1 & 2) still exhibit negative correlations, suggesting that an increase in domestic income growth tends to worsen the trade balance deterioration. Nevertheless, the coefficient becomes less significant with the magnitude also halved in magnitude relative to the corresponding ones in Table 3-1. The excessive changes of the coefficient magnitude (and the significant levels) relative to the long-run trade openness ratio suggest that with the presence of the nontradable sector, an overall increase in domestic real income tends to be associated with less (or slower) increase in the size of tradable sector *ceteris paribus*, resulting in a less sensitive trade balance adjustments shown in Table 3-2. Among the group-wise regressions, the Industrial group shows a similar case to this overall sample story. The Other Developing economies appear to follow the pattern though the significance level of the coefficient still remains under 10%.

On the contrary, it can be calculated that the ratio of the coefficients for the Emerging Market group (-0.495/-0.627 = 0.79) tends to be larger than the trade openness ratio (0.68). Also, the significance levels are similar as well in terms of the t-statistics. These jointly suggest that the changes of the domestic income tend to be associated with larger (or faster) variations of the tradable sector activities than the nontradable sectors. This may suggest the export-led growth patterns for those Emerging Market economies. The Oil Exporting group exhibits a positive coefficient in Table 3-2 though still insignificant, suggesting an even larger tendency.

Compared with Table 3-1, the terms of trade variable for the whole sample regressions in Table 3-2 has the coefficients smaller than the openness ratio scaling in magnitude (*e.g.* 0.153/0.233=0.66<0.81 for Column 1). A greater significance in terms of t-statistics is also shown for the coefficients. These suggest that an additional improvement in the terms of trade tend to encourage less increase in the overall valuation of economy size so that the trade balance improvements measured in terms of tradable goods have more sensitive results. The most obvious example is for the Oil Exporting group regression. The coefficient loses significance completely and its magnitude turns out to be the smallest among the group-wise results. This suggests that the overall economy valuation is very sensitive to the terms of trade condition since they are more likely to be exposed to more volatile external shocks. The Other Developing economies tend to exhibit similar patterns.

It can be calculated that the ratio of the two corresponding coefficients for the Industrial and Emerging Market economies (Column 3 & 6) is slightly larger than their group-wise trade openness ratios. This suggests that the terms of trade improvements tend to be associated with higher growth in the tradable sector relative to the overall economy size. Hence a more sensitive result for the trade balance improvement can be obtained in terms of GDP scaled measure.

The presence of the nontradable sector tends to weaken the sensitivity of trade balance adjustments to exchange rate fluctuations. For the whole sample regressions (Column 1 & 2), the coefficients for the contemporaneous and first lag of the exchange rate variables become less significant and half of the magnitude than corresponding ones in Table 3-1. Moreover, the no cumulative effect tests suggest that the negative correlations between appreciation and the subsequent trade balance improvements exhibit significant once the Financial and Oil Exporting economies are excluded from the overall sample. These suggest that real exchange rate shocks tend to be associated with larger variations of the overall economy than the tradable sectors, particularly for those small economies exposed to large external shocks.

By comparing among the remaining groups, it can be seen that the negative coefficients for the Other Developing economies remain insignificant but generally follow the whole sample pattern. Both the joint significance test and no effects tests cannot reject the null hypotheses for the exchange rate variables. In contrast, the overall effects remain significant for the Emerging Market economies. The contemporaneous coefficient is halved in both magnitude and t-statistics while the coefficient for the first order lag variable remains the same with t-statistics declined relative to Table 3-1. This suggests that fluctuations of the real exchange rate tend to induce volatile redistribution between tradable and non-tradable sectors.

For the Industrial group, the contemporaneous exchange rate variable becomes more significant than Table 3-1. This suggests that a real appreciation against the world tend to be associated with immediate faster (larger) changes in tradable sector activities than the overall economy so that trade balance in terms of the tradable goods turns to be less sensitive to exchange rate shocks. However, one year later, the nontradable sector adjustments tend to become more important in the overall economy growth so that the one year lag coefficient in Table 3-2 only exhibit half of the magnitude than Table 3-1.

3.4.1.2 Adjustments of Exports and Imports

Previous analyses on trade balance adjustments generally support the Marshall-Lerner conditions. In particular, appreciations tend to be negatively correlated with subsequent trade balance improvements when the tradable sector activities (exports plus imports) are used as the scaling variable. Moreover, the effects of terms of trade and domestic income changes are also roughly consistent with expectations. On the other hand, the results for the Other Developing and Oil Exporting groups tend to be less clear. This motivates the separation of assessing the dynamics respectively of the export and import sectors.

Following the previous section, the analyses should have started with the export and import values scaled by tradable sector activities. Unfortunately, this scaling variable is unable to distinguish the asymmetric adjustments of the import and export sectors. It can be shown that the changes of exports and imports in terms of the tradable goods are quantitatively equal to half of the changes of the scaled trade balance. Hence, Table 3-4 directly uses the log-changes of the nominal values of exports and imports (measured in current US dollars). This is equivalent to scaling by the country group average of exports (imports). For each group-wise regression, the year fixed effects then captures the average nominal dollar inflations and other annual common trends.

Table 3-4. Baseline Regressions on $d\ln EX$ and $d\ln IM$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable: $d\ln EX$							
dlnREER	-0.088	0.072	0.381	-0.053	-0.539	0.069	0.089
	(-0.66)	(0.63)	(4.93)***	(-0.23)	(-0.99)	(0.84)	(0.64)
dlnREER(-1)	-0.032	-0.025	-0.157	-0.198	0.039	-0.040	0.007
	(-0.70)	(-0.61)	(-3.63)***	(-1.15)	(0.32)	(-1.03)	(0.13)
dlnREER(-2)	-0.090	-0.071	-0.126	-0.010	-0.264	-0.070	-0.053
	(-1.67)*	(-2.10)**	(-2.47)**	(-0.04)	(-1.19)	(-1.82)*	(-1.12)
dlnTOT	0.434	0.199	0.444	0.116	0.846	0.341	0.124
	(3.65)***	(1.66)	(3.68)***	(0.50)	(3.04)**	(2.99)***	(0.91)
dlnGDP	0.509	0.941	1.025	0.058	0.192	0.534	1.151
	(2.15)**	(3.75)***	(3.84)***	(0.09)	(0.78)	(3.96)***	(3.39)***
R^2 Overall	0.31	0.40	0.75	0.30	0.38	0.61	0.32
R^2 Within	0.30	0.40	0.77	0.39	0.45	0.65	0.32
R^2 Between	0.38	0.36	0.40	0.15	0.11	0.14	0.36
RMSE	0.131	0.099	0.038	0.069	0.274	0.064	0.137
p-values of tests							
Joint dlnREER	0.233	0.110	0.000	0.656	0.685	0.140	0.492
No Effect dlnREER	0.270	0.880	0.347	0.486	0.330	0.708	0.833
Dependent Variable: $d\ln IM$							
dlnREER	0.196	0.260	0.457	0.150	-0.074	0.488	0.193
	(1.20)	(1.36)	(7.78)***	(0.76)	(-0.28)	(6.41)***	(0.83)
dlnREER(-1)	0.054	0.051	0.058	-0.354	0.161	0.021	0.041
	(1.38)	(1.29)	(0.78)	(-1.48)	(2.73)**	(0.33)	(0.89)
dlnREER(-2)	-0.115	-0.056	-0.039	0.010	-0.331	-0.118	-0.037
	(-2.35)**	(-1.43)	(-0.51)	(0.05)	(-1.87)*	(-2.40)**	(-0.65)
dlnTOT	-0.063	-0.121	-0.049	0.218	0.026	0.039	-0.151
	(-0.63)	(-0.90)	(-0.54)	(0.95)	(0.17)	(0.53)	(-0.91)
dlnGDP	1.458	1.846	1.884	0.897	0.874	1.793	1.725
	(4.11)***	(4.34)***	(5.84)***	(6.06)***	(1.83)*	(4.50)***	(3.12)***
R^2 Overall	0.39	0.42	0.79	0.50	0.39	0.75	0.30
R^2 Within	0.39	0.44	0.81	0.48	0.30	0.77	0.32
R^2 Between	0.48	0.25	0.47	0.66	0.86	0.41	0.21
RMSE	0.112	0.107	0.036	0.069	0.172	0.067	0.149
p-values of tests							
Joint dlnREER	0.058	0.177	0.000	0.335	0.072	0.000	0.615
No Effect dlnREER	0.452	0.193	0.001	0.515	0.518	0.001	0.424
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367

[1] See notes to Table 3-1

It can be seen from Table 3-4 that the improvement in real GDP growth tends to increase the nominal import values more than exports across the countries. For the whole sample regressions (Column 1 & 2), an increase in domestic real income tends to increase the nominal import expenditure more than twice as much as the export revenue. This suggests that the overall income growth induces a larger substitution effect towards importing goods, resulting in the overall negative correlation between domestic income and trade balance improvement shown as before. However, previous sections show less significant evidence when those nominal accounts are scaled by wealth measures. This suggests that those nominal wealth variables may increase equi-proportionally.

The most evident examples are the Financial and Oil Exporting economies (Column 4 & 5), since the positive coefficients for real GDP growth are insignificant in their export regressions but highly significant with much larger magnitude in the import regressions. The Industrial and Other Developing economies (Column 3 & 7) are close to the whole sample patterns with both significantly positive coefficients and about twice larger magnitude in the import regressions. In particular, the coefficient for the Industrial group's export regression is close to unity, suggesting an equi-proportional growth of nominal export values and domestic income. The substitution effect for the Emerging Market group (Column 6) tends to be larger than the former groups, as the positive coefficient in the import regressions appears more than triple of the export one. This is consistent with the most significant results among the groups shown in the previous section.

It can be seen that an improvement in the terms of trade tends to increase the nominal export revenues more significantly than decrease the import expenditures. For the whole sample regressions in Column 1, there is a significantly positive coefficient for the term of trade variable in the upper panel while an insignificantly negative in the lower panel. This pattern becomes less evident when the Financial and Oil Exporting economies are excluded. An immediate reason is that for the Oil Exporting group (Column 5), terms of trade improvements tend to exhibit a much larger and significant effects on export than import. However, this asymmetric effect tends to be only sufficient to generate the overall significantly positive correlation between terms of trade and trade balance improvements when the tradable sector size but not nominal GDP is used as the scaling variables as shown in the previous analyses, suggesting their export-oriented growth pattern. The Industrial economies roughly exhibit the whole sample pattern. For the Emerging Market and Other Developing economies, an improvement in the terms of trade tends to encourage the nominal export income more than imports, though the results for the latter group are less significant.

The coefficients for the real exchange rate variables in Table 3-4 suggests that the dynamic adjustments of imports sectors tends to be slower than the export sectors, with substantial cross-country heterogeneities. From the whole sample results (Column 1 & 2), it can be seen that the dynamics tend to take longer than the overall trade balance results shown before, as the second lag of the exchange rate variable is weakly significant. Moreover, the negative sign for the exchange rate variable appears in the earlier lags of the export regressions than the import ones, suggesting that export sectors tends to have quicker responses than the overall imports. The joint significance test suggest that real exchange rate fluctuations tends to have more significant short-run effect on the nominal import than export values but the cumulative effects tend to be insignificant.

By comparing among the groups, it can be seen that the Industrial economies show the most evident gradual short-run dynamics. A real appreciation tends to generate larger nominal import expenditures than export incomes in the current while it significantly reduces the export incomes in the subsequent years. The cumulative tests suggest that those dynamics in the long-run tends to be neutral for the nominal export but not for the imports, suggesting a long-run negative correlation between appreciation and trade balance improvement. The Emerging Market group tends to follow a similar pattern but the results for the export regressions are less significant.

There seems to be a slower and less significant tradable sector response to the real exchange rate changes for the Other Developing economies than the former two groups. The coefficients of the exchange rate variables are all insignificant for both export and import regressions, which is consistent with the trade balance results in the previous section. The (insignificant) negative sign only appears at the second lag of the exchange rate variable, suggesting that the weak responses. For the Oil Exporting economies, a real appreciation tends to insignificantly reduce both import and export values in the current year, suggesting the tendency of quick responses. However, the coefficient for the one-year lag is positive but negative for the second-order lag, significantly in the import regression. This tends to show a non-standard J-curve pattern though the quantitative differences of the coefficients between export and import regressions tend to yield an overall negative correlation between exchange rate appreciation and trade balance improvement.

Following the above analyses on the gradual adjustments of nominal imports and exports, Table 3-5 attempts to further assess those dynamics in terms of GDP shares. Similarly as before, scaling by GDP brings in the dynamics of nontradables relative to tradables. A rise in real exchange rate indicates higher prices of the former sector relative to the latter and hence the all the coefficients appear more negative than 3-5. The upper panel of Table 3-5 uses the dependent variable as the changes in the ratio of export values relative to GDP size while the lower panel uses the GDP-scaled imports. Hence the coefficient differentials for a given variable are expected to be comparable to Table 3-2. The standard deviations for the import regressions are generally larger than the export regressions, also implied by the smaller R-square measures.

It can be shown that domestic real GDP growth tends to encourage the import share but to reduce the export. For the whole sample (Column 1 & 2), the coefficients in the export regressions tend to be negative particularly when the Financial and Oil Exporting economies are excluded. This is in contrast to the nominal export regressions in Table 3-4, suggesting that an improvement in the real income growth tends to be associated with less proportion of exports. On the other side, the coefficients for the import regressions tend to be insignificantly different from zero. As a result, this asymmetric proportional changes between the export and import values relative to the overall economy suggests an overall negative correlation between the real GDP growth and the trade balance improvement in Table 3-2.

By comparing among the groups, it can be shown that there tends to be larger responses in the nontradable sectors to domestic income growth for developing economies. For the Industrial economies, an additional growth of domestic income tends to increase the imports significantly by more proportion of shares but insignificantly for exports. This is consistent with the previous results on nominal values of export and imports. For the Oil Exporting Economies, an increase in domestic income tends to insignifi-

Table 3-5. Baseline Regressions on $d\frac{EX}{GDP}$ and $d\frac{IM}{GDP}$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent Variable: $d\frac{EX}{GDP}$							
dlnREER	-0.193	-0.156	-0.165	-0.713	-0.225	-0.201	-0.122
	(-5.75)***	(-6.43)***	(-6.18)***	(-3.61)***	(-1.94)*	(-6.45)***	(-3.82)***
dlnREER(-1)	-0.039	-0.033	-0.063	-0.351	-0.035	-0.045	-0.017
	(-2.82)***	(-3.00)***	(-4.64)***	(-2.52)**	(-1.13)	(-1.87)*	(-1.38)
dlnREER(-2)	-0.012	-0.009	-0.015	-0.054	-0.059	-0.002	-0.006
	(-0.85)	(-0.86)	(-0.98)	(-0.59)	(-0.97)	(-0.19)	(-0.44)
dlnTOT	0.071	0.030	0.113	-0.043	0.089	0.050	0.009
	(3.16)***	(1.38)	(5.65)***	(-0.35)	(1.75)	(1.84)*	(0.34)
dlnGDP	-0.097	-0.153	0.078	-0.197	0.051	-0.339	-0.047
	(-1.53)	(-2.72)***	(1.61)	(-0.85)	(0.56)	(-4.37)***	(-0.67)
R^2 Overall	0.23	0.25	0.62	0.27	0.51	0.44	0.21
R^2 Within	0.29	0.29	0.68	0.43	0.57	0.52	0.24
R^2 Between	0.00	0.00	0.03	0.01	0.02	0.02	0.01
RMSE	0.037	0.029	0.011	0.047	0.059	0.025	0.037
p-values of tests							
Joint dlnREER	0.000	0.000	0.000	0.005	0.033	0.000	0.001
No Effect	0.000	0.000	0.000	0.001	0.123	0.000	0.000
Dependent Variable: $d\frac{IM}{GDP}$							
dlnREER	-0.136	-0.119	-0.118	-0.617	-0.217	-0.122	-0.110
	(-6.42)***	(-8.45)***	(-8.27)***	(-2.83)**	(-1.85)*	(-4.07)***	(-4.48)***
dlnREER(-1)	-0.019	-0.014	-0.009	-0.454	0.003	-0.017	-0.014
	(-1.26)	(-0.94)	(-0.49)	(-1.58)	(0.14)	(-0.72)	(-0.77)
dlnREER(-2)	-0.052	-0.005	-0.002	0.043	-0.221	-0.020	0.001
	(-1.40)	(-0.40)	(-0.16)	(0.40)	(-1.28)	(-1.05)	(0.04)
dlnTOT	-0.082	-0.069	-0.062	0.036	0.072	-0.051	-0.076
	(-3.65)***	(-2.47)**	(-1.29)	(0.19)	(0.48)	(-2.04)*	(-2.09)**
dlnGDP	-0.078	0.061	0.257	0.116	-0.395	0.156	-0.005
	(-0.47)	(0.48)	(2.92)***	(0.86)	(-2.32)**	(1.28)	(-0.03)
R^2 Overall	0.10	0.15	0.59	0.30	0.15	0.25	0.14
R^2 Within	0.12	0.17	0.63	0.32	0.24	0.28	0.16
R^2 Between	0.00	0.00	0.09	0.17	0.32	0.02	0.03
RMSE	0.054	0.038	0.011	0.064	0.119	0.027	0.053
p-values of tests							
Joint dlnREER	0.000	0.000	0.000	0.000	0.332	0.005	0.001
No Effect	0.001	0.000	0.000	0.000	0.169	0.008	0.002
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367

[1] See notes to Table 3-1

cantly increase the export shares but significantly reduce the import shares. This is consistent with the previous results in Table 3-4.

For the Emerging Market economies, an increase of real income growth tends to significantly reduce the share of exports but insignificantly increase imports. This is consistent with the coefficient with magnitude less than 1 for the nominal export regression in Table 3-4 but not for the import regression with the magnitude greater than 1.7. This may indicate the tendency of larger increase in nontradable sectors that deflate the shares of tradable sector growth. Similarly for the Other Developing economies, an increase in domestic income is associated with insignificantly reductions of the shares on import and export values, with the magnitude of former less than the latter. This is in contrast to the coefficients with the magnitude greater than 1 in the previous regressions on nominal exports and imports, suggesting larger responses in the nontradable sectors.

The results for the terms of trade variable generally preserve the same expectations for most of the groups when exports and imports are scaled by the total economy size. For the whole sample regressions in Column 1, the coefficient in the whole sample regression is positive in the upper panel and significant negative in the lower panel, suggesting an improvement in the terms of trade tends to encourage larger increase of export sectors while lower expenditures in imports relative to the overall economy. This effect tends to be stronger when the Financial and Oil Exporting economies are excluded in the regressions, since the former group of economies tend to show the opposite effects.

The Industrial and the Emerging Market economies roughly follow the overall sample patterns and have similar implications as the previous results in Table 3-4. The negative coefficient for the Other Developing group's import share becomes significant, suggesting that terms of trade improvement (deterioration) tends to have larger impacts on the nontradable and hence the overall economy growth (shrink) so that the import reduction relative to the overall economy is sharpened. For the Oil Exporting economies, the positive coefficient in the export regressions becomes insignificantly different from zero, suggesting that improvement in the terms of trade tends to induce equi-proportional increase in both tradable sector and the overall economy, resulting in an insignificant change of the fractions.

It can be shown from Table 3-5 that when the export and import sectors are measured in fraction of the overall economy size, their dynamics in response to exchange rate fluctuations tend to show different patterns as they are measured in the nominal values, though the overall implications for the trade balance adjustments preserve the same. For the overall sample regressions (Column 1 & 2), all the coefficients for the exchange rate variables are negative, suggesting that appreciations tends to reduce both exports and imports as fractions of GDP size. This is consistent with the previous comparisons using tradable goods and GDP as alternative scaling variables of trade balance, suggesting that exchange rate variations tend to be associated with larger variations of nontradable price. The coefficient magnitudes in the export regressions tend to be larger than the import regressions, suggesting an overall negative correlation between appreciation and trade balance improvements. Moreover, the adjustments of export fraction in response to exchange rate tend to last longer than the import, as only the coefficients for the contemporaneous variable is significant in the latter regressions. Both the joint significant and net cumulative effect tests becomes more significant than Table 3-4.

By examining each group, one can see that the result for the Industrial and Emerging Market groups are very close to the whole sample patterns. In contrast to the immediate larger increase in the nominal import values and subsequent larger deceases in the export values, an appreciation tends to decrease the export more than the import as fractions of GDP for both the current and one year later. For the Other Developing economies, the dynamics of tradable sectors are sharpened after the export and import values are scaled by the overall economy size. It can be seen that both the coefficients in the upper and lower panel for the contemporaneous exchange rate variable are significant and both the joint significance and net cumulative effect improves than Table 3-4. It can be seen that the coefficient magnitudes in the export regression are very close to imports. This is consistent with the previous results that the nominal values of tradable sector tend to lack responses to exchange rate fluctuations.

For the Oil Exporting economies, the non-standard J-curve dynamics becomes weakened once the export and import sectors are measured as fractions of GDP size. Both the contemporaneous coefficients are significantly negative in the upper and lower panels, with the magnitude of the former slightly larger than the latter. The two lags in the import regressions become insignificant, though the signs are still consistent with Table 3-4. This suggests that variations of the non-tradable sectors in the subsequent years of adjustments would sufficiently offset the import sector responses to an exchange rate shock.

3.4.2 Asymmetric Responses to Depreciations and Appreciations

Previous results suggest a negative correlation of the trade balance improvements with a given exchange rate appreciation The coefficients for those annual average exchange rate variables are implicitly assumed symmetric over depreciations and appreciations. However, these may not be necessary in practice, as economic activities may not be equally densely involved under the positive and negative shocks, and the perceived group-wise exchange rate fluctuations may be biased towards either depreciations or appreciations. Hence, some further summary statistics on the exchange rate variable presented in the following may help to reveal the data characteristics.

On the other hand, the trade balance may not necessarily display a symmetric response to depreciations and appreciations, particularly for developing economics. In general, a depreciation would imply higher costs of imported intermediate goods, but a more competitive relative price of exports (*e.g.* Johnson, 2012). This implication is particularly important for export-led growth economies with intensive processing trade. Alessandria et al. (2010) suggest that importers in developing economies are involved with managing substantial inventories due to the relatively high fixed cost of importing (such as bureaucratic costs). Thus larger depreciation shocks are associated with inventory reductions and the collapse of the overall imports may lead to larger short-run elasticities than the long-run.

3.4.2.1 Descriptive Statistics

Table 3-6 presents the number of observations of real exchange rate depreciation and appreciation across the economy groups. It can be seen that for the entire sample, the appreciation cases exceed depreciations by about 10%. The Industrial group generally shows a similar result. Though suffering the most incompleteness of data, the Financial and Oil Exporting economies generally show roughly equal numbers of depreciations and appreciations. The distribution for the Emerging Market tends to bias towards the appreciation domain over the sample period, since only 1/3 of the annual changes of exchange rates results in depreciation. The Other Developing economies on average exhibit equal cases of appreciation and depreciations.

Table 3-6. Observations of Appreciations and Depreciations

No. of Obs.	Whole	IND	Fin	Oil	EM	OthDev
Appreciations	549	139	46	50	130	184
Depreciations	500	121	57	50	89	183
No. of Discrepancies	49	18	-11	0	41	1
Total Obs.	1,049	260	103	100	219	367

Another attempt to summarise the exchange rate shocks is to examine the reversals of exchange rate fluctuations. Figure 3-1 shows country-wise maximum years of consecutive depreciations and appreciations over the sample period. The 45-degree dash line is added representing equal years of the country?s longest spell of continuing appreciations and depreciations. Any point above the line indicates a longer maximum spell of depreciations than appreciations and *vice versa*. Note that these maximum spells for each economy does not rule out the possibilities of having other shorter spells of consecutive changes, and the annual observations do not necessarily imply a constant depreciation/appreciation within the years.

It can be seen from the bottom right panel of Figure 3-1 that the majority of economies are roughly distributed around the 45-degree line, suggesting the annual exchange rate fluctuations are roughly symmetric for the longest depreciations and appreciations cycles. Most of the maximum years of consecutive changes are around 3-5 years, suggesting the persistence of exchange rate fluctuations over the sample period are moderate and may imply mean-reversion patterns weakly . Moreover, recall that the overall sample covers about 12 years and the data for many developing economies are subject to incomplete coverage years. Hence any country point with larger than 6 suggests a dominant direction of exchange rate path towards either depreciation or appreciation.

By comparing among the groups, one can see that the Industrial and Emerging Market economies tend to exhibit 3-4 years maximum spell of consecutive exchange

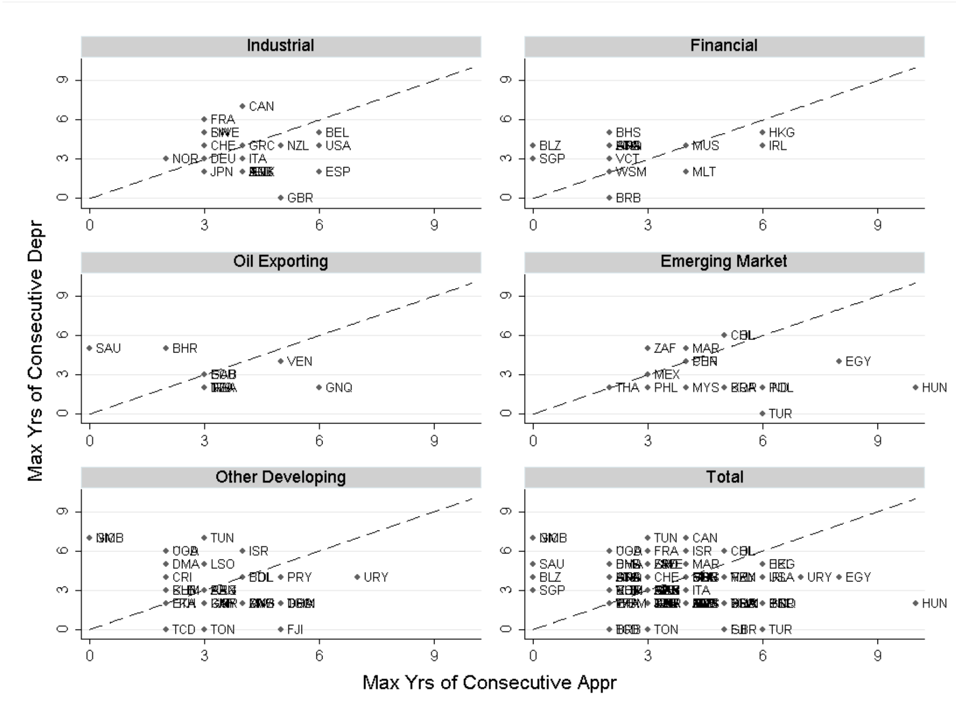

Figure 3-1. Maximum Years of Consecutive Depreciation and Appreciations

rate changes, while shorter lengths (around or less than 3 years) can be observed for the other groups. Since developing economies tend to be exposure to larger macroeconomic variations, larger and more frequent reversals could be expected than the Industrial economies. On the other side, the shorter spells may also result from data incompleteness. It can be seen that there are a few outliers exhibiting a long-term appreciation/deprecation trends. Some of Emerging Market economies tend to have persistent depreciation more than 6 years. An extreme example is Hungary with all observations as appreciation. The Industrial and Other Developing groups are symmetrically scattered with less proportion of outliers, though the latter group tend to have a larger dispersion than the former. The Financial group on average tends to have moderate symmetries and the Oil Exporting

Note that Table 3-6 and Figure 3-1 only count for the years of exchange rate fluctuations, which does not necessarily imply that these annual changes have identical magnitude. For instance, Table shows that the annual exchange rate variable exhibit an substantial depreciation for the Other Developing group over the sample period, which is not consistent with the similar numbers of depreciation and appreciation counts in Table 3-6. The 10% excessive appreciation cases for the entire sample are also corresponding to the overall depreciation in Table. Moreover, compared with the Industrial economies, the 30% excessive appreciation cases for the Emerging Market group are only associated with a moderate overall appreciation in Table 3-21. These suggest that the magnitude of exchange rate fluctuations tend not to be symmetrically realised over the deprecation and appreciation domains. In particular, annual depreciations on average tend to be larger in magnitude than appreciations for developing economies.

Accordingly, Figure 3-2 attempts to depict the period-averaged magnitudes respectively of the depreciation and appreciation for each economy. Similarly to the previous scatter plots, the 45-degree line indicates the symmetries of the average magnitudes of depreciations and appreciations, and the north-east direction indicates larger magnitudes of both depreciation and appreciations.

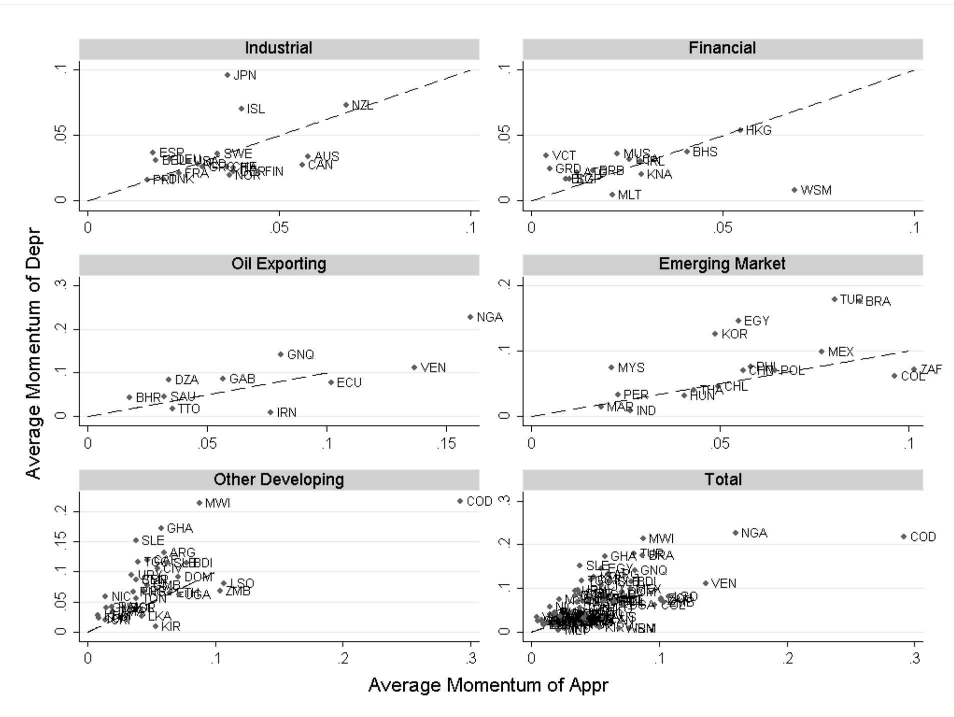

Figure 3-2. Average Momentum of Annual Depreciations and Appreciations

It can be seen from the bottom-right panel that most economies tend to exhibit symmetric fluctuations with about 3% per year, but a notable fraction of them (particularly developing economies) tend to be subject to both large depreciations and appreciations. By comparing the group-wise graphs, one can see that most of the Industrial economies are clustered around 2% points at the 45-degree line, suggesting the magnitude of real exchange rate fluctuations for those economies are smaller and less dispersed than developing economies. For the Financial group, the average changes of exchange rates are quantitatively similar to the Industrial economies. The other three groups depict obviously larger dispersions. The majority in those groups are roughly scattered around the 45-degree line with the average magnitude ranging from 2-5 percent. Some of the outlier economies have experienced substantial variations of their exchange rates.

Combing the results of Figure 3-1 and 3-2, one can infer that the exchange rate fluctuations are generally moderate and symmetric between appreciation and depreciations for the Industrial and Financial economies. The Oil Exporting group is exposed to the largest annual changes with moderate persistence. This also coincides with the large oil price volatilities shown in Section 3.6.2. A majority of the Emerging and Other Developing economies tend to be subject to the roughly symmetric exchange rate fluctuations with the magnitude larger than the Industrial group. However, several economies in those two groups have experienced a substantially large and persistent depreciations or/and appreciations.

3.4.2.2 Trade Balance Performance

To further assess the asymmetric responses of the trade balance to the perceived depreciations and appreciations, the exchange rate variables used in the previous regressions is decomposed into negative and positive domains by interacting with the respective dummies.[6] Hence the contemporaneous appreciation dummy **1**(AP_t) will take the value of one if an appreciation is observed in the current year, and the first lag dummy **1**(AP_t-1) will be one if the appreciation happened one year before. Similarly, the depreciation dummy will be switched on if the corresponding year has depreciation.

[6] In the data, there are no cases that the annual percentage change of the exchange rate is 0.

Table 3-7 presents the results comparable to the specification of Table 3-1. It can be seen firstly that the split of depreciation and appreciation dose not influence the overall performance of the regressions, *i.e.* the standard devotions (RMSE) and R-squares have little change. The coefficients for the variables other than exchange rates only show marginal changes, hence preserving the same implications. To be specific, the growth of GDP suggests negative correlations across the groups but only significantly for the Industrial and Emerging Market economies. The terms of trade is positively correlated with the trade balance except for the Financial group the Oil Exporting group exhibits the largest magnitude.

Table 3-7. Asymmetric Adjustments of $d\frac{TB}{(X+M)}$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dlnREER*	0.026	0.105	-0.082	-0.450	-0.183	-0.043	0.169
1(Ap_t)	(0.62)	(2.74)***	(-1.69)	(-1.35)	(-1.66)	(-0.52)	(3.33)***
dlnREER*	-0.222	-0.212	-0.002	0.752	-0.080	-0.297	-0.188
1(Dp_t)	(-4.02)***	(-5.29)***	(-0.02)	(0.88)	(-0.32)	(-4.01)***	(-3.36)***
dlnREER(-1)*	-0.141	-0.152	-0.099	0.281	-0.165	-0.088	-0.156
1(Ap_t-1)	(-5.27)***	(-5.95)***	(-1.85)*	(0.98)	(-1.44)	(-2.40)**	(-4.27)***
dlnREER(-1)*	0.023	0.033	-0.107	-0.436	0.047	0.017	0.071
1(Dp_t-1)	(0.55)	(1.38)	(-2.37)**	(-0.90)	(0.47)	(0.24)	(2.30)**
dlnREER(-2)*	0.013	-0.020	-0.057	-0.364	0.067	0.038	-0.008
1(Ap_t-2)	(0.26)	(-0.47)	(-0.83)	(-1.88)*	(0.44)	(0.45)	(-0.16)
dlnREER(-2)*	0.032	0.010	-0.030	0.435	0.045	0.029	0.005
1(Dp_t-2)	(1.32)	(0.36)	(-0.69)	(1.66)	(0.77)	(0.76)	(0.11)
dlnTOT	0.229	0.136	0.244	0.020	0.324	0.132	0.109
	(4.98)***	(3.43)***	(3.83)***	(0.11)	(3.68)***	(2.19)**	(2.38)**
dlnGDP	-0.350	-0.391	-0.434	-0.348	-0.143	-0.577	-0.221
	(-2.91)***	(-3.37)***	(-4.84)***	(-1.19)	(-0.71)	(-2.81)**	(-1.55)
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367
R^2 Overall	0.21	0.21	0.39	0.16	0.51	0.39	0.23
R^2 Within	0.28	0.27	0.39	0.20	0.57	0.47	0.27
R^2 Between	0.02	0.01	0.38	0.01	0.05	0.04	0.00
RMSE	0.051	0.040	0.018	0.057	0.089	0.035	0.051
Tests for Appreciations (p-values)							
Joint dlnREER	0.000	0.000	0.036	0.107	0.329	0.140	0.000
No Effect	0.107	0.271	0.032	0.235	0.159	0.418	0.953
Tests for Depreciations (p-values)							
Joint dlnREER	0.000	0.000	0.089	0.264	0.588	0.003	0.005
No Effect	0.001	0.001	0.173	0.324	0.961	0.007	0.035
Contemporaneous Appreciation = Depreciation							
p-value	0.000	0.000	0.607	0.309	0.677	0.078	0.000
Joint Equivalence for Appreciations and Depreciations							
p-value	0.472	0.279	0.598	0.252	0.317	0.349	0.299

[1] The Contemporaneous Appreciation = Depreciation test represents the test for dlnREER***1**(Ap_t) = dlnREER***1**(Dp_t)

[2] The Joint Equivalence for Appreciations and Depreciations represents the test for the sum of coefficients for appreciation variables equal to depreciations.

[3] See notes to Table 3-1

It can be shown that the trade balance tends to exhibit asymmetric short-run responses to the perceived depreciations and appreciations for developing economies. For the overall sample regression (Column 1), a significantly negative coefficient is obtained only for the contemporaneous variable, and the result remains similar when the Financial and Oil Exporting economies are excluded (Column 2). This is in contrast to the significantly negative correlation for the first lag in Table 3-1, suggesting adjustments due to depreciation tends to be faster than appreciations.

On the other hand, appreciation exhibits negative coefficients for the first order lag, but the positive coefficient for the contemporaneous variable becomes significant when the Financial and Oil Exporting groups are excluded. The tests of the quantitative equivalence of the coefficient for contemporaneous variables also confirm this short-run asymmetry but the equivalence test for the cumulative effects from appreciation and depreciations could not reject the long-term quantitative similarity, *i.e.* the same negative correlation.[7]

For the Industrial group, the trade balance tends to symmetrically respond to the annual depreciations and appreciations, and the adjustments may persist for more than one year as shown before. The coefficients for the contemporaneous variables are insignificantly negative, suggesting a depreciation (appreciation) tends to insignificantly improve the trade balance in ratio to tradable sector size. This is also confirmed by the tests shown in the lower panel. The first order lags of the perceived depreciation and appreciation variables show similar coefficients, suggesting the short-run dynamics are still symmetric one year later. The coefficients for the second order lags are both insignificant with smaller magnitudes. As a result, the overall equivalence test for cumulative effects suggests quantitative indifference between appreciation and depreciation responses.

For the Emerging Market group, the trade balance tends to show asymmetric speed of adjustments to depreciation and appreciations. It can be seen that the depreciation

[7] The cumulative effects of appreciations 0.026-0.141+0.013=-0.102 is statistically similar to depreciations -0.222+0.023+0.032 = -0.167

variables show significance only for the contemporaneous coefficient, suggesting an immediate responses with the magnitude also appear larger than the other groups. On the other hand, the negative correlation are not significant until one year later for appreciations, suggesting the trade balance adjustments relative to the tradable sector size is slower. Additional test shown in the lower panel also confirm the quantitative difference for the contemporaneous coefficients. There tends to be an ambiguity on the equivalence of net cumulative effects between appreciations and depreciations, as the test statistics cannot reject the indifference but separate tests suggest that depreciations have non-zero effects but not for appreciations. An additional test on the equivalence between the cumulative effects only for the contemporaneous and first order lag coefficients still suggest quantitative indifference with the p-value at 0.27.

The asymmetries for the Other Developing group tend to be similar to the overall sample pattern. Appreciations tend to exhibit standard J-curve pattern as an significantly positive coefficient is shown for the contemporaneous variable while a negative one is for the first order lag. The magnitudes of the two coefficients appear similar and the second order lag is insignificant and small. These result in a net cumulative effect quantitatively indifference from zero, shown in the test below the last column. In contrast, depreciations tend to exhibit an inverse-J shape, as a significantly positive coefficient appear for the first order lag while the contemporaneous variable shows negative coefficient. Nevertheless, the net cumulative effects after three year tend to be still negative (-0.188+0.071+0.005 = -0.112) and statistically different from zero. Similarly to the Emerging Market group regression, the equivalence test for the cumulative effects tends to be ambiguous. However, since the coefficients for the second order lag variables are close to zero, an additional test on the equivalence between the cumulative effect for only the contemporaneous and first order lag coefficients suggest quantitative difference with the p-value at 0.069.

For the Oil Exporting group, appreciations tend to exhibit larger and quicker responses by the trade balance in ratio to tradable sector size, since the coefficients appear to be larger toward the negative sign than depreciations. However, all of the coefficients are insignificantly different from zero, which may be due to the data incompleteness and larger variations of the variables. For the Financial economies, depreciations tend to exhibit the opposite correlations with trade balance relative to appreciation for the same periods. Similarly to the Oil Exporting group, the joint significance tests seldom show quantitatively difference from zero for those variables.

Similarly to the previous section, Table 3-8 attempts to assess the asymmetric trade balance responses relative to the overall economy size. Compared with the baseline results in Table 3-2, the general performance of the regressions are similar. The coefficients for the terms of trade and domestic income variables only exhibit second order changes and hence preserve the sample implications.

Table 3-8. Asymmetric Adjustments of $d\frac{TB}{GDP}$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dlnREER*	0.018	0.057	-0.060	-0.547	0.006	0.028	0.085
1(Ap_t)	(0.71)	(2.65)***	(-2.00)*	(-1.46)	(0.09)	(0.69)	(2.85)***
dlnREER*	-0.108	-0.097	-0.034	0.759	-0.035	-0.144	-0.075
1(Dp_t)	(-3.63)***	(-4.74)***	(-0.63)	(0.75)	(-0.24)	(-2.84)**	(-2.31)**
dlnREER(-1)*	-0.064	-0.065	-0.057	0.384	-0.061	-0.054	-0.058
1(Ap_t-1)	(-3.01)***	(-4.00)***	(-1.35)	(1.15)	(-0.58)	(-1.89)*	(-2.19)**
dlnREER(-1)*	0.010	0.010	-0.051	-0.465	-0.018	-0.003	0.033
1(Dp_t-1)	(0.27)	(0.52)	(-2.16)**	(-0.80)	(-0.15)	(-0.09)	(1.54)
dlnREER(-2)*	0.052	0.005	-0.009	-0.504	0.221	0.019	0.010
1(Ap_t-2)	(0.97)	(0.18)	(-0.22)	(-2.26)**	(0.86)	(0.68)	(0.30)
dlnREER(-2)*	0.036	-0.005	-0.014	0.466	0.112	0.025	-0.012
1(Dp_t-2)	(1.34)	(-0.31)	(-0.42)	(1.11)	(1.95)*	(1.02)	(-0.47)
dlnTOT	0.151	0.091	0.174	-0.069	0.015	0.093	0.075
	(4.26)***	(3.05)***	(2.58)**	(-0.31)	(0.12)	(2.39)**	(2.15)**
dlnGDP	-0.003	-0.189	-0.178	-0.355	0.445	-0.459	-0.017
	(-0.02)	(-1.67)	(-1.72)	(-1.38)	(1.81)	(-2.70)**	(-0.12)
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367
R^2 Overall	0.11	0.12	0.37	0.14	0.33	0.36	0.14
R^2 Within	0.11	0.16	0.37	0.17	0.36	0.46	0.15
R^2 Between	0.11	0.03	0.38	0.03	0.04	0.07	0.19
RMSE	0.051	0.031	0.012	0.071	0.112	0.023	0.041
Tests for Appreciations (p-values)							
Joint dlnREER	0.015	0.000	0.128	0.057	0.850	0.196	0.012
No Effect	0.916	0.951	0.071	0.230	0.481	0.912	0.483
Tests for Depreciations (p-values)							
Joint dlnREER	0.000	0.000	0.197	0.548	0.021	0.077	0.058
No Effect	0.166	0.010	0.117	0.496	0.708	0.058	0.202
Contemporaneous Appreciation = Depreciation							
p-value	0.002	0.000	0.729	0.349	0.751	0.039	0.003
Joint Equivalence for Appreciations and Depreciations							
p-value	0.350	0.172	0.812	0.373	0.672	0.242	0.219

[1] See notes to Table 3-7

It can be shown that although the presence of nontradable sectors tends to reduce the sensitivity of trade balance responses to exchange rate fluctuations, similarly to the comparisons between the two alternative scaling variables shown before, the asymmetric short-term adjustments for from appreciations and depreciations preserve the same implications as discussed above. For the overall sample regressions (Column 1 & 2), the coefficient magnitudes for all exchange rate variables are roughly half of the corresponding ones in Table 3-7. These ratios are always smaller than the group average openness ratio 0.80-0.70 shown in Table 3-3, suggesting larger (quicker) variations in the nontradable sectors to exchange rate shocks than the tradable sectors. Moreover, the p-values for the joint significant tests are also increased slightly relative to Table 3-7, which also suggests the weakening sensitivities for trade balance scaled by GDP size.

On the other hand, the J-curve patterns for appreciations still remain the same particularly after excluding the Financial and Oil economies. The net cumulative effect tests also show statistically indifference from zero with the p-value increased substantially relative to Table 3-7. For depreciations, the negative coefficients for the contemporaneous variable remain significant but the overall cumulative effect is different from zero only in Column 2. Above all, the weakening significance for the net cumulative effect tests results in quantitatively indifference between depreciations and appreciations after three years.

By comparing among the group-wise regressions, it can be seen that the trade balance adjustments for the Industrial economies still exhibit both short- and long-term symmetries in response to appreciation and depreciations. Although the contemporaneous variables only exhibit significance for appreciations, the coefficient magnitude for depreciations appears to be similar. The equivalent test also confirms this quantitative indifference with a large p-value at 0.729. Both the Emerging Market and Other Developing economies preserve the short-term adjustment asymmetries. The opposite case happens to depreciations since only the negative contemporaneous coefficients are significant in Column 6 & 7. Moreover, the cumulative effect tests suggest that the long-term effects of both appreciations and depreciations for the Other Developing economies are statistically different from zero while depreciations tend to exhibit negative correlation with trade balance for the Emerging Market group. The results for the Financial and Oil Exporting economies appear to be similar as before, with all the joint significance tests suggesting quantitative indifference from zero.

3.4.3 Large Depreciations and Appreciations

Despite the group-wise heterogeneities, trade balance is shown to exhibit asymmetric responses to appreciation and depreciation shocks in the first few years for developing economies. Another dimension of asymmetry could rise from the sensitivity to the magnitude of exchange rate changes. As mentioned before, developing economies are occasionally involved in extremely volatile exchange rate fluctuations. Many of them tends to be linked with contractionary currency crises or external balance reversal periods, during which developing economies tend to be more likely to experience exacerbated output cyclicality with many macroeconomic variables than the normal cases (Kaminsky et al., 2004; Frankel, 2005). In particular, a larger and faster real depreciation tends to sharpen the contrast between competitive gains and wealth contractions. Many empirical studies suggest that the economic activities, such as the price pass-through (Taylor, 2000), firm's pricing behaviours (Atkeson and Burstein, 2008) and monetary policy accommodations (Ito and Sato, 2008), are correlated with the volatilities of shocks, which would in turn determine a different sensitivity of export and import sectors' dynamic responses.

To further explore the asymmetric sensitivity of trade balance to exchange rate fluctuations, a large changes of appreciation/depreciation dummy $\mathbf{1}(\text{Large\_t})$ is created and interact with the exchange rate variables in the baseline regressions. The large changes are defined as the log-changes of the annual average REER greater than 0.2, *viz.* about 22 percent changes in the index level. Since Table 3-21 shows that the standard deviations (both overall and within) of the dlnREER variable are about 0.09 and 0.13 for the Emerging and Other Developing economies respectively. Hence 0.2

is roughly at the level of two standard-deviations. For the Oil Exporting group, the standard deviation is less than 0.15 and the exclusion level is roughly equivalent to 1.5 times of standard-deviation. Since the standard deviations for the Industrial and Financial groups are all below 0.05, one would expect few cases to be excluded.[8]

Moreover, the effective exchange rate by definition is a trade-weighted average of bilateral rates, thus the 20-percent multilateral rate changes may be corresponding to even larger bilateral real exchange rate fluctuations. For instance, if an economy has only two equal-weighted trading partners, a 20 percent annual average REER depreciation against the world would be equivalent to a) a 40 percent depreciation relative to one of the partners, b) a 20 percent changes relative to both, or c) any changes that comprise the trade-weighted depreciation differential against the two partners equal to 20%, *e.g.* 60 percent depreciation against one and 20 percent appreciation against the other.[9]

3.4.3.1 Descriptive Statistics

Table 3-9 presents the number of observations involving large real exchange rate changes across the groups. It can be seen that the whole sample covers twice as many cases of large depreciation as appreciation. This pattern is mainly driven by the Emerging Market and Other Developing groups. The Industrial and Financial groups exhibit no large changes, as expected, since the two groups have small standard deviations.[10] The Oil Exporting group tends to have an equal number of large appreciations and depreciations. A detailed country-year list is shown in Appendix.

Figure 3-3 provides the scatter plots that summarise the average magnitude of the large annual changes for each economy. It can be seen from the bottom right panel that a majority of economies are along either the vertical or horizontal axis, suggesting

[8]Since the definition is somewhat arbitrary, the analyses in the following have been also implemented by different cut-off levels at 0.25 and 0.3, and results roughly preserve the same pattern but are subject to marginal changes in the statistics.

[9]Those bilateral real exchange rate changes can be achieved by the combination of nominal exchange rate adjustments (flexible regime) and inflation differentials (fixed regime).

[10]However, previous sections also suggest that the Financial group suffers data incompleteness which may be another part of the reason.

Table 3-9. Observations of Large Appreciations and Depreciations

No. of Obs.	Whole	IND	Fin	Oil	EM	OthDev
Appreciations	15	0	0	5	3	7
Depreciations	33	0	0	6	7	19
No. of Discrepancies	-17	0	0	-1	-4	-12
Total Obs.	48	0	0	11	10	26

that most of the economies only experienced either large annual appreciation(s) or depreciation(s). There are a few economies that are scattered close to the 45-degree line, suggesting equally large magnitudes of depreciations and appreciations over the years. These are often the economies known to have domestic instabilities, *e.g.* Dem. Rep. of Congo and Venezuela. By comparing the number of countries in the figure with the number of observations listed in Table 3-9, one can figure out that most developing economies ever experienced once large changes of exchange rates.

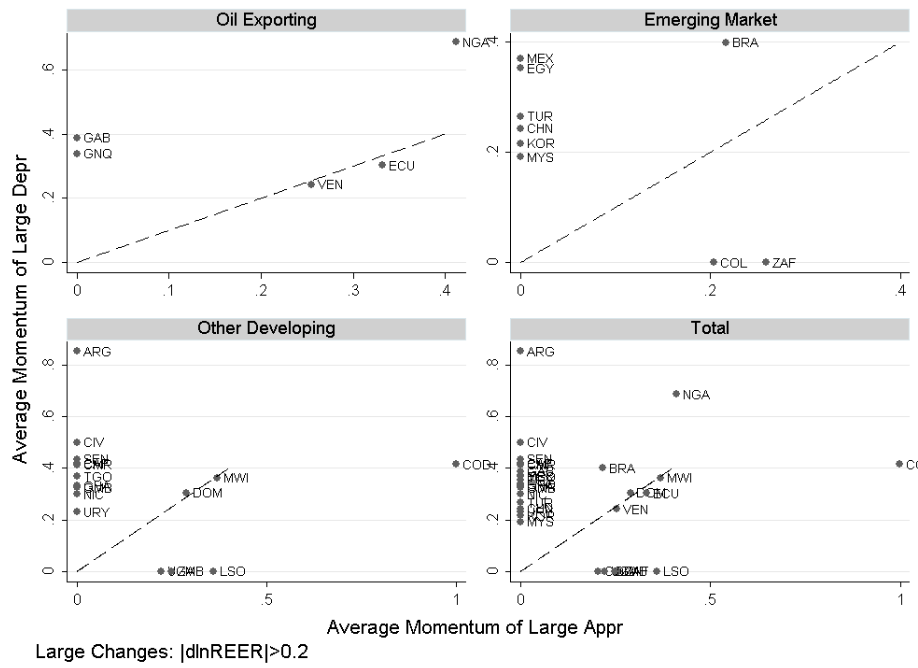

Figure 3-3. Average Momentum of Large Annual Appreciations/Depreciations

Figure 3-3 confirms the tendency that there are more economies exposed to large depreciations than appreciations, and the averaged magnitudes for depreciations are larger as well. By further examine the country-year lists, it can be seen that the perceived large depreciation cases generally cover the emerging market crises (Sachs et al., 1996) and the 1994 CFA Franc devaluation economies (Tsangarides and van den

Boogaerde, 2005). One of the stylised patterns for those EM crises was the combination of sharp devaluations and trade deficit reductions, while the CFA devaluation is believed to help those economies correct the overvalued exchange rates and hence significantly boosting growth (Frankel, 2005; Shatz and Tarr, 2000). Moreover, studies also suggest that some developing economies are particularly exposed to commodity price volatilities (Sachs, 2007) or the influence of international aid inflows (Lensink and Morrissey, 2000; Pallage and Robe, 2001) so that the extreme exchange volatilities may either indicate or be linked to the anomalous cyclicality of trade balance adjustments.

3.4.3.2 Trade Balance Performances

Table 3-10 presents the effects of large exchange rate fluctuations on trade balance adjustments relative to normal cases. It can be seen firstly that introducing the large changes dummies has insignificant influences of the general performance across the regressions. Compared with Column 1, 2 & 6 in Table 3-1 and 3-2, the standard deviations and R-squares only exhibit marginal changes. The GDP scaled trade balance regressions tend to still underperform than the tradable sector scaling ones. Moreover, the coefficients for the terms of trade and domestic income variables remain similar.

It can be shown that trade balance adjustments tend to have larger sensitivities to moderate exchange rate fluctuations for most developing economies except for the Emerging Market group. For the whole sample regressions, the negative coefficients for exchange rate variables tend to be uniformly larger in magnitude than the baseline regression results, indicating larger elasticities. The joint significance and net cumulative effects tests also confirm these negative correlations are significant both in short- and long-terms. However, the group-wise regressions suggest the opposite cases for the Emerging Market economies, shown in Column 3 & 6. It can be seen that the negative coefficients for the contemporaneous exchange rate variable are about twice as large as the baseline regressions in Table 3-1 and 3-2. The p-values for the additional tests also exhibit larger values. These suggest that for the Emerging Market group, lower contemporaneous exchange rate volatility tends to be associated with smaller short-run

Table 3-10. Asymmetric Adjustments for Large Exchange Rate Fluctuations

	$d\frac{TB}{(X+M)}$			$d\frac{TB}{GDP}$		
	Whole	Whole Excl. Fin& Oil	EM	Whole	Whole Excl. Fin& Oil	EM
	(1)	(2)	(3)	(4)	(5)	(6)
dlnREER	-0.148	-0.096	-0.138	-0.101	-0.051	-0.036
	(-2.59)**	(-1.81)*	(-2.36)**	(-2.93)***	(-1.84)*	(-1.37)
dlnREER*	0.042	0.020	-0.106	0.066	0.025	-0.069
1(Large_t)	(0.55)	(0.23)	(-0.95)	(1.44)	(0.59)	(-1.20)
dlnREER(-1)	-0.096	-0.109	-0.086	-0.044	-0.055	-0.068
	(-2.81)***	(-4.72)***	(-1.80)*	(-1.71)*	(-3.51)***	(-3.51)***
dlnREER(-1)*	0.085	0.108	0.102	0.038	0.053	0.076
1(Large_t-1)	(2.87)***	(3.32)***	(1.99)*	(1.89)*	(3.36)***	(2.33)**
dlnREER(-2)	-0.011	-0.013	0.027	0.040	0.009	0.008
	(-0.34)	(-0.36)	(0.46)	(1.11)	(0.33)	(0.25)
dlnREER(-2)*	0.050	0.016	0.007	0.000	-0.017	0.025
1(Large_t-2)	(1.17)	(0.41)	(0.09)	(0.02)	(-0.56)	(0.69)
dlnTOT	0.233	0.152	0.138	0.151	0.098	0.097
	(5.27)***	(3.77)***	(2.25)**	(4.40)***	(3.34)***	(2.51)**
dlnGDP	-0.387	-0.439	-0.594	-0.026	-0.211	-0.471
	(-3.13)***	(-3.36)***	(-2.95)***	(-0.13)	(-1.84)*	(-2.74)**
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	17	96	72	17
No. of Obs.	1049	846	219	1049	846	219
R^2 Overall	0.18	0.15	0.39	0.10	0.10	0.36
R^2 Within	0.26	0.21	0.46	0.10	0.13	0.46
R^2 Between	0.05	0.01	0.02	0.10	0.04	0.04
RMSE	0.051	0.042	0.035	0.051	0.031	0.023
Tests for dlnREER without interactions of 1(Large) Dummies in p-values						
Joint dlnREER	0.000	0.000	0.158	0.004	0.005	0.021
No Effect dlnREER	0.001	0.001	0.087	0.019	0.018	0.043
Tests for the interaction variables of dlnREER and 1(Large) in p-values						
No Effect	0.033	0.076	0.985	0.053	0.204	0.595

[1] See notes to Table 3-7

trade balance elasticities.

The results for the interaction variables suggest that for most developing economies trade balance exhibit the inverse short-run dynamics to the normal cases. The coefficients for the contemporaneous interaction variables are insignificantly positive in the whole sample regressions (Column 1, 2, 4, & 5), suggesting that trade balance improvements (deteriorations) tend to be insignificant given large exchange rate deprecations (appreciations). The positive coefficients for the first order lag of interaction variables are significant, and their magnitudes are also close to the negative coefficients for the one year lag of exchange rate variables. These suggest that under large exchange rate fluctuations, the import relative to the export sector adjustments tend to faster than the normal cases,[11] so that trade balance tends to exhibit limited responses.

[11] This can be confirmed from the export and import regressions under the same specification. The results are not shown here to avoid redundancy.

The cumulative effect test for interaction variables tends to reject the quantitative indifference from zero for the whole sample regressions, suggesting that by comparing across all the country-years, large variations of exchange rate tend to induce less (slower) trade balance adjustments in the long-term. On the other hand, the p-values for the Emerging Market group regressions (Column 3 & 6) are much higher than the other developing economy groups, suggesting that trade balance adjustments over the years given an annual average exchange rate fluctuation greater than 20% tend to be in similar proportions as the normal cases.

It can be shown that the asymmetric responses of trade balance to large exchange rate fluctuations tend to be independent of the asymmetries over appreciations and depreciations. Table 3-11 presents the results for the trade balance adjustments in terms of tradable goods[12] under the specification similar to Table 3-7. To avoid excessive number of interaction variables, the regressions instead exclude the observations with large exchange rate changes. Since there are no large changes being identified at the 20-percent cut-off[13] for the Industrial and Financial groups, only the other three groups are shown in the table. To further explore the effect of large changes, two types of exclusion are attempted. One is to only exclude the large changes for the contemporaneous year, and the other is to extend the condition in addition to all the lags (*i.e.* no large changes ever in the past 3 years).

By examining the overall regression information, it can be seen that the exclusion of large changes does not entirely rule out any individual economies within each group, though the number of observations falls substantially. In particular, the number of observations for the regressions excluding large changes in the past two years has dropped by over 20 percent across the groups. On the other hand, the exclusion of large changes tends to improve the explanatory power of the regressions for the Oil Exporting group while it enlarges the standard deviations for regression of the Emerging Market and

[12] The results for the trade balance in terms of GDP show similar patterns. As mentioned in the previous sections, scaling by tradable size is also comparable with literatures with alternative measures of trade balance.

[13] The stylized results shown in the following also apply for alternative cut-offs mentioned before.

Table 3-11. Asymmetric Adjustments of $d\frac{TB}{(X+M)}$ Excl. Large REER Changes

	Contemporaneous Year Only			Ever in Recent 3 Years		
	Oil (1)	EM (2)	OthrDev (3)	Oil (4)	EM (5)	OthrDev (6)
dlnREER*	-0.077	-0.002	0.182	-0.380	0.046	0.281
1(Ap_t)	(-0.60)	(-0.01)	(0.94)	(-0.84)	(0.35)	(1.23)
dlnREER*	-0.106	-0.270	-0.266	0.033	-0.276	-0.269
1(Dp_t)	(-0.25)	(-3.02)***	(-1.87)*	(0.09)	(-2.97)***	(-1.70)*
dlnREER(-1)*	-0.117	-0.127	-0.162	-0.501	-0.177	-0.301
1(Ap_t-1)	(-1.55)	(-2.86)**	(-2.16)**	(-1.72)	(-2.64)**	(-2.18)**
dlnREER(-1)*	-0.017	0.034	0.070	0.580	-0.065	0.049
1(Dp_t-1)	(-0.18)	(0.48)	(1.97)*	(1.47)	(-0.49)	(0.43)
dlnREER(-2)*	0.190	0.051	-0.004	-0.111	0.051	0.025
1(Ap_t-2)	(0.77)	(0.72)	(-0.05)	(-0.41)	(0.65)	(0.21)
dlnREER(-2)*	0.055	0.030	-0.015	-0.271	0.028	-0.117
1(Dp_t-2)	(1.36)	(0.74)	(-0.32)	(-0.74)	(0.27)	(-1.32)
dlnTOT	0.283	0.136	0.103	0.207	0.133	0.083
	(2.76)**	(2.18)**	(2.00)*	(3.91)***	(2.01)*	(1.69)*
dlnGDP	0.112	-0.440	-0.200	0.195	-0.401	-0.237
	(0.73)	(-2.03)*	(-1.59)	(2.58)**	(-1.83)*	(-2.00)*
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	10	17	35	10	17	35
No. of Obs.	89	208	341	73	187	302
R^2 Overall	0.59	0.25	0.15	0.58	0.22	0.15
R^2 Within	0.60	0.29	0.17	0.64	0.28	0.18
R^2 Between	0.38	0.09	0.05	0.00	0.00	0.02
RMSE	0.076	0.034	0.050	0.071	0.034	0.049
Tests for Appreciations (p-values)						
Joint dlnREER	0.494	0.01	0.03	0.086	0.012	0.192
No Effect dlnREER	0.985	0.612	0.939	0.089	0.605	0.985
Tests for Depreciations (p-values)						
Joint dlnREER	0.454	0.002	0.075	0.453	0.015	0.171
No Effect dlnREER	0.899	0.101	0.165	0.524	0.093	0.090
Contemporaneous Appreciation = Depreciation						
p-value	0.952	0.133	0.115	0.401	0.118	0.091
Joint Equivalence for Appreciations and Depreciations						
p-value	0.924	0.571	0.451	0.125	0.339	0.339

[1] See notes to Table 3-7

Other Developing economies.

Relative to the results in Table 3-7, the positive coefficients for the terms of trade variable tend to preserve similar implications as before, though the magnitude tends to be smaller for the Oil Exporting and Other Developing groups.[14] The coefficients for the domestic real GDP growth variable tend to move towards positive correlations once the observations with large annual REER changes are excluded. In particular, the magnitudes of the negative coefficients for the Emerging Market (Column 2 & 4) become smaller and the coefficients appear to be positive for the Oil Exporting group (Column 1 & 3). These suggest that the negative effects of domestic income on the

[14] Similar results can be obtained in the comparisons between the long-run trade openness ratio and the ratio of the two corresponding coefficients in the regressions for $d\frac{TB}{(X+M)}$ and $d\frac{TB}{GDP}$.

trade balance tend to be larger when real exchange rate fluctuations are more volatile for those two groups of economies. On the other side, the negative coefficients for the Other Developing economies exhibit little changes in magnitude, but become significant in the last column, suggesting that the income effects on trade balance preserve the same for different magnitude of exchange rate fluctuations.

It can be seen that the exclusion of large exchange rate fluctuation observations generally preserves the asymmetric trade balance responses to appreciations and depreciations as before. In particular, the signs of those coefficients remain the same for the Other Developing group as in Table 3-7, though the significance levels for the contemporaneous and first order lag variables are generally reduced with more observations dropped from the regressions. For the Emerging Market group, the coefficient for the contemporaneous appreciation variables becomes insignificantly positive when large exchange rate fluctuations are excluded for the past 3 years. The negative coefficient for the depreciation variable also becomes smaller in magnitude, consistent with the previous result that larger exchange rate fluctuations tend to exhibit larger trade balance adjustments. Above all, trade balance responses to depreciations are still significant for the current year depreciations but for the appreciations one year later.

The additional tests roughly follow similar patterns to Table 3-7, as depreciations are more likely to show both short-term and long-term effects that are quantitatively different from zero while appreciations only induce short-term dynamics. Previous results also suggest that large exchange rate fluctuations tend to have significantly different implications for the trade balance adjustments one year later. This can be seen particularly from the changes in the magnitude of first order appreciation variables for the Emerging Market and Other Developing economies.

3.4.4 Further Issues

Previous sections have shown that trade balance adjustments tend to exhibit groupwise short-run dynamics in response to real exchange rate fluctuations, also asymmetrically over the appreciations and depreciations for developing economies. These stylised asymmetric dynamics remain stable even after separating out the effects of extremely volatile exchange rate changes. Some other attempts are to be explored to assess the sensitivity of the results.

3.4.4.1 World Demand

There is a potential concern on the regression specification about the missing variable for world demand. As mentioned in Section 3.3, the regressions above have weakly captured the period-averaged relative position of the host economy relative to the world by using country fixed effect dummies. However, this proxy is time-invariant. Studies using bilateral trade data in country-specific regressions usually employ world GDP variable as a proxy (Bahmani-Oskooee and Ratha, 2004). Unfortunately, this would be individual-invariant and hence collinear with the time dummies that captures the group-wise common trends. As a result, an export-weighted world GDP variable is constructed instead. To be more specific, change of world demand variables for country i in year t is defined as the sum of the exporting destination partner economy j's log-differenced GDP in that year weighted by the host economy i's export share relative to its entire export basket value in the year of 2002. The formula is shown as follows:

$$d\ln GDP\_World_{it} = \sum_j w^j_{i,2002} d\ln GDP_{jt} \tag{3.4}$$

, where w is the share of export values to the destination country j relative to the total exporting basket, evaluated in the year 2002.

Similarly to the calculation of the REER variable, the export observations are restricted to have complete records over the sample period and the number of trading partners for each host economy must be no less than 90. Moreover, the data availability must be comparable with the way the REER is synthesised with WDI data. Hence if the REER series is updated with the WDI data due to the low correlation with the calculation result, the corresponding world GDP variable will be dropped for consistency.

Table 3-12 presents the stylised result for the regressions with the word GDP variable.[15] By comparing it with Table 3-7, it can be seen firstly that due to the data restrictions mentioned in the above paragraph, some of the economies have been dropped from the original sample.[16] In terms of observations, there are about 9 percent losses for the overall sample in which the Financial and Oil Exporting groups suffer the most. The overall performance of the regressions shows ignorable changes in terms of the standard deviations and explanatory power. The result for the Oil Exporting group tends be improved larger than the others but may be subject to the loss of observations.

Table 3-12. $d\frac{TB}{(X+M)}$ Regressions with Export Weighted World $d\ln GDP$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
dlnREER*	0.047	0.113	-0.08	-0.442	-0.11	-0.07	0.184
1(Ap_t)	(1.10)	(2.72)***	(-1.75)*	(-1.35)	(-1.38)	(-0.80)	(3.15)***
dlnREER*	-0.176	-0.202	0.000	0.87	0.099	-0.301	-0.179
1(Dp_t)	(-4.05)***	(-5.21)***	(-0.00)	(1.08)	(1.13)	(-4.05)***	(-3.20)***
dlnREER(-1)*	-0.146	-0.164	-0.094	0.254	-0.146	-0.099	-0.167
1(Ap_t-1)	(-5.45)***	(-6.36)***	(-1.76)*	(0.73)	(-1.71)	(-2.05)*	(-4.23)***
dlnREER(-1)*	-0.001	0.036	-0.112	-0.350	-0.031	0.016	0.076
1(Dp_t-1)	(-0.03)	(1.46)	(-2.45)**	(-0.79)	(-0.53)	-0.21	(2.43)**
dlnREER(-2)*	-0.008	-0.031	-0.059	-0.500	-0.106	0.037	-0.019
1(Ap_t-2)	(-0.16)	(-0.71)	(-0.80)	(-2.50)**	(-0.99)	-0.37	(-0.36)
dlnREER(-2)*	0.025	0.009	-0.03	0.413	0.086	0.029	0.000
1(Dp_t-2)	(1.01)	(0.31)	(-0.68)	(1.65)	(1.65)	(0.76)	(-0.01)
dlnTOT	0.227	0.133	0.243	0.064	0.315	0.14	0.103
	(4.87)***	(3.49)***	(3.83)***	-0.27	(2.70)**	(2.39)**	(2.39)**
dlnGDP_World	0.208	0.148	-0.148	-1.476	2.456	0.665	0.068
	(0.70)	(0.68)	(-0.67)	(-0.43)	(1.85)	(1.42)	(0.25)
dlnGDP	-0.509	-0.441	-0.422	-0.355	-0.744	-0.619	-0.273
	(-4.44)***	(-3.49)***	(-4.47)***	(-0.89)	(-3.86)***	(-2.66)**	(-1.75)*
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367
R^2 Overall	0.24	0.22	0.39	0.08	0.74	0.43	0.24
R^2 Within	0.31	0.29	0.39	0.19	0.79	0.49	0.29
R^2 Between	0.00	0.01	0.36	0.00	0.01	0.00	0.00
RMSE	0.046	0.04	0.018	0.06	0.057	0.035	0.051

[1] See notes to Table 3-7.

It can be see that the coefficient for the world GDP variable never shows high significance across the regressions. For the entire sample, the coefficient appears positive as expected, suggesting that an increase in the demand from the rest world tends to improve the exporter's trade balance. Similar results can be found for the group-wise

[15] Similar results can be seen for the regressions using $d\frac{TB}{GDP}$ as the dependent variables.
[16] See the relevant discussions on constructing the REER variable in Section 3.6.1.

regressions over the Oil Exporting, Emerging Market and Other Developing economies. However, the coefficients for the Industrial and Financial groups appear negative, suggesting that an increase in the rest world's income tends to worsens the trade balance.

The inclusion of the world GDP variable only makes marginal changes to the coefficients for domestic income and terms of trade variables, which preserves all the stylised effects for the previous sections. The domestic GDP growth variable shows negative correlations with trade balance improvement and the Emerging Market group tends to have larger effects among all the groups. An improvement in the terms of trade variable is positively correlated with trade balance surplus, with the largest group-wise coefficient appearing at the Oil Exporting economies.

It can be seen that the asymmetric effects between depreciation and appreciation roughly remain the same for the developing economies, while the asymmetric effects for the Industrial group tends to be sharpened. Compared with Table 3-7, the coefficients roughly have no changes in both magnitude and significance level for most developing economy groups. For the Industrial economies, the larger negative coefficient for the contemporaneous appreciation tends to be significant relative to the deprecation variable, while the coefficient for the first order lag of deprecation tends to be larger than appreciation. This sharpens the weak asymmetric patterns in Table 3-7. Nevertheless, the quantitative indifference is hardly to be rejected by the F-tests with the p-values higher than 0.6.

3.4.4.2 Other Specifications

Another relevant issue could be the potential endogeneity between the explanatory variables and the trade balance adjustments since trade balance performance may potentially influence the exchange rate parities. Moreover, studies on country-specific J-curve effects employ a lagged dependent variable to capture short-run cycles. To introduce the first-order lag of the dependent variable in the dynamic panel, the GMM approach has been implemented *à la* Roodman (2009a). Several alternative specifications have been attempted. Table 3-13 presents the stylised results under the specification that only the time dummies are treated as purely exogenous variables while the lagged trade balance, deprecation and appreciation variables are endogenous and the terms of trade and domestic GDP variables are treat as predetermined variables.

Table 3-13. Dynamic Panel on $d\frac{TB}{(X+M)}$: GMM Estimations

	Whole (1)	Whole Excl. Fin& Oil (2)	Industrial (3)	Financial (4)	Oil (5)	EM (6)	OthrDev (7)
$d\frac{TB}{(X+M)}$(-1)	-0.138	-0.082	0.068	-0.255	-0.182	-0.03	-0.137
	(-4.24)***	(-1.42)	(1.59)	(-3.02)***	(-4.94)***	(-0.46)	(-1.76)*
dlnREER*	0.040	0.101	-0.087	-0.231	-0.119	-0.081	0.139
1(Ap_t)	(0.91)	(2.46)**	(-2.24)**	(-1.00)	(-1.37)	(-1.04)	(2.85)***
dlnREER*	-0.212	-0.196	0.011	0.694	-0.098	-0.294	-0.179
1(Dp_t)	(-2.45)**	(-3.52)***	(0.11)	(1.10)	(-0.47)	(-4.03)***	(-2.68)***
dlnREER(-1)*	-0.135	-0.166	-0.101	0.271	-0.172	-0.124	-0.155
1(Ap_t-1)	(-5.60)***	(-5.86)***	(-2.03)**	(1.77)*	(-1.83)*	(-3.44)***	(-4.05)***
dlnREER(-1)*	0.009	0.043	-0.102	-0.434	0.022	0.028	0.078
1(Dp_t-1)	(0.23)	(2.04)**	(-2.22)**	(-1.41)	(0.28)	(0.72)	(3.25)***
dlnREER(-2)*	-0.011	-0.057	-0.037	-0.074	0.036	-0.003	-0.056
1(Ap_t-2)	(-0.20)	(-1.33)	(-0.62)	(-0.40)	(0.33)	(-0.04)	(-1.19)
dlnREER(-2)*	0.058	0.043	-0.032	0.208	0.059	0.060	0.046
1(Dp_t-2)	(2.33)**	(1.68)*	(-0.74)	(0.59)	(0.98)	(1.91)*	(1.27)
dlnTOT	0.227	0.123	0.243	-0.135	0.337	0.116	0.102
	(5.22)***	(3.43)***	(5.66)***	(-1.00)	(3.98)***	(1.91)*	(2.64)***
dlnGDP	-0.145	-0.207	-0.346	-0.134	0.157	-0.390	-0.058
	(-0.84)	(-2.20)**	(-3.70)***	(-1.09)	(0.94)	(-2.39)**	(-0.54)
Constant	0.001	0.014	0.009	-0.023	-0.024	0.037	0.006
	(0.13)	(2.32)**	(2.26)**	(-1.11)	(-2.05)**	(2.88)***	(0.58)
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1047	846	260	102	99	219	367
Sargan p-value	0	0.003	0.061	0.089	0.024	0.031	0.312
Hansen-J p-value	1.00	1.00	1.00	1.00	1.00	1.00	1.00
AR(2) p-value	0.055	0.803	0.357	0.067	0.145	0.325	0.426
No. Instruments	552	552	252	102	99	216	349

[1] See notes to Table 3-7.

It can be seen that the number of instruments for those system-GMM estimations are far exceeding the number of economies across the groups. This would raise the potential concern on the weak instruments problems. Hence the power of tests may be reduced as shown in the table that the p-value of J statistics are almost 1. An alternative estimation employing the collapsed instrument matrix suggested by Roodman (2009b) has been attempted. However, due to the limited data coverage, the number of instruments across the regressions seems still too large and the results roughly remain the same.

Despite those potential technical problems, one can see that the results are generally consistent with the previous sections. Domestic real GDP growth is negatively correlated with trade balance improvement and the Emerging Market group tends to exhibit the largest magnitude among the groups. Terms of trade condition exhibits positive correlation with trade balance improvement and the Oil Exporting economies tends to show the largest coefficient as expected. The trade balance adjustment in response to real depreciations depicts asymmetric patterns as appreciations. In general, appreciation tends to show significant deterioration effects one year later while depreciation tends to have instant effects.

Moreover, the coefficient for the lagged dependent variable is significantly negative for the entire sample regression, suggesting that the annual trade balance adjustment tends to have mean reversion effect. The same result can be found for the Financial, Oil Exporting and Other Developing groups. For the Emerging Market economies, the coefficient is insignificant and the magnitude is closer to zero, suggesting a much weaker mean-reversion procedure over the sample period. For the Industrial economies, the coefficient is small and positive but nevertheless insignificant, suggesting a weak persistency of annual imbalance.[17]

3.5 Conclusion

By assessing a panel data covering 96 economies and 14 years, trade balance on aggregate tends to be negatively correlated with exchange rate appreciations cumulatively after 3 years adjustments. In the short term, negative correlations can be obtained for the current and subsequent one years. For the Industrial economies, the trade balance adjustments in response to exchange rate fluctuations tend to gradually diffuse from tradable sectors to the overall economy, as larger sensitivity of trade balance relative to the overall economy size can be observed for the contemporaneous year while more significant adjustments relative to the tradable sector size can be seen one year later. On the other hand, developing economies tend to exhibit more instant and volatile dynamics. For the Emerging Market economies, less variations of trade balance ad-

[17] When the large-changes observations have been excluded, the coefficients for the Industrial Emerging Market groups are all insignificantly positive, suggesting weak persistent imbalances over the sample period. All the rest results are consistent with the previous sections.

justments in terms of the tradable goods than the overall economy can be observed for the contemporaneous year, suggesting faster structural adjustments between tradable and nontradable sectors. Similar patterns can be inferred for the Oil Exporting and Other Developing economies but the overall effects tend to be much less significant at annual frequency.

Separating the dynamics into export and import sectors tend to yield a more significant gradual adjustment of the nominal export values than imports for the Industrial economies. Significantly positive coefficients can be found for the real exchange rate variables in both export and import regressions, with the magnitude in the former smaller than the latter. The negative coefficients in the subsequent two years are only significant for the export regression. In contrast, among the Emerging Market and Oil Exporting economies, the coefficients on the nominal import values tend to be more significant than exports. For the Other Developing group, all exchange rate variables tend to be insignificant for both import and export regressions and the negative correlations only appear two years later.

When the nominal values of exports and imports are scaled by the overall economy size, the presence of the nontradable sector variations offsets the positive contemporaneous correlations of appreciation across economies, suggesting that the pass-through and quantity adjustments occur considerably within the first year of exchange rate shocks. In general, a larger magnitude of the negative correlation in the export regressions than the import can be observed for all economies except the Financial group. The group-wise regressions also suggest that the effects of exchange rate fluctuations for the Oil Exporting and Other Developing economies are only significant for the contemporaneous year while the other groups may exhibit one year longer adjustments in their export sectors. Nevertheless, the overall effects for the Oil Exporting economies still remain insignificant.

Depreciations and appreciations tend to generate asymmetric dynamics particularly for developing economies. For the Industrial economies, the trade balance adjustments tend to exhibit quantitatively similar correlations with exchange rate appreciations and depreciations. However, there is a tendency that the cumulative effects for depreciations are statistically similar to zero after 3 years. For the Oil Exporting, Emerging Market and Other Developing groups, depreciation exhibits a much larger immediate negative correlation with trade balance than appreciations. Particularly for the Other Developing group, there is a significantly positive coefficient for the contemporaneous appreciation variables but a negative correlation for the one year lag (*i.e.* J-Curve). On the other hand, depreciation tends to have more immediate and larger negative correlations on trade balance improvement. These suggest a faster response of imports than exports for appreciations but a relatively faster export adjustment for depreciation cases. For the Financial group, appreciation tends to show an immediate deterioration effect on trade balance while depreciation tends to show significant improvement effect one-year later.

Large real exchange rate changes tend to counteract the normal short-run dynamics. This leads to the cumulatively less adjustments of trade balance if one pools all the observations for developing economies. In particular, large exchange rate fluctuations significantly offset the overall negative trade balance responses one year later as in the moderate exchange rate fluctuation cases. For the Oil Exporting and Other Developing economies, large exchange rate volatility insignificantly generates less proportional immediate responses of trade balance while for the Emerging Market group, the contemporaneous negative correlation tends to be insignificantly amplified. Nevertheless, when those large-changes observations are excluded from the regressions, the faster negative responses of trade balance to depreciations than appreciations remain the same patterns.

Domestic real income and terms of trade possess explanatory powers as expected in the literature. In particular, domestic income is negatively correlated with trade balance improvements when all the country-years are pooled for comparison. The group-wise regressions also exhibit positive correlations for the Industrial and Emerging Market economies. By comparing the coefficients under the two alternative scaling variables, trade balance in terms of the overall GDP size tends be more sensitive to domestic real income changes than in terms of tradable goods for the Oil Exporting and Emerging Market groups, suggesting the stronger growth linkage with tradable sectors.

An improvement in the terms of trade tends to be positively correlated with trade balance improvement. The group-wise regressions further suggest that variations of the nontradable sectors and hence the overall economy valuation are more addicted to the terms of trade conditions for the Oil Exporting and Other Developing groups, yielding a more sensitive trade balance measures in terms of tradable goods. On the other hand, a larger sensitivity of trade balance response scaled by the overall economy size can be found for the Industrial and Emerging Market economies.

3.6 Appendix

3.6.1 Construction of Real Exchange Rates

To exploit the data availability, the REER variable is a synthesis between the calculated series by using the IMF data and some existing series from the WDI database. In the calculation, the REER for an economy by definition is constructed as the trade-weighted geometric average of its bilateral real exchange rates. The basket of trading partners is fixed at the year of 2002 according to the IMF DOT database. The bilateral trade weightings for each year are defined as the bilateral imports plus exports. Due to the data availability, a trade partner is assigned missing in the calculation if the observation is missing in anyone year during the sample period. If a host economy has missing trading partners exceeding half of the numbers in potential recording economies (*i.e.* 92), its effective exchange rate series is dropped in calculation[18].

The corresponding nominal bilateral exchange rates are defined as foreign currency price per unit of domestic currency, constructed from each country's nominal exchange rate against the USD. The series then are normalised on 2002M12 and adjusted by the inflation differentials to form the index of the real bilateral exchange rate. The inflation rate for each country is the first-order difference of the logarithmic CPI. Both the nominal exchange rate and CPI data are the end-of-period monthly series from the IMF IFS database. Similarly as before, the bilateral exchange rate against a trading partner would be missing if the series lack consistent and complete data availability. Once the monthly REER series is constructed, the annual series is the period average

[18]There is no significant difference of choosing the missing number of trade partners as a half or a quarter, to the extent that the lower correlation results are very similar to Table 3-16.

correspondingly.

Euro was formally launched in 2002 but began to be pegged by its pioneer member currencies in 1999M1. Thus the exchange rate of each member country against USD after pegging is calculated by the multiplication between their converting rates against EURO at the time of pegging and the EURO exchange rates against USD thereafter. For instance, the exchange rate of German Mark against USD in 2002M1 is converted by its fixing rate against EURO at 1.95583 in 1999M1 times the EURO Rate against USD in 2002M1. In the graph, it is equivalent to shifting the EUR/USD plot after 1999M1 to be connected to the DEM/USD rates thereafter. The fixing rates are recorded by the IFS with 6-digit accuracy and are listed in Table 3-14 below:

Table 3-14. Converting Rates for Currencies Preceding to Euro

Currency	Rate	Converting Month
Austrian schilling	13.7603	1999M1
Belgian franc	40.3399	1999M1
Dutch guilder	2.20371	1999M1
Finnish markka	5.94573	1999M1
French franc	6.55957	1999M1
German mark	1.95583	1999M1
Irish pound	0.787564	1999M1
Italian lira	1936.27	1999M1
Luxembourgian franc	40.3399	1999M1
Portuguese escudo	200.482	1999M1
Spanish peseta	166.386	1999M1
Greek drachma	340.75	2001M1

To enrich the data availability and ensure the compatibility with other data sources, the calculated REER series are synthesised with the corresponding series of the WDI database. The synthesised REER is by default using the calculated data. For the series both available in the two sources, the WDI one will be adopted if the correlation between the two is lower than 0.89. For those series only available in the calculated data, they will be adopted only if the number of trading partners in the calculation is above 90. Accordingly, Table 3-15 summarises the data source distribution across the groups. It can be seen that, in general, the observations of the Industrial and Emerging Market groups are mainly from calculation, which possibly results from their rich availability of data in the calculation. On the other hand, the two sources both contribute substantially to the observations for Financial, Oil Exporting, and Other Developing economies. These suggest the data incompleteness, and may raise the comparison issues for various data sources.

The final synthesised series contain 96 economies, of which 45 are both appearing in the two sources. A further comparison between those 45-economies sample will exhibit the differences. As shown in Table 3-16, 13 of them have the correlation lower than 0.95 over the sample period, but in overall they are higher than 0.81 except Iran. About half of the economies with lower correlations are in Other Developing group, and a quarter of them are in the Oil Exporting group. The only large discrepancies between

Table 3-15. $d \ln REER$ Data Source Distributions Across Economy Groups

	Industrial	Financial	Oil	EM	OthrDev	Total
No. of Economies						
Calculation	17	6	5	13	14	55
WDI	3	8	5	4	21	41
Total	20	14	10	17	35	96
No. of Obs.						
Calculation	221	48	51	167	164	651
WDI	39	55	49	52	203	398
Total	260	103	100	219	367	1049

the two sources among the Industrial group happen to the US. Lower correlation may partially result from missing observations of some trading partners in the calculation (the simple correlation between the last two columns of the table is about 40 percent) or/and from using different definitions of trade values and price indices.

Table 3-16. dlnREER Correlation from Calculation and WDI lower than 95%

Economy Name	Category	Correlation	Number of Trading Partners in Calculation
Ghana	Other Developing	0.944	89
Bahamas	Financial	0.942	84
Fiji	Other Developing	0.937	87
United States	Industrial	0.937	99
Cote d'Ivoire	Other Developing	0.93	98
Trinidad and Tobago	Oil Exporting	0.929	96
Pakistan	Other Developing	0.916	93
Malta	Financial	0.906	97
Dominica	Other Developing	0.897	85
Zambia	Other Developing	0.846	91
Morocco	Emerging Market	0.83	92
Nigeria	Oil Exporting	0.81	92
Iran	Oil Exporting	0.235	84

Table 3-17 shows the complementarity between the two sources. It can be seen that the calculated series mainly contribute to the Emerging Market group while the WDI data are richer in Financial and Other Developing economies. As motioned in the previous paragraph, fewer trade partner data tends to create greater distance between the various sources of data. Hence the data contributed solely by the calculation are restricted to those economies having the trading partners more than 90 in the calculation. Among the 17 Emerging Market economies in the final synthesised data, about half of them do not have comparable REER series. As shown in Table 3-17 , there are 8 economies only having the data from the calculation while 3 from WDI. Those 3 missing in the calculation are due to lacking monthly inflation series. The same reason can be found for the three industrial economies in the lower panel, except that Belgium lacks the trade value data in the IMF document due to the changes of accounting in 1997 . On the other hand, among those small economies classified as Other Developing or Financial groups, over half of them are lacking either bilateral trade value or price information. For instance, most of the Financial economies in the lower panel of the table are belonging to East Caribbean Dollar zone, of which the trade data are mostly unavailable and hence dropped in the calculation.

Table 3-17. Complementarity between Calculated and WDI $d\ln REER$ Series

Name	Category	No. Trade Partners in Calculation	Name	Category	No. Trade Partners in Calculation
Economies having Calculated REER but missing WDI					
South Korea	Emerging Market	99	Sri Lanka	Other Developing	96
India	Emerging Market	98	Thailand	Emerging Market	95
Mexico	Emerging Market	98	Peru	Emerging Market	94
Turkey	Emerging Market	98	Brazil	Emerging Market	93
Hong Kong	Financial	97	Senegal	Other Developing	92
Argentina	Other Developing	97	Mauritius	Financial	91
Egypt	Emerging Market	96	Barbados	Other High Income	90
Economies having REER in WDI but missing in Calculation					
Australia	Industrial		Cambodia	Other Developing	
Belgium	Industrial		Central African Rep	Other Developing	
New Zealand	Industrial		Chad	Other Developing	
Antigua and Barbuda	Financial		Demo.Rep. of the Congo	Other Developing	
Belize	Financial		Ethiopia	Other Developing	
Grenada	Financial		Gambia	Other Developing	
Ireland	Financial		Guyana	Other Developing	
St. Kitts and Nevis	Financial		Kiribati	Other Developing	
St. Lucia	Financial		Lesotho	Other Developing	
St. Vincent and the Grenadines	Financial		Nicaragua	Other Developing	
Samoa	Financial		Other Developing		
Bahrain	Oil Exporting		Papua New Guinea	Other Developing	
Ecuador	Oil Exporting		Paraguay	Other Developing	
Equatorial Guinea	Oil Exporting		Sierra Leone	Other Developing	
Chile	Emerging Market		Solomon Islands	Other Developing	
China	Emerging Market		Togo	Other Developing	
South Africa	Emerging Market		Tonga	Other Developing	
Bolivia	Other Developing		Tunisia	Other Developing	
Burundi	Other Developing				

In addition to the bilateral trade and price data, the IMF provides its own calculated REER annual series as well. This will help exploit the reliance of those data only available in WDI for small developing economies.[19] As shown in Table 3-18, among 77 economies that are both available in IFS and WDI database, only a limited number of them tend to have larger discrepancies from the two sources. All of them are small developing economies and are unable to construct the REER data by the calculations. Two notable economies are Lesotho and Guyana, of which the correlation of REER between the two sources are further below 90 percent.

Table 3-18. $d\ln REER$ Correlation from IMF and WDI lower than 95%

Economy Name	Category	Correlation
Grenada	Financial	0.931
Bahrain	Oil Exporting	0.918
Antigua and Barbuda	Financial	0.899
Lesotho	Other Developing	0.856
Guyana	Other Developing	0.405

[19]The lower correlation between the calculated results and IMF data are highly similar to Table 3-16 above.

3.6.2 Descriptive Statistics

3.6.2.1 Trade Balance

The summary statistics for the trade balance performance across the five economy groups are shown in Table 3-19. The first two columns are the numbers of observations and individual economies involved in the regressions. The third column is the average length of data-available years within each group of economies (the ratio of the first two columns). The sample means and standard deviations taking both variations along individual economy and time dimensions are presented in the middle two columns. The between-effect standard deviation (Std_b) in the next column calculates the variations across the individual economies' mean values. The last column shows the within-effect standard deviation (Std_w), which characterises the average of each individual economy's de-meaned variations.

Table 3-19. Summary Statistics of Trade Balance

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
TB/GDP							
Overall	1147	96	11.95	-0.0328	0.14814	0.14377	0.0702
Industrial	280	20	14	0.0134	0.05615	0.05271	0.02245
Financial	117	14	8.36	-0.0613	0.15527	0.14801	0.06596
Oil Exporting	111	10	11.1	0.0961	0.19817	0.105	0.17113
Emerging Market	236	17	13.88	-0.0017	0.05898	0.04384	0.04061
Other Developing	403	35	11.51	-0.1102	0.16658	0.16926	0.05888
TB/(X+M)							
Overall	1147	96	11.95	-0.0496	0.16682	0.16674	0.07347
Industrial	280	20	14	0.0094	0.09131	0.08639	0.03495
Financial	117	14	8.36	-0.0711	0.12476	0.11597	0.05239
Oil Exporting	111	10	11.1	0.1208	0.18656	0.11023	0.15307
Emerging Market	236	17	13.88	-0.0204	0.07999	0.05461	0.0597
Other Developing	403	35	11.51	-0.1485	0.18682	0.19879	0.07249
d(TB/GDP)							
Overall	1049	96	10.93	0.0013	0.05456	0.01551	0.05325
Industrial	260	20	13	-0.0009	0.01537	0.00483	0.01463
Financial	103	14	7.36	-0.0035	0.07259	0.02316	0.06974
Oil Exporting	100	10	10	0.0118	0.12533	0.00911	0.12508
Emerging Market	219	17	12.88	0.0036	0.03068	0.00593	0.03013
Other Developing	367	35	10.49	-0.00002	0.04509	0.01896	0.0429
d (TB/(X+M))							
Overall	1049	96	10.93	0.0032	0.06099	0.01691	0.05904
Industrial	260	20	13	-0.0025	0.02296	0.00688	0.02195
Financial	103	14	7.36	-0.0061	0.05937	0.01871	0.05705
Oil Exporting	100	10	10	0.0235	0.12515	0.0272	0.12236
Emerging Market	219	17	12.88	0.0053	0.04646	0.0085	0.04572
Other Developing	367	35	10.49	0.0031	0.06009	0.01574	0.05865

It can be seen that the overall-averaged spell of data-available years for each economy is below 12, (mainly from 1993 to 2006). The Industrial group possess the richest time coverage, which is about 14 years on average. The Financial economies suffer the poorest data completeness over the years. The Oil Exporting and Other Developing groups are the second worst. The case for the Emerging Market group tends to close to the Industrial economies. Moreover, the group-wise distribution of the number of economies is listed in Table 3-20.[20] It can be seen that the number of counties for the Industrial and Emerging Market groups are stable over the sample period. On the other hand, Financial and Oil Exporting economies double their numbers after 2000, indicating the most incomplete data among the groups. The number of economies for the Other Developing group is improved by about 1/3 after the year 2000.

Table 3-20. Distribution of the Number of Economies

Year	Total	Industrial	Financial	Oil Exporting	Emerging Market	Other Developing
1994	69	20	3	6	16	24
1995	69	20	3	6	16	24
1996	71	20	4	6	17	24
1997	71	20	4	6	17	24
1998	70	20	4	6	17	23
1999	69	20	4	5	17	23
2000	69	20	4	5	17	23
2001	94	20	13	10	17	34
2002	95	20	14	10	17	34
2003	94	20	13	10	17	34
2004	94	20	13	10	17	34
2005	92	20	12	10	17	33
2006	92	20	12	10	17	33

The upper two panels of Table 3-19 characterise the two alternative trade balance measures involved in the regressions. By comparing the two, one can observe that for those economies belonging to the Industrial, Emerging Market and Other Developing groups, trade balance scaled by GDP tends to provide greater numbers in mean levels, *i.e.* toward (larger) surplus, than relative to the one scaled by the total value of trade. However, the latter measure exhibits larger variations than the former both on the between- and within- effects. Conversely, relative to the total value of tradable goods, trade balance normalised by GDP will show a smaller surplus for the Oil Exporting economies but a larger overall variations for both Oil Exporting and Financial Economies. Nevertheless, alternative valuations, though, change the trade balance statistics quantitatively for each individual group, the qualitative implications and rankings across the groups have not been altered.

During the sample period over 1993-2006, the overall sample roughly shows a small deficit, *i.e.* the trade balance is about 3 percent of GDP or 5 percent relative to the trade value. This small discrepancies may result from measurement errors or/and incomplete country coverage, which is common in literatures (Edwards, 2004a). In terms of the simple average of the country-year observations, the Industrial group is running a small scaled trade surplus and close to balance, while those economies in the Emerging Market group are positioned in small deficits. These two categories also exhibit the smallest overall standard deviations than the others. Oil Exporting economies have the largest trade surplus compared with the rest groups, while the

[20] Since fixed effect regressions consumes one year degree-of-freedom, data samples are then listed from 1994.

Other Developing group run the largest trade deficit position on average. These two categories also exhibit the largest overall volatilities. Those economies in the Financial group generally have moderate trade deficits with a substantial size of variations.

The decomposition of between- and within- variations provide more information about the heterogeneity across the groups. By comparing the last two columns of Table 3-19, it can be seen that for the overall sample, the between effect of trade balance positions dominates the within effect, *i.e.* the long-run variations in trade balance position between the economies is larger than those annual fluctuations respectively around each individual means. The magnitude of the between effect is about twice as much as the within effect, which quantitatively show the intra-group heterogeneities. There are three groups follow this overall sample pattern: the Industrial, Financial, and Other Developing groups, of which the latter two have the largest intra-group variations among the five groups. With the second smallest between-effect variance, the Industrial economies have the smallest magnitude of within-effect, which reveals their economic stability and group-wise similarity in the sense that the trade balance fluctuates around each long-run level to a limited extent. Those Emerging Market economies have roughly equal size of the between- and within- variance. This suggests that the fluctuations are both subject to the shocks from the economy's external sectors and its intrinsic properties. Lastly, given a considerable size of both the between- and within-effect, the Oil Exporting group shows a distinctive pattern that the former effect dominates the latter one. This suggests that with the sizeable heterogeneity in the trade balance position, all of the Oil Exporting economies are subject to large (and the largest among the groups) within-variations.

In parallel to the average levels of the trade balance across the groups, the lower two panels characterise the variables measuring the annual changes. Similar to the previous quantitative effects of the two alternative measures, changes in the trade balance scaled by the total value of trade tend to yield lower mean values (i.e. larger average deficit) and greater variances among the Industrial, Financial, and Oil Exporting groups. In contrast, scaling by GDP tends to yield lower means and larger variance for the Emerging Market and Other Developing groups. A notable quantity effect is the mean value for the Other Developing category: a very small deterioration on average in terms of GDP, but an overall improvement under the total trade value measure. Nevertheless, those quantitative differences never alter the rankings of the statistics between the groups.

It can be seen that given the sample period, the scaled trade balance for the entire sample show an overall improvement. The Oil Exporting group contributes to this substantially, with both the largest mean and variance. The Emerging Market economies run towards (larger) surplus as well with about one-third overall standard deviation of the one for the Oil Exporting group. The largest average deterioration of the scaled trade balance happen to the Financial group, with the second largest overall variance (about half of the standard deviations for the Oil Exporting group). Having a similar magnitude of variations to the Financial group, the overall changes of the trade balance for the Other Developing economies tend to be either close to zero or slightly positive.

In contrast to the levels, when the changes of the scaled trade balance are being considered, the between-variation for the entire sample is dominated by the within-variation, i.e. the long-run changes of trade surplus across the individual economies is smaller than the annual variations deviating from each individuals' respective averages. Quantitatively, the within-variation is three times as much as the between effects. Among the five groups, the Oil Exporting one exhibits the largest variance both along the between- and within dimensions. The Financial and Other Developing groups are ranked at the second. The Industrial economies possess the smallest standard deviations, which again suggest the stability of macroeconomic performances relative to the others. The between-variance for the Emerging Market group is relatively in equal size to the Industrial group but the within-effect is twice in magnitude.

3.6.2.2 Real Exchange Rate and Terms of Trade

Table 3-21 presents the summary statistics for the variation of the two relative price ratios: the logarithmic changes of the real effective exchange rate index and the terms of trade. A positive realisation implies real appreciation the against the rest world or of the average export price relative to the import one (an improvement in the terms of trade). It can be seen from the upper panel that the overall country-year observations for the log-changes of the real exchange rates compose a negative mean value. The Other Developing economies on average have the largest currency devaluations with the second largest overall variance among the groups. The Financial group is the other category that has the average devaluation over the sample period, with the smallest overall standard deviations. The Emerging Market economies exhibit a larger average appreciation than the Industrial economies and their overall standard deviation is nearly twice in magnitude than the latter group. The Oil Exporting economies have one of the smallest average appreciations but are subject to the largest overall variance.

In contrast to the exchange rate deprecation, the annual changes of the terms of trade for the entire sample exhibit an average improvement. The Oil Exporting economies tend to follow this pattern distinctively by both the largest average improvement and overall standard deviation among the groups. The magnitude of average improvement is thirty times as large as the Industrial group average and four times in the overall standard deviation. The Emerging Market group exhibits moderate improvement and overall variation that are both larger than the Industrial group.

Table 3-21. Summary Statistics of $d\ln REER$ and $d\ln TOT$

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
dlnREER							
Overall	1049	96	10.93	-0.004	0.10129	0.02284	0.09896
Industrial	260	20	13	0.0025	0.04554	0.0094	0.04461
Financial	103	14	7.36	-0.0034	0.03815	0.01434	0.0357
Oil Exporting	100	10	10	0.0023	0.14569	0.03298	0.14243
Emerging Market	219	17	12.88	0.0037	0.08877	0.0138	0.08775
Other Developing	367	35	10.49	-0.0152	0.12987	0.02895	0.12731
dlnTOT							
Overall	1049	96	10.93	0.0035	0.09646	0.03865	0.08983
Industrial	260	20	13	0.0022	0.04288	0.0191	0.03862
Financial	103	14	7.36	-0.0114	0.04483	0.01922	0.04144
Oil Exporting	100	10	10	0.063	0.16219	0.03116	0.15947
Emerging Market	219	17	12.88	0.0027	0.06418	0.0209	0.06084
Other Developing	367	35	10.49	-0.0071	0.11863	0.04546	0.11176

The terms of trade of the Other Developing economies is on average worsened and subject to the second largest volatility among the groups. Both of the mean value and overall standard deviation is about triple the magnitude of the Industrial economies. The Financial group exhibits the largest worsening position in the terms of trade that are quantitatively four times larger than the Industrial group's improvement while the overall variances are of comparable sizes.

By comparing the two variables, it can be seen that the mean values appear as the same signs but in different magnitudes and rankings between the groups. The standard deviations for the two variables do not preserve the consistent rankings across the groups either. These discrepancies are mainly contributed by the Financial and Oil Exporting groups, which are also subject to the worst data completeness. For the rest three groups, the overall variation of the logarithmic terms of trade index are generally smaller than that of the real effective exchange rate index. The mean value of the log-differenced terms of trade variable is closer to zero than the exchange rate variable, with the smaller overall and with-in standard deviations as well. However, the between effect of standard deviations, which indicate the variations across the individual economies' average changes of the price ratios, are larger for the terms of trade variable than the effective exchange rate. Regardless of the qualitative similarities for some groups, the discrepancies between the two price variables tend to suggest the heterogeneities of each economy's trading environments and various sources of shocks.

By decomposing the country-year variations into the between- and within- effects, it can be seen that the annual exchange rate appreciations around each economy's mean level over the years is more volatile than the variations across those individual means. Quantitatively, the within-standard deviation is over four times of the between variation for the overall sample. The Industrial economies on average show the smallest cross-country heterogeneities and one of the smallest within variations over the sample period. The smallest overall standard deviation for the Financial group may result from its smallest within- variations and moderate between- variations. The ratio between the two standard deviations is only around two, which is much lower than the entire sample average. This implies that the heterogeneities for annual real exchange rate appreciations across the Financial economies account for more overall variations relative to the other groups. The Oil Exporting economies have both the largest between and within variance, which leads to the largest overall fluctuations among the groups. The standard deviations are about triple of the Industrial group. For the Emerging Market group, the standard deviation of the annual exchange rate appreciations around the individual economies' mean levels is nearly twice of the Industrial group, which is quantitatively consistent with the comparison for the overall variance. On the other side, the between-effect of the standard deviation is only one-sixth of that of the within effect, much lower than the entire sample average. This second smallest between-variation suggests the disproportionate annual exchange rate fluctuations for the Emerging Market economies relative to the rest ones. All of the standard deviation measures for the Other Developing economies are about three times as large as those for the Industrial groups and are slightly smaller than those for the Oil Exporting economies.

It can be seen that with respect to the entire sample, the within- variations dominate the between- effects as well for the annual changes of the terms of trade variable. However, though its overall standard deviation is quantitatively comparable to the annual exchange rate fluctuations, the ratio of the within- standard deviation to the between- one is about two, which is only half of the case for the exchange rate variable. This may imply the different sources of the contemporaneous external shocks to the tradable sectors: directly from the terms of trade condition or indirectly from the other sectors through the general price level. Furthermore, given that the within- standard deviations between the two variables are similar in magnitude, the annual changes of the terms of trade could then reveal larger cross-country heterogeneities of the tradable sectors.

In contrast to the exchange rate fluctuations, the annual changes of the terms of trade for the Industrial economies exhibit smaller standard deviations than the Financial economies. Both of these two groups show larger variances for the terms of trade variable than their exchange rate volatilities. The Oil Exporting group shows the largest number for the standard deviations, which is intuitively straightforward: the volatile oil price shooting up and down over the sample period tends to be revealed from those oil exporting economies' price ratios of exporting goods relative to imports. The within-standard deviation is five times as large as the between one, which is much higher than the entire sample average ratio. In group-wise comparisons, the overall and within- standard deviations for the Oil Exporting economies are four times larger than those for the Industrial economies and about twice for the between-effects. Relative to the Industrial economies, the annual changes in the terms of trade are less volatile than the exchange rate fluctuations for the Developing and Emerging Market economies. The overall and within- standard deviations of the terms of trade changes are respectively 1.5 times larger than the Industrial economies for the Emerging Market group and for 2.5 times for the Other Developing group. The largest intra-group cross-country differences of the terms of trade changes happen to the Other Developing group, which suggests the sharp asymmetries of the changes in trading environments.

Despite of the cross-country heterogeneities, Figure 3-4 presented below attempts to show the group-level averaged correlations of the annual changes in GDP-scaled trade balance with the lags/leads of the exchange rate and terms of trade variables. It can be seen that almost all of the correlations damping out with the increasing years of lag. On the other hand, it can be seen that the correlation functions over the entire lags/leads domain are graphically consistent with the S-shape pattern suggested by the international business cycle literatures. The bottom right panel shows the average performance of the two correlation functions for the overall sample. The largest magnitudes happen to the contemporaneous correlations. An improvement in the terms of trade is positively correlated with larger trade surplus while an appreciation shows negative value. Further lagged correlations of the scaled trade balance with the lags of both terms of trade improvement and exchange rate appreciation appear as negative values with much smaller magnitude, suggesting the subsequent deteriorations in the trade balance following the immediate adjustments.

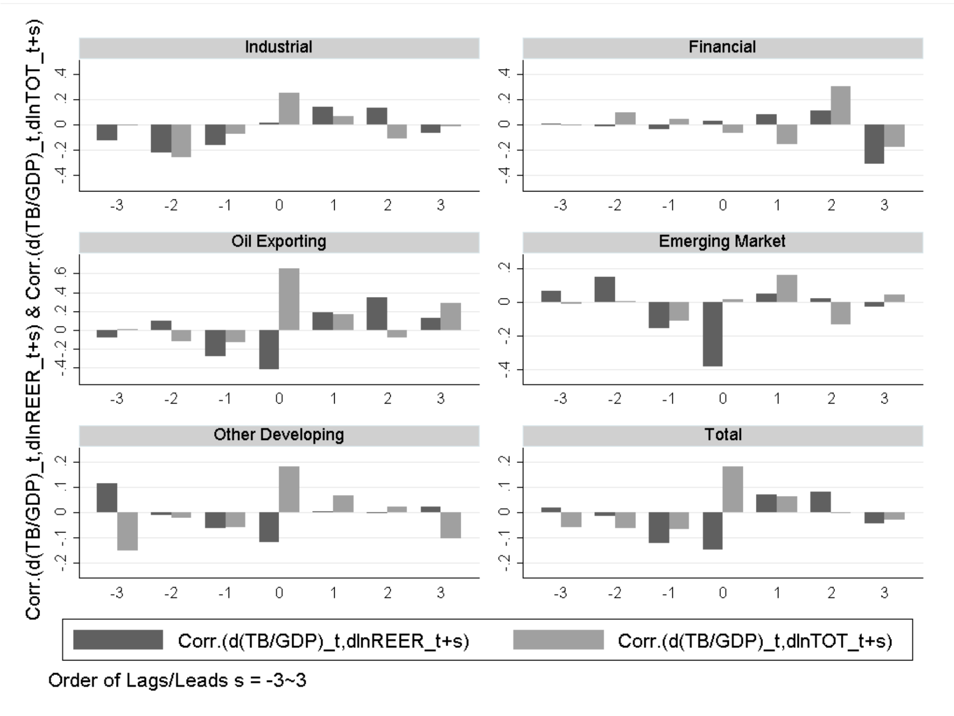

Figure 3-4. The S-Curves for dlnREER and dlnTOT

By comparing among the groups, it can be seen that for the Industrial economies, the group-level correlation function with the contemporaneous exchange rate variable is close to zero. For the Financial economies, the correlation functions over the lags domain tend to have the opposite signs to the Total group case but they are all very close to zero. The Oil Exporting economies exhibit the largest positive correlation between the trade balance and contemporaneous terms of trade changes. Much smaller positive values can be seen for the Other Developing and the Emerging Market group tends to be close to zero. On the other side, larger negative values of the correlation with the contemporaneous exchange rate appreciation can be shown for the Emerging Market and Oil Exporting groups. Almost all groups show a larger negative correlation of trade balance with the one-year lag of the exchange rate than with the term of trade. In considering of the reversal cycle over the lags domain, a longer period of the correlation function with exchange rate appears for the Industrial group than the rest.

3.6.2.3 Other Variables

Table 3-22 presents the annual growth performance of real GDP across groups over 1993-2006. It can be seen that all the groups on average exhibit positive growth with the within-variation larger than the between-effect. The Oil Exporting group exhibits both the highest average growth and the largest volatilities while the Industrial economies show the lowest but the most stable growth. Quantitatively, the former group on average is twice in growth rate and five times in both between- and within- standard deviations of the Industrial economies. The Emerging Market group in general exhibits the second highest growth rate and the second smallest volatilities, both about twice in magnitude of those for the Industrial group. The Other Developing group on average has the mean value and standard deviations close to the averages of the entire sample.

Table 3-22. Summary Statistics of dlnGDP

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
Overall	1049	96	10.93	0.0379	0.04292	0.02837	0.03426
Industrial	260	20	13	0.0279	0.01465	0.00818	0.01228
Financial	103	14	7.36	0.0405	0.03721	0.02931	0.03037
Oil Exporting	100	10	10	0.0567	0.08789	0.05908	0.0648
Emerging Market	219	17	12.88	0.0451	0.03479	0.01556	0.03135
Other Developing	367	35	10.49	0.0349	0.04144	0.02465	0.03572

3.6.3 Supplementary Tables

Table 3-23. Baseline Regressions on $d\ln(\frac{X}{M})$

	Whole	Whole Excl. Fin& Oil	Industrial	Financial	Oil	EM	OthrDev
dlnREER	-0.28	-0.183	-0.078	-0.069	-0.465	-0.409	-0.096
	(-2.27)**	(-1.88)*	(-0.88)	(-0.17)	(-0.98)	(-4.65)***	(-0.75)
dlnREER(-1)	-0.092	-0.078	-0.216	0.103	-0.122	-0.059	-0.039
	(-1.90)*	(-2.06)**	(-4.00)***	-0.23	(-1.45)	(-0.78)	(-0.84)
dlnREER(-2)	0.025	-0.012	-0.085	-0.078	0.066	0.056	-0.013
	-0.51	(-0.30)	(-1.15)	(-0.34)	-0.44	-0.99	(-0.26)
dlnTOT	0.497	0.319	0.493	0.053	0.82	0.291	0.274
	(5.21)***	(3.57)***	(3.86)***	-0.15	(3.00)**	(2.29)**	(2.47)**
dlnGDP	-0.949	-0.913	-0.873	-0.73	-0.676	-1.264	-0.583
	(-4.98)***	(-3.28)***	(-5.03)***	(-1.11)	(-2.14)*	(-3.04)***	(-1.50)
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	96	72	20	14	10	17	35
No. of Obs.	1049	846	260	103	100	219	367
R^2 Overall	0.15	0.13	0.38	0.12	0.39	0.37	0.13
R^2 Within	0.24	0.19	0.39	0.15	0.5	0.45	0.16
R^2 Between	0.09	0.01	0.36	0	0.18	0.02	0
RMSE	0.119	0.089	0.036	0.124	0.242	0.071	0.118

3.6.4 Country Year List

Table 3-24. List of Country-Years

Names	Sample Period	Names	Sample Period
Industrial		***Financial***	
Australia	1994-2006	Antigua and Barbuda	2001-2006
Belgium	1994-2006		
Canada	1994-2006	Bahamas	2001-2006
Denmark	1994-2006	Barbados	2001 2002
Finland	1994-2006	Belize	2001-2006
France	1994-2006	Grenada	2001-2006
Germany	1994-2006	Hong Kong	1994-2006
Greece	1994-2006	Ireland	1994-2006
Iceland	1994-2006	Malta	1996-2004
Italy	1994-2006	Mauritius	1994-2006
Japan	1994-2006	St. Kitts and Nevis	2001-2006
Netherlands	1994-2006	St. Lucia	2001-2006
New Zealand	1994-2006	St. Vincent and the Grenadines	2001-2006
Norway	1994-2006		
Portugal	1994-2006	Samoa	2001-2006
Spain	1994-2006	Singapore	2002-2006
Sweden	1994-2006		
Switzerland	1994-2006		
United Kingdom	1994-2006		
United States	1994-2006		

Names	Sample Period	Appreciation>0.2 Years	Depreciation>0.2 Years
Oil Exporting			
Algeria	1994-2006		
Bahrain	2001-2006		
Ecuador	1994-2006	2001	1999
Equatorial Guinea[1]	1994-1998 2001-2006		1994
Gabon[2]	1994-2006		1994
Iran	2001-2006		1994
Nigeria	1994-2006	1994 1996	1999
Saudi Arabia	2001-2006		
Trinidad and Tobago	2001-2006		
Venezuela	1994-2006	1995 1997	1996 2002
Emerging Market			
Brazil	1994-2006	2005	1999
Chile	1994-2006		
China	1994-2006		1994
Colombia	1994-2006	1994	
Egypt	1994-2006		2003
Hungary	1994-2006		
India	1996-2006		
Malaysia	1994-2006		1998
Mexico	1994-2006		1995
Morocco	1994-2006		
Peru	1994-2006		
Philippines	1994-2006		
Poland	1994-2006		
South Africa	1994-2006	2003	
South Korea	1994-2006		1998
Thailand	1994-2006		
Turkey	1994-2006		1994 2001
Other Developing			
Argentina	1994-2006		2002
Bolivia	1994-2006		
Burundi	1994-2006		
Cambodia	2001-2006		

Cameroon[2]	1994-2006		1994
Central African Rep.[2]	1994-2006		1994
Chad	2006		
Costa Rica	1994-2006		
Cote d'Ivoire[1]	1994-2006		1994
Congo, Dem. Rep. of	1994-2006	1999	1994 2000-2002
Dominica	2001-2006		
Dominican Republic	1994-2006	2005	2003
Ethiopia	2001-2006		
Fiji	2001-2005		
Gambia	1994-2006		2003
Ghana	1994-2006		1994 2000
Guyana	2001-2006		
Israel	1994-2006		
Kiribati	2001-2004		
Lesotho	1994-2006	2003	
Malawi	1994-2006	1996	1994 1998 2003
Nicaragua	1994-2006		1999
Pakistan	1994-2006		
Papua New Guinea	2001-2006		
Paraguay	1994-2006		
Senegal[1]	1994-2006		1994
Sierra Leone	2001-2006		
Solomon Islands	2001-2006		
Sri Lanka	1994-1997		
	2001-2006		
Togo[2]	1994-2006		1994
Tonga	2001-2006		
Tunisia	1994-2006		
Uganda	1994-2006	1994	
Uruguay	1994-2006		2003
Zambia	1994-2006	2005 2006	

1 & 2 belong to the CFA Franc Zone which experienced sharp devaluation in 1994.

CHAPTER 4

Net Investment Income and the Valuation Effects

4.1 Introduction

In parallel to the production side, studies on international capital flows suggest that a country's external portfolio position will link exchange rate adjustments to current account cycles through the valuation channel (Dornbusch et al., 1976; Lane and Milesi-Ferretti, 2002, 2007). Those discussions address the wealth transferring effects due to the valuation changes on the net foreign asset positions, which would generate an economy's external balance and growth dynamics (Bleaney and Castilleja Vargas, 2009; Lane and Milesi-Ferretti, 2011; Corte et al., 2012; Gourinchas et al., forthcoming). Specifically, real exchange rate movements alter the value of property income flows denominated in foreign currency relative to domestic GDP. If a country's net foreign assets (NFA) are entirely denominated in foreign currency, an unexpected real exchange rate appreciation will reduce the absolute value of net income flows relative to GDP, and depreciation will increase them, so depreciation improves net income flows for countries with positive flows and worsens them for countries with negative flows.

If assets are denominated in foreign currency and liabilities in domestic currency, as tends to be the case for the major currencies, depreciation increases the domestic-currency value of assets but not liabilities. These valuation gains on the net external assets balance sheet could either loosen the credit constraint (enabling the economy to borrow more or to run larger trade deficit) or make debt repayment cheaper and easier. The effect depends on the net foreign asset position of the country, the currency composition of assets and liabilities, and on the relative rates of return on assets and liabilities. For instance, Gourinchas and Rey (2007) provide an illustrative example for the US that at the end of 2003, a 10 percent depreciation of dollar tends to ceteris paribus bring about a 5 percent of US GDP wealth transfer from the rest world. If, for example, the average return on US net foreign asset stock were 4 percent, the 10 percent depreciation would improve US net property income flows by about 0.2 percent of GDP.

This chapter aims to assess the effects of exchange rate fluctuations on the net investment income flows for different groups of economies. In particular, for the Industrial economies with dominant shares of domestic-currency-denominated foreign liabilities, a depreciation would indicate valuation gains that improve the net investment incomes. For most developing economies with dominant shares of foreign currency liabilities, a depreciation would indicate a valuation loss that tends to amplify the wealth effects through the external balance sheets. Many studies particularly mentioned above have discussed the valuation effects on the *stock* of net foreign assets for some of countries. The contribution of this chapter is hence to assess the valuation effects through the net investment income flows.

The main contributions to empirical findings are that a) exchange rates appreciation (depreciation) tends to improve (worsen) the net investment income flow particularly for most developing economies with negative foreign currency exposure (FXE), *i.e.* net foreign currency lending position; b) given a change of exchange rate, the valuation effects increases with the degree of the FXE imbalance, particularly when the Industrial and Emerging Market economies are pooled for comparison; c) the valuation effects between the two groups' FXE positions are mainly driven by the adjustments of the foreign currency shares in external balance sheet components; d) the net investment income flows for the other developing economies are insignificantly influenced by the FXE positions that are mainly driven by the changes of the overall net borrowing position (*i.e.* net foreign asset position); e) the initial net captial outflow proxied by the lagged current account position is insignificantly associated with the subsequent net investment income flow across the countries; f) the response of the current account to exchange rate fluctuations are mainly driven by trade balance adjustments and the valuation effects are insignificant; g) given a depreciation (appreciation), the valuation loss (gain) tend to counteract the trade balance improvement (deterioration) for a representative Emerging Market economy with negative FXE position; h) exchange rate fluctuations tend to generate the same direction of adjustments on both investment and trade incomes for the Industrial economies with positive FXE.

It has been intensively investigated that the overall stock of net foreign asset portfolio tends not to be sufficiently symmetric and diversified across countries (Obstfeld, 1994; Lewis, 1999; Portes and Rey, 2005). On the one side, studies on industrial economies show that goods and factor mobility, financial development, and international financial integration may be determinants of asset portfolio holdings, supported by empirical findings (Baxter and Jermann, 1997; van Wincoop, 1999; Dumas and Uppal, 2001). An increasing number of theoretical works based on the portfolio framework attempt to model the dynamics of an economy's net foreign asset (NFA) position (Blanchard et al., 2005; Devereux and Sutherland, 2010; Tille and van Wincoop, 2010; Christopoulos et al., 2012).

On the other side, experiences from developing economies particularly suggest that currency-mismatch and original-sin problems are important for the dynamics of the balance of payments (Eichengreen et al., 2003; Reinhart et al., 2003; Tirole, 2003; Céspedes et al., 2004). The asymmetric structures of the currency exposures between major- and minor-currency economies would yield different valuation effect implications for their current account adjustments (Gourinchas and Rey, 2005; Lane and Shambaugh, 2010c). Also, studies on the structure of external assets and liabilities note that some developing economies tend to over-accumulate their reserves so that lower income is earned on foreign assets relative to their FDI interest payments (Dooley et al., 2004; Aizenman and Lee, 2007; Dominguez et al., 2012).

This chapter is organised as follows. Sector 4.2 presents a stylised structural equation for the net investment income based on the portfolio choice framework, then followed by literature reviews. The empirical specification and data descriptions are presented in Section 4.3. Section 4.4 firstly presents the baseline regression results that provide the overall effects of exchange rate changes on net investment income. By pooling the Industrial economies with developing economy groups, valuation effects of exchange rate fluctuations conditioning on foreign currency exposure are explored. Further variables measuring the currency shares and external capital positions are employed to assess different sources of valuation effects across the economy groups. Investigations on current account adjustment are attempted to indicate the extent of valuation effects compared with trade incomes. Section 4.6 concludes.

4.2 Literature Review

Empirically, the current account balance $CA = TB + NI + TR$ comprises the net productive factor incomes on trade (TB), investments (NI), and other transfers (TR) such as workers' remittances. The net investment income component is the income flows on the net foreign asset stock holdings. Since the foreign assets (liabilities) can be either denominated in foreign or domestic currencies, fluctuations of the exchange rate would then alter the relative size of the two components hence generating valuation gains/losses, *e.g.* see Gourinchas and Rey (2007)and Lane and Shambaugh (2010a). This in turn improves/worsens the net investment income flows.

Specifically, the gross holding of foreign asset stocks is determined by the amount of domestic and foreign currency components, FA_{FC} and FA_{DC}, where the domestic and foreign currency components are represented by the subscripts DC and FC. Hence the value of foreign assets (FA) in terms of domestic currency can be linked to the exchange rate levels,[1] *i.e.* $FA = FA_{DC} + FA_{FC}/E$, where E is the exchange rate of

[1] The measure is usually normalised upon a wealth measure, see later discussions.

which a rise implies appreciation of domestic. Denote

$$\omega^{FA} = \frac{FA_{FC}/E}{FA} = \frac{FA_{FC}/E}{FA_{FC}/E + FA_{DC}} \tag{4.1}$$

as the share of foreign currency denominated asset, so that the relative size of the currency components will be captured by the variations of ω. An immediate observation is that if $E = 1$, ω will be sufficient to indicate the allocation of foreign currency assets. In general, appreciation is associated with a *ceteris paribus* smaller ω for a given amount of the FA_{DC}. Similar expressions can be written for the liability side of the external balance sheet as well.

From the accounting equation, $NFA = FA - FL = DXE + \frac{FXE}{E}$ where $DXE = FA_{DC} - FL_{DC}$ and $FXE = FA_{FC} - FL_{FC}$ are respectively the domestic and foreign currency exposures. It is worth noting that a fully integrated international asset market is assumed where all the asset tradings happen. The foreign assets (in both currencies) are issued by the foreign entities, which in turn generate the investment income for the home country. Symmetrically, the foreign liabilities are linked to the home country financing activities, which induce the interest payments. The heterogeneity of assets over the term structures and currencies are ignored for simplicity. Using r^{FA} and r^{FL} respectively to denote the return rates on the gross holdings of foreign asset and liability stocks, yields

$$\begin{aligned}
NI_t &= r^{FA}\left(FA_{DC,t-1} + \frac{FA_{FC,t-1}}{E_t}\right) - r^{FL}\left(FL_{DC,t-1} + \frac{FL_{FC,t-1}}{E_t}\right) \\
&= r^{FA}FA_{DC,t-1} - r^{FL}FL_{DC,t-1} + r^{FA}\frac{FA_{FC,t-1}}{E_{t-1}} - r_t^{FL}\frac{FL_{FC,t-1}}{E_{t-1}} \\
&\quad + r^{FA}\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FA_{FC,t-1}}{E_{t-1}} - r^{FL}\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FL_{FC,t-1}}{E_{t-1}} \\
&= r^{FL}DXE_{t-1} + r^{FL}\frac{FXE_{t-1}}{E_{t-1}} + \left(r^{FA} - r^{FL}\right)FA_{t-1} \\
&\quad + r^{FL}\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FXE_{t-1}}{E_{t-1}} + \left(r^{FA} - r^{FL}\right)\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FA_{FC,t-1}}{E_{t-1}}
\end{aligned} \tag{4.2}$$

The last equality implies that the NI flow can be decomposed into two sources.

Specifically, the first line represents the net return from the initial NFA position, which can be further decomposed into domestic and foreign currency components. The second line represents the changes in the relative size of foreign currency components due to the unexpected exchange rate fluctuations *i.e.* the valuation effects.

As shown in later discussions, one can simply the return rate differentials by assuming an interest rate parity condition where one has a fixed premium over another. Under perfect capital market, by assuming the premium is zero, the long-run return rates tend to be equalised by expected exchange rate movements $r^{FA} \approx r^{FL} \equiv r$. Accordingly, the expression for the NI flow can be rewritten as

$$\begin{aligned} NI_t &= r\left(DXE_{t-1} + \frac{FXE_{t-1}}{E_{t-1}}\right) + r\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FXE_{t-1}}{E_{t-1}} \\ &= rNFA_{t-1} + r\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FXE_{t-1}}{E_{t-1}} \end{aligned} \tag{4.3}$$

Taking the first difference, yields

$$\triangle NI_t = r\left(\triangle DXE_{t-1} + \frac{\triangle FXE_{t-1}}{E_{t-1}}\right) - r\frac{FXE_{t-1}}{E_{t-1}}\frac{\triangle E_t}{E_t} \tag{4.4}$$

The whole bracket term represents the net accumulation of foreign assets, including net acquisition and reinvestments of the previous period income. The second term is the valuation changes, *i.e.* unexpected changes of the initial foreign currency exposure under the present exchange rate price.

Given an initial (or a steady-state equilibrium) NFA position, exchange rate fluctuations are associated with valuation changes of foreign currency components and hence affect the net property income flows. Taking a balanced NFA position ($NFA_{t-1} = 0$) for example, an economy with a net foreign currency creditor position, *i.e.* $FXE_{t-1} > 0$ or $\omega^{FA} > \omega^{FL}$, is equivalent to the net borrower position on domestic currency components. Hence the lower prices of domestic currency due to unexpected depreciation will be associated with higher interest rate income in foreign currency relative to the payments in domestic currency, viz. $NI_t = r\left(\frac{E_{t-1}}{E_t} - 1\right)\frac{FXE_{t-1}}{E_{t-1}} > 0$. Conversely, appreciation will be associated with NI improvements if an economy is having a negative foreign currency exposure. On the other hand, if the initial position of foreign currency exposure is balanced, *i.e.* $FXE_{t-1} = 0$, the NI flows will be only determined by domestic currency exposure position and is immune to exchange rate fluctuations.

Literatures on external imbalances and crises for developing and emerging market economies suggest that they are more likely to suffer either severe indebtedness constraints (Frankel, 2005; Calvo, 2006) or foreign asset valuation losses (Dooley et al., 2004; Lane and Shambaugh, 2010c). A stylised fact for these economies is that either their external debts are mostly denominated in foreign currency, or their external liabilities are associated with higher return rates from equity and FDI than their external asset income in the form of foreign exchange reserves (Aizenman and Lee, 2007; Lane and Milesi-Ferretti, 2008). Recent developments in modelling technique tend to combine the rigidity features of real adjustments in response to (mainly monetary) shocks together with the balance sheet constraints, providing more rigid and tractable theoretical justifications (Céspedes et al., 2004; Cook, 2004; Pavlova and Rigobon, 2008; Christopoulos et al., 2012). Weak currency sovereignty and imbalanced macroeconomic performance make them lack flexibility in exchange rate adjustments through the net foreign asset portfolio channel and more vulnerable to external shocks (Calvo et al., 2006b). Under extreme conditions, severe economic contractions and volatile macroeconomic variables tend to be observed (Edwards, 2004a; Frankel, 2010a).

To provide a more complete analysis, an illustrative model is presented following the recent literatures based upon the portfolio balance framework. Most studies usually ignore the absolute stocks of domestic and foreign currency components but directly model the net FXE positions (which are assumed equal to the NFA) only (*e.g.* Gourinchas, 2008; Devereux and Sutherland, 2010). The textbook-style budget constraints consist of two parts: the (intertemporal) macro identity that relates the contemporaneous expenditures and investments with income and the accumulation equation for the net assets wealth that governs the dynamics of the growth. The two conditions jointly link net savings to the variations of domestic wealth, *i.e.* $NA_t = RNA_{t-1} + NS_t$.

where NA is the net asset wealth of the economy at the beginning of time; R is the gross return for the net wealth over the period from t-1 to t; NS denotes the net saving flows.[2]

Suppose a small open economy is integrated with international goods and capital markets so that domestic asset stocks and consumption baskets consist of portfolios of both domestic and foreign varieties. Accordingly, domestic net asset wealth can be decomposed as $NA = A^H - NFL^H$ where A^H is the total asset stock of the home country; $NFL = FL - \frac{FA}{E} = -NFA$ is the net foreign liability position of which the foreign liability is assumed to be denominated in domestic currency while foreign assets in foreign currency; the superscript H represents the home country.

The asset accumulation equation can be written as $NA_t^H = R^{FL}(A_{t-1}^H - FL_{t-1}^H) + R^{FA}\frac{FA_{t-1}^H}{E_t} + NS_t$. Similarly to the previous discussions, this dynamic equation comprises two conditions: i) the portfolio allocation determining the shares of holding domestic and foreign assets which in turn can be written as proportions of the net asset wealth, and ii) the external balance condition that links the net international savings to domestic income and expenditures.

The allocation of portfolio structures can be determined *à la* Blanchard et al. (2005). Assume that domestic and foreign assets are not perfect substitutes such that the gross returns of the domestic R^{FL} and foreign assets R^{FA} satisfy

$$R^{FL} = R_p R^{FA} \frac{E_t}{E_{t+1}^e} \tag{4.5}$$

, where E^e is expected exchange rate and R_p is a multiplier that measures expected excessive returns required on holding domestic relative to foreign assets. The equality degenerates to the perfect substitutability case when $R_p = 1$ while in general R_p can vary to equate the expected exchange rate adjustments to the return ratio. Studies on the standard balance sheet channel concentrate on the risk premium in addition to the

[2] Taking a closed economy for instance, if net asset wealth can be regarded as the capital stock K and the gross return R is incorporated with the depreciation rate by $R = 1 - \delta$, then the accumulation equation becomes a stylised budget constraint $K_t = (1-\delta)K_{t-1} + Y_t - C_t$ where $Y_t - C_t$ is net domestic savings.

real return rate on the external portfolios (Bernanke and Gertler, 1989).

In the presence of information asymmetry, the risk premium, assumed to increase with the leverage position, creates a wedge between the returns on the domestic and foreign assets. Céspedes et al. (2004) note that depreciation of the domestic currency will have a trade-off on current account between a) an increased value of export accompanied by the reduction on cost of investment and risk premium, and b) the deterioration on the net wealth asset relative to the foreign. If the former effects dominate the latter, the economy's responses to a negative shock generally follow the conventional effects of portfolio adjustments, and the amplifier effect from the information asymmetry is moderately small. However, if the economy is taking a substantial liability position such that the net wealth concern is tightened, a negative shock will significantly amplified by the financial sector and hence leads to a larger contractionary result. Moreover, under those circumstances, fixed exchange rate regime tend to import larger impact than flexible regimes in the sense that the price rigidity tends to lose the flexibility of accommodating the external shocks under both cases.

Suppose domestic investors allocate a fraction α^H of the net wealth to domestic assets and an amount $(1-\alpha^H)NA^H$ to the foreign assets. The fraction $\alpha^H(R_p, \theta)$ is then assumed as a function of the expected excessive return ratio R_p of which larger value implies higher expected return for domestic assets hence encouraging the domestic allocation fraction α^H but reducing α^F. The parameter θ represents other factors that affect the investment choice. Utilising the asset market clearing condition $A^H = \alpha^H NA^H - (1-\alpha^F)\frac{A^F}{E}$, one can substitute the net asset wealth variables to yield the equilibrium portfolio choice condition that relates the net external asset position to exchange rate adjustments

$$-(\alpha^H + \alpha^F - 1)NFL^H = (1-\alpha^H)A^H - (1-\alpha^F)\frac{A^F}{E} \tag{4.6}$$

. By assuming the asset return rates are equal constants $r^{FL} = r^{FA}$ and other factors θ unchanged, the allocation fraction α depends only on the expected appreciation.

With the presence of home bias towards local assets, *i.e.* $\alpha^H + \alpha^F > 1$, long-run appreciations will indicate improvements in the external asset position. In particular, if domestic and foreign asset have zero substitutability, the fraction α is independent of the return ratio and hence the changes of exchange rate fully implies the redistribution of domestic and foreign asset wealth. In other words, appreciation indicates a larger positive net foreign asset position for the home country, *viz.*

$$\triangle NFL^H = -\left(\frac{1-\alpha^F}{\alpha^H + \alpha^F - 1}\frac{A^F}{E}\right)\frac{\triangle E}{E} \tag{4.7}$$

. Moreover, it can be seen that an exogenous increase in domestic asset supply A^H tends to shift the locus while an increase in the foreign asset supply A^F tends to yield a steeper slope, *i.e.* larger sensitivity (wealth effect) between net foreign asset position and appreciations.

Caballero et al. (2008) provide a dynamic framework of linking the asset supplies to the exogenous growth of the domestic economy. Hence the results for the portfolio balance condition discussed above will be an asymptotic property between capital holdings and long-run exchange rate levels. The authors also discuss the implications for an exogenous shock of asset supply, which coincides with the exogenous shocks to the asset stock variables A and AF that shifts or rotates the portfolio balance locus accordingly. Antràs and Caballero (2009) further enrich the framework by introducing a Heckscher-Ohlin trading world with an incomplete financial sector that has the upper limit capability of capitalising domestic output. This yields the complementarity between capital and trade flows which is contradicting to the traditional Heckscher-Ohlin-Mundell model and may help explain the Lucas paradox showing the capital flows from developing to developed economies.

Devereux and Sutherland (2009) generate the relatively higher risks on the assets of emerging market economies due to the lager volatility of productivity and prices in a DSGE model framework. They also calibrate the empirical fact that developing economies tend to hold foreign asset in terms of foreign reserves and take the liability as equities. The result suggests that those facts are consistent with the risk-sharing sense but nevertheless cannot achieve the level of complete diversification. Tille and van Wincoop (2010) highlight the high-order approximation solution to endogenise the return rates, which enables the DSGE modelling technique to solve the optimal portfolio problems. Christopoulos et al. (2012) introduce a model with financially constrained equilibrium so that the long-run exchange rate appreciation is associated with larger capability of borrowing, which is consistent with the empirical observation that real exchange rates of less financially opened economies tend to be driven by NFA positions as well as Balassa-Samuelson effect.

On the other side, the external balance condition for the open economy implies that the net foreign asset changes complement the discrepancy of net savings, which would in turn determine the asymptotic net wealth. Following the literatures mentioned in the above paragraph, one can assume that there is no net growth in the total supply of domestic and foreign asset stocks which are normalised to zero. The net wealth accumulation can be written as

$$\triangle NFL_t = r^{FL} NFL_{t-1} + R^{FL} \left(\frac{R^{FA}}{R^{FL}} \frac{E_{t-1}}{E_t} - 1 \right) (1 - \alpha^H_{t-1}) NA^H_{t-1} - NS_t \tag{4.8}$$

. Many studies[3] may present those asset wealth variables rescaled by some wealth measure so that the return rates R can be considered as the excess return of net foreign asset relative to the growth rate of wealth.[4]

Note that if one follows the same assumptions as to yield the portfolio balance equation 4.6, Equation 4.8 degenerates to $\triangle NFL = -NI_t - NS_t + \frac{\triangle E_t}{E_t} \frac{FXE_{t-1}}{E_{t-1}}$. The last

[3]The scaling variable is commonly used for technically normalising the variables for the stationarity requirement in the log-linearisation around the trend, *e.g.* Caballero et al. (2008). Empirical studies also commonly normalise the external wealth in terms of GDP, *e.g.* Campbell and Shiller (1988), Lane and Milesi-Ferretti (2002), and Chinn and Prasad (2003).

[4]Accordingly, the dynamics of net foreign liability position can be written as $NFL_t = \frac{W^H_{t-1}}{W^H_t} \left[R^{FL} NFL_{t-1} + R^{FL} \left(\frac{R^{FA}}{R^{FL}} \frac{E_{t-1}}{E_t} - 1 \right) (1 - \alpha^H_{t-1}) NA^H_{t-1} - NS_t \right]$. W is the wealth scaling variable of which the ratio at time t relative to its one-period lag can be regarded as its gross growth rate, denoted as G. Hence the equation can be rewritten as $NFL_t = \tilde{R}^{FL} NFL_{t-1} + \tilde{R}^{FL} \left(\frac{\tilde{R}^{FA}}{\tilde{R}^{FL}} \frac{E_{t-1}}{E_t} - 1 \right) (1 - \alpha^H_{t-1}) NA^H_{t-1} - NS_t$ where $\tilde{R} = \frac{R}{G}$ is the excess gross returns relative to the growth rate of the wealth variable.

term is the valuation effects similarly to the terms in the previous accounting equation 4.4, with the definition $\frac{FXE_{t-1}}{E_{t-1}} = (1-\alpha^H_{t-1})NA^H_{t-1}$. The difference is that this valuation effect is the changes for the overall initial foreign currency exposure, while the valuation gains in the return rates are measured in Equation 4.4.

The second term NS_t indicates the net new acquisitions of foreign assets from $t-1$ to t. By macro identity for an open economy, net savings abroad equal trade surplus given domestic equilibrium, *i.e.* $NS = TB$. Empirically, the first two terms jointly determine the net capital outflows which in the long-run would be identical to the current account balance. Thus changes in the net foreign asset position can generally decomposed as the current account changes plus the valuation effects of the initial foreign currency exposure, *i.e.*

$$\triangle NFL_t = -CA_t + VAFXE_t \tag{4.9}$$

In the long-run steady-state, there are no changes in the net foreign asset position, *i.e.* $\triangle NFL^H = 0 = r^{FL}NFL^H - TB^H$. As also noted by Gourinchas and Rey (2007), many growth models assume the return rate r (net of the growth of wealth scaling variable) to be positive, resulting in an intuitively negative correlation between the net foreign asset position and international savings[5]: a country running an asymptotic trade surplus (*i.e.* international capital outflow) will finance a net debtor position in terms of net interest payment outwards, *i.e.* $\overline{TB}^H = -\overline{NI}$. Also, this equality follows the long-run balanced position of current account balance.

Accordingly, define the trade balance as an implicit function of net external asset wealth and exchange rates, the new wealth accumulation equation around the steady-

[5]This assumption also gives the discounting factor, which is further used for non-Ponzi game assumption in evaluating a country's total external wealth position in the forward-solution of exchange rate.

state can be written as

$$\begin{aligned}\triangle NFL^H &= CAB = r^{FL}NFL^H - TB^H(E, NA^H, \frac{NA^F}{E}) \\ &= r^{FL}NFL^H - TB^H(E, A^H - NFL^H, \frac{A^F}{E} + NFL^H) = 0\end{aligned} \tag{4.10}$$

. Hence the current account balance condition can be written as

$$\frac{\triangle NFL^H}{\triangle E} = -\frac{CAB'_E}{CAB_{NFL^H}} = \frac{TB'_E - TB'_{NA^F/E}\frac{NA^F}{E^2}}{r^{FL} + TB'_{NA^H} - TB'_{NA^F/E}} \tag{4.11}$$

The numerator generally captures the changes of trade balance in response to long-run exchange rate adjustments. The first term TB'_E presents the substitution effect of domestic currency appreciation and is assumed to be negative. The second term $TB'_{NA^F/E}\frac{NA^F}{E^2}$ represents the foreign wealth changes associated with long-run appreciations. Since long-run appreciation tends to be associated with lower foreign income and hence the demand for domestic goods falls. Combing the two parts, the numerator depicts a negative sign.

The denominator generally captures the equilibrium changes of net interest rate payments. The first term indicates the marginal interest rate payment on the net external liability. The larger is the net debt position, the more interest is paid on average. The latter two components present the wealth effect of trade balance adjustments due to an increase of foreign liabilities that redistributes the long-run wealth between domestic and foreign economies. For simplicity, assume the first component always dominates the latter effect (Blanchard et al., 2005; Gourinchas, 2008) so that the denominator exhibits a positive sign. Hence the slope for the current account balance condition is negative.

Combining the portfolio allocation equation 4.6 and current account balance condition 4.10 together, a long-run equilibrium can be pinned down in the NFL and E space.[6] It can be seen that the analyses are very similar to the BRM condition on

[6] For saddle-path stability, a steeper current account balance condition is assumed, i.e. .See relevant discussions by Blanchard et al. (2005).

trade balance. When the exchange rate fluctuation is introduced into the current account balance condition given the portfolio choices,[7] it matters for both equilibrium and short-run effects.

In the short-run, there is an extra term determining the flucutuions of net foreign asset position as shown in Equation 4.8, *i.e.* $R\left(\frac{E_{t-1}}{E_t}-1\right)(1-\alpha^H_{t-1})NA^H_{t-1}$. This instant valuation changes are through both the initial position of foreign currency exposure and its interest income flows. Many empirical studies suggest that the overall effects are substantial (*e.g.* Lane and Milesi-Ferretti, 2005; Gourinchas and Rey, 2007).

Around the steady state of the current account balance condition, changes in the net interest payments are accompanied by the valuation term, which differs between developed and developing economies. For a major currency economy, its foreign asset portfolio is denoted in foreign currency while its liability in domestic currency. This yields $r\left(\frac{E_{t-1}}{E_t}-1\right)(1-\alpha^H_{t-1})NA^H_{t-1}$, so that the net foreign exposure $\frac{FXE_{t-1}}{E_{t-1}}=(1-\alpha^H_{t-1})NA^H_{t-1}$ is positive. Depreciation is then associated with valuation gains. The larger is the positive exposure, the larger is the gains *ceteris paribus*. This is because the interest rate payment on domestic currency denominated foreign liabilities falls relative to the income on foreign assets, which requires less cash flow from trade balance to maintain the current account position. Hence the valuation gains make the debt repayment cheaper and easier.

Moreover, the short-run valuation gains from a larger proportion of domestic currency denominated foreign liabilities could also loosen the credit constraint (enabling the economy to borrow more), so that depreciation tends to support a larger trade deficit. In addition, on the production side, an unexpected depreciation under certain circumstances tends to improve the competitiveness of trading sectors, which tends to generate greater trade surplus under appropriate (*e.g.* the Marshall-Lerner) conditions. These two results suggest that the capability of issuing domestic currency denominated

[7] As noted by Blanchard et al. (2005), the current account balance condition assumes the long-run steady-state adjustment path for both $\triangle NFL=0$ and $\triangle E=0$. This is an approximation facilitating the analysis of non-linear long-run equilibria and is different from the locus for $\triangle NFL=0$ only. Under zero substitutability, the locus $\triangle NFL=0$ convergences to the portfolio balance condition that gives the locus $\triangle E=0$.

liabilities tends to provide short-run flexibilities of exchange rate adjustments through the economy's external balance sheets. There is an increasing number of recent literatures empirically documenting the valuation changes (Tille, 2003; Gourinchas and Rey, 2007) or theoretically seek for the structural models (Tille, 2008; Devereux and Sutherland, 2011) as mentioned before.

In contrast to many industrial economies, many developing economies' external liabilities are unable to be issued in its own currency. This is consistent with the case when $\alpha^F = 1$ and $\alpha^H > 1$ so that the foreign currency exposure is negative *i.e.* $\frac{FXE_{t-1}}{E_{t-1}} = (1 - \alpha^H_{t-1})NA^H_{t-1} < 0$. Hence a *ceteris paribus* depreciation would imply valuation loss. This is because foreign currency denominated interest rate payment become more expensive, which counteracts the competitive gains on trade and hence requires larger surplus. Hence insufficient trade income will either tighten the credit constraint (limiting the economy to borrow more) or make the external debt repayment more expensive and difficult. Under these conditions, the tradable sectors competitiveness gains from the currency depreciation tend to be offset by the increased leverage on financial balance sheet in the short-run. Conversely, an appreciation on the one hand can relatively reduce the required trade incomes (*i.e.* net interest payment) but will generate tradable sector's competitiveness loss.

4.3 Empirical Methodology

Following Equation 4.4, changes of the net investment income flow can be written as a function of the net acquisition flows and exchange rate appreciations conditioning on the initial position of foreign currency exposure. Accordingly, the empirical analyses start with the reduced-form fixed-effect regression including the initial current account position and exchange rate appreciations. Interaction terms are further introduced to reveal the valuation effects on foreign currency exposures. The data cover a country-year panel similar to the previous chapter. The detailed country-year list and descriptive analysis of the variables are respectively presented in Table 4-24 and

Section 4.7.1. The regression can be specified as follows

$$dNI_{it} = \sum_{s=0}^{1} \beta_{t-s} d\ln REER_{it-s} + d\ln REER_{it} \times FXE_{it} + \eta \ln CA_{i,t-1} + \delta D_{it} + \epsilon_{it} \quad (4.12)$$

, where *NI* denotes the dependent variable for the net investment income; *REER* is the real effective exchange rate index; *CA* is the current account balance in ratio to GDP; *D* denotes the fixed-effect dummies for individuals and years.

4.3.1 Net Investment Income

The dependent variable is the annual changes of the net foreign investment income flows scaled as percentage of GDP size. Two sources of the measures are employed in this exercise. One is from the IMF *Balance of Payment Statistics* (hereafter referred as the IMF series) that directly measures the net investment incomes. The other is constructed by using the *Net Income from Abroad* series subtracting the net outward *Compensation of Employees and Worker's Remittance*, both in the World Bank *World Development Indicator* database (hereafter referred as the WDI series).

As shown by the descriptive analysis in the Appendix, both of the two measures suggest an overall deterioration of the net investment incomes while only the Industrial economies show an average improvement over the sample period. The comparisons of standard deviations also suggest that the Financial and Oil Exporting economies are exposed to distinctively larger variations than the other groups, with the magnitudes about twice as much as the Industrial group. Moreover, the within-country correlations between the two measures averaged for each group suggest that the Emerging Market, Industrial and Oil Exporting economies tend to have greater coincidence while the correlation for the overall sample is above 67 percent.

4.3.2 Control Variables

The first group of variables are the annual average changes of the real effect exchange rate with one year lag, following the same data and constructions as in Chapter 3. An increase of the number indicates domestic currency appreciation against the world. As mentioned before, exchange rate fluctuations mainly generate two channels affecting the net investment incomes. On the one hand, an exchange rate would be associated with the long-run external borrowing/lending positions (the portfolio allocation equation 4.6) based upon the expected fundamentals of both domestic and foreign economies. A higher exchange rate position would imply a better lender position of foreign assets and hence higher income.

On the other hand, the valuation of the overall net position of the foreign currency asset (*i.e.* foreign currency exposure) would be altered by exchange rate shocks. As shown in the Appendix, given the fact that most of the external liabilities for developing economies are denominated in foreign currency ($FXE<0$), depreciation of domestic currency tends to increase the outward interest payment in terms of domestic goods and hence deteriorates the net investment income. This implies a positive correlation between exchange rate and the dependent variable. Meanwhile, the Industrial economies on average tend to have a net positive position of foreign currency exposure and more than half of the external liabilities are denominated in terms of domestic currency. A depreciation of home currency then tends to generate higher investment income relative to the payments. A first order lag of the annual appreciation variable is introduced to capture the possible dynamics in the subsequent year.

The initial position of current account balance is measured in ratio to GDP from the WDI database. It would indicate the perceived net capital outflows. As mentioned before, the overall changes of the net foreign asset transactions will be approximated by the net capital outflows given the expected exchange rate adjustments. A negative initial position (implying a net capital inflow) is expected to be associated with an decrease in the net investment income during the subsequent periods and *vice versa*. Hence a positive coefficient is expected.

Country fixed effect dummies are included to capture the unobserved heterogeneities invariant for individual economies. Year fixed effect dummies are also included to capture global shocks that are common within the groups.

4.3.3 Country Groups

Similarly to the previous chapter, the analyses are intended to assess the group-wise performances of countries. Data incompleteness of some variables restricts the disaggregation of country categories particularly for the Oil Exporting and Financial economies. Hence the results are mainly presented for all categories whenever data permits.

4.4 Empirical Results

4.4.1 Baseline Regression Results

Table 4-1 presents the baseline specification results for the annual changes of net investment income flows. As shown in the Appendix, the IMF data (upper panel) generally covers richer country-year observations, with 108 economies for the overall sample. The dependent variable from the WDI data (lower panel) tend to have larger variations, also reflected by the standard deviations of the regressions (RMSE). Similarly to the previous chapter, very few observations can be employed before 2000 for the Financial and Oil Exporting groups, which may undermine the fixed effect asymptotic assumptions.

It can be seen from Table 4-1 that the initial position of current account rarely exhibit significance across the regressions. The coefficients for the overall sample (Column 1 & 2) are negative, suggesting a negative relationship between international capital outflows and the subsequent investment income improvements. By decomposing into country groups, only the Other Developing group tends to have negative correlation in both regressions shown in the upper and lower panel, though the coefficients are insignificant. The Oil Exporting tends to have ambiguous results under the two alternative measures. As mentioned before, this group suffers the most incomplete data coverage and the largest volatilities. The Industrial, Financial and Emerging Market economies tend to have positive coefficients, suggesting that larger net investment in-

Table 4-1. Baseline Regression on Annual Changes of NI as %GDP

	Whole	WholeExcl. Fin&Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$100d(NI/GDP)$**: IMF Series**							
dlnREER	1.967	2.374	0.044	7.499	0.449	2.122	2.326
	(3.98)***	(4.72)***	-0.03	(2.18)**	(0.29)	(3.37)***	(3.29)***
dlnREER(-1)	0.55	0.300	-1.361	-1.614	1.209	1.391	0.092
	(1.36)	(0.79)	(-0.87)	(-0.54)	(0.93)	(2.04)*	(0.19)
CApGDP(-1)	-0.958	-2.258	0.829	1.496	-1.808	1.216	-3.262
	(-0.90)	(-1.39)	(0.67)	(0.72)	(-0.88)	(0.94)	(-1.57)
No. of Econ.	108	82	21	16	10	18	43
No. of Obs.	1367	1050	282	198	119	251	517
R^2 Overall	0.03	0.04	0.06	0.03	0.08	0.14	0.09
R^2 Within	0.04	0.07	0.04	0.06	0.10	0.16	0.10
R^2 Between	0.03	0.05	0.65	0.34	0.15	0.01	0.02
RMSE	1.273	1.093	0.725	1.793	1.716	0.636	1.385
$100d(NI/GDP)$**: WDI Series**							
dlnREER	3.08	3.146	0.353	5.502	1.605	1.522	3.508
	(3.83)***	(3.91)***	(0.23)	(1.06)	(0.94)	(1.91)*	(3.17)***
dlnREER(-1)	0.567	0.491	-0.908	-7.608	2.163	3.764	0.000
	(0.88)	(0.80)	(-0.44)	(-0.90)	(1.28)	(2.76)**	(0.000)
CApGDP(-1)	-3.871	-2.991	0.632	-8.638	1.775	0.499	-4.419
	(-1.59)	(-0.89)	-0.46	(-1.95)*	(0.40)	(0.15)	(-0.96)
No. of Econ.	98	77	20	14	7	16	41
No. of Obs.	1144	893	279	180	71	194	420
R^2 Overall	0.01	0.02	0.04	0.04	0.22	0.17	0.04
R^2 Within	0.05	0.06	0.03	0.09	0.21	0.19	0.08
R^2 Between	0.14	0.27	0.52	0.02	0.84	0.16	0.24
RMSE	1.743	1.415	0.817	2.734	2.381	0.97	1.833
Country Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] Robust t-statistics (clustering at individual economy level) are presented in the parentheses.
[2] RMSE is the root mean square error of the regression.
[3] Asterisks, ***, **, *, denote the significance level at 1%, 5% and 10% respectively.

come improvement tends to be associated with larger current account surplus, though the effects are insignificant.

The contemporaneous changes of the real effective exchange rate tend to be positively correlated with net investment income flows. In the overall sample regressions (Column 1 & 2), the coefficient for the contemporaneous appreciation variable is positively significant with the magnitude between 2-3. As discussed before, the positive coefficient suggests significant valuation effects from the foreign currency exposures. Quantitatively, an economy with 10 percent annual average appreciation tends to be associated with about 0.3 percent improvements in its net investment income flows in terms of GDP.

By comparing among the groups[8], one can see that the Emerging Market and Other

[8]Those results remain similar if the regressions are conducting on the subsamples consistent with the analyses in later sections due to data incompleteness (See Appendix 4.7.1).

Developing economies both have significantly positive coefficients, with the magnitude of the former group slightly smaller than the latter. This suggests the tendency that depreciations tend to worsen their substantial proportion of foreign currency denominated liabilities that dominate the valuation changes in external asset positions. Specifically, summary statistics from Chapter 3 suggest that a representative Emerging Market economy exhibits a small annual average appreciation (0.4 percent) during the sample period while a representative Other Developing economy shows an overall depreciation (1.5 percent). This suggests that the net investment income flows for the former group tends to have a small improvements from appreciations, i.e. about 0.8 percent in ratio to GDP using the IMF series (0.004*2.12=0.008), while the latter group tends to suffer about 3 percent (-0.015*2.24=0.03) loss on the NI flows.

The Financial group tends to have the largest coefficient but the significance level tends to be ambiguous under the two alternative measures. Given the group average depreciation at about 0.3 percent over the sample period, the results from the upper panel then suggest 2 percent (-0.003*7.50=0.02) annual deterioration on net investment incomes relative to GDP. The coefficient for the Oil Exporting group is positive but insignificant. Given the group average annual appreciation at about 0.2 percent, the result suggest a small improvements (0.002*0.45=0.0009) at about 0.09 percent per year.

The coefficient for the Industrial economies is insignificant, suggesting smaller and less significant valuation effects than within developing economy groups that on average have larger unbalanced positions of external assets and liabilities. Given the group average annual appreciation is about 0.3 percent over the sample period, the positive coefficient suggests an improvement in net external capital income flows. However, when the regressions are conditioned on a smaller sample to be used in later sections, the coefficient turns to be insignificantly negative (see Table 4-20 in Appendix), suggesting that within the subsample, depreciation tends to reduce the outward interest payments or improve the incomes. This may particularly reflect both their positive FXE but negative NFA positions, in contrast to most developing economies with negative positions in both, thus gains from the foreign currency exposure channels are resulting in the similar long-run deterioration effects on their negative NFA positions.

Similarly to the contemporaneous variable, the first order lag of exchange rate appreciation variable exhibit positive sign for the overall sample regressions but insignificant, suggesting the adjustments in the subsequent year may not be substantial. By decomposing into groups, the positive coefficient can be observed for the Oil Exporting, Other Developing and Emerging Market groups. Only the last category exhibits significant result, suggesting more persistent valuation effects than the other groups. The Industrial and Financial economies tend to have insignificantly negative coefficients, suggesting that depreciation tends to improve the net investment income flows to a limited extent one year later.

4.4.2 Valuation Effects and Foreign Currency Exposures

The baseline results present a positive correlation between the net investment income improvement and real exchange rate appreciations particularly for the Emerging Market and Other Developing groups. The valuation effects depending on the structure and position of foreign capital portfolios are embedded. In particular, depreciation would imply two effects on the net investment income for a net foreign currency asset debtor economy: a deepening of the long-run debtor position (wealth effect) and a deterioration of outstanding foreign currency liability positions (valuation effect).

For developing economies that are more likely to be in negative positions of net foreign asset (*i.e.* a net borrower of foreign capital) and have dominant proportion of foreign currency denominated liabilities (Eichengreen et al., 2003; Frankel, 2005; Kirabaeva and Razin, 2010), the valuation gains is expected to be positive for appreciations but negative for depreciations. On the other extreme, some Industrial economies with positive positions of the foreign assets may possess larger share of domestic currency denominated on the liability side (Tille, 2003; Gourinchas and Rey, 2007; Gourinchas et al., forthcoming). Appreciations are then associated with valuation loss and depreciations can result in gains. Hence given the exchange rate changes, a negative correlation would be expected between net investment income and net foreign asset position.

To assess the valuations effects, a direct measure of foreign currency exposure variable (FXE) is employed. A first attempt is to examine the negative effect of FXE positions on NI flows given the exchange rate changes. Hence regressions similar to the baseline specifications are conducted by controlling the *signs* of FXE variable. An interaction variable of the annual average exchange rate changes with FXE is then introduced into the regressions for controlling the magnitude of non-zero positions of FXE.

In order to contrast the asymmetry of FXE positions between Industrial and developing economies, the regressions are re-grouped into: i) the whole sample, ii) the whole sample excluding the Financial and Oil Exporting economies, iii) the Industrial and Emerging Market economies, and iv) the Industrial and Other Developing economies. The data cover less country-year observations particularly for the Financial and Oil Exporting economies, and hence suppresses their group-wise regressions.

4.4.2.1 Asymmetries on Foreign Currency Exposures

Following the database construction for countries' foreign asset and liability stock holdings by Lane and Milesi-Ferretti (2001, 2007), Lane and Shambaugh (2010a,c) further disentangle the shares of domestic and major foreign currency shares in countries' external balance sheets and hence construct the estimates of aggregate currency exposures. For a given foreign currency component, a positive weight is assigned if it appears in the asset side but negative in the liability side[9]. Accordingly, the aggregate exposure variable, measured in ratio to GDP, would indicate the net valuation changes of foreign currency capitals due to domestic currency changes against the world.[10]

The descriptive statistics[11] (Section 4.7.1 in Appendix) show that the aggregate

[9]Specifically, the aggregate currency weight is constructed by each subcategory's currency share in the asset/liability side, weighted by relative size of the subcategory.

[10]This is the *NETFX* variable in the database, which is consistent with the definition in 4.3, $\frac{FXE}{E} = \omega^{FA}FA - \omega^{FL}FL$, where FA and FL are respectively scaled by GDP.

[11]Since the data for the FXE variable ends in 2004, the sample size is reduced substantially.

foreign currency exposure for the overall sample is roughly close to zero over the sample period but with substantial cross-country heterogeneities both across and within all the groups. The Industrial group on average has a positive position (i.e. holding more foreign currency assets than liabilities) at about 33 percent of GDP. The Financial group tends to have the largest imbalance on the external position, with an average positive position equivalent to 2.5 times of GDP size. The Emerging Market economies tend to have the smallest exposure with a negative average position less than 6 percent of GDP and the group also exhibits the smallest standard deviations. Developing and Oil Exporting groups tend to have much more foreign currency liabilities than assets, with the size at about 37 and 27 percent of GDP respectively.

Table 4-2 presents the group-wise distributions of the observation numbers for the FXE position. It can be seen that the overall sample exhibits less positive than negative positions of foreign exposure. By further comparing across the groups, one can see that the Industrial economies are more likely to have positive positions, with the number of observations 3 times as many as of negative ones. On the other side, developing economies are more likely to be in the short positions of foreign currency exposure. In particular, the ratio of positive to negative observations is about 1/2 for the Emerging Market and 1/5 for the Other Developing group over the sample period. This asymmetry between the Industrial and developing groups is generally consistent with currency-mismatch literatures motioned before.

Table 4-2. Distribution of Observations for FXE Position

No. of Obs.	Whole Sample		Excl. Fin & Oil.		Industrial		Emerging Market		Other Developing	
FXE Position	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Appreciations	191	253	167	235	107	31	36	83	24	121
Depreciations	152	199	134	180	76	26	38	46	20	108
Total	343	452	301	415	183	57	74	129	44	229

The valuation changes would be jointly determined by the combination of FXE positions and exchange rate movements. Hence Table 4-2 also depict the distribution of appreciations and depreciations. Compared with the substantial skewness of the FXE positions between Industrial and developing economies, the exchange rate movements tend to be more symmetric. This provides the counterparts of evaluating the valuation gains/losses conditioning on the FXE position for the regression analyses.

Figure 4-1 plots the country-wise combinations of the annual average exchange rate changes and the foreign currency exposure positions, averaged over the sample period. It also provides the group averages conditioning on positive and negative FXE (the country-year observations are pooled together for each group). A similar figure for the NFA variable is shown in Appendix. In general, the first quadrant (i.e. combinations of appreciation and positive position of net foreign currency assets) implies the tendency of deterioration in the foreign currency asset surplus relative to domestic currency components, while the fourth quadrant indicates an improvement. Similarly for negative FXE positions, the third quadrant (appreciations) tends to be associated with average deterioration in the net borrowing position of foreign currency capitals and the second quadrant with improvements.

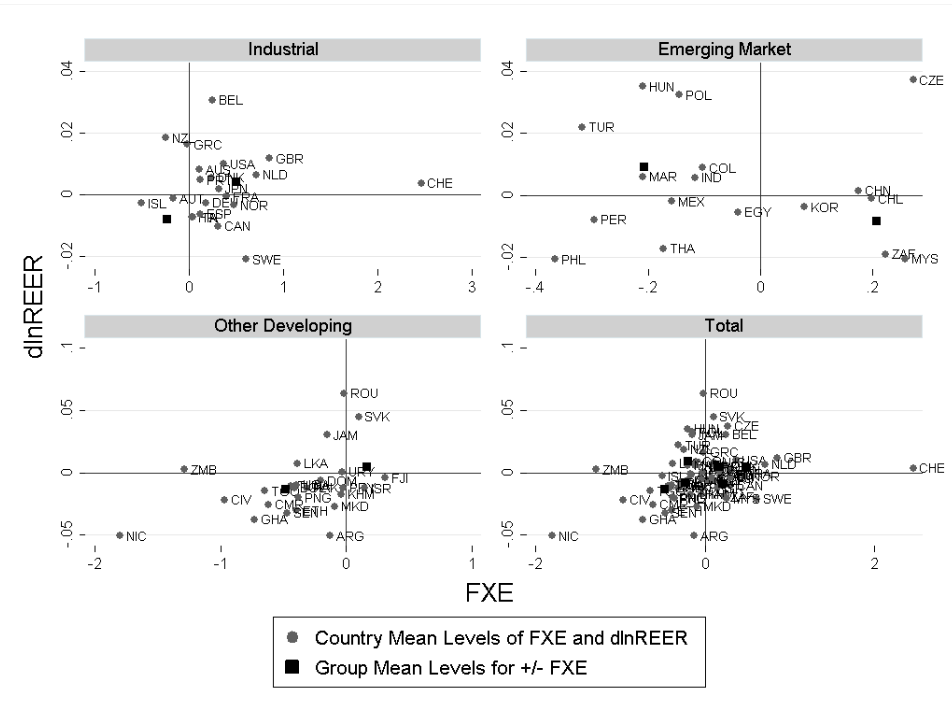

Figure 4-1. Group Average dlnREER for Positive and Negative FXE Position

It can be seen for the Industrial group that most economies on average exhibit positive FXE positions over the sample period, which is also consistent with larger number of observations with positive FXE shown in Table 4-2. The group average occurs in the first quadrant, indicating an average valuation deterioration of net foreign currency capital lending positions relative to domestic components. By comparing the distributions with the NFA variable (Figure 4-3 in the Appendix) one can show that many of the economies with positive FXE possess negative NFA values, *i.e.* a substantial net liability position of domestic currency components on the external balance sheet. This suggests an average valuation deterioration which may be particular evident for economies appearing in the third quadrant in both graphs and for those in the second quadrant of Figure 4-3 but the first quadrant in Figure 4-1.

For the Emerging Market group, most economies on average have negative positions of foreign currency capital positions and many of them have overall negative position of NFA as well. Since the group average changes of exchange rate given negative FXE is positive, this implies that those economy on average tend to have an improvement on net interest rate payments outward over the sample period. For positive FXE cases, there are two economies, China and Czech Republic, transiting rightward from the first quadrant from Figure 4-3 to Figure 4-1, suggesting an average valuation loss of foreign currency capitals relative to their domestic components on the external capital balance sheet. On the other hand, Malaysia and South Africa move rightward in the lower panel, suggesting an average valuation improvement on domestic components relative foreign. These economies tend to generate larger valuation effects for positive FXE cases.

For the Other Developing group, the majority of economies appear in the third quadrant and summary statistics suggest that almost all of the group on average have negative positions on external capitals (*i.e.* net borrowers). The group average of exchange rate changes for negative FXE is negative as well, indicating average deteriorations on their net foreign currency denominated liabilities. Moreover, there are few economies (*e.g.* Slovakia and Fiji) moving rightward from NFA to FXE positions, suggesting a larger valuation effects for positive FXE domain.

To further explore the negative correlation between foreign currency exposure and net investment income flows given the exchange rate changes, the indicator variables for positive and negative FXE are utilised by interacting with the exchange rate variables in the baseline regressions. For negative FXE positions, appreciations is expected to be associated with positive coefficient since the interest rate payments on foreign currency liabilities becomes smaller. For positive FXE, a negative coefficient is expected since depreciation tends to increase the absolute value of interest rate income on foreign currency assets given the overall negative NFA position is not large enough so that the deteriorations in the overall external borrowings would not dominate the valuation gains.

Table 4-3 presents the results using the IMF data. The stylised patterns are highly similar by using the alternative dependent variable from the WDI data, presented in the Appendix. It can be seen from the overall sample regressions (Column 1 & 2) that the valuation effects from exchange rate fluctuations tend to be larger and more instant for negative FXE domain. The coefficient for negative FXE tends to be larger and the significance levels tend to be higher than the positive case. This suggests that larger exchange rate fluctuations tend to generate larger valuation effects particularly for countries with negative FXE (net foreign currency borrower). In particular, the F-statistics tends to reject the quantitative indifference of the coefficients for the contemporaneous exchange rate variable between positive and negative FXE with the p-value at 0.02 after the Financial and Oil Exporting economies are excluded (Column 2). The positive coefficients for the first-order lag variable are significant for the positive FXE domain but insignificant for the negative cases. This is consistent with the long-run positive correlation of appreciation and NFA positions, which tends to improve the net investment income flows.

For the Industrial economies (Column 5), a negative coefficient for the contemporaneous exchange rate variable is obtained for positive FXE but positive for negative FXE positions, though both the coefficients are insignificant. The similar magnitude of the two coefficients also suggest that the valuation effects tends to be more symmetric among the Industrial economies. By further contrasting the Industrial and developing

Table 4-3. Asymmetries on FXE Positions

	Whole	WholeExcl. Fin&Oil	Industrial 2pt EM	Industrial & OthDev	Industrial
	(1)	(2)	(3)	(4)	(5)
FXE>0					
dlnREER*	0.904	0.444	-0.306	0.499	-1.638
1(FXE>0)	(1.17)	(0.45)	(-0.38)	(0.31)	(-1.24)
dlnREER*	1.219	1.587	2.377	1.133	1.783
1(FXE >0)(-1)	(2.38)**	(2.41)**	(3.35)***	(1.41)	(2.62)**
FXE<0					
dlnREER*	2.519	3.465	3.052	3.489	1.582
1(FXE <0)	(3.40)***	(4.90)***	(4.21)***	(4.01)***	(0.70)
dlnREER*	1.055	0.326	0.326	-0.001	-3.570
1(FXE <0)(-1)	(1.57)	(0.56)	(0.30)	(-0.00)	(-1.25)
CApGDP(-1)	-1.738	-1.251	0.044	-3.122	-2.126
	(-1.29)	(-0.52)	-0.03	(-0.86)	(-1.04)
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes
No. of Econ.	72	63	38	46	21
No. of Obs.	792	714	442	512	240
R^2 Overall	0.04	0.08	0.07	0.08	0.04
R^2 Within	0.06	0.10	0.08	0.09	0.08
R^2 Between	0.06	0.00	0.02	0.06	0.53
RMSE	1.061	0.923	0.669	1.023	0.704

[1] The dependent variable is $100d(NI/GDP)$ using the IMF series.
[2] See notes to Table 4-1.

groups, it can be seen that the valuation effects becomes more significant particularly for the negative FXE domain. This suggest that given an annual average depreciation, those country-years with negative foreign currency exposure positions tend to have larger deterioration of the net interest payment on foreign currency liabilities, which is consistent with third quadrant in Figure 4-1. These patterns remain similar when the observations with large annual average REER changes (>20%) ever in the last 2 years has been excluded, suggesting that the asymmetries between Industrial and developing economies are substantial the overall sample period.

4.4.2.2 Valuation Effects and Foreign Currency Exposure

The results above suggest the tendency of the negative correlation between FXE and NI given exchange rate changes across different groups of countries. To further assess the valuation effects determined by the combination of exchange rate movement and FXE positions, an interaction variable is introduced to the baseline regressions and hence a negative coefficient is expected.

Table 4-4 presents the regressions results. It can be seen that the sample size is reduced substantially (by about 40 percent relative to the previous analyses) due to the smaller coverage of economies and shorter spells over the years for the FXE variable. However, the coefficients for the initial position of the current account and the general performance of the regressions preserve the same patterns. The coefficient for the first-order lag the real exchange rate variable tends to remain positive for developing economies.

Table 4-4. Valuation Effects of Foreign Currency Exposure

	Whole	WholeExcl. Fin&Oil	Industrial & EM	Industrial & OthDev	Industrial
	(1)	(2)	(3)	(4)	(5)
$100d(NI/GDP)$: **IMF Series**					
dlnREER	2.382	2.299	1.451	2.610	0.484
	(3.73)***	(3.10)***	(2.72)***	(2.48)**	(0.37)
dlnREER *	0.672	-1.325	-6.451	-0.774	-5.291
FXE	(0.49)	(-0.92)	(-3.44)***	(-0.50)	(-1.76)*
dlnREER(-1)	1.046	0.670	1.430	0.251	-0.283
	(2.19)**	(1.36)	(2.06)**	(0.42)	(-0.22)
CApGDP(-1)	-1.747	-1.129	-0.127	-2.918	-2.494
	(-1.29)	(-0.48)	(-0.09)	(-0.81)	(-1.11)
No. of Econ.	72	63	38	46	21
No. of Obs.	795	716	443	513	240
R^2 Overall	0.04	0.06	0.09	0.07	0.03
R^2 Within	0.06	0.08	0.11	0.08	0.08
R^2 Between	0.06	0.02	0.04	0.04	0.53
RMSE	1.059	0.927	0.661	1.027	0.704
$100d(NI/GDP)$: **WDI Series**					
dlnREER	1.961	2.369	1.609	2.827	0.735
	(2.44)**	(2.42)**	(1.85)*	(2.17)**	(0.51)
dlnREER *	0.011	-0.24	-7.062	0.973	-5.117
FXE	(0.01)	(-0.10)	(-2.83)***	(0.40)	(-1.77)*
dlnREER(-1)	1.377	1.005	3.419	-0.235	0.374
	(2.09)**	(1.20)	(2.86)***	(-0.33)	(0.22)
CApGDP(-1)	0.643	1.698	-0.949	2.053	-2.412
	(0.39)	(0.80)	(-0.41)	(1.00)	(-1.13)
No. of Econ.	63	57	34	43	20
No. of Obs.	665	608	390	457	239
R^2 Overall	0.05	0.07	0.09	0.07	0.02
R^2 Within	0.05	0.06	0.11	0.06	0.06
R^2 Between	0.26	0.36	0.00	0.25	0.41
RMSE	1.180	1.088	0.879	1.098	0.785
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes

[1] See notes to 4-1

The coefficient for the contemporaneous annual average exchange rate appreciation variable is significantly positive for the overall sample regressions (Column 1 & 2). This suggests that for a representative economy with balanced foreign currency exposure position, a one percent appreciation tends to improve the net investment income by about 2 percent of GDP. Given zero FXE position, the net foreign asset position is driven by domestic currency components, *i.e.* the net lending is denominated in domestic currency and hence is the same as the theoretical discussions in Section 2.

With the long-run correlation between depreciation and net debt values, appreciation would imply better NFA position and hence improvement on NI flows.

By further examining the group-wise results, it can be seen that, in the absence of net foreign currency exposure, appreciations tend to be insignificantly associated with NI deteriorations within the Industrial group alone (Column 5). However, developing economies tend to sharpen the significantly positive relations when they are compared with the Industrial economies (Columns from 2 to 4). This may be due to the implications that developing economies are more likely to suffer credit rationing[12] and hence exhibit a stronger linkage between appreciation and external position improvements than the Industrial economies (Lane and Milesi-Ferretti, 2004; Christopoulos et al., 2012). Also, exchange rate fluctuations may vary the net return rates on some developing economies' foreign assets that have substantial capital flows to the Industrial economies (Antràs and Caballero, 2009; Dominguez et al., 2012).

Previous discussions on the valuation effects conditioning on positive and negative FXE positions indicate a negative correlation with the NI flows given exchange rate movements. This tends to be particularly evident for the comparison between the Industrial and Emerging Market economies. When the interaction variable is introduced into the regressions of Table 4-4, those tendencies become sharpened. The significantly negative coefficient for the Industrial group regressions (Column 5) indicates presence of valuation gains from depreciation upon their large share of domestic currency components of foreign liabilities. Take the result from the upper panel as an example, as the group average of foreign currency exposure is about 33 percent of GDP size, ten-percent depreciation tends to improve the net investment incomes by about 0.174 percent (0.1*0.33*5.291 = 0.174) of GDP. This valuation gains could sufficiently cover the long-run deteriorations of the net interest payment (*e.g.* through the worsening NFA positions) at about 0.048 percent of GDP, yielding a 0.126 net improvement. Alternatively, the 1.75 percent improvement may be regarded as the average marginal

[12]This can be implied by the largest negative NFA positions for the Other Developing economies. See Table. in the Appendix

valuation gains for an Industrial economy possessing one extra percent of GDP sized foreign currency exposures given the one percent annual average depreciation.

The valuation effects due to FXE positions become even sharper when the Emerging Market and Industrial economies are contrasted (Column 3). Taking the group average of FXE position at about -6 percent of GDP for a representative Emerging Market economy, the negative coefficient of the interaction variable suggests that a ten-percent depreciation would generate about 0.39 percent of GDP sized (-6.451*0.06*0.1=0.039) deteriorations in addition to the 0.145 percent deterioration from the rest overall effects. In other words, a 6 percent GDP-sized negative FXE position tends to induce 27 percent (0.039/0.145=0.27) additional effects than the zero FXE position.

The influence of FXE positions tends to be less evident for the Other Developing economies as the negative coefficient is smaller in magnitude and insignificant when they are pooled with Industrial economies (Column 4). Given the group average is about 37 percent of GDP negative position on FXE, the insignificant interaction variable tends to suggest that the Other Developing economies are more likely to be credit rationed and hence the exchange rate variations are more strongly associated with the overall wealth effect than the temporal valuation changes. This can also be inferred from the relevant discussions in the following section as well.

The results in Table 4-4 may raise the concern of the heterogeneity of interest differentials across different groups of economies as discussed before. However, following the theoretical discussions on Equation 4.2, the interest differential tends to influence the valuation effects only at the second order. Intuitively, it is the unexpected exchange rate shock that triggers the valuation changes rather than the predetermined interest rates. If the long-run differential are somewhat stable over the sample period, this effect will be much captured by country fixed effects. Moreover, Equation 4.2 indicates that exchange rate variations only enter as interaction terms, thus given the interaction with FXE, the time-varying interest rate differential effects can also be captured by the log-differenced exchange rate variables.

To illustrate this point, the regressions in Table 4-5 include an additional interaction term that is consistent with the last term of Equation 4.2, which show that the interest differential is important only in proportion to the size of assets denominated in foreign currency. It can be seen that allowing the group-specific interest differentials make small qualitative changes for the stylised results. The coefficients of the additional variables remain insignificant across country groups.

Table 4-5. Valuation Effects with Interest Rate Differentials

	Whole (1)	WholeExcl. Fin&Oil (2)	Industrial & EM (3)	Industrial & OthDev (4)	Industrial (5)
$100d(NI/GDP)$: **IMF Series**					
dlnREER	1.764	1.174	0.893	1.031	-0.732
	(1.52)	(0.91)	(0.73)	(0.59)	(-0.46)
dlnREER * FXE	0.330	-1.892	-7.571	-1.610	-7.706
	(0.20)	(-1.26)	(-2.94)***	(-1.00)	(-1.98)*
dlnREER * FA_{FC}	0.972	1.835	1.138	2.170	2.046
	(0.52)	(0.86)	(0.44)	(0.91)	(0.72)
dlnREER(-1)	1.043	0.661	1.432	0.233	-0.206
	(2.20)**	(1.40)	(2.07)**	(0.41)	(-0.16)
CApGDP(-1)	0.697	1.698	-0.994	2.059	-2.712
	(0.42)	(0.80)	(-0.43)	(1.01)	(-1.26)
No. of Econ.	72	63	38	46	21
No. of Obs.	795	716	443	513	240
R^2 Overall	0.04	0.07	0.09	0.08	0.03
R^2 Within	0.06	0.09	0.11	0.08	0.08
R^2 Between	0.04	0.01	0.04	0.04	0.51
RMSE	1.059	0.926	0.662	1.025	0.705
$100d(NI/GDP)$: **WDI Series**					
dlnREER	1.347	2.371	1.280	2.966	-0.813
	(0.97)	(1.39)	(0.92)	(1.31)	(-0.47)
dlnREER * FXE	-0.362	-0.239	-7.870	1.051	-8.212
	(-0.22)	(-0.09)	(-2.15)**	(0.38)	(-2.01)*
dlnREER * FA_{FC}	0.872	-0.003	0.730	-0.180	2.579
	(0.43)	(-0.00)	(0.24)	(-0.06)	(0.88)
dlnREER(-1)	1.377	1.005	3.414	-0.237	0.465
	(2.11)**	(1.21)	(2.85)***	(-0.33)	(0.28)
CApGDP(-1)	0.697	1.698	-0.994	2.059	-2.712
	(0.42)	(0.80)	(-0.43)	(1.01)	(-1.26)
No. of Econ.	72	63	38	46	21
No. of Obs.	795	716	443	513	240
R^2 Overall	0.05	0.07	0.09	0.07	0.02
R^2 Within	0.05	0.06	0.11	0.06	0.06
R^2 Between	0.23	0.36	0.00	0.25	0.41
RMSE	1.180	1.089	0.880	1.099	0.785
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes

[1] See notes to 4-1

4.4.3 Net Foreign Currency Shares and Net Asset Positions

Previous results suggest that given initial changes of net foreign asset positions, exchange rate depreciation (appreciation) tends to increase (decrease) the net foreign currency liabilities and hence leads to a negative correlation between foreign currency exposure and net investment income flows. A larger positive position (*i.e.* larger imbalance between foreign currency asset and liabilities) tends to generate larger valuation effects. This larger imbalanced position can result from either the larger *net shares* of foreign currency components, defined as $FAL = \omega^{FA} - \omega^{FL}$, when an economy maintains constant overall net lending (*i.e.* FA/FL as a constant), or the larger net foreign asset positions (*i.e.* $FA - FL$) when the economy is rationed to the currency denominations. In particular, following the decomposition of FXE by Lane and Shambaugh (2010c), one of the former cases would correspond to the net foreign exposure when NFA is in zero position ($FA/FL = 1$) while the latter can be obtained when all the foreign assets and liabilities are denominated in foreign currencies.

Accordingly, two variables are constructed respectively for the net foreign currency shares (denoted as FAL) and the net foreign asset (denoted as NFA). The former variable is constructed by the percentage share of foreign currency assets net the one of foreign currency liabilities from the dataset by Lane and Shambaugh (2010a). The latter variable is constructed by the net foreign asset position divided by the GDP variable, both from the EWN database by Lane and Milesi-Ferretti (2007). Two interaction variables respectively with the exchange rate changes are further constructed and introduced into the regressions. Given the overall FXE changes, both of the two variables tend to indicate the same directions and hence are expected to have the same negative sign as the FXE variable.

In practice, the correlation between FXE and NFA would depend on the flexibility of the currency choice to denominate the external liabilities. For those developed economies issuing a dominant proportion of external liabilities in domestic currency, valuation gains tend to improve the NFA position and hence indicate larger borrowing possibilities. In contrast, for those economies that are more likely to be rationed for both the overall net borrowing positions and the liabilities' currency denominations (Eichengreen et al., 2003; Calvo et al., 2008), the FXE are more likely to be a quantitatively in proportional to the NFA variable.

To provide an intuitive relationship between these three external position variables,

Figure 4-2 presents the cross-country correlations between the pairs of them over the sample period. For the Industrial economies, the correlation between NFA and FXE are close to unity, suggesting that the cross-country differences of FXE can well reflect the net external positions. On the other hand, the correlation between FAL and NFA stays close to zero and mostly in small negative numbers. This indicates a clear divergence between the net wealth effects and valuation adjustments on the external capital balance sheet. Meanwhile, the correlation between FAL and FXE are positive and close to 0.5 over the years, suggesting that the valuation changes are achieved by both the variations of foreign currency components and the net borrowing positions.

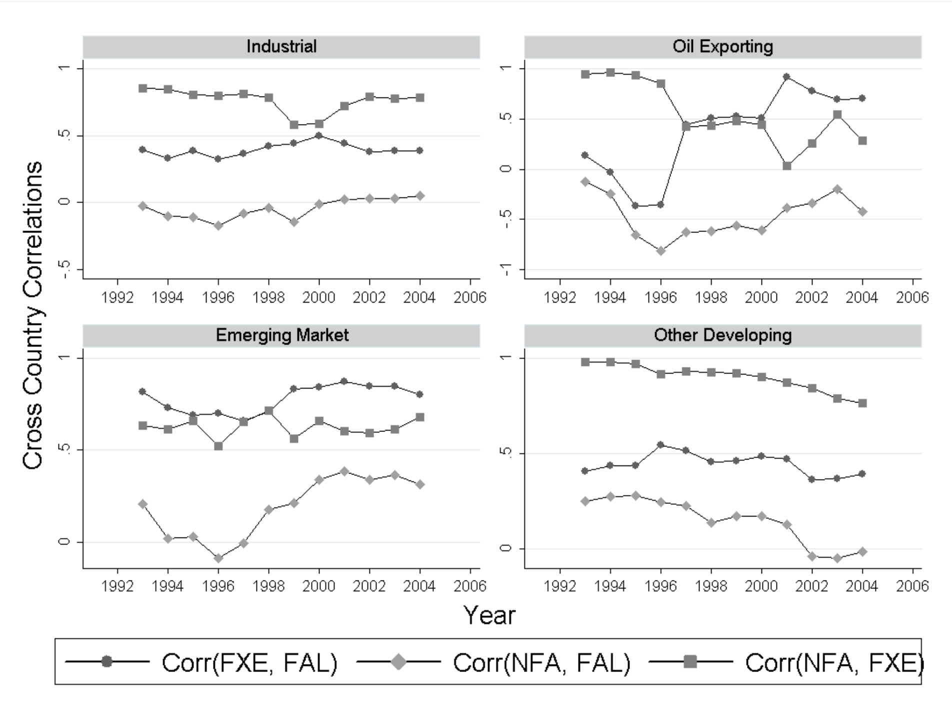

Figure 4-2. Cross Country Correlations for NFA, FXE, and FAL Pairs

For the Emerging Market group, the highest cross-country correlation happens between the FXE and FAL variable over the years. This suggests that the variations of foreign currency components are mostly captured by the share changes of foreign currency liabilities, which is also supported by the summary statistics (see Section 4.7.1 in the Appendix) that this group depicts the smallest cross-country variations of the NFA positions. Moreover, the correlation between NFA and FAL is roughly positive over the years, which may partially indicate the positive correlation between the reduction of foreign currency liabilities and the net lending position improvements. These stronger valuation effects than the Industrial economies tends to reduce the positive correlation between FXE and NFA to just above 0.5 over the period.

For the Other Developing economies, the correlation between NFA and FXE variables is close to unity, suggesting a determinating net external wealth on the foreign currency exposures. Meanwhile, the there is a positive correlation between FAL and NFA. These jointly suggest that those economies are tightened by the currency choice of foreign liabilities. Hence the correlation between FXE and FAL depicts around 0.5 over the years. These correlations may help explaining the positive coefficient for the interaction variables in Column 4 of Table 4 4 where the Other Developing economies are contrasted to the Industrial group. The comparisons of the foreign currency exposures across the economies would more likely to reveal overall wealth effect of net borrowing positions, which will counteract the valuation effects particularly for these two groups with highly correlated NFA and FXE positions and stable relative positions on FAL.

For the Oil Exporting economies, the patterns are similar to the Industrial group. The correlations for the Financial group is dropped due to data unavailability. Moreover, some large variations for developing groups may partially due to the economic conditions but may also be attributed to the changes of the observable data for countries. Given the heterogeneity of the valuation adjustments across country group, further attempts of decomposing the FXE variables are conducted at the end of this section.

4.4.3.1 Net Foreign Currency Shares

From the detailed descriptive statistics in Appendix, it can be shown from the dataset by Lane and Shambaugh (2010a) that with a gradual reduction trend, the overall sample show an average 60 percent for the foreign currency shares of external liabilities (denoted as FXL). In particular, most developing economies exhibit the foreign currency shares of liabilities at above 60 percent over the sample period while Industrial economies on average have 47 percent. On the other hand, almost all external assets are denominated in foreign currencies (denoted as FXA) for developing economies. In particular, the Other Developing and Oil Exporting groups keep 100 percent shares over the whole sample period. The Industrial economies on average have about 78 percent foreign currency assets with smaller variations than the liability side. As a result, one would anticipate the net foreign currency share variable (FAL) would be positive and mainly driven by the foreign currency share of liability variable (FXL). Thus given the overall positive effects of the exchange rate appreciation associated with the overall net lending position (NFA) adjustments, an improvement on NI flows would be expected if the net currency share is negative and deterioration if positive, which is very similar to the previous results for the FXE variable.

Table 4-6 presents the results using the interaction variables between FAL and exchange rate appreciations. It can be seen that the sample size is slightly enlarged for some developing economies relative to the previous regressions with the FXE variable. Further checks on the common subsample suggest that the results have ignorable changes both in magnitude and significance of the coefficients. The general performance of the regressions is roughly the same as previous results. The coefficients for the initial current account position variable only have second order changes compared with Table 4-4.

As discussed above, given the overall effects of exchange rate movements associated with the NFA position adjustments, the valuation effects generated by the net foreign currency share variable should be the same as a quantitatively rescaled FXE variable. This is confirmed by the same signs of the corresponding coefficients between Table 4-6 and Table 4-4. The larger magnitude of the coefficient for the contemporaneous exchange rate variable suggests that exchange rate fluctuations trigger additional NFA adjustments through the FXE variable. On the other hand, the valuation effects due to the choice of currency shares are sharpened across the groups from the interaction variables.

Table 4-6. Valuation Effects and Net Foreign Currency Shares (FAL)

	Whole	WholeExcl. Fin&Oil	Industrial & EM	Industrial & OthDev	Industrial
	(1)	(2)	(3)	(4)	(5)
$100d(NI/GDP)$: **IMF Series**					
dlnREER	4.128	4.426	5.191	4.028	3.665
	(4.80)***	(4.69)***	(4.59)***	(3.83)***	(2.30)**
dlnREER *	-0.071	-0.065	-0.104	-0.049	-0.138
FAL	(-3.16)***	(-2.86)***	(-3.65)***	(-1.63)	(-2.82)**
dlnREER(-1)	0.893	0.626	1.030	0.312	-0.375
	(1.92)*	(1.42)	(1.60)	(0.58)	(-0.29)
CApGDP(-1)	-1.543	-1.239	-0.25	-2.633	-2.462
	(-1.27)	(-0.58)	(-0.19)	(-0.86)	(-1.17)
No. of Econ.	80	70	39	52	21
No. of Obs.	861	773	453	560	240
R^2 Overall	0.04	0.08	0.07	0.07	0.03
R^2 Within	0.06	0.09	0.09	0.08	0.07
R^2 Between	0.05	0.00	0.04	0.02	0.69
RMSE	1.048	0.923	0.664	1.022	0.706
$100d(NI/GDP)$: **WDI Series**					
dlnREER	2.89	3.147	5.061	1.874	2.891
	(2.02)**	(2.00)*	(3.09)***	(1.10)	(1.87)*
dlnREER *	-0.033	-0.027	-0.101	0.022	-0.104
FAL	(-0.88)	(-0.64)	(-2.63)**	(0.36)	(-2.09)*
dlnREER(-1)	1.074	0.885	2.616	0.031	0.221
	(1.84)*	(1.30)	(2.19)**	(0.05)	(0.12)
CApGDP(-1)	0.519	0.914	-1.176	1.042	-2.312
	(0.34)	(0.49)	(-0.53)	(0.57)	(-1.14)
No. of Econ.	71	64	35	49	20
No. of Obs.	732	666	400	505	239
R^2 Overall	0.05	0.07	0.07	0.06	0.02
R^2 Within	0.05	0.06	0.09	0.05	0.04
R^2 Between	0.22	0.26	0.00	0.18	0.38
RMSE	1.171	1.086	0.881	1.106	0.79
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes

[1] See notes to 4-1

For the overall sample (Column 1 & 2), the significantly positive coefficient for the contemporaneous variables suggests that given a balanced net foreign currency share, a world representative economy tends to improve its net investment income by about 3-4 percent of GDP size for a one percent appreciation that leads to adjustments in NFA positions. Meanwhile, the negative coefficients for the interaction variable (particular for the upper panel) suggest that there are valuation gains (losses) from one extra percent holding of foreign currency assets than liabilities.

A further investigation on the quantitative implications for the interaction terms suggests that the valuation effects tend to substantially be driven by the net currency share variations. For an representative Industrial economy, the average FAL is about 30.2 percent and hence one percent deprecation would generate 4.17 (-0.138*30.2) percent improvements on the net investment income. This can sufficiently cover the overall loss from the other channels by the deprecation with about 3.67 percent deteriorations. When the Emerging Market economies are further pooled into the regressions, the negative coefficient for the interaction variable remains significant, suggesting that a *ceteris paribus* decrease of holding foreign currency liabilities would improve the net investment income given the overall NFA position unchanged.

The results for the Developing economies tend to be less significant, though the coefficient appears negative in the regression using IMF data (upper panel in column 5). As discussed before, this insignificance may result from the dominant the tightened borrowing conditions for the Other Developing economies. A further attempt to reveal this possibility is shown in the Appendix where the regressions are conditioning on NFA positions to be higher than -1.5 (*i.e.* the net external borrowing smaller than 1.5 times of GDP)[13]. The coefficient for the interaction variable is negative across the regressions.

4.4.3.2 Net Foreign Asset Positions

Previous analyses suggest that changes in the currency shares respectively in both asset and liability sides tends to be substantial in varying the magnitude of the valuation effects. Given the same net lending/borrowing position, the better is the net currency share (*i.e.* higher FAL), the larger the valuation effects tend to be. On the other hand, an interaction variable between NFA and appreciation can be introduced to assess the valuation effects changing with the net lending positions given the overall net currency share position.

The NFA variable by definition is constructed by the total external asset stocks held by an economy (in terms of US dollars) subtracted by its foreign liabilities, rescaled by GDP. From the descriptive statistics in the Appendix, it can be shown that the Other Developing group on average exhibits the largest negative position of the net foreign asset position, with the magnitude at about 73 percent of GDP size. The negative position for the Emerging Market economies is roughly 1/3 of the former

[13]This is roughly at 5 percentile of the county year observations of the NFA variable for the whole sample.

group. The Industrial economies have even smaller negative position, about 1/5 of the Other Developing group. In terms of the volatilities, the Emerging Market economies tend to have both the smallest cross-country differences and within-country fluctuations while the Other Developing group possesses the largest standard deviations. Moreover, the cross-country variations are much larger than with-in country variations for all groups, suggesting the differentials of the net foreign asset position over the sample period are mainly from the cross-country heterogeneity.

Table 4-7 presents the group-wise distributions of the observation numbers for the NFA position. It can be seen that there are only about 1/10 observations exhibiting positive positions under the NFA measure for the overall sample. This large skewness is particularly evident for developing groups while the number of the positive observations is about 1/3 of the negatives for the Industrial group. This may partially result from the measurement issues on the current account discrepancies over the years, as discussed by Lane and Milesi-Ferretti (2001, 2007). On the other hand, this is consistent with the common observations that developing economies are more likely to be in the negative external potions (*i.e.* a net debtor).

Table 4-7. Distribution of Observations for NFA Position

No. of Obs.	Whole Sample		Excl. Fin & Oil.		Industrial		Emerging Market		Other Developing	
FXE Position	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.	Pos.	Neg.
Appreciations	93	646	48	536	37	114	5	149	6	275
Depreciations	98	516	45	419	38	93	4	93	3	234
Total	191	1162	93	955	75	207	9	242	9	509

Table 4-8 presents the effect of net foreign asset positions on net investment income in addition to the exchange rate fluctuations. It can be seen the general performance of regressions remains the same as previous regressions. The corresponding coefficients for the initial position of current account and first order lag of the exchange rate variables remain similar to previous regression results. Since the NFA variable covers relatively richer observations than FXE, regressions presented in the following are with full NFA observations. Similar patterns can be found as well for the regressions conditioned on a similar sample as previous sections but are subject to some quantitative differences.

Table 4-8. Valuation Effects and Net Foreign Asset Positions

	Whole	WholeExcl. Fin&Oil	Industrial & EM	Industrial & OthDev	Industrial
	(1)	(2)	(3)	(4)	(5)
100$d(NI/GDP)$: **IMF Series**					
dlnREER	2.484	2.592	0.044	2.933	-0.940
	(3.12)***	(3.45)***	-0.05	(2.84)***	(-0.72)
dlnREER*	0.646	0.299	-5.250	0.646	-4.053
NFApGDP	(0.66)	(0.38)	(-1.65)	(0.73)	(-1.07)
dlnREER(-1)	0.494	0.260	0.823	0.025	-1.126
	(1.24)	(0.69)	(1.42)	(0.05)	(-0.81)
CApGDP(-1)	-1.063	-2.36	0.580	-2.940	0.669
	(-0.94)	(-1.44)	(0.63)	(-1.54)	(0.50)
No. of Econ.	106	82	39	64	21
No. of Obs.	1337	1048	533	797	282
R^2 Overall	0.03	0.04	0.07	0.05	0.07
R^2 Within	0.04	0.07	0.07	0.07	0.06
R^2 Between	0.06	0.05	0.02	0.04	0.61
RMSE	1.282	1.093	0.682	1.201	0.721
dNI_WDI					
dlnREER	2.655	2.77	0.030	3.39	-0.699
	(2.57)**	(2.13)**	(0.03)	(1.87)*	(-0.54)
dlnREER*	-0.576	-0.526	-4.715	0.051	-4.352
NFApGDP	(-0.49)	(-0.34)	(-1.20)	(0.03)	(-1.10)
dlnREER(-1)	0.585	0.509	2.375	-0.14	-0.642
	-0.91	-0.83	(2.15)**	(-0.22)	(-0.36)
CApGDP(-1)	-3.967	-2.965	-0.037	-3.569	0.429
	(-1.60)	(-0.90)	(-0.02)	(-0.91)	(0.30)
No. of Econ.	97	77	36	61	20
No. of Obs.	1131	893	473	699	279
R^2 Overall	0.01	0.02	0.06	0.02	0.05
R^2 Within	0.05	0.06	0.08	0.06	0.04
R^2 Between	0.13	0.25	0.02	0.28	0.18
RMSE	1.753	1.416	0.886	1.512	0.813
Country Dummies	Yes	Yes	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes	Yes

[1] See notes to 4-1

The coefficient for the contemporaneous exchange rate variable is significantly positive for the overall sample (Column 1 & 2). This suggests that appreciation on average tends to improve net investment incomes for an economy running a roughly balanced position between the external assets and liabilities. Further investigations on the group-wise regressions suggest that this result is mainly driven by the Other Developing group (Column 4). The Emerging Market group tends to show weaker significance. On the other hand, the Industrial economies (Column 5) tend to show an insignificantly negative coefficient, suggesting the reverse case that depreciation on average improves the net investments income.

Since the contemporaneous exchange rate variable mainly captures the average exchange rate effect from currency components given an NFA position, the asymmetric signs are consistent with the average valuation effect that the Industrial economies usually having positive foreign currency positions tend to have valuation gains from a ceteris paribus depreciation. In contrast, developing economies, particularly those in the Other Developing group mainly possessing negative FXE positions, are associated with an even more deteriorated net borrowing condition as the deprecation increases the foreign currency liabilities. Quantitatively, by comparing the Industrial and Other Developing economies (Column 4), an economy with one percent annual average depreciation and balanced NFA position tends to have 3 percent improvement in the net investment income relative GDP.

The interaction term between the NFA and appreciation variables tends to be insignificant across the regressions. This, in contrast to the significant results for the FAL variable, suggests that the valuation effects tends to insignificantly vary with changes of the overall lending/borrowing positions given the average currency components effects. For the Industrial economies, the coefficient appears negative, suggesting that given an average valuation gains from a *ceteris paribus* depreciation, economies with larger net borrowing positions tends to exhibit additional gains on net investment incomes. This is consistent with the group average positive FXE positions. Quantitatively, given the group mean value of NFA position at about -15 percent of GDP (*i.e.* a net debtor), one percent depreciation on average tends to exploit about 0.61 percent GDP-sized (4.053*0.15) value that undermines the average 0.94 percent valuation gains.

When the Emerging Market economies are pooled together with Industrial economies, the negative coefficient tends to be larger in magnitude but remains insignificant. Specifically, a representative Emerging Market economy with about 32 percent of GDP-sized net external debt would require its extra net interest payment at about 1.68 (5.250*0.32) percent of GDP for an additional percentage of annual depreciations.

The insignificantly positive coefficients for Column 1, 2 and 4 suggest that the Other Developing economies are substantially constraint on the foreign currency liabilities so that the overall wealth effect dominates the valuation changes. Similarly to the previous analyses, once some outliers (NFA>-1.5) are excluded, the coefficients would turn into insignificantly negative and the magnitude of the positive coefficients for the contemporaneous exchange rate variable becomes smaller (See Table 4-21 and 4-22 in the Appendix). These suggest that the valuation effects would be more significant for developing economies with less heavier liabilities.

4.4.3.3 Decomposing Net Foreign Currency Exposures

The decompositions in the previous sections suggest that valuation effects tend to through different channels particularly among developing economies. For the Emerging Market economies, adjustments of foreign currency components tend to be substantial in varying the magnitude of valuation effects. On the other hand, currency choice on external liabilities seems to be rationed for the Developing economies so that the foreign currency exposure is mainly driven by their net borrowing positions. As a result, decomposing the net foreign currency exposure variables into movements in currency shares and overall values are attempted.

Table 4-9 assesses the FXE variations on both the foreign currency shares respectively on asset (ω^{FA}) and liability side (ω^{FL}) and the total stocks of foreign asset (FA) and liability (FL) in ratio to GDP. It can be seen firstly that the signs of the coefficients are consistent with the definition of FXE across the regressions. Those variables on the asset side (ω^{FA} and FA) are positively correlated with FXE improvement while the liability variables are negatively correlated with FXE positions.

Table 4-9. Decomposing Net Foreign Currency Exposures

	Whole	WholeExcl. Fin&Oil	Industrial & EM	Industrial & OthDev	Industrial
	(1)	(2)	(3)	(4)	(5)
ω^{FA}	0.015	0.015	0.015	0.016	0.018
	(5.17)***	(5.03)***	(5.87)***	(5.25)***	(5.77)***
ω^{FL}	-0.013	-0.012	-0.011	-0.014	-0.013
	(-6.70)***	(-7.87)***	(-6.32)***	(-7.40)***	(-5.26)***
FA	1.065	1.088	0.702	1.091	0.556
	(12.45)***	(10.02)***	(5.69)***	(9.95)***	(4.12)***
FL	-0.785	-0.741	-0.277	-0.75	-0.14
	(-10.82)***	(-7.10)***	(-2.31)**	(-7.14)***	(-1.17)
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes
No. of Econ.	102	89	39	71	21
No. of Obs.	1387	1210	543	961	294
R^2 Overall	0.94	0.93	0.87	0.93	0.83
R^2 Within	0.81	0.79	0.76	0.80	0.79
R^2 Between	0.96	0.96	0.89	0.96	0.84
RMSE	0.132	0.107	0.1	0.114	0.117

[1] See notes to 4-1

By comparing among the country groups, it can be seen that the external liability stock tends to be insignificantly correlated with FXE positions for the Industrial economies. This may suggests the sizeable valuation effects that may counteract the wealth effect on the liability side. On the other hand, since only the Industrial group have some proportions of foreign assets in domestic currency, the coefficients for the FXA across the regressions would be expected similar.

When the Other Developing economies are compared with the Industrial group, the coefficient becomes much larger in magnitude and highly significant. This suggests that the foreign currency exposure is mainly driven by the overall borrowing positions since those economies are inflexible of choosing the currency denominations of liabilities. This is also supported by the coefficient for the foreign asset stock variable (FA). The coefficient is about unity, clearly reflecting that the majority number of Other Developing economies in the regression have no variations on the domestic currency components of asset side. These differences confirm that the wealth effects tend to dominate the valuation effects when the two groups are pooled in the previous analyses.

Since the Emerging Market economies experienced a general improvement on the foreign currency denominated liabilities over the sample period, the coefficient for the FL variable tends to be smaller in magnitude than the Other Developing economies. On the other hand, due to the dominant proportion of foreign currency asset shares, the coefficient for the FA variable tends to be larger than the regression with Industrial economies only. These suggest that when the Emerging Market economies are contrast to the Industrial economies, there would be a significant valuation effects from the changes of net currency shares.

4.5 Valuation Effects and Current Account Adjustments

Previous results suggest that the valuation changes due to exchange rate fluctuations tend to significantly affect the net investment income flows. In particular, depreciation is associated with improvement if domestic currency denominated liabilities dominate the external capital holdings but with deterioration if foreign currency liabilities becomes the majority components. On the other hand, analyses in Chapter 3. suggest that depreciations are generally associated with an overall improvement on net trade surplus. Accordingly, depreciation tends to generate a trade-off or an accelerated effect on the current account balance between the export and capital income flows depending on the foreign currency exposures.

Given a positive currency position, deprecation tends to boost trade income as well as the valuation gains. On the other side, given a negative currency position, there is a trade-off between the deterioration of interest rate payment on foreign liabilities and improvement of export income, which tends to be more likely to occur on developing economies. If the sensitivity of trade balance adjustments dominates the valuation effect on investment income, a negative correlation is expected between appreciation and current account surplus (i.e. still a net improvement).

To further assess the valuation effects on the overall adjustments of the current account in response to the exchange rate fluctuations, a similar specification to the baseline regressions in Table 4-1 is employed. The annual growth of current account relative to GDP size is assumed as a function of real exchange rate appreciations given its initial positions. Moreover, previous results suggest that the adjustments of trade and investment income flows may last up to 2 years, thus a first order lag of exchange rate variable is included as well. The interaction variables will be further introduced into the regressions to explore the valuation effects. Alternative specifications by replacing the initial position of current account with one-year lag of the current account changes are employed as well but yields similar results. The data for current account in ratio to GDP is directly employed from the WDI database with the same sample period as before. Group-wise descriptive statistics are shown in the Appendix.

4.5.1 Overall Effects of Exchange Rate Variations

Table 4-10 presents the baseline regressions for the annual changes of current account in responses to exchange rate fluctuations. The upper panel shows the results for OLS estimations, which may ignore the potential endogeneity problems as the annual changes of current account imbalances could indicate the REER adjustments and positions of current account. Accordingly, the lower panel shows the GMM estimation results by treating the exchange rate and current account position variables potentially endogenous. Similarly to Chapter 3, the GMM estimations may suffer excessive number of instruments. Nevertheless, the results are roughly comparable to OLS results and the coefficients remains similar magnitude and significance level after annual large REER change (*i.e.* >20%, 25% as before) observations are excluded.

Table 4-10. Baseline Regression on Annual Changes of Current Account in Ratio to GDP

	Whole	WholeExcl. Fin&Oil	Industrial	Financial	Oil	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
OLS Regressions							
dlnREER	-0.085	-0.044	-0.026	0.167	-0.146	-0.098	-0.019
	(-3.42)***	(-2.75)***	(-0.94)	(1.19)	(-2.18)*	(-3.10)***	(-0.89)
dlnREER(-1)	-0.042	-0.035	-0.062	0.020	0.031	-0.058	-0.033
	(-2.36)**	(-2.88)***	(-1.70)	(0.28)	(0.33)	(-3.56)***	(-2.11)**
CApGDP(-1)	-0.295	-0.389	-0.079	-0.51	0.136	-0.333	-0.445
	(-3.35)***	(-10.95)***	(-1.25)	(-10.52)***	(0.52)	(-4.95)***	(-10.74)***
No. of Econ.	108	82	21	16	10	18	43
No. of Obs.	1391	1062	292	210	119	251	519
R^2 Overall	0.04	0.09	0.05	0.06	0.33	0.3	0.16
R^2 Within	0.16	0.23	0.14	0.35	0.43	0.39	0.26
R^2 Between	0.07	0.03	0.50	0.15	0.30	0.15	0.12
RMSE	0.046	0.034	0.017	0.049	0.081	0.024	0.042
GMM Regressions							
dlnREER	-0.099	-0.057	-0.037	0.106	-0.13	-0.118	-0.032
	(-4.55)***	(-3.67)***	(-1.59)	(0.76)	(-2.78)***	(-3.78)***	(-1.61)
dlnREER(-1)	-0.027	-0.031	-0.069	0.062	0.066	-0.059	-0.033
	(-1.14)	(-2.51)**	(-2.17)**	-0.92	(0.62)	(-3.37)***	(-2.44)**
CApGDP(-1)	-0.036	-0.188	0.053	-0.091	0.363	-0.188	-0.254
	(-0.34)	(-5.94)***	(2.57)**	(-1.61)	(1.30)	(-3.97)***	(-7.21)***
No. of Econ.	108	82	21	16	10	18	43
No. of Obs.	1391	1062	292	210	119	251	519
Sargan p-value	0.000	0.000	0.001	0.049	0.000	0.135	0.000
Hansen-J p-value	1.000	1.000	1.000	1.000	1.000	1.000	1.000
No. of Instr.	263	260	224	184	115	204	259
Country Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes	Yes	Yes

[1] Endogenous variables in the GMM regressions are dlnREER, dlnREER(-1), and CApGDP(-1).
[2] See notes to 4-1

It can be seen that annual changes of current account exhibit negative correlations with its initial position particularly for developing economies. The negative coefficients for the Emerging Market and Other Developing groups are significant for both upper and lower panel, suggesting that among those economies, larger current account imbalances tends to be associated with larger reversals over the sample period. A similar result for the Financial economies can be shown in the upper panel but tend to be weakened after GMM estimations are employed. For the Industrial economies, the coefficient is insignificantly negative in the upper panel but significantly positive for the lower panel. This suggests that, among the Industrial economies, larger current account imbalance positions tend to be associated with longer persistence over the years. The results for the Oil Exporting economies are insignificantly positive, suggesting the within-group insignificant persistence of current account imbalance over the sample period.

In the overall sample regressions, the coefficients for the exchange rate variables are all negative, suggesting that real depreciation against the world tends to be associated with current account improvements. Compared with the negative sign in the trade balance (Table 3-2) and positive in the net investment income (Table 4-1) regressions, this suggests that given the initial position of current account (i.e. net capital outflow), depreciation tends to improve trade balance more than the valuation loss from foreign currency liabilities over the years. This pattern is particular evident in the groupwise regressions for the Emerging Market economies as both the contemporaneous and lagged exchange rate variable exhibit significantly negative coefficients.

For the Other Developing economies, the coefficient for the contemporaneous exchange rate changes is insignificantly negative. This suggests that there are significant valuation effects on the net investment income flows sufficiently offset by the trade balance improvements in response to ceteris paribus depreciations. Moreover, the one-year lag exhibits significantly negative coefficients, suggesting that the valuation effects one year later tend to be much smaller than the trade balance adjustments. The significance of the one-year lag variable is weakened after large-REER-change observations (no large changes for 2 years) are excluded, suggesting that under moderate fluctuations, the overall effects of exchange rate on net investment income tend to be comparable to the size on the counteracting net trade income.

For the Industrial economies, the coefficients for the exchange rate variables are insignificantly negative, suggesting that trade balance improvements weakly dominate the current account changes in responses to deprecation. On the other hand, for the Oil Exporting economies, the trade balance adjustments tends to be stronger for the contemporaneous year but smaller than the net investment income changes in the subsequent year. For the Financial economies, the capital income flows tends to dominate the current year current account adjustments while trade balance tends to be stronger one year later.

4.5.2 Offsetting Adjustments: Trade Balance vs. Net Investment Income

Previous results suggest that exchange rate fluctuations tend to affect the current account mainly through the trade balance channel. Also, the analyses of trade balance adjustments indicate different speeds of the adjustments across the country groups. This raises the comparison of the extent to which an economy's current account comprises the two income flows given exchange rate movements. Hence an Industrial economy indicator dummy interacted with the exchange rate variables are introduced into all the baseline regressions on trade balance, net investment income and current account changes. Since the dynamic patterns for developing economies are mostly significant for the Emerging Market economies, the following comparisons are mainly conducted among the Industrial and Emerging Market groups.

Table 4-11 presents the cross-country comparisons of the current account components' adjustment speed. The coefficient for the interaction variable in the trade balance regressions is significantly positive when the Emerging Market economies are grouped with the Industrial economies (Column 1 & 2). Further tests on the long-run quantitative difference of the trade balance responses is insignificant between the two groups. These would confirm the results in the Chapter 3 that an Emerging Market economy's trade balance tends to have the most instant and significant responses to exchange rate variations. On the other hand, the Industrial economies tend to have more smoothed and persistent adjustments, which is shown by the negative coefficient for the first-order lag of the interaction variable. Moreover, Table 4-23 in the Appendix proves the stylised results in contrasting the speed of adjustments for exports and imports between the Industrial economies and developing economy groups.

In the net investment income regressions (Column 3 & 4), the coefficient on the IND dummy interaction variable is negative but insignificant. This suggests small valuation gains from depreciation for the Industrial group but valuation losses for the Emerging Market group, which is consistent with the baseline results. Consequently, given an exchange rate changes, the valuation effects tend to offset the trade balance adjustments for the latter group of economies, most of which have negative FXE positions. On the other hand, both trade and net investment incomes response in the same direction for the Industrial economies of which most are having positive FXE positions.

Table 4-11. Asymmetric Speed of Adjustments between the Ind and EM groups

	dTB/(X+M)	dTB/GDP	dNI/GDP		dCA/GDP	
	(1)	(2)	(3)	(4)	(5)	(6)
dlnREER	-0.212	-0.090	0.021	0.015	-0.103	-0.103
	(-5.23)***	(-3.35)***	(3.67)***	(3.00)***	(-3.38)***	(-4.98)***
dlnREER*	0.151	0.043	-0.018		0.063	
1IND	(2.18)**	(1.11)	(-1.15)		(1.72)*	
dlnREER*				-0.063		0.009
FXE				(-3.38)***		(0.14)
dlnREER(-1)	-0.017	-0.019	0.015	0.022	-0.020	-0.018
	(-0.53)	(-1.23)	(2.23)**	(2.69)**	(-1.25)	(-0.87)
dlnREER(-1)*	-0.110	-0.047	-0.024	-0.024	-0.067	-0.048
1IND	(-2.68)**	(-1.98)*	(-1.40)	(-1.69)*	(-1.72)*	(-0.99)
dlnTOT	0.183	0.123			0.080	0.100
	(3.72)***	(3.27)***			(2.01)**	(2.00)**
dlnGDP	-0.612	-0.451			-0.287	-0.376
	(-4.25)***	(-3.56)***			(-2.36)**	(-3.23)***
CA/GDP(-1)			0.008	0.002	-0.040	-0.111
			(0.91)	(0.15)	(-1.42)	(-4.31)***
Country Dum.	Yes	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes	Yes
No. of Econ	37	37	39	38	37	36
No. of Obs.	514	514	533	443	512	426
R^2 Overall	0.30	0.25	0.07	0.10	0.003	0.005
R^2 Within	0.39	0.36	0.07	0.12	1.000	1.000
R^2 Between	0.01	0.02	0.09	0.00	0.962	0.885
RMSE	0.029	0.019	0.007	0.007	357	194
Tests for 1(IND) Dummies in p-values						
No Diff. Ind	0.54	0.94	0.01		0.95	

[1] The No Diff. Ind test represents the test dlnREER***1**IND + dlnREER(-1)***1**IND = 0
[2] GMM regressions with endogenous variables dlnREER, dlnREER(-1), and CApGDP(-1) are employed for Column 5 & 6.
[3] See notes to Table 4-1

By comparing the overall effects, the valuation effects in the current account adjustments are insignificant and trade balance dynamics dominate the overall cross-country patterns. Hence a more instant and larger response tends to be obtained for a representative Emerging Market economy than an Industrial one.

4.6 Conclusion

Exchange rate variations tend to have significant influences on net investment incomes. In particular, given the initial position of current account balance (and hence the net capital outflows), economies having real appreciations tend to be associated with immediate and significant net income improvements for most developing economies. Within the Emerging Market group, this positive correlation tends to be stronger. On the one side, this is consistent with the empirical findings that appreciation indicates stronger fundamentals and hence better net foreign asset positions. On the other hand, developing economies (usually as net debtor) possess dominant shares of foreign currency liabilities and hence depreciations tend to deteriorate their incomes on net external asset holdings (i.e. the valuation effects).

By controlling the positions of net foreign currency exposures, valuation effects can be found particularly significant among the Emerging Market and Industrial economies. Specifically, appreciation tends to exhibit a positive correlation with net investment income improvements for those economies with net long positions of foreign currency assets but negative with short positions. Moreover, negative FXE positions tend to exhibit more instant and larger responses of the NI flows to the exchange rate fluctuations than positive exposures. Among the Emerging Market and Industrial economies, the larger is the imbalance of FXE, the larger valuation effects can be observed. On the other hand, the comparisons between the Other Developing and Industrial economies suggest that valuation effects insignificantly vary with the FXE size.

Further decompositions on the net foreign currency exposures suggest that valuation effects tend to be via different channels particularly across developing economies. For the Industrial economies, the majority share of domestic currency denominated foreign liabilities provide flexibilities of valuation adjustments offsetting the effects from overall net external borrowing position on net investment income flows. For the Emerging

Market economies, the foreign currency share of external liabilities generally decrease while the net external borrowing positions are relatively stable over the sample period. Hence the comparison between the above two groups of economies suggest that the valuation effects are mainly driven by the net currency share adjustments. In other words, given depreciation, the net investment income will be improved with reduction of the foreign currency shares on the liability side.

On the other hand, the Other Developing economies are rationed to dominant and relatively stable proportions of foreign currency liabilities. Hence the changes in foreign currency exposure would be driven by the overall external borrowing positions. Given a depreciation, the net investment income tend to be improved with better NFA positions, and the valuation effects are insignificantly proportional to the changes in net foreign currency shares. However, when some country-years with heavy net external borrowing positions are excluded, there tends to be insignificant valuation effects from the changes in foreign currency shares.

The initial current account positions tend to have insignificantly positive effects for the Industrial and Emerging Market economies' net investment income flows, suggesting that within the two groups, larger surplus (deficit) positions tend to be associated with larger improvement (deterioration) on the net income flows. However, the insignificant correlation tends to be negative for the Other Developing economies. Given most of them tend to exhibit negative positions over the sample period, this suggests that larger current account deficits tend to be associated with larger improvement in the net interest rate payment indicating some severe indebtedness cases.

Given the initial net capital outflows (*i.e.* current account balance), adjustments of the current account in response to exchange rate fluctuations generally offset the changes in the net trade with investment income flows. Over the sample period, real depreciation tends to be associated with improvements on the current account balance for the whole sample. This suggests that the overall improvements on the net trade income dominate the deteriorations of net investment income flows for most developing economies. In particular, both the contemporaneous and the subsequent year correlations are significantly negative for the Emerging Market group, with the latter smaller in magnitude. For the Industrial and Other Developing economies, the contemporaneous effects on the trade and capital income flows are of comparable size while trade income changes tend to dominate the overall adjustment in the subsequent year.

Moreover, the initial position of the current account tends to be negatively correlated with its annual growth for developing economies. This suggests that larger current account imbalance positions tend to be associated with a larger magnitude of mean-reversal behaviours. On the other hand, there tends to be an insignificant or negative correlation among the Industrial group, suggesting that those economies tend to have some degree of persistence on current account imbalances.

By further comparing the speed of adjustments on the two current account components, the Emerging Market economies tend to have the most instant and largest responses. Hence given the exchange rate fluctuations, these economies tend to experience larger adjustment volatilities in both tradable and financial sectors than the other economies. The Industrial group tends to exhibit more smoothed and gradual adjustments in the external balances as the valuation gains tend to work in the same direction of improving trade balance for a given depreciation. The Other Developing economies tend to have negative correlation between appreciation and current account improvements, though both the trade balance and net investment income adjustments are less significant than the other groups.

4.7 Appendix

4.7.1 Summary Statistics

4.7.1.1 Net Investment Income Flows

Table 4-12 presents the overall performance of net investment income flows across the country groups. By comparing the first three columns between the two alternative measures, one can see that the IMF data cover richer country-year observations. Similarly to the previous chapters, the Industrial and Emerging Market groups have more complete data over the sample period while Oil Exporting economies tend to have the poorest average spell.

Table 4-12. Summary Statistics of Net Investment Income

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
NIpGDP _IMF*100							
Overall	1480	108	13.7	-2.8257	3.80634	4.03621	1.87529
Industrial	304	21	14.48	-0.8239	2.77546	2.60076	1.02623
Financial	215	16	13.44	-3.8843	4.92578	4.49719	2.54449
Oil Exporting	129	10	12.9	-4.7011	4.37445	4.19827	2.03152
Emerging Market	269	18	14.94	-2.5857	1.94789	1.55839	1.21806
Other Developing	563	43	13.09	-3.1874	3.87377	4.82616	2.13874
NIpGDP_WDI*100							
Overall	1255	99	12.68	-4.5541	5.85693	6.97781	2.16761
Industrial	300	20	15	-0.6187	2.98148	2.83479	1.10882
Financial	198	14	14.14	-8.3585	6.74479	6.40542	2.94032
Oil Exporting	79	8	9.88	-7.3788	5.24444	6.32394	2.01553
Emerging Market	211	16	13.19	-3.7336	2.79726	2.32873	1.6648
Other Developing	467	41	11.39	-5.362	6.38857	9.00544	2.50419
d NIpGDP _IMF*100							
Overall	1367	108	12.66	-0.0355	1.37245	0.70796	1.28965
Industrial	282	21	13.43	0.0738	0.74643	0.20489	0.71925
Financial	198	16	12.38	-0.3074	1.85426	0.59243	1.7707
Oil Exporting	119	10	11.9	-0.0491	1.8197	1.16407	1.68443
Emerging Market	251	18	13.94	-0.0382	0.70367	0.21962	0.67054
Other Developing	517	43	12.02	0.0135	1.52836	0.88129	1.43442
d NIpGD _WDI*100							
Overall	1153	98	11.77	-0.1046	1.82616	0.59578	1.77906
Industrial	280	20	14	0.1097	0.82505	0.18199	0.80569
Financial	184	14	13.14	-0.3042	2.77775	0.31787	2.76145
Oil Exporting	71	7	10.14	-0.1107	2.36915	0.31066	2.3606
Emerging Market	194	16	12.13	-0.0415	1.09759	0.44983	1.03191
Other Developing	424	41	10.34	-0.1873	1.93913	0.8162	1.8667

It can be seen from the upper two panels that the whole sample exhibits an average negative income flow position, with the magnitude at about 2.8 percent of GDP in the IMF data and 4.5 in the WDI data. The Industrial economies has the smallest negative mean less than 1 percent of GDP, suggesting the least investment outflow across the groups. The Financial and Oil Exporting groups have the largest average interest payment outward, with the magnitude at about 3-5 percent in the IMF data and 7-9 percent in the WDI measure. The mean values for the Emerging Market and Other Developing economies are positioned between the above two extremes.

By comparing the overall standard deviations between the groups, one can see that the Financial and Oil Exporting have the largest variations in their net investment income flows, with the magnitude at about twice as large as the Industrial and Emerging Market economies. The latter two groups tend to exhibit the most stable group-wise variations. By further decomposing into the between- and within- standard deviations, one can figure out that the Financial and Other Developing group tend to have the largest cross-country heterogeneity of the net investment income conditions. The Industrial and Emerging Market tend to have the most within-group similarities. On the other hand, these two groups tend to have the least within- standard deviations across the groups as well, suggesting their relative stable net flows. The Financial and Oil Exporting economies exhibit the largest within-variations.

In contrast to the levels, the lower panels of Table 4-12 provide the summary of the annual changes of the net investment income flows across the groups. The Financial and Oil Exporting groups exhibit the largest average deteriorations, with the average annual changes at about 0.05-0.3 percent of GDP. The Industrial economies on average have an improvement. The Other Developing economies exhibit an ambiguous results for the two measures, which may be due to the data coverage and some extreme observations. The Emerging Market group has an annual average deterioration at about 0.04-0.05 percent of GDP.

The rankings of the overall and within-standard deviations across the groups generally show similar patterns to the upper panels. The Financial and Oil Exporting groups are exposed to the largest volatilities among the groups. The Industrial economies and Emerging Market groups tend to have the smallest variations over the years. On the other hand, the between-effect for the standard deviation suggests that the Oil Exporting and Other Developing economies are subject to the largest cross-country heterogeneities in terms of the annual changes of net investment income flows, with the magnitude at about 4 times as large as the Industrial group. The Financial group exhibits a smaller variation than the previous two groups, but magnitude is about twice of the Emerging groups.

To further explore the similarity of the two alternative measures, Table 4-13 provides their country-wise correlations for each group. It can be seen that the correlation for the Oil Exporting and Emerging Market groups exhibit the largest similarity, with the group average over 80 percent. The result for the Other Developing economies suggests the largest disagreements, with the average correlation at about 57 percent only. From the last two columns, it can be seen that there are economies having negative correlations, suggesting somewhat the data quality issues.

Table 4-13. Correlation between the IMF and WDI series

	N_Obs.	N_Econ	T-bar	Mean	Std.	Min	Max
Overall	1251	95	13.17	0.6715	0.36042	-0.509	1
Industrial	280	20	14	0.715	0.33228	-0.311	0.994
Financial	187	14	13.36	0.634	0.37861	-0.509	1
Oil Exporting	81	6	13.5	0.8472	0.18533	0.453	0.997
Emerging Market	209	15	13.93	0.8141	0.23274	0.31	1
Other Developing	494	40	12.35	0.5718	0.39889	-0.356	1

4.7.1.2 Current Account Balance

Table 4-14 presents the summary statistics of the current account performance. It can be seen from the upper panel that the overall sample exhibits an average current account deficit over the years, which is a common empirical findings as discussed in the trade balance positions. The Oil Exporting economies possess the largest average current account surplus, with magnitude nearly 3 percent of GDP. The average surplus for Emerging Market group comes as the second largest, with about 1 percent of GDP.

The current account balance for the Industrial group is very much closer to zero than the others. The Financial and Other Developing groups have substantial average deficits, with the magnitude of 7.5 and 5.7 percent of their GDP respectively.

Table 4-14. Summary Statistics of Current Account

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
CApGDP							
Overall	1490	108	13.8	-0.0312	0.09283	0.07599	0.06214
Industrial	314	21	14.95	0.0041	0.05404	0.04625	0.02965
Financial	215	16	13.44	-0.0755	0.11229	0.10175	0.06798
Oil Exporting	129	10	12.9	0.0275	0.17027	0.15277	0.14009
Emerging Market	269	18	14.94	-0.0102	0.04409	0.02642	0.03581
Other Developing	563	43	13.09	-0.0574	0.07575	0.05183	0.05385
dCApGDP							
Overall	1377	108	12.75	0.0002	0.05351	0.03381	0.04956
Industrial	292	21	13.9	0.0003	0.01852	0.0061	0.01753
Financial	198	16	12.38	-0.0056	0.06053	0.01513	0.05923
Oil Exporting	119	10	11.9	0.0068	0.11632	0.10569	0.09915
Emerging Market	251	18	13.94	0.0015	0.02969	0.00513	0.02926
Other Developing	517	43	12.02	0.0004	0.04999	0.01859	0.04873

The variation of current account balance is considerably large for both cross-country and time dimensions. For the overall sample, the between-effect for one standard deviation is about 7.5 percent of GDP, and the within-effect is about 6.2 percent. By comparing among the groups, it can be seen that the Oil Exporting and Financial economies exhibit the largest standard deviations, with the magnitude at about 2-3 times as large as the Industrial group. The Emerging Market and Industrial groups tend to have smaller group-wise variations than the others, with about 3-5 percent of GDP as one standard deviation.

The lower panel of Table 4-14 presents the results for the annual changes of current account balance. It can be seen that the overall sample roughly shows an average annual growth rate very close to zero. This average is also applied to the Industrial and Other Developing groups. The average growth for the Emerging Market economies is slightly larger, with the magnitude at about 0.15 percent of GDP per year. The largest annual growth rate happens to the Oil Exporting group, with the magnitude at about 0.7 percent of GDP. This is also implied by the largest current account surplus over the sample period mentioned above. On the other extreme, the Financial group exhibits an average deterioration rate at about 0.7 percent of GDP, which is also consistent with its largest group-wise current account deficit.

The volatility comparison for the annual changes in current account across the groups is generally consistent with results for the level variables. The Financial and Oil Exporting economies on average exhibit the largest variations for both within- and between- effects, suggesting both substantial cross-country heterogeneities and volatile economies. The Industrial and Emerging Market economies on the other hand tend to have smaller standard deviations, with the magnitudes less than half of the above two groups.

4.7.1.3 Net Foreign Asset Positions

Table 4-15 presents the summary statistics for the net foreign asset position in terms of GDP size. It can be seen from the upper panel that the overall sample exhibits an average deteriorations over the sample period. Lane and Milesi-Ferretti (2007) show that the discrepancy is consistent with the discrepancies in the external account flows over the years and can be attributed to the inconsistent bilateral reporting of external asset holdings. The Other Developing economies on average have the largest net external liability stocks, with the average magnitude about 73 percent of GDP. The Financial group exhibits about 40 percent negative position, which may partially coincide with the bilateral inconsistence on reporting the actual domestic holdings of external asset and liabilities. The Oil Exporting and Emerging Market generally have a negative position with about 1/3 of GDP size. The Industrial economies have much smaller discrepancy between external asset and liability stocks.

Table 4-15. Summary Statistics of Net Foreign Asset Positions

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
NFApGDP							
Overall	1462	106	13.79	-0.4511	0.70364	0.8137	0.27268
Industrial	315	21	15	-0.15	0.43851	0.41336	0.17043
Financial	186	14	13.29	-0.412	0.89692	0.95428	0.30456
Oil Exporting	130	10	13	-0.2878	0.79534	0.90509	0.28654
Emerging Market	269	18	14.94	-0.3213	0.20345	0.18156	0.10094
Other Developing	562	43	13.07	-0.7328	0.77855	1.00615	0.35077
d(NFApGDP)							
Overall	1351	106	12.75	0.0071	0.1716	0.05702	0.16325
Industrial	293	21	13.95	-0.0033	0.10475	0.02827	0.10106
Financial	171	14	12.21	-0.001	0.18767	0.07491	0.17677
Oil Exporting	120	10	12	0.0337	0.21026	0.05649	0.2061
Emerging Market	251	18	13.94	0.0002	0.06196	0.01991	0.05888
Other Developing	516	43	12	0.0128	0.2167	0.07068	0.20557

It can be seen that the variation of net foreign asset positions are substantial, particularly for the cross-country heterogeneities. By comparing among the groups, the Oil Exporting, Other Developing and Financial economies on average have the overall standard-deviation comparable to their GDP size, mainly due to the between-effects. For the within-variations, one standard-deviation is about 1/3 in ratio to GDP, which is 2-3 times as much as the Industrial and Emerging Market groups.

In contrast to the levels, the annual changes of the net foreign asset position exhibit an average improvement over the sample period. By decomposing into groups, the Oil Exporting and Other Developing economies generally have the largest average improvement, with the magnitude at about 1.5-3 percent of GDP per year. However, their standard-deviations are also larger than the others. The Emerging Market and Financial groups tend to have annual changes close to zero, but the volatilities for latter one is about 3 times as large as the former. The Industrial economies on average exhibit a small deterioration, but with smaller standard deviations.

4.7.1.4 Foreign Currency Exposures

Table 4-16 presents the aggregate foreign currency exposure variables for each group. It can be seen from the upper panel that the overall sample exhibits a small short position in foreign currencies of the net external asset portfolio. This may particularly be driven by the large negative group averages for the Oil Exporting and Other Developing economies. Moreover, the standard deviations for the Other Developing economies suggest that for most of the country-year observations, the foreign currency exposure tends to be in negative positions. For the Oil Exporting economies, the between-effect of the standard deviation implies that some economies tend to have an average positive position. For the Emerging Market economies, the magnitude of average short positions is much smaller than the above two groups. The Industrial and Financial economies on average exhibit positive positions in foreign currency exposures.

Table 4-16. Summary Statistics of Aggregate Foreign Currency Exposures

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
FXE_Index							
Overall	808	72	11.22	-0.086	0.27064	0.26194	0.09858
Industrial	251	21	11.95	0.08	0.1767	0.16415	0.07349
Financial	20	3	6.67	0.2584	0.14357	0.15497	0.04533
Oil Exporting	59	6	9.83	-0.1394	0.29221	0.2941	0.13138
Emerging Market	203	17	11.94	-0.0785	0.21967	0.19404	0.11345
Other Developing	275	25	11	-0.2567	0.26146	0.24293	0.10203
FXE							
Overall	807	72	11.21	0.0029	0.7528	0.85258	0.23706
Industrial	251	21	11.95	0.3313	0.61815	0.58525	0.23191
Financial	20	3	6.67	2.4703	1.85405	2.12451	0.54582
Oil Exporting	59	6	9.83	-0.2654	0.53022	0.63426	0.26548
Emerging Market	203	17	11.94	-0.0563	0.23821	0.21291	0.11913
Other Developing	274	25	10.96	-0.3764	0.52396	0.46368	0.26543

The variable in the lower panel is rescaled by the relative size of total stocks external asset and liability to GDP. Compared with the upper panel, one can see that the overall sample average exposure switches to a very small positive position, *i.e.* a long position in foreign currency at about 0.3 percent of GDP. The Financial group exhibits the most distinctive positive exposure, with the group average at about 2 times of GDP size and within standard deviation at about 50 percent of GDP size. The Industrial group is the other one with positive position, with the magnitude at about 30 percent of GDP. The Other Developing economies on average still have the largest negative exposure, and the standard deviations suggest that their position are mostly negative over the years. The Emerging Market group on average exhibits a small negative position, with the magnitude about only 5 percent of GDP. Moreover, their standard-deviations are the smallest among all the groups.

4.7.1.5 Foreign Currency Denominated Shares

Table 4-17 summarises the group-wise statistics for the foreign currency denominated liability shares relative to the total external liability. The data limits the sample period upon 1992-2004, which is shorter than the previous analysis. It can be seen that the overall sample means suggest an 60 percent of external liabilities are denominated in foreign currencies. By comparing among the groups, it is evident that developing economies are much more likely to have external liabilities anchored in terms of foreign currency. The average proportion for the Oil Exporting, Emerging Market and Other Developing economies are all above 60 which is about 1.5 times as much as the Industrial group.

Table 4-17. Summary Statistics of the Foreign Currency Denominated Liability Shares

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
FXL							
Overall	874	80	10.93	60.2554	21.44766	18.58452	10.55174
Industrial	251	21	11.95	47.3143	22.44576	18.17717	13.68151
Financial	20	3	6.67	34.345	11.32628	2.17754	11.20059
Oil Exporting	68	7	9.71	62.7029	21.36651	18.82366	10.28966
Emerging Market	213	18	11.83	60.4878	16.66873	13.58296	10.04287
Other Developing	322	31	10.39	71.2817	16.62027	14.109	7.8028

Moreover, the standard deviations also provide distinct group-wise characteristics. The Industrial economies on average tend to have the largest overall and within- standard deviations, suggesting a more active portfolio adjustments between domestic and foreign currency denominated liabilities. The between-effect for the Financial group is much smaller than the others. This may be due to the very small number of economies that data covers. The rest three groups tend to have similar volatilities, and within one standard deviation, it can be figured out that the average proportion of foreign currency denominated liability is still above 50 percent.

Table 4-18 presents the shares of foreign currency components on the asset side of the external capital balance sheet for each group. It can be seen that nearly all of the foreign assets are denominated in foreign currency, with the average about 93 percent for the whole sample. For the Industrial economies, there are about 78 percent of the foreign assets are in foreign currency. Financial economies also posses a fraction of domestic currency foreign assets but the data are largely incomplete. For the Emerging Market, Oil Exporting and Other Developing groups, almost all of the foreign assets are denominated in foreign currency. In particular, the latter two groups have zero variations over the whole sample period. Given the greatly domiant foreign currency share on the asset side, one would expect that variations in the net foreign currency share variable (FAL) would be dominated by the FXL variable, *i.e.* changes in the foreign currency shares on the liability side.

Table 4-18. Summary Statistics of the Foreign Currency Denominated Asset Shares

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
FXA							
Overall	874	80	10.93	93.1037	17.21447	14.18126	9.0569
Industrial	251	21	11.95	77.5554	24.80127	19.43649	15.89786
Financial	20	3	6.67	80.405	25.51661	17.06528	21.05679
Oil Exporting	68	7	9.71	100	0	0	0
Emerging Market	213	18	11.83	99.9911	0.03718	0.03529	0.01359
Other Developing	322	31	10.39	100	0	0	0

Table 4-19 provide group-wise summaries for the net foreign currency share (FAL) variable. It can be seen that the whole sample exhibits a positive position over the years. This is consistent with the discussions above that most of foreign assets are in foreign currency, leading to an excessive position of shares relative to the liability side. Moreover, one can see that the group average for the Oil Exporting, Emerging Market and Other Developing economies are mainly the complementary shares of the FXL variable, due to their 100 percent FXA shares.

Table 4-19. Summary Statistics of the Net Foreign Currency Shares

	N_Obs.	N_Econ	T-bar	Mean	Std.	Std_b	Std_w
FAL							
Overall	874	80	10.93	32.8483	18.08391	15.89169	8.81933
Industrial	251	21	11.95	30.241	17.78926	15.97616	8.45395
Financial	20	3	6.67	46.06	18.72568	17.85386	10.30174
Oil Exporting	68	7	9.71	37.2971	21.36651	18.82366	10.28966
Emerging Market	213	18	11.83	39.5033	16.68116	13.599	10.04266
Other Developing	322	31	10.39	28.7183	16.62027	14.109	7.8028

4.7.2 Supplementary Results

Table 4-20. Baseline Regressions on Subsamples with FXE, FXE_I & NFA Obs.

	Whole	WholeExcl. Fin&Oil	Industrial	EM	OthrDev
	(1)	(2)	(3)	(4)	(5)
dNI_IMF					
dlnREER	2.167	2.746	-0.378	2.116	3.165
	(4.09)***	(4.90)***	(-0.30)	(3.44)***	(4.05)***
dlnREER(-1)	0.852	0.563	-0.545	1.494	0.437
	(1.81)*	-1.28	(-0.39)	(1.85)*	(0.74)
CApGDP(-1)	-1.511	-1.068	-1.991	2.026	-1.893
	(-1.20)	(-0.50)	(-1.01)	(1.01)	(-0.48)
N_Economies	80	70	21	18	31
N_Obs.	861	773	240	213	320
R2_Overall	0.04	0.07	0.01	0.18	0.13
R2_Within	0.05	0.08	0.04	0.19	0.13
R2_Between	0.06	0.00	0.57	0.03	0.10
RMSE	1.052	0.927	0.716	0.609	1.197
dNI_WDI					
dlnREER	1.954	2.405	-0.063	1.644	2.468
	(3.00)***	(3.05)***	(-0.05)	(2.19)**	(2.22)**
dlnREER(-1)	1.063	0.875	0.105	3.996	0.235
	(1.83)*	(1.29)	(0.06)	(2.71)**	-0.29
CApGDP(-1)	0.558	1.019	-1.929	1.126	2.418
	(0.36)	(0.55)	(-1.01)	(0.23)	-0.98
N_Economies	71	64	20	15	29
N_Obs.	732	666	239	161	266
R2_Overall	0.05	0.07	0.01	0.19	0.09
R2_Within	0.05	0.06	0.03	0.21	0.08
R2_Between	0.23	0.28	0.37	0.18	0.23
RMSE	1.171	1.086	0.794	0.995	1.331
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes

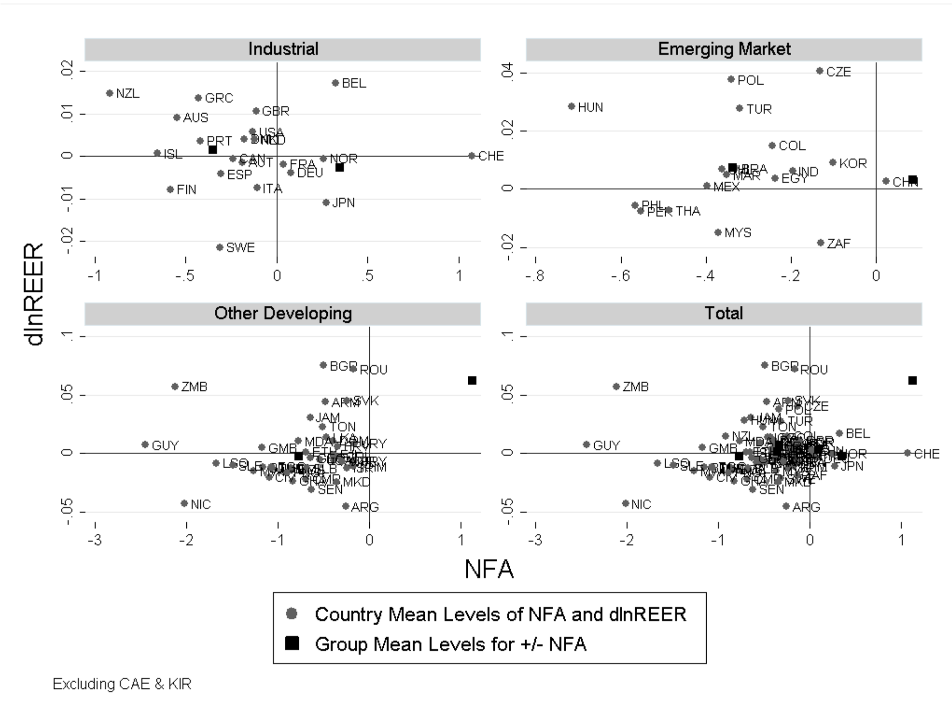

Figure 4-3. Group Average dlnREER for Positive and Negative NFA Position

Table 4-21. Valuation Effects with FAL Excl. NFA>1.5

	Whole	WholeExcl. Fin&Oil	Industrial & EM	Industrial & OthDev	Industrial
dNI_IMF					
dlnREER	3.946	4.416	5.191	3.931	3.669
	(3.88)***	(3.91)***	(4.60)***	(2.99)***	(2.29)**
dlnREER *	-0.061	-0.068	-0.104	-0.051	-0.138
FAL	(-2.66)***	(-2.63)**	(-3.65)***	(-1.53)	(-2.82)**
dlnREER(-1)	0.436	0.559	1.023	0.176	-0.391
	(1.23)	(1.28)	(1.59)	(0.34)	(-0.30)
CApGDP(-1)	0.459	0.933	-0.261	0.625	-2.516
	(0.41)	(0.66)	(-0.20)	(0.30)	(-1.19)
N_Economies	77	68	39	50	21
N_Obs.	832	750	452	537	239
R2_Overall	0.06	0.09	0.07	0.08	0.03
R2_Within	0.07	0.09	0.09	0.08	0.07
R2_Between	0.01	0.10	0.04	0.11	0.70
RMSE	0.939	0.869	0.664	0.958	0.707
dNI_WDI					
dlnREER	3.857	4.444	5.057	3.276	2.892
	(3.49)***	(4.06)***	(3.09)***	(2.82)***	(1.86)*
dlnREER *	-0.06	-0.06	-0.101	-0.018	-0.104
FAL	(-2.07)**	(-1.85)*	(-2.63)**	(-0.38)	(-2.08)*
dlnREER(-1)	0.951	0.944	2.604	0.107	0.198
	(1.77)*	(1.40)	(2.18)**	(0.17)	(0.11)
CApGDP(-1)	1.061	0.945	-1.207	1.101	-2.392
	(0.73)	(0.50)	(-0.55)	(0.60)	(-1.17)
N_Economies	70	63	35	48	20
N_Obs.	725	661	399	500	238
R2_Overall	0.06	0.08	0.07	0.08	0.02
R2_Within	0.05	0.07	0.09	0.07	0.04
R2_Between	0.17	0.23	0	0.31	0.38
RMSE	1.148	1.078	0.882	1.098	0.791
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes

Table 4-22. Valuation Effects with NFA Excl. NFA>-1.5

	Whole	WholeExcl. Fin&Oil	Industrial & EM	Industrial & OthDev	Industrial
dNI_IMF					
dlnREER	1.344	1.929	0.03	2.349	-0.937
	(1.81)*	(2.24)**	(0.03)	(2.06)**	(-0.72)
dlnREER*	-1.731	-1.164	-5.299	-0.545	-4.11
NFApGDP	(-1.25)	(-0.68)	(-1.66)	(-0.30)	(-1.08)
dlnREER(-1)	0.343	0.411	0.816	0.161	-1.143
	(1.06)	(1.03)	(1.41)	(0.33)	(-0.82)
CApGDP(-1)	0.231	-0.537	0.566	-0.725	0.619
	(0.18)	(-0.29)	(0.61)	(-0.32)	(0.46)
N_Economies	105	82	39	64	21
N_Obs.	1258	989	532	738	281
R2_Overall	0.04	0.05	0.07	0.05	0.07
R2_Within	0.05	0.07	0.07	0.07	0.06
R2_Between	0.01	0.06	0.02	0.07	0.59
RMSE	1.196	1.007	0.682	1.105	0.722
dNI_WDI					
dlnREER	2.199	2.57	0.01	3.478	-0.697
	(1.75)*	(1.62)	(0.01)	(1.56)	(-0.54)
dlnREER*	-1.713	-0.924	-4.786	0.249	-4.434
NFApGDP	(-0.80)	(-0.41)	(-1.22)	(0.09)	(-1.12)
dlnREER(-1)	0.686	0.691	2.363	-0.068	-0.664
	-1.15	-1.12	(2.14)**	(-0.11)	(-0.37)
CApGDP(-1)	-2.292	0.791	-0.067	1.062	0.36
	(-0.91)	(0.40)	(-0.04)	(0.46)	(0.25)
N_Economies	96	76	36	60	20
N_Obs.	1079	857	472	663	278
R2_Overall	0.02	0.05	0.06	0.05	0.05
R2_Within	0.04	0.06	0.08	0.06	0.04
R2_Between	0.06	0.00	0.02	0.00	0.13
RMSE	1.646	1.231	0.886	1.292	0.814
Country Dum.	Yes	Yes	Yes	Yes	Yes
Year Dum.	Yes	Yes	Yes	Yes	Yes

Table 4-23. Contrasting the Speed of Adjustments Between IND and Dev Economies

	dlnEX			dlnIM		
	Whole	Whole Excl. Fin& Oil	IND & EM	Whole	Whole Excl. Fin& Oil	IND & EM
dlnREER	-0.116	0.049	0.080	0.178	0.242	0.502
	(-0.82)	(0.40)	(1.02)	(1.03)	(1.18)	(7.28)***
dlnREER*	0.513	0.328	0.351	0.338	0.251	0.000
1(IND)	(3.02)***	(2.07)**	(3.17)***	(1.73)*	-1.07	(-0.00)
dlnREER(-1)	-0.032	-0.022	-0.037	0.047	0.044	0.006
	(-0.64)	(-0.47)	(-0.94)	(1.12)	(1.04)	(0.11)
dlnREER(-1)*	-0.107	-0.102	-0.128	0.026	0.026	0.042
1(IND)	(-1.42)	(-1.44)	(-2.03)*	(0.30)	(0.30)	(0.44)
dlnREER(-2)	-0.084	-0.062	-0.061	-0.117	-0.055	-0.119
	(-1.46)	(-1.66)	(-1.89)*	(-2.23)**	(-1.28)	(-2.54)**
dlnREER(-2)*	-0.057	-0.086	-0.081	0.032	-0.025	0.113
1(IND)	(-0.76)	(-1.28)	(-1.30)	-0.33	(-0.29)	(1.50)
dlnTOT	0.433	0.202	0.38	-0.063	-0.119	0.007
	(3.66)***	(1.69)*	(4.51)***	(-0.63)	(-0.90)	-0.11
dlnGDP	0.518	0.954	0.609	1.465	1.856	1.809
	(2.16)**	(3.75)***	(5.24)***	(4.09)***	(4.30)***	(5.39)***
Country Dummy	Yes	Yes	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes	Yes	Yes
N_Economies	96	72	37	96	72	37
N_Obs.	1049	846	479	1049	846	479
R2_Overall	0.31	0.4	0.64	0.4	0.42	0.75
R2_Within	0.31	0.41	0.69	0.39	0.44	0.77
R2_Between	0.38	0.35	0.3	0.48	0.24	0.53
RMSE	0.131	0.099	0.052	0.112	0.107	0.053
Tests for dlnREER without interactions of 1(IND) Dummies in p-values						
Joint dlnREER	0.427	0.288	0.083	0.104	0.326	0
No Effect dlnREER	0.26	0.842	0.862	0.572	0.279	0
Tests for the interaction variables of dlnREER and 1(IND) in p-values						
Joint dlnREER	0.002	0.025	0.006	0.293	0.756	0.419
No Effect dlnREER	0.15	0.502	0.345	0.068	0.319	0.216

4.7.3 Country Year List

Table 4-24. List of Country-Years

Names	Sample Period	Names	Sample Period
Industrial		***Financial***	
Australia	1993-2006	Antigua and Barbuda	1993-2006
Austria	1993-2006		
Belgium	1993-2006	Bahamas	1993-2006
Canada	1993-2006	Barbados	1993-2006
Denmark	1993-2006	Belize	1993-2006
Finland	1993-2006	Cyprus	1993-2006
France	1993-2006	Grenada	1993-2006
Germany	1993-2006	Hong Kong	1999-2006
Greece	1993-1998	Ireland	1993-2006
	2000-2006	Luxembourg	1996-2006
Iceland	1993-2006	Malta	1993-2006
Italy	1993-2006	Mauritius	1993-2006
Japan	1993-2006	St. Kitts and Nevis	2001-2006
Netherlands	1993-2006	St. Lucia	1993-2006
New Zealand	1993-2006	St. Vincent and the Grenadines	1993-2006
Norway	1993-2006		
Portugal	1993-2006	Samoa	1993-2006
Spain	1993-2006	Singapore	1993-2006
Sweden	1993-2006		
Switzerland	1993-2006		
United Kingdom	1993-2006		
United States	1993-2006		

Names	Sample Period	Appreciation>0.2 Years	Depreciation>0.2 Years
Oil Exporting			
Bahrain	1993-2006		
Ecuador	1993-2006	2001	1999
Gabon[2]	1993-2006		1994
Nigeria	1993-2006	1999	1994 1996
Russia	1996-2006	1996	1999
Saudi Arabia	1993-2006		
Trinidad and Tobago	1993-2006		
Venezuela	1993-2006	1995 1997	1996 2002
Emerging Market			
Brazil	1993-2006	2005	1999
Chile	1993-2006		
China	1993-2006		1994
Colombia	1993-2006	1994	
Czech Republic	1993-2006		
Egypt	1993-2006		2003
Hungary	1993-2006		
India	1993-2006		
Malaysia	1993-2006		1998
Mexico	1993-2006		1995
Morocco	1993-2006		
Peru	1994-2006		
Philippines	1993-2006		
Poland	1993-2006		
South Africa	1993-2006	2003	
South Korea	1993-2006		1998
Thailand	1993-2006		
Turkey	1993-2006		1994 2001
Other Developing			
Argentina	1993-2006		2002
Armenia	1996-2006		
Bolivia	1993-2006		
Burundi	1993-2006		

Cambodia	2000-2006		
Cameroon[2]	1993-2006		1994
Costa Rica	1994-2006		
Cote d'Ivoire[1]	1993-2006		1994
Croatia	1994-2006		
Dominica	1993-2006		
Dominican Republic	1993-2006	2005	2003
Ethiopia	2000-2006		
Fiji	1993-2006		
Gambia	1993-1997		2003
	2004-2006		
Georgia	1998-2006		
Ghana	1993-2006		1994 2000
Guyana	1993-2006		
Israel	1993-2006		
Jamaica	1993-2006		
Lesotho	1994-2006	2003	
Macedonia	1997-2006		
Malawi	1993-2006	1996	1994 1998 2003
Moldova	1996-2006		1999
Nicaragua	1993-2006		1999
Pakistan	1993-2006		
Papua New Guinea	1993-2006		
Paraguay	1993-2006		
Romania	1993-2006	1993 1998	
Senegal[1]	1993-2006		1994
Sierra Leone	2001-2006		
Solomon Islands	2001-2006		
Sri Lanka	1993-2006		
Togo[2]	1994-2006		1994
Tonga	2001-2006		
Tunisia	1994-2006		
Uganda	1994-2006	1994	
Ukraine	1997-2006		
Uruguay	1993-2006		2003
Zambia	1993-2006	2005 2006	

1 & 2 belong to the CFA Franc Zone which experienced sharp devaluation in 1994.

CHAPTER 5

Conclusion

5.1 Summary of Findings

Chapter 2 explored the influence of exchange rate regimes on exchange rate volatility by controlling for a series of structural factors across currency pairs. Based on the empirical traditions following the Optimal Currency Area theory, some structural variables indicating inflation and terms of trade conditions are also introduced in the analyses. In sum, a currency pair tends to exhibit larger *ceteris paribus* bilateral exchange rate volatility if the pair has less bilateral trade openness, larger economic cycle asymmetry, larger economic mass, lower population density (thus more primary goods trade). Industrial economy currencies tend to have less intrinsic volatility than developing economies.

After controlling for those factor variables, exchange rate volatility generally decreases with the rigidity of exchange rate regimes. By assessing the volatility-stabilising effects across the peg anchors, it has been shown that the lower exchange rate volatility for a peg arises entirely from the currency network effects, *i.e.* currencies that are simultaneously pegging to the same anchor would inherit lower volatility from each other. Given the same marginal stabilisation effects across the anchor currency pegs, the larger is the network size (hence the more currencies are pegging), the larger are the stabilisation benefits. Managed floats are shown to track the US dollar and hence can be regarded as quasi-USD-pegs. This enlarges the effectiveness of the USD network than the others. Basket pegs tend to exhibit weaker network effects as expected, since their basket weightings are country-specific. By contrasting the peg network effects under the arithmetic- and trade-weighed multilateral exchange rate volatilities, the effective peg networks are shown to increase with the size under the former measure but not under the latter measure.

Chapter 3 assessed the dynamics of the trade balance in response to real exchange rate fluctuations, *i.e.* depreciations (appreciations) would induce immediate deterioration (improvement) of trade balance but subsequent improvements (deterioration). By conducting reduced-form fixed-effects regressions over a panel of country-years, the trade balance across economies cumulatively exhibits negative correlations with exchange rate appreciation after mainly 2 years of adjustments. Domestic income growth and terms of trade deterioration tend to be associated with trade balance deteriorations.

By employing alternative scaling variables, the analyses showed that for the Industrial economies, the negative trade balance responses tend to be relatively smooth, and exchange rate fluctuations tend to gradually diffuse from tradable into nontradable sectors. For the Emerging Market group, trade balance adjustments tend to be faster and larger. For most developing economies, real exchange rate fluctuations tend to be associated with immediate and large size variations between tradable and nontradable sectors, *i.e.* higher real exchange rate implies larger value of nontradable sectors relative to tradables. Further investigations respectively on import and export adjustments showed that the J-curve effects tend to be significant only among the Industrial and Emerging Market economies.

It has been shown that depreciation and appreciation tend to generate asymmetric impacts on trade balance adjustments for developing economies. In particular, the trade balance in response to appreciation tend to follow the J-curve dynamics over the years but a more instant responses was shown for depreciation. A simple separation of large real exchange rate fluctuations from the normal cases suggest that those large variations are associated with additional immediate negative responses of trade balance as well as the reversal adjustments in the subsequent year. These lead to inverse dynamics of normal exchange rate fluctuations. Nevertheless, the exclusion of those observations does not eliminate the faster reposes of the trade balance to depreciations than appreciations.

Chapter 4 attempted to assess the valuation effects of exchange rate fluctuations on net investment income flows across countries. Generally, given the perceived initial capital outflow (lagged current account position) exchange rate appreciation tends to improve developing economies' net investment income. This coincides with the conjecture that given the net debtor position of foreign assets and the dominant proportion of foreign currency denominated liabilities, appreciation tends to help those countries' net interest payment outwards. By controlling the position of foreign currency exposure (*i.e.* net foreign currency lending position), the significant positive coefficient is associated exactly with the short positions. Particularly among the Industrial and Emerging Market economies, the larger the imbalance of foreign currency exposure, the larger the valuation effects there tend to be given an exchange rate movement. For the remaining developing economies, marginal improvements of the net investment income due to appreciations tends to be constant across the foreign currency exposure positions.

By further decomposing the changes of the net foreign currency lending positions into the changes of the overall foreign lending positions and the net shares of foreign currency components, it has been shown that the valuation effects for the Industrial and Emerging market economies are mainly through the latter channel, *i.e.* changes of the foreign currency shares in the external balance sheet (mainly foreign currency denominated liabilities). For the Other Developing economies, their borrowing conditions tend to be rationed to foreign currency denomination over the years. Hence appreciations (depreciations) are associated with constant marginal improvements (deteriorations) in their net investment income flows.

Combining the responses of both trade balance and net investment income flows, the current account generally exhibits negative correlations with exchange rate appreciations, and its dynamic patterns are mostly driven by the trade balance movements. There exist significantly different dynamics between the Industrial and developing economies. For the former group, the current account response to exchange rate fluctuations tends to be smooth and slow over the subsequent two years. For the developing economies, particularly the Emerging Market group, both the trade balance and current account responses are more immediate and larger. Further comparisons showed that the Industrial economies possess both negative correlations of trade and investment income with exchange rate fluctuations, while developing economies have counteracting effects between the two channels. This difference is particularly evident when one contrasts the Industrial and Emerging Market economies.

5.2 Further Discussions

Debates on the fixed exchange rate regimes may need to incorporate the discussions of participating in a particular currency network versus both the alternative anchors and the floating regimes. This may be achieved by two-step decisions. Conventional wisdoms on pegs *vs.* floats remain similar once an economy is balancing the trade-offs between one currency network and the independently floating regime, while searching for the "optimal" currency network for pegging in the first place is important but challenging.

Credible pegging stabilises a currency's exchange rate by benefiting from the other independent members' pegging in the same currency network. This implies a simple strategy of choosing the most prevailing anchor currency's network when the minimisation of a small economy's exchange rate volatility uniformly against the others becomes a policy objective. Hence a basket peg regime that may need careful designs on the volatility weightings and multilateral coordination of policies would become costly relative to a single-currency peg. Moreover, most hard pegs aiming to benefit from inflation anchoring effects are single-currency pegs, as they are intuitively more credible and transparent.

On the other hand, currency pegging may be orientated toward one/some of the potential benefits. One example that has been shown is the trade-growth strategy as suggested by literatures (*e.g.* Meissner and Oomes, 2009; Bleaney and Tian, 2012). Another possibility could be financial benefits particularly for those developing economies that are more likely to be credit rationed, indicated by some empirical studies (*e.g.* Goldberg and Tille, 2008; Hale and Spiegel, 2012). For those circumstances, a multilateral weighted average measure is need with careful justifications. Overall, identifying the choice of currency networks may need further studies.

It is worth noting that the structure of a currency network matters for the propagation of fundamental shocks among its members. The network benefits examined in this thesis assume small open peripheries anchoring to a large core economy, so that shocks to the minor currencies are mostly idiosyncratic to themselves or jointly have small influence to the core economy. For any periphery member, the division of currency network boundary generates both intra- and inter- network effects. During the normal time, peripheries benefit mostly from intra-network effects, *i.e.* volatility stabilisation between the members. They can also benefit from the inter-network effects by inheriting the relatively stable volatility between the major currencies.

However, the collectively increasing size or/and widely spreading shock from peripheries may trigger the crises for the entire network. Taking the USD network as an example, the Triffin's dilemma that points to the conflicts between domestic policy objectives of the core economy and the international liquidity demand jointly from the peripheries could substantially undermine the credibility of network during the end period of the Bretton Woods system (*e.g.* Bordo et al., 2011). Moreover, the US dollar swap exercises between the Federal Reserve and other central banks to deal with the liquidity shortage at the beginning of the recent crises (Rose and Spiegel, 2012) also indicate the feedback effects from peripheries.

Another example could be the experiences of the Euro zone during the recent crises. In contrast to those CFA economies pegging to the Euro, economies directly adopting the Euro can be considered as a multi-core system where the "peripheries" are sizeable to the “core”, thus the idiosyncratic shocks are all in comparable size among the members. The network effects are then particularly sensitive to the degree of both market integrations and the asymmetric shocks (Bekaert et al., 2010; Kadow et al., 2013). Over-exploiting the benefits of network effects, such as the over-leveraged problems (*e.g.* Feldstein, 2011; Guerrieri et al., 2012), over-optimistic regulatory institutions (*e.g.* Aizenman, 2012), and policy coordination failures (*e.g.* Frankel and Schreger, 2012) between the members, would lead to the concerns on the credibility of the entire currency network.

Theoretically modelling exchange rate regimes and currency networks still remain open questions. On the one side, a small number of attempts exploring the adoption of an international currency tend to assume either a zero-profit currency market structure to introduce the transaction costs of adopting a particular currency (*e.g.* Devereux and Shi, 2013), or a random matching process depending on the natural fraction of demand for currencies within a pair of economies (*e.g.* Matsuyama et al., 1993). On the other side, models of evaluating pegs vs. floats generally assume complete pass-through (the Law of One Price) for tradable sectors interacting with domestic wage rigidities (*e.g.* Schmitt-Grohé and Uribe, 2011, 2012) such that pegs are not characterised by market integration benefits. There hence still lacks a unified framework in assessing the performance of exchange rate regimes. The results presented in the thesis together with other empirical experiences (*e.g.* Edwards, 2011) may provide empirical implications for modelling both bilateral and multilateral exchange rate volatility behaviours under alternative regime choices.

Given exchange rate shocks, there exist clear asymmetries of current account responses between the developed and developing economies. The net investment income components provide a clear contrast between the Industrial and Emerging Market economies under the valuation effects. With the dominant position of foreign currency assets over liabilities, depreciation of the former group yields the improvements for both investment trade incomes. However, with the dominant amount of foreign currency liabilities, depreciation for the Emerging Market group is associated with net investment income deterioration, which counteracts the trade income improvements. By the portfolio approach, if one regards a country's current external asset stock position as an long-run indicator of the levels to which both exchange rate and current account would converge (*e.g.* Lane and Milesi-Ferretti, 2011; Corte et al., 2012), then the degree of adjustments of both trade balance and exchange rate for developing economies are expected to be larger than the Industrial economies.

Further investigations on the valuation effects may be motivated to explore the asymmetries shown on these aggregate results. Although traditional J-curve dynamics for the trade balance have been shown for both the Industrial and Emerging Market economies, and the long-run quantitative effects of exchange rate fluctuation tend to be indifferent between the two groups, the adjustment speed of the latter group tend to be always faster than the former. This may result from the implication that developing economies have to respond faster to compensate for the valuation effects. Moreover, the faster trade balance responses to depreciation than appreciation may be particularly relevant to the balance sheet effects. Since given the negative foreign currency exposure, depreciation increases the interest payment and hence requires larger (faster) improvements than the Industrial economies. Conversely, appreciation improves the interest rate payments so that trade balance deterioration can be compensated with smaller (slower) short-run reactions.

One can note that the analyses of the valuation effects in this thesis assume the homogeneity of foreign assets and liabilities. With more disaggregated data becoming available, an increasing number of studies start to explore the structure of foreign asset components. One of the stylised patterns is that developed economies issue debt liabilities but hold equities while developing economies do the reverse (*e.g.* Lane and Milesi-Ferretti, 2008; Lane and Shambaugh, 2010b). This leads to at least two implications. One is that there exist capital return rate differentials on the two sides of balance sheet for the Industrial and developing economies, particularly those with large holding of foreign exchange reserves (Jeanne, 2012; Dominguez, 2012; Dominguez et al., 2012).

The other is that the term structure differences between equity and debt would generate another dimension of mismatch. Particularly when a large negative shock occurs as in the crises period, balance-sheet contagions widely spread across the boarders (van Wincoop, 2011; Cetorelli and Goldberg, 2012; Eichengreen et al., 2012) and hence can result in complex dynamics of the short- and long-run return rates (*e.g.* Arellano and Ramanarayanan, 2012), i.e. anomalies on the yield curve. Those implications would further motivate both theoretical and empirical investigations (*e.g.* Kirabaeva and Razin, 2010; Gürkaynak and Wright, 2012).

The valuation effects are not solely affecting the net income flows but also relevant to the movements of the *overall stock* of assets/liabilities, *i.e.* the gross inflow and outflows of international capitals. Experiences from the emerging market economies suggest that persistent large imbalances of the current account (particularly deficits) may signal currency crises, since it may reveal the disequilibrium between the income flows and net foreign asset positions (Obstfeld, 2012). With the amplification of the financial sector, large negative shocks to those developing economies heavily relying on foreign capital finance tend to induce sudden stops of both international captial inflow and domestic credit liquidity, resulting in severe contractionary effects (Kiyotaki and Moore, 2012; Calvo, 2012b).

Recent crises from developed economies also raise a new wave of investigating the historical cycles of debt accumulation across countries (Reinhart et al., 2012; Taylor, 2012). Further analyses of the sustainability of international captial movements across income groups could reveal asymmetric valuation adjustments (*e.g.* Durdu et al., 2013) as well as to refine the investors' origins, *i.e.* distinguishing between inflows and outflows, (Forbes and Warnock, 2012). Moreover, studies on the debt overhang problem focusing on the shocks to equities and prices also indicate that the accommodating policies to the large wealth shock may differ from the conventional wisdom during the normal times (Benigno and Romei, 2012; Eggertsson and Krugman, 2012; Calvo, 2012a). Those issues may need further empirical justifications.

One could also extend the analyses of the linkage between workers' remittances and exchange rate. Workers' remittances flows attract particular attention for developing economies with large volumes of cross-border labour migrants (Amuedo-Dorantes and Mazzolari, 2010; Kennan, 2012). In the long term, remittances provide an alternative source of factor incomes, hence mitigating domestic financial constraints and promoting growth (Giuliano and Ruiz-Arranz, 2009; Bettin et al., 2012). In the short run, cyclical fluctuations of the remittances prove to have direct influences on a representative household's consumption, investment and labour supply decisions (Dustmann and Mestres, 2010; Mandelman and Zlate, 2012).

Exchange rate fluctuations strongly matter for the net remittance flows since appreciations generally imply a higher nontradable goods' price relative to tradables. In particular, over-valuation of exchange rates and inappropriate monetary policies could lead to serious misallocation of labours between tradable and nontradable sectors. This generates the "Dutch Disease" problems (Yang, 2008; Acosta et al., 2009) and undermines the counter-cyclical property of the remittance flows particularly for pegged regimes (Frankel, 2010a; Mandelman, forthcoming).

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