Determinants of the real exchange rate, misalignment and trade balance in Turkey

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Abstract

This study aims to analyse the behaviour of the real exchange rate, to identify the degree of misalignment of the real exchange rate and to investigate its effect on the trade performance in Turkey.

Initially the alternative definitions and measurement of the real exchange rate are reviewed. The real exchange rate is defined in terms of relative prices of tradable to nontradable goods. The approaches to modelling the equilibrium real exchange rate are classified as the Purchasing Power Parity models and the relative prices models. Following the latter approach, a structural model is established and then estimated empirically by two alternative cointegration techniques: The Engle and Granger method and the Johansen method. The two methods produce similar results; the real wealth of the private sector, real government expenditures on nontradable goods, external terms of trade and openness of the economy (or alternatively import tariff rate) are identified as the main determinants (fundamentals) of the Turkish equilibrium real exchange rate. Subsequently, an error correction model is estimated to investigate the short-run effects of these factors.

The second aim of this study is to measure the degree of misalignment, which is defined as persistent departures of the actual real exchange rate from its equilibrium value. Using the estimates of the cointegration analysis, an equilibrium real exchange rate series is calculated for the sustainable values of the fundamentals, which are approximated by the permanent components of the series, obtained by the Beveridge-Nelson decomposition technique. Then, this is compared with the actual rates in order to construct a misalignment series. The graphical analysis indicates that the misalignment is mainly caused by the policy-induced changes in the actual rates.

Finally, the impact of misalignment on the Turkish trade balance is analysed empirically. The results indicate that the trade balance is responsive to the misalignment of the real exchange rate as well as the cyclical government demand for tradable goods. However, the impact of the real wealth is not significant.

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CHAPTER 1

INTRODUCTION

1.1 Introduction to the research area

Real exchange rate can be defined as the relative price of tradable goods to nontradable goods (or vice versa). This definition is relevant to analyses of domestic incentives to produce and consume tradable and nontradable goods. Alternatively, where attention is on the international competitiveness of an economy's tradable goods, the nominal exchange rate adjusted for relative movements in foreign and domestic prices is used to measure the real exchange rate. This kind of definition is inspired from the well-known Purchasing Power Parity (PPP) theory of exchange rates.

The real exchange rate (RER) is increasingly recognised as a main policy variable in discussions on a wide range of issues such as indebtedness, stabilisation and growth. RER instability and misalignment, and especially overvaluation of the currency is assumed to be a major barrier to accomplishing these policy goals. In this context, it has become a major concern to estimate what the equilibrium exchange rate is.

There is increasing agreement that persistent deviations of the actual real exchange rate from its equilibrium level may generate severe macroeconomic disequilibrium and reduce economic welfare of the country. Overvaluation of the exchange rate tends to reduce the competitiveness of the country's tradable products in world markets. The fall in exports place pressure on reserves and inhibits long-term economic development. Incorrect real exchange rate alignment is an especially important issue in developing countries, where agriculture is a substantial source of their foreign exchange earnings and is usually the largest economic sector in terms of employment and output. An overvalued currency reduces the profitability of tradables including agricultural commodity exports. Instability and uncertainty with respect to relative prices may cause misallocation and/or movement of the resources between tradable and nontradable sectors, bringing high adjustment costs. Overvaluation, by making imports cheaper, generates pressures for more protection in those affected sectors. If misalignment persists and periods of overvaluation are followed by undervaluation, uncertainty increases and investment in export industries becomes increasingly risky.

Using data from a group of developing countries, Edwards (1988b, 1989a) shows that countries with a high degree of RER disequilibrium have performed worse than those with a lower degree of disequilibrium. Cottani et al (1990) argue that real exchange rate stability was essential in promoting East Asian development, while its instability restrained export growth in some of the Latin American countries. As for industrial countries, Williamson (1994) indicates the importance of equilibrium RER estimates with several pieces of evidence. For example, ignoring the available estimates of sterling's equilibrium exchange rate at the time of its entry to the ERM led directly to Black Wednesday. Similarly, ignoring the evidence of the lira's overvaluation in 1992 led to the first of the crises that affected the ERM significantly.

Despite its importance, the real exchange rate, its determinants and effects on economic performance have not been exhaustively examined in empirical literature, especially for developing countries. Even for industrial countries, a majority of the studies on the real exchange rate are limited to testing whether real exchange rates have a unit root. That is to say, relying on the PPP theory they focus on the question 'Is the equilibrium real exchange rate constant over time?'; in other words, they ask the question 'Does PPP hold?'. The most common application of this approach is to analyse the relationship between the nominal exchange rate and domestic and foreign price levels. The available evidence is ambiguous on this. For example, Dornbusch and Vogelsang (1992) tested the validity of PPP for the RER series between the USA and some industrial countries from mid-1800s to the present and found evidence in favour of PPP. Similarly, Diebold et al (1991) constructed a data set of 16 RERs covering more than a century of the gold standard period and indicated that the RER reverts to a parity value in the long-run. On the other hand, more recent work such as Rogers and Jenkins (1995) showed that PPP does not hold for two reasons: Presence of nontraded goods in the RER indices and slowness of firms' pricing policies in response to exchange rate changes. Engel (1993) argues that barriers to trade such as tariffs and transportation costs and differing consumer tastes and preferences across countries may cause the RER to change. Strauss (1995) emphasises the role of the relative price of nontradables and productivity differentials on the violation of PPP in his tests with 14 OECD countries.

Recently, many economists have believed that, along with monetary factors, there are some real variables such as terms of trade, capital flows and productivity changes, causing the RER to deviate from PPP value, and directed their attention to investigate these factors. It is argued that the actual market-determined exchange rate may not be 'the equilibrium rate' and that the equilibrium rate which is consistent with the internal and external balances of the economy can be estimated, within some margin of error, by an appropriate model and econometric techniques, and therefore it is sensible to devote intellectual effort to doing so (Williamson, 1994). Calculating the equilibrium real exchange rate not only requires assessing what factors influence the exchange rate but also extracting their sustainable values. However, there are a few empirical studies which investigate the determinants of the RER and estimate the 'equilibrium rate'. There is a serious gap that needs to be filled in both the theoretical and the empirical literature at this point. The most comprehensive work is that of Edwards (1988a,b; 1989a). His model is developed for developing countries, most of which have a fixed or at least managed floating exchange rate system. The theoretical model, in which the RER is defined as relative price of tradables to nontradables, is tested for a panel of developing countries. Less attention is paid to the estimation of the equilibrium RER, while the behaviour of actual rates is analysed in detail. Empirical testing of this model with time series data and calculation of the equilibrium real exchange rate series are among the main contributions of the present study. Going a step further, misalignment series is obtained and its effect on trade performance is analysed.

1.2 A study of Turkey

Turkey entered the 1980s in difficult economic and social circumstances. Inflation was accelerating, unemployment was rising, shortages were spreading and social unrest and political violence reached critical proportions. This situation followed the external shocks of the 1970s and severe political and economic instability over years. Despite that, successive Turkish governments sought to achieve high rate of growth (annual 6-7 % on average). However this policy target was maintained by inflationary policies, foreign borrowing and postponement of structural adjustment or very short term regulations when needed. In addition, international creditors lost their confidence in the Turkish economy and refused to lend any more before substantial measures were taken.

With these internal and external pressures, Turkey launched a program of stabilisation and structural adjustment in January 1980 under the auspices of the IMF. The short-term objectives were to bring a solution to the dual problem of inflation and external deficits. The policy makers planned to change the development strategy from import substitution to an export-oriented strategy in the long-run. Exchange rate management has played a critical role for both objectives. Namely, on the one hand, the improvement of external balances requires an exchange rate policy designed to offset the adverse affect of inflation on the competitiveness of the domestic economy. On the other hand, the resulting currency depreciation interferes with the disinflation objective through its impact on cost of production and inflationary expectations (Asikoglu, 1992).

The main developments in the exchange rates and exchange rate policies between 1980 and 1995 are summarised in Table 1.1. This period can be divided into three sub-periods from the perspective of exchange rate management (Asikoglu and Uctum, 1992; Asikoglu, 1992):

The first period, from January 1980 to May 1981, is characterised by a series of frequent devaluation to reverse the prior appreciation of the currency, as can be seen in Table-1.1. The management of the existing macroeconomic crisis, particularly the triple-digit inflation and severe balance of payments difficulties,

Table 1.1: Chronological developments in exchange rates in Turkey, 1980-1995

January 1980	Launch of the Stabilisation and Structural Adjustment Program
January 1980	Devaluation of Turkish Lira by 33 %
April-Dec. 1980	Seven other devaluation, total of 27.5 %
Jan.-April 1981	Three devaluation, total of 10 %
May 1981	Announcement of flexible exchange rate policy under which exchange rates will be adjusted daily
1982	Commercial banks are allowed to undertake foreign exchange operations, open foreign currency deposit accounts
1982	Elimination of multiple rate system for foreign exchange
December 1983	Government's intention to make TL convertible
1984	Residents and non-residents were allowed to open FOREX deposit accounts
March 1986	Commercial banks are directed to set buying and selling rates for foreign exchange within a band at 1% below or above the rates announced by the Central Bank
August 1988	Introduction of a system of partial market setting of official exchange rate
March 1990	Authorisation of commercial banks to set own rates for foreign exchanges
April 1994	Announcement of the Austerity Program

was an urgent priority for the authorities. Despite high inflation, the Turkish Lira depreciated by 23 % in real terms in 1980 and by 13 % in 1981.

The second period covering from May 1981 to August 1988 is described as an exchange regime of 'passive crawl'. Discrete devaluation was replaced by daily adjustments to the exchange rate in order to compensate inflation differentials at home and in trading partners. In addition, important steps were taken to liberalise the exchange rate system with the ultimate objective of making the lira convertible. Some of them are summarised in the above table. Meanwhile, this period witnessed new measures for the liberalisation of the capital accounts including the publication of the decree no:32 on free movements of capital. According to that decree, Turkish nationals were allowed to purchase foreign securities abroad and foreigners were allowed to buy Turkish securities on the Istanbul Stock Exchange which was recently opened (December 1985).

Finally, in August 1988 the market floating exchange rate system was introduced under the auspices of the Central Bank. Under this system, the Central Bank conducts the daily sessions of the interbank spot exchange market composed of banks, special finance institutions and licensed foreign exchange dealers and then announces the next day's exchange rates.[1]

The basic elements of the policy measures of the Stabilisation Program (in other areas) included introduction of export incentives and subsidies to reduce trade deficits and to promote export-led growth, tight monetary controls to reduce inflation and domestic demand, the liberalisation of trade by lowering quantitative restrictions and tariff structure on imports, the deregulation of interest rates to stimulate savings, the privatisation of the state economic enterprises to lessen the burden of the central governments and to encourage a greater role for the private sector, and the liberalisation of prices to improve efficiency and reduce the budget deficit.

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[1] These rate are applied for the transactions up to $3000. For larger transactions, the exchange rates are determined freely by the authorised parties.

Although some considerable improvements were recorded in areas such as export growth, removal of trade barriers and output growth, overall results were not satisfactory enough and more importantly were not sustained. Rising inflation and growing public borrowing in later years eroded some of the improvements in the economy.

Many acknowledged that the RER was one of the main policy instruments that played a crucial role in Turkish stabilisation and adjustment. On the one hand, depreciation of the currency is frequently used as a policy tool in order to increase exports. On the other hand, dependence on imported intermediate and capital goods means that depreciation could have a negative impact on growth.

1.3 Aims of the study

Notwithstanding its importance in Turkish stabilisation and economic development, the real exchange rate has not been analysed sufficiently thoroughly. This study seeks to fill this gap in the literature. It aims initially to analyse the real exchange rate issues in both industrial and developing countries. The conceptual issues and measurements problems are reviewed critically in order to find out the relevance of each definition and measurement to our study. The theoretical models of exchange rate determination and their empirical applications are surveyed in the literature to find an appropriate framework for a developing country. The specific objective of our study is to analyse in detail the behaviour of the real exchange rate of a developing country, Turkey. Determinants of the real exchange rate are investigated by using a structural model which covers the main sectors of the economy. The influence of each factor is estimated empirically by employing two alternative cointegration techniques, which are the Engle and Granger and Johansen methodologies. Then, using these estimated coefficients, an equilibrium real exchange rate series is calculated for given sustainable values of these fundamental determinants. Because there are not enough empirical works on estimating equilibrium series and approximating sustainable or long-run values of series for that purpose, this study intends to shed some light on these issues and to demonstrate a practical implementation with Turkish data. Comparison of the equilibrium rates with the actual rates is used to identify the degree of misalignment which has detrimental effects on stabilisation efforts. Here, we analyse effects of misalignment on the balance of trade empirically. The study covers the period 1980-1995, which is characterised as the post-liberalisation period. Thus, particular attention is directed to the role of the exchange rate policies in the success or failure of the stabilisation program announced in 24th of January, 1980 and the proceeding developments.

1.4 Structure of the study

The thesis consists of eight chapters:

Alternative definitions of the RER are reviewed in Chapter 2. The measurement problems are discussed critically with particular attention to the price indexes used. Theoretical models of the exchange rate determination, grouping them according to the definitions used, are also surveyed in this chapter. A summary of some empirical studies on the determinants of the RER is also given.

In Chapter 3, a theoretical model of the real exchange rate determinants is presented. It is based on Edwards (1988b, 1989a) and is used throughout the study. The building blocks of the model are the assets sector, production and consumption sectors, the government and the external sector. The solution of the model is analysed and a reduced form is obtained to use in empirical analysis. The effects of the fundamental determinants: The real wealth, government expenditures on nontradable goods, trade restrictions and external terms of trade, on the real exchange rate are discussed.

The data used in the empirical estimations are analysed in detail in Chapter 4. The data are collected from various sources on a monthly basis, from January 1980 to December 1995, a period which corresponds to the post-liberalisation period. Each data series is descriptively and graphically analysed with particular attention given to economical and political events of the period. Being aware of the danger of spurious regressions in time series, the data are checked for stationarity by detailed regression analysis.

Having determined the main factors affecting the real exchange rate and having prepared the data, an empirical investigation is carried out in Chapter 5. Firstly, a theoretical review of the cointegration procedure according to Engle and Granger is conducted. Then the existence of cointegration between the fundamental determinants is tested with the Turkish data. Following this long-run analyses, the short-run dynamics are estimated using an error correction model.

The model is also tested by the Johansen cointegration technique in Chapter 6. A vector autoregression model is formulated and tested for cointegration.

Unlike the first method which estimates the model by ordinary least squares, the Johansen technique employs the maximum likelihood estimation. It is also possible to carry out weak exogeneity and significance tests in this approach by imposing restrictions on the cointegrating vector. The short-run dynamics of the model are found out in an error correction model. The chapter ends with evaluation of the results and comparison with those obtained in the previous chapter.

The relationship between the misalignment of the real exchange rate and trade balance is investigated in Chapter 7; misalignment being defined as persistent departures of the actual real exchange rate from its equilibrium level. The chapter initially models the equilibrium real exchange rate. The possible impact of misalignment in the economy is summarised in the following section. Utilising the coefficients for the determinants of the RER estimated in the previous chapter, an index of the equilibrium real exchange rate is calculated for given 'sustainable values' of the fundamental determinants. The sustainable values are approximated by the permanent components of the series which are decomposed by the Beveridge-Nelson technique. Comparison of the equilibrium series with the actual RER series gives the degree of misalignment index. This index is skechted and analysed in detail in order to identify main overvaluation and undervaluation episodes of the RER, with particular attention to the changes in the other macroeconomic variables and policy developments in these periods. The effects of misalignment on the balance of trade are investigated and tested empirically with the Turkish data in the next section. Finally, the findings and their implications for the stabilisation policies applied in 1980s are discussed.

The main findings are summarised, and contributions and conclusions of the study are evaluated in Chapter 8. The empirical results suggested a negative relationship between the real exchange rate and government expenditures on nontradables, external terms of trade and wealth of private sector, while the degree of openness of the economy appeared to affect the real exchange rate positively. It is also shown that an increase in the degree of misalignment and an increase in government demand for tradable goods worsen the balance of trade.

CHAPTER 2

REVIEW OF THE LITERATURE ON THE REAL EXCHANGE RATE

2.1 Introduction

Attempts to define the real exchange rate have been problematic because different definitions have been employed for different economic analyses. Measurement problems also arise as the empirical counterparts of many of these definitions are often inaccurate or imprecise. Employing the right framework to analyse the relationship between the real exchange rate and other economic variables is of major importance. The recent literature on the real exchange rate is reviewed in this chapter. The first section covers the main arguments on the conceptual issues and summarises the alternative definitions of the real exchange rate. Next, the measurement issues with particular emphasis on the alternative proxies of relative price indexes are discussed. This is followed by a review of the empirical studies on the determinants of the real exchange rate.

2.2 Alternative definitions of the real exchange rate

The nominal exchange rate is defined as the number of units of domestic currency per unit of foreign money. However, there has been no unanimity in the literature regarding the definition of the *real exchange rate*.

Earlier works define the real exchange rate using the *Purchasing Power Parity (PPP)* theory. Simply stated, "the (nominal) exchange rate change between two currencies over any time period is determined by the change in the two countries' relative price level" (Dornbusch, 1988). The strong version of the

PPP is commonly called *absolute PPP* or *the law of one price*. If the price of a given good or even a common basket of goods is the same across countries when measured in the same currency, the law of one price is said to hold. That is

$$E = P / P^* \quad \text{or} \quad EP^* = P \tag{2.1}$$

On the basis of the PPP theory, the *real exchange rate* (e) is defined as

$$e_1 = EP^* / P \tag{2.2}$$

where E is the nominal exchange rate, P* and P are foreign and domestic price levels, respectively.

Absolute PPP implies that all prices are completely equalised by trade. Therefore, the RER calculated on the basis of PPP should be identical to the 'law of one price', that is unity. Real overvaluation and undervaluation of a currency would be measured, then, as deviation from the PPP.[1]

The weak or relative version of the PPP re-interprets the theory by allowing the nominal rate to change in order to offset price differentials, leaving the real exchange rate unchanged. But because of transportation and transaction costs and the existence of differing goods and weights in the price indexes, there may be persistent deviations in the RER from unity. In other words, while absolute PPP requires the real exchange rate to be constant and equal to unity, relative PPP necessitates the real exchange rate to be constant (not necessarily unity).

[1] These deviations are very controversial since some interpret them as violations of the PPP theory, while some others asserts the contrary. These issues will be discussed later on.

The PPP definition is a useful index of the degree of international competitiveness of a country. Namely, a fall in e_1, say, because of an increase in domestic inflation (i.e. a real appreciation) might represent an increase in the cost of producing tradables. In the absence of relative price changes in the rest of the world, this decline in RER represents a deterioration of the country's competitiveness in international markets (Edwards, 1989a; Zietz, 1996).

However, this definition fails to capture the changes in the relative incentives guiding resource allocation across the tradables and nontradables sectors (Edwards, 1989a).

Recent studies have defined the real exchange rate as the ratio of the domestic relative price of tradable goods (P_T) to nontradable goods (P_N), that is[2]

$$e_2 = P_T / P_N \qquad (2.3)$$

This definition identifies more easily the incentives that guide the allocation of resources across the tradables and nontradables sectors. Namely, a fall in e_2 will make the production of nontradables relatively more profitable, causing resources to shift toward the nontradables sector.

Although this definition has a firm theoretical foundation, it may not be easily

[2] Recently there has been some debate on whether the RER should be defined as P_T / P_N or as P_N / P_T. Both approaches have some advantages and disadvantages. It may be easier to interpret the latter definition, namely in that case a real appreciation is reflected by an increase in the RER index, while a decline represents a real depreciation. The IMF has adopted this definition. On the other hand, the former one is also appealing because in this case both nominal and real depreciation will result in increases of respective indexes (Edwards, 1989a).

measured in a direct manner. Assuming that the PPP holds for tradable goods and that there are no taxes on trade (so that $P_T = EP_T{}^*$), the following definition is widely used in empirical works:

$$e_3 = E\, P_T{}^* / P_N \tag{2.4}$$

where E is the nominal exchange rate, $P_T{}^*$ is the world price of tradables and P_N is the domestic price of nontradables. This definition is called as 'dependent economy or Chicago definition' in the literature.

Harberger (1986) suggests using another concept of real exchange rate: The nominal exchange rates deflated by a domestic price deflator, P (or in his own words, "real price of the dollar or some other currency unit"):

$$e_4 = E / P \tag{2.5}$$

The only defect he finds in using E/P is the fact that its equilibrium value falls (signifying an appreciation of the local currency) when there is a general world inflation. But, introducing a world price deflator, P* along with domestic deflator can solve that problem (then this definition becomes similar to the PPP-based definition, e_1).

When the focus of interest is the effect of commercial policies, Helmers (1988) recommends modifying the PPP-based definition by incorporating explicitly the import taxes and export subsidies. Then the RER is defined as

$$e_5 = [E\,(1 + \tau\,)P^*] / P \tag{2.6}$$

where τ denotes the trade restrictions.

However, in this definition, it is not clear how a trade tax or subsidy can be applied to an aggregate price index, without differentiating it as exportable and importable prices. P* is not even a tradable price index and might well include nontradable goods.

The real exchange rate is defined in terms of unit labour costs as well. This is obtained by deflating the nominal exchange rate with the relative nominal wage indexes (Halpern and Wyplosz, 1997):

$$e_6 = E\, W^* / W \tag{2.7}$$

where W* and W refer to foreign and domestic nominal wages or wage indexes or unit labour costs indexes, respectively, depending on the measurement, as will be discussed later on.

It is implicitly assumed that unit labour costs form the major component of the total costs involved in production. Thus the definition e_6 reflects the relative efficiency as well as relative profitability of production in home country and its trading partners. An increase in e_6 indicates a depreciation of the real exchange rate and might imply that the country produces less efficiently than it used to, threatening its competitiveness in the world markets.

The usual measurement problems which exist in constructing other price indexes, including limitations on data availability, comparability and quality of data, are the main shortcoming of this definition. In addition, it is argued that wages tend to respond only gradually to changes in demand and sometimes with a relatively long delay. Thus the calculated values of that index may provide wrong signals about the evolution of costs and profits (Maciejewski, 1983).

Edwards (1989a) compares the tradables-nontradables relative price definition (e_2 or e_3) with the PPP-based definition of the RER (e_1). Assuming that P and P* in the PPP definition are geometrically weighted averages of tradable and nontradable prices with weights α, $(1-\alpha)$, β and $(1-\beta)$, it is possible to write

$$P = P_T^{\alpha} P_N^{1-\alpha} \qquad \text{and} \qquad P^* = P_T^{*\beta} P_N^{*(1-\beta)} \tag{2.8}$$

Further assuming that the law of one price holds for tradable goods (i.e. $P_T = EP_T^*$) and that E is fixed and equal to 1, it is possible to find a relation between percentage changes in the (e_1) and in the (e_3) :

$$\hat{e}_3 = (1/\alpha)\hat{e}_1 + (\beta/\alpha)(P_T^* - P_N^*) \tag{2.9}$$

From here, it can be seen that changes in the two definitions of the real exchange rate will differ (i.e. $\hat{e}_3 \neq \hat{e}_1$). Depending on the behaviour of foreign relative prices (P_T^*/P_N^*), predictions based on $\hat{e}_1$ can be different, even opposite in sign, from predictions that focus on $\hat{e}_3$. For example, Williamson (1994) estimated in his study that the dollar appeared to be mildly overvalued (in 1990s), rather than chronically undervalued as the PPP-based exchange rate forecasting was proclaiming. Similarly, the yen seemed to be seriously undervalued, contrary to the PPP-based estimations (p.7).

In sum, the alternative definitions of the real exchange rates in the literature are as follows:

(a) The PPP definition: $e_1 = E\,P^* / P$,

(b) The domestic relative price of tradables to nontradables: $e_2 = P_T / P_N$,

(c) The dependent economy definition of relative prices of tradables to nontradables: $e_3 = E\,P_T^* / P_N$,

(d) Harberger's definition: $e_4 = E / P$,

(e) Helmers's definition: $e_5 = [E\,(1 + \tau)P^*] / P$,

(f) The unit cost definition: $e_6 = E\,W^* / W$.

The real exchange rate is often used as a measurement of competitiveness in international markets. It sometimes becomes a simple conversion instrument, like the nominal exchange rate, for countries that have similar inflation rates and economic structures. However, the role of the real exchange rate goes beyond that, particularly for developing countries. It is often used as a policy tool to correct external as well as internal imbalances of the economy, because it is influenced not only by changes in external trade prices but also by internal price movements. There are productivity differences across the tradable and nontradable sectors and this is reflected as noticeable price differences across these sectors. Therefore, aggregating these prices into a single price index and using it in constructing a real exchange rate index requires caution, as that index might send misleading signals to the economy. Moreover, share of the nontradable sector is higher than the tradable sector in many developing countries. Thus, an analysis of the real exchange rate for a developing country should take into account the relative prices of tradables to nontradables and employ an appropriate definition of this kind.

Among the definitions listed above, e_1, e_4, e_5 and e_6 summarise a PPP-type relationship between the nominal exchange rate and relative prices. For the reasons discussed above, the definitions e_2 and e_3 seem to be more appropriate to use in our study for Turkey. Because of the existence of trade restrictions, it might be preferable to use e_2 which includes trade taxes and subsidies. It can be defined more explicitly by expressing P_T as a geometric average of exportable (P_X) and importable prices (P_M) as follows:

$$e_7 = [\alpha\, P_X + (1-\alpha)\, P_M] / P_N \qquad (2.10)$$

where $P_X = P_X^* + \tau$ and $P_M = P_M^* + \delta$, and α is the share of exports in total trade, P_X^* and P_M^* are foreign exportable and importable prices, τ is import tariffs and δ is export taxes and subsidies.

Our study will be a time-series analysis for a single country, therefore we are not constrained to define a real exchange rate index which is comparable with other countries' indexes (in terms of measurement, coverage and aggregation) as this is often the case for cross-country and pooled-data studies.

2.3 Measurement of the real exchange rate

It is not always easy to find empirical counterparts of the various theoretical definitions of the real exchange rate. The measurement problem has centered on the definition of the nominal exchange rate and on choosing the price indices in the case of PPP approach, and on finding empirical counterparts of tradable and nontradable prices when a relative prices approach is employed.

In the case of PPP approach, one has to decide initially on choosing appropriate nominal exchange rates: Which types of exchange rates should be used: Bilateral or multilateral? Which country's currency to be chosen, if bilateral is to be used? What to do when there is multiple official nominal exchange rates? What if there are black or parallel markets for nominal exchange rates?

One may encounter many problems associated with constructing price indexes: Choosing appropriate base year and weights, quality change, changing composition of products within broader goods categories along with the additional requirement of reasonable comparability across countries.

Basically four alternative aggregate price indexes have been suggested as possible proxies for the construction of the PPP-based RER. They have also been utilised to approximate the tradable and nontradable prices.

(i) Consumer price index, (ii) Wholesale price index, (iii) GDP deflator, and (iv) Wage rate index.

In most cases, it has been suggested using the same price index for the foreign country as for the domestic country in the construction of a PPP-based RER index.

The most widely used index is the **Consumer Price Index**. It has been argued that this indicator will provide a comprehensive measure of changes in competitiveness for including a broad group of goods (Genberg, 1978). Another advantage of this index is that it is easy to find data on CPI behaviour in almost all countries.

The CPI is often used as an approximation for the price of nontradable goods because it includes price movements of consumer services. Obviously not all nontradable goods are covered by the CPI. For example, services and some nontradable goods which are not purchased by households - such as business services and public administration, as well as non-residential construction - are excluded. Also this index may well include some tradable goods.

The second candidate for an appropriate price index is the **Wholesale Price Index**. It is a readily available index for almost all countries with varying frequencies and thus widely used in constructing PPP-based RER indexes. It has also often been used to approximate P_T because WPI contains mainly tradable goods.

However there are some criticisms of using the WPI. Because these indexes contain highly homogeneous tradable goods whose prices tend to be equated across countries when expressed in a common currency, the RER computed using WPI will not vary enough to measure actual changes in competitiveness. In addition, international comparisons based on WPI may be distorted by the use of different weights across countries (Edwards, 1988a). A further defect is that its component price indexes measure prices of goods at varying stages of production, thus leading to the possibility of double-counting (Goldstein and Officer, 1979).

A real exchange rate index computed using a **Gross Domestic Product Deflator** at home and abroad can be said to be a good indicator of changes in competitiveness in production because it is a genuine price index of aggregate production and is not subject to direct distortions stemming from price controls. The advantage of the GDP deflator over CPI is that the national accounts deflators measure the price movement of all domestic production on a value-added basis, not just that part of production purchased by households. As a general price index, the GDP deflator can be considered as a representation of a weighted average of equivalents of tradable and nontradable price indexes, where the weights are proportional to domestic production of tradables and nontradables, respectively. However, it may not be an appropriate proxy for tradable or nontradable prices alone (Goldstein and Officer, 1979). The main deficiency of the deflators is that they are typically available only on a yearly basis.

Harberger (1989) suggests that when deflating the domestic price index one should include nontradables as well as tradables. The GDP deflator may be a good candidate for this.

Some researchers including IMF staff, prefer to compute the RER as **a ratio of unit labor costs** (Edwards, 1988a). Namely this index is a direct measure of relative competitiveness across countries (Maciejewski, 1983). It is also argued that relative labor costs are more stable than relative goods prices. Nonetheless this index like the others also is not a perfect measure. First, an indicator based on wage rate behaviour will be highly sensitive to cyclical productivity changes. Second, it takes into account only one factor of production. Finally, the data on wages for developing countries are quite limited and of poor quality (Edwards, 1988a).

The above arguments are about aggregate price indexes which have been used generally for the PPP definition of the real exchange rate. As discussed earlier, these indexes have several drawbacks in approximating the tradable and nontradable prices. The first-best measurement of the tradable prices would be the actual transactions or contractual prices for imports and exports themselves. Indexes based on such international transactions prices exist, however, their country, product and time-period coverage are very limited. These price data are available for only a few industrial countries. The time-series rarely extends also beyond a ten year period and only some manufactured goods are included (Goldstein and Khan, 1985).

In the absence of such comprehensive data, empirical researchers have relied on a second-best measure, namely **unit value indexes (UVI)**. UVI are calculated by dividing the value of imports (exports) by the quantities of imports (exports). It is reasonable to use them in case of a single product, but this method might give spurious price indexes when many different products are combined in one index. For example, when the commodity composition of exports changes, a UVI will change even if all "true" prices of the component export products remain unchanged. Similarly, since these indexes are not fixed-weight indexes, a price increase accompanied by a decrease in quantity demanded automatically lowers that good's weight in the index (Goldstein and Khan, 1985). Thus a change in a UVI (export or import price index in practical usage) may not always indicate a change in prices, but may be due to a mixture of factors including price changes.

More recently other proxies have been suggested for the price of tradables as well as that of nontradables in order to overcome some of the deficiencies of the existing indexes. Some suggest constructing new indexes from the disaggregated data on the existing price indexes. For example, Kravis and Lipsey suggested using the GDP deflator for services and government to construct a proxy for nontradables and the deflators of the other sectors to construct a proxy for tradables (Edwards, 1988a).

Goldstein and Officer (1979) employed three criteria to distinguish between tradable and nontradable goods or industries: (a) the degree of foreign trade participation should be substantially higher for tradables than nontradables, (b) tradables should be closer substitutes for traded goods from other countries (imports) than are nontradables, (c) cross-country correlation of price changes should be much higher for tradables than nontradables. Accordingly, they constructed alternative proxies for tradable and nontradable prices for a group of OECD countries by utilising the disaggregated data on GDP deflator by industry of origin.[3] They allocated agriculture and related activities, mining and quarrying and manufacturing to tradable sectors; and all other industries in which GDP originates to nontradable sectors. The main deficiencies of such indexes are that a GDP deflator is inherently a current-weighted price index. However, for the analysis of price movements, a base-weighted price index is often preferred to a current-weighted one. Secondly, because of the high level of aggregation of the existing data, it is difficult to get a clear classification of the industries into one sector or the other. Thus the resulting P_N (P_T) index

[3] GDP deflator is an implicit price index which is defined as the ratio of output at current prices to output at constant prices. Accordingly, they defined the P_T as the ratio of tradable components of GDP at current prices to those at constant prices, and similarly P_N is defined as the nontradable components of GDP at current prices to those at constant prices.

might include some tradable (nontradable) goods (Goldstein and Officer, 1979; Goldstein, Khan and Officer, 1980).

Alternative P_T and P_N indexes can be constructed using disaggregated data for the consumer price index which are available for many countries. Recently, Milner and McKay (1996) constructed tradable and nontradable price indexes for Mauritius using the sub-indexes of CPI. They allocated food, beverages and tobacco and clothing, footwear and bedding as tradable sectors and other sectors including fuel and lighting, housing, transport and communication, medical and personal care, education and recreation as nontradables. In a similar fashion, but this time using cost of living index for middle income families, Milner, Presley and Westaway (1995) constructed nontradables and importables price indexes for Saudi Arabia. They measured the importable price index as an average of the fabrics and apparel, house furnishing, all food and other expenditures items of the cost of living index; and the nontradable price index by taking average of other elements of that index. Then the tradable price index is calculated as a geometric mean of the importable price index and export price index which is approximated by the unit value of exports.

Similarly, Harberger (1986) suggests an index as a proxy for foreign price index, constructed from agricultural, mining and manufacturing components of the US GNP deflator.

Marston (1990) argues that the RER can be defined for an individual sector, say manufacturing, as

$$e_m = E\,[\,P_m / P_m^*\,] \qquad (2.11)$$

where e_m is the RER for manufacturing sector, E is the nominal exchange rate, P_m and P_m* are value-added deflators for domestic and foreign country, respectively.

It is not unusual to find some indexes in the literature, which consist of weighted averages of price indexes of different countries. For instance, Harberger (1986) computed the SDR (Special Drawing Rights) weighted WPI as

$$SDR\text{-}WPI = w_i\ [\ WPI_i / E_i] \qquad (2.12)$$

where w_i is weight of each country applied by the IMF in calculating the value of the SDR.

Meltzer (1993) calculated the nominal exchange rate for the USA by taking geometric average of ten industrialised countries' dollar value of their currencies weighted by their shares of world trade and then deflated it by the ratio of the USA CPI to the ten countries' trade-weighted CPIs to obtain the real exchange rate for the USA.

Consequently, to be economically meaningful, relative price indexes should have three basic properties (Maciejewski, 1983):

- A meaningful base year and suitable weights
- Adequacy with respect to the set of market conditions involved
- Specificity of what they are intended to measure.

"The indexes are preferences, not choices determined by profound analytical dictates. In other words, there is much room for fruitful debate over and experimentation with different indexes" (Harberger, 1986).

2.4 Determinants of the real exchange rate

The main objective of the theoretical models of exchange rate determination is to produce a clear understanding of the economic mechanisms governing the actual behaviour of exchange rates in the real world. In addition, they should give satisfactory explanations for the relationship between exchange rates and other important economic variables.

The key question to ask in exchange rate determination is "what is the right framework?". In other words, "how well do alternative models explain the movements in the real exchange rates (RER)?".

There are many approaches modelling the behaviour of the real exchange rate. They may fall, however, into one of two groups: PPP calculations and tradables \ nontradables models.

2.4.1 Purchasing Power Parity approach

Purchasing Power Parity Theory is one of the simplest and oldest theories of exchange rates. Its origin goes three or more centuries back, but it was first operationalised and empirically tested by Gustav Cassel.[4]

As explained earlier, there are two versions of the PPP theory: The absolute version of the theory states that the nominal exchange rates should reflect the purchasing power of one currency against another. On the other hand,

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[4] See Officer (1976) for the history of the PPP theory.

according to the relative version of the PPP theory, changes in relative prices would indicate the necessary adjustment in exchange rates in comparison to a base period when equilibrium rates prevailed.

There have been numerous studies on the use of PPP theory in the determination of the equilibrium RER. Breuer (1994) and also Bleaney and Mizen (1993) provide excellent surveys of the empirical studies. In addition, Officer (1976) reviews the theoretical issues on the PPP theory comprehensively. In Table 2.1, we only attempt to update these surveys, however, comparing with the general conclusions drawn from the earlier works reviewed in these surveys.[5]

These studies have analysed different sample periods, different currencies, different price indexes, different specifications and different estimation methods. Inevitably, they produced mixed results of some of which support the PPP while some others are not in favour of the PPP theory.

The main questions whose answers are sought in these studies are: Is the RER constant over time or follow a stochastic process? Or in other words, does PPP hold? If it does not, what are the sources of deviations from PPP? Can the PPP theory explain all movements in the RER? What are the advantages/ disadvantages of the PPP theory over the alternative theories in the exchange rate determination?

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[5] In this section, we paid particular attention to the studies which focus on deviations from the PPP theory. They explain the reasons for the failure of the PPP theory in explaining the movements in the RER. These reasons form, at the same time, a basis for alternative theories as they are established to complement these deficiencies of the PPP theory to some extent. That is why, these studies are included in the review even though we use relative prices approach in our study.

As can be seen from Table 2.1, sample periods of our review cover generally the era of the flexible exchange rates that began in 1973. The empirical estimations provide almost no support for the PPP theory. Using more frequent data such as monthly or quarterly data does not seem to change this result. Some studies analyse the period of floating rates of the 1920s, the Bretton-Woods fixed exchange rate era or the earlier gold standard period, as summarised in Breuer (1994). It is more common to find a stationary relationship between the nominal exchange rates and prices in these periods, particularly with a longer span of data. Most of the empirical works suffer from low power of the unit root tests. Two options are suggested to solve that problem: Either increasing the length of the series, covering both fixed and flexible exchange rate regimes, or increasing the number of countries in the sample and performing panel tests (Devereux, 1997).

The majority of the studies concentrate on bilateral rates of the industrial countries against the US dollar, occasionally against German mark. Recently, PPP has been tested for developing countries such as Erol and van Wijnbergen (1997) and Hoque (1995).

Different specifications have been used to test PPP. The most commonly used is the one analysing the trivariate relationship between the nominal exchange rate, domestic and foreign price series. The specifications may also differ according to the price series used. Most studies use CPI and WPI. GDP deflator, unit

Table 2.1 : Main features of the studies on the purchasing power parity

	Cheung et al (1995)	DeLoach (1997)	Diebold et al (1991)	Dornbusch et al (1991)	Dropsy (1996)	Edison et al (1997)	Erol et al (1997)	Feenstra et al (1997)
STUDY PERIOD	1979.3 - 1991.12	1957.1 - 1990.12	1791 - 1913	1800s - 1980s	1973.4 - 1993.3	1974.I - 1992.IV	1980.I - 1993.IV	1974.I - 1994.IV
EXCHANGE RATE REGIME	flexible	fixed/flexible	metallic standard	mixed	flexible	mixed	crawling peg	flexible
COUNTRY	industrial	industrial	industrial	industrial	industrial	mixed	developing	industrial
PRICE INDEX	WPI	CPI / WPI	CPI / WPI	CPI / GDPD	CPI	CPI	WPI	EPI / IPI
DATA	time series	time series	time series	time series	time series	time series	time series	time series
FREQUENCY	monthly	monthly	annual	annual	monthly	quarterly	quarterly	quarterly
ESTIMATION METHOD	Johansen	Johansen	Davidson-Fletcher-Powell	unit root	Johansen	Johansen/ Harvatt&Watson	unit root	Johansen
RESULTS								
PPP holds?	yes	yes for tradables (but weak)	yes	yes but not for subsamples	no	yes with H&W test, no with others	no	no
If not, why?		-exch. regime -proxies			-structural breaks	-low power of tests	-no reason stated	-pass-through

Table 2.1: (continued)

	Fraser et al (1991)	Henricsson et al (1995)	Hoque (1995)	In (1995)	Lim (1992)	Lippert et al (1994)	Mark (1990)
TIME PERIOD	1975.1 - 1980.10	1960.1 - 1989.12	1961.I - 1990.IV	1972.I - 1986.II	1974.II - 1989.II	1974.I - 1991.IV	1973.6 - 1988.2
EXCHANGE RATE REGIME	flexible	fixed / flexible	fixed / managed floating	flexible	flexible	flexible	flexible
COUNTRY	industrial	industrial	developing	indistrial	industrial	industrial	industrial
PRICE INDEX	WPI	CPI	WPI	CPI / WPI	CPI	CPI	CPI
DATA	cross-section	time series	time series	time series	time series	time series	time series
FREQUENCY	monthly	monthly	quarterly	quarterly	quarterly	quarterly	montly
ESTIMATION METHOD	Engle&Granger	unit root/ KPSS	Engle&Granger	Johansen	unit root / Engle & Granger	OLS/ unit root	Engle&Granger
RESULTS							
PPP holds?	no	no	no	yes	no	no, yes if real shocks incorporated	no
If not, why?	-PPP fails even at disaggregated level	-PPP fails (methods or data used NOT a problem)	-transaction cost -simultaneity bias -price indexes		-real shocks	-real shocks	-nominal exchange rates and prices are unrelated

Table 2.1 : (continued)

	McNown et al (1989)	Meier (1997)	O'Connell (1998)	Rogers et al (1995)	Sarno (1997)	Strauss (1995)	Wu (1997)
TIME PERIOD	1970s - 1980s	1973 - 1994	1973.II- 1995.IV	1973.1 - 1991.12	1973.1 - 1994.12	1960 - 1990	1979.1 - 1994.10
EXCHANGE RATE REGIME	crawling peg	flexible	mixed	flexible	flexible	fixed / flexible	flexible
COUNTRY	developing	industrial	mixed	industrial	industrial	industrial	industrial
PRICE INDEX	CPI / WPI	GDPD	CPI	CPI	WPI	GDPD	unit labour cost
DATA	time series	panel data	panel data	time series	time series	time series	panel data
FREQUENCY	monthly	annual	quarterly	monthly	monthly	annual	monthly
ESTIMATION METHOD	Johansen	GLS / SURE	unit root	Engle&Granger	E&G / Johansen	Johansen	unit root/ Zivot&Andrew
RESULTS							
PPP holds?	no with CPI, yes with WPI	yes	yes if cross sectional dependence ignored	no	no by E&G, yes by Johansen	no	no by ADF, yes by Z&A
If not, why?	-tradables			-tradables -sticky prices -menu costs -transportation costs	-low power -misspecifica tion	-productivity changes	-structural breaks

labour cost index and export (import) unit value index are also employed occasionally. It is also not unusual to find some work that uses disaggregated data to construct new price indexes for tradable goods, including Rogers and Jenkins (1995) and Strauss (1995).

Various methods have been employed to test the PPP. Before 1980s, ordinary least squares or generalised least squares are usually used in empirical estimations. However, more recently, unit root stationarity tests, Perron-type tests, variance ratio tests, the Engle-Granger two-step method, error correction models and the Johansen cointegration method are often employed.

The regression specification typically used in testing is expressed as

$$E_t = \alpha + \beta(P_t - P_t^*) + u_t \qquad (2.13)$$

where E is the nominal exchange rate, P and P* are domestic and foreign price indexes, respectively.

In the studies before mid-1980s, the above regression was estimated by ordinary or generalised least squares methods. Thus the test of PPP was in the form of restriction tests. That is, testing whether $\beta = 1$ and $\alpha = 0$ for the absolute version to hold, and whether $\beta = 1$ only for the relative version to hold. However, the advances in time series econometrics after mid-1980s revealed that the classical testing may be inappropriate if the series are not stationary. The emphasis in the recent methods of testing PPP is on the residuals from the above regression. That is, testing whether the deviations from the relationship between the level of the exchange rate and the price series tend to return to some fixed mean (or the series are cointegrated). An evidence in favour of cointegration implies that PPP holds.

Recent works have brought new interpretations on PPP. However, that has meant the weakening of the traditional or Casselian PPP theory (Breuer, 1994):

> The distinction made between short run and long run was interpreted as the first weakening of the PPP theory. The studies in the last decade confirmed that PPP does not hold in the short run, but might hold in the long-run. However some current studies have still failed to give evidences in favour of the PPP theory although they used a longer span of data. A new expression, 'ultra-long run' has come into existence.
>
> Moreover, new interpretations started to require stationarity of the RER, rather than fixity as required by traditional PPP. According to that, the RER may be variable over time and may show large and sustained deviations from its mean as long as the deviations revert to the mean that is purchasing power value. In the ultra-long run the RER may be considered as fixed.
>
> Finally, disregarding the symmetry and proportionality restrictions means that domestic and foreign prices are not fully responsible for the changes in the nominal exchange rates. This implies cointegration results should be interpreted carefully. Besides the price level changes, other factors might be taken into account to analyse changes in exchange rates. Then, attention has turned to the investigation of the ***sources of deviations*** from the purchasing power parity. Possible reasons, some of which are already summarised in Table 2.1 (the last row), are detailed below:

Rogers and Jenkins (1995) investigate the role of two possible reasons for the failure of the PPP theory in explaining the changes in the RER: Is it more due to 'haircuts' (***presence of nontraded goods in the indexes***) or 'hysteresis' (slowness in firms' pricing policies in response to exchange rate changes)? Their disaggregated data support both factors. Both relative price movements and ***sticky prices*** or hysteretic price setting cause movements in the RER.[1] In addition, ***transportation costs*** as well as ***menu costs*** play a role in explaining the departures. In the absence of trade barriers, arbitrage keeps relative prices between tradables equal across countries. This relationship does not hold for nontradables as transportation costs are very high for these goods. Thus it is more likely to reject the null hypothesis of PPP when a price index such as CPI which is dominated mostly nontradable goods, is used. McKnown and Wallace (1989) provide evidence for that argument. Namely, PPP holds when WPI (dominated by tradable goods) is used instead of CPI.

Using disaggregated price data, Engel (1993) finds that the variances in prices of different goods within countries are greater than the variances in prices of similar goods across countries. This supports the above argument that relative price movements (probably due to sectoral productivity differences) might cause deviations from the PPP.

Similarly, Strauss (1995) examines two possible sources of PPP violations: Is the failure of PPP because of shifts in the domestic and foreign prices of nontradables or productivity differentials between tradables and nontradables sectors? Or is it a problem with the constructing of the price indexes? The paper constructs traded and nontraded GDP indexes and productivity rates for 14

[1] Movements in the RER are considered as synonymous with deviations from PPP.

OECD countries to carry out the tests. The results suggest that the violation of PPP may be due to mainly changes in the relative prices of tradables and nontradables goods as a result of ***productivity differentials*** in these sectors.

The importance of productivity differentials between the sectors within and across countries was emphasised earlier by Balassa (1964). He states that "the greater are productivity differentials in the production of traded goods between two countries, the larger will be the differences in wages and in the prices of services and correspondingly, the greater the gap between PPP and the equilibrium exchange rate." (p. 586).

Fraser, Taylor and Webster (1991) suggest another reason which may likely lead to the rejection of PPP hypothesis. It is the ***methods of aggregation***. That is, if relative prices change and different countries use different weights in constructing price indexes, these indexes may cause a measurement error and rejection of the PPP hypothesis. Using monthly disaggregated data at industry level on the UK wholesale price index and US producer price index for the period 1975-1980 and employing cointegration technique, they conclude that the failure of PPP theory is not caused by aggregated prices indexes. Johnson (1991) also cannot find any support to this argument in his empirical investigation.

Hoque (1995) adds a further, rather technical issue to the above sources. Namely, the price levels and exchange rates are treated as endogenous variables in estimations. However, this may raise the possibility of a bias in the estimated coefficient due to a ***simultaneity problem***.

Edison et al (1997) relates the failure of the PPP approach in exchange rate determination to the ***tests and methods employed***. They state that univariate and single equation methods fail because they do not efficiently model the interaction between, and the different dynamic behaviour of prices and exchange rates. Multivariate methods better model these interactions and dynamics, but they usually do not impose the symmetry and proportionality restrictions implied by PPP. Using the newly devised test of Horvath and Watson which is said to have more power than the Johansen cointegration test, they find moderate evidence in favour of the PPP for the post-Bretton Woods era. Although it is tested for different periods and different sample of countries, Sarno (1997) provides evidence supporting this argument, rejecting PPP hypothesis by the Engle and Granger method but not by the Johansen method. He explains this by ***misspecification*** and ***low power of the test***.

Cheung et al (1995) find favourable results for the PPP and, they attribute the difference in results with those of the previous studies partly to the statistical technique used, the ***correction for the small sample bias*** and the ***adjustment for currency realignment effects*** (to maintain PPP).

Recently, O'Connell (1998) highlighted the importance of ***controlling for cross-sectional dependence*** when testing for a unit root in panels of RER. Not doing so affects size and power of the statistical tests adversely and in turn can lead to rejection of PPP hypothesis.

Dropsy (1996) states that because cointegration tests applied have low power, particularly the ***structural shocks*** in data can alter the long-run RER, resulting in rejection of the existence of cointegration between nominal rates and prices.

Similarly, Wu (1997) argues that many real exchange rates (of OECD countries) can be characterised as a segmented trend stationary process with a one-time ***permanent shift either in the slope or/ and in intercept***. Thus he tests the PPP by taking into account these shifts and cannot reject it.

Feenstra and Kendall (1997) find that ***pass-through behaviour*** appears to explain a significant portion of the deviations from PPP observed during the floating rate period since 1974. They also claim that PPP should hold on forward rather than spot exchange rates due to ***hedging by firms***, and thus the interest rate differentials should enter the PPP relation for spot rates. However, unlike the first hypothesis, they find no evidence supporting the second hypothesis.

Domestic market distortions including tariffs, quotas and exchange rate controls or pegged exchange rate regime may lead the PPP tests to fail. Because these distortions can cause changes in relative prices of tradables and nontradables and distort the relationship between the exchange rate and prices (McKnown and Wallace, 1989; Hoque, 1995).

Finally, it has been argued that ***real shocks*** in the economy cause divergence from PPP. Lippert and Breuer (1994) re-test PPP by obtaining the fitted value from a real exchange rate regression (with real factors other than prices such as changes in tastes, productivity, technology and so on) and incorporating it as an explanatory variable along with prices in PPP test. Their results display an improvement in PPP.

Despite the improvements in tests, econometric estimation methods, extending sample period and so on, why PPP still does not hold? One explanation would be that movements in real exchange rates are so persistent that they must be accounted for by real disturbances. Recent studies on the long-run determinants of the RER seem to provide support for this view. Next section reviews the relevant literature.

2.4.2 Tradables / nontradables models

In this section, we review all other RER models than PPP approach under the name, tradables\nontradables models; because most of them define the RER in terms of relative prices of tradable and nontradable goods. Moreover, they argue that RER movements stemming from real shocks may often represent fundamental shifts in relative prices. Hence a more general view of RER determination than the one offered by PPP is needed. These kind of models might be *structural or macroeconomic balance models* (which involve estimating RER that is consistent with macroeconomic balance : Full employment, low inflation and sustainable current account) as well as *behavioural models* (which use econometric methods to establish a behavioural link between the RER and relevant economic variables.[2]

Although the factors which are likely to affect the RER behaviour are generally known (but not specifically for each country), problems arise in estimating their effects since it may not be possible to find data for all these factors. Using appropriate proxies has solved that problem to some extent. At least the

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[2] Clark and MacDonald (1998) name these models as Fundamental Equilibrium Exchange Rate Approach (originally proposed by Williamson (1994) and Behavioural Equilibrium Exchange Rate Approach and compare them.

direction of the variations can be determined by means of empirical studies. A sampling of empirical papers are reviewed and main determinants (usually called '***fundamentals***') of the real exchange rate are listed in Table 2.2.

The fundamentals can be grouped into two as external factors and domestic factors (as in Edwards (1988a, 1989a) which provides an extensive theoretical and empirical analysis of these factors[3]).

External factors :

External terms of trade (ratio of foreign export prices to import prices) is found to be one of the main factors affecting the equilibrium RER in many empirical works. Although its ultimate impact on the RER is ambiguous in the economic theory, varying according to relative importance of income and substitution effects, many empirical works suggests that the equilibrium rate would depreciate to accommodate a deterioration in terms of trade. This is supported by the papers reviewed in Table 2.2, except Wetzel (1995). In addition, the coefficients are significant at 5 % level in most cases.

There is a negative relationship between ***capital inflows*** and the real exchange rate (provided the RER is defined as P_T/P_N, otherwise a positive relationship exists). Because inflow of capital injects more income to the economy, generating an excess demand for nontradable goods. To restore equilibrium, the relative price of nontradables has to rise, leading an appreciation of the RER.

[3] Edwards classifieds the domestic factors into two: Policy variables (those variables affected by policy decisions) and non-policy variables. Among the variables listed in Table 2.2, GDP growth and per capita GDP may fall into the second group, while the others can be grouped as policy variables.

Table 2.2: The determinants of the real exchange rates

Fundamentals \ Studies	(1)	(2)*	(3)	(4)	(5)*	(6)	(7)*	(8)*
EXTERNAL FACTORS								
Terms of trade		+++	(–)*		(+)*	(–)	++	(+)*
Capital flows	(–)*		(–)*		(+)*	(–)*		
Interest rate differentials	(–)*	+++						(+)*
Gov't exp. differentials				(–)*				
Productivity differentials		+++		(–)*			+*+*	(+)*
Foreign money supply								
Foreign gov't exp/GDP								
Net foreign assets		+++					+* –	
World oil price				(+)*				
DOMESTIC FACTORS								
Gov't expenditures/GDP	(–)*				(+)*	+ –		
GDP growth						(+)*		
Excess credits			(–)*			(–)*		
Exchange rate controls						(–)*		
Investment/GDP						(+)		
GDP/export + import			(–)*		(–)*			
Defense spending								
Devaluation						(+)*		
Black market discount								
Export/GDP								
Per capita Y								
$Demand_N$ / $Demand_T$								
Money supply								
Gov't debt / GDP		++–						
Money wages								

Table 2.2 : (Continued)

Fundamentals \ Studies	(9)	(10)*	(11)	(12)	(13)*	(14)	(15)	(16)
EXTERNAL FACTORS								
Terms of trade	(–)*	+++				(+)*		
Capital flows	(–)*							
Interest rate differentials		+–+			(+)*			
Gov'nt exp. differentials								
Productivity differentials		+++		(+)*	(–)*		(+)	–*–*
Foreign money supply			(+)*					
Foreign gov't exp/GDP								+*+*
Net foreign assets		+–+						
World oil price		+++						+*+*
DOMESTIC FACTORS								
Gov't expenditures/GDP						(–)*		+ –*
Export tax rate						(+)*		
Excess credits	(–)*							
Import tariff rate						(-)*		
Total revenue						(+)*		
GDP/export + import	(–)*							
Defense spending			(+)*					
Devaluation	(+)*			(+)*				
Black market discount						(–)*	(+)*	
Export/GDP							(+)*	
Per capita Y							(+)*	
$Demand_N$ / $Demand_T$							(+)*	
Money supply			(–)*					– –
Budget deficit/GDP		–++			(–)*			
Money wages				(+)*				

Notes :

Dependent variable is the real exchange rate (RER).
* by the sign denotes that the coefficient is significant at least 5% level.
‡ indicates the papers in which RER is defined as either P_N / P_T or P/EP* (but not P_T /P_N or EP*/P). Thus (+) sign denotes an appreciation of the RER, while (-) sign implies a depreciation. In other papers, (+) indicates a depreciation and (-) indicates an appreciation of the RER.

(1) Agenor et al (1997a,b) [Time series (TS) data on Turkey; dependent variable is temporary component of the RER],
(2) Clark and MacDonald (1998) [TS data on G-3: Germany, Japan and USA, respectively and all significant (though not starred due to lack of space); all variables are in differentials],
(3) Cottani et al (1990) [Pooled data; some countries' coefficients have opposite signs but insignificant, thus ignored],
(4) Dibooglu (1995) [TS data on Italy, Germany & Japan],
(5) Elbadawi (1994) [Pooled data on Chile, Ghana and India; openness defined as (X+M/GDP)],
(6) Edwards (1989a) [Pooled data; estimates presented are mixture of different equations],
(7) Faruqee (1995) [TS data on USA and Japan, respectively],
(8) Feyzioglu (1997) [TS data on Finland],
(9) Ghura et al (1993) [Cross-section and pooled data on 33 Sub-Saharan African countries],
(10) MacDonald (1997) [TS data on G-3: Germany , Japan and USA, respectively; all variables are in differentials; no significance test],
(11) Meltzer (1993) [TS data on USA],
(12) Modeste (1994) [TS data on Barbados],
(13) Stein (1992) [TS data on USA; RER expressed as growth rate (not level); results from the NATREX approach],
(14) Wetzel (1995) [TS data on Ghana; estimation results of column 1 only; total government expenditures is used (not share in GDP)];
(15) Wood (1988) [Panel data on 79 countries; inverse of black market ratio is used (i.e. official rate/ parallel rate)],
(16) Zhou (1995) [TS data on Finland and Japan, respectively].

Capital inflows are usually defined in empirical estimations as the net capital inflow as a percentage of GDP as in Edwards (1989a), Agenor et al (1997) and Cottani et al (1990). Ghura and Grenness (1993) measures it as the difference between net change in reserves and trade balance scaled by GDP. Elbadawi (1994) uses this measurement for India and Chile, while he proxies capital inflow as imports minus exports divided by GDP for Ghana. However, whatever the proxy is used, all papers support the above argument.

The study of Agenor et al (1997a,b) is one of the most recent works on Turkey. They examine the links between fiscal policy, capital inflows and the RER from 1987 to 1995 (with quarterly series). Unlike the present study which intends to investigate the impact of trade restrictions on the RER in the long-run, trade policy variables are ignored in this paper. They carry out an analysis of the short-run dynamic interactions among government spending, capital flows (both expressed as a ratio of GNP), interest rate differentials and the temporary component of the RER by using impulse response functions and variance decompositions. Their analysis indicate that positive shocks to government spending, capital inflows and uncovered interest rate differentials lead to an appreciation of the RER.

Real interest rate differentials (the ratio of domestic (long-run) real interest rate to the foreign rate) are considered as one of the main determinant of the equilibrium RER in monetary and uncovered interest rate parity models. A series of studies carried out by the IMF staff use similar proxies and thus obtain similar results, although they are of different countries and with data in different frequencies. For example, Clark and MacDonald (1998) approximate the domestic real interest rate by the average annual nominal long-term (ten-year) government bond yield minus the change in the CPI from previous year (for Germany, Japan and USA), while its foreign counterpart is calculated in the same manner for partner G-7 countries. Agenor et al (1997) use the interest rate on treasury bills (of Turkey) and the eurodollar rate in London instead. Only foreign interest rate (of Germany) is used, instead of differentials, in Feyzioglu (1997). MacDonald (1997) also defines the real interest rate similarly with Clark and MacDonald (1998) in his study on G-3 countries, but he employs the ratio of long-term interest rate differential (10-years bond) to short-term one (3-months treasury bill) in estimations. Apart from the above IMF papers, Stein (1992), employing a similar proxy, also finds that the interest rate differentials are one of the fundamental determinants of the equilibrium RER. The above empirical evidences suggest that the RER appreciates in response to a positive shock in interest rate differentials.

The equilibrium real exchange rate may be influenced by ***foreign government expenditures***. Economic theory suggests a positive relationship, through its effect on tradable prices. This is supported by Zhou (1995). In his time-series study on Japan and Finland, he found a positive sign for the foreign government expenditures (of the USA) divided by GDP for both countries. Using differentials, that is the ratio of local government expenditures to foreign government expenditures (both expressed as a ratio of respective GDPs), Dibooglu (1995) found a negative sign for that variable, however, it should be noted that an increase in foreign expenditures means a decrease in the differential expenditures, thus the negative sign is consistent with the theory.

One of the main contributions of Balassa (1964) to international economics literature is his emphasis on ***productivity differentials*** between the sectors within and across countries. He noted the systematic tendency for productivity to grow more rapidly in tradable than nontradable sectors, and for this differential to be greater in faster-growing countries. One might expect the relative price of nontradables to tradables to be higher in faster-growing countries. Thus productivity differentials might account for changes in the real exchange rates. A negative relationship is suggested by the theory. Namely, lower productivity in nontradable sector will cause higher prices in this sector. Then an increase in productivity differentials will lead an appreciation in RER to sustain the equilibrium. This is supported by the empirical works reviewed in Table 2.2, in spite of the fact that different proxies are used. Two proxies are employed: The first one is a comparative index of the relative price of traded to nontraded goods, which is constructed from the ratio of the domestic CPI to WPI relative to the corresponding (usually trade-weighted) index for trade partners. Clark and MacDonald (1998) and Faruqee (1995) use this proxy. Second is a comparative index of labour productivity levels, which is composed of rates of growth of real output per man-hour (or per worker). The other papers that consider the productivity differentials as one of the determinants of the RER use this proxy either in sectoral level or country level, depending on the availability of data. MacDonald (1997), on the other hand, uses the ratio of the former proxy to the latter proxy in his study.

Meltzer (1993) argues that ***foreign money supply*** also affects the real exchange rates with a similar impact of domestic money supply. He predicts that a rise in foreign money supply (using M2 definition) would appreciate the RER and the estimation results support this.

Some empirical analyses estimate a long-run relationship between the RER and

net foreign assets. The rationale behind that is that the structural components of both the current and capital accounts (underlying a country's net trade and net foreign asset positions) jointly determine the long-run equilibrium real exchange rate. The RER is expected to appreciate in response to a positive shock in net foreign asset position. Net foreign assets are measured as total foreign assets (of domestic country) less total liabilities to foreigners, expressed as a ratio of GNP as in Clark and MacDonald (1998), Faruqee (1995) and MacDonald (1997). Clark and MacDonald estimate a positive sign for the USA, Germany and Japan, while both Faruqee and MacDonald find unexpectedly a negative sign for Japan (but positive for other countries). Overall evidences support the underlying economic theory.

Finally, any change in ***world oil price*** is expected to influence the equilibrium real exchange rate. Namely, a real oil price hike may increase the prices of tradables relative to nontradables in oil-importing countries and thus cause a real depreciation of their currencies. This positive relationship is supported by Zhou (1995), MacDonald (1997) and Dibooglu (1995).

Domestic factors :

Fiscal policy change is one of the main factors affecting the equilibrium RER. Its impact is more obvious in developing countries where government sector usually dominates the economy. Composition of government expenditures, that is share of expenditures on nontradable goods in total expenditures (Edwards, 1989a; Wetzel, 1995; Elbadawi, 1994), level of government expenditures (Agenor et al, 1997a,b; Elbadawi, 1994; Zhou, 1995), budget deficits (Wetzel, 1995; Clark and MacDonald; MacDonald, 1997; Stein, 1992) and government defense expenditures (Meltzer, 1993) are some of the fiscal policy variables used in the literature. However, data availability, especially lack of disaggregated data constraint employing such variables and force using proxies of varying suitability in empirical estimations. Mostly ***total government expenditures*** as a share of GDP is used as a proxy for expenditures on nontradables. Although the economic theory suggest a negative relationship between the RER and government expenditures on nontradables, it is difficult to predict a sign a priori when total expenditures are used in estimations. However the empirical evidences suggest that the RER depreciates in response to a rise in these expenditures (Agenor at al, 1997a,b; Elbadawi, 1994; Wetzel, 1995 and Zhou, 1995). Edwards (1989a) and Zhou (1995) for Japan find a positive sign for that variable, but insignificant.

MacDonald (1997) and Stein (1992) argue that ***budget deficits*** affect the movements in the RER. An increase in deficits may cause a real appreciation, through its impact on domestic prices. MacDonald (1997) introduces this fiscal variable to estimation as the domestic total revenue less expenditures, expressed as a percentage of GDP, relative to the counterparts of the partner countries. The estimation results confirm this relationship for Japan and USA but not Germany.

Because government budget gives deficits in most of the time particularly in developing countries, Wetzel (1995) prefers to use the components of budget deficits in order to use logarithms in her study on Ghana. She finds a negative significant relationship between the RER and total government spending, while it is positive for ***total government revenues***. Although her model suggests that government expenditures on nontradable goods is one of the main determinants of the RER, she drops that variable in estimations due to lack of data.

On the other hand, Clark and MacDonald (1998) use ***relative supply of domestic to foreign government debt*** as a proxy for foreign exchange risk premium. An increase in relative debt will increase the domestic risk premium, thereby requiring a depreciation of the equilibrium RER. He measures the variable as a ratio of domestic government net financial liabilities to nominal GDP relative to the effective ratio of partner countries, and finds consistent and significant coefficients for Germany and Japan (+) but not for the USA (-).

The final fiscal variable appeared in the review is ***government's defense spending***. Following Friedman's emphasis on the effects of rearmament on US real exchange rates in the post-war years, Meltzer (1993) explains the mechanism as follows: Increases in defense spending raise total spending and interest rates. Higher interest rates attract a capital inflow, appreciating the exchange rate. His empirical estimation supports this positive relationship.

In addition to fiscal policy changes, monetary policy change is also a possible factor affecting the equilibrium RER. Expansionary monetary policies, for example, ***excess supply of domestic credits*** are likely to cause an appreciation of the RER. Because injection of extra credits into the economy increases domestic prices, causing a fall in the RER. Edwards (1989a) measures this variable by the rate of growth of domestic credit minus the lagged rate of growth of real GDP. Ghura and Grenness (1993) uses a similar model and similar definition of excess credits with Edwards (1989a). Cottani et al (1990) defines a similar variable, domestic credit creation in excess of devaluation, foreign inflation and real GDP growth. All three studies find empirically a negative significant relationship between the RER and excess supply of credits.

An increase in ***money supply*** has a similar impact on the RER as in excess domestic credits. The theory suggest that this effect would be temporary. Because the RER deviates from equilibrium in response to an increase in money supply, when prices adjust slowly. However, in long-run the adjustment may be completed and the RER may return to its previous equilibrium level. Zhou (1995)'s estimation results give evidence in favour of this argument. Using monetary base to approximate money supply (in fact, the differential of domestic to foreign monetary base is used), he finds a negative but insignificant coefficient for that variable. On the other hand, Meltzer (1993) finds a negative significant coefficient for the money supply variable (M2 definition), implying that there is a systematic and persistent effect of money supply on the RER.

Technological progress (a non-policy variable) is considered to have a permanent effect on the RER. Closely related with Balassa effect, as discussed earlier, technological progress improves productivity, creating price differentials across sectors and countries and thus leading changes in the RER. Measurement of this variable is one of the problems in empirical estimations. Edwards (1989a) approximates technological progress by the ***growth rate of GDP***, while Wood (1988) uses the ***growth of per capita GDP***. Both find a positive significant coefficient for this variable. Wood also uses the ***ratio of exports to GDP*** as a proxy. The rationale behind that is that for countries where technical advance (either cost reduction or quality improvement) is faster in export sectors than in other sectors will tend to export an increasing proportion of their total output. The third proxy Wood uses to approximate technological differentials is ***the***

ratio of demand for nontradables to tradables. He uses disaggregated data on GDP to obtain this variable.

Edwards (1989a) suggests that ***investment share*** in GDP might influence the long-run equilibrium RER, but estimation results do not support that.

It has been argued that trade restrictions have direct effects on appreciation or depreciation of the RER. A relaxation of the extent of barriers to international trade results in real exchange rate depreciation. Various variables (or proxies) are used to capture this effect empirically. In order to approximate exchange and trade controls, Edwards (1989a) offers two proxies : The first one is ***ratio of government import revenues to actual imports***. The second one is the ***spread rate between the parallel and official rates*** in the foreign exchange market. Wetzel (1995) employs both proxies in her empirical investigation. The results of both studies support the above negative relationship between the RER and trade restrictions. Wood (1988) uses the inverse of the latter proxy, thus finds a positive sign for that variable. Besides these proxies, Wetzel (1995) uses ***export tax rate***, which is measured as a ratio of export duties to total exports and estimates a significant positive coefficient for that, which is consistent with the theory.

Various ***openness indexes*** are used to capture the possible effects of trade impediments. The most common one is the ratio of the volume of trade to GDP. Any measurement that rises the openness of the economy is expected to depreciate the RER, through its impact on nontradable prices. Ghura and Grenness (1993), Elbadawi (1994) and Cottani at al (1990) give empirical evidence in favour of this argument, finding a negative significant coefficient for that variable.

Finally, it has been argued that ***nominal devaluation*** influences the equilibrium RER and can particularly be used to re-establish the equilibrium, through its impact on trade balance. Its final effect on the RER or the conditions for a devaluation to be effective have been discussed in many studies. Three papers reviewed in Table 2.2 estimate a significant positive impact of nominal devaluation on the equilibrium RER: Edwards (1989a), Ghura and Grenness (1993) and Modeste (1994).

2.5 Summary

Defining the real exchange rate has been one of the highly debated issues in international economics literature. It is important to employ an appropriate definition in an analysis as the effects of, say, commercial policies, fiscal policies or external policy changes on the real exchange rate would be sensitive to definition employed. Discussions have centered around mainly two types of definitions, namely, PPP-based definition ($e_{ppp} = EP^*/ P$) and relative prices approach ($e = P_T / P_N$). However, finding the empirical counterparts of these definitions, particularly of the latter one, is not straightforward. Consumer price index, wholesale price index, gross domestic product deflator, unit labour costs index, unit value indexes of exports and imports are often used in measuring the RER. One can find other indexes constructed by using the relevant components of the existing indexes in order to approximate better to the true prices. The main advantages and disadvantages of each index were discussed in this chapter.

The principal theoretical models of the real exchange rate determinants were reviewed, grouping them as PPP-based models and relative prices models. The empirical works in the former group focus on testing the validity of the PPP hypothesis. PPP remains a useful theoretical building block, while its empirical importance is an open question. The more recent works in this group argue that the RER deviates from its equilibrium value and that changes in the price levels do not fully explain these changes in the RER. Changes in relative prices across tradable and nontradable sectors and across countries (mainly due to productivity differences), existence of nontraded goods in aggregate price indexes, transportation and menu costs, domestic market distortions and structural shocks are among the factors which explain these deviations from the PPP. The latter group of studies (tradable/nontradable models) explain the changes in the real exchange rate by real factors such as terms of trade, government expenditures, productivity differences, trade restrictions, capital flows and so on.

The main difficulty faced in empirical studies is the data limitations. Time series data are not available for all variables and for all countries. Measurement errors in using proxies is another problem. In addition simple regressions or correlations between the RER and its determinants may not provide reliable information, because the equilibrium RER is not observable and the actual rate may depart from the equilibrium level.

Most of the existing studies are multi-country studies. It may be more appropriate to look at individual countries independently, so that choices of the proxies would then be more relevant to the country being studied (country-specific).

Consequently, "despite the uncertainties of measurement and the conceptual problems, usefulness of equilibrium real exchange rate estimates in helping economists evaluate past movements of actual exchange rates and likely or appropriate prospective future changes will be ample repayment for the efforts that go into their calculations" (Black, 1994, p.292).

CHAPTER 3

MODELLING THE DETERMINANTS OF THE REAL EXCHANGE RATE

3.1 Introduction

The objective of this chapter is to describe an appropriate theoretical framework in which the equilibrium real exchange rate is determined. It investigates the main factors effecting the equilibrium real exchange rate and then analyses how the equilibrium rate responds to these disturbances. The building blocks of the model are presented in the first section. This is followed by the evaluation of the solution of the model and discussion of the influences on the real exchange rate of its fundamental determinants.

3.2 A theoretical model of the real exchange rate

In this part, we present a model to analyse the determinants of the real exchange rates (RER). The model is based on Edwards (1988b, 1989a) model which is in fact, an extension of the model developed by Calvo and Rodriguez (1977)[1] to the case where there is a dual exchange rate system and a government sector. Rodriguez (1978), Lizondo (1987) and Kiguel and Lizondo (1987) also developed similar models extending the Calvo-Rodriguez model in order to analyse some specific issues such as the relationship between the real exchange rate and fiscal policies or capital flows.

[1] The origin of such kind of tradables/nontradables modelling goes back to Salter (1959) and Swan (1960) and also Dornbusch (1974).

Recent empirical studies have cast doubts on PPP approach in explaining the movements in the real exchange rates. Many have believed that these movements can hardly be explained solely by price changes and that the equilibrium real exchange rate changes in response to real shocks in the economy. Therefore, they have inclined to construct new models which incorporate these real factors and estimate the equilibrium rate. Edwards (1988b, 1989a)' work can be considered as one of the pioneers of these approach. He provides a general equilibrium framework to model the equilibrium real exchange rate. It is developed particularly for developing countries, taking into account the main characteristics of these countries such as existence of a wide nontradable sector, import tariffs and quotas, excess domestic credits and fiscal deficits. A multicountry large macroeconometric model is probably unnecessary for a small country whose impact on the world economy is negligible. This model defines the real exchange rate in terms of relative prices of tradable and nontradable goods. It explains the large fluctuations in the real exchange rates of especially developing countries by real variables besides the relative price changes, and specifies the equilibrium rate and its main determinants explicitly. Therefore it seems to be appropriate to use this model in order to investigate the main determinants of Turkish real exchange rate in this study.

Recently, Pick and Vollrath (1994), Ghura and Grennes (1993) and Cottani et al (1990) carried out empirical work which is similar to the empirical parts of Edwards' study.[2] Following Edwards' definition of the equilibrium real

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[2] They are similar to Edwards' model in terms of the variables used in the empirical estimations only. However, these variables are determined through intuitive explanations, not through the solution of the model (i.e. the reduced form). This is true for Edwards' own empirical estimations too.

exchange rate, Elbadawi (1992, 1994) develops a similar model for the real exchange rate determination. The novelty of our work might be testing this model by a time series data for a single country unlike other empirical applications which use mostly pooled-data for a group of countries.

The model is a small open economy model, consisting of three goods - exportables, importables and nontradables. There is a government sector. It is assumed that the country produces the exportable (X) and nontradable (N) goods and consumes importable (M) and N goods. The government consumes both M and N, and uses both domestic credit creation and non-distortionary taxes to finance its expenditures. Also, it is assumed that the government cannot borrow from public and from abroad. Residents of the country hold both domestic money and foreign money.

There are tariffs on imports and subsidies for exports. It is assumed that subsidies are financed by lump-sum taxes and that tariff revenues are distributed back to the public in a non-distortionary way.[3] All transactions take place under flexible nominal exchange rate system.[4] The price of exportable goods in terms of foreign currency is taken as numéraire. Finally, it is assumed that there is perfect foresight.

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[3] There are two analytical methods of treating the disposition of the tariff revenues. We may assume that government spends these proceeds on the tradable and nontradable goods in a given proportion, or we suppose that tax revenues are redistributed as income subsidies to customers. The latter method is simpler as it avoids the necessity of introducing a government demand equation (Mundell, 1968: 27). Alternatively, it might be assumed that import tariff revenues are distributed to exporters as subsidies so that net effect will be zero.

[4] Edwards uses a dual exchange rate system in his model. However, for Turkey although parallel exchange rates existed for capital and current accounts between 1970-1979 to some extent, they existed for only capital accounts after 1980 and their importance has decreased gradually. In fact, between 1980-1989, parallel exchange rate premium was 8.4 on average, which is in the low premium group together with France, Belgium and Italy (Kiguel, 1995). From 1984 black market rate has varied around the official rate.

The model consists of five sectors which are summarised by the equations (3.1) - (3.16) :

3.2.1 Assets sector

In this model, we will assume that total wealth of the private sector consists of only domestic and foreign currency held by the residents. It is also assumed that the small country's currency is not held by foreigners and thus the total stock of domestic currency is equal to the money supply determined by the monetary authority. The only way for the economy to change the level of its foreign currency holdings is through an excess supply or demand of traded goods. Denoting the total stock of domestic currency by S, the stock of foreign currency by F and the nominal exchange rate by E, the total value of assets (wealth), W, in domestic currency are

$$W = S + EF \tag{3.1}$$

This can be expressed in real terms in terms of the price of home goods as

$$w = s + f \tag{3.2}$$

where $w = W/P_N$, $s = S/P_N$ and $f = EF/P_N$.

The ratio of domestic to foreign currency is assumed to be a function of the expected difference of the rates of return on both assets, which under perfect foresight, is equal to the actual change in the exchange rate, E. Namely, if we let a (-) over a letter show the proportional rate of change in a variable, the real rate of return on domestic currency holdings is $-\bar{p}$, where p is the domestic price level (i.e. inflation rate) while the real rate of return in foreign currency is $\bar{E} - \bar{p}$, so the difference between the returns is $\bar{E}$, which is the rate of depreciation of the domestic currency (Calvo and Rodriguez, 1977). Thus, the portfolio composition equation is

$$s = \sigma(\bar{E})\,F \qquad \sigma'<0 \tag{3.3}$$

which describes that the desired ratio of real domestic money to real foreign money is a function of the expected rate of depreciation of the nominal rate. This negative relationship implies that the higher the expected rate of depreciation, the smaller there will be the fraction of wealth that is held in the form of domestic currency.

Finally we assume that there is no capital mobility[5], however the economy has inherited a positive stock of foreign money, that is $F_0 > 0$ and in equilibrium

$$\bar{F} = 0 \tag{3.4}$$

3.2.2 Demand side

The equations (3.5) to (3.7) describe the demand side of the economy:

$$P_M = EP_M^* + \tau, \qquad e_M = P_M / P_N$$
$$P_X = EP_X^* + \delta, \qquad e_X = P_X / P_N \tag{3.5}$$

where

P_M : Domestic price of importables

[5] See section 3.4.

P_X : Domestic price of exportables

E : Nominal exchange rate

P_M^*: World price of importables

P_X^*: World price of exportables (which is taken as numéraire)

τ : Import tariffs

δ : Export subsidies

P_N : Domestic price of nontradables

e_X : Domestic relative price of exportables with respect to nontradables

e_M : Domestic relative price of importables with respect to nontradables

Equation (3.5) defines the relative prices.[6] Here, e_X shows the relative price of exportables and e_M shows the relative price of importables with respect to nontradables.

By invoking small country assumption, world prices of exportables and importables, P_X^* and P_M^*, can be considered as exogenous variables. Therefore, for a given set of exchange rate and commercial policies, the corresponding domestic prices, P_X and P_M are determined by P_X^* and P_M^*, respectively. In addition, the domestic price of importables and the domestic price of exportables are influenced by the commercial policies. Both import tariffs and export subsidies[7] deviate the domestic prices from the world prices.

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[6] In the two-goods models, consisting of tradables and nontradables, the real exchange rate (e) is defined as the relative prices of tradables to nontradables in domestic currency, that is $e = EP_T^*/P_N$. Taking the world price of tradables as constant (unity), then the real exchange rate is $e = E / P_N$. See, for example, Calvo and Rodriguez (1977), Edwards (1989a), Rodriguez (1978), Khan and Lizondo (1987).
However , in this model we differentiate the tradable goods as importables and exportables, so, in a way, we have two definitions of the real exchange rate as $e_X = P_X/ P_N$ and $e_M = P_M/ P_N$. The definition used in the model as *the real exchange rate* is the geometric average of these two definitions (see forthcoming equation (3.16)).

[7] Taxes are rarely imposed on exports in Turkey (particularly during the study period, 1980-1995), so they are ignored.

The demand of private sector for the importable goods (C_M) and nontradable goods (C_N) are expressed as

$$C_M = C_M(e_M, w), \qquad \partial C_M / \partial e_M < 0 \ , \ \partial C_M / \partial w > 0 \qquad (3.6)$$

$$C_N = C_N(e_M, w), \qquad \partial C_N / \partial e_M > 0 \ , \ \partial C_N / \partial w > 0 \qquad (3.7)$$

The demand functions are drawn by using the traditional duality theory (income-expenditure approach).[8] First derivatives of the expenditure function with respect to prices give the relevant demand functions (Dixit and Norman, 1980). They both depend on the relative price of importables and on the level of real assets. The demand for importable goods responds negatively to increases in its relative price, whereas changes in relative prices affect the demand for home goods positively. On the other hand, higher level of assets increases consumption of both goods.

3.2.3 Supply side

The supply side of the model is explained by the equations (3.8) and (3.9):

$$Q_X = Q_X(e_X), \qquad \partial Q_X / \partial e_X > 0 \qquad (3.8)$$

$$Q_N = Q_N(e_X), \qquad \partial Q_N / \partial e_X < 0 \qquad (3.9)$$

where

Q_X : Output of exportables

Q_N : Output of nontradables

[8] See Appendix-3 for derivations.

Similarly, from the duality theory, the first derivatives of the revenue function with respect to prices give the relevant supply functions (Dixit and Norman, 1980).[9] The equation (3.8) defines the supply of exportable goods, while the equation (3.9) explains the supply of nontradable goods. Given factor endowments, the supply of exportables and nontradables both depend on the relative price of exportables to nontradables. The direction of this relationship is predicted to be positive for the supply of exportables, while it is negative for the supply of nontradable goods.

3.2.4 Government sector

The equations (3.10) through (3.12) summarise the government sector:

$$G = P_N G_N + EP_M^* G_M \tag{3.10}$$

$$g = g_N + g_M$$

$$\text{where } g = G/P_N,\ g_N = P_N G_N / P_N = G_N \text{ and } g_M = P_M^* G_M / P_N \tag{3.11}$$

$$G = T + \bar{D} \tag{3.12}$$

where

G : Total government consumption (expenditure) in domestic currency

G_M: Government consumption of importables

G_N : Government consumption of nontradables

[9] See Appendix-3 for derivations.

T : Taxes

D : Domestic credits to government

Government consumes both importable and nontradable goods. Equation (3.10) defines the total government expenditures as sum of expenditures on nontradable (P_NG_N) and expenditures on importable goods ($EP_M{}^*G_M$), expressed in domestic currency. Deflating the expenditures by the price of nontradable goods gives us the real government expenditures (equation 3.11). Finally equation (3.12) presents the government budget constraint. Expenditures are to be financed by either non-distortionary taxes[10] or domestic credit creation (usually from the central bank).

3.2.5 External sector

The last part of the model explains the external sector by the equations (3.13) to (3.16):

$$CA = Q_X(e_X) - [P_M{}^* C_M(e_M, w) + P_M{}^* G_M] \tag{3.13}$$

$$\bar{R} = CA \tag{3.14}$$

$$\bar{S} = \bar{D} + E\,\bar{R} \tag{3.15}$$

$$e = \alpha e_X + (1-\alpha)e_M = [\alpha P_X + (1-\alpha)P_M] / P_N\,, \quad 0<\alpha<1 \tag{3.16}$$

[10] For simplicity and integrity, we assume that expenditures are financed by non-distortionary taxes. This enables us to avoid dealing with the sources of taxes as well as their effects on the demand and supply functions.

where

CA: Current account in foreign currency

R : Stock of international reserves held by the central bank in foreign currency

e : Real exchange rate

α : Share of exports in the volume of trade

The equation (3.13) describes the current account balance in foreign currency. The current account is defined as the difference between the output of exportables (Q_X (e_X)) and total consumption (of the private and public sectors) of importables (P_M*C_M(e_M,w) + P_M*G_M). Given that there is no capital inflow or outflow, the current account is supposed to be identical with the balance of payments as presented by the equation (3.14).[11] It is assumed that initially there is a positive stock of international reserves (R_0 >0). Foreign exchange reserves can only be increased by the excess supply of exports. Equation (3.15) shows the link between the changes in the international reserves, changes in domestic credit creation and changes in the domestic money supply. This equation implies that credit creation to government to finance the budget deficits and changes in the reserves are the only sources of monetary expansion. Finally the model is closed by the definition of the real exchange rate. This definition is the geometric average of the domestic relative prices of the importables and exportables with respect to nontradables.

3.3 Solution of the model : The equilibrium

Edwards states four conditions for a steady state equilibrium:

[11] See section 3.4.

1. The domestic market clears,
2. The external sector is in equilibrium. That is: $\bar{R} = 0 = CA = \bar{s}$,
3. Fiscal policy is sustainable, $G = \dot{t}$, and
4. Portfolio equilibrium holds.

The RER prevailing under these conditions is the *long-run equilibrium real exchange rate.*

The nontradable goods market clears when the demand for nontradables is equal to supply of nontradables. That is

$$C_N + G_N = Q_N \tag{3.17}$$

or,

$$C_N(e_M, w) + g_N = Q_N(e_X) \tag{3.18}$$

Recall that $e_M = P_M / P_N$ and $e_X = P_X / P_N$
where $P_M = EP_M^* + \tau$ and $P_X = E + \delta$.

Then, from (3.18) it is possible to express the equilibrium value of P_N as a function of w, P_M^*, g_N, τ and δ :

$$P_N = z\,(w, P_M^*, g_N, \tau, \delta) \tag{3.19}$$

Because the economy in question is a small economy that cannot change the world trade prices, the fundamental determinants will affect the equilibrium real exchange rate only through nontradable prices (P_N) in (3.16). In the absence of explicit functional forms of the structural equations, the long-run equilibrium real exchange rate (e_{LR}) which maintains equation (3.18) can be expressed implicitly as a function of sustainable levels of the private wealth (w_0), government expenditures on nontradable goods (g_{N0}), world import prices (P_{M0}^*), import tariff rate (τ_0) and export subsidy rate (δ_0) :

$$e_{LR} = v\,(w_0,\, g_{N0},\, P_{M0}^*,\, \tau_0,\, \delta_0) \tag{3.20}$$

These variables are called *fundamentals* of the equilibrium real exchange rate. The economic theory suggests that

$$\partial v/\partial w < 0,\ \ \partial v/\partial g_N < 0,\ \ \partial v/\partial P_M^* >< 0,\ \ \partial v/\partial \tau >< 0 \ \text{ and } \ \partial v/\partial \delta >< 0. \tag{3.21}$$

Now, we will explain the intuition behind these relationships:[12]

Recall that world price of exportables is set as numéraire, i.e. $P_X^* = 1$. Thus P_M^* represents, in fact, the reciprocal of the external terms of trade. Therefore, here, we will discuss the effect of terms of trade changes on the equilibrium real exchange rate. *A priori*, it is difficult to determine the impact of a change in ***external terms of trade*** on the real exchange rate. The relative importance of income and substitution effects determines the direction of the change in the real exchange rate. However it may not be always easy to separate the effects of these movements and even sometimes they work together and are interrelated.

A deterioration of the terms of trade caused by an increase in import prices reduces the real income and causes the demand for all goods including nontradables to decline. In order to restore equilibrium, the relative price of

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[12] For mathematical presentation, see Edwards (1988b): 318-24 and Edwards (1989a): 25-50.

nontradable goods has to decline and thus the real exchange rate will depreciate. This process is described as *the income effect*. On the other hand, when the foreign price of importables increases, the demand for these goods may shift to nontradable goods (provided that they are substitutable), pushing their prices up. This causes the real exchange rate to appreciate and this process is described as *the substitution effect*.

It is argued that the demand for importables in less developed countries is mostly inelastic, which implies the possibility of the income effect dominating the substitution effect. Therefore, an increase in foreign import prices may not shift demand for importables towards nontradables and thus may cause a depreciation of the RER.[13] Thus the usual experiences suggest a negative relationship between external terms of trade and the real exchange rate.

In our model, ***wealth of the private sector*** is assumed to consist of domestic money plus foreign money held by the residents of the country. Thus, monetary expansion may be a result of either domestic credit creation or reserves accumulation (as explained in the theoretical model, assets sector). In any case, excess monetary expansion causes an increase in real wealth. Because the demand for nontradable goods is a function of real wealth, this creates an excess demand for these goods and then drives their prices up. This results in an appreciation of the real exchange rate.

An imposition of ***tariffs on imports*** and a deterioration of external terms of trade due to an import price rise have similar impacts on the real exchange rates.

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[13] For analytical exposition of the income and substitution effects, see Connolly and Devereux, 1992; Neary, 1988; Khan and Ostry, 1992).

Thus the arguments above about income and substitution effects work similarly for the changes in the tariff rate. However, there is an additional ambiguity in this case, due the definition of the real exchange rate in (3.16).

The domestic price of imports increases in response to an imposition of a tariff. This shifts demand towards home goods, causing their prices to go up (assuming that importables and nontradables are substitutes). If there is no income effect, the increase in nontradable prices will require a real appreciation to sustain the equilibrium. Because we define the RER in terms of relative prices which include import tariffs, an increase in the numerator (tariff rate) will be accompanied with an increase in the denominator (nontradable prices). Thus, the substitution effect on the real exchange rate of an import tariff increase will be undetermined.

In many developing countries initial tariff levels are quite high and in the case of liberalisation of the trade, changes in tariff rate also affect the level of real income in the economy. A reduction in general level of tariffs (or removal of tariffs on imports of certain goods) tends to raise real income by reducing initial distortions (particularly when these imported goods constitute a large portion of total imports), and this may lead to an increase in the demand for these imported goods as well as for nontradable goods. The increasing price of nontradables causes the RER to appreciate, which is a movement opposite to the above process where the substitution effect prevails.

As a result, the final impact on the real exchange rate of a tariff rate change may not be known *a priori*[14] and may only be determined by empirical investigation.

Any change in the level of ***government expenditures on nontradable goods*** may influence the path of the RER. Namely, an increase in the level of government consumption (that is, demand for) of nontradable goods generates an increase in their prices. In this case, the actual real exchange rate will have to appreciate in order sustain the equilibrium level.[15]

Finally, the net impact of **an export subsidy** on the real exchange rate is ambiguous. An increase in the subsidy rate will encourage more supply of exportable goods. This will shift the resources of production towards the exportable sectors from nontradable sectors (provided they are substitutable). Decreasing supply of nontradables will cause an increase in their prices. The real exchange rate is expected to appreciate as a response to the increase in nontradable prices. However, it is not possible to draw that conclusion from the definition in (3.16), as both numerator (export subsidy rate) and the denominator (nontradable prices) will go up.

This is the case for income effect of a change in export subsidy rate. An increase in the subsidy rate will raise the real income, leading an increase in demand for all goods including the nontradables. This will cause a rise an increase in the price of nontradable goods. The net effect on the real exchange rate will not be

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[14] Edwards (1988b, 1989a) defines the real exchange rate in terms of world prices which ignore the tariffs and subsidies, therefore he predicts a negative relationship between the import tariff rate and the real exchange rate.

[15] On the other hand, an increase in government expenditure, either by public borrowing or tax increases, will reduce the real disposable income of private sector. This will cause a fall in demand for nontradable goods, inducing a fall in their prices. However, it is assumed in our model that government does not borrow from the public and that taxes are non-distortinary, this income effect on the real exchange rate of government expenditures is ignored.

determined according to the definition in (3.16).

Consequently, both income and substitution effects of a change in export subsidy rate will be undetermined according to our definition of the real exchange rate.

3.4 Other modelling issues

The model presented concentrates on current account determinants of the RER in Turkey. This is because one of the purposes of the thesis is to analyse the trade effects on the RER of the liberalisation policies. Therefore, capital immobility is assumed in the model and the stock of international reserves is limited to the excess supply of exports over demand imports. However it is possible to extend the model to capture the capital account issues.

In the presence of capital flows ($\bar{F} > 0$ in equation (3.4)), the balance of payments equation (3.14) can be expressed in foreign currency as

$$\bar{R} = CA - \bar{F} \qquad (3.14')$$

where $\bar{R}$ denotes the changes in the stock of international reserves held by the central bank, CA denotes the current account and $\bar{F}$ denotes the changes in capital account. An increase in private sector holdings of foreign currency will draw down central bank reserves (See Khan and Lizondo, 1987).

Until now, foreign currency is assumed to be the only internationally traded asset, and neither domestic nor foreign money is assumed to be interest bearing. One might extend the model further to incorporate foreign and domestic bonds in measuring the wealth of private sector in equations (3.1) - (3.3) (See Frenkel and Rodriguez, 1975). When these extensions are included in the model, new variables including net capital flows and foreign and domestic interest rates will appear in the reduced form solution (3.20). Although these variables, besides probably several others, might be important factors in explaining the changes in the RER, analysing their effects in the same model might have several disadvantages. First, sample size may not allow such an extended model to be estimated efficiently. Namely, particularly in cointegration analysis which will be used in the present work, the degrees of freedom will be reduced considerably (due to lags) as the number of variables increases. Secondly, interaction among the variables might undermine the impact of a variable on the possible dependent variable. For example, Pentecost (1993) states that assumption of perfect capital mobility does not permit the trade balance to influence the path of exchange rate (p.125).

In fact, our model will indirectly capture, partially at least, the capital effects as well as current account effects via inclusion of a wealth variable. Agenor et al (1997a) argue that capital flows are an endogenous response to perceived or expected changes in relative rates of return between domestic and foreign assets. In turn, domestic rates of return are influenced by macroeconomic equilibrium conditions. Equation (3.3) may partially capture therefore these asset substitution affects of capital movements.

3.5 Summary

A theoretical model of real exchange rate was presented in this chapter. It is based on Edwards (1988b, 1989a) model which consists of five blocks of equations explaining the demand and supply activities, government sector, portfolio composition and the external sector of the economy. The solution of the model specified the determinants of the real exchange rate as the wealth of private sector, government expenditure on nontradable goods, external terms of trade, the import tariff and export subsidy rates. The intuitive discussions suggested a negative relationship between the real exchange rate and government's demand for nontradables, and between the real exchange rate and private wealth. However, it is difficult to determine the impact on the real exchange rate of a change in external terms of trade, import tariff rate and export subsidy rate *a priori*.

APPENDIX 3

DERIVATION OF DEMAND AND SUPPLY FUNCTIONS

Revenue function

In the duality theory[A.1] the production side of the model is described by revenue functions which give the maximum revenue that maximising firms obtain from producing exportable (X), importable (M) and nontradable (N) goods, subject to prevailing domestic prices, available technology and available factors of production.

$$R = \text{Max } \{ P_X Q_X + P_M Q_M + P_N Q_N \ / \ F(Q,V)<0 \} \quad (A3.1)$$

Normalising the equation by P_N enables us to express the function in terms of relative prices:

$$R = \text{Max } \{ e_X Q_X + e_M Q_M + Q_N \ / \ F(Q,V)<0 \} \quad (A3.2)$$

We can rewrite the equation (A3.2) in reduced form as

$$R = R(e_X, e_M : V) \quad (A3.3)$$

where

Q_X, Q_M and Q_N are quantities produced of exportables, importables and nontradables. Q is a vector that summarises these quantities,

P_X, P_M and P_N are prices of exportables, importables and nontradables

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[A.1] See Dixit and Norman (1980) and also Edwards (1989a) for details.

V is a vector of factors of production,

F( ) is the production function that summarises existing technology,

e_X is the domestic price of exportables relative to nontradables (or RER for exports), and

e_M is the domestic price of importables relative to nontradables (or RER for imports).

Derivatives of the revenue function with respect to prices give the corresponding supply functions of exportables, importables and nontradables (For simplicity, we can neglect the factors of production, V):

$R_X = Q_X(e_X)$ Supply function of exportables (A3.4)

$R_M = Q_M(e_M)$ Supply function of importables (A3.5)

$R_N = Q_N(e_X, e_M)$ Supply function of nontradables (A3.6)

Expenditure function

The consumption side of the model is summarised by expenditure functions that give the minimum value of expenditure required to obtain a level of utility for given domestic prices.

$$E = \text{Min} \{ P_X C_X + P_M C_M + P_N C_N \ / \ W(U) > U \} \quad \text{(A3.7)}$$

Again, dividing the equation by P_N enables us to express the function in terms of relative prices:

$$E = \text{Min} \{ e_X C_X + e_M C_M + C_N \ / \ W(U) > U \} \qquad (A3.8)$$

We can rewrite this equation in terms of relative prices and utility as

$$E = E(e_X, e_M; W) \qquad (A3.9)$$

where

C_X ,C_M and C_N are quantities consumed of exportables, importables and nontradables, and

$W(U)$ Utility function (we consider as total wealth)

Derivatives of the expenditure function with respect to prices give the corresponding demand functions for exportable, importable and nontradable goods:

$E_X = C_X (e_X, W)$ Demand function for exportables (A3.10)

$E_M = C_M (e_M, W)$ Demand function for importables (A3.11)

$E_N = C_N (e_X , e_M ,W)$ Demand function for nontradables (A3.12)

CHAPTER 4

DATA ANALYSIS

4.1 Introduction

In the previous chapter, the fundamental determinants of the equilibrium real exchange rate were specified as private wealth, government expenditures on nontradable goods, external terms of trade and import tariff rate.[1] It is intended in this chapter to analyse the data for these variables descriptively, graphically and statistically. We first define the variables and discuss alternative proxies for them. Then, we explain the data processing such as generating missing values, constructing indexes, deflating series and so on. The plots of the series are expected to describe the data more clearly in terms of the main trends and related economic developments. Finally evidence on testing for stationarity of the series (unit root tests) is reported. The appendix 4 provides a detailed list of the data sources.

4.2 Data description and graphical analysis

4.2.1 Real exchange rate

The real exchange rate is defined in our model as

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[1] Export subsidies was one of the fundamentals specified in the solution of the model because of their direct impact on export prices in domestic terms. Export credits might be used as a proxy for that variable. However, the monthly data on that variable do not exist for our sample period, therefore, besides the import tariff rate, we will approximate the trade restrictions by an openness index which might capture the effects of both tariff and subsidy rates as well as of other non-quantitative restrictions such as quotas and licences and other exchange rate controls.

$$RER = [\alpha P_X + (1-\alpha) P_M] / P_N \qquad (4.1)$$

where the weight α is the share of exports in total trade and $(1-\alpha)$ is the share of imports in total trade; P_X, P_M and P_N are domestic prices of exportable, importable and nontradable goods, respectively.

It is necessary to have three price series to construct a real exchange rate index in terms of relative prices. These are exportable goods prices, importable goods prices and nontradable goods prices. As in many countries, data on actual prices for export and imports do not exist for Turkey. There are two second-best and widely available indexes used for trade prices, which are unit value indexes and wholesale price indexes.[2] Wholesale price indexes include some goods often regarded as nontradables, use domestic rather than international weights for the tradable goods, and refer to list rather than transaction prices (Goldstein and Khan, 1985). Unit value indexes, calculated by dividing the value of imports (exports) by the physical quantities of imports (exports), escape some of these problems and the data have been compiled from completely traded goods, therefore we prefer to use these indexes in the study. However, they are not without shortcomings. Although the unit value index is quite useful to measure the price of a single product, some problems may arise in aggregation. For example, when the commodity composition of imports changes, a unit value index will change even if all "true" prices of the component import products remain unchanged. Another inevitable problem is that some items, which are not traded every year (but traded occasionally) and are not well-defined in terms of size, quality and kind, have to be excluded from the index.

[2] The consumer price index and GDP deflator are also used, although rarely, in empirical works. However, the former index contains many nontradable goods and the second one is available usually on annual basis.

In Turkey, the State Institute of Statistics (SIS) calculates foreign trade price and quantity indexes using the eight-digit classification. The Fisher index, a geometric average of the Laspeyres and Paasche indexes, is used in the calculations. The latest index is one with a 1989 base year. The reason for choosing that year is that it is a relatively economically stable year and from 1.1.1989 the harmonised system has been used in foreign trade indexes. As a result, the number of item codes rose to approximately 18000 from 8000. According to the harmonised system, the items in foreign trade are classified according to a 2-digit level, a 4-digit level, a 6-digit level and an 8-digit level disaggregation, and statistics are formed according to this classification (see SIS, 1993 for details of construction of the indexes).

Concerning the coverage of these indexes; total exports in 1989 were 11624 million US dollars. The value of items included in the index is 7686 million dollars. Items included represent 66.12 % of total exports. For imports, the realised value was 15789 million dollars. The value of items included is 9684 million dollars so the index covers 61.74 % of actual imports.

The data on export and import unit value indexes by the SIS are available from 1982 to 1995 on a monthly basis. The data on 1980.1 to 1981.12 were completed from the indexes by the Central Bank (1984-86 = 100), converting its base year to 1989.

The third component of the real exchange rate index is the price of nontradables. The usual practice is to use consumer price index (CPI) as a proxy.[3] However, the CPI might include some items which are often regarded as tradable goods. In order to overcome this drawback to some extent, we tried to exclude certain groups which may be regarded as tradables, and constructed a nontradable price index.

The CPI data are available in 7 groups:

1. Group index of foodstuff
2. Group index of clothing and footwear
3. Household furniture and tools
4. Medical health and personal care
5. Transportation and communication
6. Culture, education and entertainment
7. Housing

From these 7 groups, the last four groups seem to contain mainly services and nontradable goods. Although there are some items which can be regarded as tradable goods within each group chosen, overall weight is small. Then we constructed a price index for nontradable goods taking the weighted averages of these four groups.

Expenditure share of each group in total household budget might be appropriate to use as weights. For this purpose, we benefited from the most recent "1994 household income and consumption expenditures questionnaire" by SIS (SIS,

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[3] The unit labour cost index is used by the IMF as a proxy for nontradable prices, however, this type of index is available only for some industrial countries. Another alternative might be using the GDP deflator classified by the kind of economic activity (on which we had data). From these data, we might choose certain groups including transportation, communication, financial services, business and personal services and government services, in order to construct a nontradable price index. However, these data reflect mainly value of production rather than prices and are available only in quarterly basis.

1996). In there, we can find the relative importance for the households of the expenditures on these 7 groups. The share of nontradables in total expenditures is 41 %, whereas that of tradables is 59 %. We calculated the weight of each item within the nontradable group and then used these weights to construct a nontradable price index. It is expected that this new index is closer to the "true" nontradable prices than other proxies commonly used.

Finally, for the weight α in the formulation of the real exchange rate in (4.1), we used the actual share of exports in the total volume of trade for each month. It is expected that this might reflect the change in the composition of trade besides the change in trade prices.

Figure 4.1 : Real exchange rate index (1989=100)

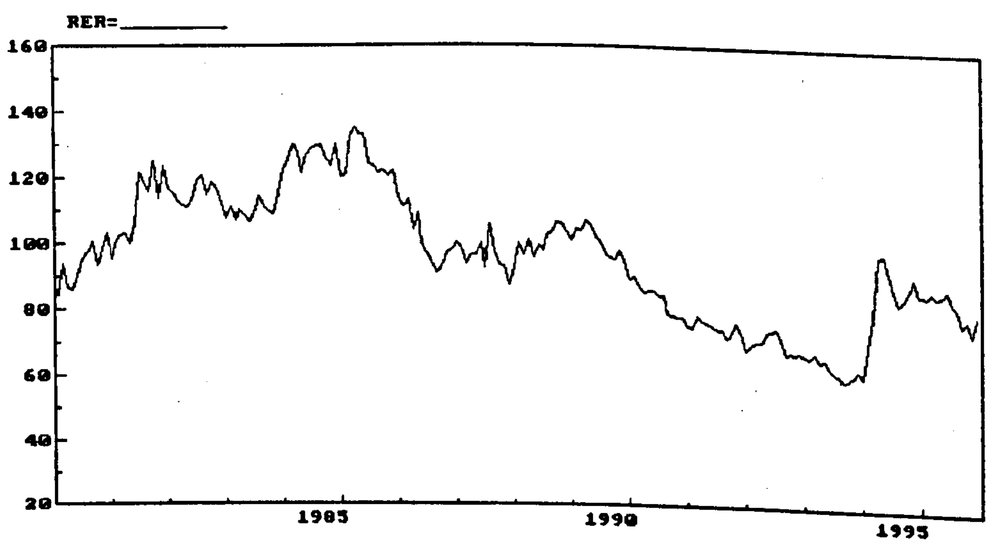


Figure 4.1 plots the actual real exchange rate series constructed as discussed above. An increase in the index numbers indicates a depreciation, while a decrease shows an appreciation of the rate. Movement of the real exchange rate and related economic developments from 1980 to 1995 are already explained in detail in Chapter 1. We summarise the main trends here. It seems that the

stabilisation policies announced at January 1980, which included an immediate devaluation of the nominal currency by 33 % and continuous devaluation in the following years lead to depreciation of the real exchange rate until 1986. From 1990 the real exchange rate appears to be appreciating. The effect of April 1994 austerity program which included devaluation of the nominal currency seems to be short-lived as it started to appreciate again from the beginning of 1995.

To our knowledge, this is the first RER index constructed for Turkey using relative prices of tradable and nontradable goods on a monthly basis. Our series seems to be consistent with other series constructed by using aggregate price indexes (PPP-type definition), in terms of tracing main trends in the real exchange rate in this period. For example, the appreciating trend of 1980-1989 period and the depreciating trend in the following years can be marked in the quarterly series of Erol and van Wijnbergen (1997) for 1980.I-1993.IV, the quarterly series of Agenor et al (1997a,b) for 1980.I-1995.I and the annual real effective rate index of the Central Bank in Asikoglu and Uctum (1992) for 1979-1990.

4.2.2 Private wealth

The wealth of the private sector is represented by the sum of domestic and foreign money held by the residents of the country. The *M2Y* definition of money supply by the Central Bank of Turkey covers both components. That is, the M2 money supply includes currency in circulation, sight deposits and time deposits with deposit money banks and deposits with the central bank. Adding foreign exchange deposits (in local currency units) to that gives the M2Y figure.

Monthly data on M2 money supply are available in the Central Bank EDDS from 1980.1 to 1995.12. The data on foreign money for 1986-1995 were collected from Central Bank Quarterly Bulletins, under the heading 'M2Y money supply'. For the years 1984 and 1985, the data were published as foreign exchange deposits in the same publications. Before 1984, domestic residents were not allowed to hold foreign exchange deposits.

Figure 4.2 : Ratio of foreign exchange deposits (F) in M2Y money supply (1984.1-1995.12)

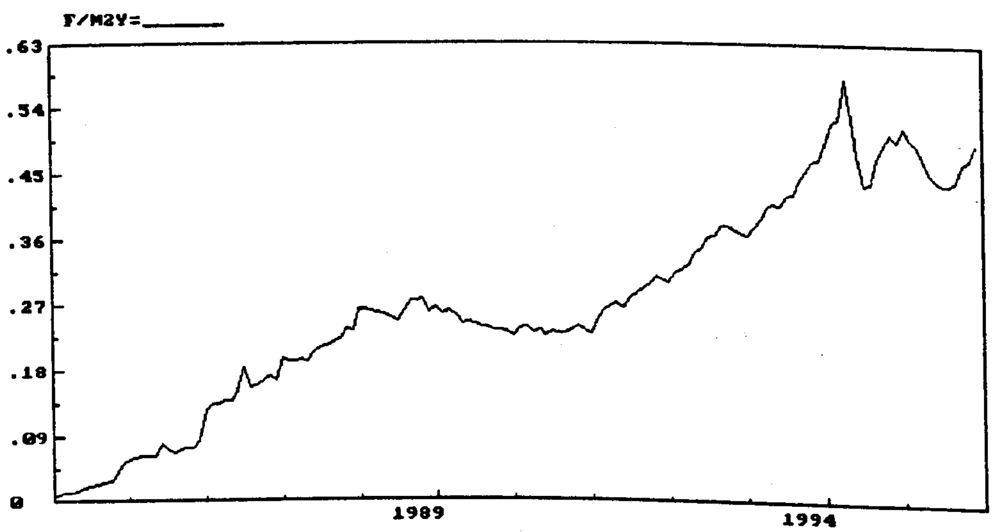


Figure 4.2 displays the evolution of the composition of wealth between domestic and foreign money. Foreign exchange deposits were a negligible element in the early 1980s of the total money supply. However, from the late 1980s, the ratio of foreign money in total M2Y money supply has started to rise. While this ratio was around 30 % in 1990, it reached to 50 % till the end of the sample period; indicating an increasing degree of asset substitution from local to foreign currency deposits. This period has also witnessed a significant volume of capital flows into the economy through foreign direct investment and portfolio investment as well as workers' remittances which is an important

source of foreign exchange for Turkey. As explained earlier in section 3.4, the wealth variable tracks these capital account effects quite well.

Figure 4.3 : Real wealth of the private sector (in millions of TL)

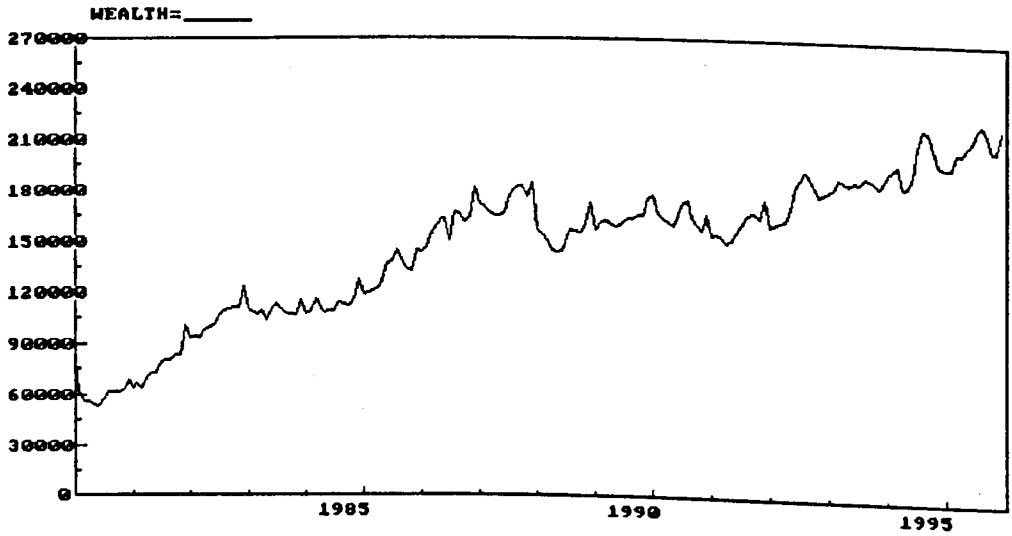


Figure 4.3 demonstrates the movement of the real wealth of the private sector over time. It shows mainly an upward trend throughout the period. Real wealth went up at an increasing rate until 1987 increasing threefold relative to the 1980 level. It was relatively stable between 1987 and 1991, but started to rise again from 1992. This increase might be due to rapid increases in the nominal money supply as the annual growth rate of M1 was 72 %, 84 % and 73 % in 1993, 1994 and 1995 respectively.

4.2.3 Government expenditures on nontradable goods

Actual data on government expenditure on nontradables are very limited and monthly data are almost non-existent for many countries. Thus, many studies including Edwards (1988b, 1989a) employ total government expenditures as a proxy. Obviously total expenditures of the government may well include many tradable goods, so this proxy has serious drawbacks. Because the budgetary data on government expenditures classified by item exists for Turkey from 1984.1 to 1995.12 (but were not published before 1984), we tried to improve this proxy by excluding those items which are usually regarded as tradables.

The consolidated budget expenditures by items are classified as :

000 Special allowances

100 Personnel

200 Allowances

300 Service procurement

400 Consumption goods and materials

500 Fixtures and equipment

600 Machinery equipment and motor vehicles

700 Construction, installation and large repairs

800 Other payments

900 Transfers

Among these items, the purchases of consumption goods, equipment and machinery (400, 500 and 600) may be regarded as "expenditures on tradable goods". Thus we constructed new series using the remaining expenditures of the government.

There are many problems with the original data on consolidated budget expenditures. The main problem is, as mentioned earlier, that monthly and classified data are not available for the years before 1984 and need to be generated by using tools/data in hand. Fortunately there are monthly data on total expenditures (but not classified) for the missing years. Assuming that the composition of government expenditures is similar in the years 1980 to 1983 to those of 1984 and 1985, it was thought that taking the shares of each group in total expenditures for each month of a year (or more years, but then one needs to take averages) and then applying these shares to the total monthly expenditures would be a plausible way to generate the missing values of the period 1980-83.

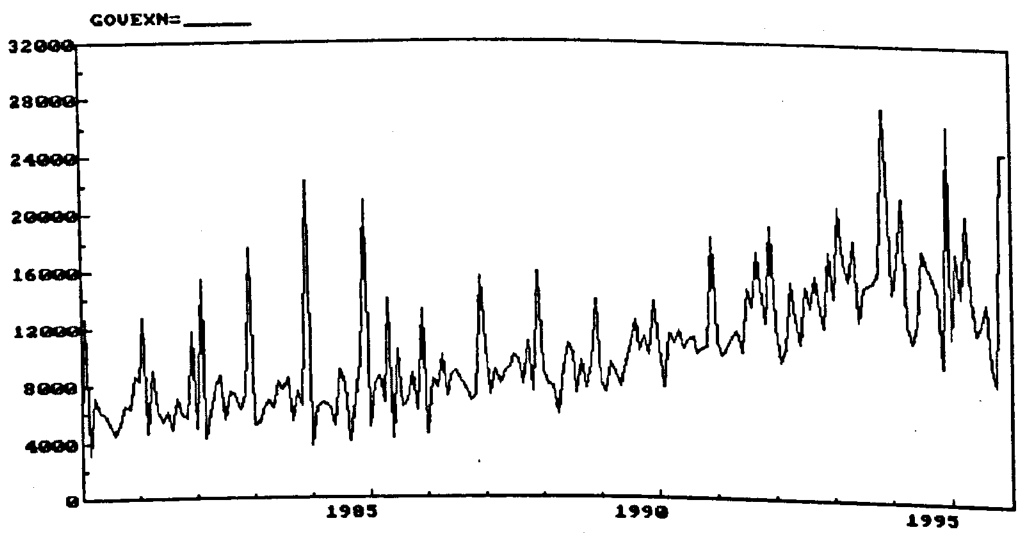
To operationalise this process, some difficulties have to be overcome. First of all, the detailed monthly expenditures are given as cumulative values. All cumulative numbers were converted to absolute monthly numbers by taking differences. Then the shares of the each group in total expenditures were calculated for 1984 as well as 1985 because taking the shares of a single year may reflect some particularities of that year in the new values. Then, we calculated average monthly shares over the two years.

Budget expenditures have shown highly seasonality. In particular, the beginning of the fiscal year has to be taken into account in making correct interpretations. Until 1983, the fiscal year started in March, but it has been changed to January since 1983. Thus the year 1982 lasts 10 months as a fiscal year. In generating the classified monthly values for 1980-83, the shares of January (of the average of 1984-1985) were applied to the total expenditures of March, February to April and so on for the years 1980, 1981 and 1982, but January to January, February to February and so on for the year of 1983.

Having derived the missing values, all expenditures were deflated by the CPI to get the real values.

Alternatively, the functional distribution of the government expenditures (on which we had already collected data) could be used to construct series of expenditures on nontradable goods. The general and annexed budget (in the Ministry of Finance and Customs, Fiscal Year Budget Plan) are classified by services as general services, defence, security, agriculture, mining, water, transportation, reconstruction, education, health, social services and tourism. All public institutions including the ministries and universities are grouped under one of these classes. The main shortcoming of this approach is that an institution regarded as producing a nontradable good such as those classified under education may well spend on tradable goods such as equipment and machinery. Thus it is unlikely to differentiate the spending on tradable and nontradable goods. Anyway, data for 1980 - 1983 are not available for this variable either.

Figure 4.4 : Real government expenditures on nontradable goods (in millions of TL)



The series of government expenditures on nontradable goods, expressed in real terms are plotted is Figure 4.4. One can observe the large increase of spending at the end of each fiscal year, which is represented as peaks in December of each year. There is a positive trend in the series. Early elections, frequent changes of governments and coalitions might have contributed to growing government expenditures in the 1990s.

4.2.4 External terms of trade

The terms of trade is defined as the ratio of export prices to import prices. Export and import unit value indexes are often used to approximate these prices. Terms of trade data are not available for Turkey for monthly frequency. Thus we use a measure of the industrial countries' terms of trade as a proxy. These countries (mainly OECD members) account for a large portion of Turkey's trade (63%, 65%, 66% and 66% in 1991, 1992, 1993 and 1994, respectively). In addition, a comparison of the quarterly terms of trade series for Turkey with those for industrial countries gives a correlation coefficient of 0.82. The composition of imports and particularly exports of Turkey may be different from the OECD countries, but comparison of Turkish and OECD terms of trade for quarterly data[4] shows that this is unlikely to be a serious problem.

Export and import unit value indexes of industrial countries (1990 = 100) are obtained from the International Financial Statistics of the IMF (on CD-ROM), and then terms of trade is calculated for each month.

[4] Quarterly series are available in International Financial Statistics of the IMF only from 1980.1 to 1984.3 and 1989.1 to 1995.4. However, data on terms of trade can be compiled from the State Institute of Statistics publications (Turkey) from 1982 onwards.

Figure 4.5 : Terms of trade for industrial countries

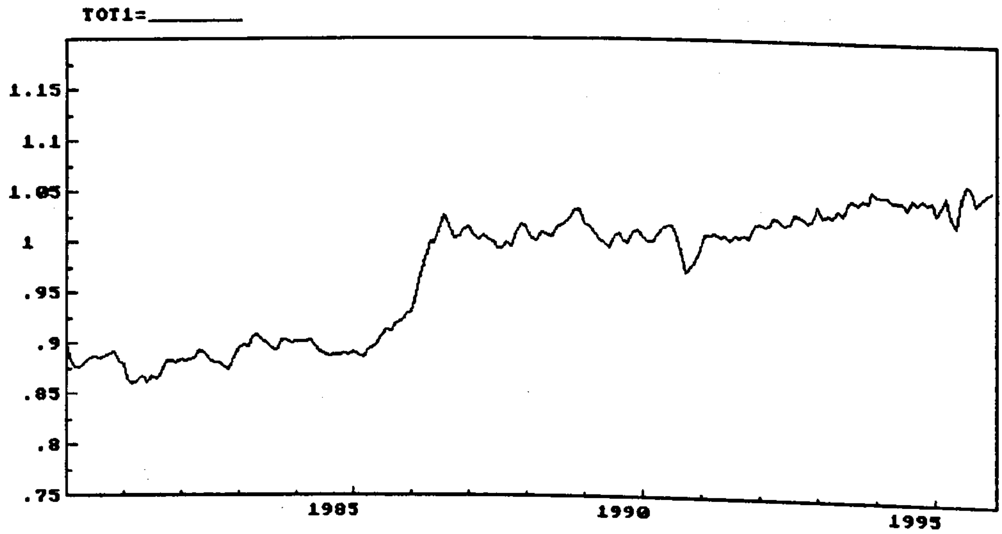
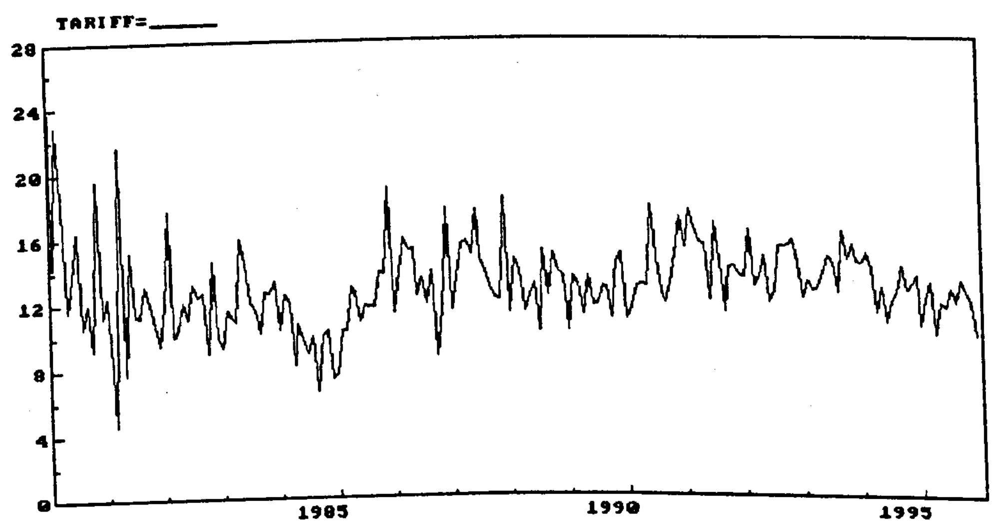


Figure 4.5 presents the movement in the external trade prices of industrial countries. The most remarkable feature of the figure is the structural break in 1986s. The import price index exceeds the export price index until that time, but later the terms of trade changed in favour of the industrial countries. This might be due to the 'inverted oil crisis' which affected many countries significantly. The sharp decrease in the oil prices in the 1985s caused a deterioration in the terms of trade of oil-producing countries while it influenced the oil-importing countries positively. In addition, the fact that oil or oil products are used as raw materials in the production of many more developed or processed commodities by the industrial countries might have helped to improve the terms of trade of these countries as the prices of raw materials declined. Apart from that jump, external trade prices were relatively stable with a slight upward trend, especially after 1991.

4.2.5 The import tariff rate

Data on the tariff rate that applies on imports are often unavailable at the appropriate level of aggregation. The ratio of foreign trade revenues to total imports is sometimes used to approximate the import tariff rate. It is, however, subject to drawbacks. First, changes in this measured rate may be caused by changes in the composition of imports rather than the rate of duty. Secondly, it ignores the role of non-tariff or quantitative barriers.

Figure 4.6 : The import tariff rate (%)



In the consolidated budget of Turkey, the revenues from foreign trade appear in the form of custom duty, production tax on imports, stamp duty on imports and port duty. It can be said that total value of these taxes and duties imposed on imports might indicate the degree of restriction on imports. Therefore we constructed a monthly import tariff rate series by dividing the value of total taxes and duties to the value of imports. The series are plotted in Figure 4.6. The liberalisation policies of January 1980 required an elimination of the restrictions on foreign trade. Accordingly, the import tariff rate declined to 6 % in 1984 from an initial level of 18 % in 1980. It fluctuated overall within about 5 % range over the period. From the figure, the rate seems to increase in 1986, and after that it stayed around 14% level on average. The last period, 1994-1995 witnessed a decrease in the import tariff rate.

4.2.6 The openness index

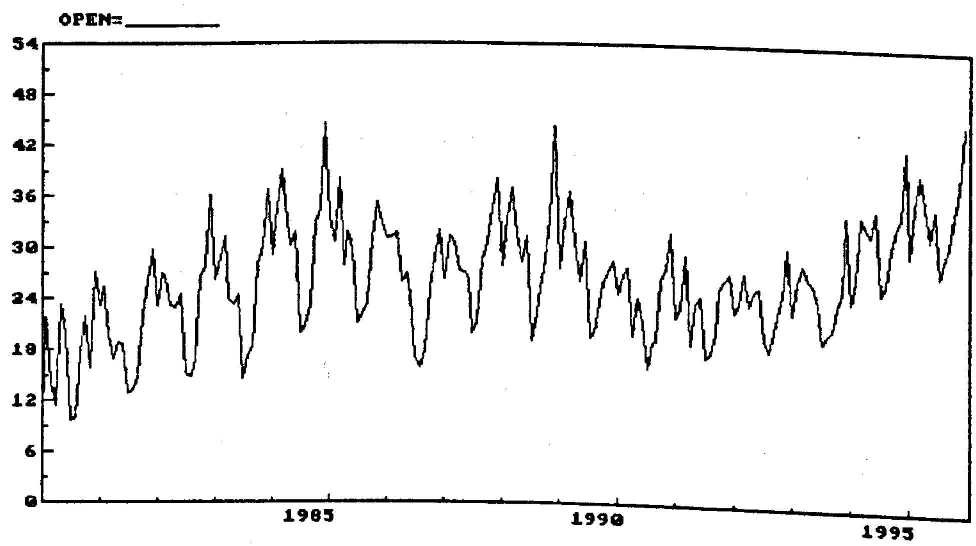
As the import tariff rate ignores the effects of non-tariff barriers, we try a more comprehensive measure of restrictions on foreign trade, that is the openness index. The trade intensity ratio, defined simply as exports plus imports divided by GNP, is one of the basic measures of openness of an economy. In order to compare the levels of trade barriers across countries more sensibly, Leamer (1988) recommends an adjustment to the trade intensity ratio. He uses data on the supply of productive resources to remove the variability associated with resource supplies, and data on distance to markets to remove the variability associated with natural barriers. Absence of monthly data on these variables and the fact that the present study is an analysis of a single country (not country comparisons) forced the use of the simple openness index.

Even for the measurement of the simple openness index, there is a data problem. Although there are data on imports and exports on a monthly basis, data on the denominator of the expression, that is GNP, are available only at quarterly frequency.[5] Therefore, the data on quarterly GNP were converted into monthly frequency by using monthly electricity production. In the absence of precise information on the monthly behaviour of GNP, it was assumed here that monthly growth of the value of GNP and of the electricity production are

[5] In fact the State Institute of Statistics (SIS) has collected and published original quarterly GNP data since the first quarter of 1987. However the SIS extrapolated the data back to 1980 on a quarterly frequency. Interpretation of the quarterly behaviour of the data or drawing results from an analysis based solely on these data requires some caution.

similar in respective quarters. For example, if the value of electricity production in January 1980 is 35 % of the total production of the first quarter of that year, the share of GNP in that quarter was assumed to be 35 % as well.

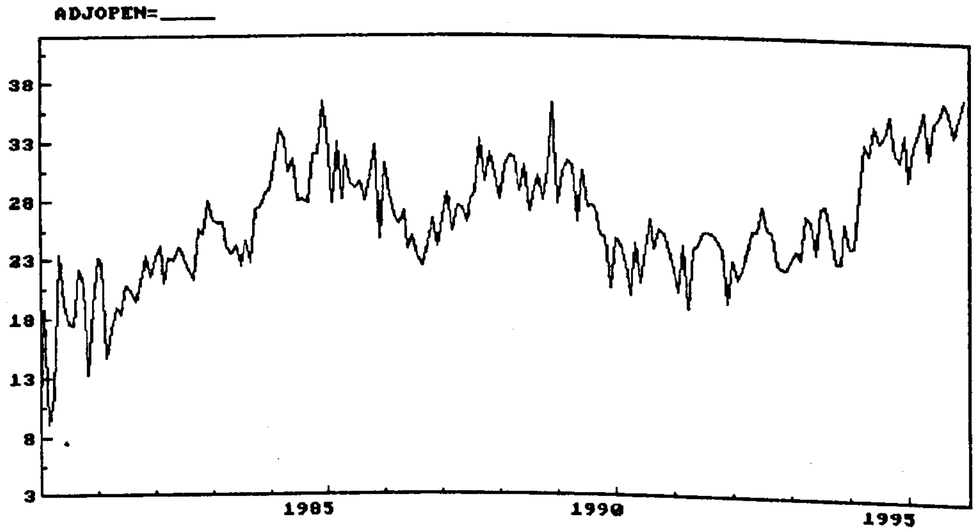
Figure 4.7 : Degree of openness of the Turkish economy (%)



The generated monthly series still reflects the seasonal characteristics of the quarterly GNP. These series were then used to calculate an openness index for Turkey. The main problem with the new series of openness is that the seasonal behaviour of the GNP dominated the series, as can be seen clearly from Figure 4.7.

It may be misleading to suggest that the degree of the openness of the economy has shown such quarterly seasonal fluctuations. Moreover, because the openness index will be used as a proxy for trade restrictions, and trade restrictions are not usually very volatile in the short-run, it may be appropriate to remove such short-run fluctuations in that proxy. That is why, we adjusted the series seasonally by using X11-ARIMA filter (by SPSS software program).[6] The adjusted series is depicted in Figure 4.8.

Figure 4.8 : Adjusted openness index (%)



The overall trend of the series appears to capture fairly well the main changes in the volume of trade and in turn in openness, accompanying important economic policy changes. Namely, continuous devaluation of the nominal exchange rate, decrease of import tariffs and quantitative restrictions and subsidising exports contributed a considerable increase in exports until 1985. Although inflation induced the government to refrain from further depreciation causing a slowdown in openness in 1985 and 1986, increasing exports raised it in the following years. However, in the 1990s accelerating inflation, appreciating real exchange rate and increasing government debt together with inconsistent macro policies caused the volume of trade to decline. The austerity program on April 1994, which included a high rate of devaluation, seems to help the openness level restore to the level of 1985.

[6] X11-ARIMA is a procedure for seasonal adjustment of time series data, developed by Statistics Canada as a modification of Method II-X-11 of the United States Census Bureau (See "SPSS for Windows, Base System User's Guide, release 6.0, 1993" by M.J. Norusis).

A glance at Figures 4.6 and 4.8 might give the impression that the series for import tariff rate and the openness index move together. This provides some grounds for believing that they both reflect the main changes in the series they are proxying.

4.3 Stationarity tests

Existence of a common trend between any two data series does not always imply that there is a meaningful economic relationship between them. If the series are not *stationary* (i.e. their mean, variance and auto-covariances are *not* independent of time), the regressions involving these series can falsely imply the existence of a relationship. This is called as *spurious regression* by Granger and Newbold (1974). Ignoring this fact and estimating a regression model containing nonstationary variables might lead to insensible results. Moreover such a regression ignores important information about the underlying statistical and economic processes generating the data. Therefore, it is important to test the presence of unit roots and if they are present, to use appropriate modelling. Simply differencing the data might eliminate the nonstationary trend in the data, but, at the cost of removing any long-run information. In modelling time series, one needs to ensure that the long-run relationship reflects the co-movements of variables due to underlying equilibrium tendencies of economic forces, rather than common, but unrelated, time trends in the data (Harris, 1995).

The Dickey-Fuller (DF) test or Augmented Dickey-Fuller (ADF) test is widely used in testing whether a data series has a unit root. Many econometric software packages include DF and ADF test routines. However, they may not take into account the true process in which a series is generated. Therefore, it is recommended to confirm results with individual regressions.

Dickey and Fuller (1979) consider three different autoregressive (AR) equations which can be used to test for the presence of a unit root :[7]

$$\Delta y_t = \gamma y_{t-1} + \varepsilon_t \tag{4.2}$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \varepsilon_t \tag{4.3}$$

$$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \varepsilon_t \tag{4.4}$$

The first equation is a pure random walk model, a drift term is added in the second one, and the last equation includes a linear time trend as well. It is very important to use a regression equation which captures the true data-generating process. Omitting the intercept or time trend which are actually in the data generating process may decrease the power of the test to zero as the sample size increases. On the other hand, inclusion of unnecessary regressors increases the absolute value of the critical values so that one may end up with not rejecting the null of a unit root when one ought (Enders, 1995).

In all equations (4.2) to (4.4), the test parameter is if

$$\gamma = 0$$

which means y_t contains a unit root.

[7] An AR(k) process can approximate an unknown ARMA(p,q) process if k is large enough to give approximately white noise error terms (Banerjee at al, 1993: 107-108; Harris, 1995 : 34).

The regressions can be estimated using OLS, regardless of which of the three forms of equations is estimated. The resulting t-statistic cannot be compared with the student-t distribution because the classical assumptions of a regression model require all series to be stationary and the errors to have a zero mean and finite variance. In the presence of nonstationary variables, there might be a spurious regression, and regressions with such series produce errors which are not invariant through time. This makes the conventional tests such as t-test, F-test, R^2 unreliable (see Banerjee et al (1993) for the proofs and explanations of the reasons).

Fortunately, Dickey and Fuller (1979) provide appropriate critical values in order to test the null hypothesis of a unit root, $\gamma = 0$. These values depend on sample size and change according to the presence of a trend or a drift in the equation. The essential point in testing the hypothesis is to use appropriate critical values. Namely, in order to test whether $\gamma = 0$ in equation (4.2), the t-statistics should be compared with τ in Dickey & Fuller table. Similarly, to carry out the same test in the equations (4.3) and (4.4), the appropriate critical values are τ_μ and τ_τ , respectively.

The equations (4.2) - (4.4) can be augmented with a sufficient number of lags of the dependent variable in order to allow for autocorrelation among the residuals:

$$\Delta y_t = \gamma y_{t-1} + \sum_{i=0}^{n} \beta \Delta y_{t-i-1} + \varepsilon_t \tag{4.2a}$$

$$\Delta y_t = \alpha_0 + \gamma y_{t-1} + \sum_{i=0}^{n} \beta \Delta y_{t-i-1} + \varepsilon_t \tag{4.3a}$$

$$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=0}^{n}\beta\Delta y_{t-i-1} + \varepsilon_t \qquad (4.4a)$$

Using the appropriate lag length is an important issue in unit root tests. Including too many lags reduces the power of the test to reject the null of a unit root because the increased number of lags necessitates the estimation of additional parameters and a loss of degrees of freedom. On the other hand, too few lags may not capture the actual error process, so that γ and its standard error may not be well estimated.

Appropriate length of lags to be included in the equation may be decided upon by checking the model selection criteria such as Akaike Information Criterion and Schwartz Criterion and also by inspecting the diagnostic tests. It is conventional to start with a relatively generous lag length. In addition, frequency of the data used can be taken into account in deciding the initial lag length.

Dickey and Fuller (1981) provide three additional tests (F-statistics, called ϕ_1, ϕ_2, ϕ_3) to carry out joint hypothesis tests on the coefficients. These tests enable us to test the presence of a drift or a deterministic trend in the data generating process. ϕ_i statistics are constructed in the same way as ordinary F-tests are:

$$\phi_i = [(RSS_R - RSS_U)/ r] / [RSS_U / (T-k)] \qquad (4.5)$$

where

RSS_R and RSS_U = The sums of the squared residuals from the restricted and unrestricted models, respectively, r = number of restrictions

T = number of observations

k = number of parameters estimated in the unrestricted model.

In equations (4.3) or (4.3a), the null hypothesis $\alpha_0 = \gamma = 0$ is tested using the ϕ_1 statistic. In the equations with trend, that is (4.4) or (4.4a), the joint hypothesis $\alpha_0 = \alpha_1 = \gamma = 0$ is tested using ϕ_2 statistic and the joint hypothesis $\alpha_1 = \gamma = 0$ is tested using ϕ_3 statistic.

In the next section, unit root tests will be carried out for each variable using regression analysis. We use the sequential testing procedure, suggested by many scholars such as Enders (1995), Holden and Perman (1994) and Harris (1995). The main advantage of that procedure (which will be explained below) is that it takes into account full data generating process with drift and trend term and test the null hypothesis of unit root sequentially.

This approach begins by estimating the most unrestricted model, which is (4.4a), together with an appropriate number of lags of the dependent variable, and then testing the null of $\gamma = 0$. If it is rejected, there is no need to go further because unit root tests in such a regression will have low power to reject the null, then we can conclude that there is no unit root. If it is not rejected, in the second stage, we test the significance of α_1 (time trend) under the null hypothesis of a unit root because the power of the test may have been reduced due to the presence of unnecessary drift and / or trend terms. If α_1 is significant, the null hypothesis of a unit root can be tested by using the t-distribution which will be asymptotically normal in this case. If the trend is not significant, which implies there is no trend in the data generating process, estimate the model (3a) and test the null of unit root using t-statistics for γ. If it is rejected, testing can be stopped, however, if it is not rejected, test the significance of the constant in that model. If it is not significant, proceed to estimate the model (4.2a) and carry on testing the null of unit root in that model as a final step. If this null hypothesis is not rejected, one cannot reject the hypothesis that the series contains a unit root.

Now, we start to test for unit roots in each series, estimating initially the least restrictive model (4.4a):

$$\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=0}^{n} \beta \Delta y_{t-i-1} + \varepsilon_t \quad (4.4a)$$

where y represents RER, WEALTH, GOVEXN, TARIFF, TOT, OPEN (in logarithm).

The model (4.4a) is estimated firstly for ***the real exchange rate*** (RER).[8] The regression results with diagnostic tests are presented in Table 4.1. The table also provides the results of the regressions run by excluding time trend. We reported 1st order as well as 12th order autocorrelation and ARCH tests, for the data in monthly frequency therefore annual correlation, beside monthly correlation can be checked. The residual sums of squares (RSS) are also reported in the table so

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[8] The inspection of the actual RER in Figure 4.1 might suggest a structural break in 1994.4, which coincides the announcement of the Austerity Program. Thus we estimated the following regression to test for a unit root when a dummy for that break is included, as suggested in Perron (1989), model A:

$$\Delta RER_t = \alpha_0 + \alpha_1 t + \theta_1 DU_t + \theta_2 D(TB)_t + \gamma RER_{t-1} + \sum_{i=0}^{n} \beta \Delta RER_{t-i-1} + \varepsilon_t \quad (4.4a)'$$

where $DU_t = 1$ if $t > 1994.4$, 0 otherwise, and $D(TB)_t = 1$ if $t = 1994.5$, 0 otherwise. The estimation gives a t-value of γ is -2.84, which is smaller that the critical value of -3.68 (Perron, 1989: Table IV.B). The null hypothesis of unit root cannot be rejected. Besides, the coefficients θ_1, θ_2 are insignificant. Thus, the results without dummy are reported in Table 4.1.

that one can carry out joint hypothesis tests (ϕ-tests) for the existence of a drift and a trend in the model.

Table 4.1: Regression results of model: $\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=0}^{n} \beta \Delta y_{t-i-1} + \varepsilon_t$

	dlrer		dlwealth		dlgovexn	
constant (t-stats)	0.18 (2.36)	0.03 (1.07)	0.81 (2.51)	0.29 (1.94)	5.33 (2.02)	0.27 (0.44)
trend (t-stats)	-0.00 (-3.19)		0.00 (1.82)		0.00 (2.00)	
lrer_1 (t-stats)	-0.08 **(-2.37)**	-0.02 **(-1.01)**				
lwealt_1 (t-stats)			-0.07 **(-2.47)**	-0.02 **(-1.90)**		
lgovex_1 (t-stats)					-0.62 **(-2.03)**	-0.02 **(-0.35)**
lags	20	20	24	24	23	23
no. of observ.	171	171	167	167	168	168
SC	-7.44	-7.44	-6.26	-6.26	-2.15	-2.15
F_{ar1-1} (prob)	1.73 (0.18)	2.07 (0.15)	0.03 (0.85)	0.21 (0.64)	0.01 (0.89)	0.15 (0.69)
F_{ar1-12} (prob)	1.03 (0.42)	1.16 (0.31)	0.65 (0.79)	0.77 (0.67)	1.64 (0.06)	1.64 (0.09)
F_{arch1} (prob)	1.57 (0.10)	1.53 (0.12)	0.39 (0.53)	0.68 (0.40)	0.80 (0.37)	1.25 (0.26)
F_{arch12} (prob)	1.54 (0.11)	1.43 (0.16)	0.97 (0.47)	0.78 (0.66)	1.75 (0.06)	1.40 (0.17)
RSS	0.0499	0.0514	0.139	0.143	8.829	9.079

Table 4.1 : (continued)

	dltot		dltariff		dlopen	
constant	0.00	0.02	0.81	0.68	0.36	-0.29
(t-stats)	(-3.41)	(3.07)	(2.76)	(2.58)	(1.98)	(-1.71)
trend	-0.00		0.00		0.00	
(t-stats)	(2.00)		(1.00)		(1.11)	
ltot_1	-0.09	-0.05				
(t-stats)	**(-3.82)**	**(-3.51)**				
ltariff_1			-0.33	-0.27		
(t-stats)			**(-2.73)**	**(-2.59)**		
lopen_1					-0.11	-0.08
(t-stats)					**(-1.99)**	**(-1.68)**
lags	4	4	9	9	14	14
no. of observ.	187	187	182	182	177	177
SC	-11.42	-11.43	-3.49	-3.51	-4.16	-4.18
$F_{ar1\text{-}1}$	0.25	0.00	0.00	0.00	0.76	0.64
(prob)	(0.61)	(0.97)	(0.99)	(0.99)	(0.38)	(0.42)
$F_{ar1\text{-}12}$	1.00	0.75	1.36	1.34	1.11	0.65
(prob)	(0.44)	(0.69)	(0.19)	(0.20)	(0.35)	(0.41)
F_{arch1}	0.25	0.47	0.52	0.43	0.07	0.09
(prob)	(0.61)	(0.49)	(0.47)	(0.51)	(0.78)	(0.76)
F_{arch12}	1.41	1.37	1.28	1.41	0.49	0.44
(prob)	(0.16)	(0.18)	(0.24)	(0.17)	(0.91)	(0.94)
RSS	0.00158	0.00161	3.960	3.983	1.673	1.686

Notes:
1. SC is the Schwartz Criterion (an information criterion for model selection),
2. F_{ar} is Breusch-Godfrey serial correlation test,
3. F_{arch} is autoregressive conditional heteroscedasticity test,
4. RSS is residual sums of squares.

The estimation results for the RER seem to be statistically acceptable as they pass main diagnostic tests such as serial autocorrelation and heteroskedasticity, as reported column 1 and 2 of Table 4.1. There is no evidence of serial autocorrelation up to 1st and 12th orders. Also the null hypothesis of no conditional heteroskedasticity cannot be rejected at 1 % and 5 % significance levels. Now we test the null hypothesis of unit root by comparing the t-statistic of the lagged LRER with the critical values :

$H_0 : \gamma = 0$:

$\gamma = -2.37 < \tau_\tau = -3.99$ (1 % significance level, in absolute terms)

$< \tau_\tau = -3.43$ (5 % significance level, in absolute terms)

Table 4.2 : Unit root tests: $H_0 : \gamma = 0$ in $\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=0}^{n} \beta \Delta y_{t-i-1} + \varepsilon_t$

	t-statistics	5% critical value	Reject H_0	1% critical value	Reject H_0
lrer	-2.37	-3.430	No	-3.990	No
lwealth	-2.47	-3.430	No	-3.990	No
lgovexn	-2.03	-3.430	No	-3.990	No
ltot	-3.82	-3.760	Yes	-4.390	No
ltariff	-2.73	-3.430	No	-3.990	No
lopen	-1.99	-3.430	No	-3.990	No

Note: Critical values are taken from Dickey & Fuller (1979), Table 8.5.2, p.373 for 250 samples, except those for ltot from Perron (1989), Table IV-B for λ (time of break relative to total sample size) = 0.3.

Table 4.3: Joint tests: $H_0 : \gamma = \alpha_1 = 0$ in $\Delta y_t = \alpha_0 + \alpha_1 t + \gamma y_{t-1} + \sum_{i=0}^{n} \beta \Delta y_{t-i-1} + \varepsilon_t$

	ϕ_3	5% critical value	Reject H_0	1% critical value	Reject H_0
lrer	4.448	6.340	No	8.430	No
lwealth	4.029	6.340	No	8.430	No
lgovexn	4.021	6.340	No	8.430	No
ltot	3.395	6.340	No	8.430	No
ltariff	0.987	6.340	No	8.430	No
lopen	1.243	6.340	No	8.430	No

Note: Critical values are taken from Dickey & Fuller (1981), Table VI, p.1063.

The null hypothesis cannot be rejected. To check whether there are extra variables in the regression because the power of the test may have been reduced due to the presence of unnecessary drift and/or trend term, we test the significance of trend term, given that the series is nonstationary.

$$H_0 : \alpha_1 = 0 \text{ given } \gamma = 0$$

Comparing the t-statistics of α_1, which is -2.09, with the critical values $\tau_{\beta\tau}$ given for 100 observations in Enders (1995), p.223, which are 2.79 and 3.53, for 95 % and 99 % confidence intervals, the hypothesis cannot be rejected. In order to check the result, we can test the joint hypothesis of $H_0 : \alpha_1 = \gamma = 0$ by ϕ_3 test. As can be followed from the Table 4.3, the null cannot be rejected, this implies the trend term is not significant for the model. Schwartz Criterion supports that conclusion as there is no significant change in the model when trend term is removed (SC = -7.44 in both cases). Proceeding the next step, we estimate the model (3a), which is the model without trend term. As reported in Table 4.1, the t-statistics of γ is -1.01, which is not higher than the critical values to reject the null hypothesis of a unit root. We do not go further to test the significance of the intercept term[9] and conclude that the data series is not stationary in levels and should be differenced to achieve stationarity.

[9] The model (4.2a), which is the one without constant and trend, was run for each data series in order to check the existence of a drift term in the data generating processes. The results were not reported in Table 4.1 because the conclusion that none of the series are stationary, remained unchanged. The ϕ_1 tests indicated that the real exchange rate (ϕ = 9.55), openness index (ϕ = 5.41) and external terms of trade (ϕ = 19.48) have an AR processes with drift, while private wealth (ϕ = 2.96), government expenditures on nontradables (ϕ = 0.189) and tariff rate (ϕ = 0.3) do not have a drift, at 5 % significance level (where the critical value is 4.63 in Dickey and Fuller (1981)).

Secondly, we test for a unit root in the ***private wealth*** series. The residual autocorrelation is only removed by adding 24 lags of the dependent variable. The estimation of (4.4a) with and without trend term gives the results presented in the Table 4.1. The null hypothesis of $H_0 : \gamma = 0$ cannot be rejected as t-value (-2.47) is smaller than the critical values -3.43 and -3.99 at 5% and 1% significance levels, respectively.

To check whether there are extra variables in the regression, we test the significance of trend term, given that the series is nonstationary. Comparing the t-statistics of α_1, which is 1.82, with the critical values $\tau_{\beta\tau}$,which are 2.79 and 3.53, for 95 % and 99 % confidence intervals indicates that the null hypothesis of $\alpha_1 = 1$ given $\gamma = 0$ cannot be rejected under both significance levels. The joint hypothesis of $H_0 : \alpha_1 = \gamma = 0$ also cannot be rejected, as seen in Table 4.3, confirming the above conclusion that the trend term is not significant for the model. Proceeding the next step, we estimate the model type (4.3a), which is the model without trend term. As presented in the Table 4.1, the t-statistics of γ is -1.90, which is lower than the critical value, leading to the rejection of the null hypothesis of unit root. We do not go further to test the significance of the intercept term (see footnote 9) and conclude that the data series is not stationary in levels and should be differenced to achieve stationarity.

Estimation results of the model (4.4a) for ***the government expenditures on nontradable goods*** are presented in Table 4.1. There seems to be no diagnostic problems of residual autocorrelation and heteroskedasticity. The null hypothesis of a unit root in the series cannot be rejected in all regressions with or without trend and drift terms (Table 4.2 and Table 4.3).

The plot of the levels of ***external terms of trade*** in Figure 4.4 indicates a possible structural break in 1985s due to the sharp decline in oil prices. Following Perron (1989) methodology, we introduce a dummy variable as follows:

$$\Delta TOT_t = \alpha_0 + \alpha_1 t + \theta_1 DU_t + \theta_2 D(TB)_t + \gamma TOT_{t-1} + \sum_{i=0}^{n} \beta \Delta TOT_{t-i-1} + \varepsilon_t \qquad (4.6)$$

where $DU_t = 1$ if $t > 1985.3$, 0 otherwise, and

$D(TB)_t = 1$ if $t = 1985.4$, 0 otherwise.

The coefficient, θ_1 is highly significant. The estimation results are presented in Table 4.1. The regression passes the diagnostic tests of serial autocorrelation and the ARCH. Table 4.2 indicates that the null hypothesis of a unit root in that series can be rejected at 5% level but not at 1% level. However, the joint hypothesis of $H_0 : \alpha_1 = \gamma = 0$ in Table 4.3 and also the null of $H_0 : \alpha_1 = 0$ given $\gamma = 0$ (in the regression without trend) cannot be rejected, indicating that the power of the test might be lowered due to the existence of trend term. In fact, the null of a unit root in the model without trend cannot be rejected ($t_\gamma = -3.51$). Therefore, we conclude that the terms of trade series is not stationary in levels.

Estimation of the model (4.4a) for the ***import tariff rate*** gives the results presented in Table 4.1. Diagnostic tests and SC information criterion support the testing down to 9 lags, which seem to be enough to whiten the residual errors. The null hypothesis of a unit root cannot be rejected at conventional significance levels, as can be followed from Table 4.2. Removing the trend term and constant term which are found to be inappropriately included into the equation (see Table 4.3 and footnote 9) does not change the above conclusion that the data series on the import tariff rate is not stationary in levels.

Finally, the data series on the ***openness index*** is tested for stationarity. The null hypotheses of no serial autocorrelation and no heteroskedasticity cannot be rejected at 5% and 1% levels, as seen in Table 4.1. The tests suggest that there are no trend and drift in the series (Table 4.3 and footnote 9). The null hypothesis of a unit root cannot be rejected at conventional levels, as indicated in Table 4.2.

To sum up, the data series on the real exchange rate, real wealth, real government expenditures on nontradable goods, import tariff rate, external terms of trade and openness are not stationary in levels, and therefore need to be differenced before using them in econometric analyses.

Unit root tests for first-differences :

The above analyses indicate that all data series which will be used in our study contain unit roots in levels. It is likely that the regressions containing these series can produce spurious relationships. However, a recent estimation technique, cointegration, which will be discussed in the next two chapters in detail, suggests that such series can imply a sensible economic relationship if they form a stationary cointegration relationship together. In that case, it is important to establish how many times the variable needs to be differenced to result in a stationary series. The first differences of the series are plotted in Figure 4.7. All series look stationary as they fluctuate around zero. To confirm that, we carry out unit root tests for the first differences of the variables. The results of ADF tests are presented in Table 4.4. All series are stationary in first differences at both 1 % and 5 % significance levels. In other words, the order of integration of each series in a model would be I(1).

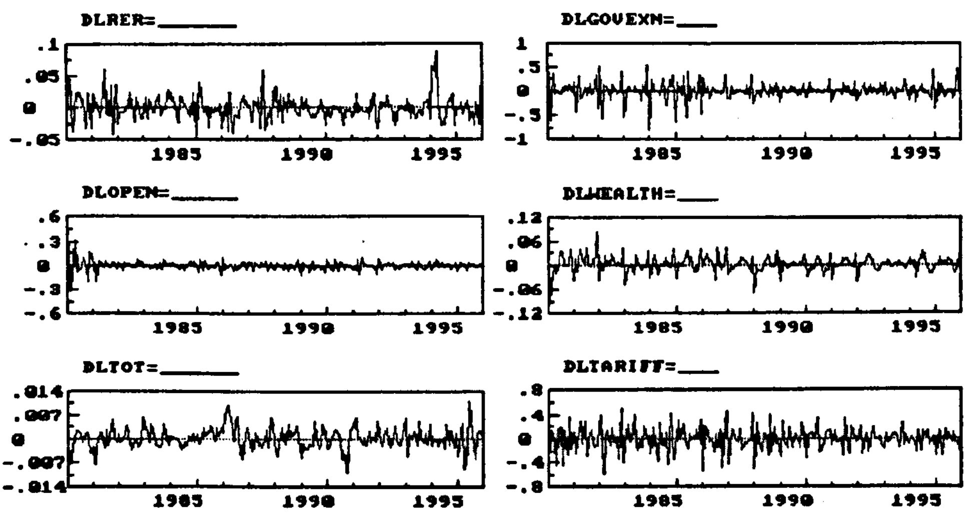
Table 4.4 : Unit root tests for first-differences, $H_0 : \delta = 0$

$$\text{in } \Delta\Delta y_t = \lambda_0 + \delta\Delta y_{t-1} + \sum_{i=0}^{n} \eta\Delta\Delta y_{t-i-1} + \varepsilon_t$$

	t-statistics	5% CV	Reject H_0	1% CV	Reject H_0
dlrer	-8.95	-2.88	Yes	-3.47	Yes
dlwealth	-10.41	-2.88	Yes	-3.47	Yes
dlgovexn	-16.76	-2.88	Yes	-3.47	Yes
dltot	-9.09	-2.88	Yes	-3.47	Yes
dltariff	-16.99	-2.88	Yes	-3.47	Yes
dlopen	-4.86	-2.88	Yes	-3.47	Yes

Note: Critical values are taken from Dickey & Fuller (1976), Table 8.5.2, p.373 for 250 samples.

Figure 4.9 : First differences of the series



4.4 Summary

In this chapter we analysed the data series which will be used in the empirical estimations in the next chapters. In the absence of proper data for the actual variables, some proxies were offered. A real exchange rate index was constructed using export and import unit values for tradable prices and a disaggregated consumer price index for nontradable prices. These prices seem to be closer to the 'true' tradable and nontradable prices than aggregate price indexes commonly used, and the index constructed by these prices is expected to reflect more correctly the domestic incentives to produce and consume as well as the international competitiveness of the economy than other aggregate indexes. The wealth of the private sector is represented by M2Y money supply, which is the sum of domestic money and foreign exchange deposits held by the residents. As a proxy for government expenditure on nontradable goods, a series was constructed from classified government expenditures by excluding certain items which may be regarded as 'expenditures on tradable goods'. The terms of trade of industrial countries is used to approximate foreign trade prices because of unavailability of data for Turkey on a monthly frequency. The correlation coefficient between the quarterly series for Turkey and OECD terms of trade is 0.82. Two proxies are planned to capture the effects of trade restrictions. One is the import tariff rate which is defined as the ratio of revenues from foreign trade taxes to the GNP. The other is the trade intensity ratio which is defined as the volume of trade divided by the GNP (a measure of openness of the economy). The latter proxy is expected to capture both tariff and non-tariff barriers which may not be covered by the former proxy.

A detailed graphical analysis of each series with main economic developments in that period is followed by statistical analysis. The unit root tests on the levels of the data indicates that all series contain a unit root, but become stationary when differenced once.

APPENDIX 4

DATA SOURCES

Abbreviations :

CBRT : Central Bank of Republic of Turkey
SIS : State Institute of Statistics
CBRT-EDDS : CBRT Electronic Data Distribution System (Telnet tcmb580.gov.tr)
MF : Ministry of Finance (and Customs)
IMF-IFS : International Monetary Fund - International Financial Statistics

Variable	Period	Source
Export price index	1980.1 - 1981.12	CBRT Database (1984-86=100)
	1982.1 - 1995.12	SIS Database (1989=100)
Import price index	1980.1 - 1981.12	CBRT Database (1984-86=100)
	1982.1 - 1995.12	SIS Database (1989=100)
Consumer price index	1980.1 - 1981.12	SIS Database (1968=100)
	1982.1 - 1987.12	CBRT Database (1978-79=100)
	1988.1 - 1995.12	CBRT - EDDS (1987=100)
Exports	1980.1 - 1995.12	SIS Database
Imports	1980.1 - 1995.12	SIS Database
Money supply (M2)	1980.1 - 1995.8	CBRT Monthly Economic Indicators, Quarterly Bulletins, Money and Banking Statistics; various issues
	1995.9 - 1995.12	SIS Turkish Economy Statistics and Analyses, March-April 1996
Foreign exchange deposits	1984.1 - 1986.12	CBRT Quarterly Bulletin, 1993-3
	1987.1 - 1995.12	Same as Money Supply (M2)
Consolidated budget expenditures by items	1984.1 - 1995.12	MF, Bulletin of Public Accounts, various issues
Terms of trade	1980.1 - 1995.12	IMF-IFS in CD-ROM

(industrial countries)

Revenues from foreign trade	1980.1 - 1981.9	MF, General Directorate of Budget and Fiscal Control, no:1993/11
	1981.10 - 1995.9	SIS Monthly Statistical Bulletin, various issues
	1995.10 - 1995.12	Treasury Monthly Statistics, May-June 1996
Nominal exchange rate (TL / $)	1980.1 - 1995.12	CBRT - EDDS
Gross Domestic Product	1980.1 - 1995.12	SIS Database
Electricity production	1980.1 - 1995.12	CBRT - EDDS

CHAPTER 5

AN EMPIRICAL ANALYSIS OF THE DETERMINANTS THE REAL EXCHANGE RATE

5.1 Introduction

Recent developments in time series econometrics have cast a shadow upon the inferences drawn from ordinary least squares estimations with stationary series. However, the existence of *cointegration* between such series made it still possible to use them in economic analyses. The concept of 'cointegration' and test of cointegration in time series using the Engle and Granger method are discussed in the first section of this chapter. Then, our model, outlined in Chapter 3, is estimated to investigate the existence of a long-run relationship between the variables in question. The short-run dynamics of the model are analysed in the last section.

5.2 Cointegration with Engle and Granger method

We mentioned the importance of distinguishing between stationary and nonstationary variables in long run economic analysis earlier. Failure to do so can lead to a problem of spurious regression and apparently statistically significant long run relationships between the variables in a regression model resulting from random correlations.

However, does this necessitate us to ignore the nonstationary series completely? The simple answer is no if they are cointegrated. In the Engle and Granger (1987) definition, if two or more series are linked to form an equilibrium relationship, even though the series themselves may contain stochastic trends (i.e. being nonstationary), they will move closely together over time and the difference between them will be stationary. In other words, a linear combination of two or more variables may be stationary even though the variables themselves have unit roots.

Engle and Granger (1987) defines cointegration formally as follows:

The components of the vector $x_t = (x_{1t}, x_{2t}, ..., x_{nt})$ are said to be *cointegrated of order d, b*, denoted by $x \sim CI(d,b)$ if

1. All components of x_t are integrated of order *d*,
2. There exists a vector $\beta = (\beta_1, \beta_2, ...,\beta_n)$ such that linear combination $\beta x_t = \beta_1 x_{1t} + \beta_2 x_{2t} + ... + \beta_n x_{nt}$ is integrated of order $(d\text{-}b)$, where $b > 0$.

The vector β is called the **cointegrating vector**.

If x_t has n components, there may be as many as $n\text{-}1$ linearly cointegrating vectors. The number of cointegrating vectors is called the **cointegrating rank** of x_t.

A major feature of cointegrated variables is that their time paths are influenced by the extent of any deviation from long-run equilibrium. After all, if the system is to return to the long-run equilibrium, the movements of at least some of the variables should respond to the magnitude of the disequilibrium (Enders, 1995). In other words, the existence of cointegration implies that deviations from this equilibrium are stationary and there will be economic forces that do not allow these deviations to become increasingly large over time. To capture both long-run and short-run dynamics, a cointegrated system of variables can be represented in an **error correction** form.

There are two commonly used methods to test for cointegration. The *Engle-Granger method* tests the residuals of the cointegration regression for stationarity in a single equation. On the other hand, the *Johansen method* which will be discussed in Chapter 6, carries out cointegration analysis in multivariate systems.

Engle and Granger procedure has been widely used in the recent literature particularly where interest is focused on the explanation of long-run relationships. In that circumstance, it is straightforward to estimate the long-run equilibrium relationship consistently by OLS regression involving the levels of the variables. Moreover, it is argued that Engle and Granger procedure performs better in small samples relative to the Johansen method, which is based on the estimation of a system of equations and requires a number of lags, reducing the degrees of freedom substantially.

The Engle and Granger method is often criticised on the ground of normalisation on one variable *a priori* and use of the others as regressors, ignoring the possibility that there may be more than one long-run relationship (i.e. cointegrating vector). However, if there is a firm theoretical justification for treating one variable as endogenous and explaining it with some other variables, and the researcher is interested only in that relationship (as in the present study), this method is more practical than the Johansen method. It saves time and effort from searching a reasonable relationship (i.e. coefficients with consistent signs and magnitudes) among many other cointegrating vectors.

Engle and Granger begin by testing the order of integration of the variables as the first step. If the variables are found to be integrated of the same order, the next step is to estimate the long run equilibrium relationship of the form:

$$y_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_n x_{nt} + e_t \qquad (5.1)$$

When the variables are cointegrated, the estimators β_i's have asymptotic properties different from those of least squares estimators in stationary time series models. Namely, the estimation of the above equation gives "super-consistent" estimates of the parameters β_i s in that they converge to the true values as the sample size increases. Also they are highly efficient in that the variances of the estimates are smaller in the cointegrated case than in the standard case where the variables are not cointegrated. Thus the OLS estimates of β_i converge to their true values at a faster rate than the usual OLS estimators with stationary I(0) variables (Stock, 1987).

While OLS estimates of the static regressions are super-consistent, Monte-Carlo experiments suggest that a large number of observations may be necessary before the biases become small. Thus, Banerjee et al (1993) recommends the use of dynamic regressions to reduce finite sample biases which arise from static estimation and which can be very substantial in practice. In addition, in the absence of information on the data generating process, dynamic regressions may give better estimates of the cointegrating vector. In particular they may be more robust to a range of data generating processes (p.214). Moreover, the biases are strongly positively correlated with (1- R^2), which implies that a cointegrating regression with low R^2 should be viewed with caution (p.220).

Harris (1995) states that one of the reasons for the better performance of the dynamic model may be the result of not pushing the short-run dynamics into the residual term of the estimated OLS regression.

In order to determine if the variables are actually cointegrated, the residuals from the equation (5.1), say $\hat{e}_t$, need to be tested for a unit root. If these deviations from the long run equilibrium are found to be stationary, the variables are said to be cointegrated. To do that, we estimate the following equation:

$$\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \sum_{i=1}^{n} b_i \Delta \hat{e}_{t-i} + \varepsilon_t \tag{5.2}$$

If we cannot reject the null hypothesis of $a_1 = 0$, we can conclude that residual series contains a unit root. Hence we conclude that the variables involved in the long run relationship are not cointegrated.

However, it is not possible to use the standard Dickey-Fuller (or ADF) critical values to test the null hypothesis, unless the components of the cointegrating vector β are known. There are two major reasons for that. First, the $\hat{e}_t$ series is generated from a regression estimate of the error e_t. Because the OLS estimator chooses the residuals in equation (5.1) to have the smallest variance, making $\hat{e}_t$ appear as stationary as possible, the DF distribution would tend to over-reject the null (Enders, 1995; Harris, 1995). Second, the distribution of the test statistic under the null is affected by the number of regressors (n) as well as by whether constant and trend terms are included. Thus different critical values are needed as n changes (Harris,1995).

Fortunately, Engle and Granger provide test statistics that can be used to test the null hypothesis of $a_1 = 0$. When there are more than two variables in the equilibrium relationship, the tables by Engle and Yoo (1987) can be used. In addition, MacKinnon (1991) has linked the critical values for particular tests to a set of parameters of an equation of the response surfaces. In that way, it is possible to obtain the appropriate critical value for any test involving the residuals from an OLS equation where the number of regressors lies between $1 \leq n \leq 6$.

The cointegration analysis presented so far has only focused on the long run characteristics of the variables and the model in general. Engle and Granger (1987) have proved that if two or more series are I(1) and cointegrated then there exists an error correction representation of the model and *vice versa*. The attractiveness of the error correction form comes from its incorporation of information related to both the long run relationship and the short run dynamics between the variables. In other words, in error correction models, deviations from a long-run equilibrium condition feed back into short-run dynamics so that the long-run relation tends to be maintained. Thus if the variables are cointegrated, the residuals from the equilibrium regression (5.1) can be used to estimate the error-correction model. Formally, repeating the equation (5.1):

$$y_t = \beta_1 x_{1t} + \beta_2 x_{2t} + \ldots + \beta_n x_{nt} + e_t$$

If the variables x_i's are cointegrated of the same order, they have the error-correction form of :

$$\Delta y_t = \alpha_0 + \alpha_e(y_{t-1} - \sum_{i=1}^{n}\beta_i x_{it-1}) + \sum_{i=1}^{n}\alpha_1 \Delta y_{t-i} + \sum_{i=1}^{n}\alpha_{2i}\Delta x_{it-1} + \varepsilon_t \qquad (5.1a)$$

The differenced terms in the above equation explain the short-run dynamics, whereas the long-run relationship is picked up by the lagged-levels term in the parenthesis. α_e denotes the adjustment coefficient to the deviations from the long-run equilibrium, β_i's are the parameters of the cointegrating vector, and ε_t is white-noise disturbance.

Engle and Granger (1987) propose that it is possible to use the estimated residuals ($\hat{e}_{t-1}$) obtained from the regression (5.1) as an instrument for the expression $(y_{t-1} - \Sigma\beta_i x_{it-1})$ in (5.1a) because the value of the residuals estimates the deviation from long run equilibrium in period (t-1). Thus the equation (5.1a) transforms as follows:

$$\Delta y_t = \alpha_0 + \alpha_e \hat{e}_{t-1} + \sum_{i=1}^{n} \alpha_1 \Delta y_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta x_{it-1} + \varepsilon_t \qquad (5.1b)$$

As all components in (5.1b) are stationary under cointegration, the ECM can be estimated by OLS and statistical inferences may be based on standard critical values.

5.3 Estimation of the model

As explained earlier, the Engle and Granger residual-based methodology for cointegration analysis consists of three steps:

i. Identification of the order of integration of the series involved in the model,

ii. Estimating the long-run relationship(s) and testing for cointegration, and

iii. Formulating the short-run dynamics through an error-correction model.

5.3.1 Testing for the order of integration

We showed in the previous chapter that all the variables in the present empirical work are non-stationary in levels (Chapter 4, Table 4.2). Although in practice this result might imply for most data that these variables are I(1), it is recommended to check the order of integration as it has implications for the existence of cointegration.[1] We carried out further unit root tests with first-differences of the variables and found that the null hypothesis of unit root was rejected for all variables (Chapter 4, Table 4.4). Thus we conclude that the variables are integrated of the order one.

5.3.2 Estimating the long-run relationship and testing for cointegration

Once the order of integration has been established, in the second step one has to estimate a regression equation which involves all I(1) variables in the system. This regression is called a *cointegrating regression*, and ordinary least squares estimation can be applied to obtain the cointegrating vector. Then, the existence of cointegration can be tested with a Dickey-Fuller test by using the residuals from these regressions.

The data used in this study is of monthly frequency, therefore one might expect a certain degree of seasonality in the series. An inspection of the graphs of the data in Chapter 4 suggests that there might be seasonality in some series

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[1] For example, in two variables case ($n=2$), if $y_t \sim I(1)$ and $x_t \sim I(0)$, then these series cannot be cointegrated as the I(0) series has a constant mean while I(1) series tends to drift over time. In case of $n>2$, it is possible to have a mixture of different order series, then a subset of the higher-order series must cointegrate to the order of the lower-order series (Harris, 1995).

including government expenditures, openness index and wealth, but with varying patterns. In other words, seasonal patterns do not appear to be constant over time for each variable. It is also not easy to disentangle seasonal from cyclical variations. In addition, the seasonal filters may distort the underlying properties of the data and some of them (like Moving Average methods) cause lose of some observations, reducing the degrees of freedom. Therefore, we prefer to model seasonality explicitly instead of its removal using seasonal adjustments, except the openness variable, which is seasonally adjusted for the reasons explained earlier. In the following analysis, we do not expect any seasonal behaviour to influence the equilibrium RER in the long-run. The diagnostic tests in Table 5.1 do not suggest any misspecification because of exclusion of seasonal dummy variables. However, this may not be the case in the short-run analysis, where seasonal dummies will explicitly be incorporated.

Owing to the advantages of a dynamic regression over a static one[2], which are discussed earlier, we estimated the following dynamic cointegrating regressions setting the initial lag length as 14 according to the Schwert formula[3] :

$$X_t = \mu + A_1X_{t-1} + \ldots + A_kX_{t-k} + u_t \qquad t = 1, \ldots. T \qquad (5.4)$$

where

k is the number of lags, A is a vector of coefficients, and X_t is a vector comprising the variables; real exchange rate (RER), government expenditures on nontradables (GOVEXN), private wealth (WEALTH), external terms of trade

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[2] A static regression was also estimated, but not reported here as all diagnostic tests failed.

[3] The initial lag length for monthly data can be calculated as

$$l_{12} = int\{\, 12(T/100)^{1/4} \,\} \qquad (5.3)$$

where T denotes the sample size (Schwert, 1989, p.151). See Harris, 1995 for empirical examples.

(TOT) and openness index (OPEN) and μ is a constant vector. The same VAR models are estimated using the import tariff rate (TARIFF) as an alternative proxy for trade restrictions instead of the openness index.

The model evaluation results are presented in Table 5.1.

Table 5.1 : Model evaluation tests (openness case)

$F_{k=1}(5,109) = 20.989^{**}$	$F_{arch}(1,107) = 0.565$
$F_{k=12}(5,109) = 1.811$	$F_{arch}(13,83) = 0.872$
$F_{k=13}(5,109) = 2.705^{**}$	$F_{res}(1,108) = 1.614$
$F_{ar}(1,108) = 1.573$	$\chi^2_n(2) = 15.174^{**}$
$F_{ar}(12,97) = 0.943$	$R^2 = 0.977$
$F_{ar}(13,96) = 0.870$	$\chi^2_{WALD}(4) = 189.190^{**}$

Notes: 1.* and ** rejects the null hypothesis at 1% and 5% significance levels, respectively.
2. $F_{k=i}$ is the F-test on the significance of *i*th lag, F_{ar} Breusch-Godfrey serial correlation test, F_{arch} Auto-Regressive-Conditional-Heteroscedasticity test, F_{res} Ramsey's RESET misspecification test, χ^2_n Doornik-Hansen normality test and χ^2_{WALD} Wald's coefficient restriction test.

An F-test on the insignificance of the 13th lag can be rejected at 5 % significance level. [F(5,109)=2.70], therefore all variables are introduced into the model with 13 lags.[4] As can be seen from the table, first lags are significantly different from zero. It is not unexpected that the changes in the previous month of the last year (X_{t-13}) will have an impact on the current variable as for that of the same year (X_{t-1}). The model passes a series of diagnostic tests. The null hypotheses of no serial correlation (F_{ar}) and no auto-regressive conditional heteroscedasticity (F_{arch}) can not be rejected for the first order as well as up to

[4] All variables should be introduced to the cointegration analysis with similar lag length (Harris, 1995: 82).

13rd order. Similar tests are conducted up to 12th order to check the annual correlation and the null hypothesis of no autocorrelation cannot be rejected. Also the null hypotheses of no misspecification (F_{res}) cannot be rejected at conventional significance levels (1 % and 5 %). Only the normality test (χ^2_n) fails, but that is not expected to undermine the statistical inferences substantially about the model[5].

Estimation of the model (5.4) specifies the following long-run relationship between the real exchange rate and its fundamental determinants:

$$RER = 3.876 - 0.346WEALTH - 0.313GOVEXN + 0.794OPEN - 0.307TOT \quad (5.5)$$

It has a reasonably high R-squared (0.98) which suggests that the estimated coefficients are relatively unbiased. A Wald restriction test rejects the null hypothesis that all of the long-run coefficients (except the constant) are zero. Before interpreting this equation, it is necessary to check whether this is a stationary relationship, that is whether they are cointegrated. Otherwise the estimated result will be a spurious regression from which no economic and statistical inferences can be drawn.

As explained in the theoretical part, the cointegration test in the Engle and Granger procedure is a unit root test for the residuals of the cointegrating regression (5.5). This regression produces a unit root t-test of -4.90 (ADF). When compared to the critical value of -4.48 at 5% significance level, the null

[5] Johansen and Juselius (1990) argue that the consequences of failing normality tests are probably more serious when we are dealing with a skewed distribution than when we are dealing with a symmetric one. In the present case, the density functions are symmetric around zero.

hypothesis of *no cointegration* can be rejected, implying that the data on the real exchange rate, real assets of the private sector, government expenditures on nontradable goods, external terms of trade and openness index do constitute a stationary linear relationship according to the Engle and Granger approach.

In general, all the coefficients in (5.5) have consistent signs with the underlying theory. The relatively higher coefficient for the openness index might suggest that the real exchange rate is highly responsive to the changes trade policies. Although the final impact on the real exchange rate of a change in trade policy might depend on the policy tool used, the traditional view is that any measure that brings about more openness to free trade causes the RER to depreciate. This is supported by the present data. Like many liberalising countries, Turkey has used import tariffs and quotas among the other policy tools in order to liberalise its trade. A positive coefficient on the openness index indicates that the substitution effect seems to dominate the income effect. Namely, the domestic price of imports tends to fall due to a decrease in import tariffs. This causes the demand to shift towards importable goods, leading a decline in nontradable prices and in turn, an increase in the RER. In our model, *ceteris paribus*, a 1 % increase in openness leads to 0.79 % increase in the RER in order to sustain equilibrium.

Government expenditure on nontradable goods appears to have a positive impact on the real exchange rate. In our case, the substitution effect seems to be dominant relative to the income effect. Namely, an increase in the level of government expenditures (demand) on nontradable goods generates an increase in their prices. This, in turn, causes the real exchange rate to fall, that is to appreciate. A possible reason for the relatively small income effect might be that individuals do not perceive well future effects of an increase in government spending in the long-run. For example, if the extra expenditures are to be financed by increases in taxes, it is likely to expect a reduction in disposable income in next periods.

The negative coefficient for the variable terms of trade can be explained in two ways: If the external price shock is in the importable sector, the income effects might have dominated the substitution effect, resulting in appreciation of the RER. On the other hand, if the price shock is in the exportable sector, the income and substitution effects work in the same direction, thus a terms of trade deterioration will result in a depreciation of the RER no matter which effect is dominant. An inspection of the data on the relevant prices supports the latter case that the exportable prices for the industrial countries increased more rapidly than the importable prices in most of the period, especially from 1984 to 1995.

A deterioration of the external terms of trade by 1 % results in a depreciation of the RER by 0.31 %, which looks, however, a relatively low response. High growth countries like Turkey are expected to be more responsive to changes in the external prices than others, as these economies adjusting more effectively to external shocks than closed economies (Cottani et al, 1990).[6]

Finally, a negative coefficient for the real wealth variable is predicted by economic theory. Monetary expansion leads to an increase in real wealth,

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[6] This is subject to the caveat that the terms of trade of industrial countries proxies Turkey's terms of trade adequately. One might expect a negative sign, with the income and substitution effects working in the same direction. However, the magnitude of the coefficient might be higher as Turkey's own trade prices may be more responsive to the real exchange rate changes than those of industrial countries.

causing the demand for all goods including nontradables to go up. The resulting excess demand drives the prices of the goods up and brings about a fall in the real exchange rate.

An increase in the real wealth variable might capture the effects of capital inflows to the economy. It has a similar impact on the RER as an increase in domestic money. Namely, inflow of capital injects more income to the economy, which in turn, generates an excess demand for all goods including nontradables.

As mentioned earlier, because of the imperfect proxy for trade restrictions, we tried another alternative proxy to the openness index to capture the effects of trade policies on the real exchange rates, namely the import tariff rate which is defined here as the ratio of total revenue from trade taxes to the total value of imports.

Table 5.2 reports some statistics which help evaluate the model estimated. Again we start the estimation with a relatively more generous form, 14 lags. The F-test on the insignificance of the 14th lag [$F(5,103) = 2.39$] can be rejected at 5% significance level, persuading us to use 14 lags for all variables.

As seen from Table 5.2, the model passes a series of diagnostic tests including residual autocorrelation (first order as well as 14th order), conditional heteroscedasticity (first order as well as 14th order) and misspecification tests, implying that the model is statistically acceptable.

Table 5.2 : Model evaluation tests (import tariff case)

$F_{k=1}$ (5,105) = 27.417**	F_{arch} (14,75) = 1.724
$F_{k=14}$ (5,103) = 2.397*	F_{res} (1,102) = 1.060
F_{ar} (1,102) = 0.338	χ^2_n (2) = 18.167*
F_{ar} (14,89) = 0.701	R^2 = 0.978
F_{arch}(1,101) = 0.403	χ^2_{WALD} (4) = 76.298**

Notes: See the notes in Table5.1.

Consequently, the model generates a long-run relationship between the variables in question in the following form:

$$RER = 15.54 - 0.429WEALTH - 0.305GOVEX - 1.187TARIFF + 1.335TOT \quad (5.6)$$

It has reasonably high R-squared (0.98), indicating the estimators are relatively unbiased, and the coefficients except that on the terms of trade have signs consistent with the theory. The Wald test cannot reject the null hypothesis that all coefficients (except the constant) are significantly different from zero. However, because the variables are estimated in levels although they are not stationary, for the equation to be economically and statistically meaningful, its estimated residuals should be stationary, implying the variables in question are cointegrated through time. In order to see whether these variables are cointegrated, we carry out a unit root test on the residuals obtained from the above cointegrating regression (5.6). The ADF test gives a value of -3.09 which is not high enough to reject the null hypothesis of no cointegration when compared with the critical value of -4.48 at the 5 % significance level (Engle and Yoo, 1987, Table-2). Thus there is no stationary relationship between the real exchange rate, real assets of the private sector, government expenditures on nontradables, import tariff rate and external terms of trade, according to Engle and Granger estimation results.

Several reasons might be offered for the failure to reject the null hypothesis of no cointegration in the latter model. It may be argued that the model which uses the import tariff rate is misspecified, and that the openness index should be preferred as a proxy for trade restrictions. Although the economic theory anticipates a negative relationship between the real exchange rate and the terms of trade, it appears to be a positive for that variable in the above equation. In fact, in theory using the tariff rate has several disadvantages over the alternative proxies. For example, it does not cover quantitative restrictions on trade. In addition, it fails to reflect the changes in the composition of imports as well as that of import taxes (or trade taxes in general).

Besides these specific comments, some general problems with the estimation procedure and with the data might have been suggested. There might be problems with the specification of the model. Thus as stated by Enders (1995: 385), any error introduced in the first step of the procedure might be carried into the second step in solving the unit root test on the residuals. Another reason might be the characteristics of the data. Unstable economic conditions and multiple interventions might disturb the natural trends of the data.

5.3.3 Formulating the error correction model

Having established a cointegrating relationship in our model (using openness index as a proxy), it is possible to use the feedback from that long-run relationship, specified in (5.5), in order to formulate the short-run dynamics of the model. Because monthly series are used in the study, we start with a fairly general form which includes first differences of the variables, their lags (k = 12), centered-seasonal dummies and the error correction term, and then follow a testing-down procedure to obtain more easily interpretable and parsimonious model. Because differenced variables simply reflect the short-run dynamics, about which theory has nothing to say, elimination of any of these variables does not involve any violation of the theory. In fact, that only implies the imposition of a restriction on the general model. In testing-down, we always check the restrictions on the coefficients with Wald's likelihood ratio test and also with two information criteria, the Schwartz Criterion (SC) and Hannan-Quinn (HQ) Criterion. We continue to impose zero restrictions on the relatively insignificant variables until further restrictions are rejected or one of the diagnostic tests fails. Table 5.3 illustrates the parsimonious error correction model.

Table 5.3 : Parsimonious error correction model

Dependent variable is DLRER :

Variable	*Coefficient*	*Std.Error*	*t-value*	*t-prob*
Constant	-0.001	0.001	-0.721	0.472
DLRER_3	-0.104	0.073	-1.415	0.159
DLRER_4	-0.224	0.074	-3.026	0.003
DLRER_9	-0.118	0.071	-1.654	0.100
DLRER_10	-0.222	0.072	-3.088	0.002
DLRER_11	-0.186	0.073	-2.514	0.013
DLRER_12	-0.213	0.081	-2.632	0.009
DLWEALTH_4	-0.128	0.073	-1.773	0.078
DLWEALTH_5	-0.137	0.073	-1.875	0.062

DLWEALTH_8	0.155	0.071	2.185	0.031
DLWEALTH_10	-0.098	0.077	- 1.270	0.206
DLWEALTH_12	0.143	0.074	1.936	0.055
DLGOVEXN_9	-0.030	0.010	-2.768	0.006
DLGOVEXN_10	-0.031	0.015	-2.110	0.036
DLGOVEXN_11	-0.044	0.015	-2.824	0.005
DLGOVEXN_12	-0.037	0.015	-2.460	0.015
DLTOT_1	-1.342	0.414	-3.241	0.002
DLTOT_2	0.782	0.416	1.876	0.063
DLTOT_6	-0.470	0.417	-1.126	0.262
DLTOT_9	1.041	0.445	2.311	0.022
DLOPEN_4	0.033	0.032	1.028	0.306
DLOPEN_5	0.034	0.033	0.986	0.325
DLOPEN_6	0.044	0.030	1.413	0.159
DLOPEN_9	0.108	0.030	3.507	0.000
DLOPEN_10	0.152	0.034	4.390	0.000
DLOPEN_11	0.128	0.036	3.523	0.000
DLOPEN_12	0.154	0.035	4.379	0.000
ECM_13	**-0.166**	**0.041**	**-4.047**	**0.000**

$R^2 = 0.372$, $F(27, 151) = 3.311$ [0.000], $\sigma = 0.016$,

RSS = 0.042 for 28 variables and 179 observations,

Information Criteria: SC = -7.542, HQ = -7.838.

Diagnostic tests :

F_{ar} (1,150) = 0.030 [0.862]

F_{ar} (12,139) = 0.493 [0.916]

F_{het} (54,96) = 0.391 [0.999]

F_{res} (1,150) = 0.313 [0.576]

F_{arch} (1,147) = 0.936 [0.335]

F_{arch} (12,125) = 0.605 [0.835]

$\chi_n^2(2)$ = 5.949 [0.051]

Notes:
-prefix D and prefix L denote the first differences and logarithm of the variables, respectively and *X_i* is the *i*'th lag of the variable *X*,

-RER is real exchange rate, WEALTH is the sum of domestic and foreign money, OPEN is openness index, GOVEXN is government expenditures on nontradable goods, TOT is the terms of trade for industrial countries, and finally ECM is the error correction term,
-The abbreviations for the diagnostic tests are as explained in the note.2 of Table-5.1.

The above parsimonious short run model seems to be an acceptable reparametrisation of the unrestricted model as the Wald test cannot reject the null of zero restrictions on the variables deleted from the general model [$F(34,117) = 0.478$]. In addition, both information criteria stated above support this elimination as both are smaller than those in the unrestricted model, which are SC = -6.687 and HQ = -7.343. The model is also well-behaved statistically since there is no evidence of serial correlation and auto-regressive conditional heteroscedasticity up to 12th order. Also the null hypotheses of no heteroscedasdicity, no misspecification and no non-normal distribution are not rejected at 5% significance level. With the F-statistic for joint significance being 3.311, the model is acceptable as a whole. Finally the goodness of fit is 37 %, which is reasonable for such a model specified with differenced-variables.

As seen from the Table 5.3, the model yields a highly significant negative coefficient of -0.17 for the error correction term (bold), implying that 17 % of the disequilibrium of the previous period is corrected in the next month. This coefficient may be used to determine the speed of adjustment which is needed to restore the equilibrium. Using the formula

$$t = \log(1-p) / \log(1-\mathrm{ECM}) \qquad (5.7)$$

where t denotes the time period, p the percentage of the disequilibrium to be corrected and ECM denotes the estimated coefficient on the error correction term.

We calculated the time length which is necessary to eliminate the 50 % and 90 % of the disequilibrium in the real exchange rate as 4 months and 13 months, respectively.

A significant negative coefficient on the error correction term supports the conclusion (indicated in the cointegration test) that a long-run relationship exists between the levels of the variables and that the estimated results of the cointegrating regression may be treated as the best estimates of this long-run relationship.

The results indicate that changes in fundamental determinants have significant effects on the changes in the real exchange rate though the length of immediate impacts vary (lagged). It seems that almost all variables have a strong 12th order autoregressive effects on the growth of the RER. Varying seasonal effects might have been picked up by these lags, instead of the seasonal dummy variables which do not appear in the parsimonious model as the Wald test cannot reject the null of zero restrictions on these variables. The fact that deletion of seasonal dummies does not cause any statistical problems gives some support to that argument.

The short-run estimates, like their long-run counterparts, seem to have consistent signs with the underlying theory, with a few exceptions. Namely, the economic theory suggests a negative relationship between the real exchange rate and the private wealth and this is supported by the long-run coefficient. However, changes in wealth seem to affect the real exchange rate positively in the short run, although its negative effect is statistically insignificant. This would be explained by the sluggishness of the adjustment towards long-run equilibrium value. Moreover, in an unstable economy with many interventions to the free market, immediate responses to the changes in a variable might be unpredictable or the shocks may not be reflected immediately in changes in the RER in the short-run. This might be the reason for observing a positive sign for the coefficient on the terms of trade, despite the fact that the theory predicts an inverse relationship. Again, this might partially be explained by the inadequacy of the proxy used.

Otherwise, an increase in the growth rate of government expenditure on nontradable goods causes the growth rate of the RER to appreciate, while any change in trade policy leading more openness of the economy is expected to bring about an increase (depreciation) in the RER growth. Finally, the changes in the real exchange rate seem to be reacting to the changes in the previous periods in order to return to the equilibrium level.

5.4 Summary

Estimations with non-stationary series might produce statistically invalid results as the residuals are not white noise. However, these series can still be used if they are cointegrated to form a stable long-run relationship. The concept of cointegration and its test by the Engle and Granger method is discussed in this chapter. Then this procedure is applied to Turkish data in order to investigate the existence of a relationship between the real exchange rate and its fundamental determinants. The estimation results indicate that the real exchange rate, government expenditure on nontradable goods, wealth of private sector external terms of trade and openness of the economy form a stable long-run relationship even though such a relationship does not seem to be exist when the import tariff rate is used instead of an openness index. All economic variables have sensible signs and magnitudes as expected by the theory. The short-run dynamics of the model are analysed by incorporating the feedback (error correction term) obtained from the long-run regression. In this model, the error correction terms appears to be highly significant, with a value of 0.17, giving a further evidence for the existence of a cointegration.

CHAPTER 6

AN ALTERNATIVE EMPIRICAL INVESTIGATION OF THE REAL EXCHANGE RATE DETERMINANTS : THE JOHANSEN METHOD

6.1 Introduction

Owing to the shortcomings of the single-equation approach estimation, the model of the real exchange rate is re-estimated by a multi-equation approach in this chapter. After a brief theoretical review of the Johansen technique, the determinants of the real exchange rate are investigated by implementing this approach in several steps. This includes testing for the order of integration, estimating VAR models, testing for cointegration, testing on the adjustment and coefficients matrices and finally estimating the short-run dynamics. The results will be compared with those obtained in the previous chapter and the findings will be evaluated in the last section.

6.2 Cointegration analysis with the Johansen method

The Johansen method (Johansen, 1988) relies on maximum likelihood estimation of cointegrating vectors in a system of equations, assuming that all the variables are endogenous. It is based on estimation of a vector autoregression (VAR) model. The VAR model of variables comprising X_t including up to k-lags may be written as :

$$X_t = \mu + A_1 X_{t-1} + \ldots + A_k X_{t-k} + \varphi Z_t + u_t \qquad t = 1, \ldots. T \tag{6.1}$$

where X_t is $(n \times 1)$ vector that contains current and lagged values of n variables which are assumed to be I(1), each of the A_i is an $(n \times n)$ matrix of parameters, Z_t is a vector I(0) variables,[1] μ is a constant vector and u_t is the vector of random errors.

Here, the formulation of the VAR model is of major importance because the results of the cointegration test can be very sensitive to that formulation. There are two main interrelated issues which particularly should be taken into consideration. The first one is to include an appropriate lag length to ensure that the residuals are white noise. Using too many lags reduces the power of the statistics. The second point is to decide whether or not deterministic components such as intercept, trend or dummy variables should be included. In addition, the question of whether these components are expected to be significant in the long- or short-run, and thus should be included or not in the cointegration space, has to be considered carefully. Setting the length of lag is also closely related with the issue of deterministic components. Omitted variables will be reflected in the error term and a residual misspecification problem will arise. Increasing the lag-length is unlikely to a solution. Indeed, if residual autocorrelation is because of omitted variables, increasing lag-length results in potentially harmful over-parametrisation which influences the estimates of cointegration rank, making it difficult to interpret (in terms of economics) the existing cointegration relations (Harris, 1995).

If there are linear trends in the levels of the data such that the first-differenced series do not have a zero mean, then it is necessary to specify a model with an

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[1] Z_t actually represents a vector of any variables which are included in the system to ensure that the errors u_t are white noise, thus it may contain dummy variables as well.

intercept which is restricted to the long-run model. Even if this is not the case, in practice, an intercept may be included (but may not be restricted) to the model to account for the units of measurement of the variables. However, if there are quadratic trends in the levels of the data, a model may allow for a time trend in the cointegration space to account for long-run linear growth.

Because of non-stationarity that characterises most of the time series, the equation (6.1) can be rearranged in a *vector error correction* (VECM) form as follows:

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \varphi Z_t + u_t \qquad (6.2)$$

where

$$\Gamma_i = -(I - A_1 - \ldots - A_i) \qquad i = 1, \ldots, k\text{-}1$$

and

$$\Pi = -(I - A_1 - \ldots - A_k).$$

Specifying the system in that form contains information on both the short- and long-run adjustment to changes in X via the estimates of Γ_i and Π respectively. As shown in Harris (1995), $\Pi = \alpha\beta'$, where α represents the speed of adjustment to disequilibrium, while β is a matrix of long-run coefficients such that the term $\beta' X_{t-k}$ embedded in (6.2) represents up to (n-1) cointegrating relationships in the multivariate model.

Assuming X is a vector of nonstationary I(1) variables, then all terms in (6.2) are I(0) and ΠX_{t-k} must also be stationary for $u_t \sim I(0)$ to be white noise. In this case, there are three instances:

• If Rank(Π) = n, that is the matrix Π has full rank, all the variables in X_t are in fact stationary and thus there is no point to search for cointegration because the variables can be modelled in levels.

• If Rank(Π) = 0, that is the matrix Π is the null matrix, there is no cointegration at all because there are no linear combination of the X_t that are I(0). Hence, the system can be formulated as a VAR model in first differences involving no long-run elements.

• If $0 < \text{Rank}(\Pi) = r < p$, there exists up to (n-1) cointegration relationships. In other words, there are p×r matrices such that $\Pi = \alpha\beta'$ where β is the cointegrating vector that has the property to transform $\beta' X_{t-k}$ into a stationary process even though X is not stationary itself.

In practice, we are mostly interested in the last case. However, it is not usually possible to apply ordinary regression methods to the individual equations comprising the system in (6.1). Rather, Johansen (1988) obtains estimates of α and β using the procedure known as *reduced rank regression*.

The rank of Π, that is the number of cointegrating relationships *r*, can be determined by testing whether or not its eigenvalues (λ_i 's) are statistically different from zero. i.e.

$$H_0 : \lambda_i = 0 \quad i = r + 1, \ldots n$$

where only the first *r* eigenvalues are non-zero. In other words, we test the null hypothesis that there are at most *r* cointegrating vectors. This restriction can be imposed for different values of *r* and then log of the maximised likelihood function for the restricted model is compared to the log of the maximised likelihood function of the unrestricted model and a standard likelihood ratio test is computed. That is, it is possible to test the null hypothesis using what has known as the *trace statistic* :

$$\lambda_{trace} = -2\log(Q) = -T\sum_{i=r+1}^{n}\log(1-\hat{\lambda}_i)\; r = 0,1,2, \dots, n-2, n-1 \qquad (6.3)$$

where Q= (restricted maximised likelihood)/(unrestricted maximised likelihood).

This statistic tests that there are at most r cointegrating vectors against the alternative of more than r cointegrating vectors. For example, the null and alternative hypotheses may be stated in the following way:

$H_0: r = 0$ $H_A: r \geq 1$

$H_0: r \leq 1$ $H_A: r \geq 2$

$H_0: r \leq 2$ $H_A: r \geq 3$

...   ...

Initially the null hypothesis of no cointegration is tested against the alternative that there exists at least one cointegrating vector. If the null is rejected, implying that there is at least one vector, then the next step requires us to test the null of a single vector against the alternative that there are at least two cointegrating vectors, and so the procedure goes on.

Another test of the significance of the largest λ is the *maximal eigenvalue* or *λ-max* statistic:

$$\lambda_{max} = -T\log(1-\hat{\lambda}_{r+1}) \quad r = 0,1,2, \dots, n-2, n-1 \qquad (6.4)$$

The λ-*max* statistic tests whether there are exactly r cointegrating vectors against the alternative that there are $(r+1)$ cointegrating vectors. For example, the null and alternative hypotheses may be stated as:

$H_0: r=0$	$H_A: r=1$
$H_0: r=1$	$H_A: r=2$
$H_0: r=2$	$H_A: r=3$
...	...

The λ-*max statistic* states in alternative hypothesis that there are exactly r cointegrating vectors, while it is more flexible in *trace statistic*, stating that there are more than r vectors.

After having computed both trace and maximal eigenvalue statistics, we may proceed to compare them with the critical values provided by Johansen and Juselius (1990) or Osterwald-Lenum (1992). In practice, it is recommended to begin by testing the null hypothesis that there exists no cointegrating vector (i.e. $r = 0$). If this hypothesis is not rejected, the testing procedure stops; however if it is rejected it is possible to consider sequentially the null hypotheses that $r \leq 1$, $r \leq 2$, $r \leq 3$ and so on.

Having determined the number of cointegrating vectors, the Johansen methodology facilitates the testing of a variety of hypotheses using likelihood ratio tests. One may want to test for weak exogeneity, imposing restrictions on the α (speed of adjustment) matrix, while it is also possible to impose restrictions on the β matrix to test some linear hypotheses.

In a vector error correction model (VECM) of the form equation (6.2), as discussed in the theoretical part, it has been shown that the matrix Π contains long-run relationships, where $\Pi = \alpha\beta'$ and β is a matrix of long-run coefficients and α represents the speed of adjustment to disequilibrium. If there are $r \leq (n-1)$ cointegration vectors in β then this means that the last (n-r) columns of α are zero because every row in the β matrix corresponds to a column of α matrix (Harris, 1995). For example, suppose that r = 1, i.e. there is one cointegrating vector, if the variable set $z_t = [\, y_{1t}, y_{2t}, y_{3t} \,]$ and $\alpha = [\alpha_{11},\alpha_{21},\alpha_{31}]$. Then the first term in α represents the speed of adjustment of the dependent variable Δy_{1t} in the first equation of the VECM towards the single long-run cointegration relationship ($\beta y_{1t-1} + \beta y_{2t-1} + \beta y_{3t-1}$), while α_{21} shows how fast Δy_{2t} responds to the disequilibrium changes represented by the cointegration vector and α_{31} represents the speed at which Δy_{3t} adjusts.

Going a step further, for example, if α_{31} is zero, this means that the equation for Δy_{1t} contains no information about the long-run β because the cointegration relationships do not enter into this equation. Thus it can be said that the variable Δy_{1t} is *weakly exogenous to the system* and can enter on the right-hand side of the VECM. Formally, Banerjee et al (1993) states that "weak exogeneity requires that there is no loss of information about the parameters of interest in reducing the analysis from the joint distribution to a conditional model".

That is why testing for weak exogeneity reduces to testing restrictions on the row of α matrix which contains adjustment coefficients. This test is conducted by placing row restrictions on α to give a new restricted model with new eigenvalues λ_i^*, then restricted and unrestricted models are compared by a likelihood ratio (LR) statistic as follows:

$$LR = T \sum_{i=1}^{r} \log [(1 - \lambda_i^*) / (1 - \lambda_i)] \tag{6.5}$$

This test statistic is compared with the χ-distribution with $(r \times (n-m))$ degrees of freedom to obtain the significance level for rejecting the null hypothesis [where r is the rank or number of cointegrating vectors and (n-m) is the number of row restrictions imposed on α].

Once it is determined how many cointegration vectors there are, it possible to impose some restrictions on the long-run coefficients presented in the β matrix. Such restrictions can be those motivated by economic arguments such as an homogeneity restriction or zero-restrictions to test the significance of the variables.

In order to test the significance of each long-run coefficient, one can impose zero-restrictions on the columns of the standardised β matrix and test them using the similar LR statistic as formulated in (6.5).

Empirical analysis can be finalised by estimating the short-run dynamics in an error correction model framework. Obtaining long-run estimates of the cointegration relationships is only an initial step to estimating the complete model. The formulation of the short-run dynamics is also important in terms of the information it carries on the short-run adjustment behaviour of economic variables.

Finally, having obtained the long-run cointegration relations using Johansen approach, it is possible to estimate the short-run structure of the model in a VAR of error-correction form (VECM) with that cointegration relationships included, Re-writing the equation (6.2):

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \Pi X_{t-k} + \varphi Z_t + u_t \tag{6.2}$$

where X_t is the set of the variables in the model, Z_t contains the deterministic components as well as dummy variables, and $\Gamma_i = -(I - A_1 - \dots - A_i)$, $(i = 1, \dots, k-1)$, and $\Pi = -(I - A_1 - \dots - A_k)$.

It is possible to re-formulate that equation by including the error-correction term, α explicitly as :

$$\Delta X_t = \Gamma_1 \Delta X_{t-1} + \ \dots \ + \Gamma_{k-1} \Delta X_{t-k+1} + \ \alpha(\hat{\beta}_i' \tilde{X}_{t-1}) + \varphi Z_t + u_t \tag{6.2a}$$

where $\Gamma_i = -(I - A_1 - \dots - A_i)$, $(i = 1, \dots, k-1)$.

6.3 Empirical Analysis

In this section, we will be using the following steps to implement the Johansen approach :

i- Testing the order of integration,
ii- Estimating and evaluating vector auto-regression (VAR) models,
iii- Determining the rank of cointegration matrix (i.e. testing for cointegration),
iv- Testing restrictions on α matrix (i.e. testing for weak exogeneity),

v- Testing restrictions on β matrix (i.e. coefficients significance tests),

vi- Formulating the error correction model (ECM).

6.3.1 Testing for order of integration :

The Johansen method which uses the maximum likelihood estimation technique begins by testing the order of integration of each variable involved in the model. Because in Chapter 4, we have already found that all variables are integrated of the order one (see Tables 4.2 and 4.4), we may proceed to the second step.

6.3.2 Estimating the VAR models :

In order to test the existence of cointegration among the variables, various VAR models of the following type are estimated :

$$X_t = \mu + A_1X_{t-1} + \ldots + A_kX_{t-k} + u_t \qquad t = 1, \ldots. T \qquad (6.6)$$

where

k is the number of lags, and

X_t is a vector comprising the variables; real exchange rate (RER), government expenditures on nontradables (GOVEXN), private wealth (WEALTH), external terms of trade (TOT) and an openness index (OPEN) and μ is a constant vector.

Similar VAR models are estimated by using the import tariff rate (TARIFF) as an alternative proxy for trade restrictions instead of openness index.

There are several issues to consider before estimating the model: Although the graphs of the first-differenced series do not show serious trends in the data, an intercept term is restricted to the cointegration space in order to account for units of measurement. Given that the F-test on the insignificance of the constant term can be rejected [$F(4,122) = 4.801$], and removing the constant causes the misspecification test to fail, this is justified.

Turkey can be accepted as a price-taker in international trade (small country property), therefore it is convenient to assume exogeneity of that variable. Conditioning on some variables in the model ensures that the rest of the system has better stochastic properties (Harris, 1995: 98), which is particularly important in finite samples as in the present case at which the degrees of freedom are lowered considerably because of higher lags.

Taking into consideration the above issues, we begin estimations with a fairly high order VAR model of 14 lags which are set according to the Schwert formula (see Chapter.5, footnote 3). As can be seen from Table 6.1, the F-tests on the insignificance of 13th lag can be rejected for the variable WEALTH at a 5 % significance level, therefore all variables are introduced into the model with 13 lags for the Johansen procedure requires all the variables to enter to the system with common lag-length.

Owing to the fact that monthly data have been used, serial autocorrelation and ARCH tests are carried out up to 13th order as well as 12th order to check for possible annual autocorrelation. The null hypotheses of no autocorrelation cannot be rejected for either of the 1st , 12th and 13th orders. Similar results are obtained for the null of no ARCH (autoregressive conditional heteroscedasticity). The only test that fails is the normality test for the real exchange rate equation. As far as the multivariate tests are concerned, the system as a whole passes a series of diagnostic tests except that of normality, implying that the model is statistically acceptable as a whole.

Table 6.1 : Model evaluation statistics (openness case)

Statistics	RER	GOVEXN	WEALTH	OPEN
$F_{k=1}$ (4,122)	30.962**	1.141	21.612**	2.609*
F_{k-12} (4,122)	0.599	6.109**	4.582**	1.433
$F_{k=13}$ (4,122)	0.159	0.608	6.603**	1.038
F_{ar} (1,124)	3.731	0.006	2.285	2.706
F_{ar} (12,113)	0.915	1.290	1.299	1.313
F_{ar} (13,112)	0.946	1.241	1.240	1.202
F_{arch} (1,123)	2.701	0.026	0.453	0.428
F_{arch} (12,101)	1.166	0.213	0.789	0.510
F_{arch} (13,99)	1.053	0.195	0.727	0.482
χ^2_n(2)	21.376**	3.981	5.268	7.364*
Multivariate tests				
$F_{ar1-1}(16,361) = 1.581$; $F_{ar1-12}(192,298) = 1.146$; $F_{ar1-13}(208,282) = 1.129$; $\chi^2_n(8) = 33.426^{**}$; $F_{het}(1060,123) = 0.232$				

Notes:
1.* Rejects null hypothesis at 5% significance level, ** rejects null hypothesis at 1% significance level.
2. F_{ar} stands for Breusch-Godfrey serial correlation test, F_{arch} for autoregressive conditional heteroscedasticity, F_{het} for White's functional form/heteroscedasticity test and χ^2_n for White's normality test.

In order to see the performance of 'import tariff rate' as a proxy for trade restrictions, we estimated various VAR models under similar conditions discussed above. The terms of trade is again assumed to be exogeneous to the system, owing to the small country property. This assumption seems to reduce small sample bias and improve the model considerably.

Table 6.2 : Model evaluation statistics (import tariff case)

Statistics	RER	GOVEXN	WEALTH	TARIFF
$F_{k=1}$ (4,117)	41.509**	1.977	28.405**	0.517
$F_{k=13}$ (4,117)	1.238	2.179	8.178**	1.175
$F_{k=14}$ (4,117)	1.923	0.444	5.141**	1.883
F_{ar} (1,119)	0.068	1.767	0.722	1.781
F_{ar} (12,108)	0.776	1.171	1.480	1.166
F_{ar} (14,106)	0.811	1.079	1.263	1.266
F_{arch} (1,118)	1.316	0.322	0.837	0.000
F_{arch} (12,96)	1.401	0.193	0.448	0.906
F_{arch} (14,92)	1.152	0.237	0.430	0.811
χ^2_n(2)	33.282**	1.484	2.653	2.515
Multivariate tests				
$F_{ar1\text{-}1}$(16,345)=1.260; $F_{ar1\text{-}12}$(192,278) =1.159; $F_{ar1\text{-}14}$(224,246) = 1.198; χ^2_n(8) = 36.160**				

Notes: See notes 1 and 2 in Table 6.1.

As can be seen from the diagnostic tests presented in Table 6.2, the F-test on the insignificance of the 14th lag for WEALTH can be rejected at 1% level, therefore all variables are entered into the system with 14 lags. The null hypotheses of no serial correlation and no ARCH can not be rejected for the 1th, 12th and 14th orders. This is valid for the multivariate tests as well. Similarly, the null hypotheses of no heteroscedasticity cannot be rejected for the system itself. The only diagnostic test that fails is the normality test for the real exchange rate and for the system.

6.3.3 Testing for cointegration :

Testing for cointegration by the Johansen method requires testing for the reduced rank or the number of cointegrating vectors. As explained earlier, the rank of the matrix Π can be determined by testing whether or not its eigenvalues (λ) are statistically different from zero. There are two test statistics to be used for that purpose: Trace statistic and maximal eigenvalue statistic. The eigenvalues obtained from the VAR models, test statistics and critical values are presented in Table 6.3. It also shows Reimers' adjusted test statistics for small sample bias. Reimers (1992) suggests taking account of the number of parameters to be estimated in the model and making an adjustment for the degrees of freedom by replacing T in (6.3) and (6.4) by $T\text{-}nk$, where T is the number of observations, n is the number of variables and k is the number of lags.

We start to test the null hypothesis of no cointegration with the λ-*max* statistic, i.e.

$$H_0 : r = 0 \text{ versus } H_A : r = 1.$$

Table 6.3 : Test of the cointegration rank (openness case)

$H_0 : r$	λ_I	λ-*max*	Reimers	$CV^{+}_{\lambda max}$	*Trace*	Reimers	CV^{+}_{trace}
0	0.182	36.04	25.57	28.10	81.02	57.49	53.10
1	0.155	30.29	21.49	22.00	44.99	31.92	34.90
2	0.061	11.35	8.05	15.70	14.70	10.43	20.00
3	0.018	3.35	2.37	9.20	3.35	2.38	9.20

$^{+}$Critical values (CV) are taken from Osterwald-Lenum (1992) and at 5% level.

Because for r = 0 case, the *λ-max* statistic is 36.04, which is higher than the critical value of 28.1, we reject the null of no cointegration. Being the adjusted value of 25.57 lower than the critical value, it does not support that conclusion. Then we proceed to test

$$H_0 : r = 1 \text{ versus } H_A : r = 2.$$

The *λ-max* statistic is 30.29 which is again higher than the critical value of 22.0, so we can reject the null hypothesis that there is a single cointegrating vector. However, Reimers' adjusted value of 21.49 is smaller than the critical value and therefore does not confirm this result. The null hypothesis that r = 2 cannot be rejected and thus we stop testing procedure, concluding that there are two cointegrating vectors according to the λ-max statistic (but not to the adjusted statistic).

Now, using the *trace statistic*, we test

$$H_0 : r = 0 \text{ versus } H_A : r \geq 1.$$

Because *trace statistic* = 81.02 > CV_{trace} = 53.1 , we reject the null hypothesis of no cointegration. Proceeding to test

$$H_0 : r = 1 \text{ versus } H_A : r \geq 2$$

indicates that we still can reject the null of one cointegrating vector at 5% significance level since trace = 44.99 > CV_{trace} = 34.9. Reimers' adjusted tests confirms the first result while rejecting the second one.

We continue to test for r = 2 against r ≥ 3. Because the trace statistic gives a value of 14.7 which is lower than the critical value of 20.0, the null hypothesis cannot be rejected and one can conclude that there are two cointegrating vectors according to the trace statistic.

To sum up, the tests for the reduced rank produce ambiguous results. Namely, the λ-max statistic and the trace statistic indicate the presence of two cointegrating vectors, however the trace statistic adjusted for small samples accepts the existence of a single cointegrating vector.

Such contradiction in the tests for cointegration tests is not unusual. The small sample bias towards over-rejection of the no cointegrating hypothesis rises as the number of variables and the length of lag increases (Cheung and Lai, 1993). Johansen attributes the ambiguity in the results to the low power in cases when the cointegration relation is quite close to the nonstationary boundary. The final judgement may be made using the test results, the interpretability of the obtained coefficients as well as the graphs of the cointegrating vectors (Johansen, 1992).

Consequently, in our case, the overall evidence is in favour of the presence of a single cointegrating vector which explains a long-run stationary relationship between RER, GOVEXN, WEALTH, OPEN and TOT. An inspection of the graphs of the four possible cointegrating vectors indicates that only the second vector indicates a clear stationary relationship, although the first one also looks close to stationarity. Moreover, since the main concern of the present study is to investigate only the determinants of the real exchange rates, a single cointegrating vector will be assumed in the rest of the study.[2]

Now, using Table 6.4, we can follow a similar procedure for the VAR model which uses the import tariff rate.

Table 6.4 : Test of the cointegration rank (tariff case)

$H_0 : r$	λ_I	λ-max	Reimers	$CV^{+}_{\lambda max}$	*Trace*	Reimers	CV^{+}_{trace}
0	0.207	41.51	28.45	28.10	92.40	63.33	53.10
1	0.163	31.78	21.78	22.00	50.90	34.88	34.90
2	0.075	13.97	9.58	15.70	19.12	13.11	20.00
3	0.028	5.15	3.53	9.20	5.15	3.53	9.20

$^{+}$Critical values (CV) are taken from Osterwald-Lenum (1992) and at 5% level.

As can be seen from Table 6.4, although the trace statistics and maximal value statistics indicate that there are at least two cointegrating vectors, the (Reimers') adjusted values of these statistics for small samples bias gives evidence for the existence of a single vector. A further support comes from the α adjustment matrix, which will be presented in Table 6.6. Three columns of this matrix (except the second one) consists of very small (almost zero) coefficients. As stated in Doornik and Hendry (1994; 78), if the cointegration rank, r = 1, n - r columns of the adjustment matrix are expected to be insignificantly small, which is the case in the present matrix. Consequently, it seems that there is one stationary relationship between RER, GOVEXN, WEALTH, TARIFF and TOT.

[2] Because five variables of which all except terms of trade might be endogeneous variables in theory, are introduced into the cointegrating space, it would not be surprising to find more than one stationary relationships between them.

6.3.4 Testing for weak exogeneity :

As explained earlier, testing for weak exogeneity reduces to testing restrictions on the row(s) of α matrix which contains the speed of adjustment coefficients. The standardised α coefficients obtained from the estimation of the VAR model and the likelihood ratio statistics calculated imposing restrictions on the rows of that matrix are presented in Table 6.5. For instance, the null hypothesis to be tested for the weak exogeneity of the first variable, government expenditures would be

$$H_0 : \alpha_{1i} = 0 \quad \text{against } H_0 : \alpha_{1i} \neq 0 \quad \text{for } i = 1,...4.$$

Imposing three zero restrictions gives the likelihood ratio of 13.787, which is higher than the critical value of 11.341 at 1% level, leading the null to be rejected. Therefore, the variable government expenditures on nontradables is not exogenous to the system and needs to be modelled explicitly. A similar conclusion can be drawn from the tests for the real exchange rate, real wealth and openness index.

Table 6.5 : Standardised α matrix and LR statistics (openness case)

Variables					LR^+
GOVEXN	-0.269	-1.488	-0.007	0.044	13.787
RER	0.002	-0.243	0.002	-0.008	10.904
WEALTH	0.072	-0.143	-0.003	0.002	17.963
OPEN	-0.224	-0.012	-0.006	-0.011	16.803

$^+$Critical values are $\chi(3)$=11.341 at 1% and $\chi(3)$=7.815 at 5% (Johnston, 1987, Table-3).

In fact, the second column of α matrix shows a large effect of these error correction terms on all four equations, violating any possibility of treating any of the four variables as weakly exogeneous in a model of real exchange rate.[3]

Table 6.6 demonstrates the speed of adjustment coefficients (α matrix) obtained from the VAR model which uses import tariff rate:

Table 6.6 : Standardised α matrix and LR statistics (tariff case)

Variables					LR^{+}
GOVEXN	-0.001	-1.804	-0.060	-0.034	18.470
RER	-0.000	-0.073	-0.016	0.010	2.555
WEALTH	-0.003	0.007	-0.015	-0.005	22.775
TARIFF	-0.011	-0.469	0.109	0.001	21.577

$^{+}$Critical values are $\chi(3)$=11.341 at 1% and $\chi(3)$=7.815 at 5% (Johnston, 1987, Table-3).

By imposing zero restrictions on the rows of α matrix, it is possible to test the null hypothesis that

$$H_0 : \alpha_{ij} = 0 \text{ against } H_A : \alpha_{ij} \neq 0 \qquad j = 1,2,3$$

Non-rejection of the null indicates the weak exogeneity of the variable which corresponds to that adjustment vector.

Table 6.6 also gives the likelihood ratio tests which compare the restricted and unrestricted models as formulated in (6.5). Comparing the likelihood ratio statistics with the critical values given at the bottom of the table indicates that

[3] As will be presented in section 6.3.6, the error correction term in the short-run model is negative and highly significant. This provides a further evidence to the above result that the real exchange rate is endogenous to the system.

the null hypothesis of zero-restrictions are rejected for the variables, government expenditures on nontradables, wealth and the import tariff rate at 5 % significance level, implying that they are not weakly exogenous and have to be modelled explicitly. However, the null hypothesis cannot be rejected for the real exchange rate at the conventional significance levels. It might indicate that the model is misspecified when the import tariff rate is used. That result might be arisen from the characteristics of the data. The sample size is relatively small and the economy from which the data are collected is not stable and subject to highly volatile changes.

However, the non-rejection of the null does not imply that it is not an endogenous variable. In fact, economic theory assumes that the real exchange rate is an endogenous variable (Stockman, 1987). Because it is made up of relative prices by definition, real disturbances to supplies of goods and demand for goods are expected to cause changes in the real exchange rates as well, thus its equilibrium value is determined by the market forces. Therefore, there are strong analytical reasons for believing that the real exchange rate is endogenous.

6.3.5 Testing restrictions on the cointegrating matrix :

Estimation of the model yields the following long-run relationship for the real exchange rate (in logarithm):[4]

$$RER = 7.946 - 0.426GOVEXN - 0.126WEALTH + 0.616OPEN - 0.606TOT \quad (6.7)$$

Before interpreting the equation, it may be appropriate to test the significance of

[4] It is obtained by normalising on the coefficient for the real exchange rate in the *second row* of the β matrix. Apart from the fact that only this equation has economically interpretable signs and magnitudes in terms of explaining the RER changes, having the largest values in the *second column* of the adjustment matrix, presented in Table 6.5, supports that judgement.

each long-run coefficient so that those which do not contribute to the explanation of the changes in the equilibrium real exchange rate can be excluded. For that, one can impose zero-restrictions on the columns of the standardised β matrix and test them using a similar LR statistic as formulated in (6.5) in testing weak exogeneity. We test the null hypothesis that

$$H_0 : \beta_i = 0 \quad \text{against} \quad H_A : \beta_i \neq 0$$

where i denotes the coefficient for the ith variable in the cointegrating vector.

Table 6.7 : LR statistics for restrictions on cointegrating vector (open)⁺

GOVEXN	WEALTH	OPEN	TOT	Constant
22.186	22.153	22.823	22.736	15.923

⁺Critical values are $\chi(1) = 6.635$ for 1% level and $\chi(1) = 3.842$ for 5 % level.

As presented in Table 6.7, the null hypothesis of zero restriction can be rejected for any of the variables indicating their significance for the specified long-run relationship.

The equation (6.7) specifies the impacts on the equilibrium real exchange rate of the fundamental determinants. Overall, the direction of these impacts appear to be as expected by the underlying theory which is discussed in Chapter 2. Namely, the response of the real exchange rate to any changes in the openness is positive and relatively high. Any policy liberalising the trade leads to a depreciation of the RER. On the other hand, there is negative relationship between the real exchange rate and government expenditures on nontradables. An increase in demand for nontradables by the government puts pressure on their prices, causing the RER to fall. Similarly, a change in foreign trade prices affects the RER negatively as expected. Finally, an increase in the real wealth of the private sector rises the demand for all goods including the domestic goods, pushing the prices up.[5] In that case, the RER is expected to appreciate to sustain the equilibrium. More detailed interpretation and comparison of the results with those estimated by the Engle and Granger technique will be given in section 6.4 of this chapter.

As far as the model which uses the tariff rate is concerned, estimation of the model specifies the determinants of the real exchange rate in the following form (in logarithms) :

$$RER = 7.540 - 0.683GOVEXN + 0.419WEALTH - 0.672TARIFF - 0.410TOT \quad (6.8)$$

Table 6.8 reports the significance tests conducted on the relevant cointegrating vector:

Table 6.8 : LR statistics for restrictions on cointegrating vector (tariff)⁺

GOVEXN	WEALTH	TARIFF	TOT	Constant
25.574	24.107	24.029	24.258	24.240

⁺Critical values are $\chi(1) = 6.635$ for 1% level and $\chi(1) = 3.842$ for 5 % level.

Again, all the coefficients in the vector seem to be significantly different from zero according to the relevant LR statistics at the conventional levels. The estimation yields consistent signs with the theory for GOVEXN, TARIFF and TOT, while WEALTH appears to be affecting the RER positively as opposed to the expectations. This may be interpreted as a further support for the

[5] Similarly, an increase in capital inflows will lead to an appreciation of the RER.

misspecification of the model with tariff rate as suggested by the non-rejection of the weak exogeneity test for the RER in the previous section. In fact, this result is consistent with the finding that the null hypothesis of no cointegration could not be rejected for these variables by the Engle and Granger estimation method, as recalled from Chapter 5. Further discussions will be followed in section 6.4.

6.3.6 Formulating the short-run dynamics :

Obtaining long-run estimates of a cointegration relationship is only an initial step to estimating the complete model. The formulation of the short-run dynamics is also important in terms of the information it carries on the short-run adjustment behaviour of economic variables. As discussed in the theoretical part, it is possible to estimate the short-run structure of the model in an error-correction form with the estimated cointegration relationships included.

Now, we can estimate the short-run dynamics of our model. The Hendry general-to-specific methodology will be adopted to obtain a parsimonious ECM model which is easier to interpret and to discuss the implications for the model. In this methodology, researchers are allowed to eliminate any of the differenced variables in the ECM, without any concern of violating the underlying theory, if this is justified by the F-testing procedure (Thomas, 1993; 156). Thus we begin with fairly general model with 12 lags as the cointegrating regression contained 13 lags. Centered-seasonal dummies are added to model the seasonal behaviour of the data. Then the general model is restricted by deleting relatively less significant coefficients at the first instance. We continue the restrictions until the Wald's variable deletion test is rejected or any of the diagnostic tests fails. The model is reduced to the following parsimonious error correction model (PECM):

Table 6.9 : Parsimonious error correction model

Dependent variable is DLRER

Variable	*Coefficient*	*Std.Error*	*t-value*	*t-prob*
Constant	-0.004	0.003	-1.322	0.112
DLRER_3	-0.150	0.076	-1.969	0.051
DLRER_4	-0.244	0.075	-3.234	0.002
DLRER_9	-0.079	0.072	-1.092	0.276
DLRER_10	-0.227	0.074	-3.092	0.002
DLRER_11	-0.163	0.075	-2.165	0.032
DLRER_12	-0.217	0.084	-2.562	0.011
DLWEALTH_5	-0.181	0.073	-2.452	0.015
DLWEALTH_8	0.141	0.074	1.912	0.057
DLWEALTH_10	-0.111	0.081	-1.372	0.172
DLWEALTH_12	0.091	0.082	1.105	0.271
DLGOVEXN_9	-0.035	0.011	-3.127	0.002
DLGOVEXN_10	-0.043	0.017	-2.506	0.013
DLGOVEXN_11	-0.062	0.019	-3.168	0.001
DLGOVEXN_12	-0.057	0.022	-2.519	0.012
DLTOT	-0.904	0.420	-2.149	0.033
DLOPEN_4	0.054	0.030	1.764	0.079
DLOPEN_9	0.097	0.037	2.569	0.011
DLOPEN_10	0.124	0.043	2.848	0.005
DLOPEN_11	0.123	0.045	2.735	0.007
DLOPEN_12	0.177	0.042	4.199	0.000
CIvec2_13	**-0.178**	**0.055**	**-3.224**	**0.001**

$R^2 = 0.323$, $F(21, 144) = 3.278$ [0.000], $\sigma = 0.037$;

RSS = 0.204 for 22 variables and 166 observations,

Information Criteria : SC = -6.019, HQ = -6.264,

Information Criteria (unrestricted model) : SC = -5.321; HQ = -5.889.

Diagnostic tests :

$F_{ar}(1,143)$	= 0.035 [0.852]	$F_{arch}(1,139)$	= 1.936 [0.104]
$F_{ar}(12,132)$	= 0.492 [0.916]	$F_{arch}(12,117)$	= 0.483 [0.922]
$F_{het}(42,101)$	= 0.602 [0.966]	$\chi_n^2(2)$	= 26.072 [0.000]
$F_{res}(1,143)$	= 0.063 [0.802]		

Notes:
1. Prefixes D and L denote the first differences and logarithms of the variables, respectively and X_i is the i'th lag of the variable X, RER is real exchange rate, WEALTH is private wealth, OPEN is openness index, GOVEXN is government expenditures on nontradable goods, TOT is the terms of trade for industrial countries, and finally CIvec2 is the error correction term.[6]
2. SC stands for Schwartz Criterion and HQ stands for Hannan and Quinn information criterion.
3. Abbreviations for the diagnostic tests are as presented in Note.2, Table 6.1.

The statistical properties of the model are quite reasonable: First of all, the F-test for the joint significance of the variables is 3.28, which is higher than the critical value. The parsimonious model is an acceptable simplification of the general model. The Wald test confirms this result, not-rejecting the null hypothesis of the deletion of the relatively insignificant variables (F(29,115) = 0.851 [0.684]). A comparison of the information criteria, SC and HQ for the present model with those for the unrestricted model gives further evidence in favour of the restricted model (as smaller values of these criteria are preferred). There is no evidence of residual autocorrelation, auto - regressive conditional heteroscedasticity or misspecification at 5% significance level.

Most of the coefficients are significantly different from zero at 5 % level,

[6] CIvec2 is the adjustment coefficient for the second cointegrating vector, that is the second column of the α matrix. Although the other error correction terms were introduced into the model, only the one for the second vector is significantly different from zero, supporting our decision in preferring to normalise on that vector as 'the real exchange rate equation'.

implying that the fundamentals have influence in determining the short-run value of the RER as well as its long-run equilibrium value.[7]

As far as the economic interpretation of the model is concerned, the most important feature of the model is that it yields a highly significant negative coefficient for the error correction term (bold). Being significant gives further evidence of the existence of cointegration between the variables in question, while being negative confirms the existence of a tendency of any disequilibrium to move back towards the long-run equilibrium level. The coefficient estimated is -0.18, which implies that 18% of the disequilibrium of the previous period is expected to be corrected in the next period. In addition, this magnitude can be used to determine approximately the speed of adjustment which is necessary to restore the equilibrium. Recalling the formula (5.7) :

$$t = \log(1\text{-}p) / \log(1\text{-ECM})$$

it is calculated that 50 % of the disequilibrium will be eliminated in about 4 months time, while it may take 12 months for removing 90 % of the disequilibrium.

It seems that the growth of the RER is significantly affected by its lagged changes in the short-run. This can be interpreted as a self-adjustment mechanism as the RER growth counteracts to the changes in the previous periods. As in the long-run, the changes in the growth of the government expenditures on nontradables and the external trade prices influence the growth of the RER

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[7] Particularly the 12th lags of the variables are significantly different from zero, as in the short-run model estimated in the previous chapter. Possible seasonal effects might have been captured by these lags.

negatively while a positive relationship is suggested in the case of openness of the economy. However, the lagged effect of the real wealth growth on the RER growth is ambiguous.

6.4 Comparison and evaluation of the empirical results under two alternative estimation techniques

Estimation of the model by the Engle and Granger (E&G) and Johansen techniques produce strikingly similar results both in the long-run and in the short-run[8], indicating its robustness to the estimation techniques. Re-writing the long-run equilibrium relationships :

Engle and Granger estimates :

$$RER = 3.876 - 0.313GOVEXN - 0.346WEALTH + 0.794OPEN - 0.307TOT \quad (5.5)$$

Johansen estimates :

$$RER = 7.946 - 0.426GOVEXN - 0.126WEALTH + 0.616OPEN - 0.606TOT \quad (6.7)$$

First of all, both equations have a significant constant term. All coefficients have reasonable signs as expected by the underlying theory. When the import tariff rate is used instead of openness index to approximate the trade restrictions, the following equations are specified :

[8] It should be acknowledged here that the Engle and Granger and Johansen use very different techniques in estimation. The former employs ordinary least squares while the latter uses the maximum likelihood estimation method. Thus, one-to-one comparison of the magnitudes of the coefficients may not be appropriate and requires some caution.

Engle and Granger estimates :

$$RER = 15.54 - 0.305GOVEXN - 0.429WEALTH - 1.187TARIFF + 1.335TOT \quad (5.6)$$

Johansen estimates :

$$RER = 7.540 - 0.683GOVEXN + 0.419WEALTH - 0.672TARIFF - 0.410TOT \quad (6.8)$$

The common conclusion drawn from the above estimations is that both seem to be misspecified. In fact, the equation estimated by the E & G method cannot be used in economic analyses as the variables are not cointegrated. Although the Johansen technique indicates the existence of at least one cointegrating vector between these variables, the failure of the weak exogeneity test for the dependent variable and more importantly, the error correction term being insignificant in the short-run model (though not reported here) casts a shadow upon it. Consequently, openness index is preferred over the import tariff rate in our RER model.

Regarding the short-run dynamics of the model, again the E & G and Johansen methodologies produce similar results (compare Table 5.3 and Table 6.8). First of all, a significant negative coefficient is obtained in both cases, although the adjustment is slightly slower in the former model. Simplification procedure produces a very similar parsimonious form with an exception of the terms of trade variable. The E & G estimation includes various lags of the terms of trade variable while it is introduced to the model as an exogeneous variable (thus without lags) in the Johansen estimation. The impact of the growth of real wealth on the RER growth is ambiguous in both models.

Now, turning back to the long-run estimates of the RER determinants (with openness index, from now on), it may be useful to compare our results with other works. Edwards (1988b, 1989a) estimates long-run RER equations using pooled data for a group of 12 developing countries (excluding Turkey). He finds a significant negative relationship between the RER and terms of trade, which is consistent but lower (-0.05) than our finding. The coefficient on the (total) government expenditure which is used as a proxy for expenditures on nontradable goods, is negative but insignificant in many cases. It is highly significant in the present study as expected because government controls many economic activities in developing countries. It seems that using a better proxy, as in the present case, might have captured this effect. It is also shown that growth of domestic credits has a significant negative impacts on the RER. This matches our results for the private wealth (proxied by the domestic and foreign deposits). In addition to Edwards (1988b, 1989a), the findings of some other similar works are presented in Table 6.9.[9]

Table 6.10 : A comparison of the empirical findings

Variable	**Present study**	**(1)**	**(2)**	**(3)**	**(4)[+]**
Terms of trade	(-)*	(-)*	(-)*	(-)*	(+)*
Gov'nt exp./GDP	(-)*	(-)			(+)*
Excess credits	(-)*	(-)*	(-)*	(-)*	(+)*
Import tariff	(-)*	(-)			
export+import/GDP	(+)*		(+)*	(+)*	(+)*

Notes:
(1) Edwards (1989a), (2) Cottani et al (1990), (3) Ghura et al (1993), (4) Elbadawi (1994).
[+] RER is defined as P_N / P_T .

[9] Only the findings on the variables which are used in the present work are reported here, though there are many other variables included in each study.

These studies are also on one or a group of developing countries and follow mainly Edwards' approach to modelling the RER determinants. All results are consistent with our findings.

To sum up, the empirical results suggest that the equilibrium real exchange rate is not a constant value, as stated by the PPP theory, and that it may fluctuate in response to changes in the real variables (called fundamentals). The equilibrium rate appears to be sensitive to the changes in fiscal (if approximated by GOVEXN variable), monetary (if approximated by WEALTH variable) and trade (if approximated by OPEN variable) policies besides the domestic and external price shocks. Although the equilibrium real exchange rate fluctuates temporarily to accommodate these shocks, persistent inconsistencies in these policies may cause the real exchange rate to depart from its long-run equilibrium value. This might suggest that although the nominal exchange rate is devalued from time to time in order to correct external imbalances as well as to curb inflation, its impact on the real exchange rate should be viewed carefully by the policymakers. Devaluation effects the other sectors of the economy and therefore, it may well be ineffective unless supported by the other policies such as fiscal and monetary policies.

6.5 Summary

The model of the real exchange rate determinants is estimated by the Johansen cointegration approach in a system of equations. The results indicated the existence of a stable long-run relationship between the real exchange rate, government expenditures on nontradables, private wealth, openness of the economy and the external trade prices. A negative relationship is specified between the equilibrium real exchange rate and the fundamentals except openness which has a positive impact. The obtained long-run estimates are very similar to those obtained in Engle and Granger estimation, indicating the robustness of the model. Further support for that comes from the short-run modelling, where both techniques produce a highly significant negative coefficient for the error correction terms and similar parsimonious forms. The adjustment to disequilibrium is slightly slower in E & G estimation (17% each period) than the Johansen estimation (18% each period). However, the model which uses import tariff rate as an alternative proxy for trade restrictions seems to be misspecified. This result confirms the Engle and Granger estimation results, in the previous chapter, which failed to give evidence in favour of a cointegration.

CHAPTER 7

MISALIGNMENT OF THE REAL EXCHANGE RATE and TRADE PERFORMANCE

7.1 Introduction

Stability and correct alignment of the real exchange rate, that is maintaining the exchange rate at its long-run equilibrium level, have been crucial conditions to improve economic performance in developing countries. Evidence from Latin American, Asian and African countries is often cited to support the view that the link between RER and economic performance is strong. It is argued that RER stability was essential in promoting East Asian development, while their instability restrained export growth in some of Latin America (Cottani et al, 1990). RER instability and misalignment, and especially overvaluation of currency is particularly important for countries who follow an export-oriented development strategy.

Turkey began a reform of its trade regime as a part of a stabilisation program and outward-oriented development strategy in 1980. These policies have been associated with increasing exports, however, the forces underlying this observed improvement in export performance have been subject of controversy. Some researchers interpreted this export performance as a statistical artefact that resulted from a switch from under-invoicing of exports in the 1970s, when the Turkish Lira was overvalued, to over-invoicing in the 1980s when it was relatively undervalued (Celasun and Rodrik, 1989). On the other hand, Arslan and Wijnbergen (1993) argued that over/under-invoicing might explain only a small part of the export growth. It has also been argued that the increased income in neighbouring oil-producing countries might have caused the Turkish exports to increase rapidly in that period. Less attention has been paid to the role of exchange rate policies, particularly to the alignment of the real exchange rate in the improvement of the trade balance in the first half of the decade and in the slowdown in the second half.

Notwithstanding its importance, the relationship between the real exchange rate behaviour and trade performance has not been examined sufficiently in empirical literature. This chapter intends to fill this gap.

The next two sections reviews some conceptual issues on the equilibrium real exchange rate and deviations from the equilibrium. The effects of a misaligned-real exchange rate on the economy are discussed in the fourth section. The next section focuses on the measurement of misalignment. Building on the equilibrium value of the real exchange rate estimated in the previous chapter, it is planned, in the sixth section, to investigate empirically the relationship between misalignment of the real exchange rates and trade performance. The chapter ends with an evaluation of the results and their implications for exchange rates policies applied after 1980 in Turkey.

7.2 Equilibrium real exchange rate (ERER)

The concept of 'equilibrium' is very elusive. In general terms it implies a state of balance. The 'equilibrium real exchange rate' (ERER) is the rate which is consistent with macroeconomic balance. In other words, it is defined as the relative price of tradables to nontradables which, for given sustainable values of other relevant variables such as international terms of trade, taxes, commercial policy and technology, results in the simultaneous attainment of internal and external balances (Edwards, 1989a). Even this situation is given different names by different authors. For example, while Edwards (1988a,b, 1989a,b) and Elbadawi (1994) use simply the term 'equilibrium real exchange rate'; Williamson (1994), Church (1992) and Clark et al (1994) call equilibrium rate as '*fundamental* equilibrium exchange rate' , defining it as a function of fundamental variables.

Stein's '*natural* real exchange rate' prevails if speculative and cyclical factors are removed while unemployment is at its natural rate. The necessary conditions to achieve this rate are the balance in goods market and the portfolio balance between the holding of assets denominated in the home and in the foreign currency (Stein, 1994).

Bayoumi et al (1994) argue that the concept of ERER consistent with underlying macroeconomic balance is based on a set of desired macroeconomic objectives (desired positions of internal and external balances). Thus they use the term '*desired* equilibrium exchange rate' to refer this concept. In a similar line (but not using the same term), Pfefferman (1985) states that equilibrium can only be defined in relation to some objectives such as the attainment of a particular growth rate of exports or GDP.

Several characteristics of the equilibrium real exchange rate can be drawn from the above studies: First of all, the ERER is not a fixed value. It may change over time in response to shocks which affect the country's internal and external balances. Williamson (1994: 179) quotes from Joan Robinson that "In any given situation there is an equilibrium rate corresponding to each rate of interest and level of effective demand, and any rate of exchange, within very wide limits, can be turned into the equilibrium rate by altering the rate of interest appropriately.". A number of reasons might be suggested for believing that the ERER changes over time: Balassa (1964) noted that there is systematic tendency for productivity to grow faster in sectors producing tradable goods than those producing nontradables, and that this differential is greater in faster growing countries. As a result, such countries may need to apply more appreciation of their currencies to maintain the competitiveness constant. Another reason may be that a country experiencing deficit continuously will be accumulating net foreign liabilities. In order to service this increasing debt and to maintain the current account constant, the country will need to depreciate its currency to increase trade balance (Williamson, 1994:181-182).

MacDonald (1997) adds further two reasons for the variability of the real exchange rate. They are nonconstancy of the RER for traded goods, which will arise if the traded goods are imperfect substitutes and there are factors which introduce systematic variability into the price of these goods; and differing weights used to construct the overall prices in the home and foreign country.

Closely related to the issue of the variability of the RER, is that there may not be a unique equilibrium value, but rather a range within which equilibrium real exchange rate is likely to lie. Thus the ERER has to be taken as a trend path rather than a constant level.[1]

[1] These two features of the ERER obviously are not consistent with the definitions which are based on PPP theory in which the ERER is assumed to be constant over time. What follows that is that deviations from the PPP do not show misalignment of the RER because actual rate has to vary in response to shocks modifying the equilibrium rate. The changing path of the ERER can only be identified using a structural model. Thus it can be claimed that using PPP measures of the RER in evaluating the policy implications may lead to erroneous conclusions.

Thirdly, the path of ERER is influenced not only by current values of the fundamental determinants, but also by their expected future values. Because of the possibilities for intertemporal substitution of consumption through foreign borrowing and lending and intertemporal substitution of production through investment, expected future events may affect the current and expected values of the ERER (Edwards, 1988a: 6).

Finally, the ERER may be affected differently by permanent and temporary changes as well as expected and unexpected changes in the fundamentals.

7.3 Deviations from the equilibrium real exchange rate

One of the purposes of calculating equilibrium real exchange rate is to establish a benchmark against which to measure misalignments in the market exchange rates. Misalignment is simply defined as persistent departures of the real exchange rate from its equilibrium value. Obviously not every change in the RER indicates its misalignment, but in fact those changes in the RER may be necessary to reflect the external and or internal shocks that change the ERER (Cottani et al, 1990). The emphasis here should be on whether or not the actual RER is moving consistently with the other dynamics of the economy or is not responding properly to exogenous or policy-induced shocks, thus departing from the equilibrium path which is assumed to bring the domestic and external sectors into the balance.

Edwards (1988a) distinguishes two types of misalignment of the RER. The first, called economic policy-induced misalignment, takes place when the actual RER deviates from its equilibrium value because of frequent changes in the nominal exchange rate or inconsistencies between macroeconomic policies and nominal exchange rate system. For example, expansive monetary policies generate pressures on the price of home goods. If a fixed exchange rate system prevails or if the adjustment is too slow in a flexible exchange rate system, the real exchange rate will tend to appreciate. This also may widen the gap between nominal exchange rates in official and parallel markets.

The second type of misalignment is called structural misalignment. It occurs when changes in the long-run values of the real determinants of the ERER are not translated in the short-run into changes of the actual RER. Any change in one of the fundamental determinants (say, a worsening of the terms of trade), will cause a change in the ERER. Unless the actual RER adjusts to reflect that change so that to maintain the equilibrium in the economy, the RER will be structurally misaligned.

7.4 Costs of misalignment

Misalignment of the real exchange rate may cause substantial welfare and efficiency losses in the economy. The results may be more severe when accompanied by exchange and trade controls (which often happen) to slow the depletion of the foreign exchange reserves (Edwards, 1988a: 22-23).

First of all, overvaluation of the currency affects the exports negatively, reducing profitability and making the exportable goods prices more expensive relative to the competitors' prices for the trading partners. If persists, this may lead to a loss of competitiveness in the international markets. However, a developing export sector is very important in the course of development. Even in the countries where exports account for only a small portion of GDP, a shortfall in foreign exchanges can slow growth for the entire economy.

An overvalued exchange rate undermines incentives to produce not only exportable goods but also import substitutes. While exports lose competitiveness, imports become cheaper as a result of overvaluation (Pfefferman, 1985).

When there are imperfections in the local capital markets and stock exchange markets, RER misalignment brings about speculation and uncertainty, and generates massive capital flights out of the country. Moreover, promoting the parallel markets, it increases the gap between the official rates and black market rates for the foreign exchanges.

Incorrect real exchange rate alignment is especially an important issue in developing countries where agriculture is a substantial source of their foreign exchange earnings and is usually the dominant economic sector, providing large employment opportunities. In addition it is a vulnerable sector, while many industries in other sectors are protected by government. Overvalued currency reduces profitability of tradables including agricultural commodity exports. "A World Bank study of agricultural policies in Mexico concludes that changes in the real exchange rate have, since 1960, had far more impact on agricultural incentives and output than any of the government's agricultural pricing policies. This is because the effect of the exchange rate was more pervasive than that of the price support mechanism, resulting in a decline in relative prices."(Pfefferman, 1985;18).

Overvalued exchange rates undermine incentives not only in agriculture but also in some other sectors including forestry, mining and basic industries. By making imports relatively cheaper, overvaluation discriminates against the development of appropriate domestic technologies. Moreover, because of cheaper imports of capital goods, it encourages relatively capital intensive methods, thus discouraging employment creation (Pfefferman, 1985).

Instability and uncertainty with respect to relative prices cause misallocation and/or movement of the resources between tradable and nontradable sectors, bringing adjustment costs.

Overvaluation as a result of inconsistent underlying policies imposes pressures on the current account of the balance of payments. Government may have to borrow to finance additional consumer goods imports, which increases the debt-servicing burden and may lead to a crisis.

Overvaluation, by making imports relatively cheaper, generates pressures for more protection on those affected sectors. The protective structures in some developing countries, erected partially in response to overvaluation, have in turn caused chronic overvaluation. The reason is that on the one hand restrictions on imports dampen demand for foreign exchange by raising the price of foreign goods and services; on the other hand, restricted access to foreign exchange translates into more overvalued exchange rate (Pfefferman, 1985).

If misalignment persists and periods of overvaluation are followed by undervaluation, uncertainty increases and investment in export industries becomes increasingly risky.

Finally, overvalued exchange rates promote rent-seeking activities in the economy. Because of the increased protection, overvaluation increases rents of those with access to import licenses and foreign credits, and encourages the politicisation of the economic process (Pfefferman, 1985).

7.5 Measurement of the misalignment

There are only a few studies on the departures of the RER from its equilibrium level. Most of the extant studies use simple comparisons of the purchasing power parity rates over time as an indicator of disequilibrium of the RER. However, when the real exchange rate variability is related to equilibrium behaviour, which might be the case for many developing countries, an analysis of misalignment based on historical comparisons of observed RER levels (particularly, when they are measured as ratios of aggregate price indexes) may lead to erroneous conclusions and thus does not assist analyse of how the disequilibrium situations affect economic performance.

As there is no unanimity in relation to definition of the equilibrium, scholars have employed different approaches to measure the ERER. Edwards (1988a: 41-46) argues that "in order to understand RER misalignment, it is necessary to understand the way in which the equilibrium real exchange rate behaves and evolves". Therefore, he initially estimates a model of the real exchange rate using the pooled-data for a group of 12 countries for the period of 1960-1985. In his study of (1989a), the equilibrium real exchange rate is defined as 'the rate which attains the internal and external balances simultaneously for given sustainable values of the fundamental determinants', therefore he attempts to compute 'sustainable values' by smoothing the series by five-year moving averages, then constructs a long-run ERER index using the estimated coefficients obtained in the empirical analysis.

Following the above argument, Cottani et al (1990) state that measuring misalignment requires an empirical analysis of RER determinants. Thus, in order to investigate the relationship between policy-induced misalignment and economic performance, they initially run a regression and then analyse the determinants of the RER used in that regression to determine the situations which cause a RER disequilibrium. Finally, they compute an indicator of misalignment for each country by taking the averages of these variables for the periods when they are believed to cause an overvaluation or undervaluation of the RER (in other words, when they are not at their sustainable levels).

Church (1992) follows Williamson (1994)'s definition of the fundamental equilibrium exchange rate (FEER) which is the rate delivering a sustainable current account balance. He estimates a trade balance equation for the exports and imports of goods and services in which the RER is one of the variables, and then draws the RER in that equation as an equilibrium value. However, this approach seems to ignore the equilibrium situation in domestic (nontradable) market.

Collins (1996) uses different potential indicators of misalignment in a single regression. The indicators include large external deficits, slow GDP growth, inflation in excess of foreign inflation and existence of multiple exchange rates. These proxies may indicate misalignment, however, this study does not attempt to specify an equilibrium concept and its determinants so that one can measure whether or not there are deviations from equilibrium.

Adapting a similar approach with Edwards (1989a), Pick and Vollrath (1994) estimate a long-run equation for the ERER and its determinants using a set of pooled-cross sectional data for 10 developing countries from 1971 to 1988. Assuming that monetary variables such as growth of domestic credits and fiscal deficits have no effect on the ERER in the long-run, they exclude these variables from the analysis and then they calculate the ERER for a 4-year calculated moving averages of the real exchange rate fundamentals. Misalignment is then calculated as the ratio of actual RER to the calculated ERER.

Elbadawi (1994) also follows the tradition of Edwards (1989a). He establishes a model of RER and estimates the reduced form in a regression to get the long-run coefficients. The 'sustainable' or 'permanent' values of fundamentals are obtained by decomposing them into permanent and cyclical components by means of some time series techniques such as Nelson and Plosser, Cuddington and Winters, Beveridge and Nelson. After computing an index of equilibrium RER for given sustainable values of other variables, he constructs a misalignment index as

$$M = [(RER - ERER) / ERER] * 100 \tag{7.1}$$

From the discussion on the equilibrium real exchange rate and the attempts to measure it, several points can be drawn: First of all, the ERER is not constant, thus deviations from the PPP do not show misalignment because actual rate has to vary in response to shocks modifying equilibrium rate. Therefore a model-based approach which is capable of generating a vector of ERER that are allowed to change over time, has to be employed. Secondly, almost all studies agree that the ERER is the rate which brings internal and external sectors in to the balance. Thus definition of these balances and specification of the parameters that define the relationships among the current account, real demand and real exchange rate are of primary importance to identifying the ERER.

To sum up, there are mainly two approaches to measuring the equilibrium/ misalignment of the RER in the literature :

The first one is estimating a misalignment series using its main determinants (either by running a regression or by simply taking averages of these variables). Such variables as large external deficits, slow growth, domestic inflation in excess of foreign inflation, multiple exchange rate system, excess domestic credit creation are used as indicators of the misalignment (Cottani et al, 1990; Collins, 1996). The main purpose in these studies is to analyse the effects of RER misalignment on certain sectors such as agriculture or export sectors and usually they do not focus on equilibrium behaviour of the RER. In addition, carrying out such an analysis requires a separate econometric estimation as well as data on each determinants of misalignment. The initial aim in our study is to analyse equilibrium behaviour of the RER which is obtained as a result of solution of a model which takes into account both internal and external balances of the economy. The ERER is defined in the current study in terms of sustainable values of the RER determinants, unlike the above studies which use the actual values only. Moreover, we do not have monthly data on many of these variables to compute an misalignment index.

The second type of studies such as Pick and Vollrath,1994; Elbadawi, 1994; Edwards, 1989a, initially estimate a model of real exchange rates using mainly cointegration analysis and obtain the estimates of long-run equilibrium coefficients for given sustainable values of other variables in the model. They use a number of methods to approximate the sustainable values: Some of them decomposes the series into permanent and temporary components by means of the Beveridge and Nelson technique and then uses the former series to calculate ERER series. Some others employs simply some smoothing methods such as moving averages assuming that average level of series might approximate the sustainable values.

The latter approach to measuring the ERER is consistent with earlier theoretical discussions, thus we prefer this second approach to construct a misalignment series.

As discussed in the second section, both internal and external sectors are well-specified in our model and the solution yields a path of steady-state equilibrium values[2] of the real exchange rates for a given set of variables (fundamentals). Once the long-run coefficients for the ERER are obtained, we can find the estimates of the ERER. In order to do this, we first have to decide which values of the fundamentals actually will be used. In other words, the economic concept of 'long-run value' must be transformed into a measurable quantity. Using actual values conflicts with our theoretical definition of the ERER because they are subject to many seasonal, cyclical or irregular fluctuations and thus it is unlikely for them to be in equilibrium values all the times. A second approach would be to choose values based on some historical patterns; that is, analysing the data with respect to main changes in the economy and deciding upon the

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[2] Because of mainly two reasons steady-state values might depart from the equilibrium values. These are price inertia and differences between short-run and long-run elasticities. However, testing the existence of these factors requires complex arithmetics, therefore as many econometricians including Hendry do, we call the solution of the cointegrating regression as 'long-run equilibrium solution'.

periods when they are likely to be stable. This method seems to be better than the former one, however, it still carries arbitrariness and subjectivity to some extent. Moreover, it is more appropriate to use this approach in the case of panel data studies than it is for time series analyses. Finally, the sustainable values might be proxied by permanent components, which can be obtained either by some smoothing techniques or by decomposition methods.

Moving averages or centered-moving averages are the main smoothing techniques used in many time series studies. This method would be more appropriate for the series whose data generating processes are simply a random walk. In addition, moving averages, especially, higher-order ones smooth the series well but this may be at the expense of distorting the nature of the series. When the series shows more complex processes than a random walk, it is recommended to use some ARIMA process which takes into consideration of autoregressive behaviour in the series together with moving averages. The Beveridge and Nelson (BN) technique is based on an ARIMA process. The next section will cover firstly theoretical discussion of the BN method and then it will be applied to the present data to obtain estimates of the equilibrium real exchange rate series.

7.5.1 Decomposition of series into permanent and transitory components

Non-stationary time series can be decomposed into two additive components, a stationary series and a pure random walk. The stationary part is the cyclical or transitory component. The random walk is the permanent or secular component. Since cyclical fluctuations are assumed to die out over time, any long-run movement is necessarily attributed to the secular component (Nelson and Plosser, 1982).

In applied work, it is often necessary to carry out an analysis of macroeconomic trends before determining policies to achieve short-run stabilisation and/or long-run economic growth. The easiest method of detrending is regressing the series on time and then interpreting the residuals as the cyclical components. This approach assumes a data generating process which can be expressed as a time trend plus a stationary stochastic process with mean zero. That is,

$$y_t = a + bt + e_t \tag{7.2}$$

where y_t denotes the logarithm of a series and t time trend.

In this modeling, the path of the series is assumed to be completely deterministic, that is neither current nor past events can change the long-run expectations. However, if the secular movement in a series is stochastic rather than deterministic in nature, then models based on time trend residuals are misspecified (Nelson and Plosser, 1982). Cuddington and Urzua (1989), using time-series results on the Colombian economy, show that a standard time-trend fitting procedure may be misleading. It tends to overestimate the magnitude of the cyclical component in time series and thus, to underestimate the secular or growth effects.

Beveridge and Nelson (1981) propose an alternative description of nonstationary time series, namely a 'difference stationary model'. This approach assumes that the steady-state growth path of the series may shift upward or downward over time. Shifts in the growth path displays permanent effects, while fluctuations around the growth path are cyclical effects. A difference stationary model can be formulated as,

$$y_t - y_{t-1} = a + e_t \tag{7.3}$$

$$\text{with} \quad A(L)e_t = B(L)u_t \tag{7.4}$$

where u_t is white noise and L denotes the lag operators.

That is the growth rate of y (because y is in logarithm) is regressed on a constant and an error term with a general Autoregressive-Moving average (ARMA) specification.

In fact many economic time series can be well represented by the class of nonstationary ARIMA processes for which the first differences are a stationary process of an autoregressive-moving average form. Denoting the first differences of the series y_t by w_t, that is $w_t = y_t - y_{t-1}$, if w's are stationary in the sense of fluctuating around a fixed mean with stable autocovariance structure then w_t may be expressed as

$$w_t = \mu + \varepsilon_t + \lambda_1\varepsilon_{t-1} + \ \ldots \tag{7.5}$$

where μ is the long-run mean of the series, the λ's are constants and ε's are uncorrelated random disturbances with mean zero and variance. The ε's are often referred to as 'innovations' because they are the part of w_t and y_t which are not predictable from the past.

Beveridge-Nelson (BN)'s decomposition technique is motivated by considering the relation of the current value y_t to the forecast profile for future y's. Thus the forecast profile takes the place of a deterministic trend as the benchmark for the location of the series and therefore for measuring the cyclical component.

They derive expressions for the change in the permanent component of series y as[3]:

$$\bar{y}_t - \bar{y}_{t-1} = \mu + (\sum_{0}^{\infty} \lambda_i)\varepsilon_t \ , \quad \lambda_0 = 1 \tag{7.6}$$

That is, the permanent component y is a random walk with rate of drift equal to μ and a non-correlated innovation equal to $(\Sigma^{\infty}{}_0\lambda_i)\varepsilon_t$.

The permanent component can be interpreted as the current observed value of y plus all forecastible future changes in series beyond the mean rate of drift. That is :

$$\bar{y}_t = y_t + \lim_{k \to \infty}\{[\hat{w}_t(1) + \hat{w}_t(2) + \ldots + \hat{w}_t(k)] - k\mu \ \} \tag{7.7}$$

Then the cyclical component c_t is defined as :

$$\hat{c}_t = \lim_{k \to \infty}\{[\hat{w}_t(1) + \hat{w}_t(2) + \ldots + \hat{w}_t(k)] - k\mu \ \} \tag{7.8}$$

where $w(k)$ is the conditional k-period ahead forecast of w given information up to period t. That is,

[3] See Beveridge and Nelson (1981), p.155 for derivations.

$$\hat{w}_t(k) = \mu + \lambda_k \varepsilon_t + \lambda_{k-1} \varepsilon_{t-1} + \ldots \tag{7.9}$$

The practical implementation of the BN procedure requires that they confine their attention to linear processes of rational form,

$$w_t = \mu + \frac{\theta(L)}{\phi(L)} \varepsilon_t$$

$$= \mu + \frac{1 - \theta_1 L - \theta_2 L^2 - \ldots - \theta_q L^q}{1 - \phi_1 L - \phi_2 L^2 - \ldots - \phi_p L^p} \varepsilon_t \tag{7.10}$$

Assuming that the process (7.5) may be written in rational form (7.10), then the equation

$$w_t = \phi_1 w_{t-1} + \ldots + \phi_p w_{t-p} + \mu(1 - \phi_1 - \ldots \phi_p) + \varepsilon_t - \theta_1 \varepsilon_{t-1} - \ldots - \theta_q \varepsilon_{t-q} \tag{7.11}$$

in which case $\{w\}$ is referred to as a mixed ARIMA process of orders p and q. Equation (7.11) is estimable and gives estimates of the parameters (ϕ, μ and θ) and the innovations ε_t. These are then used to calculate the cyclical components in (7.8). Because the theory will not provide the appropriate values of p and q, these must be determined by analysis of data. Box and Jenkins (1976) have recommended the use of autocorrelation and partial autocorrelation functions of the series for model identification.

To sum up, decomposition of series into permanent and transitory components by BN technique involves two steps: (i) identification and estimation of an

ARIMA model for first differences of the nonstationary series, (ii) numerical evaluation of c_t using a practical equivalent of (7.8).

Obviously the second step involves several calculations. However, Cuddington and Winters (1987) propose a simpler method for carrying out the decomposition analysis. It is based on the key observation that the expression ($\Sigma^{\infty}{}_{0}\lambda_i$) in (7.6), (which describes the change in the permanent part), is the *steady-state gain function* for a transfer function of the form (7.5). Using the rational form (7.10), the steady-state gain function, which is determined by setting L = 1, equals

$$\bar{y}_t - \bar{y}_{t-1} = \mu + \frac{1-\theta_1-\theta_2-\ldots-\theta_q}{1-\phi_1-\phi_2-\ldots-\phi_p}\varepsilon_t \tag{7.12}$$

This equation describes the evolution of the permanent components of the time series as innovations ε_t occur. This difference equation can be solved for the levels of the permanent components and the cyclical components then obtain the permanent minus the observed series.

7.5.2 Practical implementation of the Beveridge and Nelson technique and application to Turkish data

In this section, firstly the BN technique will be applied to decompose the series of fundamental variables into permanent and temporary components. Secondly, an index of the long-run equilibrium real exchange rate will be estimated for given 'sustainable' values of the fundamentals by using the cointegration results. Finally, a misalignment index will be constructed and analysed.

Recall from the cointegration analysis that the determinants of the RER include the government expenditures on nontradable goods, total wealth of the private sector, openness of the economy and external terms of trade. The BN technique requires specification of an ARIMA model in the first step. In the estimation process, three indicators have been used mainly for model fitting: Residual autocorrelation (Box & Ljung statistic), standard error of regression and Akaike Information Criterion (AIC). The diagnostic results of some of the estimations are presented in Table 7.1.

Modeling the **private wealth (WEALTH)** variable with a first order ARIMA process exhibits autocorrelation among the residuals, according to Box-Ljung statistics. When 12 lags are added to the MA component, the autocorrelation is removed and the standard error of the regression decreased. However, none of the coefficients for the MA part are significant in this case. The model evaluation ends up with a specification of ARIMA(12,1,3) for this variable, since this model fits statistically well with the lowest information criterion :

$$\underset{(-2.27)}{(1 - 0.25L} - \underset{(-2.40)}{0.25L^3} + \underset{(2.05)}{0.15L^8} + \underset{(7.77)}{0.54L^{12}})\Delta WEALTH_t = (1 - \underset{(-2.74)}{0.35L} - \underset{(-2.91)}{0.35L^3})u_t \qquad (7.13)$$

The *gain function* for this variable would be

$$\Delta WEALTH_{pt} = 2.09\varepsilon_t \qquad (7.14)$$

The residual autocorrelation could not be eliminated from any of the models of **openness (OPEN)** variable, probably due to the high seasonality in this variable.[4]

[4] It is highly likely that the seasonality arises from the construction of the variable. Namely, openness is defined as the ratio of volume of trade to the GDP. The GDP is originally a quarterly data and is converted into a monthly base using the average changes in monthly electricity production (See Chapter 4 for details).

Table 7.1 : Model evaluation

ARIMA(p,d,q) specification[1]	Standard error of regression	Box-Ljung statistic Q(12) / Q(24)[2]	AIC [3]
WEALTH			
ARIMA(1,1,1)	0.020	42.39* / 83.87*	-945.74
ARIMA(12,1,12)	0.017	7.64 / 13.17	-986.59
ARIMA(12,1,3)	0.017	5.01 / 20.54	-989.95
OPEN[4]			
ARIMA(1,1,1)	0.053	50.1* / 60.7*	-579.59
ARIMA(12,1,12)	0.048	4.21 / 11.71	-590.11
ARIMA(12,1,0)	0.047	4.54 / 20.44	-605.82
GOVEXN			
ARIMA(1,1,1)	0.127	45.09* / 88.01*	-240.12
ARIMA(12,1,12)	0.104	1.54 / 8.55	-280.31
ARIMA(11,1,0)	0.113	6.99 / 24.91	-271.95
TOT			
ARIMA(1,1,1)	0.003	11.75 / 29.13	-9655.3

[1]p,d,q stand for orders of autoregression, difference and moving average, respectively.
[2]Q(.) Box-Ljung autocorrelation statistics of 12th and 24th orders, * shows the existence of autocorrelation, compared with the critical values of $\chi^2(12) = 21$, $\chi^2(24) = 36.4$ at 5% level.
[3]AIC is Akaike Information Criterion, where the model with smaller value is preferred.
[4]Seasonally adjusted.

Thus it was deseasonalised using the X11-ARIMA method[5] and then various specifications of ARIMA were estimated with some of them presented in the Table 7.1. The adjusted openness still exhibits serial autocorrelation in the first order. Increasing the number of auto-regressive lags seems to be enough to solve that problem, with (12,1,12) none of the MA coefficients are significant.

[5] X11-ARIMA is a procedure for seasonal adjustment of time series data, developed by Statistics Canada as a modification of Method II-X-11 of the United States Census Bureau (See "SPSS for Windows, Base System User's Guide, release 6.0, 1993" by M.J. Norusis).

Thus the model AR(12) looks a better fit than the alternative specifications. The standard error is relatively low and the Akaike information criterion favours this model. The final specification is expressed as :

$$\underset{}{(1} - \underset{(-7.18)}{0.55L} - \underset{(-4.35)}{0.38L^2} - \underset{(-3.39)}{0.29L^6} + \underset{(2.76)}{0.20L^{12}})\Delta OPEN_t = u_t \qquad (7.15)$$

which simply explains the variable as autoregressive behaviour without a drift.

The steady-state *gain function* is

$$\Delta OPEN_t = 0.50\varepsilon_t \qquad (7.16)$$

The **government expenditures on nontradables (GOVEXN)** variable is estimated initially with an ARIMA(1,1,1) process similar to the above two variables. It also has residual autocorrelation at both 12th and 24th orders at 5% level, a result which is not unexpected given monthly data. Serial autocorrelation is removed in the model ARIMA(12,1,12), however, the coefficient for the 12th order AR and the coefficients for all orders of MA are not statistically significant. Then, an AR(11) is estimated. It has no evidence of autocorrelation. As a result, this model is used in obtaining the permanent values of government expenditures on nontradable goods. The model has a drift and consists of merely autoregressive components, where the coefficients are significantly different from zero for all lags as seen below :

$$(1 - \underset{(-16.24)}{1.05L} - \underset{(-10.32)}{0.99L^2} - \underset{(-8.59)}{0.97L^3} - \underset{(-6.58)}{0.83L^4} - \underset{(-5.92)}{0.77L^5} - \underset{(-6.31)}{0.82L^6} - \underset{(-5.39)}{0.71L^7} - \underset{(-5.27)}{0.67L^8} -$$

$$\underset{(-5.43)}{0.62L^9} - \underset{(-5.24)}{0.51L^{10}} - \underset{(-7.56)}{0.51L^{11}})\,\Delta GOVEXN_t = \underset{(2.38)}{0.002} + u_t \qquad (7.17)$$

The *steady-state gain function* can be expressed as[6] :

$$\Delta GOVEXN_t = 0.106\varepsilon_t \qquad (7.18)$$

Finally, consider the **external terms of trade (TOT)** variable. Neither the AR nor the MA components are significantly different from zero in ARIMA(1,1,1), which might imply that there are no meaningful cycles (or they are too small) for that variable and that it seems to have simply a random walk process. Thus the permanent components are proxied by taking centered-moving averages of 12th order.

To sum up, estimations of ARIMA processes by SPSS program for these variables shows that all can be specified as difference stationary models with various orders of ARIMA processes without drift, except the government expenditure variable. None of the variables has a trend stationary process.[7]

Having obtained the coefficients for the AR and MA parts, the next step is to decompose the series into permanent and cyclical components. Using the coefficients in the gain functions specified above and using the equations 7.7, 7.8 and 7.9, permanent and cyclical components are obtained in levels. Generally speaking, removing cyclical components from the series seems to remove some of the short run variability, but a great deal of short run variability remains, as can be seen in Figures A7.1-A7.5 presented in Appendix-7. Consequently, short run variations dominated the equilibrium RER and in turn,

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[6] The constant term, μ in the gain function of the form equation (7.12) is calculated from the expression, $\mu(1-\phi_1 - \ldots - \phi_p)$ in the equation (7.11), where ϕ's are the AR coefficients. The constant term, μ for the gain function of GOVEXN is computed as 0.00021, which is too small, thus ignored.

misalignment series obtained.[8] Whilst such variability is consistent with the Beveridge-Nelson definition of a permanent component,[9] it is implausible to suggest that there is so much short run variability in actual misalignment. Given the short time series available for estimation, and the need to use a proxy for openness, these limitations in the monthly data are perhaps inevitable. Nevertheless, the average level of misalignment calculated for any one year might give an indication of the degree of misalignment in that year. Therefore centered-moving averages are taken on an annual basis.

The resulting permanent and cyclical series are sketched in Figure 7.1 for the sake of comparing the two components. Now, the long-run trends or movements of the series can be followed more clearly. The cyclical components fluctuated in about a 10% range on average, but look, as expected, remarkably stationary. After constructing the equilibrium RER and misalignment series in the next paragraphs, these permanent series of fundamentals will be plotted against the permanent RER to see their co-movement over time, and then be analysed in detail with particular reference to the equilibrium and misalignment series.

In the next step, the equilibrium RER series are constructed using the long-run estimates obtained by the Johansen procedure in Chapter-6, for given the sustainable values of the fundamental determinants. Recall that the long-run equation for the ERER was as follows:

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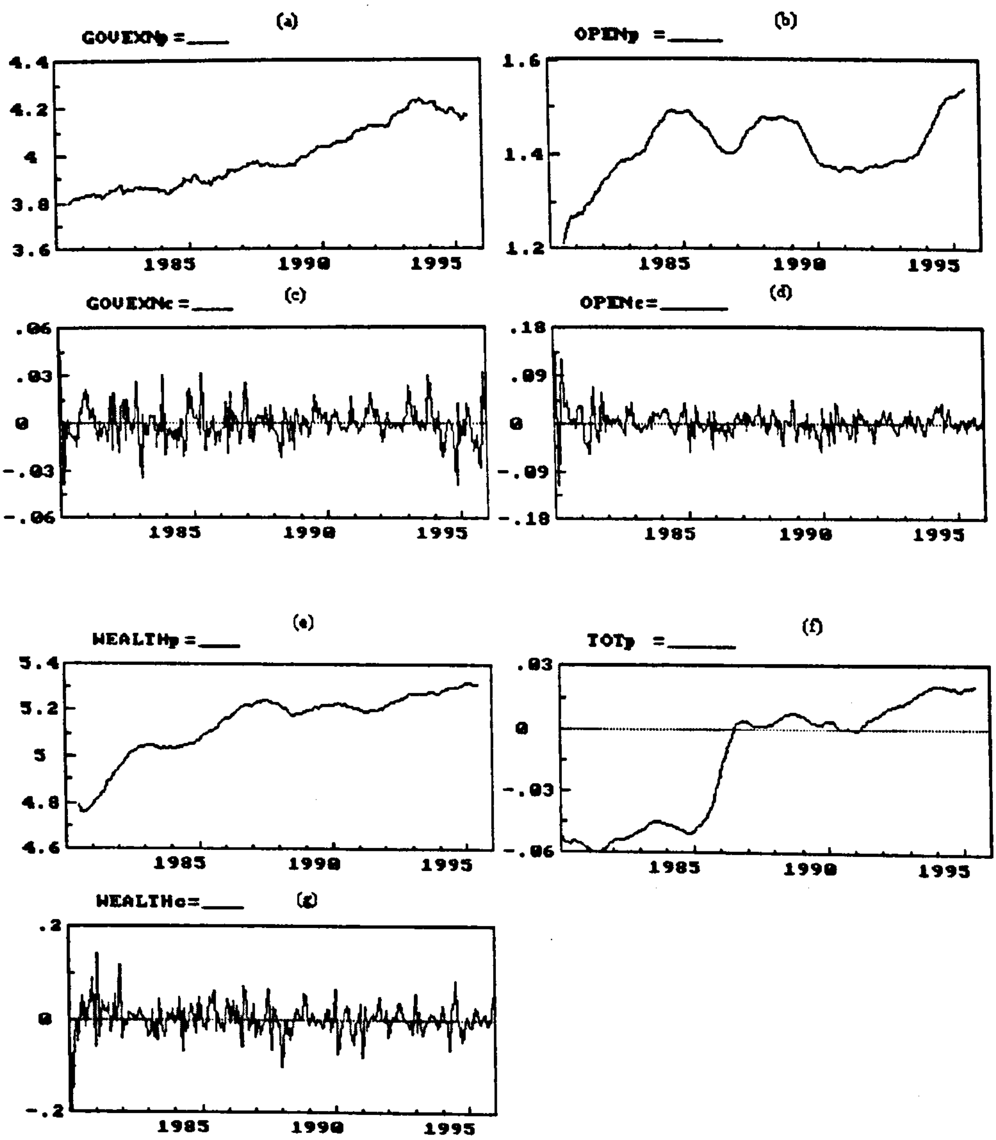
[7] This result confirms the results of the stationarity tests in Chapter 4 in which all series including the RER become stationary in the first differences and trend term is not significant.
[8] See the Appendix-7 for a discussion and inspection of the figures.
[9] The permanent component is an I(1) series and the temporary component is I(0), so the former contains all the permanent shocks to the series. The problem is that we are using a proxy which is likely to be subject to more frequent shocks than the series it is proxying.

$$ERER = 7.95 - 0.43GOVEXN^{*} - 0.13WEALTH^{*} + 0.62OPEN^{*} - 0.61TOT^{*} \quad (7.19)$$

where * indicates the sustainable values.

Figure 7.1 : Permanent (Xp) and cyclical (Xc) components of the series



Then, comparing the values of ERER with the actual rates gives an index of misalignment as follows:

$$MIS = [(RER - ERER) / ERER] * 100 \quad (7.1)$$

Here, it should be noted that the computed ERER values do not represent a unique equilibrium in terms of the intercept and thus it has to be normalised. The ERER and actual RER are scaled in such a way that their averages are equal to each other over the period in which the fundamentals look relatively stable and close to their equilibrium levels (so do the internal and external sectors). Inspection of the graphs of the variables in question (see Chapter 4) shows that the period 1986-1990, especially the year 1989 seems to be appropriate as a base year because in that year the actual RER is very close to the ERER computed and there were no major fluctuations in the data. In fact, the actual RER index is a 1989-based index.

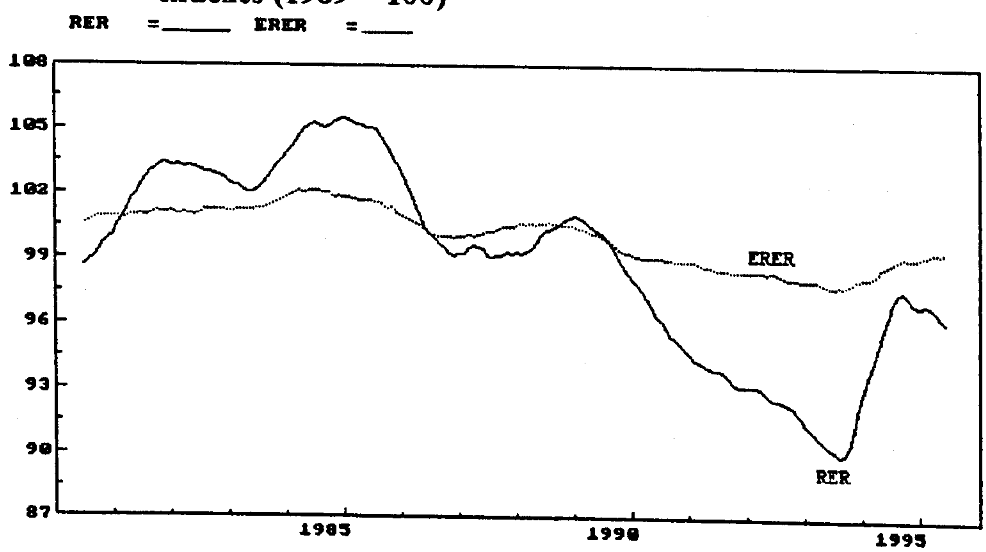
Therefore, an index of ERER is constructed by scaling the series on the average of 1989 and plotted in Figure 7.2. An increase in the series implies depreciation of the ERER, while a decrease means appreciation. The ERER moved up steadily as response to the liberalisation policies in 1980. However from the early 1984, the trend turned to appreciation of the ERER until the beginning of the 1986 when the nominal currency was devalued further. The period 1989-1993 witnessed a continuous real appreciation of the ERER. The April-1994 Austerity Program managed to stop further decreases in the ERER. The index looks relatively stable. It fluctuates within a reasonable range of about 4%, having the maximum value of 102.19 at July 1984 and the minimum value of 97.82 at July 1993.

Using the formula in (7.20) which compares the equilibrium series with the actual ones, a series of misalignment is calculated as presented in Figure 7.3.[10]

The positive values represent undervaluation of the RER, while the negative values denote overvaluation. The depreciation and appreciation episodes figured in the previous graph can be seen now more clearly.

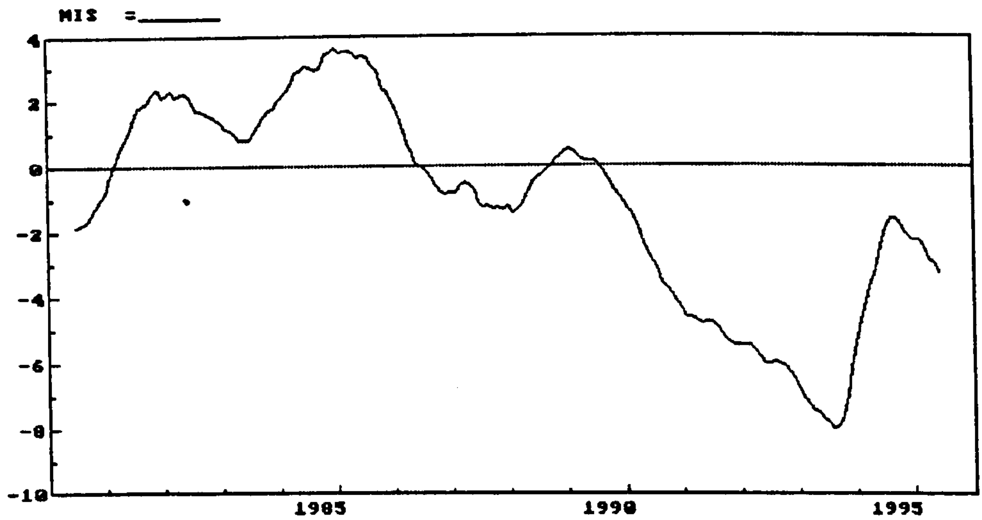
The most striking feature of the misalignment series is the dominance of the actual RER changes in these series. This might suggest that most of the misalignment of Turkish real exchange rate in that period is mainly caused by changes in the actual rate (and partially by frequent changes in the nominal rate induced by liberalisation policies).

Figure 7.2 : Actual (RER) and equilibrium real exchange rates (ERER) indexes (1989 = 100)



[10] Although not reported here, the calculated misalignment index seems to be robust to various ARIMA specifications. The general trend of the series remained unchanged although some fluctuations which might not be attributed to the long-run behaviour of the series, might be observed.

Figure 7.3 : Misalignment index (%)



In order to see the performance of the misalignment series calculated in reproducing the well-known overvaluation and undervaluation episodes (of nominal exchange rates), the obtained series will be analysed in detail with particular attention to the macroeconomic developments in the economy and the movements of the fundamental variables over the sample period. Comparing the movements in the observed RER with those in the fundamentals might give an idea about the source of misalignment as well. It should be noticed here that such an approach requires the assumption of *ceteris paribus*. That is, we interpret the movements in the RER with respect to movements in a single factor, say government expenditures, assuming that all other things are not changing. Obviously depreciation of RER in a certain period might be caused by many other factors besides a decrease in government expenditures on nontradable goods. Moreover, some principal macroeconomic indicators of Turkish economy from 1980 to 1995 are presented in Table 7.2 in order to help analyse the movement of the RER with respect to other economic parameters.

The whole period is divided into two episodes as before- and after-August 1988

Table 7.2 : Selected macroeconomic indicators of Turkey, 1980-1995

	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995
	(Annual percentage change)*															
Real GNP[1]	-1.1	4.2	4.6	3.3	5.9	5.1	8.1	7.5	3.6	1.9	9.2	0.5	6.4	7.6	-6.0	8.1
Exports[2]	28.7	61.6	25.2	0.25	25.1	11.7	-8.1	36.1	15.6	-1.2	10.6	4.9	8.3	4.3	18.0	19.5
Imports[3]	56.0	14.0	-0.6	4.4	16.1	8.7	-5.0	27.1	1.1	16.7	41.1	-6.9	8.7	28.7	-20.9	53.5
CPI (1987=100)[4]	101.4	33.9	28.3	31.4	48.4	45.0	34.6	38.9	73.7	63.3	60.3	66.0	71.1	66.0	125.5	78.9
WPI (1987=100)[5]	107.2	36.8	27.0	30.5	50.3	43.2	29.6	32.0	70.5	63.9	52.3	55.4	59.2	61.4	149.6	64.9
M1[6]	57.9	38.0	38.0	48.1	17.5	39.7	56.6	62.1	30.3	72.9	60.5	34.1	66.8	71.9	84.1	72.9
PSBR (% of GNP)[7]	10.5	4.9	4.3	6.0	6.5	4.6	4.7	7.8	6.2	7.1	10.5	14.4	12.6	9.0		
RER[8]		18.7	4.4	-4.6	15.3	-0.8	-19.1	-5.1	4.5	-0.1	-16.6	-10.4	-6.3	-9.6	33.8	-2.1
	(in billions of US dollars)															
Current acc.balance[9]	-3048	-1936	-952	-1923	-1439	-1013	-1465	-806	1596	961	-2611	258	-974	-6433	2631	-2339

*Own calculations

SOURCE : [1,2,3,4,5,7,9] 1980-1991: The Economic and Social Indicators, 1950-1992, The State Planning Organisation; 1992-1995: Selected Short-Term Indicators, The State Institute of Statistics, March- April 1996.

[6] 1980-1991: Main Economic Indicators, (SPO), June 1993; 1992-1995: Same above.

[8] Own series (Annual average of monthly series, a negative sign indicates appreciation).

periods. August 1988 has been taken by many economists as a policy shift point which is the beginning of the flexible exchange rate system. In addition, the former sub-period coincides with the main undervaluation period while the second sub-period can be characterised as an overvaluation period. Dividing into periods might make the analysis easier in that knowing the general characteristics of a period beforehand may enable us to analyse a second variable without necessarily keeping the first one (here, RER) constant.

January 1980 - July 1988 :

This period corresponds to the beginning of the liberalisation program which is characterised mainly by voluntary, real depreciation of the nominal exchange rate in order to encourage exports. The system was a passive crawling peg regime and in that period the outward-oriented development strategy was supported by financial liberalisation and restrictive fiscal policies. Nominal exchange rates are often used as an instrument to promote the exports. In January 1980, the nominal rate was devalued by 33 % and another 13 % in 1981. The immediate impact was a sharp boom in exports by over 60 % in 1981, as seen from Table 7.2. This contributed a high rate of growth of GNP by 4 %. The current account deficit began to decrease gradually at the same time. Inflation fell to 34 % from a three-digit level at 1980 by means of demand management policies. The rate of growth of money supply (M1) also slowed down, indicating restrictive monetary policies as a part of stabilisation program. Public borrowing decreased relatively as a result of restrictive fiscal policies. Consistency of economic policies continued until 1986 (that is, steep depreciation, restrictive fiscal policy, financial liberalisation, low public sector borrowing requirement etc.). However consistency was lost significantly thereafter (Asikoglu and Uctum, 1992). In fact from 1985 the RER tended to appreciate, resulting in a fall in exports and an increase in current account deficit.

If we want to see what happened to the fundamental variables of our model during this period, the permanent values of these variables are compared with the actual movements of the RER (moving averaged) in Figures 7.4 to 7.7.[11] As a result of the frequent devaluation of the nominal currency and hence continuous depreciation of the RER, openness of the economy increased remarkably until 1985, as expected, as illustrated in Figure 7.4. Then it slowed down and it tended to rise again in 1987 with further devaluation. The external terms of trade moved in the opposite direction to the RER, as expected. Contrary to the prediction of the theory, however, real wealth seems to move in the same direction as the RER until 1984s. This might roughly be interpreted as an indication of inconsistency between monetary policy and exchange rate policy applied in this period. However, after this date, it continued to increase while the increase of the RER slowed down. Government expenditures followed a steady increasing trend in this period.

[11] In these figures, means and ranges are adjusted in order to see the co-movement of the series in a similar scale.

Figure 7.4 : Actual RER and openness of the economy (OPEN)

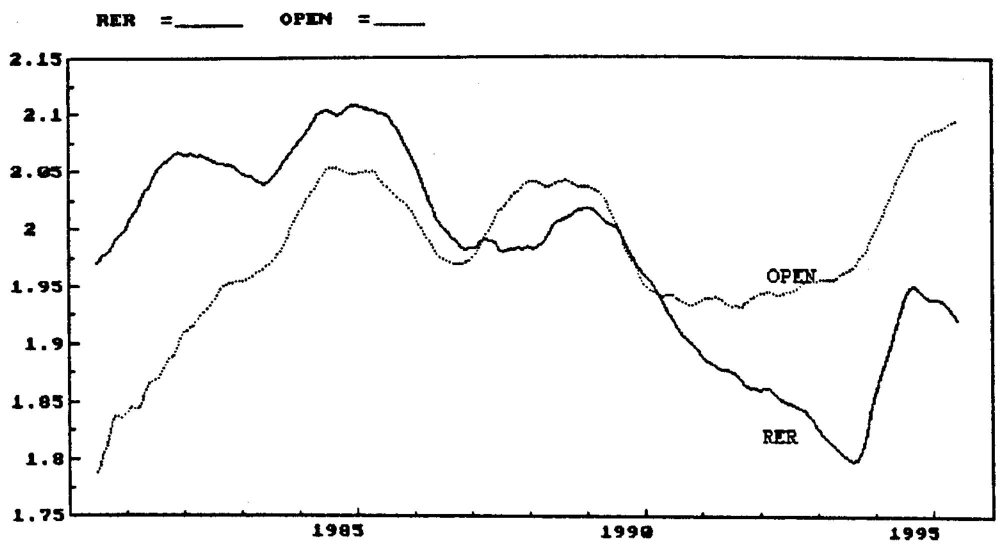


Figure 7.5 : Actual RER and government expenditures on nontradable goods (GOVEXN)

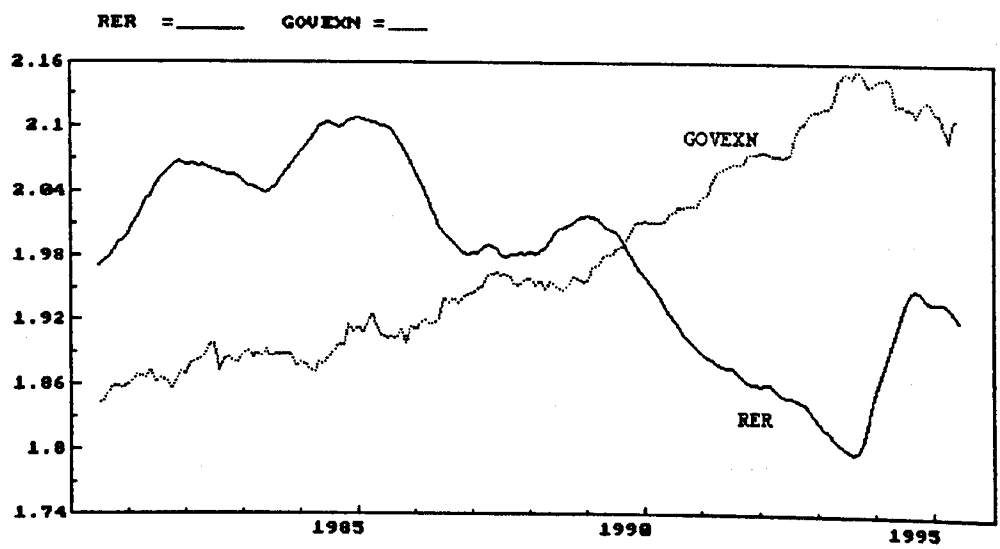


Figure 7.6 : Actual RER and real wealth of private sector (WEALTH)

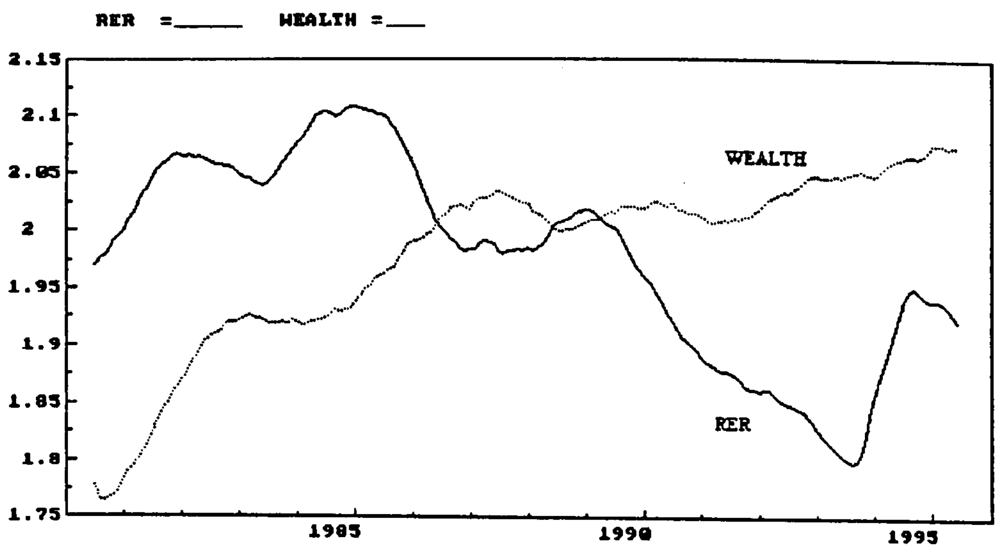
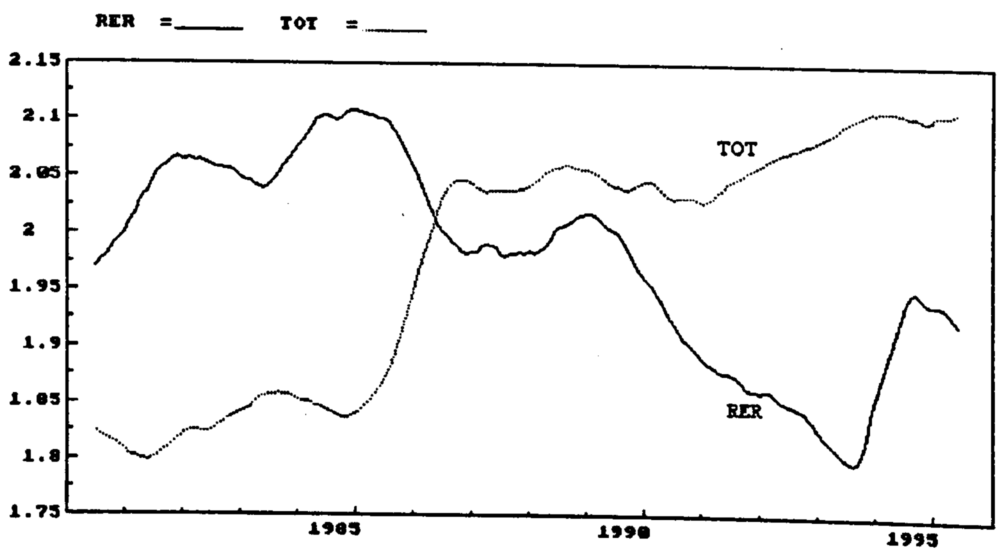


Figure 7.7 : Actual RER and external terms of trade (TOT)



Finally, if we look at the misalignment series (Figure 7.3), the period is dominated by undervaluation, which tracks successfully the continual depreciation of the nominal currency in that period. The RER was remarkably overvalued in 1979. The initial devaluation in January 1980 with the liberalisation policies intended the RER to restore to its equilibrium level and this could not be achieved until the beginning of 1981. As an incentive to encourage exports, the RER was kept undervalued. Concerns over accelerating inflation led the authorities to refrain from sizable real depreciation in some years such as 1983 and 1987, thus the rate of depreciation was lower in these years relative to the initial years of the liberalisation (Asikoglu and Uctum, 1992). The index reached its maximum value of 6.24 % undervaluation in December 1984. The period 1987-1989 was a relatively stagnant period. The RER stayed close to its equilibrium value, thus the misalignment was around zero.

August 1988 - December 1995 :

In August 1988 the Central Bank introduced a system of partial market setting of the official exchange rate. Under this new system, the Central Bank conducted the daily sessions of the interbank spot exchange market composed of banks, special finance institutions and licensed foreign exchange dealers.

From 1988s the authorities started implicitly to use the nominal exchange rate as a part of an anti-inflationary strategy. The export promotion target was subordinated to the disinflation policy. As a result, the rate of nominal depreciation fell consistently behind the rate of inflation, resulting in a sizable real appreciation. Exchange rate policies were not supported by consistent demand polices and public finances also deteriorated. Fiscal policy inclined to be expansionary and financial liberalisation started to conflict with fiscal balances. Failure to substitute the lost revenues due to trade liberalisation with noninflationary methods of financing made the over all economic policies inconsistent with each other, leading to acceleration of inflation (Asikoglu and Uctum, 1992). Looking at Table 7.2, the RER appreciated steeply up to 17 % in 1990; the inflation rate rose to the level of pre-liberalisation period (125 % in 1994); growth rate slowed down and even became -6 % in 1994. Although the current account surprisingly had a surplus (probably due to capital inflows, mainly from foreign credits and workers' remittances) in 1988, 1989 and 1991, it also reached a record deficit of 6433 billion of US dollars in 1993. The rate of increase of the public sector borrowing requirement as a percentage of GNP exceeded the rate in the pre-liberalisation period (14.4 % in 1991) as a result of the expansionary public policies. On the other hand, the government pressed the Central Bank to issue money to get extra funds and this accelerated the inflation rate (Table 7.2).

These negative developments called for immediate measures to be taken and at the 5th of April 1994. An austerity program was announced and Turkish Lira was devalued against other currencies to try to stop further appreciation in the nominal rates. This is reflected in a real depreciation of the real exchange rate by 33.8% in 1994. The program included some restrictive monetary and fiscal policies to curb the inflation. When compared to 1994, inflation declined, exports increased slightly, but imports increased much more in 1995. However, from 1991 to the present, none of the political parties has had power alone and there has been coalition governments even whose partners and thus the cabinets had to change often.[12] This made implementation of a long-term stabilisation program and its management difficult to cope with these major economic problems. Thus, because of the political instability the Austerity program was not applied properly and the devaluation of the currency was not accompanied by the necessary monetary and fiscal policies. Its effect became short-lived. Thus, the inflation rate began to rise, money supply increased and the RER started to appreciate from the second half of 1995.

Interestingly, the fundamentals and the RER seem to move consistently in line theoretical expectations in that period, with the RER falling and GOVEXN, WEALTH and TOT increasing until 1994. OPEN first declined, then stayed relatively stable. From 1994, while the RER was moving up due to devaluation, GOVEXN declined and OPEN rose sharply as expected. However, WEALTH continued to rise probably because of the lax monetary control (Figures 7.4 to 7.7).

It is obvious from Figure 7.3 that after 1989 the objective of export growth was subordinated to the objective of disinflation as nominal depreciation fell behind the inflation rate. In this period, the index indicates the highest level of the misalignment, a 9.56 % overvaluation, with the period average -6.08 %, which successfully reproduces the actual continuous appreciation observed in this period. From 1988s to the major devaluation in April 1994, the RER appreciated continuously. The devaluation stopped further appreciation, but it still remained overvalued. Because of the reasons explained above, the rate of appreciation tended to rise again from the beginning of 1995.

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[12] 1991 elections: DYP-SHP coalition government, but the cabinet changed three times because both parties' leaders changed. 1996 elections: Three different coalition governments since then: ANAP-DYP, RP-DYP and ANAP-DSP-CHP.

From the above analysis one can conclude that the misalignment of the RER until 1988s seems to be a policy-induced misalignment. The policy of persistent depreciation has been an essential part of the outward-oriented growth strategy Turkey adopted in 1980. The impressive growth of exports as well as growth of GNP, improvement in current account balance and external debt were accomplished by mainly exchange rate policy. However, the exchange rate policy as well as trade and financial liberalisation policies employed simultaneously required additional fiscal discipline. The fiscal requirements of the planned reforms were not fully met. The inconsistency of the underlying fiscal policy with the exchange rate policy and other areas of liberalisation program became more obvious after 1988s (Asikoglu and Uctum, 1992) and the misalignment of the RER in this period might be attributed to that reason. In addition, the measured misalignment may be caused by some non-fundamental or speculative changes or by structural effects which may exist due to lagged-responses or insufficient adjustment of the RER to the changes in the fundamentals in the short-run. The reason for observing relatively low[13] but continuous misalignment may be that because the nominal exchange rates have been used as an instrument to achieve certain policies such as controlling inflation, real exchange rates have adjusted relatively rapidly to macroeconomic changes. The adjustment took place directly until 1988 with a small but continual devaluation. After 1988 the adjustment was indirect with the central bank selling and buying foreign exchanges.[14]

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[13] For comparative purposes, the range of the misalignment indexes calculated by Elbadawi changes from -40% to 50% for Chile, from -30% to 70% for Ghana and from -5% to 15% for India. It fluctuates in our index between -9% and 6%.

[14] Edwards (1989a) treats the nominal exchange rate as a policy instrument and the RER as an intermediate target. Under crawling peg regime the nominal rate is changed frequently to sustain a given real rate. Thus, authorities have a strong control over their intermediate target. This applies to Turkey where the authorities have control over the RER through the ways explained above.

7.6 Real exchange rate misalignment and trade performance : An empirical analysis

In the previous section, we tried to identify the degree of misalignment of the RER. As explained earlier, liberalisation of trade was one of the main objectives of the Turkish authorities after 1980 as it was a crucial part of new outward-oriented development strategy. That is why we intend to analyse the effects of misalignment of the RER on particularly trade performance in this section, leaving the analysis of effects on other sectors of the economy for a further research, as it is beyond the scope of this thesis.

As recalled from the main model (Chapter 3, equation 13), the current account balance is expressed as the excess of supply of exports over the demand for imports (sum of private and public demand). In the absence of capital accounts, this expression would be identical to the trade balance equation (B). That is

$$B = Q_X(e_X) - [P_M{}^*C_M(e_M, w) + P_M{}^*G_M] \tag{7.20}$$

where

Q_X is supply of exports as a function of the relative price of exportables to nontradable goods (e_X),

$P_M{}^*$ is world price of importables,

C_M is demand for imports by the private sector as a function of the relative price of importables to nontradable goods (e_M) and of the total assets of private sector (w),

and, G_M is the demand for imports by the government sector.

In the long-run, one might expect that

$$\{B - B^e\} = \{Q - Q^e\} - \{C - C^e\} - \{G_M - G_M{}^e\} \tag{7.21}$$

where superscript 'e' denotes equilibrium values.

Denoting the deviations from the equilibrium with '~', a reduced form from the above equation can be expressed as

$$\tilde{B} = f(\tilde{r}, \tilde{w}, \tilde{g}) \qquad (7.22)$$

Any actual time series (*X*) can be decomposed into permanent (*Xp*) and cyclical (*Xc*) components. That is

$$X = Xp + Xc \text{ , then}$$
$$Xc = X - Xp \qquad (7.23)$$

If we approximate the equilibrium values with permanent components, the deviations of the actual values from equilibrium will give the cyclical values. Then, the balance of trade can be expressed as follows:

$$B = f'(\text{MIS}, w_c, g_c) \qquad (7.24)$$

where

B is the actual trade balance,[15]

MIS is the deviations of the real exchange rate from the equilibrium rate, i.e. misalignment index,

w_c is the cyclical values of real private wealth, and

g_c is the cyclical values of government demand for imports.

The equation 7.24 can be written in a linear functional form as

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[15] In the model, it is assumed that trade balance will give neither surplus nor deficits in equilibrium. Thus $B^e = 0$ in the long-run.

$$B_t = \alpha_0 + \alpha_1 MIS_{c\,t} + \alpha_2 W_{c\,t} + \alpha_3 G_{c\,t} + u_t \qquad (7.25)$$

Here, the trade balance B is defined as the ratio of exports to imports in order to allow the use a logarithm. Similarly MIS is defined as the ratio of equilibrium RER to the actual RER. According to our definition of the RER (relative price of tradables to nontradables), values greater than unity indicate overvaluation of the RER, while values less than unity imply undervaluation of the RER. Thus, economic theory suggests a negative relationship between the misalignment and the balance of trade. Namely, higher degree of misalignment will decrease the exports and deteriorate the trade balance.

Concerning the real wealth of the private sector (W), recall from the assets sector of the main model in Chapter-3, it is assumed that domestic and foreign currency are the only available assets. Total stock of domestic currency is equal to the money supply determined by the monetary authority. The only way for the economy to change the level of its foreign currency holdings is through an excess supply or demand of traded goods (in the absence of capital flows and borrowing). Thus as in the previous empirical estimations, W is approximated by the M2Y definition of money supply, which gives the sum of domestic money and foreign deposits held by the residents. The cyclical values are obtained through ARIMA estimations, as explained earlier. One might expect a negative relationship between the real wealth and the trade balance. Because an increase in real assets will increase the demand for imports and this will worsen the balance of trade.

Finally, for the variable government demand for imports, we use government expenditures on tradable goods which is calculated by summing up the tradable components of the classified total government expenditures (as the government does not consume exportable goods by assumption). Again, cyclical components are decomposed using ARIMA estimations. A negative relationship is expected between the trade balance and the government demand for imports. Namely, increasing demand for imports will deteriorate the trade balance.

It should be noted that we expect the constant term to be zero so that trade balance will be equal to zero as the deviations from the equilibrium approach to zero in the long-run. Because it is likely that one or more of the explanatory variables might be endogenous, their lagged values will be used as instruments in the estimations.

Equation 7.25 is estimated using monthly data from 1981.2 to 1995.6.[16] Owing to the fact that all data including the trade balance are stationary in levels, ordinary least squares technique is employed in estimation. The model is initially estimated using 13 lags (which is enough to whiten the residual errors) and a constant. However, the constant term was not significant, a fact which supports the equilibrium situation specified above. The coefficient for the real wealth variable was found to be negative as expected but was not significant. As an alternative proxy, we used the cyclical values of the real GDP instead of real wealth and estimated the above model, but the result did not change. Its coefficient was also negative but insignificant. The other coefficients were almost unchanged, indicating the robustness of the model. Excluding the constant and wealth term together with other insignificant lags of the dependent variable reduces the following parsimonious model :

$$\underset{}{B} = -\underset{(-3.28)}{0.10MIS(-1)} - \underset{(-2.17)}{0.98G_c(-1)} + \underset{(6.13)}{0.43B(-1)} + \underset{(4.20)}{0.30B(-2)} + \underset{(2.24)}{0.15B(-5)} -$$

$$\underset{(-2.93)}{0.19B(-6)} + \underset{(2.78)}{0.15B(-9)} - \underset{(-1.75)}{0.08B(-13)} \qquad (7.26)$$

where the numbers under the coefficients are t-ratios.

$\bar{R}^2 = 0.845$ [$\bar{R}^2 = 0.843$ for the unrestricted model]

[16] Although original data were available from 1980.1 to 1995.12, due to moving average and decomposition procedures and also to lags, 20 observation were lost from the estimation.

Information criteria :

SC = -3.88, HQ = -3.97 [SC = -3.66, HQ = -3.83 for the unrestricted model]

Diagnostic tests:

$F_{ar}(1,164)$	= 0.18 [0.66]	$F_{ar}(13,152)$	= 1.21 [0.28]
$F_{arch}(1,163)$	= 0.04 [0.83]	$F_{arch}(13,139)$	= 0.89 [0.56]
$F_{mis}(16,148)$	= 1.10 [0.36]	$F_{res}(1,164)$	= 3.31 [0.07]
$\chi^2_n(2)$	= 2.17 [0.34]		

All the coefficients except the one for B(-13) are significantly different from zero at both 1% and 5% significance levels.[17] Deleting the 13th lag causes autocorrelation, thus it was left in the equation. The model is statistically acceptable. There is no evidence of residual autocorrelation and conditional heteroscedasticity up to first and 13th orders. The residuals are normally distributed, no misspecification and functional form problem exists.

The adjusted R^2 for the parsimonious model is slightly higher than the unrestricted form. In addition, the information criteria SC (Schwartz Criterion) and HQ (Hannan and Quinn) are smaller in the above model than the unrestricted form. The Wald test for linear restrictions gives a value of 0.275 [0.98], which cannot reject the hypothesis on deletion of the relatively insignificant variables. These statistics indicate that the above model is statistically acceptable parsimonious form of the general model.

The sample period is divided into two sub-periods: 1981.1 - 1988.7 (pre-flexible exchange rate period) and 1988.8 - 1994.7 (flexible exchange rate period). The

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[17] Because none of the series are from raw data but estimated series, some errors might have already been injected into the standard errors to some extent. Owing to the fact that they are the only available information to decide upon coefficients' significance, interpretation of the t-values requires some caution.

estimated is repeated for these sub-periods. However, the results did not change considerably, indicating the stability of the coefficients and the robustness of the model.

As suggested by the theory, there is a significant negative relationship between the misalignment and the balance of trade. In other words, the trade balance is responsive to the deviations from the equilibrium RER, suggesting that exchange rate policy has potential to maintain a satisfactory trade balance. The net effect of the misalignment on the trade balance is -0.38, implying that, ceteris paribus, a 1% increase in misalignment might lead to a 0.38% deterioration of the trade balance. The response of the trade balance to the government expenditures on tradable goods is high with a net impact of -3.77. A 1% rise in the demand for importable goods by the government will worsen the trade balance by 3.77%. Changes in the trade balance in previous periods affect the current value significantly. Their effect reduces in further lags.

The present empirical analysis indicated that the balance of trade is highly responsive to the misalignment of the real exchange rate. Frequent devaluation of the nominal currency seemed to improve the balance of trade, especially in the first half of the decade. However, since 1990 nominal adjustment has been eroded by high inflation. In such a case, exchange rate depreciation, even with restrictive macro policies, may not be sufficient to ensure the competitiveness of the Turkish RER as long as there are structural factors in the economy which cause inflation. This might explain the short-lived effect of the considerable nominal adjustment to the exchange rates in April 1994. As can be seen from Table 7.2, the nominal devaluation of the currency, which brings about 33 % real depreciation seems to improve the current account remarkably, giving a surplus of 2631 billion of US dollars. However, this improvement did not last long probably because 125 % inflation (CPI), together with 84 % increase in nominal money supply eroded the effect of nominal adjustment.

The trade balance seems to be very responsive to the change in government demand for tradable (importable) goods as well. It might be because the public sector is dominant in the economy and one of the main consumer of the imported goods. On the other hand, the cyclical changes in real wealth of the private sector do not appear to have a significant impact on the balance of trade.

Several studies analysed the relationship between the RER and trade balance.[18] They mainly used the RER (or change or lagged values) as an explanatory variable in the trade balance formulation. Some of these works found evidence supporting that relationship, whereas some others found no evidence. On the other hand, some empirical works observed that the changes in the RER affect the balance of trade in a *J-curve* movement. That is, the trade balance may deteriorate at first due to a change in the RER, but an improvement might come after a certain time lag.

The empirical results of Bahmani-Oskooee (1985) indicate a significant J-curve movement in the trade balance for three out of four countries. They are India, Korea and Greece. The only difference is in the time lags in which improvement occurs after initial deterioration. For example, while it only takes 2 quarters for the trade balance of Greece to improve after devaluation, it takes 3 quarters for Korea and 4 quarters for India. Among the other variables in the model,

[18] They may be grouped into three: (1) *Imperfect substitutes or elasticities approach*, which explains the necessary and sufficient conditions (knows as Marshall-Lerner conditions) for an improvement in the balance of trade in terms of demand and supply elasticities. (2) *Absorption approach* describes how exchange rate changes may change the terms of trade, increase production, switch expenditure from foreign to domestic goods, thus improve the trade balance. (3)*International monetarist approach* argues that devaluation reduces the real value of cash balances and/or change the relative prices of traded and nontraded goods, thus improves the trade balance (See Bahmani-Oskooee, 1985; Miles, 1979 for more explanations and references).

domestic income has a negative sign but is not significantly different from zero for all countries except Korea. Similarly, domestic money variable has also negative sign as expected and significant for Greece and Thailand only. Although the misalignment index is used in our model, both income and money variables have negative signs although not significant.

Rose (1991) found only a little evidence supporting the relationship between the RER and trade balance. Using monthly data from 1974 to 1986, he estimated a trade balance equation in first differences and lags for 5 OECD countries. The cumulative impact of the RER was significantly different from zero only for the USA.

Employing an absorption approach, Miles (1979) formulated a trade balance equation with similar variables which are used in our reduced form, including money and government expenditures. However he specified the variables as differentials of domestic and foreign values and used nominal exchange rate in order to see the effects of devaluation on trade balance. His estimation results produced only a little evidence for that effect. For only 3 countries out of 14 , the coefficient for the exchange rate is significant and positive as expected in the model (note that the nominal exchange rate is defined as the units of domestic currency per unit of foreign currency). Similarly, only 4 of the monetary coefficients and 6 of the government consumption coefficients are negative and significant.

The only work, to the author's knowledge, analysing the Turkish experience on the exchange rate and the balance of trade for the last decade is done by Brada et al (1997). Employing the imperfect substitutes approach, they specified the trade balance equation as a function of the RER, domestic and foreign income variables. They found a cointegrating vector for the period 1980.1 to 1993.1 (quarterly) specifying a relationship between these variables although the hypothesis on the existence of cointegration is rejected for the period 1969.1 to

1979.4. This result is explained by the argument that "trade controls imposed by the Turkish government, before 1980, likely limited the ability of changes in the exchange rate to influence the volume of Turkish imports and exports". For the post-liberalisation period, they found that the RER affects the trade balance positively and significantly.

There are two more works, worth mentioning here, which used specifically a misalignment index in analysing its effect on export performance (even though not on trade balance). The first one is carried out by Pick and Vollrath (1994). As recalled from the measurement of misalignment, they defined the misalignment as the ratio of the actual RER to the calculated equilibrium rate. The empirical estimations showed that exchange rate misalignment had a negative impact on agricultural export performance. This impact was statistically significant in 4 of the 10 developing countries. The second study, Cottani et al (1990) covers the 1960-1983 period for a group of developing countries. It shows that the misalignment is not a significant determinant of the export growth rate.

To sum up, the empirical studies, some of which are mentioned above give mixed results on the relationship between the misalignment (or the RER) and the trade balance. This is not surprising because the results may vary according to specification of the model, functional form, the variables included in the estimation, estimation techniques, sample period, countries in question and so on. Even if two model are specified similarly, different definitions of the RER or misalignment may give different signs for the coefficients. Besides these general issues, the RER may not be a significant determinant of the trade balance for the developed countries where exchange rates are determined in a free market. However, for many developing countries, more specifically for Turkey, one might expect a significant relationship between the RER and the balance of trade. The reason is that the nominal exchange rate has often been used as a policy tool to encourage the exports thus to improve trade balance and even to combat with high rate of inflation.

Another common point in the above works is that government expenditures have a negative significant impact and the monetary variable has a negative but usually insignificant impact on the trade balance whatever the model used is. Our results are consistent with this findings.

The innovation of our work comes from several sources: First of all, the RER is defined here with respect to relative prices of tradable and nontradable goods. Ziets (1996) found that this approach performs better than PPP approach in explaining the trade balance. It is a dynamic equilibrium analysis which employs deviations from equilibrium rather than static actual values in the model. Unlike many other studies which use the actual RER as a determinant, misalignment is used in this study. The misalignment series are constructed using a well-refined equilibrium series. It may be argued that using the deviations from the equilibrium instead of actual values may be more appropriate in terms of the impact on the trade balance. As explained earlier in discussing the effects and costs of misalignment, it is the persistent departures from the equilibrium which accounts for the success or failure of trade policies. Particularly, trade performance is affected directly by the continuous depreciation or appreciation of the RER.

Another contribution of the present work is that it is originated from a sound theoretical model, and not a simple regression of the trade balance on an ad hoc list of potential explanatory variables. In addition using stationary variables in the model reduces the risk of spurious regression. It is more likely that such an analysis produces robust results.

7.7 Summary

The objective of this chapter was to measure the extent of real exchange rate misalignment and to assess the effect of such misalignment on the balance of trade. For that purpose, initially an equilibrium real exchange rate series was computed by using the long-run estimates of the fundamentals estimated in the previous chapter, for given sustainable values of these fundamentals. The sustainable components of the series were obtained through the Beveridge and Nelson decomposition technique. Then, the equilibrium RER series was compared with the actual series in order to construct a misalignment index. It was shown that the RER was usually undervalued during the period 1980 - 1986, while it turned to be highly overvalued especially after 1990, with serious adverse effects on the economy. The misalignment of the RER in both episodes seems to be caused mainly by changes in the actual RER (i.e. policy-induced changes) while the equilibrium rate is relatively stable. Finally, the impact of the RER misalignment on the balance of trade was analysed empirically. The results indicated that the trade balance is highly responsive to the deviations from the equilibrium RER, suggesting that exchange rate policy has potential to maintain a satisfactory trade balance. Moreover, the effect of the transitory government expenditures on the trade balance is considerably high. However, the impact on the trade balance of the real wealth of private sector seems to be insignificant. These results are consistent with the findings of several empirical studies.

APPENDIX 7

Permanent and cyclical components: Unadjusted series

The permanent components of the series before the smoothing technique is applied, are plotted in Figures A7.1-A7.3. Because the original series are not seasonally adjusted, the decomposition process probably removed some irregular or cyclical fluctuations, leaving the seasonal characteristics unaffected. Obviously this is reflected in the equilibrium RER series as well misalignment series. Figure A7.4 plots the equilibrium RER together with the actual values. It may be noted that the former series which is expected to be more stable, shows as much fluctuations as the latter series. The reason might be that the ERER series might reflect some seasonal variations observed in the fundamentals, which are not removed completely during the decomposition process.

Undoubtedly, not all the changes in the misalignment can be attributed to changes in the fundamentals. There are some remarkable changes in the misalignment index, which are caused by drastic changes in the actual RER due to devaluation of the currency. For example, it is highly likely that 6.67 % undervaluation in the misalignment index in April 1994 is mainly caused by the changes in the RER (not the ERER) because of the devaluation of the nominal currency announced in the Austerity Program (The RER index moved to 99.09 in April 1994 from 83.9 in January 1994).

As a result, in order to draw plausible conclusions, the series have to be either deseasonalised or be smoothed to reduce or eliminate the volatile fluctuations and then the equilibrium and misalignment indexes would be constructed using these sustainable values of the series.

Figure A7.1 : Permanent components of GOVEXN (unadjusted series)

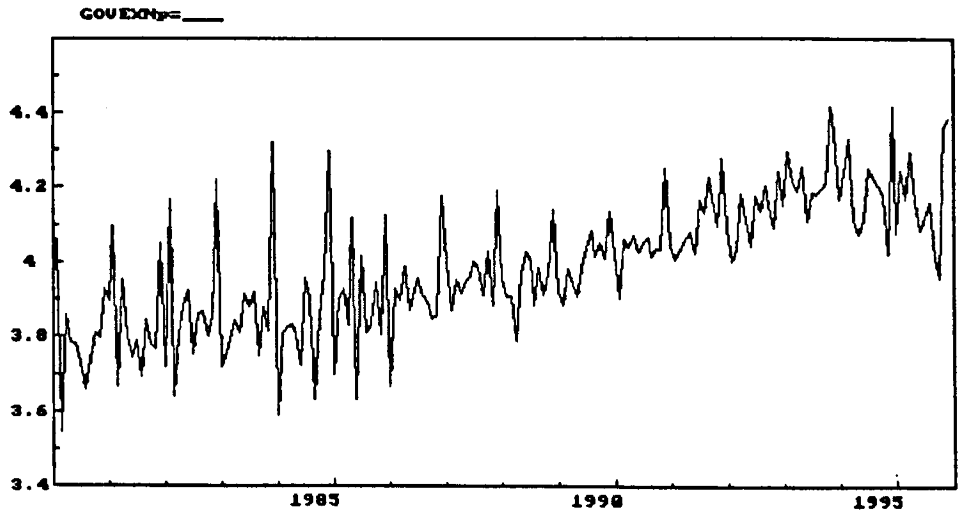


Figure A7.2 : Permanent components of WEALTH (unadjusted series)

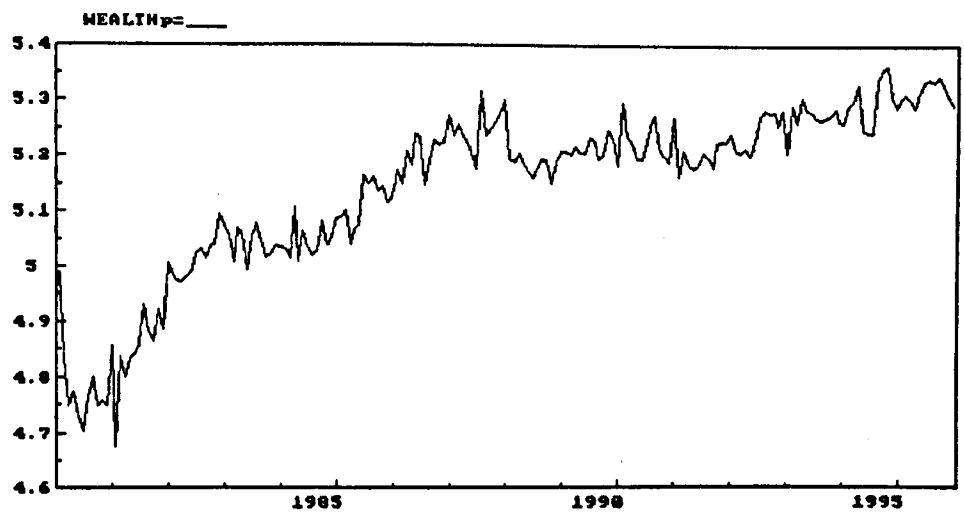


Figure A7.3 : Permanent components of OPEN (unadjusted series)

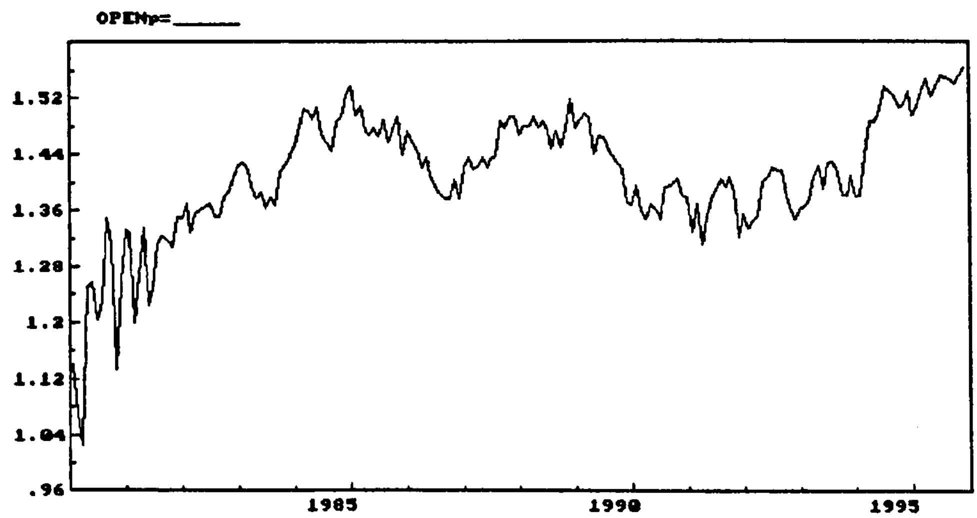


Figure A7.4 : Actual and equilibrium RER indexes (unadjusted series)

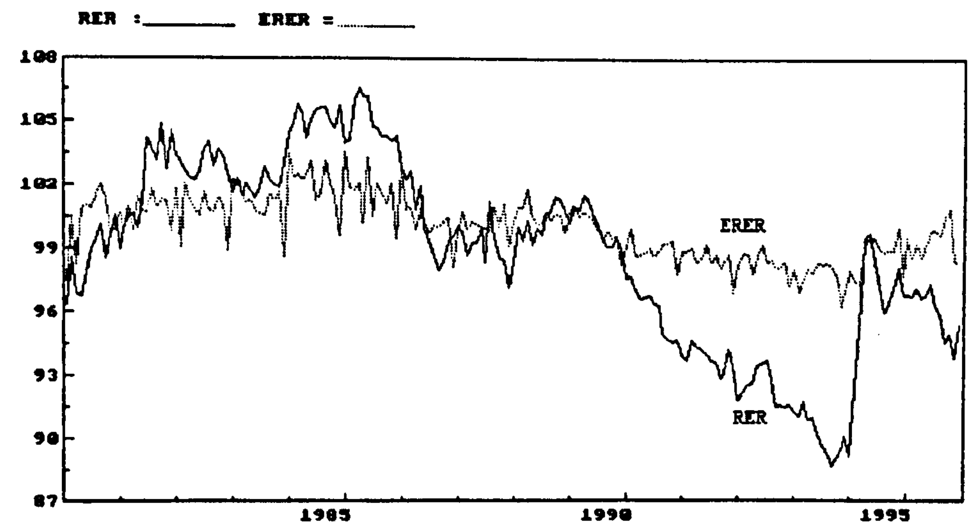
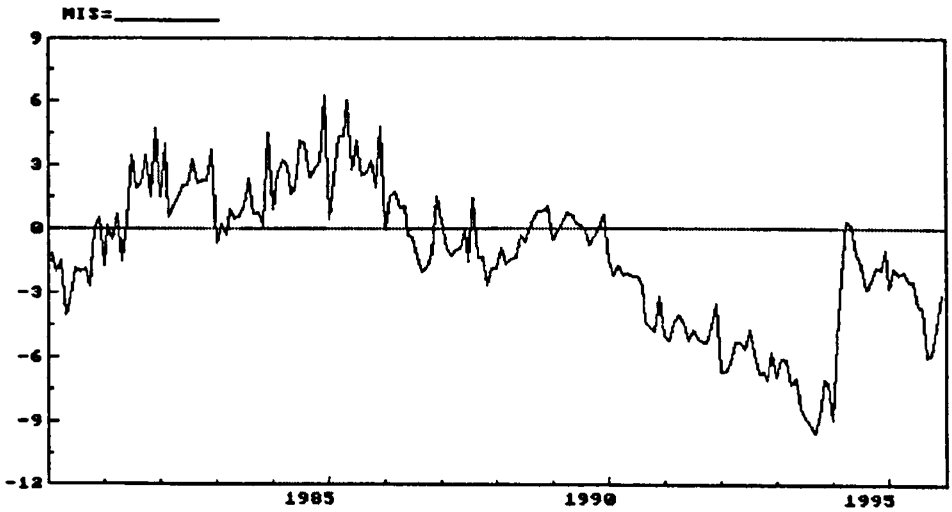


Figure A7.5 : Misalignment index (unadjusted series)



CHAPTER 8

CONCLUSION

8.1 Summary of the results

The major objective of the present study was to analyse the behaviour of the real exchange rate and to explore the factors which determine its equilibrium value. A secondary objective was to determine the degree of deviations of the actual real exchange rate from its equilibrium value (which is called as misalignment) and to investigate its effects on the Turkish trade balance.

Earlier studies use various alternative definitions of the real exchange rate. Some use a definition of the real exchange rate based on Purchasing Power Parity theory. Simply stated, "the exchange rate change between two currencies over any time period is determined by the change in the two countries' relative price level". However, the objectives stated above requires us to go beyond this definition, that is, an equilibrium analysis requires us to take into account some other economic dynamics than relative international prices. In fact, much empirical studies have demonstrated that the real exchange rate is not constant over time, as suggested by the PPP theory, but is subject to changes deriving from changes in its fundamental determinants. Some of the reasons cited for the deviations from the PPP includes barriers to trade such as tariffs and transportation costs, the presence of nontraded goods in the price indices, differing consumer tastes or preferences and productivity differences across countries and sticky prices.

Some recent work defines the real exchange rate in terms of the relative price of tradable to nontradable goods. This approach seems to be more appropriate for developing countries where nontradable sector occupies relatively a larger place in the economy and for situations where domestic relative incentives to produce and consume are likely to be important in determining internal and external balance. Thus, in this study, the real exchange rate is defined as the ratio of the tradable prices (which in turn a weighted average of exportable and importable prices) to the nontradable prices. Unlike many other studies which approximate these prices by aggregate price indices such as wholesale price index and consumer price index, this study uses actual export and imports price indexes and nontradable components of the consumer price index.

The main purpose of the theoretical modelling is to produce a clear understanding of the economic mechanisms governing the actual behaviour of the real exchange rate. In addition, the modelling should give a satisfactory explanation of the relationship between the real exchange rate and other important economic variables. In line with the alternative definitions, we grouped the theoretical models as the PPP approach and the tradable/nontradable approach.

In Chapter 2, we provided a critical review of the recent PPP studies, with a particular emphasis on the sources of deviations of the equilibrium real exchange rate from the PPP level. In addition, we listed a number of empirical studies which employed a tradable / nontradable approach to model the equilibrium real exchange rate. They offered various internal and external factors (i.e. fundamentals) which possibly determine the equilibrium rate. Within the latter group (relative prices approach), the model developed by Edwards seems to be appropriate to our objectives. Namely, it is developed particularly for developing countries, taking into account main characteristics of these countries such as the existence of parallel markets, a large nontradable sector, import tariffs and quotas, excess domestic credit and fiscal deficits. This model specifies the equilibrium real exchange rate and its main determinants explicitly. It incorporates nontradable prices explicitly together with exportable and importable prices.

The model consists of equations explaining production and consumption activities, assets, government and external sectors. The solution of the model specifies the fundamental determinants of the real exchange rate as wealth of private sector, government expenditures on nontradable goods, trade restrictions and external terms of trade. However, this model has not been thoroughly tested for a single developing country with time-series data and with modern econometric estimation techniques. The main contribution of the present study is in this respect and its careful selection of proxies used to measure the determinants of the real exchange rate.

As the actual data are not available with accuracy and precision for most of the variables specified above, we provided a detailed information on constructing the proxy data series for them, in Chapter 4. Subsequently, the data series were tested for a unit root.

As to the empirical estimations, the relationship between the real exchange rate and its determinants listed above has been tested by two alternative econometric methods of cointegration: The Engle and Granger procedure and the Johansen procedure. The facts that many time series data are non-stationary and that estimations with such data might produce spurious regressions (indicating a relationship even though it does not actually exist) makes cointegration analysis important. The econometric estimations by the two techniques produce similar results. The results suggest that there is a significant relationship between the real exchange rate and its fundamentals and that any change in these variables might cause a change in the equilibrium real exchange rate.

In general, all the coefficients have signs as suggested by theory. The real exchange rate is highly responsive to changes in fiscal and trade policies, having high coefficients on government expenditures on nontradables and on the openness variables. An increase in government expenditures on nontradables necessitates an appreciation (a decrease) in the real exchange rate to maintain equilibrium. The present study suggests that the substitution effect dominates the income effect. Namely, an increased demand for nontradables by the government sector pushes these prices up, leading a fall in the real exchange rate. A possible reason for the relatively small income effect might be that individuals do not perceive well future effects of an increase in government spending (which is likely to be financed by increases in taxes) in the long-run and thus do not attempt to change the level of their consumption.

The results indicate a positive relationship between the real exchange rate and the openness of the economy, again as predicted by theory. Elimination of import tariffs and quotas is one of the main instruments to liberalise the economy. A reduction in the tariff rate tends to reduce the demand for nontradables and in turn, their price because of the substitution effect. Decreasing nontradable prices causes the RER to depreciate. In addition, because intermediate inputs as well as capital goods constitute a fairly large part of total imports in developing countries, a reduction in the tariff rate or in other restrictions on imports reduces the cost of production of home goods and thus leads to an increase in the supply of nontradable goods. A decrease in the price of nontradables due to supply increases causes the RER to increase. As a result, changes in the RER are expected to respond positively to changes in the degree of openness.

A negative relationship between the external terms of trade variable and real exchange rate is observed. This implies that the income and substitution effects work in the same direction in this case, a result in line with a priori expectations in the case of Turkey and with the conventional view that a deterioration of external terms of trade will lead to a depreciation of the real exchange rate.

Finally, a negative coefficient was estimated for the real wealth variable. Monetary expansion leads to an increase in real wealth, causing the demand for all goods including nontradables to go up. The resulting excess demand drives the prices up and brings about a fall in the real exchange rate. The wealth variable consists of a high proportion of foreign exchange deposits, especially from the late 1980s. It may therefore be capturing capital flow effects as well. This may be in the form of asset substitution from domestic to foreign currency deposits, as well as in the direct capital inflows through workers' remittances. In either case, an increase in capital inflows leads an appreciation of the real exchange rate.

Using an error correction model from the long-run estimations of the equilibrium real exchange rate, the short-run dynamics of the model have been estimated subsequently. The results are again similar in both estimation techniques. The major finding is that the model has a highly significant coefficient on the error correction term, supporting the existence of cointegration among the variables and indicating that the estimated results of the cointegrating regression may be treated as the best estimates of this long-run relationship. The estimated coefficient on the error correction term is 0.18. It is calculated that the adjustment may take over a year for the system to return to the equilibrium level.

Having specified the determinants of the real exchange rate and estimated their responses, we calculated the equilibrium real exchange rate series in Chapter 7. The equilibrium rate is defined as the relative price of tradables to nontradables which, for given 'sustainable' values of fundamentals, results in the simultaneous attainment of internal and external balance. The sustainable values were approximated by the permanent components of the series decomposed by the widely-used Beveridge-Nelson technique. These components were weighted by the coefficients obtained by the cointegrating regression in order to obtain the equilibrium series. Then a misalignment index was constructed by comparing these series with the actual real exchange rate series.

The misalignment series identified successfully the well-known undervaluation episode of 1981-1987 and the overvaluation episode of 1988-1995. The former period coincided with the beginning of the liberalisation program and was characterised mainly by depreciation of the nominal exchange rate in order to encourage exports. However the latter period was dominated by the (involuntary) overvaluation of the real exchange rate probably due to the inconsistent macroeconomic policies and the political instability. A comparison of the equilibrium and misalignment series shows that the former series is fairly stable over time and that misalignment is caused mainly by the changes in the actual rates. This is not surprising because the nominal exchange rate has been used as an instrument by the authorities to achieve objectives such as the controlling of inflation. However, because this policy was not been supported by other macroeconomic measures, devaluation of the nominal rate was not effective enough even to improve the trade balance, let alone these other objectives. As a result, the real exchange rate stayed overvalued after 1988 up to the end of the period of analysis.

Finally, because the success recorded in export performance after the 1980 stabilisation program has been subject of much debate, we sought to investigate the role of exchange rate policy and the real exchange rate on the improvement of the trade balance. Utilising the current account equation of the main model, the trade balance was specified as a function of misalignment, real wealth and government expenditures on tradable goods, with all expressed in deviations from equilibrium values (i.e. cyclical values). The empirical results suggest that misalignment has a negative impact on the balance of trade. In other words, the trade balance is responsive to deviations from the equilibrium real exchange rate, suggesting that exchange rate policy has a potential to maintain a satisfactory trade balance. An increase in the demand for imports by the government tends to worsen the trade balance. The real wealth effect appears to be insignificant in the trade balance equation. Although economic theory suggests the existence of a relationship between the real exchange rate and the trade balance, a number of empirical studies have found no evidence of this. Having estimated a significant relationship between misalignment and trade balance in our model, this might imply that trade balance is responsive to the deviations from rather than changes in actual real exchange rate.

8.2 Policy implications

The nominal exchange rate is often treated as a policy instrument while the real exchange rate as an intermediate target especially in developing countries. In other words, the real exchange rate is a channel between policy target and policy instrument. Thus authorities have strong control over their intermediate target because the influence area of a real exchange rate change is considerably large. Namely, change in the real exchange rate are largely reflections of changes in underlying economic forces which also affect other prices and quantities. These economic forces might originate from government policies as well as the preferences, capabilities and expectations of both private and public sectors. The empirical results of the present study seem to confirm that argument. Both estimation results (Engle-Granger and Johansen) indicate that changes in fiscal policy (if represented by the government expenditure on nontradable goods variable), monetary policy (if represented by private wealth variable) and trade policy (if represented by openness and import tariff rate variables) influence the equilibrium value of the real exchange rate significantly. The inconsistencies between these policies and exchange rate policy might reduce the ultimate effect of a policy instrument, such as nominal exchange rate, on a policy target such as improving the trade balance.

Devaluation of the nominal currency might be helpful to restore the equilibrium RER when it is misaligned. However, its impact is quite limited if not supported by additional fiscal and monetary discipline. This, in turn, requires political stability and determination. Otherwise, nominal exchange rate changes and even real exchange rate changes in the presence of high inflation may cause only persistent deviations from the equilibrium rate. The economic developments in

Turkey between 1980 and 1995 provide evidences supporting the above arguments. The Turkish real exchange rate was highly overvalued in the late 1970s. Nominal devaluation in early 1980s seems to help the real exchange regain the equilibrium level. It should be acknowledged that this exchange rate policy was supported by other fiscal and monetary policies which were designed to restrict the domestic demand. However, the 1990s witnessed a political and economical instability in the country and the real exchange rate was considerably overvalued again. The adjustment program in April 1994 stopped further appreciation of the currency, however, its effect was short-lived as the political and economic instability have still existed and even deteriorated. This situation has brought about an insecure environment for domestic and foreign investments. Persistent fall in the value of the local currency and continuous increases in prices have caused an inconvenience against the Turkish Lira and the private sector and even individuals have avoided keeping domestic currency even for a short time. The dolarisation of the domestic money has reached to considerable amounts. The authorities have to design economic policies to break these expectations and to re-gain the convenience to Turkish Lira. That requires, first of all, a political stability and determination.

Finally, with the liberalisation process, Turkey relied on continuous depreciation of the real exchange rate and export incentives to keep its export drive. However these policies are counterproductive in the long-run with an inflationary effect as a result of the first policy and a financial pressure on budget if it continues its second policy. Both strategies reflect Turkey's reliance on price competitiveness rather than quality improvement of tradable products and this might have serious drawbacks at home. Moreover, Aricanli and Rodrik (1990) believed that export growth success was mostly due to the unutilised industrial capacity formed in the 1970s and this was exploited by the mid-1980s. It has become crucial to expand the productive capacity through investments.

8.3 Main contributions of the study

The main contributions of this study to the literature may be summarised as follows:

- This is the first work, to the author's knowledge, which has constructed a real exchange rate series using tradable/nontradable prices, equilibrium real exchange series and misalignment series for Turkey. Because the real exchange rate is used itself as one of the main determinants in many macro-models including trade models, investment models and money demand models, it is believed that these series would be of great use for applied economists in Turkey as well as in other countries.
- Recent macroeconomic indicators (1996 and 1997) show that the Turkish real exchange rate is still appreciating and inflation and balance of payment difficulties are still major problems of the Turkish economy. This study analysed the real exchange rate and its relation with other economic variables, the degree of misalignment and its effect on the trade balance in detail. The findings and implications of the results, as discussed in the previous section, will be helpful to policy makers in determining and designing new policies for Turkey.
- Earlier studies on real exchange rates have tended to concentrate on industrial countries. There are a few studies which comprehensively analyse exchange rate issues in developing countries. This study aims to fill in part at least this gap in the literature. The findings contribute to what is an important policy issue in many developing countries.

- Most of the earlier empirical studies uses cross-sectional or panel data for a group of countries, and this usually imposes some limitations on the research. For example, a panel study requires the use of common proxies for each variable for each country. Direct measures or more realistic proxies may be available for a particular variable. Similarly, in panel data studies researchers often are forced to ignore some country-specific variables and events (or use dummy variables for that purpose). The present work uses time-series data on a single country, and allows therefore for the specific structural characteristics of this economy.
- The study employs a structural model covering the main sectors of the economy and obtains the reduced form from its solution. This is expected to capture the equilibrium characteristics of the real exchange rate more satisfactorily than employing a regression approach with ad hoc list of potential variables or simply comparing the price ratios across countries as in the PPP approach.
- Measurement of the equilibrium real exchange rate and misalignment is also a major contribution of this study, using as it does a step-by-step sequential procedure to construct a misalignment series. We modelled the real exchange rate, specified the fundamental determinants, estimated their relative influences (i.e. coefficients) on the equilibrium rate, decomposed the fundamentals to obtain the sustainable values, calculated equilibrium series and finally constructed misalignment series. This might provide a good practice for applied economists.
- The specification of the trade balance equation is also unique. Existing studies tend to express this equation as a function of levels of real income, real exchange rate and other relevant variables. However, the trade balance was specified with deviations from their equilibrium values of the variables in

the current work. This enabled us to estimate the equation with stationary variables, avoiding the spurious regression problem in time series. That the trade balance was found to be responsive to the misalignment supported our judgement.

- Because many developing countries have been shifting to an outward-oriented development strategy from an inward-oriented one, the stages and the problems encountered might be similar across the countries. The empirical results of this study and the following policy implications might be used by other developing countries who are in a process of liberalisation and wish to use (or have been using) the exchange rate policies actively in that effort.
- Defining and measurement of the real exchange rate in terms of exportable, importable and nontradable prices instead of aggregate price indices is viewed as more appropriate for the present modelling exercise, and offers therefore more robust results in the empirical estimations. It may be misleading to approximate, for example, tradable prices by the wholesale price index, which contains nontradable goods, or the domestic prices by the consumer price index, which might contain tradable components. We also use more robust proxies for the other variables. For instance, other studies which employ Edwards' approach in modelling the real exchange rate (including his own) invariably use total government spending as a proxy for government expenditures on nontradable goods. In the present study data on classified government expenditures was available and this was used to construct a measure of expenditure on nontradable goods only. Similarly, the tradable components were removed from the consumer price index before using it as a nontradable price index.

- Finally, the current study employed the robust tests such as Augmented Dickey-Fuller unit root test for preparing the data for econometric analysis and also robust procedures for identifying cointegration and error correction relationships in econometric estimations. These are expected to minimise the possible statistical errors, thus to yield reliable results. This might explain the reason for obtaining similar results from two different estimation techniques. We used dynamic regressions in the Engle and Granger, unlike many other empirical works which employ static regressions (i.e. in levels only). That might have reduced the biases of the estimates, as predicted by the econometric theory, and thus produced long-run estimates similar to those obtained from the Johansen method.

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