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Essays on International Capital Markets

by

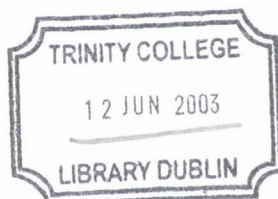
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Thesis submitted to the University of Dublin,

Trinity College, in fulfilment of the

requirements for the degree of Ph.D.





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Summary

This thesis concentrates on the macroeconomic effects of increased capital mobility in international capital markets. The focal points of attention encompass the relationship between capital flows and infrastructure, countries' choice between different exchange rate regimes as well as saving and investment in relation to net foreign assets.

In the last two decades economic research has focused on the increased capital flows to developing countries. The question why some developing countries attract higher amounts of capital than others arises. A possible explanatory factor may be the level of infrastructure inherent in these economies. Various components of infrastructure variables are tested in relation to their impact on different kinds of external capital liabilities for developing countries in Africa, Asia and Latin America. The results suggest a positive relationship between the level of infrastructure and capital inflows although statistical significance cannot be established for all variables in question.

Small open developing countries are frequently subject to external shocks such as world interest rate or world output shocks. The assertion that flexible exchange rates are superior to fixed exchange rates in absorbing such shocks is investigated. Both, empirical and theoretical evidence suggests that flexible exchange rate regimes allow small open economies to restore economic equilibrium more quickly and smoothly.

Industrial and developing countries' wealth is reflected in their net foreign asset position. The question to be posed is whether it is domestic wealth or domestic capital stock which drives the external wealth of economies. The

analysis of the short and long-term relationships between saving, investment and net foreign assets illustrates the importance of the saving and investment rate in determining net creditors and debtors via public debt, GDP per capita and demographic factors.

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1 Chapter One

Introduction

This thesis concentrates on the macroeconomic effects of contemporaneous changes in international capital markets. During the last two decades the world economy has witnessed increased capital flows, both between industrialised countries but also between industrialised and developing countries. The emerging interconnectedness between countries results in international macroeconomic phenomena which represent a source of new insights to be gained on international capital flows. This work is born out of the intellectual interest in analysing international capital flows and their ability to influence the macroeconomic environment in low, middle and high income economies. Despite the vast array of literature on international macroeconomics, there are numerous observations and relationships whose explanations need to be refined and investigated further. This thesis explores key issues by utilising a range of econometric techniques, such as cross section and panel data analyses as well as panel vector autoregression. To clarify the economic relationships and theoretical channels the thesis also applies some formal approaches. In particular, it utilises an intertemporal model with nominal rigidities and optimising economic agents.

International capital movements can be viewed from different sides: Capital flows in the form of foreign direct investment (FDI), portfolio equity or debt might facilitate the further growth of a developing country. They challenge emerging countries to make use of the growing interest of investors in their markets to enter a cycle of productive financial integration. However, not all countries are able to attract capital inflows to a large extent. Sudden outflows of capital harm the economic development and many questions remain unanswered

why some countries have a stronger ability to receive inflows of different forms of capital. A valid question is whether the initial public infrastructure conditions of developing countries are able to explain capital movements to those countries. Since capital market frictions and country specific economic conditions play an important role in influencing investment decisions internationally, specific infrastructure provision may affect market distortions and domestic performance.

The increased capital mobility and ensuing volatility of international financial and capital markets creates a further problem for developing countries. How can these countries benefit from trade and capital flows and simultaneously not be adversely affected by the instability of large financial exposure? Developing countries want to stabilise their economy, hence, the choice between different exchange rate regimes becomes crucial for these countries. The experience of numerous emerging market economies over the last decade has led to a refreshed discussion of the question whether to adopt a fixed or flexible exchange rate regime. In time of financial turmoil such as the Southeast Asian financial crises it becomes debatable whether fixed or floating exchange rates act as a superior mechanism to mitigate the adverse effects of sudden capital movements. Despite the prominent role played by exchange rate regimes, there is relatively little empirical work addressing their properties.

Increased capital flows lead to an intensified integration between economies' goods and capital markets. In a world with capital mobility, a country is able to run current account deficits if consumption and investment cannot be funded domestically. Thus, financial integration de-links national saving and domestic investment in an open economy. The net foreign asset position, therefore, reflects the imbalances in saving and investment and determines the long-run

movements of consumption and output. The United States' switch from being a large net foreign creditor to being a net foreign debtor as a result of a large and persistent current account deficit in the 1980s and 1990s is a good example of the importance of saving and investment in an open economy. The change in the net foreign asset position was due to a sharp fall in the national saving rate relative to investment undertaken. The shortfall in saving was covered by foreign capital inflows, a necessary counterpart to the current account deficit. As the United States turned into a net foreign debtor, other industrialised countries became net foreign creditors. This example illustrates the importance of examining mechanisms which lead to changes in savings and investment and, hence, changes in the net foreign asset position.

In order to analyse some of the consequences of international capital mobility, discussed above, this thesis concentrates on three key issues, all of which are presented in individual chapters. The second chapter is titled 'Cross-Country Evidence on the Link between the Level of Infrastructure and Capital Inflows'.

Lucas (1990) discusses why capital does not flow from rich to poor countries. First, he focuses on the predictions of the standard neoclassical model of trade and growth and concludes that the implied higher rates of return for less developed countries are not able to attract a higher amount of capital flows to those countries. Second, he argues that political risk and the lack of international enforcement mechanisms cannot explain the relatively low level of capital flows during the 1980s. Capital flows to developing countries have increased in the last two decades. Hence, it is essential to determine the factors which are responsible for these capital flows. One important factor is Aschauer's (1989) established link between public capital and economic productivity upon which this chapter is primarily based.

The aim of this chapter is to shed further light on the determinants of capital inflows to developing countries. In particular, the relationship between the level of infrastructure in these countries and their ability to attract external capital is investigated. The chapter focuses on the empirical relationship between public infrastructure, which can generate important positive spillover effects for private investment, and international capital flows. Out of a sample of thirty countries a cross-sectional econometric model is constructed to estimate the effects. Different variables of infrastructure components are tested in relation to their impact on different kinds of external capital liabilities. The second chapter contributes to the literature by emphasising the role of initial infrastructure conditions in developing countries to explain international capital movements and, hence, improves the understanding of the determinants of international capital flows.

In 1953, Friedman established himself as a proponent for the adoption of flexible exchange rates. He argues that under floating exchange rates open economies can overcome the problem of nominal factor price rigidities more easily. Mundell (1961) extended this observation by demonstrating that flexible exchange rates represent a better shock absorber for external shocks than fixed exchange rates. Obstfeld and Rogoff (1995b) introduced a new strand of literature by creating an intertemporal model with nominal rigidities, the New Open Economy Macroeconomics. This modelling approach facilitates the analysis of fixed and flexible exchange rates in a dynamic setting.

In chapter three, 'Fixed versus Flexible Exchange Rates: A Panel-VAR Analysis', the conventional wisdom that external shocks are less contractionary under floating exchange rates is examined. Especially in small open developing economies, macroeconomic dynamics are heavily influenced by the outside

world. The purpose of the third chapter is to theoretically and empirically examine the impact of external shocks on small open economies which adopt different exchange rate regimes. A panel vector autoregression approach is utilised to test whether economies respond differently to such shocks. The panel vector autoregression captures both the stochastic patterns and co-movements of macroeconomic variables and allows us to study dynamics in terms of deviations from the equilibrium across countries. The chapter analyses and compares the adjustment process of home real output, the trade balance and the real exchange rate by concentrating on world real interest rate and world output shocks. Thus, by building on the new dynamic general equilibrium open economy macroeconomic models and dynamic panel data the chapter establishes different effects of fixed and flexible exchange rate regimes. Consequently, it adds meaningfully to the debate in the literature regarding the relative merits of fixed and flexible exchange rates.

Feldstein and Horioka (1980) initiated the empirical literature on asset trade. The authors focus on the evolution of current accounts across countries. The response of net capital flows to cyclical macroeconomic shocks is investigated by other authors such as Obstfeld and Rogoff (1996). Most relevant for the fourth chapter, Lane and Milesi-Ferretti (2002a) focus on international financial integration between countries with respect to stocks of net foreign assets. They establish GDP per capita, public debt and demographic factors as the main determinants of countries' net foreign asset positions.

The fourth chapter, 'Saving, Investment and the Net Foreign Asset Position' contributes to the literature by incorporating the saving and investment channel into the analysis of the net foreign asset position across countries. To be more precise it explores the importance of long-run changes in the level of

domestic wealth and capital stock utilising cointegrated panel data. Drawing on time series and cross section data, the chapter analyses the importance of a country's output per capita, public debt and population age structure in determining saving and investment flows. Thereby, it assesses the channels by which these factors affect the external asset position of a country. This chapter differentiates between the effect of output per capita, public debt and demography on saving and investment. Once the precise influence of GDP per capita, public debt and demographic factors has been clarified, further insights on their ability to influence net foreign assets via saving and investment are obtained. It becomes evident in which ways GDP per capita, public debt and demographic factors impact upon saving and investment and, as a result, the net foreign asset position.

The thesis concludes in chapter five with a résumé of the findings established in the three main chapters and a discussion about possible future research.

Three main data sources are used in the thesis. The first two, the International Financial Statistics (IFS) and World Development Indicators (WDI) contain data that generally rely on official sources, although some adjustments are made in the balance of payments to account for fiscal and calendar-year differences. Within these publications the two organisations attempt to present data that are consistent in definition, timing, and methods. Even so, updates and revisions over time may introduce discrepancies from one edition to the next. The aggregation rules are intended to yield estimates for a consistent set of economies from one period to the next and for all indicators. Small differences between sums of subgroup aggregates as well as overall totals and averages may occur because of the approximations used. In addition, compilation errors

and data reporting practices may cause discrepancies in theoretically identical aggregates. In general, the two organisations are the most reliable sources for the macroeconomic data utilised in the thesis.

The third main data source is provided by Lane and Milesi-Ferretti (2001 and 2002a). The authors employ a uniform methodology to generate estimates of foreign asset and liability positions for 67 industrial and developing countries over the time horizon 1970 to 1998 by exploring balance of payments data. The data sources are obtained from various issues of the IFS, WDI, World Debt Tables by the World Bank and data provided by the OECD. The constructed data set enables researchers to analyse foreign assets and liabilities as well as their equity and debt subcomponents in a comprehensive manner. The estimates of assets and liabilities are based on stock measures, when available, and supplemented by cumulative flows with appropriate valuation adjustment. In particular, Lane and Milesi-Ferretti estimate stocks of equity and foreign direct investment based on flow data which are adjusted to reflect the effect of changes in market prices and exchange rates. Nevertheless, the data constructed may contain ample margins for errors. The estimates of foreign direct investment are based on book values, while the equity estimates are adjusted to reflect market value. Estimates of gross debt positions of industrial countries are hampered by the lack of data comparable to external debt statistics for developing countries.

Chapters two and four were presented at the Trinity International Group Seminar. A version of chapter two is forthcoming in the journal 'Applied Economics'. Previous versions of chapter three were presented at the European University Institute in Florence at the Workshop on 'Competitiveness and EU Enlargement: Exchange Rates and Financial Markets' (2001), the Irish Economic Association Conference (2002), the Trinity International Group Seminar

and the Money, Macro and Finance Conference (2002). I would like to thank participants and anonymous referees for providing comments which enhanced the research.

2 Chapter Two

Cross-Country Evidence on the Link between the Level of Infrastructure and Capital Inflows

2.1 Introduction

The aim of this chapter is to shed further light on the determinants of capital inflows to developing countries. In particular, the relationship between the level of infrastructure in these countries and their ability to attract external capital is investigated. The rationale of this chapter becomes evident when examining the literature on the provision of public capital and productivity. Public investment can generate important positive spillover effects for private sector investment.¹ Aschauer (1989) analyses the relationship between public capital and production, using aggregated data of the United States. His results point out that the United States' productivity decline of the 1970s was due to underinvestment in infrastructure. By contrast it could be argued that public capital is endogenous so that the causation runs from productivity to public investment (Fernald, 1999). The latter author finds out that the aggregate correlation between productivity and public capital in the U.S. primarily reflects the causation from public capital to productivity. Fernald considers roads and his evidence suggests that the massive road building during the 1960s offered a one-time increase in the level of productivity. Demetriades and Mamuneas (2000) create an intertemporal model of output and employment to test for the effects of public infrastructure capital and their rates of return. They confirm Aschauer's finding for twelve OECD countries in the long-run. The authors argue that the productivity of public capital is significantly lower than the one of private capital in the

¹For an overview on this literature see Gramlich (1994).

short-run but more productive in most countries analysed in the long-run. Their findings suggest that the short-run rates of return to public capital are rather low while the long-run rates of return tend to be relatively high. Hence, public capital is often oversupplied in the short-run and undersupplied in the long-run. They conclude that it is important to consider the effects of public capital not only on current but also on future producer decisions. In the context of international capital, Clarida (1993) looks at the relationship between international capital flows, public investment and growth. He develops a neoclassical growth model under perfect international capital mobility in which private and public capital are complements in production. Empirically he finds out that productivity and public capital are cointegrated in four OECD Countries.² Nevertheless, the question whether productivity is exogenous or endogenous with respect to public capital cannot be answered so that the structural relationship needs to be investigated further.

This chapter attempts to explain the structural relationship between the initial public infrastructure conditions of countries and capital movements in a cross-section of countries. It concentrates on different types of capital stocks and flows, namely total liabilities, FDI and debt.³ The relation between the stock of a country's infrastructure and the inflow of external capital will be conditional on a set of country-specific characteristics. Airports, power plants, railways, roads or telecommunication facilities are important components of national production. Hence, the chapter focuses on the provision of infrastructure

²Namely the USA, Germany, France and the United Kingdom.

³The main reason why portfolio equity is not considered in the empirical part of the paper is due to the fact that trade in portfolio equity requires the presence of well developed financial markets. Additionally, portfolio equity flows require the existence of listed companies which trade equity shares. Most developing countries considered in this chapter lack such conditions.

and it will be investigated whether infrastructure influences international investors' decisions to invest in particular countries.

The following subsection provides the motivation for the data choice and explains the relationship to be addressed. The empirical part presents the descriptive statistics of the data in subsection 2.3.1, while the econometric approach will be explained in part 2.3.2. The results of the cross-sectional analysis and the empirical evidence of capital flows and its relation to the level of infrastructure will be discussed in the remaining subsections. Section 2.4 concludes.

2.2 Choice of Variables

Capital market frictions and country-specific economic conditions play an important role in influencing investment decisions internationally. Specific infrastructure provision may affect market distortions and domestic performance by reducing information collection costs, transporting costs or capital formation costs.

A country's telecommunication system has an important impact on information collection and transmission. It can promote a fast exchange of information and thereby increase the ability of investors to acquire important knowledge about recent changes in the investment environment. Hence, investors are able to monitor investment projects more closely. Obviously, geographical distance is relevant. The greater the distance, the less attractive a country is for investment, due to increasing costs of acquiring information. Information costs are expected to be positively correlated to distance. The provision of a well-established telecommunication network lowers the costs of collecting information. Therefore, *international telephone circuits* are used as a variable which captures the informational dimension in the empirical section. The collection of

personal information is another important factor in deciding whether to invest in a country, so that good air connections are potentially important. By using the explicit variable of *flight air departures*, this effect will be measured.

Transportation costs also have an impact on investment decisions. They influence the relative prices of capital goods, since some goods must be transported from one region to another to start or continue the production process. A good network of transportation infrastructure can lower the costs of moving goods between regions and thereby increases the efficiency of the production process in the country. The better the transport system, the lower the costs. This relationship is measured by using the total length of *paved roads* as a proxy for the transportation system. The assumption is that a positive correlation between the length of roads in the country and the propensity to invest in such a country should exist. The costs of sending goods to retailers and distributors at home and abroad are decreasing with a rising level of transport facilities. It is interesting to consider countries which are *landlocked*, i.e. which have no direct access to coastal areas, hence, might possibly have higher costs of final production.⁴ Landlocked countries can therefore be expected to receive less inflows of new investment. Nevertheless, the provision of an alternative network in terms of air transport could attract more investment into these regions. The aforementioned variable on air departures might also be able to capture these effects.

Another aspect worthwhile investigating is the question whether the geographical position of the country has any impact on capital flows. In general, it can be argued that countries with an increasing distance to the equator are

⁴Especially developing countries need to import most equipment investment from abroad to start the production.

equipped with a better infrastructure and are stronger in the process of production and economic growth. Looking at Africa, most countries at the equator have not developed a solid infrastructure basis yet and lack a good economic performance. Countries closer to the equator are expected to receive smaller amounts of capital inflows, especially portfolio flows. To assess this the variable *latitude* is utilised.

To consider the product differentiation in exports the ratio of *mineral exports* relative to merchandise exports is used to test for such effects.⁵ A high natural resource endowment may have ambiguous effects on capital inflows. On the one hand, countries which tend to be more diversified in production are less affected by strong fluctuations in mineral prices. Hence, they may represent better credit risks and permit new forms of international investment. On the other hand, a high natural resource endowment allows an increase in the credit ceiling facing a country since natural resources serve as a good collateral for international loans, especially debt.

In order to account for macroeconomic heterogeneity of countries additional control variables are introduced. The country size (here the *total GDP*) plays an important role. On the one hand large countries are more attractive due to the existence of fixed costs in acquiring information about the investment conditions in the country. They may also be less vulnerable to external shocks, due to diversified production. On the other hand, a small open country can be more attractive since its economy may be able to adjust to changes in the international economic environment more quickly and flexibly. This makes such a country more competitive and safe to invest in. The wealth of the country,

⁵This variable was chosen to be consistent with the literature on international capital flows, e.g. Lane (2000a).

GDP per capita, has implications for the country's position as a net creditor or debtor. Wealthier countries tend to have more asset positions than liabilities.⁶ The *openness* of a country should not be neglected as more open countries represent better credit risks. They are more vulnerable to external sanctions and gain less from defaulting. Openness is measured by using the sum of predicted bilateral trade shares from the geographical determinants in the gravity theory (see Frankel and Romer, 1999).

2.3 Evidence on the Linkage of Infrastructure and Capital Flows

In this section a cross-country data set, exhibited in Tables 2.1 and 2.2, is utilised to test the prediction that the inflows of external capital to countries are positively related to the level of infrastructure in the economy.⁷ The relationship becomes vital if the level of infrastructure is able to promote the inflow of capital to a certain extent.⁸

The regression analysis makes use of a cross-sectional approach. This type of approach allows us to abstract oneself from short-run fluctuations in the external capital liabilities which occur due to temporary shocks in the world capital markets. Another motivation for a cross-sectional analysis is that measures of

⁶This argument has been confirmed by Lane and Milesi-Ferretti (2001).

⁷In an earlier version of this chapter public investment and its relationship with external capital inflows was also considered. The measurement was obtained by the construction of a perpetual public capital stock. However, since it cannot be said whether public investment is used efficiently, the results are not reported.

⁸Non-economic factors such as public and political stability and efficiency were also considered in this chapter. To capture these effects data on the stability of political institutions were utilised (see Keefer and Knack (1997) for the provision of data). However, the variable did not enter the regression specification statistically significantly.

infrastructure are more convincing in capturing cross-country variations rather than tracking changes in the level of infrastructure of an individual country over time.

The cross sectional analysis consists of 30 countries from Asia, Africa as well as Latin America and uses data from 1990 to 1995 (refer to Table 2.3).⁹ With reference to the stock of total liabilities and debt the sample size is restricted to 29 observations due to the fact that South Africa did not report on these items. The results on longer time periods, including periods from the 1970s onwards, were similar to the ones reported here. A sample which contained industrialised countries was also experimented with. However, the most interesting results occurred for the developing country sample.

The developing country sample appears to be appropriate since variations in infrastructure between developing countries may have a stronger impact on the attraction of capital inflows. The definition of developing countries in this chapter is broadly consistent with those countries likely to be elected for developing country treatment by the World Trade Organization (WTO). The group therefore includes the Republic of Korea and Singapore, which were clearly developing economies in the last decades but are now classified as high-income by the World Bank. However, Singapore is not included in the list of developing countries, since it has an extraordinary position as a financial centre.¹⁰ Including Singapore improves the results in fact.

⁹Multivariate outliers were tested for using the procedure suggested by Hadi (1992, 1994) in the regression specification. Hadi applies a cluster analysis. This analysis is based on a procedure that recursively defines the distance of an observation from a cluster of observations.

¹⁰In general, an outlier like Singapore is not necessarily bad. The variation in the data is exactly what allows the identification of relationships. However, if an outlier is non-representative due to factors that differentiate it from the rest of the sample, it makes sense to exclude it from the sample.

2.3.1 Descriptive Statistics

This section discusses the sample's descriptive statistics. Figures 2.1 to 2.3 are histograms of the infrastructure variables used in the empirical section. Each histogram is divided into four groups. Figure 2.1 shows air departures per inhabitant in 1990. Group 1 contains the 16 countries (53 percentage of the sample size) with a level of less than 0.2 air departures in 1990. Only two countries have a ratio of 0.6 air departures per capita or above. Figure 2.2 displays paved road length. 16 countries are grouped in category 1, which represents paved roads per square km below 0.05. Six countries belong to group 2 with a road length below 0.1 km per square km. Only 27 percent of the countries provide a paved road length of more than 0.1 km per square km. Figure 2.3 presents the ratio of international telephone circuits per inhabitant in 1990. Group 1 contains 19 countries (67 percent of the sample size), which have an international telephone circuits ratio of less than 0.09. Group 3 and 4 consist of only three countries, which have more than 0.17 international telephone circuits per capita. Accordingly, Figures 2.1 to 2.3 indicate considerable cross-country heterogeneity in the infrastructure variables. Table 2.4 reports the summary statistics of all variables included in the regression analysis. As evidenced above, there is a considerable standard deviation in the data on the level of infrastructure. The analysis of the capital data reveals that the mean of all stock and flow positions is positive for the entire sample.

2.3.2 Econometric Approach

For the estimation procedure ordinary least squares (OLS) is applied to specify the prediction that a link between the level of infrastructure and capital flows

to a country exists.¹¹ Table 2.5 provides Test results of White's (1980) test for heteroskedasticity in the residuals from the OLS regression. This test is a test of the null of no heteroskedasticity against heteroskedasticity of some general form.¹² Overall, there is no evidence for the presence of heteroskedasticity. However, to facilitate a comparison the statistical inference reported makes use of normal as well as standard errors corrected by the White procedure.¹³ Overall, two concepts of external capital liabilities, namely gross liability flows and stocks, are considered. Much of the benefits of asset trade arise from gross rather than net positions. Results for net asset positions were also tested. Since most of the countries included in this sample are net debtors, the relationship found is not very different from the one reported for the gross liability data.

The stock position is the relevant state variable on the macroeconomic level. Flows arise to close the gap between the actual and desired stock position. Financial flows and stocks can be divided into FDI, portfolio equity and debt. Thus, to obtain a precise picture, the stock and flow variables are split into their sub-components. All liability measures are calculated as a share of GDP and are then used as a dependent variable y_i in the regression analysis. This ratio therefore expresses the stocks or flows relative to GDP. The variable y_i is calculated as an annual average over the period 1990-95.

¹¹An infrastructure index was also experimented with. The index was constructed out of a principal component analysis. The first and second principal components were utilised to construct weights of the infrastructure variables. However, the index did not enter the regression analysis significantly.

¹²The advantage of White's test is that it is not necessary to specify the nature of heteroskedasticity and, hence, does not require an additional structure on the alternative hypothesis. Thus, the test is a generalisation of the Breusch-Pagan (1980) test.

¹³Note that the statistical inference made in section 2.3.3 does not change to a great extent when the normal error variance-covariance matrix is used from the OLS specification. In any case changes are reported when they occur.

For the OLS application, the level of infrastructure in the countries is captured by $x_{i,level}$ for each infrastructure variable separately and jointly by the vector $X_{i,level}$.¹⁴ The latter provides the set of infrastructure variables explained above: air departures, roads as well as international telephone circuits. Since the time period 1990-95 is observed, the level of infrastructure relates to the stock of infrastructure in 1990.

In the first step, y_i and $x_{i,level}$ are regressed in a bivariate form. Subsequently, a set of other variables Z_i is added. Z_i includes regressors such as natural resources, latitude and trade openness, which could also be potential determinants for capital inflows to countries. Z_i also includes variables which control for heterogeneity between the cross-section of countries. Country differences are adjusted by using measures of country size (GDP) and wealth (GDP per capita). These two variables are expressed in logs. Accordingly, the basic specification of the regression analysis can be written as follows:

$$y_i = \alpha + \beta x_{i,level} + \gamma' Z_i + u_i \quad (2.1)$$

In the last step the complete set of infrastructure variables $X_{i,level}$ is utilised. Additionally, a dummy variable, d_i , is used in order to account for unobservable factors such as being landlocked. As a result, the estimated model then takes the form:

¹⁴In previous drafts effects of other infrastructure variables, such as railway length, energy generating power, number of telephones and telephone mainlines as well as air transport (airfreight and persons carried) were tested for. The last two can be seen as substitutes for international telephone circuits and air-departures. The results obtained were similar to the ones reported here. The former variables were not included due to the fact that they did not add any further explanatory power to the model. To measure the effect of human capital on the attraction of capital inflows a variable, which is calculated by the percentage of secondary schooling degrees in the work force, was defined. This variable was not statistically significant.

$$y_i = \alpha + \beta' X_{i,level} + \gamma' Z_i + \delta d_i + u_i \quad (2.2)$$

2.3.3 Results

Following the procedure introduced above the results are discussed in the next subsections. Regression results for the cross-section analysis on capital stocks are presented in Tables 2.7 to 2.9 whereas Table 2.9 exhibits results of capital flow data. Since the focal point of interest lies in comparing the influence of the same determinants across categories, the same set of specifications, as explained below for Table 2.7, is adopted in each case. Alternatively, a step-wise regression could be applied to analyse the significance of the infrastructure variables.¹⁵ Nevertheless, this study follows a different approach for the following reasons: Firstly, in order to be consistent with the empirical literature on international capital flows, this chapter follows a similar structure of regression analysis as implemented by Fernandez-Arias and Hausmann (2000), Hausmann and Fernandez-Arias (2000) and Lane and Milesi-Ferretti (2000). Secondly, the choice of regressing the dependent variable subsequently on the individual infrastructure variables and a set of controls is explained by economic reasoning. GDP and GDP per capita are the main control variables when analysing cross-country differences in international capital flows (Lane and Milesi-Ferretti, 2001). Thus, the robustness of the infrastructure variables is checked by including these two variables. To analyse the importance of the infrastructure variables in relation to other possible determinants of capital flows the additional control

¹⁵This technique allows the exclusion or inclusion of the explanatory variables in the regression so that their relative contribution to the overall explanation of the dependent variable may be determined. However, the sequences by which the explanatory variables are included or dropped from the regression is crucial and are determined by the researcher.

variables are introduced. It becomes clear that this approach acknowledges the importance of economic factors in a systematic way to observe the importance of the infrastructure variables in explaining capital flows to developing countries. To lend support to all of the t and F tests reported, Table 2.6 presents results on the Jarque-Bera test for normality. The test is a test of the null hypothesis of normal distribution. The results support the view that the errors of the regression analyses are normally distributed.

1990-95 Cross-Section Analysis of the Stock Data: For the analysis of the stock of total liabilities, 29 countries are included in the sample as South Africa is excluded due to missing observations. Table 2.7 contains the regression results of the total liability stock relative to GDP as the dependent variable. In columns (1) to (3) the basic bivariate relationships between the average total liability stocks and the infrastructure variables are shown. A positive effect for measures on the level of roads, air departures as well as the level of international telephone circuits is established. However, only air departures and telephone circuits enter significantly into the basic specification. Those variables are able to explain 20 and 42 percent of the cross-country variations in total liabilities respectively. A one percentage point improvement in the level of air departures in 1990 is associated with an increase in the average annual stock of total liabilities of 0.802 percentage point. The effect is even stronger for international telephone circuits. Here, a one percentage point improvement in the level of international telephone circuits in 1990 leads to a rise in total liabilities by 2.982 percentage points. To allow for the cross-sectional variations in size and wealth, GDP and GDP per capita are included as general control variables in the regressions in columns (4) to (10). The other regressors are jointly added in

columns (7) to (10). When controlling for the wealth and size of the countries in columns (4) to (6), only international telephone circuits maintain a positive and individually significant relationship with the average total liability stock. Interestingly, throughout columns (4) to (6), total GDP enters negatively and is statistically significant in the specification. Thus, smaller countries hold more liabilities relative to GDP. Columns (7) to (9) include all explanatory variables for each of the infrastructure variables. Only international telephone circuits and air depatures reveal a significantly positive relationship with the total liability stock. However, for the later the statistical conclusion only holds under normal standard errors. The size of the country loses significance as the remaining explanatory variables are added. Instead, trade openness now enters significantly and its point estimate is positive and stable across columns (7) to (9). One explanation is that trading countries represent a better credit risk and receive more liabilities. On average, a ten percentage point increase in trade openness is associated with a 0.15 percentage point increase in total liabilities. Latitude enters the specification individually significantly and negatively in columns (8) and (9). This implies that the geographical position of countries matters. Countries north from the equator hold a lower stock of total liabilities. Column (10) in Table 2.7 includes all infrastructure variables and the other explanatory variables. 67 percent of the cross-sectional variation in total liabilities is explained by the last regression equation. None of the infrastructure variables is individually significant. Joint significance of the infrastructure variables is tested for using a F-Statistic.¹⁶ The joint test for the three variables has a p-value of 0.239 and 0.588 under the robust and normal covariance matrix respectively. Thus,

¹⁶Since a linear restriction in a small sample is tested for, the F statistic instead of the chi-square distribution is utilised.

the infrastructure variables are jointly insignificant. Only trade openness keeps its statistical significance and enters with a positive sign. The other regressors have much less importance in the final specification.

The analysis of the relationship between the average stock of FDI liabilities and the level of infrastructure is provided in Table 2.8.¹⁷ The sample size consists of 30 countries. The specifications for columns (1) to (10) are identical to the one explained above. In the bivariate analysis air departures enter significantly although roads and international telephone circuits also have a positive sign. A three percentage point increase in the level of air departures as a ratio to total population is associated with a one percentage point increase in the average annual FDI stock per GDP of a country. Overall, 48 percent of the variation in FDI is explained in the cross-section. Air departures remain individually significant when further controls are added and the variable's positive point estimate remains stable across columns (4), (7) and (10). Controlling for wealth and size in columns (4) to (6) leaves the sign of the other infrastructure coefficients unchanged. GDP enters with a negative sign that is only marginally significant in the specification for roads and international telephone circuits in columns (5) and (6).¹⁸ Throughout columns (7) to (9) country size, trade openness and natural resources have a strong negative and individually significant impact on the average stock of FDI liabilities. This impact is stable for each of the infrastructure variables used. The implication is that, other things being equal, less open countries have a higher stock of FDI liabilities. This finding

¹⁷It can be assumed that parts of the FDI inflows in the 1990s are due to privatisation. The relationship between the adopted privatisation schemes in many of the countries and FDI stocks and flows were analysed. However, a significant relationship for the countries could not be found.

¹⁸For international telephone circuits this is only true when robust standard errors are applied.

can be related to the problem of asymmetric information. Trade openness may reduce asymmetric information problems, since trade increases the familiarity and provides useful information to overseas investors. Thus less trading countries limit information to foreign investors. FDI may be a way to reduce or eliminate the informational asymmetry, insofar as foreign investors control the firms they invest in. This might explain the higher amount of FDI in less open countries. Additionally, the increased credit risk of less open countries might be eliminated or reduced when international investors directly purchase a controlling interest in firms, using FDI. Countries that are equipped with higher amounts of natural resources relative to merchandise exports dispose of less FDI liabilities. This emphasises, leaving other controls unchanged, that countries with a diversified export structure are better candidates for receiving FDI. The dummy concerning being landlocked is negative and highly statistically significant throughout columns (7) to (10). Landlocked countries receive less FDI, which implies that countries with ports and harbours provide better opportunities for FDI. Column (10) shows the joint impact of the infrastructure variables. Again, 67 percent of the variation in the cross-section is explained by the regression specification. Interestingly, looking at latitude, countries further north from the equator receive more FDI. While air departures remain significantly positive in the regression, a negative and individually significant impact of roads and international telephone circuits can be observed. A test for the joint significance of the three infrastructure variables has a p-value of 0.000, using either the normal or corrected covariance matrix, therefore the variables are also jointly highly significant. The arising question is why roads and international telephone circuits become negative in sign. One explanation is that the correlations between the infrastructure variables, especially between air depar-

tures and international telephone circuits, contribute to the changes in sign.¹⁹ The findings in Table 2.8 suggest that the level of air departures is an important determinant of the FDI stock per GDP in a cross-section of countries. As before, openness partly explains the stock of international capital. This time openness is negatively correlated to FDI. The results obtained suggest that also natural resources have a negative impact on the attraction of FDI stocks. An interesting finding, illustrated in Table 2.8, is that countries with access to coastal areas, i.e. ports, are able to attract more FDI liabilities. The analysis of the portfolio equity stock does not show any effects overall. Therefore, results are omitted from the discussion.

The relationship between the average stock of debt and infrastructure is documented in Table 2.9.²⁰ Out of the three bivariate specifications in columns (1) to (3) the variable on international telephone circuits is significant at the 1 percent level and explains 30 percent of the variation in the stock of debt across countries. A one percentage point improvement in the level of international telephone circuits is associated with an increase of 2.35 percentage points in the average annual stock of debt. Controlling for cross-sectional variations in countries' wealth and size in columns (4) to (6), even the coefficient of international telephone circuits loses its statistical significance when one concentrates the statistical inference on robust standard errors. In all three columns the size

¹⁹Looking at the correlation matrix of the variables used in column (10) it becomes evident that the correlation of air departures and international telephone circuits equals 0.64 while the correlation between roads and air departures equals 0.39 and roads and international telephone circuits 0.38. Thus, more observations with sufficient variation in the infrastructure would be necessary to identify the relationship of the infrastructure variables, especially between air departures and international telephone circuits. However, these are not available for this study at present.

²⁰South Africa is excluded due to missing observations.

variable, GDP, has a negative and individually highly significant impact on the average stock of debt. Introducing the remaining regressors in columns (7) to (9) does not alter the characteristics of the infrastructure variables. None of the infrastructure variables enters significantly in the specification, even though they keep their positive sign. However, now also the wealth of the country plays a negative and individually significant role in determining the average stock of debt. This suggests that poorer countries hold higher stocks of debt. As it is the case for the stock of total liabilities, openness is positively related to the countries' stock of debt liabilities. This is confirmed in columns (7) to (10). Natural resources enter significantly in all the specification and expose a positive sign for the three infrastructure variables. The joint specification in column (10) reveals the importance of countries' geographical position. Countries closer to the equator receive more debt. A joint test of the infrastructure variables provides a p-value of only 0.924 and 0.941 when looking at the robust and normal covariance matrix respectively. The implication is that no joint significance of the infrastructure variables exists.

The findings for the average stock of foreign capital liabilities and its sub-components can be summarised as follows. Considering the infrastructure variables separately, roads do not seem to contribute to the attraction of new international capital. By contrast, air departures and international telephone circuits generally have a positive and statistically significant relationship with the average total liability stock for the period 1990-95. Air departures also show a positive and statistically significant influence on FDI, while international telephone circuits have a positive impact on the attraction of new debt. Overall, the joint impact of the chosen infrastructure variables on the stock of capital inflows is not statistically significant. An exception is provided by the sub-component

on FDI. Here a statistical significant impact of infrastructure on new FDI is found.

1990-95 Cross-Section Analysis of the Flow Data: The analysis of the average capital flows illuminates interesting effects on FDI flows. All infrastructure variables enter with a positive sign into the bivariate specification of FDI flows in Table 2.8. However, as seen above for the stock of FDI, only air departures are statistically significant at the 1 percent level (column (1)). A 2.5 percentage point increase in the level of air departures raises the average annual inflow of FDI liabilities by 0.1 percentage points. Note that 33 percent of the cross-country variations in FDI flows are explained by this variable. The result are similar when country differences, depicted in columns (4) to (6), are controlled for. However, the inclusion of the remaining regressors in columns (7) to (9) reduces the individual significance of the air departure variable under robust standard errors and leaves the other infrastructure coefficients unchanged. In all three specifications of columns (7) to (9) trade openness has a negative and statistically significant impact on the specifications. The same is true for natural resources in columns (8) and (9). In these columns, the dummy variable concerning being landlocked also enters individually significantly and with the expected negative sign. It becomes obvious that the results are similar to the ones obtained for the stock of FDI. Interestingly, looking at the joint influence of infrastructure in column (10), an individually significant relationship of air departures and roads as well as international telephone circuits is found. While the former reveals a positive sign, the latter are negative. A test for the joint significance of the three infrastructure variables has a p-value of 0.001 (0.000

under the normal covariance matrix).²¹ The variables are jointly highly significant. More observations with sufficient variation in the infrastructure variables might be necessary to identify the relationship of the infrastructure variables and their changes in sign. The individual impact of openness and natural resources remains stable. Overall, for the flow data only joint significance of the infrastructure variables for FDI flows is found. An individually positive relationship exists for air departures and FDI inflows, as documented above.

2.4 Conclusion

The aim of this chapter is to explore the link between the level of developing countries' infrastructure and their gross foreign liabilities positions. The evidence is presented in a cross-section of countries and suggests generally positive relationship between the level of infrastructure and capital flows. It has been illustrated that there exists a positive correlation between international telephone circuits and countries' stock of debt. A positive impact of air departures on the average stock and flow position of FDI is established. Additionally, there are joint effects of the infrastructure variables by analysing the FDI positions of countries.

Controlling for other determinants, countries with a diversified export structure or access to coastal areas are able to attract more FDI. Country size matters for explaining the total liability position of countries. Smaller countries hold more liabilities. Trade openness also plays an important role in explaining the stock of liabilities in the cross-section. Trading countries hold higher stocks of total liabilities and debt. However, trade openness is inversely related to

²¹Again, turning to the correlation matrix of column (10) a correlation between roads and air departures of 0.40 and roads and international telephone circuits of 0.37 is established. The correlation between air departures and international telephone circuits equals 0.65.

the stock and flow of FDI. As one would expect, poorer countries have a higher stock of debt liabilities. Considering the geographical position, countries further north from the equator receive lower stocks of debt and total liabilities, while it is linked to a higher stock of FDI.

Given the results established above, the level of infrastructure in countries, especially in information and transport technology, is able to explain cross country variations in FDI and debt positions of countries. Thus, it can serve as a further determinant in explaining capital flows between countries.²² If countries wish to increase international capital inflows, they should improve their information and transport infrastructure.

²²Nevertheless, there is an issue of causality. Note the possibility that a sufficient level of infrastructure might be also due to a country's ability to attract international infrastructure. To overcome this problem the study has analysed the relationship of the average inflow of capital of the period 1990 to 1995 in relation to the level of infrastructure in 1990.

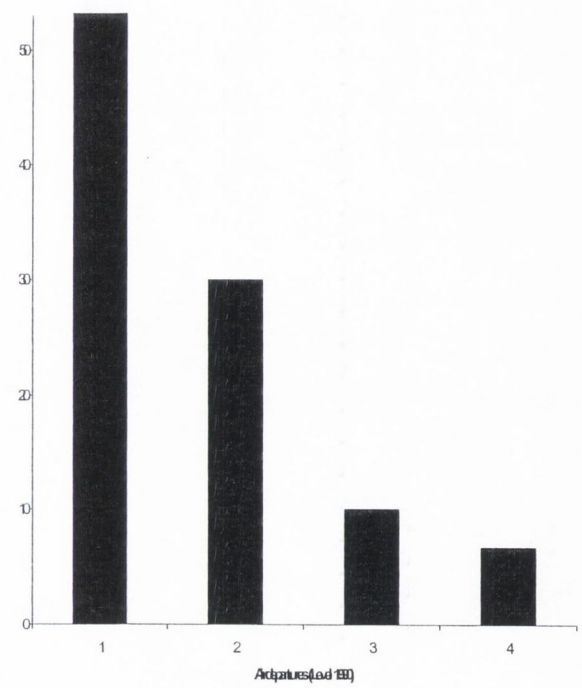


Figure 2.1: Histogram of Air Departures per Capita 1990. *Note: Category 1 ratio of less than 0.2 departures; 2 less than 0.4; 3 less than 0.6; 4 equal or greater than 0.6.*

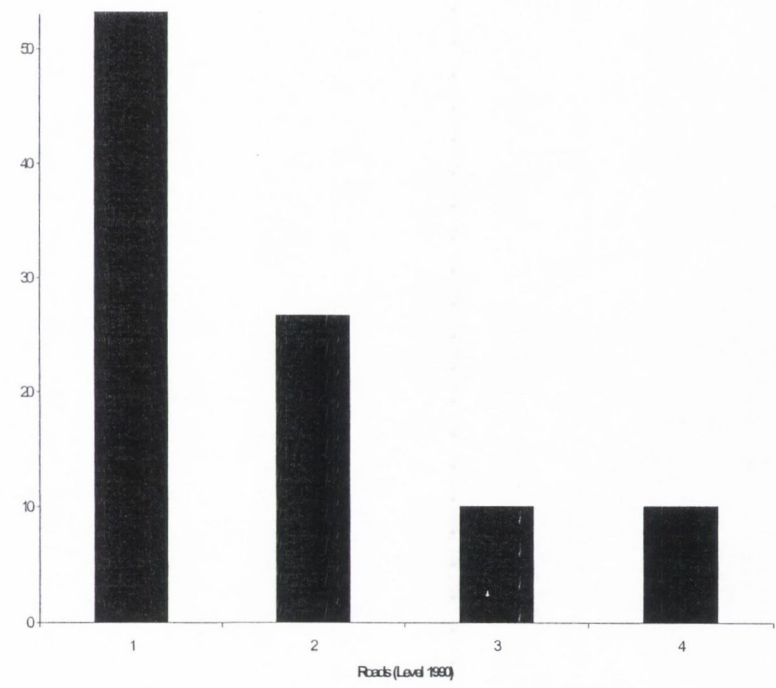


Figure 2.2: Histogram of Total Roads Length per Square km 1990. *Note: Category 1 ratio of less than 0.05 km; 2 less than 0.1 km; 3 less than 1.5 km; 4 equal or greater than 1.5 km.*

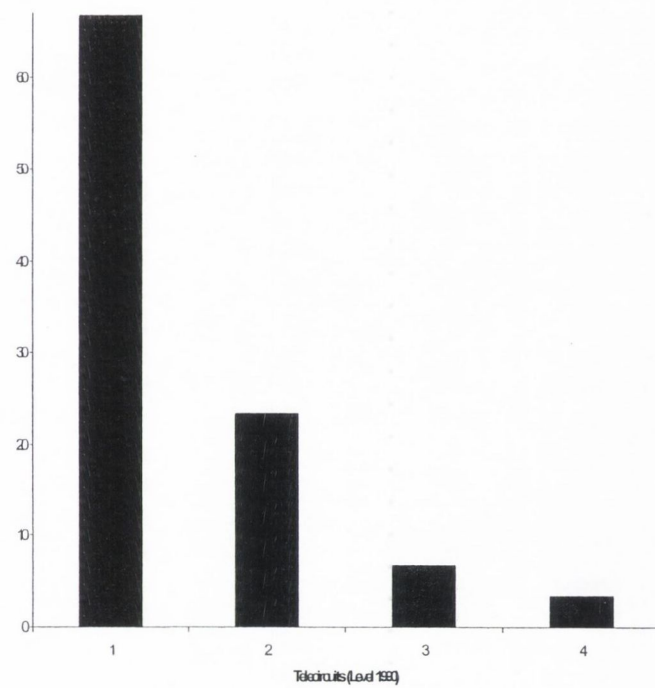


Figure 2.3: Histogram of International Telephone Circuits per Capita 1990. *Note: Category 1 ratio of less than 0.09 telecircuits; 2 less than 0.18; 3 between 0.18 and 0.36; 4 greater than 0.36.*

Variable	Description	Sources
Total External Liability Stock per GDP	Total External Liability Stock = Cum. FDI Liab.+ Cum. Portfolio Equity Liab. +Debt GDP in Current US \$ Average for 1990-95	Lane and Milesi-Feretti (2001) World Bank (GDF WDI, 1999 a,b)
FDI Liability Stocks per GDP	Cum. FDI Liabilities: estimated by cumulating US dollar flows. Stocks are adjusted for changes in relative capital goods' prices between home country and US. GDP in Current US \$ Average for 1990-95	Lane and Milesi-Feretti (2001) World Bank (GDF WDI, 1999 a,b)
Portfolio Equity Liab. Stocks per GDP	Cum. Portfolio Equity Liabilities: estimated by cumulating US dollar flows. Stocks are adjusted to reflect year on year changes in the US dollar value of the domestic stock market index. GDP in Current US \$ Average for 1990-95	Lane and Milesi-Feretti (2001) World Bank (GDF, 1999 a)
Debt Stock per GDP	Developing Countries: Stock of external debt GDP in Current US \$ Average for 1990-95	World Bank (GDD, 2001) World Bank (GDF WDI, 1999 a,b)
Total External Liability Flows per GDP	Total External Liability Flow = Flow of Inward Direct Investment + Inward Portf. Equity +Debt GDP in Current US \$ Average for 1990-95	Lane and Milesi-Feretti (2001) World Bank (GDF, 1999 a)
FDI Liability Flows per GDP	Flow of Inward Direct Investment GDP in Current US \$ Average for 1990-95	IMF (IFS BOPS, 1999 a,b) World Bank (GDF, 1999 a)
Portf. Equity Liability Flows per GDP	Flow of Inward Portfolio Equity GDP in Current US \$ Average for 1990-95	IMF (IFS & BOPS, 1999 a,b) World Bank (GDF & WDI, 1999 a,b)
Debt Flows per GDP	Flow of External Debt GDP in Current US \$ Average for 1990-95	IMF (BOPS, 1999 b) World Bank (GDF & WDI, 1999 a,b)

Table 2.1: The Dependent Variables. *Note: Cum. = Cumulative; Liab. = Liability; Portf. = Portfolio. GDF = Global Development Finance; WDI = World Development Indicators; GDD = Global Development Network Growth Database; IFS = International Financial Statistics; BOPS = Balance of Payments Statistics.*

Variable	Description	Sources
Wealth	log(GDP per Capita in Current US \$) Average for 1990-95	World Bank (GDF & WDI, 1999 a,b)
Size	log(GDP in Current US \$) Average for 1990-95	World Bank (GDF & WDI, 1999 a,b)
Nat. Resources	Mineral Fuels as a Percentage of Merchandise Exports Average for 1990-95	World Bank (WDI, 1999 b)
Telecircuit	Int. Telephone Circuits / Population Population in Total. Level at 1990	World Telecom. Indicators (ITU, 2001) World Bank (WDI, 1999 b)
Road	Total Lenght of Concrete or Bitumen-Surfaced Roads / Square km Square km as of Country Size. Level at 1990	Canning (1998) World Bank (WDI, 1999 b)
Air Departures per Population	Aircraft departures (thousands) / Population Population in Total. Level at 1990	World Bank (WDI, 1999 b)
Openness	Sum of predicted Bilateral Trade Shares (taken from geographical determinants of the gravity model)	Frankel and Romer (1999)
Latitude	Latitude of country centroid. In those countries where the country's centroid fell in the ocean it was moved within the nearest land boundary	Sachs and Warner (1997)
Landlocked	Dummy which takes the value 1 if the country has no access to any coastline, otherwise 0.	Gallup, Sachs and Mellinger (1999)

Table 2.2: The Explanatory Variables. *Note: Nat. = Natural; Int. = International; ITU = International Telecommunication Union. Other abbreviations as explained previously.*

Asia	Africa	Latin America
China	Algeria	Argentina
India	Egypt	Bolivia
Indonesia	Morocco	Brazil
Jordan	South Africa	Chile
Korea	Tunisia	Colombia
Malaysia	Zimbabwe	Costa Rica
Pakistan		Ecuador
Philippines		Guatemala
Sri Lanka		Jamaica
Syria		Mexico
Thailand		Paraguay
Turkey		Peru
		Venezuela

Table 2.3: Country List

Variables	Mean	StDev	Max	Min
Air-Departure _{Level}	0.23	0.20	0.89	0.014
Road _{Level}	0.082	0.114	0.461	0.002
Telecircuit _{Level}	0.084	0.086	0.375	0.002
log((GDP/Capita) _{Average})	7.99	0.504	8.97	7.08
log((GDP) _{Average})	10.73	1.47	13.16	8.29
Openness	14.09	13.017	68.18	2.30
Nat. Resource _{Average}	16.23	24.66	95.93	0.0041
Latitude	9.21	23.02	39.02	-35.82
Stock Tot. Liab. _{Average}	0.73	0.363	1.79	0.224
Stock FDI _{Average}	0.12	0.096	0.40	0.005
Stock Port. Equity _{Average}	0.012	0.023	0.098	0.00
Stock Debt _{Average}	0.589	0.339	1.62	0.157
Flow Tot. Liab. _{Average}	0.04	0.037	0.11	-0.028
Flow FDI _{Average}	0.016	0.014	0.069	0.00013
Flow Port. Equity _{Average}	0.0025	0.0035	0.013	0.00
Flow Debt _{Average}	0.025	0.033	0.119	-0.046

Table 2.4: Summary Statistics. *Note: Abbreviations as explained previously.*

White's Test on Heteroscedasticity			
Dep. Variable: Stock of Total Liab.	Air Departures	Roads	Int. Telecircuit
	White	White	White
Bivariate Form (Column (1)-(3))	1.40 [0.49]	3.57 [0.16]	1.19 [0.57]
Control for Wealth and Size (Column (4)-(6))	12.15 [0.58]	10.36 [0.11]	7.30 [0.29]
All Controls (Column (7)-(9))	13.16 [0.43]	8.47 [0.81]	11.34 [0.58]
All Controls and Infrastructure Variables(Column (10))		18.60 [0.35]	
Dep. Variable: Stock of FDI	Air Departures	Roads	Int. Telecircuit
	White	White	White
Bivariate Form (Column (1)-(3))	0.66 [0.72]	9.11 ^{××} [0.012]	3.90 [0.14]
Control for Wealth and Size (Column (4)-(6))	3.56 [0.74]	9.69 [0.14]	8.52 [0.20]
All Controls (Column (7)-(9))	16.28 [0.23]	6.09 [0.94]	8.34 [0.82]
All Controls and Infrastructure Variables(Column (10))		19.72 [0.29]	
Dep. Variable: Stock of Debt	Air Departures	Roads	Int. Telecircuit
	White	White	White
Bivariate Form (Column (1)-(3))	1.14 [0.56]	1.71 [0.42]	1.22 [0.54]
Control for Wealth and Size (Column (4)-(6))	12.40 ^{××} [0.05]	13.24 ^{××} [0.03]	7.52 [0.28]
All Controls (Column (7)-(9))	12.90 [0.45]	8.19 [0.83]	12.16 [0.51]
All Controls and Infrastructure Variables(Column (10))		19.74 [0.28]	
Dep. Variable: Flow of FDI	Air Departures	Roads	Int. Telecircuit
	White	White	White
Bivariate Form (Column (1)-(3))	4.54 [0.11]	3.24 [0.19]	0.92 [0.62]
Control for Wealth and Size (Column (4)-(6))	8.10 [0.23]	4.63 [0.59]	3.18 [0.78]
All Controls (Column (7)-(9))	17.06 [0.19]	5.08 [0.92]	6.04 [0.94]
All Controls and Infrastructure Variables(Column (10))		21.78 [0.19]	

Table 2.5: The White Test for Heteroskedasticity. *Test of the null hypothesis of no heteroskedasticity. The test statistic is distributed as a chi-square with degrees of freedom equal to the number of slope coefficients in the auxiliary regression. Critical probabilities in square brackets. ++ Significance at the 5 percent, + at the 10 percent level.*

Test for Normality			
Dep. Variable: Stock of Total Liab.	Air Depatures	Roads	Int. Telecircuit
	Jarque-Bera	Jarque-Bera	Jarque-Bera
Bivariate Form (Column (1)-(3))	2.49 [0.29]	3.67 [0.18]	1.80 [0.40]
Control for Wealth and Size (Column (4)-(6))	2.04 [0.36]	1.01 [0.60]	0.38 [0.82]
All Controls (Column (7)-(9))	0.36 [0.83]	1.36 [0.50]	2.15 [0.34]
All Controls and Infrastructure Variables(Column (10))	0.51 [0.77]		
Dep. Variable: Stock of FDI	Air Depatures	Roads	Int. Telecircuit
	Jarque-Bera	Jarque-Bera	Jarque-Bera
Bivariate Form (Column (1)-(3))	1.30 [0.52]	3.84 [0.12]	4.79 [×] [0.09]
Control for Wealth and Size (Column (4)-(6))	1.29 [0.53]	1.80 [0.41]	2.70 [0.25]
All Controls (Column (7)-(9))	1.80 [0.40]	1.55 [0.42]	1.57 [0.37]
All Controls and Infrastructure Variables(Column (10))	0.17 [0.91]		
Dep. Variable: Stock of Debt	Air Depatures	Roads	Int. Telecircuit
	Jarque-Bera	Jarque-Bera	Jarque-Bera
Bivariate Form (Column (1)-(3))	1.20 [0.59]	3.51 [0.16]	3.67 [0.13]
Control for Wealth and Size (Column (4)-(6))	2.45 [0.31]	4.63 [×] [0.10]	3.57 [0.14]
All Controls (Column (7)-(9))	0.42 [0.81]	0.89 [0.63]	1.25 [0.53]
All Controls and Infrastructure Variables(Column (10))	2.02 [0.36]		
Dep. Variable: Flow of FDI	Air Depatures	Roads	Int. Telecircuit
	Jarque-Bera	Jarque-Bera	Jarque-Bera
Bivariate Form (Column (1)-(3))	2.71 [0.26]	1.02 [0.65]	2.16 [0.34]
Control for Wealth and Size (Column (4)-(6))	1.78 [0.40]	2.96 [0.27]	4.51 [0.12]
All Controls (Column (7)-(9))	1.23 [0.56]	0.67 [0.74]	3.89 [0.15]
All Controls and Infrastructure Variables(Column (10))	0.51 [0.77]		

Table 2.6: Jarque-Bera Test for Normality. *Test of the null hypothesis of normal distribution. The test statistic is distributed as a chi-square with two degrees of freedom. Critical probabilities in square brackets. ++ Significance at the 5 percent, + at the 10 percent level.*

Explanatory Variables	Statistical Results reported with robust and normal Standard Errors. t-statistics for normal Standard Errors in emphasised Parenthesis									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Air Departure _{Level}	0.802*** +++ (2.58)(2.61)	-	-	0.469 (1.36)(1.46)	-	-	0.473+ (1.58)(1.85)	-	-	0.243 (0.57)(0.60)
Road _{Level}	-	0.422 (0.45)(0.71)	-	-	0.423 (0.95)(0.94)	-	-	0.409 (0.80)(1.02)	-	-0.0003 (0.001)(0.6)
Telecircuit _{Level}	-	-	2.982*** +++ (4.70)(4.45)	-	-	1.961*** +++ (2.50)(2.74)	-	-	1.331** + (2.21)(1.95)	0.862 (1.00)(0.84)
log((GDP/Capita) _{Ave.})				0.037 (0.29)(0.29)	0.137* (1.72)(1.29)	0.020 (0.32)(0.28)	-0.152 (1.46)(1.39)	-0.073 (0.76)(0.71)	-0.121 (1.51)(1.21)	-0.149 (1.39)(1.32)
log((GDP) _{Ave.})				-0.147*** +++ (2.91)(3.62)	-0.176*** +++ (4.15)(4.81)	-0.117*** +++ (2.72)(2.99)	-0.069 (1.38)(1.39)	-0.097* + (1.84)(1.97)	-0.065 (1.54)(1.29)	-0.060 (1.23)(1.14)
Openness							0.015*** +++ (5.16)(3.18)	0.016*** +++ (4.18)(3.06)	0.014*** +++ (4.56)(2.85)	0.014*** +++ (3.71)(2.77)
Nat. Resource _{Ave.}							0.002 (0.89)(1.17)	0.002 (1.00)(1.13)	0.002 (1.01)(1.31)	0.002 (0.92)(1.21)
Latitude							-0.002 (1.03)(0.70)	-0.003* + (1.88)(1.82)	-0.003* + (2.30)(1.84)	-0.003 (1.38)(0.89)
Landlocked _{Dum.}							-0.263 (1.28)(1.46)	-0.334+ (1.49)(1.81)	-0.286 (1.42)(1.62)	-0.265 (-1.22)(1.42)
R ²	0.20	0.02	0.42	-	-	-	-	-	-	-
adj. R ²	0.17	-0.02	0.40	0.46	0.43	0.54	0.69	0.65	0.69	0.67
SE	0.33	0.37	0.28	0.27	0.27	0.24	0.20	0.21	0.20	0.21
Sample Size	29	29	29	29	29	29	29	29	29	29

Table 2.7: Regression Results: Stock of Total Liabilities. *Note: Dependent variable: Stock of Total Liabilities. Time period 1990-95. t-Statistics in absolute values. ***,+++ Significance at the 1; **,++ at the 5; *,+ at the 10 percent Level. + refers to normal standard errors.*

Explanatory Variables	Statistical Results reported with robust and normal Standard Errors. t-statistics for normal Standard Errors in emphasised Parenthesis									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Air Departure _{Level}	0.333*** (4.68)(5.06)	-	-	0.345*** (4.03)(4.00)	-	-	0.291*** (2.84)(3.61)	-	-	0.471*** (4.61)(5.16)
Road _{Level}	-	0.133 (0.51)(0.84)	-	-	0.122 (0.52)(0.75)	-	-	0.038 (0.24)(0.25)	-	-0.226* (2.35)(1.81)
Telecircuit _{Level}	-	-	0.301 (1.07)(1.52)	-	-	0.109 (0.33)(0.48)	-	-	0.035 (0.13)(0.15)	-0.387*** (2.87)(2.14)
log((GDP/Capita) _{Ave.})				-0.017 (0.55)(0.51)	0.061+ (1.48)(1.73)	0.057 (1.25)(1.52)	0.014 (0.42)(0.40)	0.075* (1.85)(2.00)	0.076+ (1.68)(2.02)	0.001 (0.03)(0.02)
log((GDP) _{Ave.})				-0.004 (0.36)(0.36)	-0.025* (2.02)(2.05)	-0.022* (1.72)(1.63)	-0.042*** (2.89)(2.72)	-0.064*** (4.12)(3.53)	-0.064*** (3.85)(3.46)	-0.004*** (3.18)(3.01)
Openness							-0.004*** (4.21)(2.57)	-0.004*** (3.48)(2.13)	-0.004*** (3.12)(2.16)	-0.003*** (3.13)(2.43)
Nat. Resource _{Ave.}							-0.001** (2.05)(1.74)	-0.001** (2.43)(1.78)	-0.001*** (2.56)(1.82)	-0.001*** (2.95)(2.70)
Latitude							0.0004 (0.58)(0.60)	-0.0001 (0.17)(0.15)	-0.0004 (0.05)(0.05)	0.001* (1.73)(1.78)
Landlocked _{Dum.}							-0.131*** (2.82)(2.33)	-0.179*** (3.56)(2.60)	-0.178*** (3.96)(2.52)	-0.136*** (3.37)(2.78)
R ²	0.48	0.02	0.08	-	-	-	-	-	-	-
adj. R ²	0.46	-0.01	0.04	0.43	0.10	0.09	0.55	0.29	0.29	0.67
SE	0.46	0.10	0.28	0.07	0.09	0.09	0.06	0.08	0.08	0.05
Sample Size	30	30	30	30	30	30	30	30	30	30

Table 2.8: Regression Results: Stock of FDI. Note: Dependent variable: Stock of FDI. Time period 1990-95. t-Statistics in absolute values. ***,+++ Significance at the 1; **,++ at the 5; *,+ at the 10 percent Level. + refers to normal standard errors.

Explanatory Variables	Statistical Results reported with robust and normal Standard Errors. t-statistics for normal Standard Errors in emphasised Parenthesis									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Air Departure _{Level}	0.433 (1.31)(1.39)	-	-	0.121 (0.31)(0.37)	-	-	0.214 (0.62)(0.86)	-	-	-0.145 (0.32)(2.52)
Road _{Level}	-	0.262 (0.39)(0.47)	-	-	0.293 (1.09)(0.64)	-	-	-0.368 (0.94)(0.99)	-	0.223 (0.56)(0.50)
Telecircuit _{Level}	-	-	2.350*** (3.00)(3.42)	-	-	1.544++ (1.56)(2.05)	-	-	0.945 (1.61)(1.45)	1.045 (1.28)(1.06)
log((GDP/Capita) _{Ave.})				0.029 (0.21)(0.22)	0.050 (0.64)(0.47)	-0.036 (0.39)(0.32)	-0.193** (2.05)(1.82)	-0.168** (2.10)(1.79)	-0.198*** (2.66)(2.07)	-0.180* (1.89)(1.71)
log((GDP) _{Ave.})				-0.142*** (2.52)(3.35)	-0.149*** (3.47)(4.04)	-0.103*** (2.16)(2.49)	-0.028 (0.53)(0.57)	-0.037 (0.79)(0.81)	-0.015 (0.36)(0.32)	-0.019 (0.38)(0.37)
Openness							0.018*** (5.80)(3.86)	0.019*** (5.38)(3.95)	0.017*** (5.38)(3.73)	0.017*** (4.41)(3.50)
Nat. Resource _{Ave.}							0.004* (1.88)(2.22)	0.004* (2.00)(2.34)	0.004** (2.05)(2.45)	0.004* (1.97)(2.40)
Latitude							-0.001 (0.40)(0.62)	-0.003 (1.53)(1.11)	-0.002* (1.77)(1.80)	-0.003* (1.77)(1.75)
Landlocked _{Dum.}							-0.110 (0.56)(0.63)	-0.138 (0.72)(0.81)	-0.106 (0.58)(0.63)	-0.120 (0.56)(0.67)
R ²	0.07	0.01	0.30	-	-	-	-	-	-	-
adj. R ²	0.03	-0.03	0.28	0.33	0.34	0.42	0.66	0.66	0.68	0.65
SE	0.33	0.34	0.29	0.27	0.27	0.26	0.20	0.19	0.19	0.20
Sample Size	29	29	29	29	29	29	29	29	29	29

Table 2.9: Regression Results: Stock of Debt. *Note: Dependent variable: Stock of Debt. Time period 1990-95. t-Statistics in absolute values. ***,+++ Significance at the 1; **,++ at the 5; *,+ at the 10 percent Level. + refers to normal standard errors.*

Explanatory Variables	Statistical Results reported with robust and normal Standard Errors. t-statistics for normal Standard Errors in emphasised Parenthesis									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Air Departure _{Level}	0.041*** (2.50)(3.68)	-	-	0.047*** (2.45)(3.15)	-	-	0.042* (1.71)(2.76)	-	-	0.079*** (2.94)(4.69)
Road _{Level}	-	0.008 (0.31)(0.35)	-	-	0.006 (0.23)(0.24)	-	-	-0.002 (0.09)(0.07)	-	-0.040* (1.78)(1.75)
Telecircuit _{Level}	-	-	0.01 (0.26)(0.31)	-	-	-0.015 (0.37)(0.43)	-	-	-0.016 (0.56)(0.43)	-0.085** (2.42)(2.58)
log((GDP/Capita) _{Ave.})				-0.004 (0.64)(0.59)	0.007 (1.02)(1.28)	0.008 (1.05)(1.38)	0.002 (0.32)(0.33)	0.011+ (1.52)(1.74)	0.012+ (1.43)(1.83)	-0.001 (0.09)(0.10)
log((GDP) _{Ave.})				0.001 (0.30)(0.36)	-0.002 (1.01)(0.10)	-0.003 (1.18)(1.19)	-0.004 (1.22)(1.39)	-0.007*** (2.63)(2.34)	-0.008*** (2.49)(2.39)	-0.004 (-1.24)(1.55)
Openness							-0.001*** (3.27)(2.12)	-0.001*** (4.67)(1.93)	-0.001*** (3.82)(1.81)	-0.001** (2.41)(1.89)
Nat. Resource _{Ave.}							-0.0001 (1.50)(1.06)	-0.0002** (2.14)(1.77)	-0.0002** (2.38)(2.39)	-0.0002*** (2.49)(2.03)
Latitude							0.0001 (0.67)(0.67)	0.0002 (0.17)(0.15)	0.0001 (0.13)(0.09)	0.0002 (1.60)(1.68)
Landlocked _{Dum.}							-0.008 (0.93)(0.76)	-0.015* (1.95)(1.78)	-0.016** (2.08)(1.84)	-0.010 (1.33)(1.07)
R ²	0.33	0.005	0.003	-	-	-	-	-	-	-
adj. R ²	0.30	-0.03	-0.03	0.26	0.02	0.01	0.29	0.04	0.05	0.50
SE	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Sample Size	30	30	30	30	30	30	30	30	30	30

Table 2.10: Regression Results: Flow of FDI. *Note: Dependent variable: Flow of FDI. Time period 1990-95. t-Statistics in absolute values. ***,+++ Significance at the 1; **,++ at the 5; *,+ at the 10 percent Level. + refers to normal standard errors.*

3 Chapter Three

Fixed versus Flexible Exchange Rates: A Panel VAR Analysis

3.1 Introduction

An important feature of the global economy is the great variety of exchange rate policies. Since Bretton Woods, the comparative properties of fixed and flexible exchange rates have been of concern and interest for many international economists and policy makers.¹ The experience of numerous emerging market economies over the last decade has led to a refreshed discussion of the question whether to adopt a fixed or flexible exchange rate regime.² The general argument in favour of flexible exchange rates follows Mundell's (1961) formalisation that they act as a 'shock absorber' in a small economy.³

The theoretical argument was revived in the financial crises period of the 1990s. All of the worst hit economies were attempting to peg or stabilise their exchange rates in the pre-crisis period. Sachs (1998) argues that the Asian

¹In a classical paper Helpman (1981) formally compares different exchange rate regimes. He points out that in the presence of no market distortions and perfect foresight all equilibrium allocations are Pareto efficient.

²See Obstfeld (2002) for a discussion of the stabilisation benefits of different exchange rate regimes under the perspectives of the New Open Economy Macroeconomics. Lane (2002) also discusses the effectiveness of stabilisation policies in emerging markets in the context of different exchange rate regimes.

³Friedman (1953) argues that in the presence of nominal rigidities it is both faster and cheaper to adjust the nominal exchange rate in response to a shock, which requires a rise in the real exchange rate (depreciation) rather than to wait until excess demand in the goods and labour market pushes nominal wages and goods prices down. The latter leads to a decline in output and employment.

and Mexican crises were supported by the adoption of a pegged exchange rate regime. The stability of the exchange rate regime led to the over-accumulation of unhedged, foreign currency debt, giving rise to the financial crises. Other contributors question the wisdom of floating exchange rates for developing countries. As an example, Calvo (1999) points out that flexible exchange rates give too much discretion to the monetary authority. This in turn has led to damaging episodes of inflation, especially in Latin America. Aghion, Bacchetta and Banerjee (2001), Eichengreen and Hausmann (1999) and Krugman (1999) have discussed issues related to financial fragility in emerging markets in the context of fixed versus flexible exchange rates. Even though explanations vary among the authors, their conclusion is that the combination of financial market vulnerability and a high exposure to exchange rate changes via foreign currency liabilities make developing countries very reluctant to adopt fluctuating exchange rates.

More recently, some authors have calibrated models to investigate the behaviour of exchange rate regimes to different kinds of shocks. Devereux and Lane (2001) use a small open economy model with two sectors of production. Their finding is that under financing constraints the relative benefits of floating exchange rates tend to diminish. Gertler, Gilchrist and Natalucci (2001) investigate the effects of a financial accelerator mechanism in a small open economy. Their results suggest that financial accelerator effects are much stronger under fixed rates than under flexible exchange rates.

The aim of this chapter is to test the conventional wisdom that external shocks are less contractionary under floating exchange rates. Especially in small open developing economies, macroeconomic dynamics are heavily influenced by the outside world. The collapse of international prices for their exports, demand short falls, interest rate fluctuations or the withdrawal of foreign capi-

tal provide good examples of exogenous macroeconomic dynamics which affect open economies. The purpose of this study is to examine the impact of external shocks on a selected group of small open economies which adopt different exchange rate regimes. A panel vector autoregression (PVAR) approach will be utilised to test whether economies respond differently to such shocks. The PVAR captures both the stochastic patterns and co-movements of macroeconomic variables and allows to study dynamics in terms of deviations from the equilibrium across countries. The chapter analyses and compares the adjustment process of home real output, the trade balance and the real exchange rate by concentrating on world real interest rate and world output shocks. The external disturbances affect each country in an individual counter-cyclical way, owing to country-specific characteristics.

Despite the prominent role played by exchange rate regimes, there is relatively little empirical work addressing their properties. Among the first authors to analyse different exchange rate regimes were Baxter and Stockman (1989). They focus on correlations in the data to analyse the variability of output and inflation over time in an atheoretical approach. Their finding is that different regimes are able to explain shifts in the data. However, a difficulty with this approach is that a given set of observations may be compatible with different economic interpretations. To overcome this problem, Bayoumi and Eichengreen (1994) use a VAR model to analyse nominal and real shocks under different exchange rate regimes. However, the authors do not explicitly test for any hypothesis under fixed and floating exchange rates. Hoffmaister and Roldos (1997a,b) utilise a PVAR approach to analyse business cycle behaviour in Asian and Latin American countries. Similar to Bayoumi and Eichengreen, they apply the Blanchard and Quah (1989) approach to separate nominal and real shocks.

Except for Broda (2000), who analyses terms of trade shocks, there has not been any PVAR research analysing the effects of shocks under different exchange rate regimes.

The structure of the chapter is as follows. Section 3.2 explains the role of the world interest rate and world output in a small open economy. Using an illustrative model, section 3.3 develops the theoretical impact of different exchange rate regimes on output, the trade balance and the real exchange rate. While section 3.4 outlines the econometric issues involved, section 3.5 presents the empirical evidence by utilising cross-section and time series data. The shocks are summarised by variance decomposition and their dynamic adjustment will be illustrated by the impulse response functions. Section 3.6 concludes.

3.2 The World Interest Rate and World Output

Small open economies provide several channels by which world shocks influence their performance. Fluctuations in world output and the world interest rate are important external disturbances which affect their macroeconomic performance.

In theory, the world interest rate is an important mechanism by which foreign shocks and business cycles are transmitted to small economies. In recent years emerging market economies have faced large disturbances in international financial markets.⁴ The collapse of asset values in Japan at the onset of the current recession can be seen as one event causing such a disturbance. The increase in the interest rates in the United States as a result of restrictive monetary policy to control inflation in the beginning of the 1980s as well as the decrease of the interest rate to stimulate the economy in response to the 1990-1991 reces-

⁴See for example Calvo et al. (1993) who point out the importance of external factors, such as financial market volatility, for macroeconomic developments in Latin America.

sion are also good examples of disturbances in the financial markets. From the perspective of developing countries, all these examples above represent external financial shocks. Changes in the world interest rate are therefore shocks to the financial system and affect the behaviour of variables in the economy in a unique way, depending on the domestic conditions. By generating the intertemporal substitution of households, affecting wealth, investment and the capital stock as well as the portfolio allocation, the world real interest rate has an impact on the 'real side' of the economy and alters the allocation of resources. A shock to the world interest rate can also have large effects on net foreign assets, net exports and the present value of debt. With respect to foreign assets and debt a direct link to the financial crises in Asia and Latin America can be drawn. In the recent debate about the causes of the crises, disagreement still exists about whether the adoption of a fixed exchange rate regime reinforced the crises. The world interest rate provides a useful focus for the analysis, since it causes significant disturbances to real economic performance.⁵ Mendoza (1991) as well as Correia, Neves and Rebelo (1992) were among the first authors who analysed effects of the world interest rates in small open economies.⁶ More recently, Neumeyer and Perri (2001) have shown that there exists a strong relationship between domestic interest rates and business cycles in emerging economies. However, the authors

⁵However, there are some difficulties in obtaining the world interest rate. Obstfeld and Rogoff (1995a, p. 1781) discuss tests of intertemporal current account models and note that it is not obvious which real interest rate should be used.

⁶To construct the world real interest rate price indices and inflation expectations are utilised. With respect to the former, Mendoza (1991) and Barro and Sala-i-Martin (1990) use the US and other countries' 3-month T-Bill rate. Correia, Neves and Rebelo (1992) use the Standard & Poor 500 index. To construct prices Barro and Sala-i-Martin (1990) utilise CPI while other authors, such as Schmitt-Grohe (1998), use the GDP deflator. For modelling inflation expectations ARMA specifications have been employed.

have not separated between different exchange rate regimes among countries.⁷ In recent calibration studies (Gertler et al, 2001; Cespedes et al, 2000), a shock to the world interest rate is considered in order to compare the behaviour of the economy under different exchange rate regimes. Using the world interest rate as an exogenous shock makes it possible to directly compare this study's results, obtained by the VAR approach, with the findings of those authors.

Looking at the analysis of the effects of the world real interest rate on the small open economy's output, trade balance and real exchange rate requires the consideration of interactions between world output and the world interest rate. The world interest rate and world output are presumably not independent. To estimate the effect of one, it is also necessary to include the other. Movements in world output affect the world interest rate. For example, in times of high world output, demand for investment may be high and so may be the world interest rate. Changes in world output can be seen as exogenous movements in the demand for small open economies' goods and services. The change in domestic absorption leads firms to revise expectations about future demand and, hence, alters investment. This affects aggregate supply and, as a consequence, output and the trade balance. Home prices are also affected and feedback effects are exerted on the real exchange rate. Assuming the economy consists of a traded and nontraded production sector, changes in the real exchange rate lead to changes in the price for tradable relative to nontradable goods. This stimulates production in either the traded or nontraded good sector, depending on shifts in exogenous demand for traded or nontraded goods. To examine the theoretical issues in more detail the next section outlines a model of imperfect competition with nominal price rigidities.

⁷See also Kose (2002).

3.3 An Illustrative Model

As a backdrop to the empirical work this section presents a formal treatment of the adjustment process of flexible and fixed exchange rates. The model employs the New Open Economy Macroeconomics (NOEM) framework to revisit a central issue in the open economy, namely the analysis of fixed versus flexible exchange rates. As Lane (2001) points out, the majority of the contributions assume a two-country world. There are fewer contributions addressing issues affecting small open economies.

The small open economy presented in this paper follows Obstfeld and Rogoff (1995b, 1996) and Lane (1999). The small open economy is endowed with a competitively-priced export good. Imports are competitively priced by the outside world. The nontraded goods sector is characterised by monopolistic producers who set domestic product prices. Nontraded goods are quantitatively important and can play a role in breaking the link between foreign and domestic consumption.⁸ Being economically small within the world economy, the country takes the foreign price of the imported traded good as given. The monetary rules are assumed to either keep the growth rate of money or the nominal exchange rate constant.

⁸Nontraded goods and sectoral price rigidities are helpful in explaining robust stylised facts in international macroeconomics, such as co-movements of output and consumption between countries (Lubik, 2000). Additionally, the "Purchasing Power Parity Theory" predicts that at least in the long-run no changes of the real exchange rate occur. However, many empirical studies fail to confirm such an effect (see Sarno and Taylor (2002) for an overview). The presence of nontraded goods is able to explain differences in price levels across countries.

3.3.1 International Asset Markets and Budget Constraint

It is assumed that households in the small open economy can allocate their wealth among domestic money, M_s , and foreign bond holdings, F_s , expressed in units of tradeable goods, $P_{T,s}$. The typical home agent's i budget constraint at time t becomes:

$$P_{T,t}F_t^i + M_t^i = (1+r)P_{T,t}F_{t-1}^i + M_{t-1}^i + P_{N,t}(z)Y_{N,t}^i + P_{T,t}Y_{T,t} - P_t C_t - \tau_t, \quad (3.1)$$

where

$$P_t C_t = P_{T,t}C_{T,t}^i + P_{N,t}C_{N,t}^i \quad (3.2)$$

Equation (3.2) can be seen as the trade balance condition. τ_t denotes household taxes at period t . To simplify the analysis a balanced government budget is assumed and no government consumption is present. The government redistributes its seignorage income to the households such that $-\tau_t = M_t - M_{t-1}$. r equals the world real interest rate.⁹

3.3.2 Individual Preferences

Home agent i , which is both a consumer and a producer, has the following utility function:

$$U_t^i = \sum_{s=t}^{\infty} \beta^{s-t} \left(\frac{\sigma}{\sigma-1} C_s^{\frac{\sigma-1}{\sigma}} + \mu \ln \left(\frac{M_s}{P_s} \right) - \frac{\kappa}{2} Y_{N,s}(i)^2 \right), \quad (3.3)$$

where β is the subjective discount factor and $\kappa > 0$ represents the disutility of work effort.¹⁰ $\mu > 0$ is a scale parameter and is the weight of money in the utility function. σ is the intertemporal elasticity of substitution between

⁹In section 3.3.5 the world real interest rate is accompanied by the parameter ϵ_t , which reflects a temporary deviation from the world real interest rate.

¹⁰It can also be seen as an inverse productivity shock.

current and future consumption and has to be greater than zero. Households associate utility benefits from holding real money balances and disutility from having to produce more output of the nontraded good (z) at quantity $Y_N(i)$. C_s denotes the consumption index, which aggregates the consumption of traded and nontraded goods. γ and $1 - \gamma$ are the weights of traded and nontraded goods in the consumption index:

$$C_s = C_{sT}^\gamma C_{sN}^{1-\gamma}. \quad (3.4)$$

The implication of the consumption index is that the intratemporal elasticity of substitution equals *unity*. C_T reflects the consumption of tradable goods while C_N is the aggregate of nontraded goods consumption characterised by a range of goods (z) over the interval $[0, 1]$. The composite of nontraded goods is defined by

$$C_N = \left(\int_0^1 C_N(z)^{\frac{\theta-1}{\theta}} dz \right)^{\frac{\theta}{\theta-1}}, \theta > 1. \quad (3.5)$$

θ is the elasticity of substitution between any two heterogeneous nontraded goods. For $\theta \rightarrow \infty$ different $C_N(z)$ become perfect substitutes, which results in a perfectly competitive situation. The nontraded price index is hence defined as

$$P_N = \left(\int_0^1 P_N(z)^{1-\theta} dz \right)^{\frac{1}{1-\theta}}. \quad (3.6)$$

The consumption price index at time s is given by

$$P_s = \frac{P_{sT}^\gamma P_{sN}^{1-\gamma}}{\gamma^\gamma (1-\gamma)^{1-\gamma}}. \quad (3.7)$$

It is assumed that the law of one price (LOOP) holds for traded goods so that

$$P_T = SP_T^*. \quad (3.8)$$

P_T^* is the world price and S is the nominal exchange rate, defined as the number of domestic currency units per unit of foreign currency. Thus, the price for traded goods is linked to the world price, which is exogenously determined for the small open economy. For part of the analysis it is not assumed to be constant. The real exchange rate is defined as

$$E = \frac{SP^*}{P}. \quad (3.9)$$

P^* is the foreign consumption price index. When normalising the foreign price index to one, the real exchange rate becomes:

$$E = \frac{S}{P_T^\gamma P_N^{1-\gamma}} \xi = \left(\frac{S}{P_N} \right)^{1-\gamma} P_T^{*- \gamma} \xi. \quad (3.10)$$

Equation (3.10) links the price of foreign traded and domestic nontraded goods to the real exchange rate.¹¹ ξ reflects the constant $\gamma^\gamma(1-\gamma)^{1-\gamma}$ from equation (3.7).

The Households' Intertemporal and Intratemporal Choice: The first order conditions for the representative domestic agent are obtained by maximising the utility function of equation (3.3) subject to the budget constraint outlined in equation (3.1). The Euler equation, which links present and future consumption, follows from maximising with respect to consumption, C , and bond holding, F :

¹¹Gali and Monacelli (2002) derive the real exchange rate in a different way by using the terms of trade relationship in a model that contains only an internationally traded good. The authors arrive at a log-linear version of the real exchange rate similar to this chapter.

$$\left(\frac{C_{t+1}}{C_t}\right)^{\frac{1}{\sigma}} = \frac{P_{T,t+1}}{P_{T,t}} \frac{P_t}{P_{t+1}} \beta(1+r). \quad (3.11)$$

In the following it is assumed that $\beta(1+r) = 1$. Consumers like to smooth consumption and therefore take into account relative price changes. The money demand relates the desired real balances to expected relative price changes and the variable on which transactions are based, C_t :

$$\frac{M_t}{P_t} = \left(\frac{\mu C_t^{\frac{1}{\sigma}}}{1 - \frac{1}{(1+r)} \frac{P_{T,t}}{P_{T,t+1}}} \right). \quad (3.12)$$

Real balances increase in the level of consumption, C_t , but also depend negatively on the internationally given interest rate, $(1+r)$, and the tradeable price change, $\frac{P_{T,t}}{P_{T,t+1}}$.

Given the level of aggregate consumption, households have to choose how to allocate C among the tradable and nontradable goods. This budgeting procedure is based on the sub-utility function in equation (3.4). Maximising the objective function (3.3) subject to equation (3.1) and (3.2) the total demand functions for traded and nontraded goods can be derived:

$$C_{T,t} = \gamma \left(\frac{P_{T,t}}{P_t} \right)^{-1} C_t \text{ and } C_{N,t} = (1-\gamma) \left(\frac{P_{N,t}}{P_t} \right)^{-1} C_t. \quad (3.13)$$

From equation (3.13) it becomes clear that the relative demand for traded and nontraded goods,

$$\frac{C_{N,t}}{C_{T,t}} = \frac{(1-\gamma)}{\gamma} \left(\frac{P_{N,t}}{P_{T,t}} \right)^{-1}, \quad (3.14)$$

depends on relative prices, $P_{N,t}/P_{T,t}$, the elasticity of substitution between traded and nontraded goods, which equals *unity*, as well as the relative share of traded goods, γ . Given the total demand function for traded goods, the Euler equation can be rewritten in the following form:

$$\frac{C_{T,t+1}}{C_{T,t}} = \left(\frac{P_{T,t+1}}{P_{T,t}} \right)^{\sigma-1} = \left(\frac{P_{t+1}}{P_t} \right)^{1-\sigma} \left(\frac{S_{t+1} P_{T,t+1}^*}{S_t P_{T,t}^*} \right)^{\sigma-1}. \quad (3.15)$$

The growth of traded goods consumption depends on the sequence of relative prices. If the aggregate price level relative to the price of traded goods is currently low relative to future values, present consumption will be encouraged over future consumption (Dornbusch, 1983). It also adds to the substitution of traded by nontraded goods. The latter effect dominates if $1 > \sigma$ and vice versa.

Production in the Small Open Economy: The production in the economy constitutes nontraded goods, Y_N . Agents are also endowed with a constant amount of homogenous traded good, Y_T . The notion is that production takes place in the nontraded sector, however, changes in the consumption dynamics of nontraded goods affect the optimal consumption of traded goods. The implication is that changes in the traded goods consumption mirror changes in the trade balance of the small open economy.

The nontraded goods sector, Y_N , is characterised by monopolistic firms. Each agent i is a monopolistic producer of a variety of goods (z). The producer's product demand curve for good (z) can be derived by $\min_{C_{N,t}(z)} \int_0^1 P_{N,t}(z) C_{N,t}(z) dz$ subject to $C_N = \left(\int_0^1 C_N(z)^{\frac{\theta-1}{\theta}} dz \right)^{\frac{\theta}{\theta-1}}$. The interpretation is that consumers minimise their costs of consumption by taking aggregate prices as given:

$$C_{N,t}(z) = \left(\frac{P_{N,t}(z)}{P_{N,t}} \right)^{-\theta} C_{N,t}, \quad (3.16)$$

where $P_{N,t}$ is given by equation (3.6). Adding up individual demands for good (z) shows that the producer of good (z) faces the period t aggregate demand curve

$$Y_{N,t}(z) = \left(\frac{P_{N,t}(z)}{P_{N,t}} \right)^{-\theta} C_{N,t}^A, \text{ where } C_{N,t}^A = \int_0^1 C_{N,t}^i(i) di. \quad (3.17)$$

The income or total revenue earned from producing the good (z) equals

$$P_{N,t}(z)Y_{N,t}(z) = P_{N,t}C_{N,t}^{\frac{1}{\theta}}Y_{N,t}(z)^{\frac{\theta-1}{\theta}}. \quad (3.18)$$

Replacing $P_{N,t}(z)Y_{N,t}^i$ in the budget constraint, equation (3.1), by equation (3.18) the condition for the optimal monopolistic price setting can be derived.

Each supplier will wish to charge a relative price satisfying

$$\frac{P_{N,t}(z)}{P_t} = \frac{\theta}{\theta-1} \frac{\kappa Y_{N,t}(z)}{\left(\frac{C_{N,t}P_{N,t}}{(1-\gamma)P_t} \right)^{-\frac{1}{\sigma}}}. \quad (3.19)$$

The right-hand side of equation (3.19) expresses the marginal costs of production. Supplying an additional unit of good z depends on the marginal disutility, $\kappa Y_{N,t}(z)$, relative to the marginal utility of consuming an additional unit of nontraded goods, $C_{N,t}$. It becomes also clear from equation (3.19) that the monopolistic price setting incorporates a price mark-up of $\frac{\theta}{\theta-1}$ relative to the competitive equilibrium where the marginal consumption equals the marginal costs of production. The mark-up would disappear as $\theta \rightarrow \infty$, which reflects the perfectly competitive case.

3.3.3 Steady State and the Current Account

The steady state solution provides the reference values (denoted by overbars) around which the model is linearised in order to capture its dynamics. Given the consumption smoothing and a constant net endowment of traded goods it follows that $\bar{Y}_T = \bar{C}_{T,t} = \bar{C}_T$. It is assumed that the endowment of traded goods ensures that the relative price of nontraded and traded goods equals unity,

$P_N/P_T = 1$, in the steady state. Market clearing for nontradables under symmetric household production implies $C_{N,t}^A = C_{N,t} = Y_{N,t}(z)$ for all (z) .¹² The nontradable steady state production is obtained in conjunction with equation (3.19):

$$\bar{Y}_N = \left(\left(\frac{\theta - 1}{\theta} \right) \frac{1}{\kappa} (1 - \gamma) \right)^{\frac{\sigma}{1+\sigma}} \left(\frac{\gamma}{1 - \gamma} \right)^{\frac{\gamma(\sigma-1)}{\sigma+1}}. \quad (3.20)$$

From this expression it can be seen that a production increase in the nontraded sector is mainly influenced by three factors. First, the more competitive the nontraded goods sector is (a bigger θ), second, the smaller the disutility from work, κ (more productive workers are) and third, the more weight is placed on the consumption of nontraded goods (the smaller γ), the more does production augment. Constant tradeable prices in the steady state determine the aggregate price level as

$$\bar{P} = \bar{M} \left(\frac{1 - \beta}{\mu \bar{C}^{\frac{1}{\sigma}}} \right). \quad (3.21)$$

From this equation the nominal exchange rate follows:

$$\bar{S} = \frac{\bar{M}}{\bar{P}^*} \left(\frac{1 - \beta}{\mu \bar{C}^{\frac{1}{\sigma}}} \right). \quad (3.22)$$

It is assumed that domestic households initially hold a zero stock of net foreign assets, $F_0 = 0$. In the long-run, the current account is balanced, in the short-run, however, the home country's current account can move in either way (surplus or deficit). The current account equality, or in other words the consolidated budget constraint, can be expressed by the following equation:

$$F_t = (1 + r)F_{t-1} + TB, \text{ where } TB = Y_{T,t} - C_{T,t} \quad (3.23)$$

¹²Note that population equals one in this set-up.

To determine the path of the current account the evolution of foreign assets as well as the tradeable consumption are of importance. Since initial foreign asset holdings are zero, $F_0 = F_{t-1} = 0$, the short-run current account identity can be stated as:

$$F_{short-run} = Y_{T, short-run} - C_{T, short-run}. \quad (3.24)$$

However, in the long-run the current account must be balanced and, hence, $F_t = F_{t-1} = F_{long-run}$. Thus, from equation (3.23) the following long-run relationship is generated:

$$-rF_{long-run} = Y_{T, long-run} - C_{T, long-run}. \quad (3.25)$$

The implication is that real consumption spending in the traded goods sector needs to equal the interest payments on net foreign assets plus real production in the traded goods sector. Putting it differently, any debt repayment can only be generated out of a trade surplus, which is an excess of the traded goods production, Y_T , over traded goods expenditure, C_T .

3.3.4 Log-Linearised Model

The model derived above can now be log-linearised around its steady state. The linear approximation of the model has to distinguish between the short-run adjustment to policy or external changes with nominal price rigidities and the long-run dynamics, where price flexibility is the appropriate benchmark. Short-run deviations from the steady state are denoted by hats. Hence, for any variable X , $d\ln X = \frac{dX}{\bar{X}_0} = \hat{X}$ holds. By contrast, any long-run deviations from the benchmark value $\bar{X}_0$ are denoted by $\frac{d\bar{X}}{\bar{X}_0} = \tilde{X}$. If X_0 equals zero the variables are normalised by C_0 . Following this notation, the system of equations

needed to depict the mechanisms at work can now be log-linearised. The short-run stickiness in nontraded goods prices implies that $\hat{P}_N = 0$. Log-linearising equation (3.10), the short-run percentage change of the real exchange rate equals

$$\hat{E} = (1 - \gamma)\hat{S} - \gamma\hat{P}_T^*, \quad (3.26)$$

for any price changes in the foreign traded good.¹³ The long-run real exchange rate change takes the following form:

$$\tilde{E} = (1 - \gamma)(\tilde{S} - \tilde{P}_N) - \gamma\tilde{P}_T^*. \quad (3.27)$$

The short and long-run traded goods consumptions are linked by the current account equations (3.24) and (3.25). Equation (3.24) implies that

$$\frac{dF}{C_0} = -\hat{C}_T, \quad (3.28)$$

which holds for a constant endowment of traded goods. In the long-run, traded goods consumption can only be financed from an accumulation of foreign assets. From equation (3.25) the long-run change in net foreign assets is derived:

$$\frac{dF}{C_0} = \frac{\tilde{C}_T}{r} = -\hat{C}_T. \quad (3.29)$$

The implication of the two equations above is that a current account deficit in the first period must be accomplished by a trade balance surplus in the subsequent period and vice versa since the current account must be balanced in the end of the second period (long-run). From the log-linearised equation (3.15) in conjunction with equation (3.29) the long-run traded goods consumption is

¹³This expression is similar to Galí and Monacelli's (2002) definition of the real exchange rate. The authors establish a link between the domestic price level, the nominal exchange rate and the foreign price.

derived:

$$\begin{aligned}
 \tilde{C}_T - \hat{C}_T &= (\sigma - 1)(\hat{P} - \hat{P}_T) - (\sigma - 1)(\tilde{P} - \tilde{P}_T), \\
 &= (1 - \sigma)(1 - \gamma)\hat{P}_T - (1 - \sigma)(1 - \gamma)(\tilde{P}_T - \tilde{P}_N), \\
 &= (1 - \sigma)(1 - \gamma)(\hat{P}_T^* + \hat{S}) - (1 - \sigma)(1 - \gamma)(\tilde{P}_T^* + \tilde{S} - \tilde{P}_N), \\
 \tilde{C}_T\left(\frac{1+r}{r}\right) &= (1 - \sigma)(\hat{E} - \tilde{E}) + (1 - \sigma)(\hat{P}_T^* - \tilde{P}_T^*).
 \end{aligned} \tag{3.30}$$

In the last two terms the LOOP condition from equation (3.8) and the definition of the short and long-run real exchange rate have been utilised. The steady state changes in nontraded and traded goods consumption are linked by equation (3.14):

$$\begin{aligned}
 \tilde{C}_N - \tilde{C}_T &= -(\tilde{P}_N - \tilde{P}_T), \\
 &= (\tilde{P}_T^* + \tilde{S} - \tilde{P}_N), \\
 \tilde{C}_N - \tilde{C}_T &= \frac{\tilde{P}_T^*}{(1 - \gamma)} + \frac{\tilde{E}}{(1 - \gamma)}.
 \end{aligned} \tag{3.31}$$

In the short-run, when nontraded goods prices are sticky, the level of nontraded goods demand is given by

$$\begin{aligned}
 \hat{C}_N - \hat{C}_T &= \hat{P}_T, \\
 \hat{C}_N + \frac{\tilde{C}_T}{r} &= (\hat{P}_T^* + \hat{S}), \\
 \hat{C}_N &= \frac{\hat{E}}{(1 - \gamma)} + \frac{\hat{P}_T^*}{(1 - \gamma)} - \frac{\tilde{C}_T}{r}.
 \end{aligned} \tag{3.32}$$

The supply condition of equation (3.19) and (3.20) together with (3.14) enables the derivation of the long-run nontraded goods consumption:

$$\begin{aligned}
\tilde{C}_N &= \frac{(\sigma-1)\gamma}{1+\sigma}(\tilde{P}_N - \tilde{P}_T), \\
&= \frac{(1-\sigma)\gamma}{1+\sigma}(\tilde{P}_T - \tilde{P}_N), \\
\tilde{C}_N &= \frac{(1-\sigma)\gamma}{(1+\sigma)(1-\gamma)}\tilde{E} + \frac{(1-\sigma)\gamma}{(1+\sigma)(1-\gamma)}\tilde{P}_T^*.
\end{aligned} \tag{3.33}$$

From the real balance condition in equation (3.12) and the optimal demand condition for traded goods (equation (3.14)) the short and long-run monetary equilibrium equations can be derived. They are given by

$$\hat{M} - \hat{P} = \frac{1}{\sigma}(\hat{P}_T - \hat{P}) - \frac{\tilde{C}_T}{\sigma r} - \frac{1}{r}(\tilde{P}_T - \hat{P}_T), \tag{3.34}$$

and

$$\tilde{M} - \tilde{P} = \frac{1}{\sigma}(\tilde{P}_T - \tilde{P}) + \frac{\tilde{C}_T}{\sigma}. \tag{3.35}$$

3.3.5 Behaviour of the Economy under Fixed and Floating Exchange Rate Regimes

The system of equations established in the previous section can be used to demonstrate the economy's adjustment to temporary changes in foreign import prices, $\hat{P}_T^*$, which reflect a world output shock in the short-run.¹⁴ The system can also demonstrate effects of temporary deviations in the world interest rate, expressed by ϵ_t .¹⁵ Nontraded goods price rigidities are allowed to last for one period only due to monopoly power in the nontraded goods sector. Under this assumption nontraded goods prices are above marginal costs. Nontraded goods producers will change output to accommodate small changes in demand, given

¹⁴See Kose (2002) for a similar argument.

¹⁵Temporary deviations are chosen since the econometric part of the chapter also focuses on temporary shocks.

that they cannot adjust their prices. This is crucial for the behaviour of the variables in the short-run, since perfect competitors would not change output above or below the steady state level in response to a shift in the nontraded goods demand. In the second period, nontraded goods prices are free to adjust and the economy moves towards the new steady state. Conventional wisdom has long been that flexible exchange rates are less contractionary than fixed exchange rates. This case was made first by Friedman (1953) who argues that under sticky prices flexible exchange rate regimes can be used to insulate the economy against real shocks. In the following this assumption will be analysed in more detail.

Flexible Exchange Rates: The central bank uses money supply to target the rate of money growth in the economy. Therefore, the monetary authority's policy instrument is used to maintain a constant (growth rate of the) money supply, $\hat{M} = \tilde{M} = 0$. From equation (3.26) it becomes obvious that the short-run real exchange rate follows movements in the nominal exchange rate since the price of nontraded goods, $\hat{P}_N = 0$, is fixed in the short-run. It is also affected by movements in the exogenous foreign price, $\hat{P}_T^*$. The short and long-run monetary equilibrium equations (3.34) and (3.35) take the following form under the proposed monetary rule:

$$\begin{aligned}
 -\gamma \hat{P}_T &= \frac{1-\gamma}{\sigma} \hat{P}_T - \frac{\tilde{C}_T}{\sigma r} - \frac{1}{r} (\tilde{P}_T - \hat{P}_T), \\
 -\gamma (\hat{P}_T^* + \hat{S}) &= \frac{1-\gamma}{\sigma} (\hat{P}_T^* + \hat{S}) - \frac{\tilde{C}_T}{\sigma r} - \frac{1}{r} (\tilde{P}_T^* + \tilde{S}) + \frac{1}{r} (\hat{P}_T^* + \hat{S}), \\
 -\frac{\gamma \hat{P}_T^*}{1-\gamma} - \frac{\gamma \hat{E}}{1-\gamma} &= \frac{\hat{P}_T^*}{\sigma} + \frac{\hat{P}_T^*}{(1-\gamma)r} + \frac{\hat{E}}{\sigma} + \frac{\hat{E}}{(1-\gamma)r} - \frac{\tilde{C}_T}{\sigma r} - \frac{1}{r} (\tilde{P}_T^* + \tilde{S}), \\
 \tilde{C}_T &= \left(\frac{\gamma \sigma r + (1-\gamma)r + \sigma}{(1-\gamma)} \right) (\hat{P}_T^* + \hat{E}) - \sigma \left(\frac{\tilde{P}_T^* + \tilde{E} + (1-\gamma)\tilde{P}_N}{(1-\gamma)} \right),
 \end{aligned} \tag{3.36}$$

and

$$\begin{aligned}
-\gamma(\tilde{P}_T^* + \tilde{S}) - (1 - \gamma)\tilde{P}_N &= \frac{1}{\sigma} \left(\tilde{P}_T^* + \tilde{S} - \gamma(\tilde{P}_T^* + \tilde{S}) - (1 - \gamma)\tilde{P}_N \right) (3.37) \\
&\quad + \frac{\tilde{C}_T}{\sigma}, \\
&= \frac{1}{\sigma} \left(\tilde{P}_T^* + \tilde{E} \right) + \frac{\tilde{C}_T}{\sigma}, \\
\tilde{C}_T &= -\tilde{P}_T^* - \tilde{E} - \sigma \left(\gamma(\tilde{P}_T^* + \tilde{S}) + (1 - \gamma)\tilde{P}_N \right).
\end{aligned}$$

The two equations above allow the linkage between the short and long-run real exchange rate by

$$(\sigma - 1)(\tilde{P}_T^* + \tilde{E}) = \left(\frac{\gamma\sigma r + (1 - \gamma)r + \sigma}{1 - \gamma} \right) (\hat{P}_T^* + \hat{E}). \quad (3.38)$$

Changes in the real exchange rate depend on movements in foreign import prices, the world real interest rate and the share of traded goods in the economy.¹⁶ Equations (3.30), (3.31), (3.33) are still valid under the assumption that flexible exchange rates prevail. Those equations in conjunction with equation (3.38) allow us to solve for long-run traded goods consumption, $\tilde{C}_T$, long-run nontraded goods consumption $\tilde{C}_N$ as well as the long-run real exchange rate, $\tilde{E}$, and the short-run real exchange rate, $\hat{E}$, under floats. The results can be utilised with equations (3.28), (3.29) and (3.32) to solve for the short-run traded, $\hat{C}_T$, and nontraded, $\hat{C}_N$, goods consumption.

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under Floats: This section discusses an unanticipated temporary change, $\hat{P}_T^* < 0$ and $\tilde{P}_T^* = 0$, in foreign import prices as well as a change in the world real interest rate. Thus, agents make their decisions expecting that the steady state will be obtained in the next period. In the case of a temporary fall in

¹⁶See Hau (2001) for a discussion on the last point.

world prices for imports changes in equations (3.30), (3.31), (3.33) and (3.38) have to be considered. Equation (3.30) becomes

$$(1 + r) \tilde{C}_T = r(1 - \sigma)(\hat{E} - \tilde{E}) - r(1 - \sigma)\hat{P}_T^*. \quad (3.39)$$

The steady state changes of traded and nontraded goods consumption are only linked by long-run changes in the real exchange rate. As a result equation (3.31) takes the following form:

$$\tilde{C}_N - \tilde{C}_T = \frac{\tilde{E}}{(1 - \gamma)}. \quad (3.40)$$

The long-run nontraded goods consumption is affected by the real exchange rate and the interplay between the elasticities of substitution and the share of traded goods in consumption:

$$\tilde{C}_N = \frac{(1 - \sigma)\gamma}{(1 + \sigma)(1 - \gamma)} \tilde{E}. \quad (3.41)$$

Equation (3.38) can be expressed as

$$-(\gamma\sigma r + (1 - \gamma)r + \sigma)(\hat{E} - \hat{P}_T^*) = (1 - \gamma)(1 - \sigma)\tilde{E}, \quad (3.42)$$

which provides the interaction of the short and long-run real exchange rate. The four equations above in conjunction with equation (3.28), (3.29) and (3.32) have to be used to solve for a temporary change in the world import price.

For the analysis of a positive change of the world real interest rate it is assumed that the short and long-run foreign import prices remain constant. However, to model a shock to the world real interest rate it is assumed that outside the steady state the world real interest rate, $(1 + r)$, is augmented by ϵ_t in the short-run, $((1 + r) + \epsilon_t)$. The variable ϵ_t reflects the temporary deviation of the world real interest rate. It is assumed that $\epsilon_{t+1} = 0$ and $\epsilon_t = 0$ in the

steady state. Note that the condition $\beta(1+r) = 1$ is still valid. Consequently, a temporary world interest rate shock is reflected in equation (3.43) below. A similar argument has been made by Schmitt-Grohe and Uribe (2001), who demonstrate that an expression similar to the one above ensures stationarity of the equilibrium dynamics. Therefore, the log-linear version of the Euler equation, (3.11) and equation (3.15), takes the following form:

$$(1+r)\tilde{C}_T = r(1-\sigma)(\hat{E} - \tilde{E}) + \sigma\hat{e}. \quad (3.43)$$

The set of equations below, which are defined for constant world output prices, can be used to analyse the effects of a change in the world real interest rate. The link between the short and long-run real exchange rate reduces to

$$(1-\gamma)(\sigma-1)\tilde{E} = (\gamma\sigma r + (1-\gamma)r + \sigma)\hat{E}. \quad (3.44)$$

The equation above joint with equations (3.31), (3.33), (3.28), (3.29) and (3.32) need to be applied for $\hat{P}_T^* = \tilde{P}_T^* = 0$ to solve the model.

Fixed Exchange Rates: It is assumed that the fixed exchange rate is fully credible and sustainable. Under a fixed exchange rate regime, e.g. a currency board or a dollarisation policy, the monetary authority targets the nominal exchange rate, which implies that $\hat{S} = \tilde{S} = 0$. This assumption has important implications for the real exchange rate in the short and in the long-run. In the short-run, equation (3.26) takes the following form:

$$\hat{E} = -\gamma\hat{P}_T^* \quad (3.45)$$

Thus, the real exchange rate movements of the small open economy only reflect changes in the exogenous economic environment in the short-run. However, this

result rests on the assumption that $\hat{P}_T^* \neq 0$. In the long-run the real exchange rate becomes

$$\tilde{E} = - \left((1 - \gamma)\tilde{P}_N + \gamma\tilde{P}_T^* \right). \quad (3.46)$$

This equation illustrates that changes in the long-run real exchange rate, either an appreciation or depreciation, have to be accomplished by inflation or disinflation. Additionally, the long-run real exchange rate is also affected by movements in foreign prices, $\tilde{P}_T^*$. Since the monetary authority targets the nominal exchange rate, the money supply becomes endogenous to the economy. Movements in the short and long-run money demand are captured by the following two equations:

$$\hat{M} = \left(\frac{\gamma\sigma r + (1 - \gamma)r + \sigma}{\sigma r} \right) \hat{P}_T^* - \frac{1}{r}\tilde{P}_T^* - \frac{\tilde{C}_T}{\sigma r}, \quad (3.47)$$

and

$$\tilde{M} = \frac{\tilde{P}_T^*}{\sigma} + \frac{\tilde{C}_T}{\sigma} + \frac{(1 - \sigma)}{\sigma}\tilde{E}. \quad (3.48)$$

The short-run money demand is affected by the relative price changes of foreign imports as well as the demand for traded goods. In the long-run, money demand reacts to the long-run real exchange rate as well as long-run price changes in foreign tradeable goods and traded goods consumption. Given the definition of the fixed exchange rate regime the long-run traded goods consumption is given by

$$(1 + r)\tilde{C}_T = -r(1 - \sigma)\tilde{E} - r(1 - \sigma)\tilde{P}_T^* + r(1 - \sigma)(1 - \gamma)\hat{P}_T^*. \quad (3.49)$$

The short-run nontraded goods consumption under a pegging regime is defined as

$$\hat{C}_N = \hat{P}_T^* - \frac{\tilde{C}_T}{r}, \quad (3.50)$$

and only depends on short-run movements in foreign traded goods prices and long-run traded goods consumption. Equations (3.49) and (3.50), (3.47) and (3.48) as well as (3.28), (3.29) and (3.31) allow us to solve explicitly for the consumption of traded goods, $\tilde{C}_T$ and $\hat{C}_T$, the consumption of nontraded goods, $\tilde{C}_N$ and $\hat{C}_N$, the long-run real exchange rate, $\tilde{E}$, as well as the short, $\hat{M}$, and long-run money demand, $\tilde{M}$, under the fixed exchange rate regime.

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under Pegs: As in the case of the floating exchange rate regime, the equations discussed above are modified to solve for a temporary change in foreign import prices or for temporary changes in the world real interest rate. Given a temporary change in foreign traded goods equation (3.49) can be expressed as

$$(1+r)\tilde{C}_T = -r(1-\sigma)\tilde{E} - r(1-\sigma)(1-\gamma)\hat{P}_T^*. \quad (3.51)$$

The steady state changes in traded and nontraded good consumption take the same form as in equation (3.40). Equation (3.41) is also valid for changes in the long-run nontraded goods consumption under fixed exchange rate regimes. The short and long-run money demand equations now take the following form:

$$\hat{M} = -\left(\frac{\gamma\sigma r + (1-\gamma)r + \sigma}{\sigma r}\right)\hat{P}_T^* - \frac{\tilde{C}_T}{\sigma r} \text{ and} \quad (3.52)$$

$$\tilde{M} = \frac{\tilde{C}_T}{\sigma} + \frac{(1-\sigma)}{\sigma}\tilde{E}. \quad (3.53)$$

The equations can be utilised to solve not only for temporary changes in foreign prices but also to solve for changes in the world real interest rate by setting $\hat{P}_T^* = 0$ and $\hat{\epsilon} > 0$. As it has been explained in the section on floating exchange rates, for a temporary world real interest rate shock the Euler equation now becomes

$$(1 + r) \tilde{C}_T = -r(1 - \sigma) \tilde{E} + \sigma \hat{e}. \quad (3.54)$$

The model above is a system of six (seven) linear equations under the floating (fixed) exchange rate economy and can be solved with the use of linear algebra. A solution to the system of equations is found by solving the following equation:

$$\mathbf{m} = \mathbf{A} * \mathbf{x}. \quad (3.55)$$

The vector $\mathbf{x}$ contains the set of n endogenous variables and takes the form $[\tilde{C}_T, \hat{C}_T, \tilde{C}_N, \hat{C}_N, \tilde{E}, \hat{E}]'$ under floats, while it contains $[\tilde{C}_T, \hat{C}_T, \tilde{C}_N, \hat{C}_N, \tilde{E}, \tilde{M}, \hat{M}]'$ under pegs. The $n \times 1$ vector $\mathbf{m}$ captures the exogenous variables of the system.¹⁷ The $n \times n$ matrix $\mathbf{A}$ includes all model parameters γ , σ and r . The solutions for equation (3.55) are provided in the appendix A and allow for the discussion of the different implications of the theoretical model under fixed and floating exchange rates, which constitutes the contents of the subsequent section.

3.3.6 Evaluation of Fixed and Flexible Exchange Rates

The evaluation of the different exchange rate regimes crucially depends on the relative strengths of the intertemporal elasticity of aggregate consumption, σ , and the intratemporal elasticity of consumption between tradable and nontradable goods, which is assumed to equal *unity* in this set-up. In general, a smaller intratemporal elasticity implies a stronger link between traded and nontraded goods consumption since the substitutability between the two consumption goods is very low. The intertemporal elasticity of substitution indicates the households' willingness to accept deviations from a uniform pattern of total

¹⁷The system is solved in Maple 7 by using linear algebra.

consumption over time. As σ approaches higher values, households are indifferent to the timing of consumption. In the following a graphical analysis will be pursued to demonstrate the differences in adjustment between fixed and flexible exchange rates. To do so, three different cases need to be considered: In the first case the intertemporal elasticity of substitution is higher than *unity*, (1) $\sigma > 1$. Second, the intertemporal elasticity of substitution equals *unity*, (2) $\sigma = 1$. In the third case the intertemporal elasticity is below *unity*, (3) $\sigma < 1$. Ostry and Reinhart (1992) estimate the intertemporal, σ , and intratemporal elasticity of substitution, here equal to 1, for thirteen developing countries. Their findings indicate the intratemporal elasticity to be significantly larger than the intertemporal elasticity of substitution, σ , which would favour case (3) in the analysis above. Cases (1) and (2) are discussed in appendix B.

Temporary World Output Shock: The temporary decline in world output is modelled by a decrease in the price for the foreign tradable good, $\hat{P}_T^*$. A fall in foreign tradable goods prices has a negative wealth effect on the representative consumer since he is endowed with a constant amount of tradable goods. Therefore, the temporary fall in prices influences his wealth negatively. Additionally, for a constant endowment of traded goods a shortfall in the demand for traded goods, due to a contraction in world output (consumption), requires a decline in traded good prices to restore the equilibrium in the world traded good market.

Figures 3.1 to 3.6 depict effects of this shock.¹⁸ In the third case under consideration, (3) $\sigma < 1$, the real exchange rate depreciates in the short-run under both floats and pegs. However, as Figure 3.1 shows, the rate of the real

¹⁸The vertical axis of all following graphs reflects the response of the variable of interest while the horizontal axis shows different values of the intertemporal elasticity of substitution, σ .

depreciation is stronger under floating exchange rate regimes. The strong real depreciation completely insulates the floating exchange rate economy against the external shock. This is due to the fact that the nominal exchange rate acts as a shock absorber and inversely mirrors changes in the external variable.¹⁹ The fall in foreign tradable good prices leads the nominal exchange rate to depreciate (rise) by the same amount. As a consequence, the home price for traded goods remains unchanged. No further adjustment of the long-run real exchange rate, output and the trade balance is required.

Under pegs the nominal exchange rate is not able to cushion the external shock and the price fall in foreign traded goods decreases domestic traded goods prices. Hence, consumption of nontraded goods becomes relatively more expensive and production in the nontraded goods sector deteriorates in the short-run, as illustrated in Figure 3.5. The negative impact on nontraded consumption positively spills over into the traded goods sector since the elasticity of substitution between traded and nontraded goods is high in relation to the intertemporal elasticity. It follows that the positive short-run traded good consumption is accompanied by a trade balance deficit under pegs (Figure 3.3).

However, in the long-run, the current account needs to be balanced, which requires a decrease in long-run tradable consumption. The long-run consumption of tradable goods must be reduced to allow for a trade balance surplus and an accumulation of net foreign assets to repay the outstanding debt. Figure 3.4 confirms this mechanism. The negative long-run tradable consumption re-

¹⁹From the short-run real exchange rate equation in appendix A and equation (3.26) the nominal exchange rate can be solved. A fall of $\hat{P}_T^*$ by $-x$ implies an opposite move of $\hat{S}$ by x . It follows from the LOOP condition in equation (3.8) that $\hat{P}_T = \hat{S} + \hat{P}_T^*$. Therefore, no changes in $\hat{P}_T$ occur and the economy is completely insulated due to movements in the nominal exchange rate.

quires a real depreciation of the long-run real exchange rate (Figure 3.2). The change in traded goods consumption has a wealth effect on the level of desired consumption of nontraded goods. The economy is required to accumulate net foreign assets to repay its debt. The fall in long-run consumption of traded goods results in the improvement of production and consumption in nontraded goods under pegs (see Figure 3.6). Households are willing to supply more labour than to consume less units of nontraded goods when the consumption of traded goods falls. It can be ascertained that output in the nontraded sector declines under pegs while the real exchange rate depreciates in the short-run. The fall in nontraded consumption goes along with a trade balance deficit since traded goods consumption increases in the short-run.

Temporary World Interest Rate Shock: Figures 3.7 to 3.12 demonstrate the adjustment of the economy under different exchange rate regimes to a temporary increase in the world real interest rate, $\hat{e}$. An unexpected temporary increase in the world real interest rate implies that current consumption becomes relatively more expensive and consumers favour future over current consumption. As a consequence, consumption falls in the short-run.

In case (3) the intertemporal elasticity of substitution is relatively low, $\sigma < 1$, and indicates a less distinctive fall in nontradable and tradable consumption. The nontraded good production declines to a smaller extent under floating exchange rate regimes (Figure 3.11). The less pronounced deterioration in nontraded good consumption is due to the real exchange rate depreciation under floats (Figure 3.7) in the short-run. Equation (3.26) and the assumption of constant foreign traded good prices imply that a depreciation of the real exchange rate is followed by a nominal depreciation. The rise in the nominal exchange

rate increases the price of traded goods (LOOP condition) and, therefore, makes nontraded good consumption relative cheaper under floats and induces a less substantial fall in the nontraded goods production.²⁰

The generated trade balance surplus, illustrated in Figure 3.9, is higher under floats compared to pegs. However, a balanced current account in the long-run requires a positive traded goods consumption. Figure 3.10 shows the trade balance deficit in the long-run, which is more pronounced in the economy with a floating exchange rate. The positive long-run traded goods consumption requires a real appreciation of the exchange rate (Figure 3.8). The appreciation of the real exchange rate is stronger under floats than under pegs. Since $\sigma < 1$ holds, the spillover between traded and nontraded consumption is negative. Thus, the increase in traded goods consumption generates a decline in consumption and, hence, production of nontradables. Households are more willing to supply less labour than to consume more units of nontraded goods. Figure 3.12 illuminates that the decline in long-run nontradable consumption is smaller under the pegging exchange rate regime. The compilation of the findings indicates that short-run (nontraded goods) production in the economy would decline to a lesser extent under floats. The depreciation of the real exchange rate raises the price of traded goods relative to nontraded goods more strongly under floating exchange rate regimes and, hence, implies a higher trade balance surplus under floats relative to the pegging exchange rate economy in the short-run.

The model captures the spirit of recent literature on the intertemporal utility maximising agents under price and wage rigidities. It illustrates the theoretical behaviour of economies which are subject to different exchange rate regimes.

²⁰The LOOP condition implies that under the assumption of constant foreign goods prices a rise in the nominal exchange rate increases the price of home traded goods.

The theoretical results derived for consumption, output, the trade balance and the real exchange rate are ambiguous and dependent on the specification of preferences in the model. The model above is highly stylised, as it provides a simplistic account of the sources and duration of price stickiness. For this reason, an econometric model is not derived from this foundation. The econometric approach is broader and employs the theory in a less restrictive way when identifying the role of shocks (see for example Sims, 1980) as will be explained in the next section.

3.4 Econometric Approach: Panel VAR

In this section the econometric method used to test the hypothesis that floating exchange rates are superior in insulating an economy against external shocks will be explained. Given a dynamic relationship between world output, the world real interest rate and the real exchange rate, real home output as well as net exports, the chapter proceeds with a dynamic estimation using a VAR. However, the relevant shocks and the responses of the system to the shocks have to be identified first. Additionally, the choice of the data and the exchange rate regime dummies need to be specified.

3.4.1 Data

The econometric model, to be outlined in section 3.4.4, analyses a set of variables to recover the pattern of shocks in 42 low, lower and middle income economies for the sampling period 1973 to 1999. For a complete country list the reader can refer to Table 3.1. All data, except the world interest rate and net exports, are measured in logs.

The first set of data includes the world interest rate. To measure the world

real interest rate the method suggested by Barro and Sala-i-Martin (1990) and applied by Bergin and Sheffrin (2000) is utilised. Short-term nominal interest rates, e.g. T-bill rates and the equivalent for the other G-7 countries, are derived from the International Financial Statistics (IFS, 2000b). The nominal interest rate in each country is adjusted by the inflation expectations to calculate the ex-ante real interest rate for each country.²¹ To compute an individual average world real interest rate for country i in the sample, weights based on the trade shares of country i with each of the G-7 countries are used to construct a modified world real interest rate. The use of the modified world interest rate captures the fact that loans to developing countries by the G-7 countries is closely related to their trade flows with such countries. The modified world real interest rate takes an individual time path for each of the 42 economies. To obtain a notion of the general evolution of the world real interest rate, Figure 3.13 portrays the average interest rate based on real GDP weights of the G-7 countries. The world real output is measured by the trade weighted GDP of the countries' trading partners in constant currency units. To construct the home real output, the developing country's GDP is utilised in constant units. All output data are obtained from the World Development Indicators (WDI) in 2001 and are measured in constant national currency.²² Countries' net exports are measured by the external balance on goods and services as a percentage of GDP in constant domestic currency units (WDI). The countries' real exchange

²¹Inflation expectations are forecasts, calculated by a six-quarter autoregression (see Bergin, 2001).

²²The real output data are measured in domestic currencies to overcome the real exchange rate effects, which would influence the data if they were obtained in US dollar terms. To see this more clearly, consider the following equality: $\frac{Y_i^H}{P_{i/\$}} = \frac{S_{\$/HomeCurrency} * Y_i^H}{P_{i/\$}} = \frac{S_{\$/HomeCurrency}}{P_{i/\$}} * P_i * \frac{Y_i^H}{P_i}$. Thus, real output is measured in terms of constant domestic currency units.

rate is the ratio of CPI indexes, adjusted by the nominal exchange rate (national currency per dollar). Data on the real exchange rate are taken from Lane and Milesi-Ferretti (2002b) and are re-based so that a rise in the real exchange rate reflects a depreciation and a fall an appreciation. This is done in order to be consistent with the theoretical model introduced above.

3.4.2 Nonstationarity and Cointegration in Panel Data

Prior to the statistical analysis the data series are tested for unit roots and cointegration, since a necessity for calculating means and variances is the data's stationarity.²³ The Levin and Lin (1992), Levin, Lin and Chu (2002) test procedure is designed to evaluate the null hypothesis that each individual in the panel has integrated time series versus the alternative hypothesis that all individuals time series are stationary.²⁴ The Levin and Lin Test applies to macro panels since T increases faster than N . Table 3.2 presents the test results. Overall there is no evidence for the data's stationarity in levels. However, the data appear to be stationary in first differences (Table 3.2).

Given that the time series properties of the data are not stationary in levels, the long-run relationships between the different time series have to be considered in order to see whether possible cointegration relationships exist between the data. The null hypothesis that the variables are cointegrated is tested. Mc Coskey and Kao (1998) derive such a residual based test statistic in form of

²³Tests are implemented using the NPT 1.2 in Gauss, provided by Chiang and Kao (2001).

²⁴Consider the model $y_{i,t} = \rho_i y_{i,t-1} + z'_{i,t} u_{i,t}$. $u_{i,t}$ is a stationary process and $z_{i,t}$ could be zero, one, the fixed effects as well as a time trend. $z_t = (z_{1,t}, \dots, z_{N,t})'$. Levin and Lin (1992), Levin, Lin and Chu (2002) test the null hypothesis $H_0 : \rho = 1$ against the alternative $H_a : \rho < 1$. The authors show that the corresponding t-statistic under H_0 is given by $t_\rho = \frac{(\hat{\rho}-1) \sqrt{\sum_{i=1}^N \sum_{t=1}^T \tilde{y}_{i,t-1}^2}}{s_e}$, where $\tilde{y}_{i,t} = y_{i,t} - \sum_{s=1}^T \left(z'_t \left(\sum_{t=1}^T z_t z'_t \right) z_s \right) y_{i,s}$ and $s_e = \sqrt{\frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \left(u_{i,t} - \sum_{s=1}^T \left(z'_t \left(\sum_{t=1}^T z_t z'_t \right) z_s \right) u_{i,s} \right)^2}$.

an Lagrange Multiplier test. The asymptotics of Mc Coskey and Kao's test depend on the possible cointegration relationships.²⁵ For the residual based test of the null of cointegration it is necessary to use an efficient estimation technique of cointegrated variables. Therefore, dynamic OLS, which is asymptotically normally distributed, is applied in addition to OLS, as suggested by Mc Coskey and Kao.²⁶ Table 3.3 depicts the results, which shows that there do not exist long-run relationships between the variables.

Hence, the econometric model is estimated in first differences without imposing any cointegration relationship. It has been pointed out by other authors researching business cycles that the empirical implications of theoretical models like the one presented here are mainly concerned with business cycle effects which are captured well in first differences.²⁷ Given the time series properties of the data set, Table 3.4 presents the summary statistics of the data used in the empirical analysis. It becomes apparent from Table 3.4 that the real exchange rate appreciates or depreciates on average more strongly under floats than under pegs during the sample period under both the de jure and de facto specification.²⁸ The standard deviation of the change in the real exchange rate

²⁵Under the null hypothesis of cointegration the asymptotics no longer depend on the asymptotic properties of the estimated spurious regression. Instead, the asymptotics of the estimated cointegrated relationship are needed.

²⁶Mc Coskey and Kao (1998, p. 8) point out that the estimation by dynamic OLS facilitates the obtainment of an optimal estimator equal to the estimation procedure suggested by Saikkonen (1991). To present the test statistic consider the model $y_{i,t} = \alpha_i + x'_{i,t}\beta_i + e_{i,t}$. The $x_{i,t} = x_{i,t-1} + \varepsilon_{i,t}$ and $e_{i,t} = \gamma_{i,t-1} + (1 + \theta)u_{i,t}$. The null hypothesis of cointegration is equivalent to $\theta = 0$. The test statistic is defined as $LM = \frac{\frac{1}{N} \sum_{i=1}^N \frac{1}{T^2} \sum_{t=1}^T s_{i,t}^2}{S^2}$. $s_{i,t}^2$ is the partial sum process of the residuals $\sum_{j=1}^T \hat{e}_{i,j}$ and $S^2 = \frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \hat{e}_{i,t}^2$.

²⁷Note that all variables, except for the world real interest rate and net exports, are measured in logs and that the first difference of a variable in log equals the growth rate between these periods.

²⁸For a discussion of the two exchange rate specifications please refer to the next section.

is always higher under floats. This implies that a higher real exchange rate volatility is evident in floating countries. Table 3.4 also shows that under pegs average changes in net exports are lower and even negative when looking at the de facto specification. Additionally, fixed exchange rate economies experience a higher volatility in net export changes on average, as Table 3.4 shows. Interestingly, the statistical analysis demonstrates that the average growth rate of real GDP is higher under the de jure specification in countries which adopt a fixed exchange rate. Nevertheless, under both specifications the real GDP growth rate is more volatile under pegs than under floats.²⁹

3.4.3 Choice of Exchange Rate Regimes

It is necessary to define the exchange rate regimes, which are used for the econometric analysis. Following Frankel (1999), nine exchange rate regimes are identified, which can be categorised into three types. Currency unions, currency boards and truly fixed exchange rates can be specified as *fixed exchange rates*. *Intermediate regimes* comprise crawling pegs (adjustable pegs, crawling pegs and basket pegs) and dirty floats (target zone/bands or managed floats). Free floats represent a *pure float* regime. For the econometric analysis intermediate regimes are considered under the floating category.

This chapter follows the recent work by Reinhart and Rogoff (2002) and the International Monetary Fund's (2000a) Annual Report on Exchange Arrangements and Exchange Rate Restrictions (AREAER) to classify the exchange rate regimes of the 42 countries of interest. The AREAER report is based on the publicly stated commitment of the authorities in the countries in question. This approach is known as the de jure analysis. The problem with the approach is

²⁹ According to Taylor (1989) flexible exchange rates reduce output volatility by almost one half.

that it constitutes the uncertainty of not knowing whether the actual policy in the country is consistent with the commitment stated in the AREAER. Frankel (1999) argues that out of 185 economies, the IMF classifies 47 as independently floating and 45 as following rigid pegs. However, in his opinion most of the countries classified as fixed regimes have in fact had realignments within the last ten years. Similarly, most of the countries that are listed as floating regimes frequently intervene in the foreign exchange market. In addition, Reinhart and Rogoff (2002) find that *de facto* floating was not uncommon during the Bretton Woods era and that it is difficult to detect any change in the exchange rate behaviour between the two periods for many countries.

The problem of the *de jure* approach can be solved if the classification is based on the observed behaviour of the exchange rate. Thus, data on interventions (reserve changes), exchange rate volatility, exchange rate changes or on market-determined parallel exchange rates can be applied. Reinhart and Rogoff (2002) utilised the last approach for the period from 1950 until 2001. Their *de facto* classification forms the basis of the following empirical analysis and is compared to the *de jure* approach.

Tables 3.5 and 3.6 provide the annual choice of the exchange rate regime for the individual countries under the *de jure* and *de facto* selection criteria, while Figures 3.14 and 3.15 provide an overview of the evolution of the exchange rate regimes under the *de jure* and *de facto* approach. In both figures a clear trend towards a floating exchange rate policy can be noticed. However, when comparing the two charts, differences emerge for the period from 1973 to 1983. Figure 3.15 shows that from the mid 1970s until the mid 1980s a policy towards floating exchange rate regimes existed, which cannot be seen from Figure 3.14 in such clarity.

3.4.4 Identification and Restriction of the Econometric Model

Developing countries represent the focal point of attention of the empirical analysis. Hence, the econometric application is derived from small open economy assumptions. Domestic innovations do not affect external variables, i.e. the world real interest rate, r , and world (foreign) real output, $y^{Foreign}$. To be more precise, it is assumed that current and past values of the real exchange rate, rer , real output, y^{Home} , and net exports, nx , of a small open economy do not affect r and $y^{Foreign}$, neither in the short nor in the long-run. However, the data generation process of home output, the trade balance and the real exchange rate is affected by world output and the world real interest rate, which are determined outside the system under investigation. Additionally, the real exchange rate, trade balance and domestic output are jointly influenced by movements of one of the three variables. For example, changes in the real exchange rate impact on the private sector's real wealth and expenditure through its effect on domestic prices. The change in domestic absorption leads firms to revise expectations on future demand and, hence, changes production and investment. This affects aggregate supply and, therefore, output and the trade balance. The latter has an impact on home prices and has feedback effects on the real exchange rate. The joint effects on home output, net exports and the real exchange rate complicate the identification of structural innovations in a model which contains all variables. To overcome this problem an exogenous Vector Autoregression (VARX) model is applied in which world output and the world real interest rate are treated as exogenous variables. This approach imposes no restrictions on the model. However, the exogeneity of world output and the world real interest rate enables the tracing of such shocks through the system. The econometric model takes the following form:

$$\mathbf{Y}_{i,t} = \mathbf{B}(\mathbf{L})\mathbf{Y}_{i,t} + \mathbf{C}_0\mathbf{X}_{i,t} + \mathbf{C}(\mathbf{L})\mathbf{X}_{i,t} + \mathbf{u}_{i,t}. \quad (3.56)$$

$\mathbf{Y}_{i,t}$ is the 3 x 1 dependent and endogenous variable vector. $\mathbf{Y}_{i,t}$ comprises changes in real home output, y^{Home} , the real exchange rate, rer , and net exports, nx and equals $[\Delta \log y^{Home}, \Delta \log rer, \Delta nx]'$. $\mathbf{X}_{i,t} = [\Delta \log y^{Foreign}, \Delta r]'$ is a 2 x 1 vector of the exogenous real world output, $y^{Foreign}$, and the world real interest rate, r . $\mathbf{u}_{i,t}$ reflects the model's error term. $\mathbf{B}(\mathbf{L})$ (3 x 3) and $\mathbf{C}(\mathbf{L})$ (3 x 2) are matrix polynomials in the lag operator of p^{th} order.³⁰ To examine whether the responses of the exogenous shocks are different between regimes the estimated model becomes

$$\begin{aligned} \mathbf{Y}_{i,t} = & \mathbf{B}_{peg}(\mathbf{L})\mathbf{Y}_{i,t} * D_{fix_{i,t}} + \mathbf{B}_{float}(\mathbf{L})\mathbf{Y}_{i,t} * D_{float_{i,t}} \\ & + \mathbf{C}_{peg,0}\mathbf{X}_{i,t} * D_{fix_{i,t}} + \mathbf{C}_{float,0}\mathbf{X}_{i,t} * D_{float_{i,t}} \\ & + \mathbf{C}_{peg}(\mathbf{L})\mathbf{X}_{i,t} * D_{fix_{i,t}} + \mathbf{C}_{float}(\mathbf{L})\mathbf{X}_{i,t} * D_{float_{i,t}} + \mathbf{u}_{i,t}, \end{aligned} \quad (3.57)$$

where $D_{fix_{i,t}}$ and $D_{float_{i,t}}$ are dummy variables which capture the effects of the different exchange rate regimes.

Countries that float today might peg their exchange rate tomorrow which would consequently lead to a confusion between responses of floats and pegs. To overcome this potential source of bias, the sample includes only observations of countries with the same exchange rate regime within four periods.³¹ From equation (3.56) the representation of the exogenous process takes the form

$$Y_{i,t} = \sum_{s=0}^{\infty} \mathcal{B}^s \mathbf{C} \mathbf{X}_{i,t-s} + \sum_{s=0}^{\infty} \mathcal{B}^s \mathcal{J} \mathbf{u}_{i,t-s}. \quad (3.58)$$

³⁰The lag length is specified in sub-section 3.4.6.

³¹This issue was also raised by Broda (2000).

The expression in equation (3.58) contains the dynamic multipliers, which are represented by the coefficient matrices JB^*C .³² They allow the derivation of the impulse response functions for a given exogenous shock to the system, which will be discussed in more detail in section 3.5.

3.4.5 Estimation Strategy

To examine whether the findings and responses to real shocks are robust several sensitivity analyses will be applied. The problem of attributing responses to different exchange rate regimes which actually might be associated with other characteristics is overcome by conducting a number of sample splits.

In the context of a shock to the world real interest rate the main variable is the degree of financial openness. On the one hand, more financially open countries might be affected more strongly by a shock to the world real interest rate. On the other hand, those countries might be able to borrow from other countries less affected by the shock and hedge against the effect of the exogenous disturbance. Therefore, the impulse response analysis is also carried out for financially open countries only. Another possibly omitted variable might be the degree of trade openness. Hence, it will be analysed whether trade openness affects the overall results found for the shock to the world real interest rate. With respect to the world output shock, countries with a higher degree of trade openness are compared with the whole sample and the impulse responses under trade openness are generated. Countries open to trade are more vulnerable against negative external output shocks. However, trade relations of those countries allow us to compensate an output shock by expanding trade with countries

³² $J := [I_k \ 0 \ 0]$ has the format $K * (K * p + M * p)$, where K and M are the dimensions of the endogenous, here 3, and exogenous variables, here 2) in the system. p specifies the lag length.

which are less affected by the decline in world output. Financial openness also influences the individual response of the sample countries when a world output shock occurs. Thus, results on this sub-sample will be also discussed. Last, the impulse responses obtained from the *de facto* approach are compared with responses under the *de jure* specification, given that shocks to the world real interest rate and world output occur.

3.4.6 Estimation Method

The estimation strategy of dynamic panel data depends on the error term being serially uncorrelated.³³ In a dynamic panel data model serial correlation can arise due to the presence of individual effects (fixed or random), since the individual effects are correlated with the observed data for the right-side variables, as well as by omission of lags.³⁴ Hence, the average structure of the error term is of importance.

There are different estimation approaches for dynamic panel data. The choice of the estimation approach can be answered by implementing specification tests to validate the consistency of the estimates. The application of instrumental variables depends on the structure of the error term in the model.³⁵

³³A common procedure in panel data estimation is to include an individual effect as a component of the stochastic disturbance.

³⁴Note at this point that wiping out the individual effect does not necessarily result in obtaining an unbiased estimator. Only if $T \rightarrow \infty$ will the estimator be consistent for the dynamic panel data model.

³⁵At this point it is worth noting that instrumental variables in the form of first-differenced GMM estimators (see Arellano and Bond, 1991) are biased and imprecise when the time series is nonstationary (Bond et al, 2001). This is confirmed by simulation results applied by Blundell and Bond (1998). The authors show that the first-differenced GMM estimator is also subject to large downward finite-sample bias. This is especially true when the number of time series is small.

Holtz-Eakin (1988) derives a linear test for the presence of individual effects in dynamic models with panel data.³⁶ Under the null hypothesis of no individual effects, a set of orthogonality conditions holds which provide over-identifying restrictions. They can be used to test for individual effects. The test compares the residual terms under the unrestricted model where all data are used in levels with the restricted model where an instrumental variable approach is used. The Holtz-Eakin test is implemented by estimating the squared transformed residual terms of a restricted and an unrestricted model. Intuitively, the test compares the sample moments corresponding to the restrictions imposed and explores whether they are close to zero. The closer the squared residual term of the restricted model compared with the squared residuals of the unrestricted model is to zero, the less likely it is that any individual effect has a strong impact on the model's disturbances.

In the restricted model all orthogonality conditions are used, which are valid in the presence of no individual effects. For the unrestricted model only instrumental variables, dated back $t - 2$ or earlier, are implemented.³⁷ The test statistic is distributed as a chi-squared with two degrees of freedom. The results are presented in the upper part of Table 3.7. The null hypothesis has to be accepted for all chosen lag lengths. As a consequence the lagged dependent variables are orthogonal to the error component and it is not necessary to include an additional stochastic disturbance term. Additionally, the chapter tests whether second-order serial correlation for the disturbances of the estimated first-differenced equations is present. Under no second-order serial correlation

³⁶In a recent paper Jimenez-Martin (1998) analyses the behaviour of Holtz-Eakin's test.

His finding is that the test behaves correctly for moderate autoregressive coefficients.

³⁷Such orthogonality condition under the null hypothesis takes the following general form:

$$E(y_{i,t-j}\varepsilon_{i,t}) = 0, j = 1, \dots, t-1.$$

both OLS and instrumental variable estimators of the first-differenced model are consistent (Baltagi, 2001).³⁸ Arellano and Bond (1991) propose such a test statistic for the hypothesis that second-order serial correlation is not present.³⁹ The lower part of Table 3.7 presents the results. Serial correlation of the error term in the dynamic panel estimation does not occur. A lag length of order three is chosen. This is done by estimating the VAR model for each cross-section and by taking the average optimal lag length over the complete sample.⁴⁰

3.5 Empirical Results

Given the findings of the specification test above, the empirical model in section 3.4.4 is estimated by generalised least square (GLS). It can be used to compute the dynamic response functions, which study the effects of changes in the world real interest rate and world output on domestic real output of countries as well as their real exchange rate and net exports. The impulse response functions are accompanied by one standard deviation error bands.⁴¹

³⁸The hypothesis is true if the errors in levels are not serially correlated. Note that the consistency of the instrumental estimator relies upon the fact that $E(\Delta\varepsilon_{i,t}\Delta\varepsilon_{i,t-2}) = 0$.

³⁹The test procedure uses lagged first-difference and level endogenous variables and requires no AR(2) (or higher) component in the error for consistency. The test statistic is given in Arellano and Bond (1991, p.282). The test is performed using the DPD 98 for Gauss, which is provided by Arellano and Bond (1998).

⁴⁰To the author's knowledge no tests are available to test for the appropriate lag length in a PVAR. Thus, the AIC and Schwartz criteria as well as the likelihood ratio test are applied for each sample country.

⁴¹The confidence intervals were computed using the approach by Luetkepohl (1990). Luetkepohl demonstrates that the error bands can be calculated by the standard errors of the impulse response coefficients. The intuition is that for a given impulse response, ϕ_i , the estimated standard errors follow as the numerical deviation of the impulse response in relation to its variance-covariance matrix. In a more general form the standard errors of a set of impulse responses Φ are derived by the square roots of the diagonal elements of the expression $G_i \hat{W}_\phi G_i'$.

The main objective of the empirical part is to determine the relative differences of world interest rate and world output shocks to small open developing economies which are subject to different exchange rate commitments. Nevertheless, as a precursor to the analysis of the adjustment process under fixed and flexible exchange rates the following two sections establish the adjustment process without distinguishing between pegging and floating economies.

3.5.1 World Real Interest Rate

Figures 3.16 to 3.18 illustrate the responses of the complete sample to a one period one hundred basis point rise in the world real interest rate. Initially, the growth rate of domestic GDP declines, as shown in Figure 3.16, and the economy moves into recession. The initial impact effect as well as the response in the first period after the shock are statistically different from zero.⁴² The adjustment process of the real GDP growth rate is completed in the medium-run, i.e. during the third period of the shock. Figure 3.17 provides the response of net exports. After an instantaneous decline net exports move into surplus in the first period. They remain positive until the adjustment process is completed in the long-run, i.e. eighth period after the shock. The positive trade balance effect might be explained by the depreciation of the real exchange rate, which occurs in the first period after the shock in Figure 3.18. The initial impact effect as well as the following two periods of the real exchange rate depreciation are statistically different from zero.

$\hat{W}_\phi$ is the variance covariance matrix from the estimated impulse responses and $G_i := \frac{\partial \text{vec} \Phi_i}{\partial \phi'}$, are the numerical deviations of the impulse responses. Note that the *vec* operator transforms a matrix into a vector by stacking the columns.

⁴²The statistical significance reported here and in the following is equivalent to the statistical significance at the 5 percent level.

3.5.2 World Output

In this section a negative world output shock will be discussed, which is captured by a one time one percent decline in world output. Figures 3.19 to 3.21 illustrate the adjustment process of real GDP, net exports and the real exchange rate. The negative shock to world output leads to a decline in real GDP growth in the initial period of the shock (Figure 3.19). After a recovery of real GDP in the short-run, i.e. first period of the shock, output growth declines again in the second period after the shock. Overall only the impact effect as well as the first period of the shock is statistically different from zero. The adjustment process is completed in the medium-run. After a positive impact effect, shown in Figure 3.20, net exports move into deficit in the first period of shock and remain negative until they reach the pre-shock value in the medium-run. The impulse response coefficients remain statistically significant until the second period after the shock. In Figure 3.21 the behaviour of the real exchange rate is illustrated. The real exchange rate appreciates strongly in the short-run before it moves only slowly towards its pre-shock value in the sixth period after the shock.

So far no differentiation between fixed and flexible exchange rates has been applied. The following sections will discuss the adjustment behaviour by separating the small open developing economies into countries that either peg their nominal exchange rate or allow let the nominal exchange rate to float.

3.5.3 World Real Interest Rate: Fixed versus Flexible Exchange Rates

Figures 3.22 to 3.27 show the responses of the complete sample under the *de facto* specification of Reinhart and Rogoff (2002) to the one period one hundred basis point rise in the world real interest rate. Table 3.8 presents the variance

decomposition of the world real interest rate, which is partly in line with the finding by Kose (2002).⁴³ He claims that less than one percent of the variations in the trade balance is explained by interest rate disturbances. However, it becomes evident from Table 3.8 that the countries' net exports and real exchange rates under fixed exchange rate regimes are more strongly affected by changes in the world real interest rate, especially in the short and medium-run forecast horizon.

In Figure 3.22 the adjustment process of the real output in the fixed exchange rate economies is depicted. After an initial positive impact effect, the economy is pushed into recession in the short-run. This negative effect of the external shock equates to 0.05 percentage points and is statistically different from zero. In the medium-run output growth declines again and reaches a negative growth rate of 0.01 percentage points. Overall, the adjustment process is relatively volatile.

Figure 3.24 shows the time path of adjustment of the trade balance. The impulse response function suggests that the adjustment process of the trade balance is only completed in the long-run. After an initial deterioration of the trade balance, which is statistically significant, net exports improve in the short-run by 0.88 percentage points. Thus, countries with a nominal fixed exchange rate off-set the external shock to the trade balance by increasing their exports relative to their import demands in the short-run.⁴⁴

⁴³The variance decomposition is obtained from a five variable VAR. A Choleski decomposition, in which world output is ordered first and the world real interest rate ordered second, allows to obtain the variance decomposition reported in Table 3.8. A different ordering of the three endogenous variables does not influence the main results of the variance decomposition. Therefore, results reported here follow by ordering the real exchange rate third and home real output fourth.

⁴⁴In the theoretical section 3.3.6 a similar finding was made for case (3), where $\sigma < 1$.

The real exchange rate response is outlined in Figure 3.26. Initially, the real exchange rate appreciates before slowly moving towards a real depreciation by 0.13 percentage points in the second period after the shock. Overall, the responses are significant for the first two periods of the adjustment process. The adjustment process is completed in the fifth period after the shock. The total long-run impact on the real exchange rate equals -1.5 percentage points (Table 3.11).

The analysis of the flexible exchange rate regimes shows that the effect of a one time change of the world real interest rate on real output growth under floating exchange rates is negative and significantly different from zero in the initial period of the shock (Figure 3.23). The economy moves into recession. The real GDP growth rate declines by 0.33 percentage points. In the medium-run, real GDP growth returns to its pre-shock level. Overall, real output adjusts smoothly and the adjustment process is less volatile than under fixed exchange rate regimes.

Figure 3.25 illuminates the behaviour of the trade balance to the shock of the world real interest rate. The trade balance instantaneously improves by 0.02 percentage points. In the following periods the trade balance improves further and remains in surplus. Only the short-run and second period improvements of net exports by 0.28 and 0.1 percentage points remain statistically significant. Overall, the adjustment process is completed after five years. This is in contrast to the trade balance response under the fixed exchange rate regimes where the adjustment process is finalised only in the long-run.

Figure 3.27 shows the real exchange rate response to the external shock. The real exchange rate depreciates strongly in the short-run, although it is subject to an initial appreciation. The real exchange rate in a floating exchange rate

regime behaves markedly in contrast to pegged exchange rate regimes. The short-run depreciation by 0.55 percentage points is statistically different from zero.⁴⁵ The accumulated long-run impact of the world real interest rate shock on the real exchange rate equals 0.72 percentage points, as illustrated in Table 3.11.

The real exchange rate response gives empirical validity to the theoretical proposition that under floating exchange rate regimes the real exchange rate should depreciate stronger. It is also found that the adjustment process of the trade balance is longer under pegs than it is the case under floats. Floating regimes are able to smooth effects of negative real shocks on real GDP growth by depreciating the real exchange rate more strongly than it would be the case under pegs. Hence, floating exchange rate regimes are able to utilise the nominal exchange rate as a shock absorber. By contrast, the growth rate of real GDP under pegging exchange rate regimes needs a longer time horizon of adjustment and reflects a higher volatility during the process of adjustment.

Statistical differences between the estimated coefficients of the two regimes also play an important role in the analysis. Tables 3.9 to 3.11 present Wald tests which report the joint significance of the difference between the floating and pegged coefficients from the VAR in conjunction with the estimated accumulated coefficients of the impulse response process for the adjustment of the variables of interest. Table 3.11 illustrates that the accumulated total responses of the real exchange rate are in line with the predictions that the real exchange rate depreciates more strongly under floats and, hence, allows the trade balance to adjust faster under floats. However, an examination of the real output response

⁴⁵The formal model in section 3.3.6 establishes a depreciation of the real exchange rate for case (3), where $\sigma < 1$.

in Table 3.9 reveals that the accumulated long-run response of real GDP is less contractionary under fixed exchange rate regimes on the whole. A statistical difference of the floating and pegged coefficients is found for the trade balance and real exchange rate variables.

3.5.4 Sensitivity Analysis

To obtain further information about the mechanics of the empirical model this section proceeds with a series of robustness checks. First, the effect of financial openness on the transmission of shocks to the world interest rate is discussed. Second, the response of trade open countries is analysed. Third, the *de facto* approach is compared with the *de jure* specification.

Financial Openness: Financially open countries are more vulnerable towards real interest rate shocks but also have an enhanced ability to hedge against external shocks. The results on responses to a shock of the world interest rate are portrayed in Figures 3.28 to 3.33.⁴⁶ The initial impact on the real GDP growth rate is positive and statistically different from zero under pegs. Under floats the economy initially moves into recession and the impact multiplier is statistically different from zero. Figures 3.28 and 3.29, illustrate that the adjustment process is more accentuated under the fixed exchange rate regime. This is also confirmed when the findings are compared with the total sample in Figure 3.22. While the economy under the pegging exchange rate regime experiences a strong decline in output growth in the short-run, the economy under float-

⁴⁶The selected countries are obtained from Lane and Milesi-Ferretti (2001). Countries with an Asset plus Liability to GDP ratio of less than 50 percent over the period 1973 to 1998 are excluded. Those countries are Argentina, Brazil, El Salvador, Guatemala, Paraguay, India, South Africa, South Korea, Turkey and Zimbabwe. The sample size equals 534 observations.

ing exchange rates recovers in the second period after the shock and reaches a positive growth rate of 0.003 percentage points.

Figures 3.30 and 3.31 depict the trade balance. Differences in the accommodation of the shock to the world real interest rate are established for the instantaneous impact effect and the subsequent following periods. Net exports deteriorate by 0.78 percentage points under pegs while an initial trade surplus of 0.12 percentage points is established under the floating exchange rate regime, which is also more pronounced than in the complete sample (Figure 3.25). As for the total sample, the trade balance requires a longer adjustment process under fixed exchange rates. A Wald test for the joint significance of the difference between all floating and peg coefficients returns a value of 55.56. Hence, the difference of all floating and peg coefficients is statistically significant at the 1 percent level. Moreover, a test of the joint significance of the world interest rate coefficients confirms the difference between the floating and peg coefficients with a chi-square value of 14.18.

The real exchange rate is illustrated in Figures 3.32 and 3.33. After an initial appreciation the real exchange rate of the floating countries depreciates strongly towards the short-run and reaches a positive value of 0.5 percentage points in the first period. The adjustment process under a floating regime stands in contrast to the case of pegs, where the real exchange rate depreciation occurs within a slower adjustment process. Comparing the estimated coefficients, statistical differences are established by Wald tests, which return values of 17.91 and 58.25 for the world real interest rate and all coefficients respectively. The overall adjustment process of the real exchange rate under floats and pegs is similar to the one found for the total sample above.

Trade Openness: In Table 3.12 the adjustment process of trade open countries, subjected to a shock to the world real interest, is compared with the overall sample.⁴⁷ The same pattern of the adjustment process is evidenced for the trade balance and the real exchange rate as for the entire sample. The real exchange rate depreciates more strongly under floats than under pegs. In the medium-run the dynamic multiplier equals 0.05 percentage points while it takes a value of -0.026 percentage points under pegs. The stronger real depreciation under floats allows net exports to adjust more smoothly in floating exchange rate regimes. Statistical differences in the regime coefficients are established by a Wald test for the real exchange rate. In the long-run, the accumulated impact of the world real interest rate shock on the trade balance equals 0.798 percentage points under floats, which is in contrast to the findings under pegs. The overall accumulated effect of the trade balance in the long-run under fixed exchange rate regimes equals 5.17 percentage points. The diverse finding on the trade balances are supported by a joint Wald test which evaluates statistical differences between the coefficients under floats and pegs. As Table 3.12 depicts, real GDP instantaneously declines under floating exchange rate regimes. By contrast, the pegging countries initially experience a positive impact effect. This is congruent with the findings of the complete sample. Overall, the negative cumulative change of real GDP is similar under floats and pegs. This is also

⁴⁷Openness is measured by the sum of predicted bilateral trade shares from the geographical determinants in the gravity theory and countries are obtained from Frankel and Romer (1999). The experiment includes 457 observations and consists of the following countries, whose trade shares are equal to or greater than 20 percent: Botswana, Costa Rica, Cote D'Ivoire, Dominican Republic, Ecuador, Egypt, El Salvador, Guatemala, Israel, Jamaica, Jordan, Saudi Arabia, South Korea, Malaysia, Mauritius, Morocco, Philippines, Singapore, Sri Lanka, Syria, Thailand, Tunisia, Turkey and Uruguay.

confirmed by the Wald test in Table 3.12, which cannot establish any statistical difference of the float and peg coefficients.

De Jure Specification: In this subsection the analysis above is replicated for the de jure specification. At this point it is worth noting that the estimation of the de jure approach follows the publicly stated exchange rate commitments by countries. However, as discussed above and shown in Tables 3.5 and 3.6, the actual and publicly stated exchange rate behaviours do not necessarily coincide. Hence, the previous findings of the evolution of real output are revised in Figures 3.34 and 3.35. Under both regimes the economy initially moves into recession. The recessionary impact is more pronounced under pegs than under floats (see Table 3.13). Nevertheless, in the short-run both regimes recover. The process of recovery is clearly more accentuated under floating exchange rate regimes. The negative accumulated effect on the real GDP growth rate in the medium-run is equal to 0.17 percentage points under pegs, while the accumulated effect of the real output under floats equals 0.6 percentage points. Wald tests, which evaluate differences between the world real interest rate and GDP coefficients, generate statistical significance and are reported in Table 3.13.

The behaviour of net exports are described in Figures 3.36 and 3.37. The initial trade balance effect is negative in the pegging countries. The first four periods after the shock are statistically significant. The trade balance improves only in the second period after the shock. Overall, the trade balance deteriorates by 0.9 percentage points (Table 3.14) and is relatively volatile. Under floats net exports follow a different adjustment pattern. After an initial improvement net exports remain in surplus. Overall an accumulated trade balance surplus of 0.76 percentage points in the long-run is established (see also Table 3.14). The Wald

test of the differences in all trade balance coefficients is statistically significant.

The adjustment process of the real exchange rate is portrayed in Figures 3.38 and 3.39. The instantaneous real exchange rate movements illuminate a negative effect in floating exchange rate economies. Under fixed exchange rate regimes a depreciation of the real exchange rate occurs instantaneously and the rise of the real exchange rate reaches its peak during the first period. Under floats a real depreciation occurs in the first period. However, the real exchange rate depreciation is stronger in the fixed exchange rate economy. The overall accumulated impact on the real exchange rate is presented in Table 3.15, which shows a stronger positive effect under fixed exchange rate regimes. Again, Wald tests of the difference between the real exchange rate coefficients are statistically significant at the one percent level (see Table 3.15).

3.5.5 World Output: Fixed versus Flexible Exchange Rates

In the following the results of the previous section are compared with a one time one percent decrease in world output. Table 3.8 relates results of the variance decomposition and shows that shocks to world output account for up to 36 (33) percent in the variations of home output in the case of floats (pegs). This is in stark contrast to results obtained for the world real interest rate, where only one percent of the variations are explained by a shock to the world real interest rate. Looking at net exports, variations in world output have stronger effects under pegs than under floats. Figures 3.40 to 3.45 represent the adjustment of real GDP, net exports and the real exchange rate, given a temporary fall in world output.

The contraction in world output has a recessionary impact under both fixed and floating regimes. Initially, home output declines strongly in Figures 3.40 and

3.41 and the growth rate under fixed regimes deteriorates by 0.85 percentage points. This is in contrast to a reduction in growth by only 0.46 percentage points under floats. Thus, floating regimes are superior in absorbing the initial external shock. In the following periods output growth recovers under both regimes. However, the adjustment process has a more favourable impact under floating exchange rates. Table 3.16 illustrates that the accumulated long-run effect under pegs equals -0.94 percentage points while it is only -0.29 under floats. The statistical comparison between the estimated world output coefficients is established by a Wald test, which is statistically significant at the 10 percent level (see Table 3.16).

Figures 3.42 and 3.43 give details on the adjustment of the trade balance. The initial impact of the world output shock is positive under pegging regimes, nevertheless the trade balance moves into a deficit of 0.08 percentage points in the first period after the shock.⁴⁸ Under floating exchange rates the trade balance deteriorates until the first period after the shock. Net exports improve and reach their pre-shock value after the second period. In general, the speed of adjustment of the trade balance is faster under floats. Table 3.17 illustrates that the accumulated impact is a surplus on the whole under pegs while a deficit is found in a floating regime.

The movements of the real exchange rates under pegs and floating regimes are compared in Figures 3.44 and 3.45. In both figures a real appreciation can be observed. After the shock to the world output the real exchange rate appreciates by 0.08 percentage points in floating countries. Under pegs the real appreciation is around four times higher and equals 0.32 percentage points. However, both

⁴⁸The negative trade balance effect is also found in section 3.3.6, where traded goods consumption increases for $\sigma < 1$.

regimes follow different adjustment patterns thereafter. Under floats the real exchange rate appreciates further and reaches its peak in the short-run. The higher appreciation might explain the negative net exports under floats, which are documented above. Under pegs the real exchange rate slowly depreciates and reaches its pre-shock value in the fifth period after the shock.⁴⁹ A Wald test establishes statistical differences between all pegged and floating real exchange rate coefficients (see Table 3.18).

In summary, as a reaction to an external world output shock fixed and floating exchange rate regimes experience a contraction in domestic output and an appreciation of the real exchange rate. Net exports adjust faster under the floating exchange rate regime. How can these reactions to a world output contraction be explained? A fall in world output induces a decline in the demand for developing countries' exports; hence, it adversely affects domestic production and has a recessionary impact on the home countries' output.⁵⁰ Most developing countries need to import capital and investment goods to continue home production.⁵¹ This might explain the intermediate trade balance deficits observed in Figures 3.42 and 3.43. The decline in world output might simultaneously occur to an increase in the relative prices of capital and investment goods, which are due to a contraction in world output. Home producers pass on these higher prices to consumers which might increase the domestic price level. This effect can explain the appreciation of the real exchange rate found in Figures 3.44 and 3.45. Indeed, Macowiak (2001) finds evidence of inflationary price levels in emerging market economies following a contraction of US output.

⁴⁹This finding is confirmed in section 3.3.6. For any value of σ it is found that the real exchange rate depreciates under pegs in the short and long-run.

⁵⁰In the theoretical part, section 3.3.6, domestic nontraded goods production (under fixed exchange rate regimes) declines in the short-run as well.

⁵¹These effects are not captured in the formal model introduced previously.

3.5.6 Sensitivity Analysis

To assess the robustness of the findings above a set of sample splits is undertaken in this section. First, less financially open countries are excluded from the analysis. Second, trade open countries constitute the focal point of attention. Last, the *de facto* specification is directly compared with the *de jure* approach.

Financial Openness: Table 3.19 provides the estimation results for financially open countries. Adjustment patterns similar to the results presented above are established. As before home output declines under both regimes and the overall loss in output growth is higher under pegs, which implies that the external shock has a stronger impact under fixed exchange rate regimes. However, compared with the overall sample no statistical differences are established by a Wald test. The trade balance initially improves under pegs before it deteriorates in the medium-run. In floating exchange rate countries net exports decline instantaneously and the overall deterioration is stronger under floats, as evidenced in Table 3.19. This finding is also in line with the analysis of the entire sample period. A Wald test, whose result can be found in Table 3.19, verifies statistical differences in the estimated trade balance coefficients. The real exchange rate movements are similar under both regimes with the occurrence of a real appreciation in the initial period of the shock. Nevertheless, the total effect of the real exchange rate is stronger and negative under floats. A Wald test of the difference between the real exchange rate coefficients is statistically significant at the one percent level (Table 3.19).

Trade Openness: Economies with a higher trade openness can be strongly affected by a decline in world output but may also be able to adjust more quickly to an external shock. The results of the adjustment process of more

open economies are presented in Figures 3.46 to 3.51. The initial impact on the real GDP growth rate is negative. Again, the negative impact is more pronounced under fixed exchange rate regimes, as illustrated in Figure 3.46. The recessionary impact is reversed in the short-run. The world output shock remains statistically significant for the first two periods under pegs, while only the initial period of the shock is statistically different from zero under floats. A comparison between Figures 3.46 and 3.47 with the overall sample (Figures 3.40 and 3.41) suggests that trade openness is important as it leads to an improved adjustment process under fixed relative to floating exchange rates. This stands in contrast to the findings obtained above.

Figures 3.48 and 3.49 reproduce the adjustment process of net exports. The initial negative effect of a decline in world output on the trade balance is stronger in the pegging countries of the sample. Figure 3.49 illustrates that the adjustment process of the trade balance is completed in the third period under floats while under pegs it is only terminated in the sixth period after the shock. The accumulated long-run effect on net exports equals -0.21 percentage points under floats, which is in contrast to the accumulated negative effect established for the fixed exchange rate regimes, namely -0.75 percentage points. A Wald test evaluates statistical differences between the world output coefficients at the 10 percent level.

In Figures 3.50 and 3.51 the real exchange rates' behaviour is delineated. After a short-run depreciation of the real exchange rate, it appreciates in the second period under pegs. This is contrary to the behaviour of the real exchange rate under floats. Figure 3.51 shows that the real exchange rate strongly appreciates in the first period. The different real exchange rate movements are confirmed by a Wald test, which is statistically significant at the one percent

level.

De Jure Specification: As a final robustness check, the effects of a decline in world output are now analysed under the de jure specification. Figures 3.52 and 3.53 confirm the negative effect of the reduction in world output on the home countries' real GDP. Under both regimes output declines, however, the initial effect is stronger under pegs. Table 3.20 presents results on the accumulated effects of the external shock. It becomes evident that the accumulated long-run effects are stronger under fixed regimes.

In Figures 3.54 and 3.55 the analysis of the trade balance is depicted. The initial impact is positive under fixed exchange rate regimes but the path is marked by a strong downturn during the adjustment process. Under floats net exports improve after five periods while net exports reach their pre-shock level only after seven periods in fixed exchange rate regimes. A Wald test confirms statistical differences between the estimated coefficients (see Table 3.21).

The real exchange rate movements are illustrated in Figures 3.56 and 3.57. They are similar to the findings under the de facto specification. While initially the real exchange rate appreciates under both regimes, the real exchange rate movements are significantly different in the following periods. In the first period the real exchange rate depreciates under pegs (see Figure 3.56) and a more volatile adjustment is observed thereafter. Under floats a strong appreciation in the first period is combined with a smooth adjustment of the real exchange rate in the following periods before it finally adjusts in the long-run. The difference in the adjustment process is also reflected in Table 3.22. A Wald test of the joint significance of the difference between the floating and peg coefficients statistically confirms the different effects of the external shock on the real exchange

rate under fixed and floating regimes (see Table 3.22).

In conclusion it is worthwhile comparing the *de jure* and the *de facto* specifications' results. As regards world interest rate shocks, the specifications result in different adjustment processes. Nevertheless, the ensuing final outcome is the same for both approaches. With respect to a world output shock, the *de jure* and the *de facto* approaches do not only result in the a similar outcome, but the processes leading to the result are congruent. The similarity of the findings may be explained by the specifications of countries' exchange rate regimes. The analysis of countries which appear in both the *de jure* and the *de facto* approaches shows that countries' exchange rate regimes are defined in the same manner in two out of three cases.

3.6 Conclusion

The relative merits of fixed and flexible exchange rates are of interest to many international economists and policy makers but no consensus regarding one system's superiority has been found. In order to meaningfully add to the debate, this chapter examines the theoretical hypothesis that nominal exchange rates act as a shock absorber under floating exchange rate regimes.

Formally, a simple dynamic small open economy model of traded and non-traded goods gives support for the assertion that countries which adopt a floating exchange rate regime insulate themselves better against external shocks in the form of the world real interest rate and world output. This assertion holds for empirically relevant preference specifications.

In the empirical part of the chapter the theoretical findings are assessed utilising a PVAR approach. The empirical results provide support for the predictions of the literature on exchange rate regimes. Given a shock to the world real

interest rate, the chapter confirms for the *de facto* sample that the adjustment process of real GDP is more volatile under pegs. Real exchange rate movements in form of a real depreciation are stronger under floats. Hence, a smooth trade balance adjustment is achieved more quickly under floating exchange rate regimes. These findings are also confirmed by considering only financially or trade open countries. The *de jure* specification confirms the results for the evolution of real output and the trade balance. Overall, the contrasts between the two exchange rate regimes are more pronounced under this specification. The *de facto* and the *de jure* analysis of a negative world output shock indicates a faster recovery of real GDP growth under floats and confirms that the trade balance adjusts faster under floating exchange rate regimes. The real exchange rate supports the absorption of the shock under floats by letting the real exchange rate appreciate. However, other factors also play a role in the adjustment process, such as trade openness. In contrast to the findings of the total sample it is found that the home countries' real GDP growth rate improves faster in trade open countries, which adopt a fixed exchange rate.

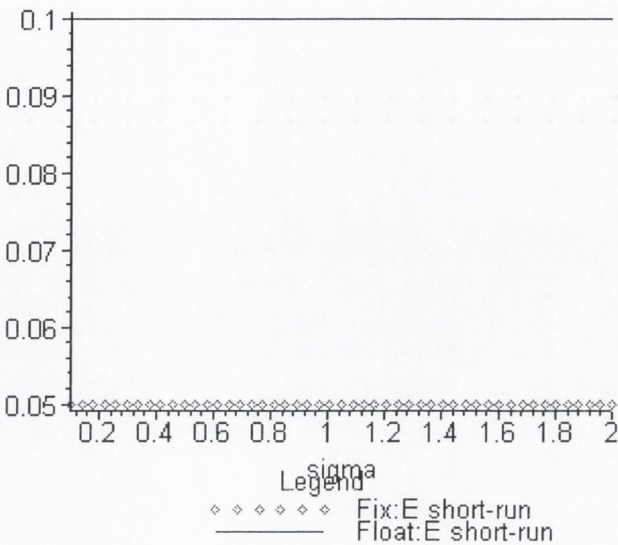


Figure 3.1: Adjustment of the Short-Run Real Exchange Rate to a Temporary World Output Shock. *Note: Different values of the intertemporal elasticity of substitution.*

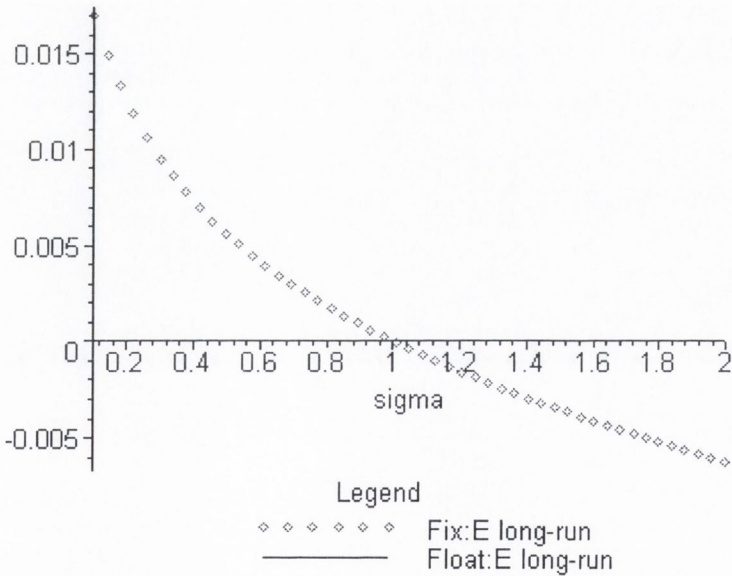


Figure 3.2: Adjustment of the Long-Run Real Exchange Rate to a Temporary World Output Shock. *Note: Different values of the intertemporal elasticity of substitution.*

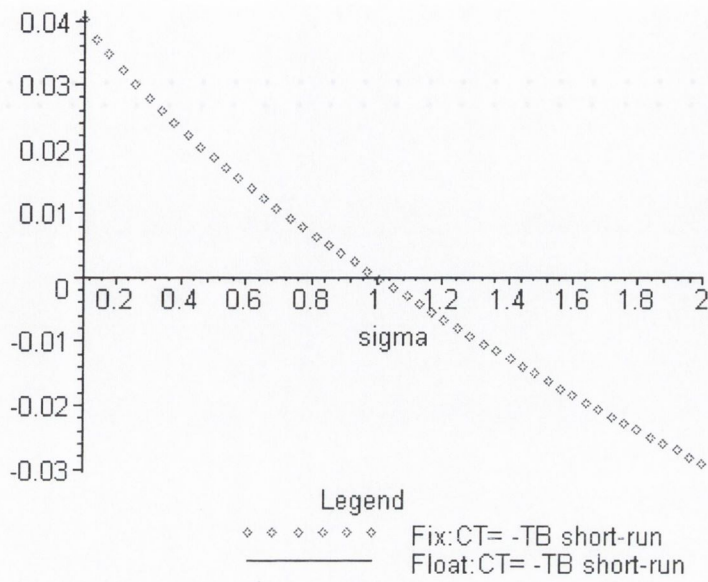


Figure 3.3: Adjustment of the Short-Run 'Trade Balance' to a Temporary World Output Shock.
Note: Different values of the intertemporal elasticity of substitution.

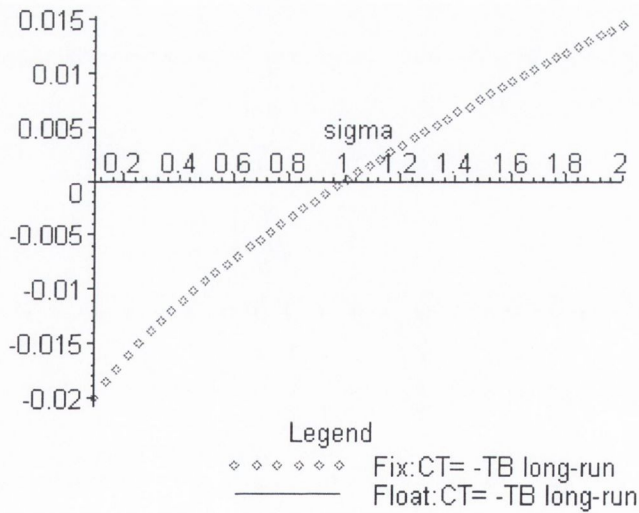


Figure 3.4: Adjustment of the Long-Run 'Trade Balance' to a Temporary World Output Shock.
Note: Different values of the intertemporal elasticity of substitution.

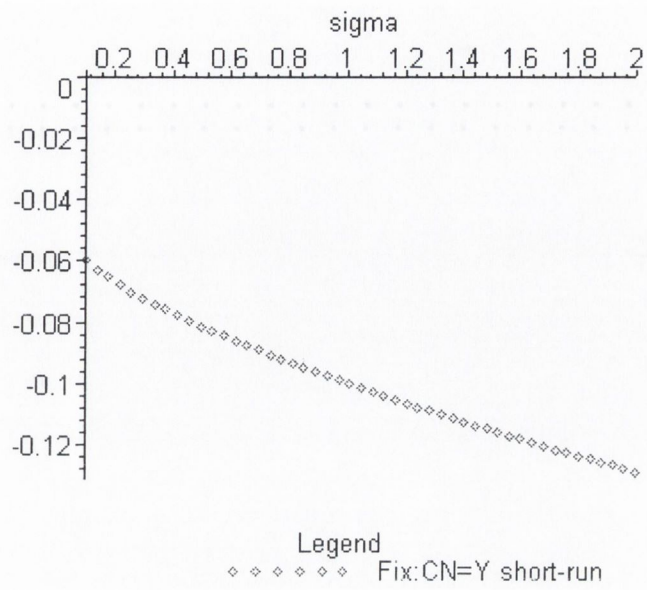


Figure 3.5: Adjustment of the Short-Run ‘Nontraded Goods Output’ to a Temporary World Output Shock. *Note: Different values of the intertemporal elasticity of substitution.*

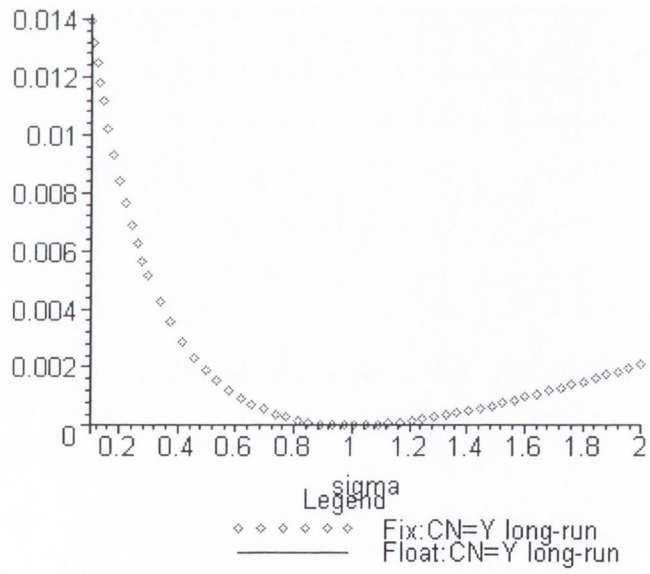


Figure 3.6: Adjustment of the Long-Run ‘Nontraded Goods Output’ to a Temporary World Output shock. *Note: Different values of the intertemporal elasticity of substitution.*

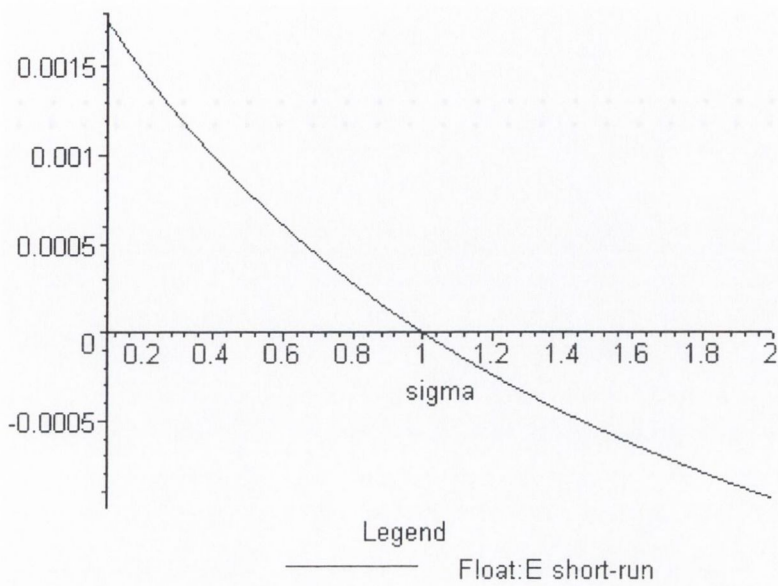


Figure 3.7: Adjustment of the Short-Run Real Exchange Rate to a Temporary World Interest Rate Shock. *Note: Different values of the intertemporal elasticity of substitution.*

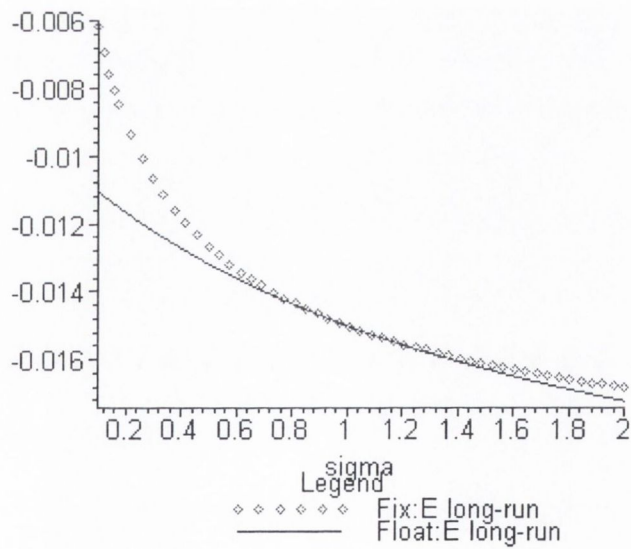


Figure 3.8: Adjustment of the Long-Run Real Exchange Rate to a Temporary World Interest Rate Shock. *Note: Different values of the intertemporal elasticity of substitution.*

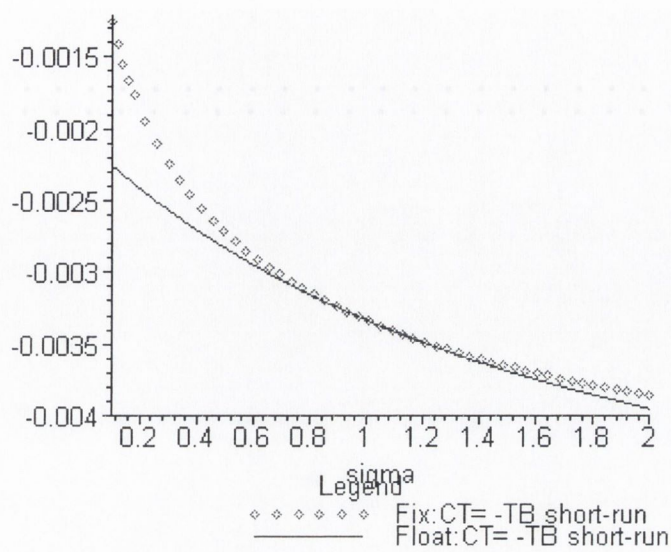


Figure 3.9: Adjustment of the Short-Run 'Trade Balance' to a Temporary World Interest Rate Shock. *Note: Different values of the intertemporal elasticity of substitution.*

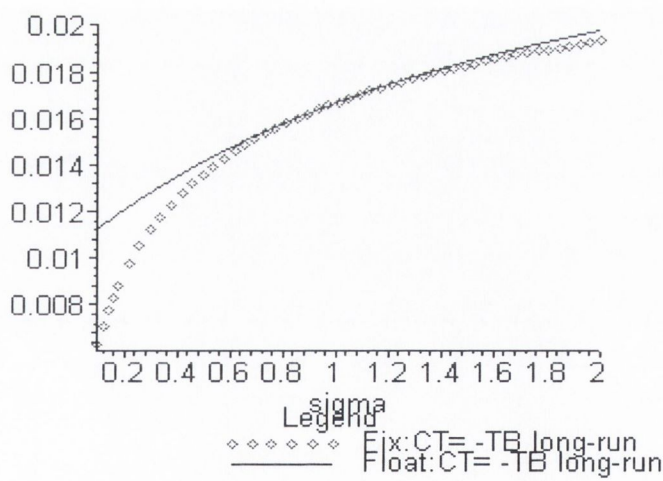


Figure 3.10: Adjustment of the Long-Run 'Trade Balance' to a Temporary World Interest Rate Shock. *Note: Different values of the intertemporal elasticity of substitution.*

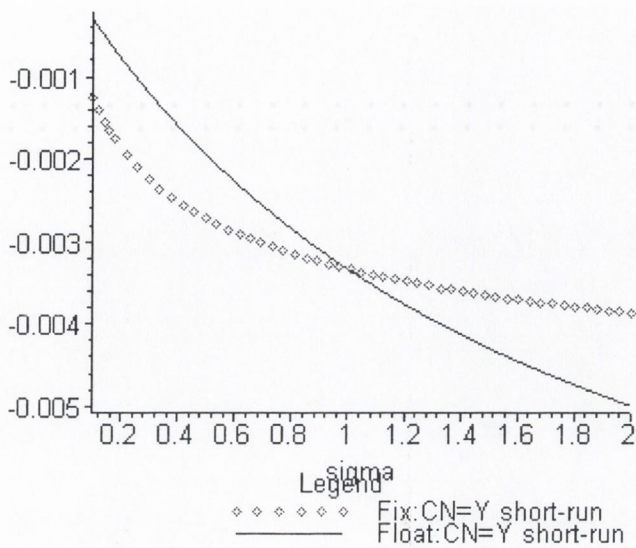


Figure 3.11: Adjustment of the Short-Run ‘Nontraded Goods Output’ to a Temporary World Interest Rate Shock. *Note: Different values of the intertemporal elasticity of substitution.*

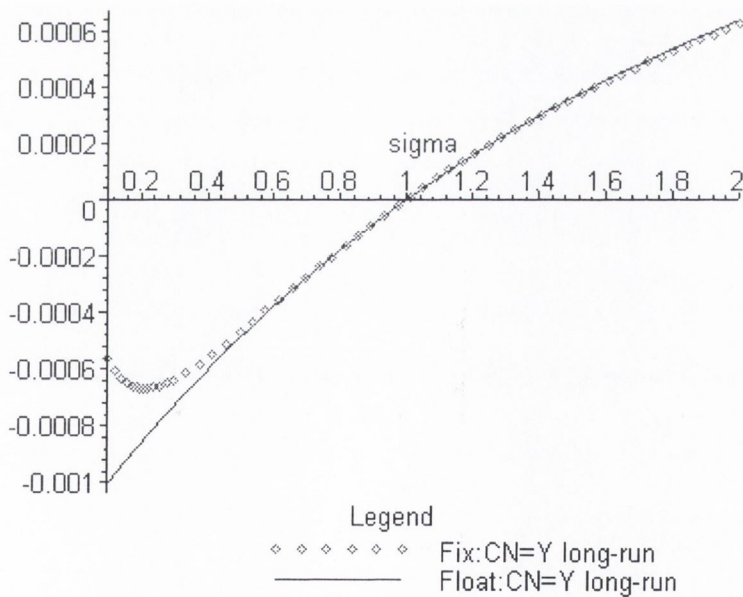


Figure 3.12: Adjustment of the Long-Run ‘Nontraded Goods Output’ to a Temporary World Interest Rate Shock. *Note: Different values of the intertemporal elasticity of substitution.*

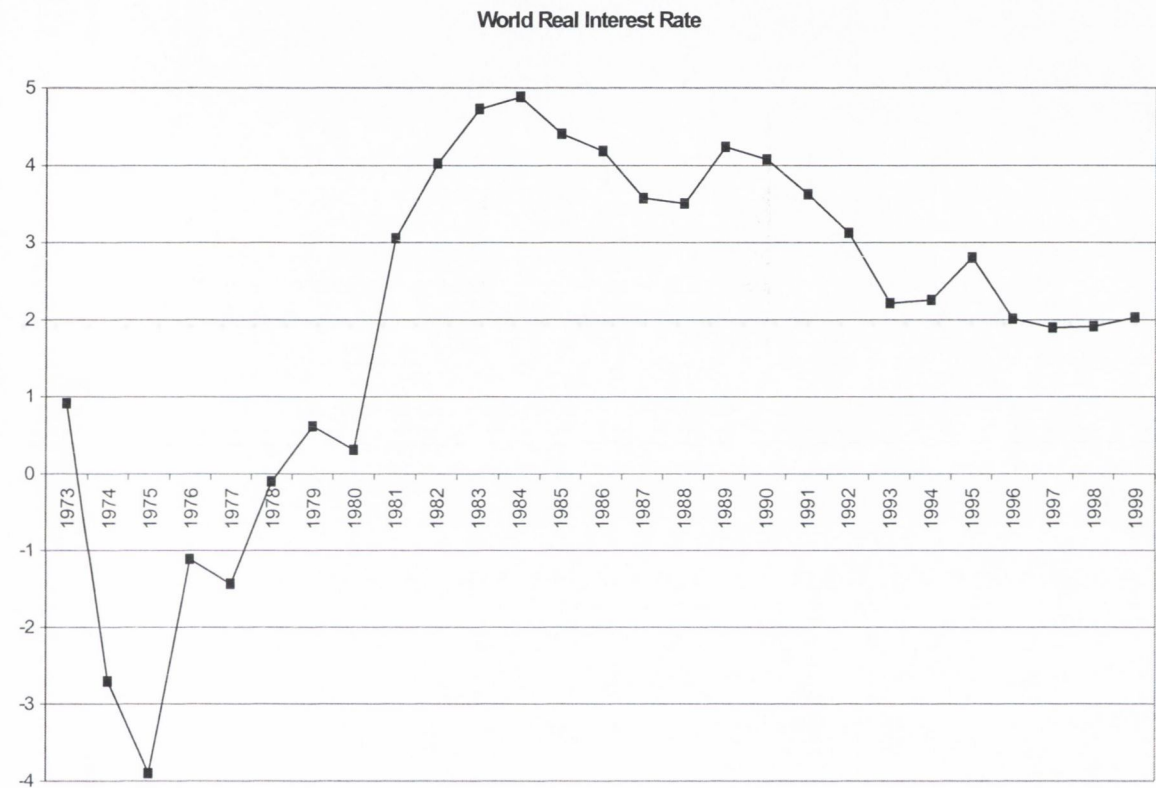


Figure 3.13: Evolution of the World Real Interest Rate. *Note: The vertical axis shows the percentage value of the world real interest rate; Time period 1973-1999.*

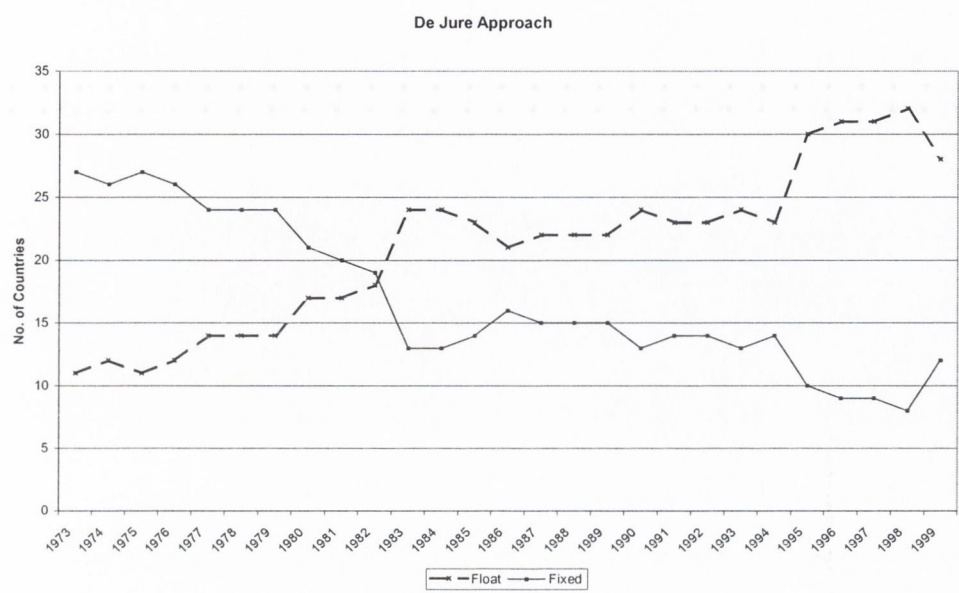


Figure 3.14: Development of the De Jure Exchange Rate Regimes. *Note* 1973-1999.

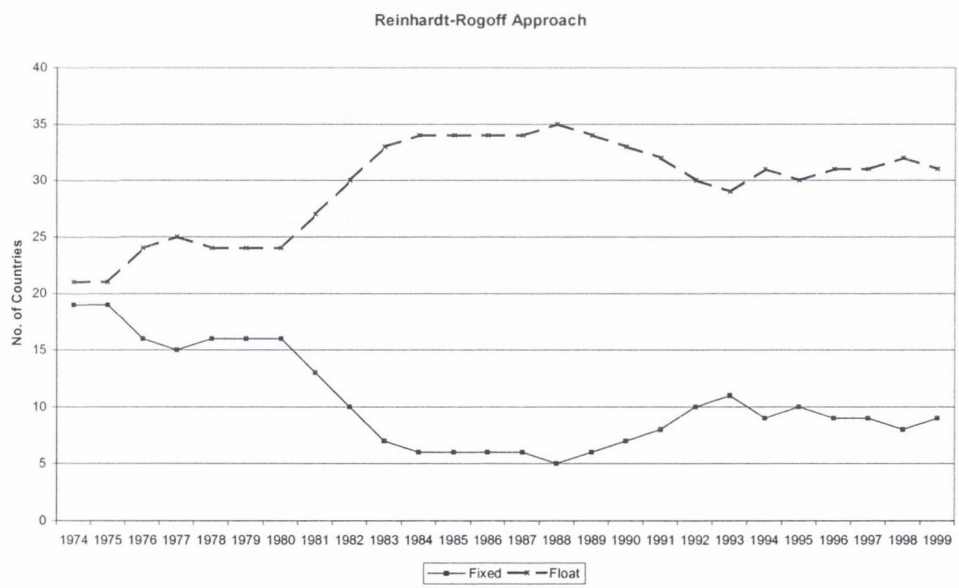


Figure 3.15: Development of the De Facto Exchange Rate Regimes. *Note:* 1973-1999. *Classification of Reinhardt and Rogoff.*

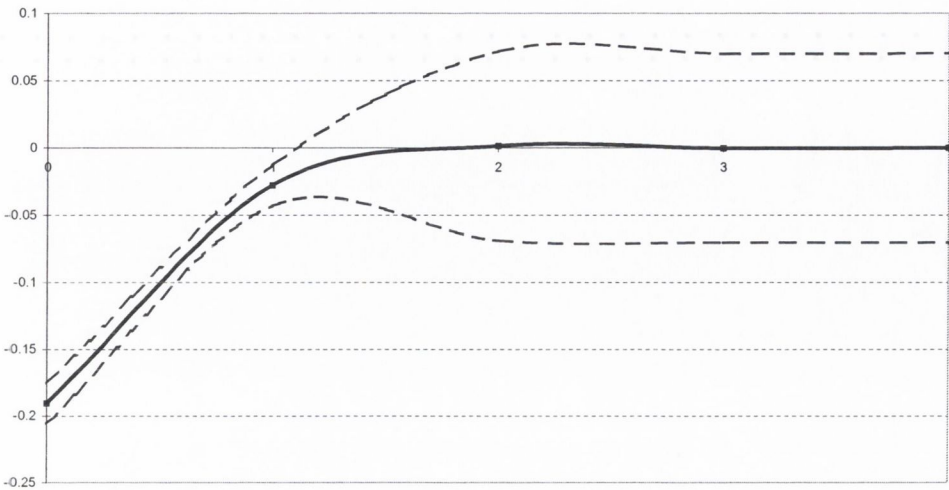


Figure 3.16: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock.

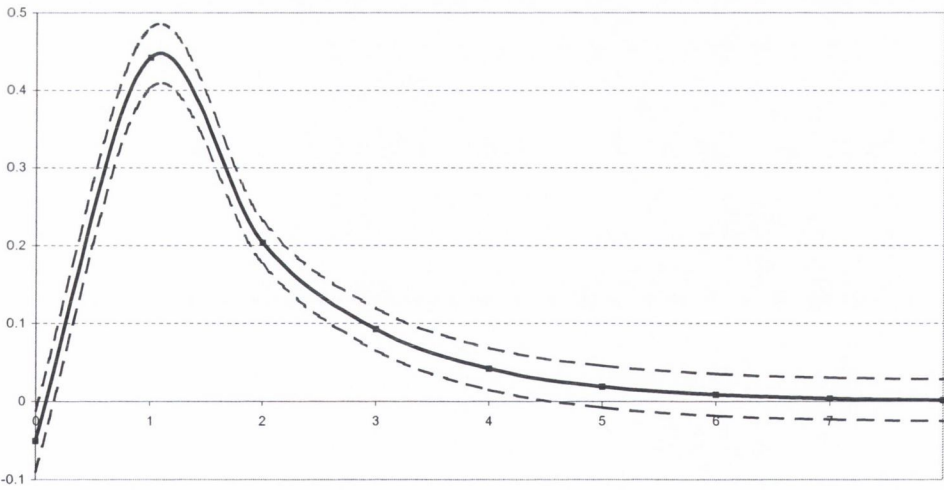


Figure 3.17: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock.

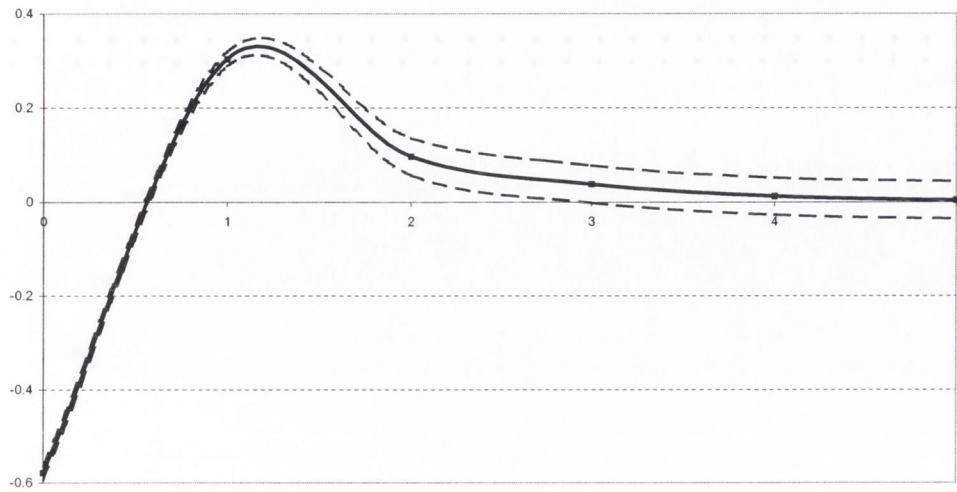


Figure 3.18: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock.

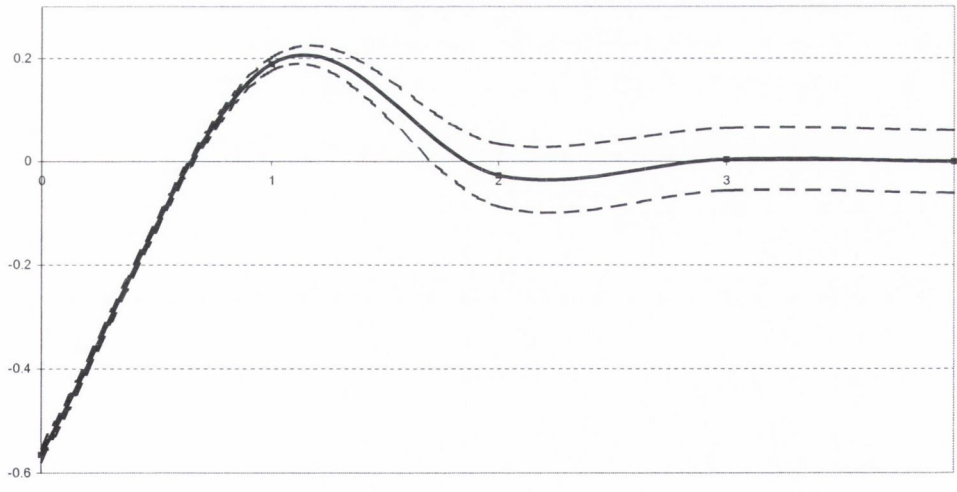


Figure 3.19: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock.

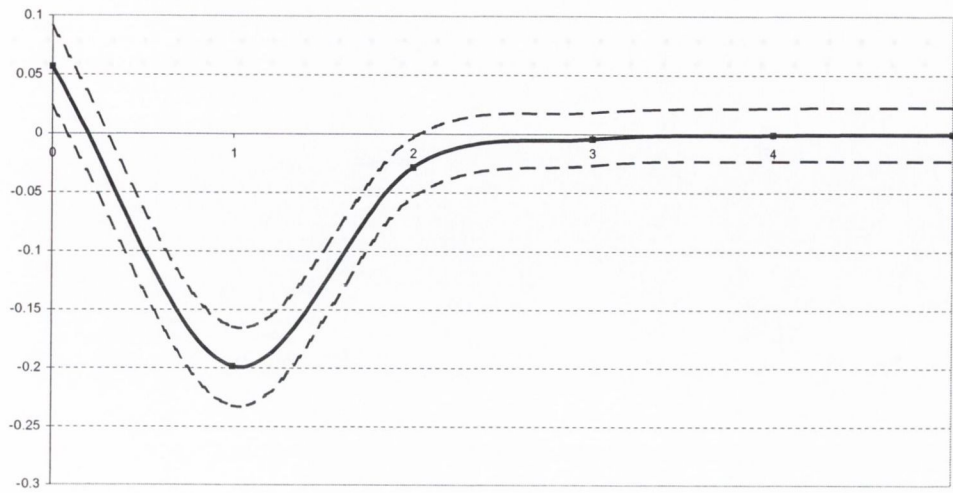


Figure 3.20: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock.

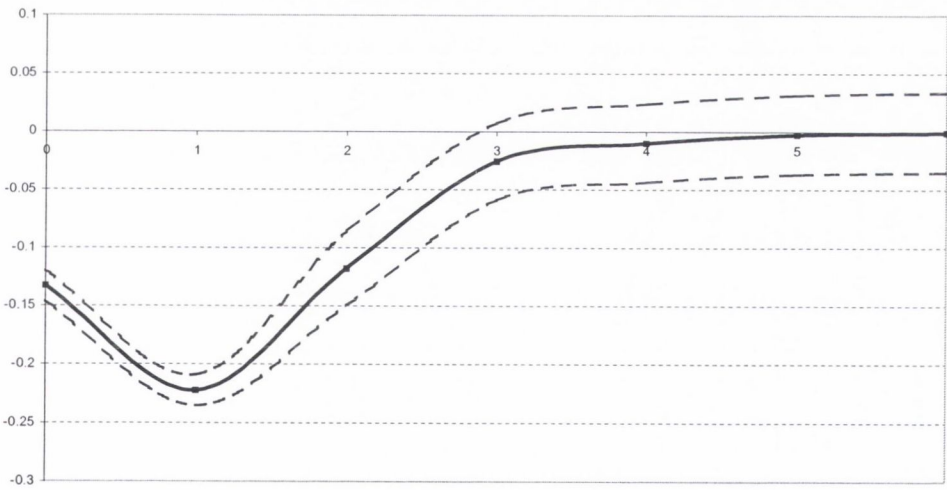


Figure 3.21: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock.

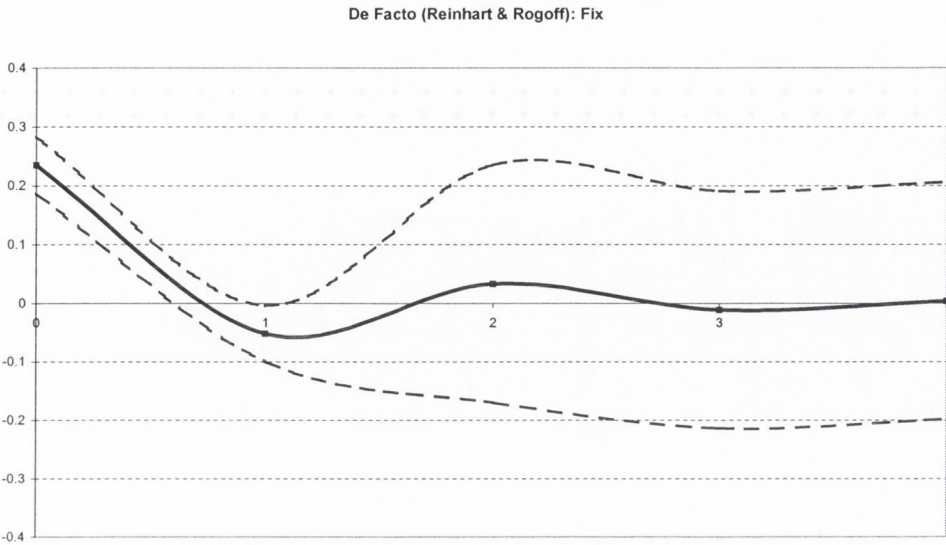


Figure 3.22: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Peg).

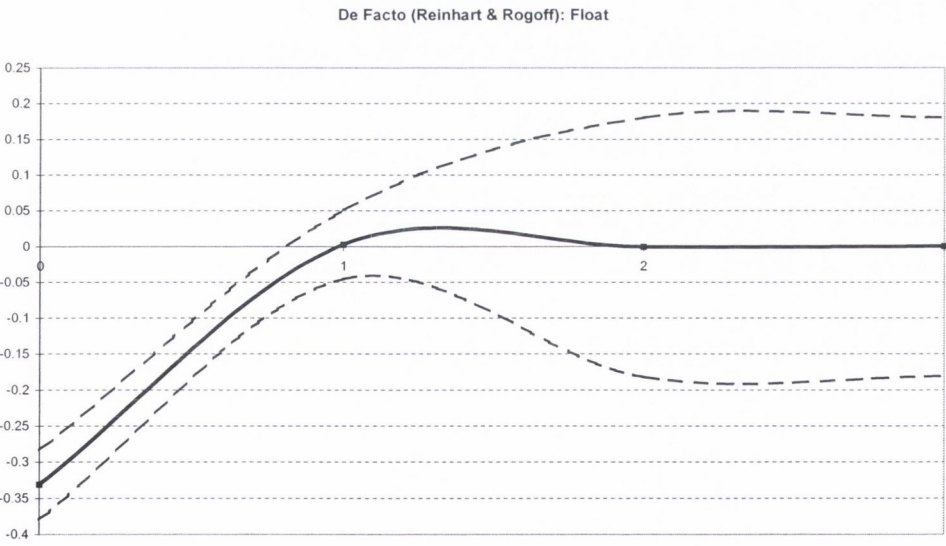


Figure 3.23: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Float).

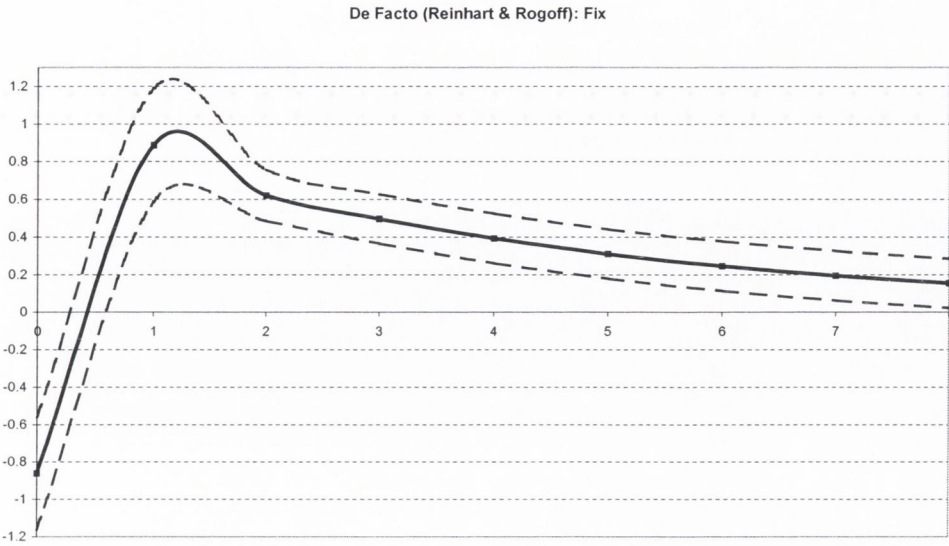


Figure 3.24: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Peg).

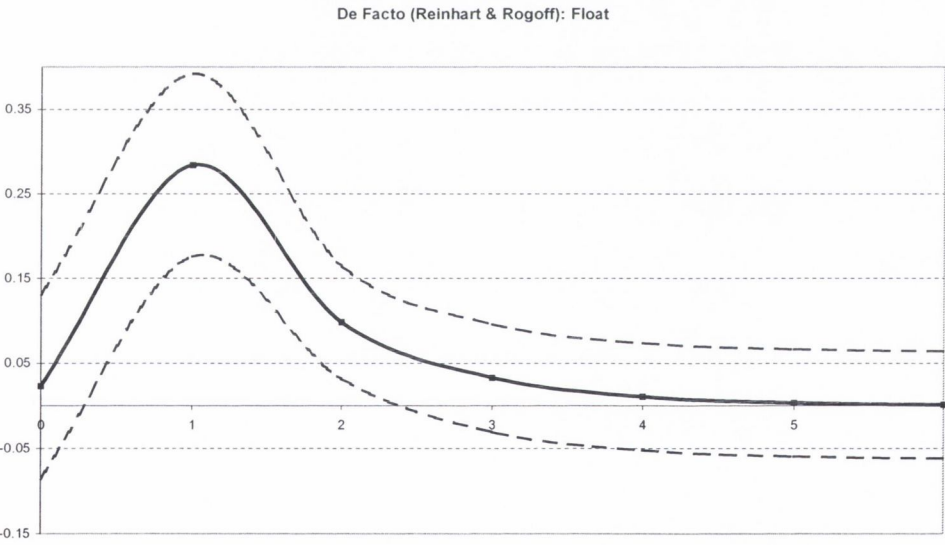


Figure 3.25: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Float).

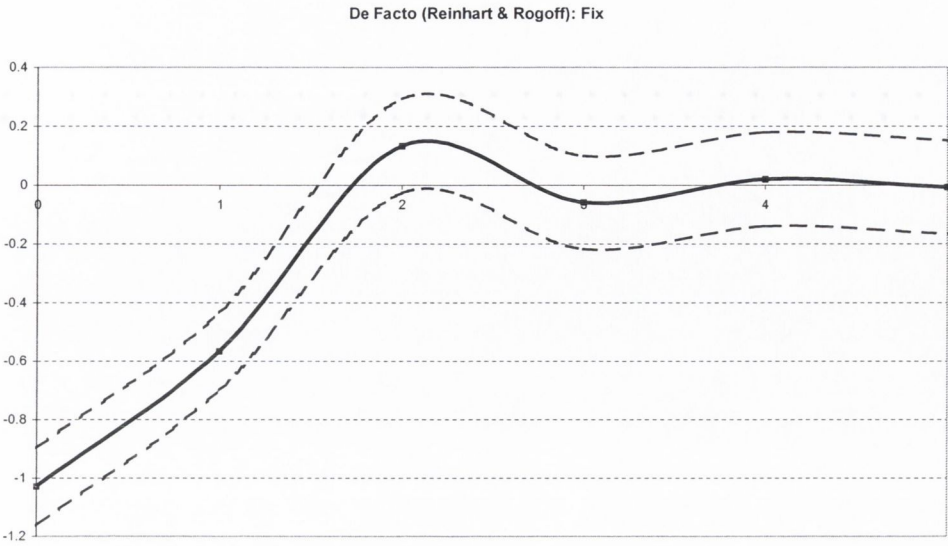


Figure 3.26: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Peg).

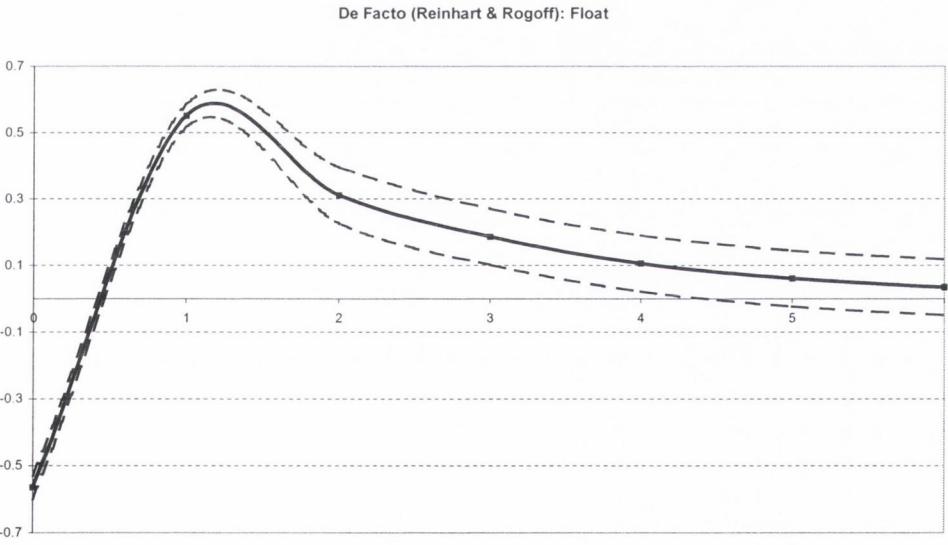


Figure 3.27: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Float).

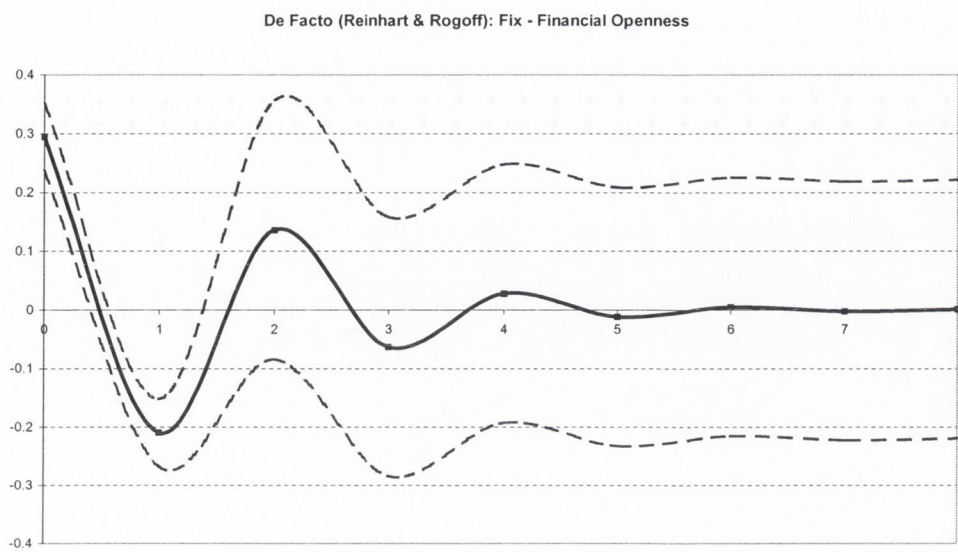


Figure 3.28: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Peg: Financial Openness).

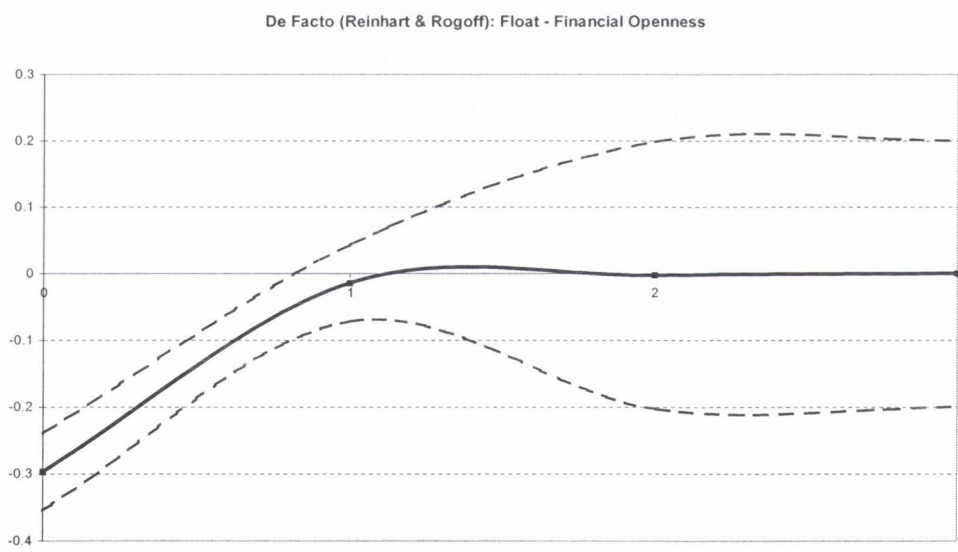


Figure 3.29: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Float: Financial Openness).

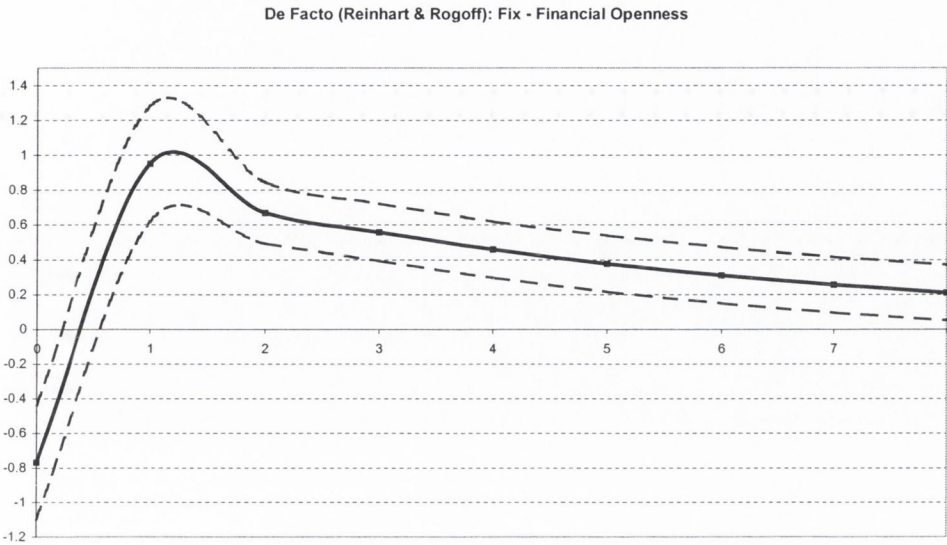


Figure 3.30: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Peg: Financial Openness).

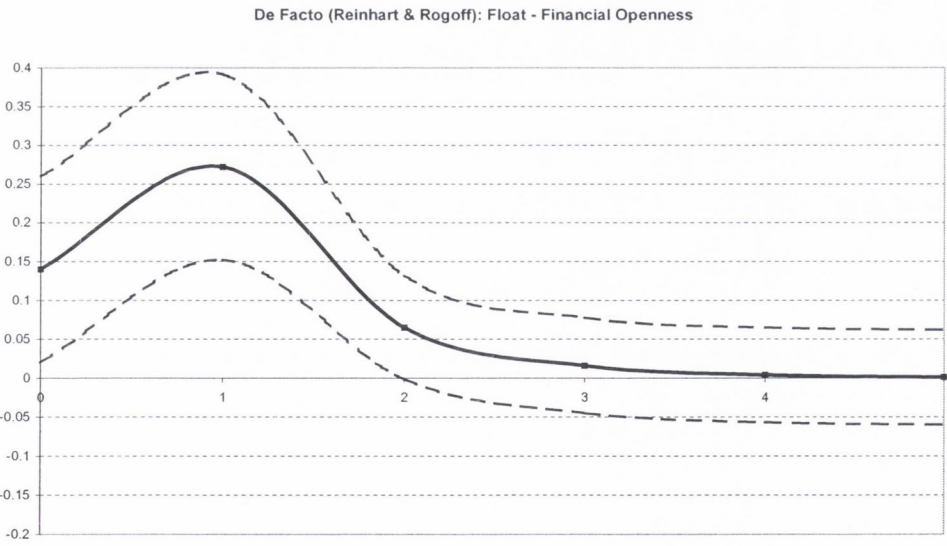


Figure 3.31: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Float: Financial Openness).

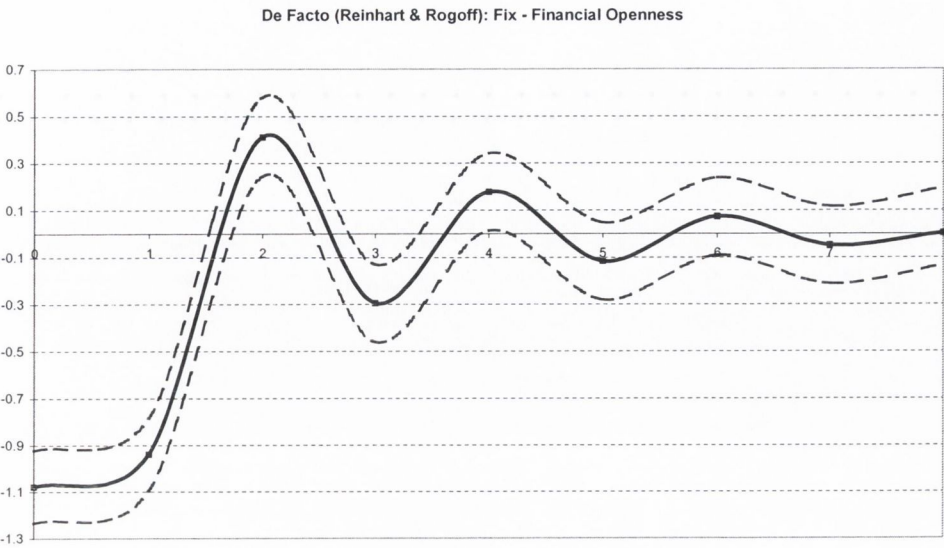


Figure 3.32: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Peg: Financial Openness).

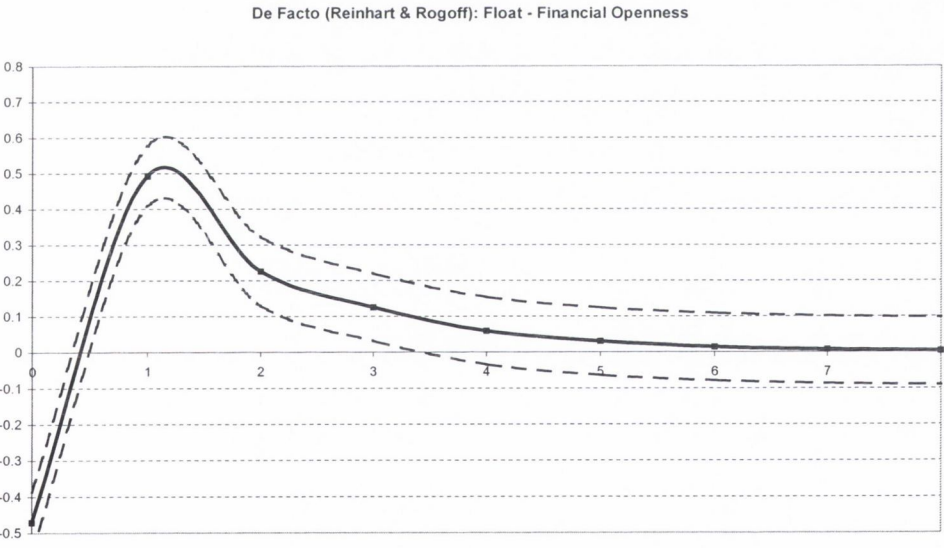


Figure 3.33: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock (De Facto, Float: Financial Openness).

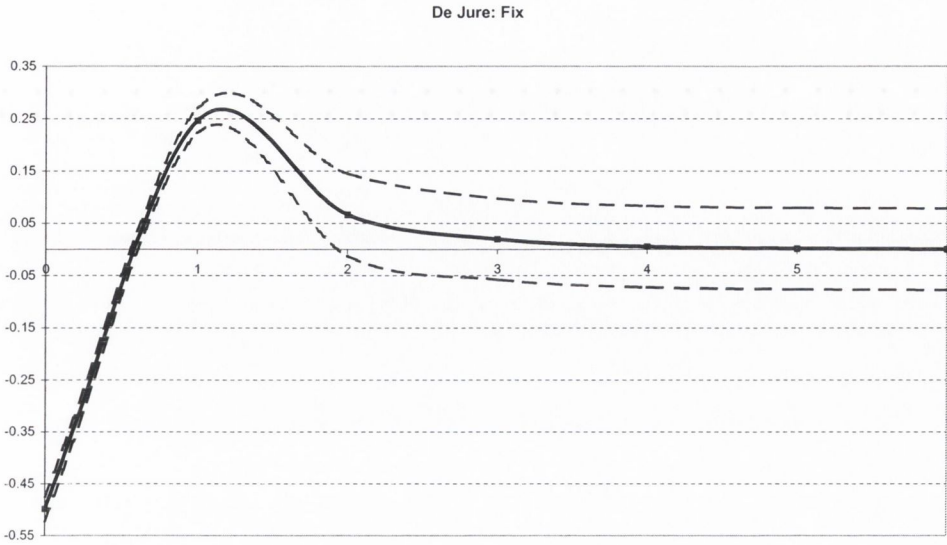


Figure 3.34: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock (De Jure, Peg).

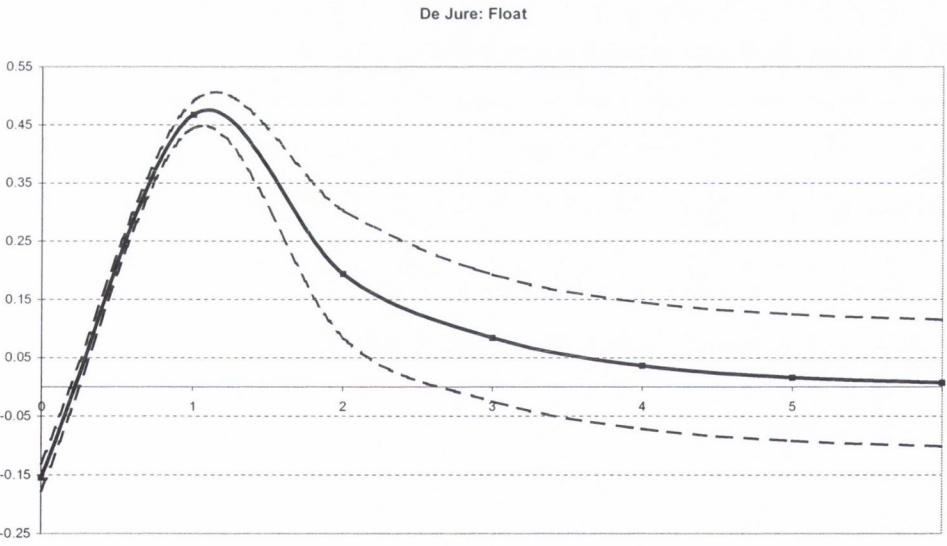


Figure 3.35: Impulse Response Function of Real GDP to a Temporary 100 Basis Point World Real Interest Rate Shock (De Jure, Float).

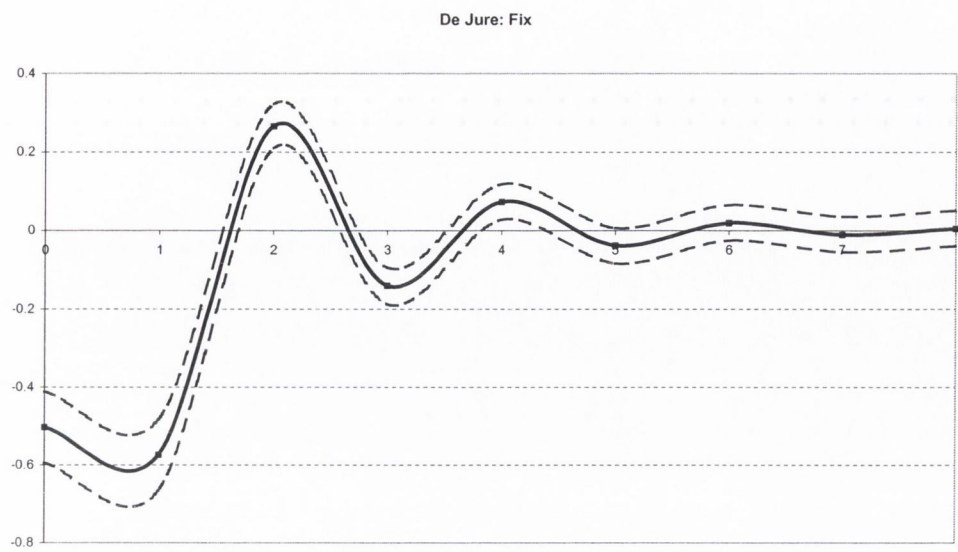


Figure 3.36: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock (De Jure, Peg).

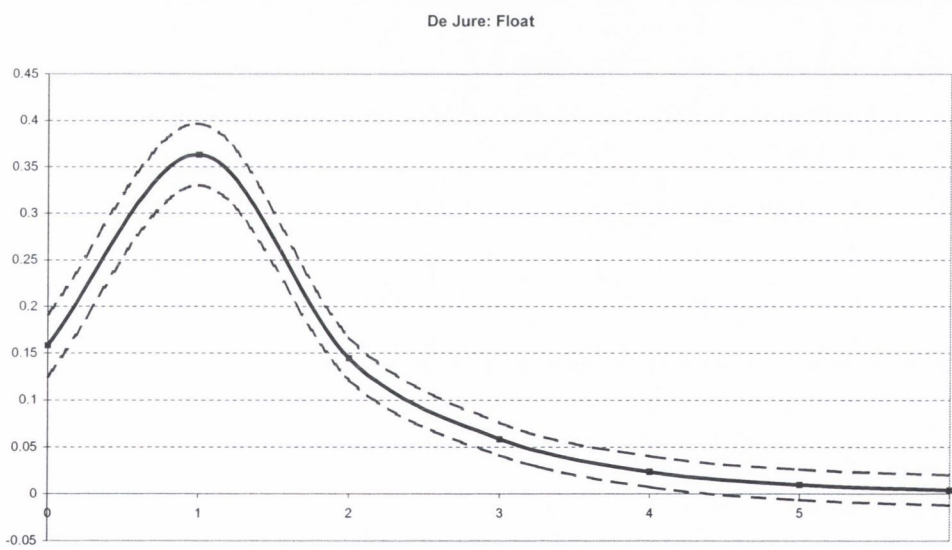


Figure 3.37: Impulse Response Function of Net Exports to a Temporary 100 Basis Point World Real Interest Rate Shock (De Jure, Float).

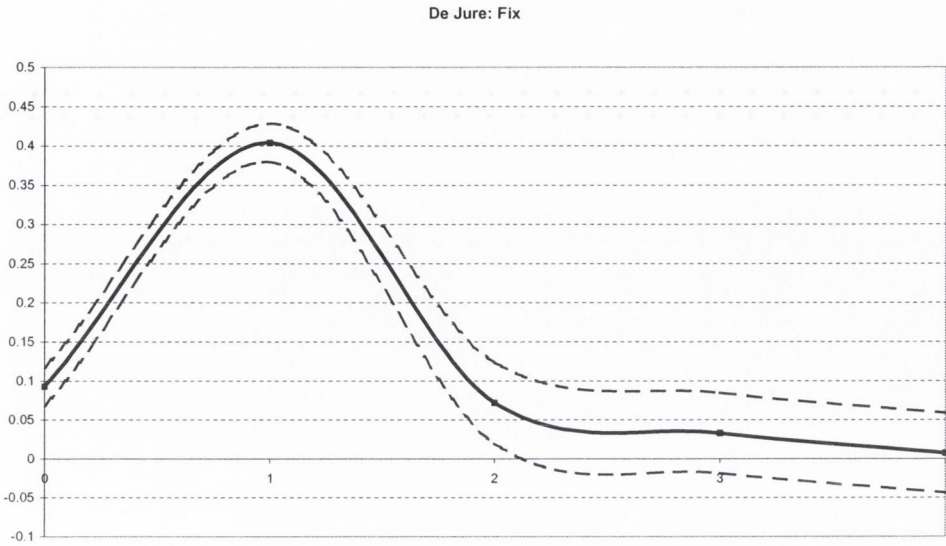


Figure 3.38: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock (De Jure, Peg).

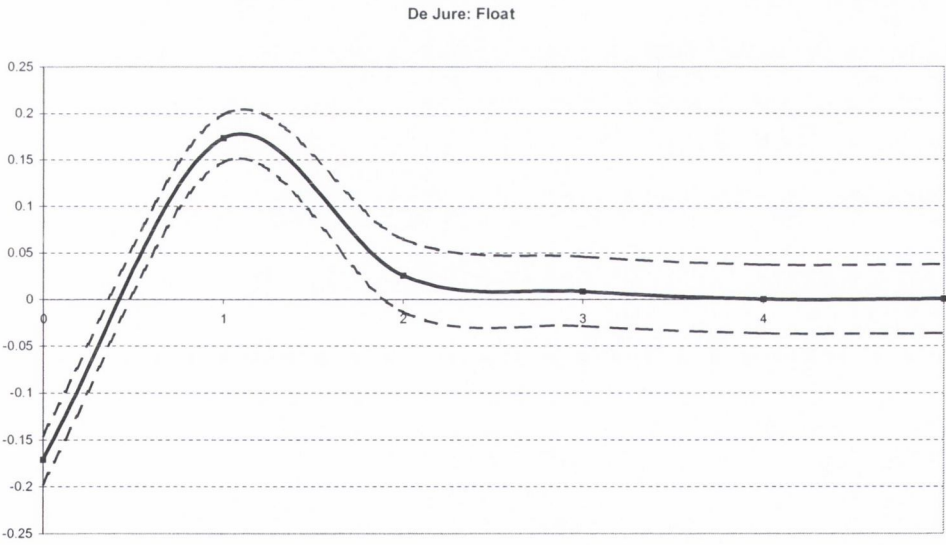


Figure 3.39: Impulse Response Function of Real Exchange Rate to a Temporary 100 Basis Point World Real Interest Rate Shock (De Jure, Float).

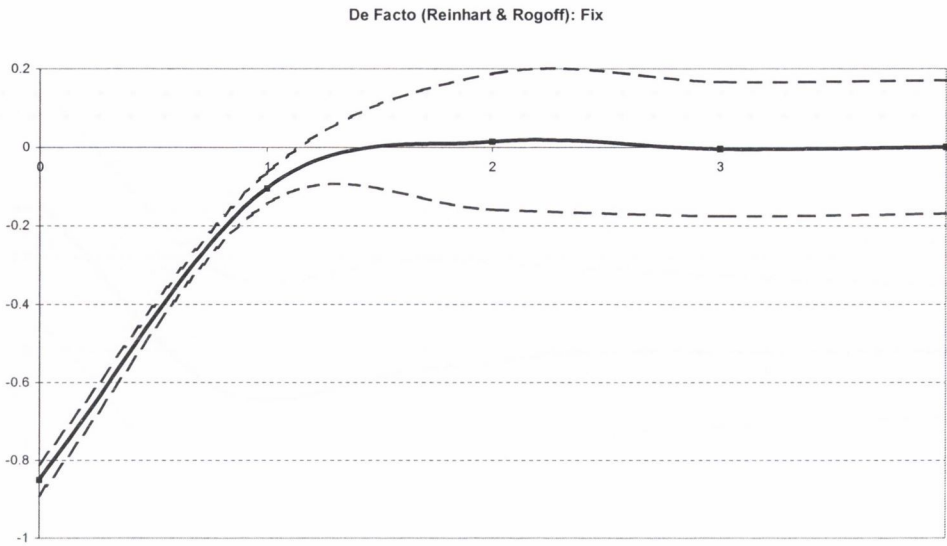


Figure 3.40: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock (De Facto, Peg).

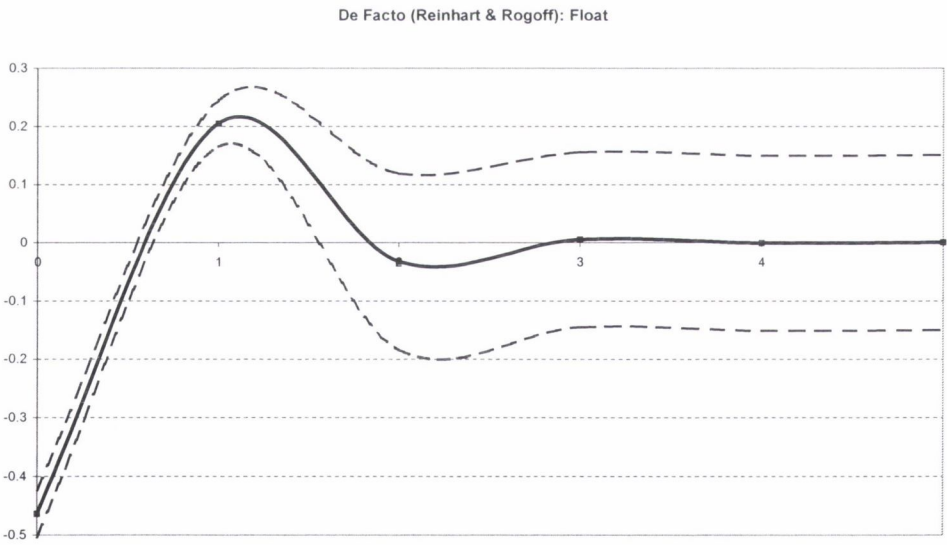


Figure 3.41: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock (De Facto, Float).

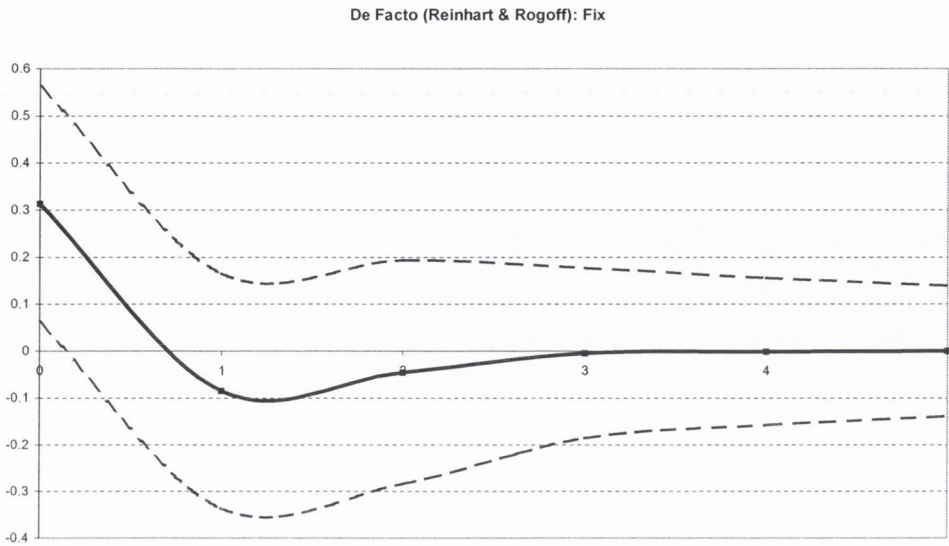


Figure 3.42: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock (De Facto, Peg).

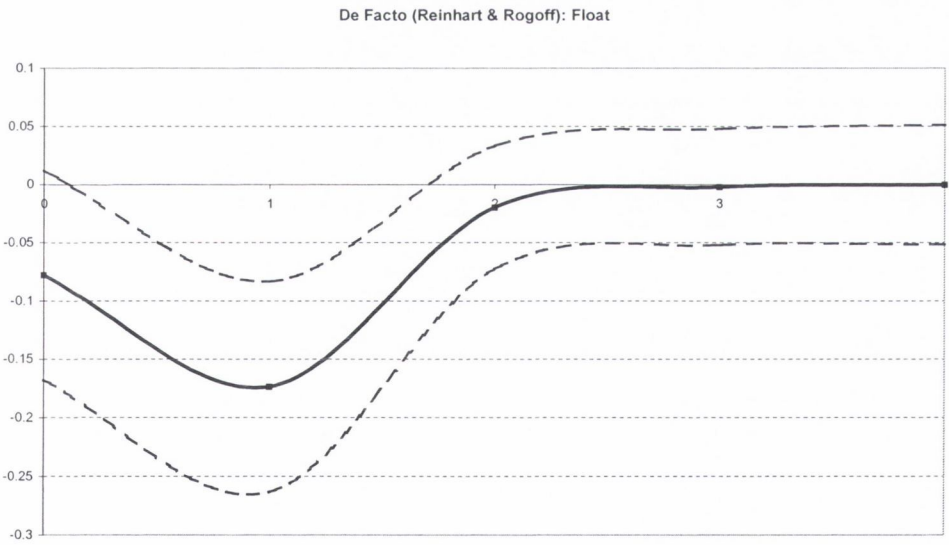


Figure 3.43: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock (De Facto, Float).

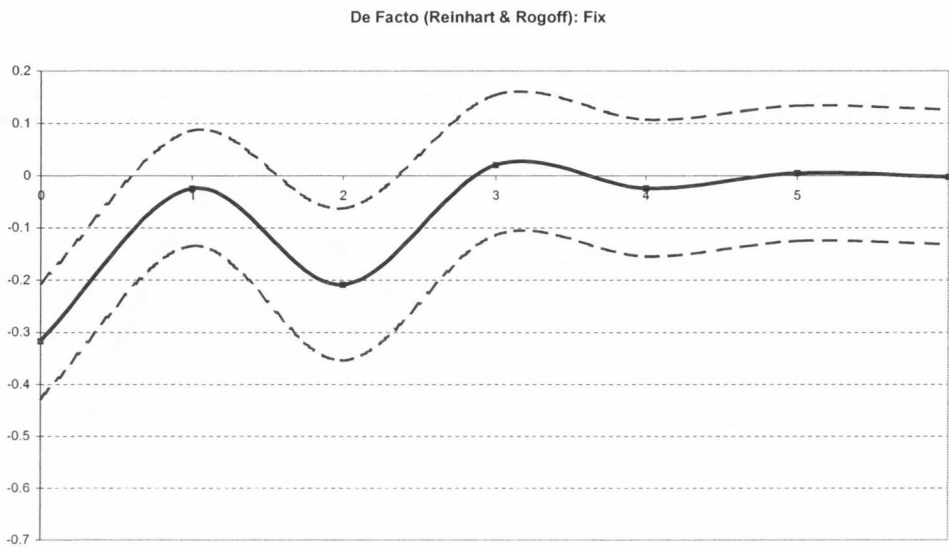


Figure 3.44: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock (De Facto, Peg).

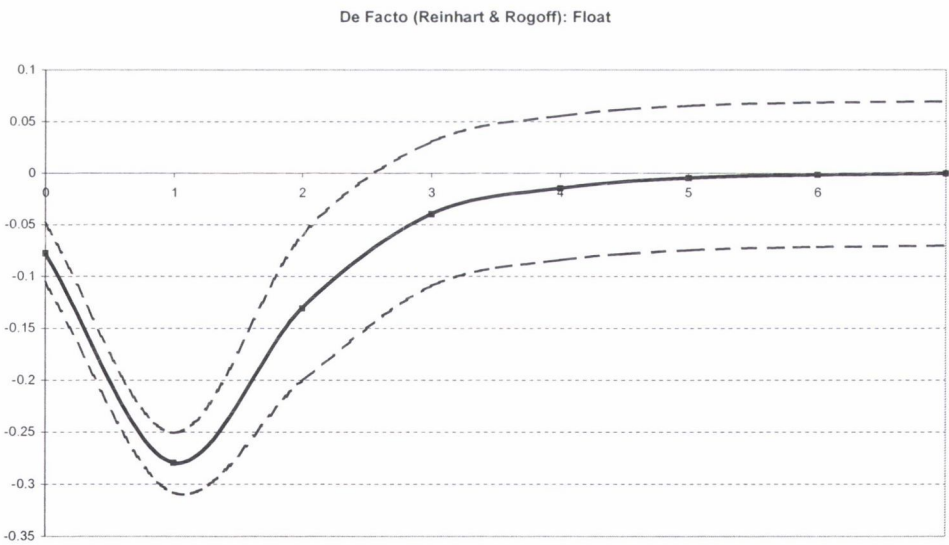


Figure 3.45: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock (De Facto, Float).

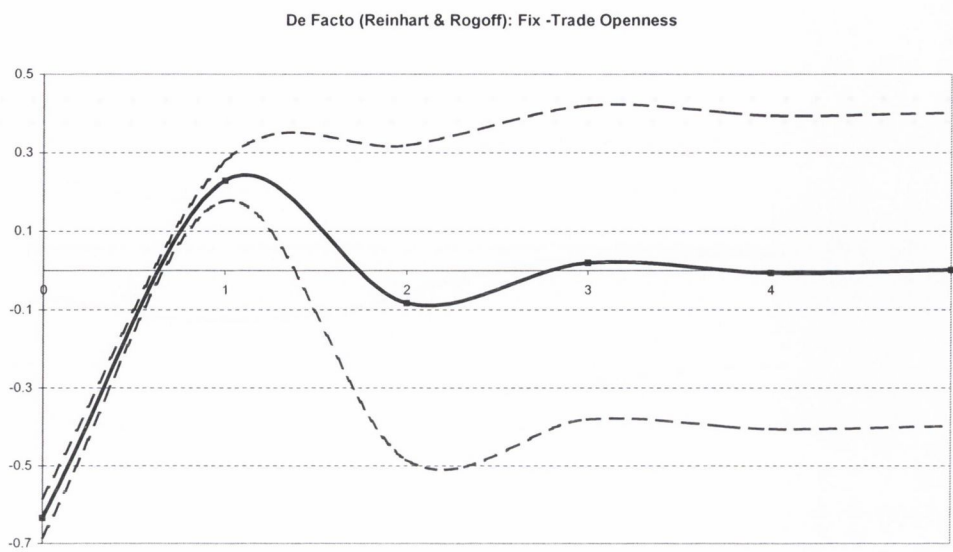


Figure 3.46: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock (De Facto, Peg: Trade Openness).

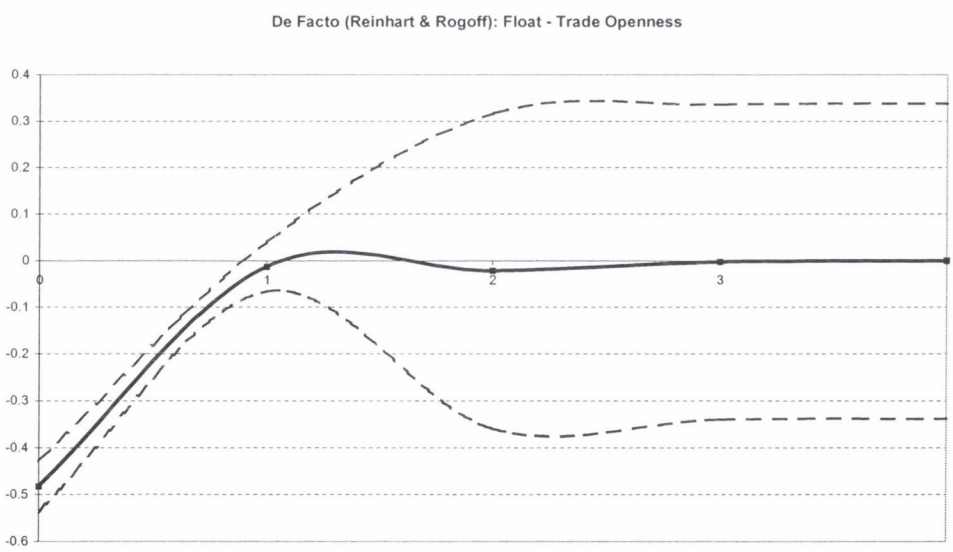


Figure 3.47: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock (De Facto, Float: Trade Openness).

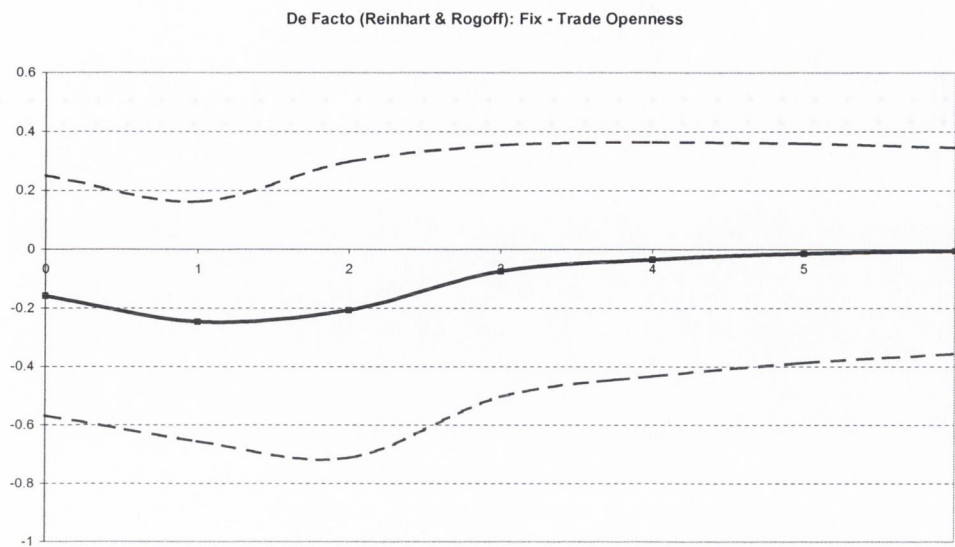


Figure 3.48: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock (De Facto, Peg: Trade Openness).

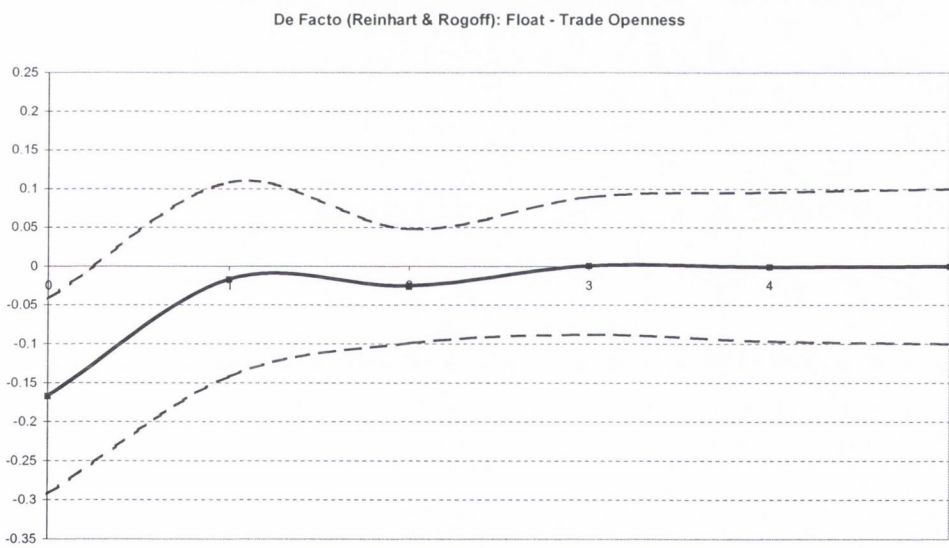


Figure 3.49: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock (De Facto, Float: Trade Openness).

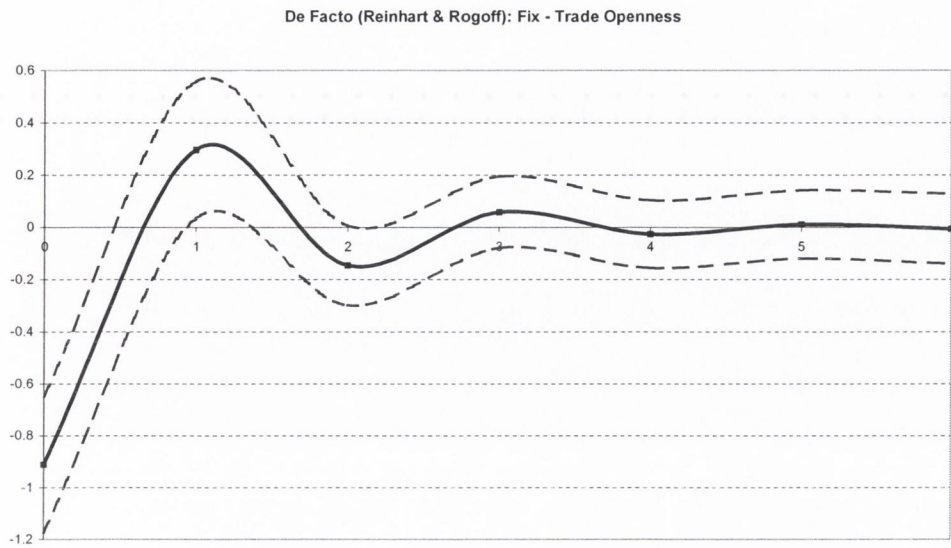


Figure 3.50: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock (De Facto, Peg: Trade Openness).

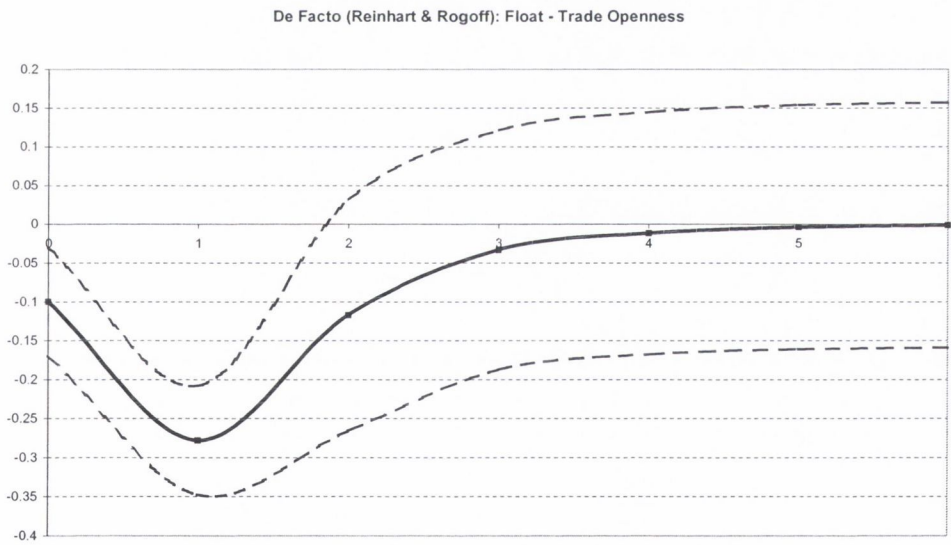


Figure 3.51: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock (De Facto, Float: Trade Openness).

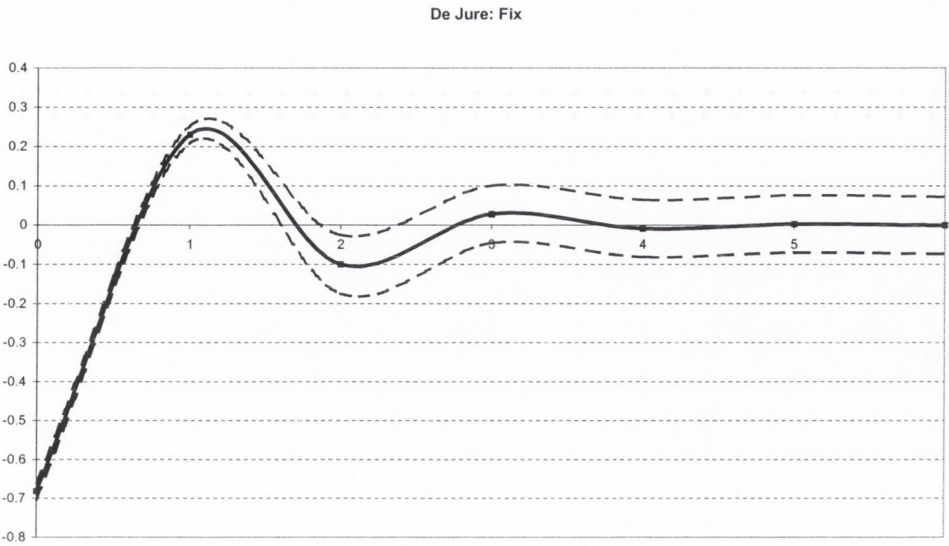


Figure 3.52: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock (De Jure, Peg).

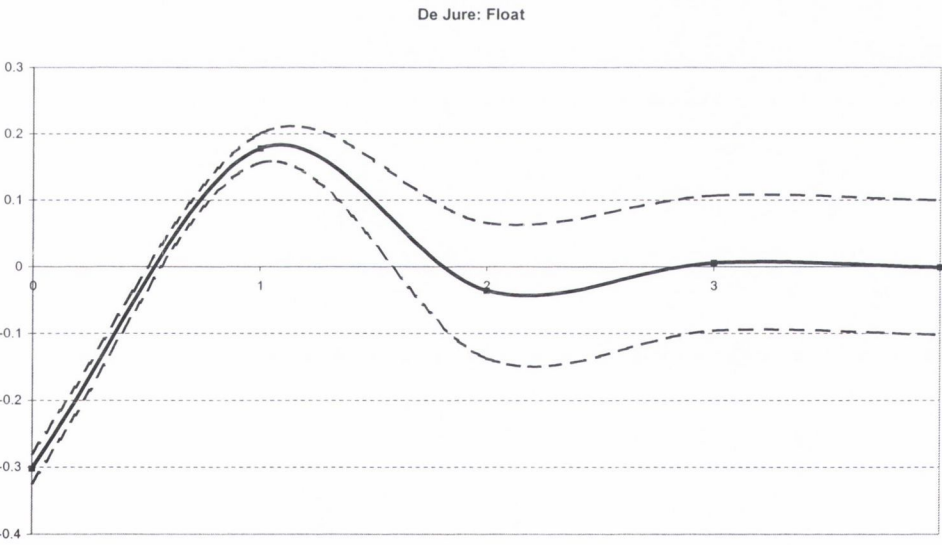


Figure 3.53: Impulse Response Function of Real GDP to a negative Temporary 1 Percent World Output Shock (De Jure, Float).

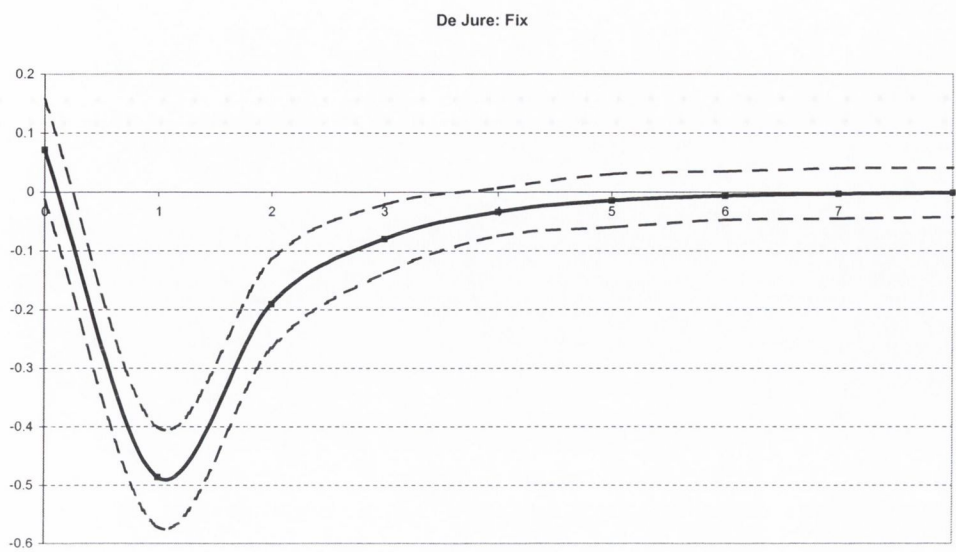


Figure 3.54: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock (De Jure, Peg).

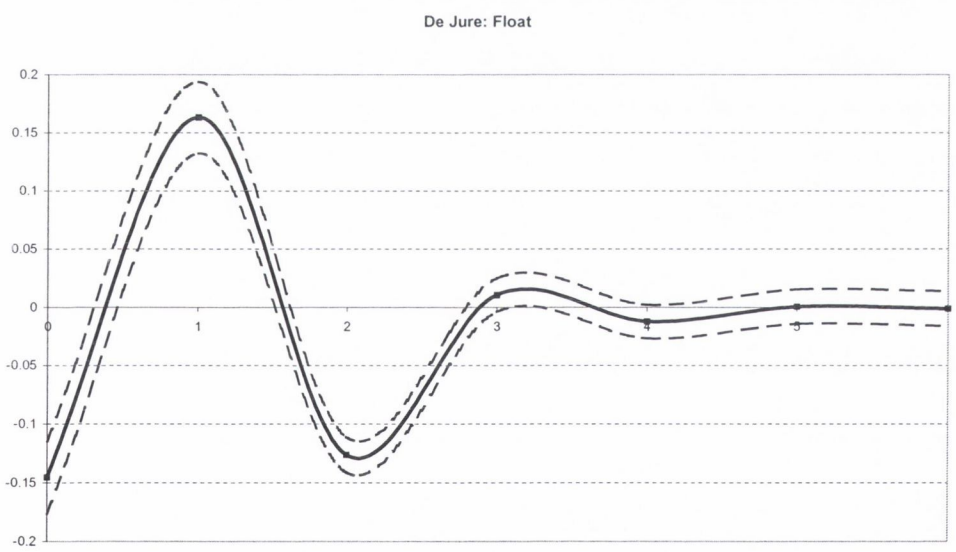


Figure 3.55: Impulse Response Function of Net Exports to a negative Temporary 1 Percent World Output Shock (De Jure, Float).

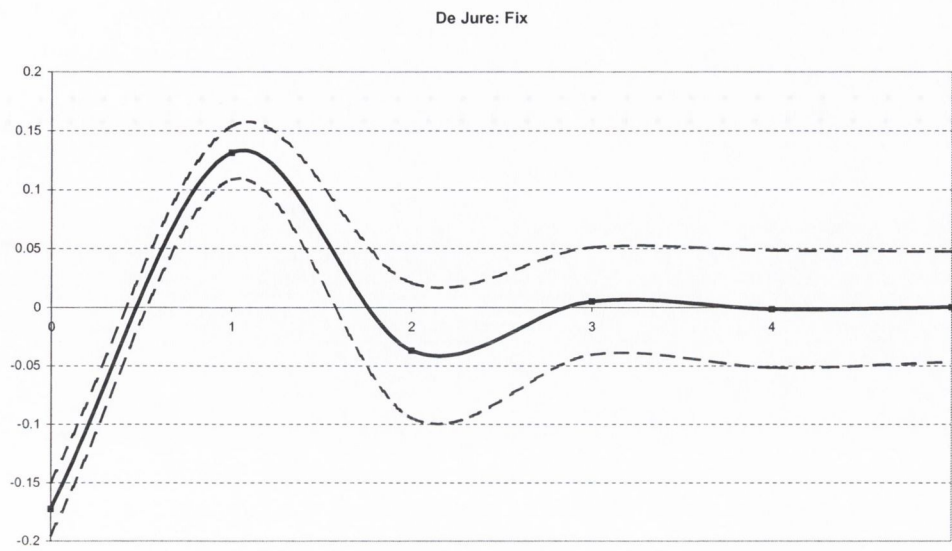


Figure 3.56: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock (De Jure, Peg).

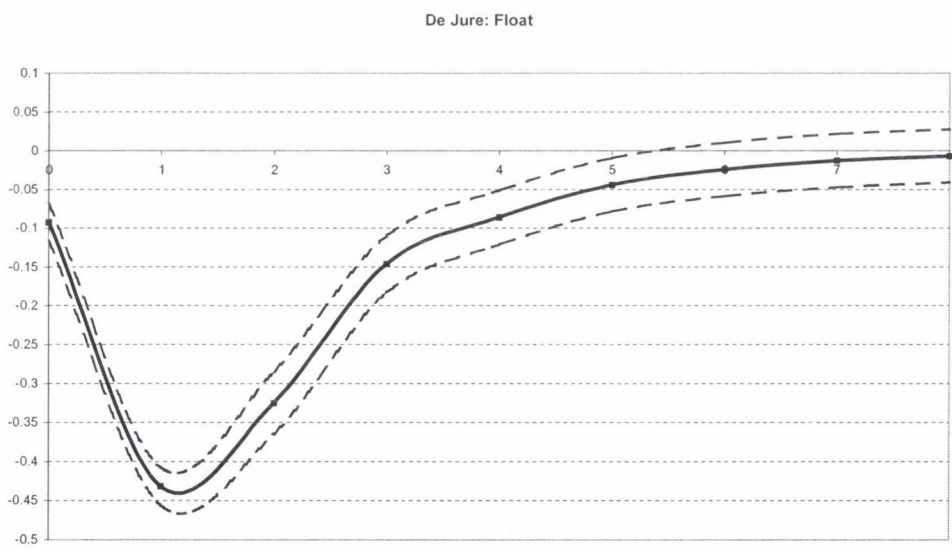


Figure 3.57: Impulse Response Function of Real Exchange Rate to a negative Temporary 1 Percent World Output Shock (De Jure, Float).

Asia	Middle East	Africa	Latin America
India (IND)	Bahrain (BHR)	Botswana (BWA)	Argentina (ARG)
Indonesia (IDN)	Israel (ISR)	Cote D'Ivoire (CIV)	Bolivia (BOL)
Korea (KOR)	Jordan (JOR)	Egypt (EGY)	Brazil (BRA)
Malaysia (MYS)	Oman (OMN)	Mauritius (MUS)	Chile (CHL)
Pakistan (PAK)	Saudi Arabia (SAU)	Morocco (MAR)	Colombia (COL)
Philippines (PHL)	Syria (SYR)	South Africa (ZAF)	Costa Rica (CRI)
Singapore (SGP)	Turkey (TUR)	Tunisia (TUN)	Dominican Republic (DOM)
Sri Lanka (LKA)		Zimbabwe (ZWE)	Ecuador (ECU)
Thailand (THA)			El Salvador (SLV)
			Guatemala (GTM)
			Jamaica (JAM)
			Mexico (MEX)
			Panama (PAN)
			Paraguay (PRY)
			Peru (PER)
			Trinidad and Tobago (TTO)
			Uruguay (URY)
			Venezuela (VEN)

Table 3.1: Country List

Variables				
Levin and Lin Test				
Levels:	t_{Rho}	criticalProb.		
Real GDP (Level)	0.291	0.418	(accept)	
Real Exchange Rate (Level)	0.376	0.395	(accept)	
Net Exports (Levels)	0.825	0.314	(accept)	
World Interest Rate (Level)	0.078	0.478	(accept)	
World Real GDP (Level)	0.24	0.432	(accept)	
First Differences:				
Δ Real GDP	-58.97	0.000	(reject)	
Δ Real Exchange Rate	-152.58	0.000	(reject)	
Δ Net Exports	-180.75	0.000	(reject)	
Δ World Interest Rate	-166.07	0.000	(reject)	
Δ World Real GDP	-60.59	0.000	(reject)	

Table 3.2: Panel Unit Root Test. *Note: The null hypothesis is that the series are unit root processes.*

Variables (Relation)	Mc Coskey and Kao	
	LM Plus Test	
Real GDP: World Real GDP→World Interest Rate →Net Exports→Real Exchange Rate	38.827 (0.0000)	(reject)
Real Exchange Rate: World Real GDP→World Interest Rate →Net Exports→Real GDP	26.268 (0.0000)	(reject)
Net Exports: World Real GDP→World Interest Rate →Real Exchange Rate→Real GDP	26.495 (0.0000)	(reject)

Table 3.3: Residual Based Cointegration Test. *Note: Model with varying slopes and intercepts. The null hypothesis is that there is cointegration (no unit root in the errors). The critical probabilities are in parentheses.*

Variables	Complete		Sample	
	Mean	StDev	Max	Min
Fix: De Jure				
Real GDP	0.045	0.05	0.22	-0.14
Net Exports	0.001	0.06	0.21	-0.23
RER	0.0012	0.10	0.62	-0.39
Float: De Jure				
Real GDP	0.038	0.04	0.12	-0.14
Net Exports	0.002	0.04	0.21	-0.14
RER	0.021	0.13	1.05	-0.38
Fix: De Facto				
Real GDP	0.039	0.05	0.17	-0.14
Net Exports	-0.0003	0.05	0.17	-0.23
RER	0.007	0.08	0.48	-0.18
Float: De Facto				
Real GDP	0.040	0.04	0.17	-0.13
Net Exports	0.0003	0.03	0.20	-0.17
RER	0.01	0.12	0.81	-0.38

Table 3.4: Summary Statistics. *Note: First differenced variables in the system.*

Asia			Middle East			Africa			Latin America		
Periods			Periods			Periods			Periods		
Float	Fix		Float	Fix		Float	Fix		Float	Fix	
IND	79 -99	73 -78	BHR		73 -99	BWA		73 -99	ARG	73 -78	79 -80
IDN	79 -99	73 -78	ISR	74 -85	73	CIV	N.A.	N.A.		81 -84	85
KOR	73	74 -79		95 -99	86 -94	EGY	92 -'98	73 -91		86 -90	91 -99
	80 -99		JOR		73 -99			99	BOL	85 -99	73 -84
MYS	73 -98	99	OMN		73 -99	MUS	83 -99	73 -82	BRA	73 -85	86
PAK	82 -99	73 -81	SAU		73 -99	MAR	80 -89	73 -79		87 -99	
PHL	73 -99		SYR	N.A.	N.A.			90 -99	CHL	73 -77	78 -82
SGP	73 -99		TUR	73 -99		ZAF	74	73		83 -85	86 -94
LKA	77 -99	73 -76					80 -99	75 -79	COL	73 -93	94
THA	98 -99	73 -97				TUN	73 -99			95 -99	
						ZWE	95 -99	N.A.	CRI	82 -99	73 -81
									DOM	95 -99	73 -80
									ECU	83 -99	73 -82
									SLV	95 -98	99
									GTM	90 -99	73 -89
									JAM	78	73 -77
										90 -99	79 -89
									MEX	77 -81	73 -76
										83 -88	82
										95 -99	89 -94
									PAN	73 -99	
									PRY	89 -99	73 -88
									PER	76 -84	73 -75
										90 -99	85 -89
									TTO	93 -99	73 -92
											99
									URY	73 -80	81 -82
										83 -91	92 -94
										95 -99	
									VEN	83 -94	73 -82
										96 -99	95

Table 3.5: Country List of the De Jure Exchange Rate Regimes. *Note: Missing years correspond to missing observations.*

Asia			Middle East			Africa			Latin America		
Periods			Periods			Periods			Periods		
Float Fix			Float Fix			Float Fix			Float Fix		
IND	76 -90 96 -99	73 -75 91 -95	BHR	N.A.	N.A.	BWA	81 -99	73 -80	ARG	73 -90	91 -99
IDN	73 -99		ISR	73 -99		CIV		73 -99	BOL	73 -99	
KOR	73 81 -97	74 -80 98 -99	JOR	88 -99	73 -87	EGY	73 -91	92 -99	BRA	73 -99	
MYS	76 -97	73 -75 98 -99	OMN	N.A.	N.A.	MUS	76 -99	73 -75	CHL	73 -79 83 -99	80 -82
PAK	82 -99	73 -81	SAU		73 -99	MAR	73 -99		COL	73 -99	
PHL	73 -94 98 -99	95 -97	SYR	73 -99		ZAF	73 -99		CRI	73 -74 81 -99	75 -80
SGP	73 -99		TUR	73 -99		TUN	75 -99	73 -74	DOM	73 -99	
LKA	73 -88 91 -99	89 -90				ZWE	80 -99		ECU	82 -99	73 -81
THA	98 -99	73 -97							SLV	73 -89	90 -99
									GTM	84 -99	73 -83
									JAM	83 -92 94 -99	73 -82 93
									MEX	77 82 -91 94 -99	73 -76 78 -81 92 -93
									PAN		73 -99
									PRY	73 -99	
									PER	73 -98	99
									TTO	N.A.	N.A.
									URY	73 -99	
									VEN	83 -99	73 -82

Table 3.6: Country List of the De Facto Exchange Rate Regimes. *Note: Missing years correspond to missing observations.*

Holtz-Eakin: Test for Individual Effects					
Dependent Variables:	Real GDP		Real Exchange Rate		Net Exports
	3 lags		3 lags		3 lags
	1.672 (5.991)	(accept)	0.321 (5.991)	(accept)	0.124 (5.991) (accept)
	1 lag		1 lag		1 lag
	0.0026 (5.991)	(accept)	0.090 (5.991)	(accept)	0.016 (5.991) (accept)
Arellano and Bond: Test for Second-Order Serial Correlation					
Dependent Variables:	Real GDP		Real Exchange Rate		Net Exports
	-0.597	(0.550)	-0.417	(0.677)	-0.250 (0.810)

Table 3.7: Tests for Residual Based Individual Effects (Holtz-Eakin) and Second-Order Serial Correlation (Arellano and Bond). *Note: Holtz-Eakin Test for the null hypothesis that there is no individual effect. The chi-square critical value for two degrees of freedom and the 5 percent significance level is in parentheses. Arellano and Bond test for the null hypothesis that there is no second-order serial correlation. The critical probabilities are in parentheses.*

Periods	Variance Decomposition					
	Real GDP		Net Exports		RER	
	De Facto: Float					
	WY	W I R	WY	W I R	WY	W I R
1	15.1	0.60	0.44	0.003	0.06	0.51
2	18.6	0.69	0.70	0.03	1.21	0.49
3	22.9	0.74	0.83	0.52	1.29	0.51
4	26.6	0.72	0.8	0.52	1.41	0.52
5	29.4	0.69	0.92	0.52	1.55	0.53
6	32.0	0.67	0.92	0.53	1.62	0.54
7	34.0	0.65	0.93	0.53	1.67	0.54
8	35.6	0.63	0.93	0.53	1.71	0.54
	De Facto: Fix					
	WY	W I R	WY	W I R	WY	W I R
1	11.9	0.2	0.17	0.03	0.69	0.42
2	23.4	0.34	0.19	0.27	1.1	0.87
3	25.2	0.30	2.21	0.49	1.21	0.88
4	27.4	0.44	2.41	0.89	1.21	0.89
5	29.5	0.47	2.45	0.93	1.21	0.91
6	30.9	0.5	2.58	0.93	1.21	0.91
7	31.8	0.5	2.65	0.93	1.21	0.92
8	32.9	0.5	2.77	0.93	1.21	0.92

Table 3.8: Variance Decomposition. *Note: WY = ‘World’ GDP and W I R =World Interest Rate. Expressed in total percentage values.*

	Wald-Test	Real Output	
		Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	2.39		
All Coeff. $\chi^2_{(13)}$	6.02		
Impact		-0.331 (0.024)	0.235 (0.025)
Medium-Run		-0.329 (1.165)	0.205 (1.669)
Long-Run		-0.329 (1.164)	0.208 (1.669)
Sample Size		724	
Estimation Period		1974-99	

Table 3.9: Accumulated Coefficients of Real GDP on the De Facto Estimation to a Positive Shock to the World Real Interest Rate. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Wald-Test	Net Exports	
		Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	8.58*		
All Coeff. $\chi^2_{(13)}$	14.82		
Impact		0.023 (0.055)	-0.856 (0.046)
Medium-Run		0.438 (0.297)	1.145 (0.768)
Long-Run		0.453 (0.30)	2.442 (0.761)
Sample Size		724	
Estimation Period		1974-99	

Table 3.10: Accumulated Coefficients of Net Exports on the De Facto Estimation to a Positive Shock to the World Real Interest Rate. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Real Exchange Rate	
	Wald-Test	FloatFixed
All WIR Coeff. $\chi^2_{(4)}$	12.08***	
All Coeff. $\chi^2_{(13)}$	47.59***	
Impact	-0.565 (0.017)	-1.029 (0.068)
Medium-Run	0.483 (0.541)	-1.522 (1.304)
Long-Run	0.716 (0.543)	-1.508 (1.299)
Sample Size	724	
Estimation Period	1974-99	

Table 3.11: Accumulated Coefficients of Real Exchange Rate on the De Facto Estimation to a Positive Shock to the World Real Interest Rate. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Variables	Reinhart and Rogoff: De Facto							
	Impact	3	Float 8	Accum. Long-run Multiplier	Impact	3	Fix 8	Accum. Long-run Multiplier
Trade Openness: 457 observations								
Real GDP	-0.315 (0.027)	-0.032 (0.174)	0.00 (0.173)	-0.61 (1.187)	0.09 (0.026)	-0.002 (0.202)	0.00 (0.205)	-0.594 (4.671)
All Coeff. $\chi^2_{(13)}$		8.80		All WIR Coeff. $\chi^2_{(4)}$		2.19		
Net Exports	0.005 (0.064)	0.079 (0.053)	0.001 (0.052)	0.798 (0.914)	-0.493 (0.211)	0.774 (0.076)	0.504 (0.074)	5.168 (0.937)
All Coeff. $\chi^2_{(13)}$		16.81		All WIR Coeff. $\chi^2_{(4)}$		8.38*		
RER	-0.394 (0.035)	0.049 (0.081)	0.0003 (0.082)	0.172 (1.473)	-1.418 (0.135)	-0.026 (0.157)	0.0001 (0.126)	-1.822 (3.449)
All Coeff. $\chi^2_{(13)}$		75.20***		All WIR Coeff. $\chi^2_{(4)}$		15.31***		

Table 3.12: Trade Openness: Dynamic Multipliers on the De Facto Estimation to a Positive Shock to the World Real Interest Rate. *Note: Standard errors in parentheses. Wald Test as described above. *** Significance at the 1 Percent, ** at the 5 percent, * at the 10 percent Level. The long-run reflects 8 years after the shock.*

	Wald-Test	Real Output	
		Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	7.78*		
All Coeff. $\chi^2_{(13)}$	36.11***		
Impact		-0.154 (0.012)	-0.499 (0.011)
Medium-Run		0.591 (0.373)	-0.166 (0.238)
Long-Run		0.655 (0.371)	-0.159 (0.236)
Sample Size		629	
Estimation Period		1974-99	

Table 3.13: Accumulated Coefficients of Real GDP on the De Jure Estimation to a Positive Shock to the World Real Interest Rate. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Wald-Test	Net Exports	
		Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	6.55		
All Coeff. $\chi^2_{(13)}$	29.49***		
Impact		0.158 (0.017)	-0.503 (0.046)
Medium-Run		0.724 (0.046)	-0.952 (0.132)
Long-Run		0.763 (0.041)	-0.902 (0.125)
Sample Size		629	
Estimation Period		1974-99	

Table 3.14: Accumulated Coefficients of Net Exports on the De Jure Estimation to a Positive Shock to the World Real Interest Rate. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Wald-Test	Real Exchange Rate	
		Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	31.03***		
All Coeff. $\chi^2_{(13)}$	62.11***		
Impact		-0.171 (0.0131)	0.093 (0.012)
Medium-Run		0.04 (0.126)	0.602 (0.153)
Long-Run		0.04 (0.124)	0.613 (0.154)
Sample Size		629	
Estimation Period		1974-99	

Table 3.15: Accumulated Coefficients of Real Exchange Rate on the De Jure Estimation to a Positive Shock to the World Real Interest Rate. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

	Wald-Test	Real Output	
		Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	9.19*		
All Coeff. $\chi^2_{(13)}$	13.06		
Impact		-0.463 (0.02)	-0.849 (0.02)
Medium-Run		-0.285 (0.809)	-0.945 (1.375)
Long-Run		-0.286 (0.804)	-0.944 (1.192)
Sample Size		724	
Estimation Period		1974-99	

Table 3.16: Accumulated Coefficients of Real GDP on the De Facto Estimation to a Negative Shock to World Output. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Net Exports		
	Wald-Test	Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	4.32		
All Coeff. $\chi^2_{(13)}$	12.94		
Impact		-0.078 (0.046)	0.313 (0.127)
Medium-Run		-0.274 (0.152)	0.178 (1.709)
Long-Run		-0.274 (0.207)	0.176 (0.707)
Sample Size	724		
Estimation Period	1974-99		

Table 3.17: Accumulated Coefficients of Net Exports on the De Facto Estimation to a Negative Shock to World Output. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Real Exchange Rate		
	Wald-Test	Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	4.26		
All Coeff. $\chi^2_{(13)}$	37.85***		
Impact		-0.077 (0.015)	-0.317 (0.065)
Medium-Run		-0.527 (0.375)	-0.529 (1.072)
Long-Run		-0.549 (0.374)	-0.551 (0.886)
Sample Size	724		
Estimation Period	1974-99		

Table 3.18: Accumulated Coefficients of Real Exchange Rate on the De Facto Estimation to a Negative Shock to World Output. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Variables	Reinhart and Rogoff: De Facto							
	Impact	3	Float 8	Accum. Long-run Multiplier	Impact	3	Fix 8	Accum. Long-run Multiplier
Financial Openness: 534 observations								
Real GDP	-0.467 (0.023)	0.009 (0.08)	0.00 (0.081)	-0.261 (0.74)	-0.823 (0.023)	-0.003 (0.09)	0.00 (0.088)	-0.974 (1.124)
All Coeff. $\chi^2_{(13)}$		16.15		All WIR Coeff. $\chi^2_{(4)}$			3.28	
Net Exports	-0.167 (0.048)	-0.011 (0.024)	0.00 (0.024)	-0.493 (0.157)	0.288 (0.132)	-0.008 (0.108)	0.00 (0.071)	0.127 (0.841)
All Coeff. $\chi^2_{(13)}$		65.28***		All WIR Coeff. $\chi^2_{(4)}$			22.37***	
RER	-0.318 (0.033)	-0.042 (0.037)	-0.0008 (0.038)	-0.827 (0.341)	-0.403 (0.062)	0.026 (0.074)	-0.0003 (0.066)	-0.577 (0.771)
All Coeff. $\chi^2_{(13)}$		47.32***		All WIR Coeff. $\chi^2_{(4)}$			2.78	

Table 3.19: Financial Openness: Dynamic Multipliers on the De Facto Estimation to a Negative Shock to World Output. *Note: Standard errors in parentheses. Wald Test as described above.*
*** Significance at the 1 Percent, ** at the 5 percent, * at the 10 percent Level. The long-run reflects 8 years after the shock.

	Real Output	
	Wald-Test	Float Fixed
All WIR Coeff. $\chi^2_{(4)}$	19.81***	
All Coeff. $\chi^2_{(13)}$	46.89***	
Impact		-0.301 (0.011)
Medium-Run		-0.153 (0.329)
Long-Run		-0.154 (0.324)
Sample Size	629	
Estimation Period	1974-99	

Table 3.20: Accumulated Coefficients of Real GDP on the De Jure Estimation to a Negative Shock to World Output. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Net Exports		
	Wald-Test	Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	16.21***		
All Coeff. $\chi^2_{(13)}$	36.49***		
Impact		-0.145 (0.015)	0.072 (0.043)
Medium-Run		-0.098 (0.033)	-0.685 (0.157)
Long-Run		-0.111 (0.356)	-0.744 (0.111)
Sample Size	629		
Estimation Period	1974-99		

Table 3.21: Accumulated Coefficients of Net Exports on the De Jure Estimation to a Negative Shock to World Output. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

Elasticities	Real Exchange Rate		
	Wald-Test	Float	Fixed
All WIR Coeff. $\chi^2_{(4)}$	35.45***		
All Coeff. $\chi^2_{(13)}$	46.89***		
Impact		-0.093 (0.0123)	-0.172 (0.0116)
Medium-Run		-0.995 (0.120)	-0.073 (0.139)
Long-Run		-1.17 (0.108)	-0.074 (0.134)
Sample Size	629		
Estimation Period	1974-99		

Table 3.22: Accumulated Coefficients of Real Exchange Rate on the De Jure Estimation to a Negative Shock to World Output. *Note: All countries. Standard errors in parentheses. Wald Test for the joint significance of the difference of the peg and float coefficients of the real output equation. (.) indicate the number of restrictions. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level. The medium-run reflects 3 years and the long-run 8 years after the shock.*

4 Chapter Four

Saving, Investment and the Net Foreign Asset Position

4.1 Introduction

In a world with capital mobility, a country is able to run current account deficits if consumption and investment cannot be funded domestically, since financial integration de-links national saving and domestic investment in an open economy. This insight motivated Feldstein and Horioka's (1980) seminal work in which the authors highlight the correlation between national savings and domestic investment.¹ This chapter takes another perspective and explores the importance of long-run changes in the level of domestic wealth and capital stock. Drawing on time series and cross section data, the chapter analyses the importance of a country's output per capita, public debt and population age structure in determining saving and investment flows. Thereby, it assesses how these factors affect the external asset position of a country via saving and investment.

The switch of the United States from a large net foreign creditor to a net foreign debtor as a result of a large and persistent current account deficit in the 1980s and 1990s is a good example of the importance of savings and investment in an open economy.² The change in the net foreign asset position was due to

¹Nevertheless, an alternative explanation for the strong correlation between domestic saving and investment is given by the intertemporal budget constraint. It imposes stationarity of the current account in the long-run (around a non-zero mean), which keeps savings and investment rates together. A high coefficient in this analysis is indicative of the intertemporal budget constraint being satisfied. However, this finding may also be consistent with high capital mobility.

²Countries with growing output might be able to run perpetual current account deficits by reducing their external liabilities relative to GDP. Nevertheless, should foreign investors

a sharp fall in the national saving rate relative to investment undertaken. The shortfall in saving was covered by foreign capital inflows, a necessary counterpart to the current account deficit. As the United States turned into a net foreign debtor other industrialised countries became net foreign creditors. The Federal Reserve Board (2002) finds that during the past six years, about 40 percent of the total increase in the United States' capital stock has been financed, on net, by savings from abroad. This illustrates the importance of analysing the link between saving, investment and the external asset position.

Lane and Milesi-Ferretti (2002a) establish that GDP per capita, public debt and demographic factors act as the principal determinants of net foreign assets in the long-run.³ In contrast to considering the impact of GDP per capita, public debt and demographic factors on the net foreign asset position on the whole, this chapter distinguishes between the effect of the three variables on saving and investment. Once the precise influence of GDP per capita, public debt and demographic factors has been clarified, further insights on their ability to influence net foreign assets via saving and investment are obtained. It will become evident in which ways GDP per capita, public debt and demographic factors impact upon saving and investment and, as a result, the net foreign asset position. The effect on the external position depends on the extent to which the saving rate restricts the domestic supply of capital. If the investment rate is not influenced by output per capita, public debt and the population age structure, become less willing to invest in a country, the debt would have to be repaid by running trade surpluses. In that case, maintaining domestic investment will necessitate an increase in national saving.

³The authors concentrate on the stocks of net foreign assets. The stock position is the relevant state variable at the macroeconomic level. Earlier literature on foreign assets and liabilities concentrated on flows rather than stock positions of countries. Flows arise to close the gap between the actual and desired stock position.

changes in savings will be directly reflected in the net foreign asset position. If capital is not perfectly mobile, the outcome is less pronounced; the effects of the three factors on the net foreign asset position vanish if capital is immobile. Nevertheless, if investment is independently affected by changes in the three factors, a more complex case arises. Domestic investment and saving rates may be more or less correlated. The effects on the country's net foreign asset position might be either reinforced or weakened even if capital is internationally mobile. Thus, the main focus of this chapter is to investigate the effects of GDP per capita, public debt and demographic factors on both the saving or investment rate in the long as well as in the short-run. As it becomes clear from the results obtained below different effects of public debt, GDP per capita and demography on saving and investment exist in industrialised and developing countries in the short and long-run. This important point justifies the use of the same set of variables when analysing the effect of GDP per capita, public debt and demographic factors on the net foreign asset position of countries via saving and investment.

The effects of the three variables on wealth, capital stock and, hence, the net foreign asset position might be contingent on other macroeconomic variables which influence the intertemporal saving decision, such as global fluctuations in world output, institutional changes in individual countries, capital account liberalisation, income inequality, relative prices of goods, real exchange rate movements and terms of trade. To overcome this problem the data will be adjusted for any time-invariant or country specific effects to control for any omitted variable bias.⁴

⁴However, note that panel estimation does not control for omitted variables that are highly volatile over time.

Other papers close to this work are Higgins (1998) and Taylor (1994). Higgins analyses demographic effects on national savings and investment. The author discusses the implications for the current account balance but does not take into account effects of public debt and domestic wealth. Taylor also incorporates demographic factors to investigate the saving-investment puzzle initiated by Feldstein and Horioka (1980). However, Taylor only concentrates on the correlation between saving and investment.

In the next section the theoretical background underlying this work will be discussed in more detail in order to outline the predictional impact of the saving and investment flows on a country's net foreign asset position. Section 4.3 depicts the empirical strategy and the data used for this study. Estimates of the effects of income per capita, debt and the population age structure on saving and investment are also presented in this section. Moreover, the role of GDP per capita, public debt and demographic factors in influencing the net foreign asset position via saving and investment is delineated in more detail. Section 4.4 concludes.

4.2 Theoretical Background

In a closed economy saving and investment are identical by definition. However, in an open economy they do not need to equalise. If capital is mobile, changes in the saving rate will be directly mirrored in the current account, CA , and the net foreign asset position, F .⁵ Hence, the gap between saving and investment is financed by borrowing or lending, and CA is the indicator of the saving-

⁵In the intertemporal model of the current account an optimising infinitely lived representative household determines the consumption path under perfect foresight. This formulation assumes saving to be endogenous in the economy. Hence, saving, investment and net foreign assets are clearly part of a unified theory with an intertemporal dimension.

investment balance of an economy. The net foreign asset position includes all forms of financial assets and is calculated as the sum of all foreign claims minus all foreign liabilities. Thus, countries with negative net foreign assets at time t , $F_t < 0$, are net debtors while $F_t > 0$ identifies the country as a net creditor at time t . In the balance of payments, the change in the net foreign asset position equals the current account and a term $\mathcal{E}_t$, which captures valuation effects and net errors and omissions, as discussed in more detail by Lane and Milesi-Ferretti (2002a). $\mathcal{E}_t$ includes changes in unrecorded debt assets held by country residents abroad as well as capital gains and losses on existing claims.⁶

The empirical strategy of the paper and the relationship between saving, investment and GDP per capita, public debt and demographic factors becomes clear by recognising that in a small open economy the net foreign asset position, F , at time t follows the difference between country i 's wealth, $W_{t,i}$, and its capital stock, $K_{t,i}$:

$$F_{t,i} = W_{t,i} - K_{t,i}. \quad (4.1)$$

Lane and Milesi-Ferretti (2002a) have shown that the net foreign asset position of country i can be explained by income per capita, YC , public debt, D_G , and the population age structure, Dem . Hence, the long-run or steady state effects of domestic wealth and capital stock on net foreign assets can also be approximated by the behaviour of GDP per capita, public debt and demographic factors. In the steady state a fixed fraction of an economy's wealth, W , will be consumed while the remaining fraction γ is used for saving,

⁶In general, the long-run or steady state net foreign asset position in a non-zero growth environment depends on output growth as well as the rates of return, which are not explicitly discussed above but captured by $\mathcal{E}_t$. Rates of return vary across countries, over time and between different categories of assets and liabilities.

$$W_{t,i} = \omega S_{t,i}, \text{ where } \omega = \frac{1}{\gamma}. \quad (4.2)$$

The capital stock, K , consists of all productive assets in the economy. A constant fraction, λ , of productive assets, K , in the economy is assumed to be used for the reproduction of new capital and, hence, will be reinvested in the steady state:

$$K_{t,i} = \kappa I_{t,i}, \text{ where } \kappa = \frac{1}{\lambda}. \quad (4.3)$$

The linear relation of domestic wealth and saving as well as domestic capital stock and investment in the long-run or steady state allows the approximation of net foreign assets by the difference in saving and investment. This is due to the fact that the relationship between saving and domestic wealth as well as investment and the domestic capital stock needs to be stable to ensure that economy i remains in the neighbourhood of its steady state. With the use of equation (4.2) and (4.3) it is possible to express the net foreign asset relationship in equation (4.1) as

$$F_{t,i} = \omega S_{t,i} - \kappa I_{t,i}. \quad (4.4)$$

Equation (4.4) shows that the net foreign asset position can also be approximated by saving and investment around the steady state. Thus, in the empirical part the capital stock and domestic wealth are captured by country i 's investment and saving rate. The question to what extent wealth (saving) and the capital stock (investment) are affected by income per capita, public debt and the population age structure arises. In general, the behaviour of wealth and the saving rate in relation to income per capita is ambiguous as it involves offsetting impacts from substitution and income effects in the closed economy. More developed countries tend to have higher capital stocks and, if productivity is

the same, lower marginal products of capital. This decreases the rate of return on domestic capital and tends to lower savings (substitution effect). As a result in the closed economy

$$\frac{dW}{dYC} < 0 \text{ as well as } \frac{dK}{dYC} < 0 \text{ would hold.} \quad (4.5)$$

However, in the open economy the negative saving effect might be offset if home investors have access to international capital markets. This allows them to seek new investment opportunities abroad with higher rates of return than at home. This would transform the home country into a holder of net foreign assets. The saving rate tends to rise as a closed economy grows richer, due to the diminishing gap between current and permanent income (income effect). Consumption tends to fall relative to income and the saving rate rises:

$$\frac{dW}{dYC} > 0. \quad (4.6)$$

In the open economy there could be a permanent change in the net foreign asset position even if the path of the high saving rate is temporary. Developing countries might operate under credit constraints. Such constraints are particularly binding for low-income countries with low growth performance. Thus, domestic saving and investment might be linked more tightly under such conditions. However, an increase in growth and, hence, production allows such countries to participate more strongly in international capital markets as well as in borrowing and lending. Consequently, the link between domestic saving and investment might be relaxed.

The demographic effects on a country's wealth and capital stock depend on the population age structure and can be summarised by the dependency rate theories of savings and theories of population-sensitive capital formation.

According to Lane and Milesi-Ferretti (2002a) as well as Higgins (1998) the demographic structure is of importance in explaining the evolution of net foreign asset positions between countries. Saving rates are negatively affected by a high dependency rate or an old population ratio, since dependents and elderly people are consuming more than they produce and depend on the provision of goods by productive members of the economy. The following should hold:

$$\frac{dW}{dDem}|_{Youth, Old} < 0. \quad (4.7)$$

The intuition follows from the life cycle theory of consumption, where higher income and saving in mid-life offset dissaving when young and old. This, on the other hand, implies that countries with a high ratio of a working-age population should experience positive saving effects:

$$\frac{dW}{dDem}|_{Young Adults, Middle Age} > 0. \quad (4.8)$$

Inequalities (4.7) and (4.8) exhibit opposite effects on the saving rate due to offsetting demographic mechanisms at work. The influence of the demographic structure in an economy on the domestic investment rate can be explained by scrutinising subcomponents of investment. Domestic investment will be negatively affected by a reduction in growth of the working-age population if capital and labour are complements in production. This will especially hold for business investment, $I^{Bus.}$. The following pattern will arise:

$$\frac{dK}{dDem}|_{I^{Bus.}}|_{Youth, Old} < 0 \text{ and } \frac{dK}{dDem}|_{I^{Bus.}}|_{Young Adults, Middle Age} > 0. \quad (4.9)$$

Inequality (4.9) implies a positive effect of the working age population on business investment, which follows from the favourable impact of an efficient and

experienced workforce on capital accumulation in production. The opposite is true for the young and old population. However, a high dependency and old population ratio implies a heavy demand for social infrastructure. Public investment rates, I^{Public} , are assumed to be positively affected:

$$\frac{dK}{dDem} \Big|_{I^{Public}}^{Youth, Old} > 0. \quad (4.10)$$

Residential investment demand, $I^{Housing}$, provides another investment channel. A positive effect is expected when young people form new households or the middle age group extend their housing investment. This effect, however, will be offset when the oldest make housing slots available. The effect of the dependent population might be either neutral or positive if households with children seek new houses. The following should hold:

$$\frac{dK}{dDem} \Big|_{I^{Housing}}^{Young, Middle Age} > 0 \text{ and } \frac{dK}{dDem} \Big|_{I^{Housing}}^{Old} < 0. \quad (4.11)$$

From the discussion it becomes clear that the impact of demographic factors on the saving and investment rate clearly depends on the distribution of population age in the economy. Thus, the empirical investigation helps to shed further light on the actual relationship between saving, investment and demography.

The last variable to be considered in the analysis is the stock of public debt. The effects on the saving rate depend on whether the Ricardian equivalence holds. Higher levels of public debt are associated with higher domestic saving rates by households, S^H , when the Ricardian equivalence theorem holds:

$$\frac{dW}{dD_G} \Big|_{S^H}^{Ricardian} > 0 \text{ and } \frac{dW}{dD_G} \Big|_{S}^{Ricardian} = 0. \quad (4.12)$$

However, as the second term of (4.12) implies, the Ricardian view also predicts

that a rise in public debt may have no effect on the overall saving rate of the economy, S , since private saving will rise by an equivalent amount in anticipation of future repayments of debt. A departure from the Ricardian equivalence implies that an increase in public debt is not fully offset by an increase in private saving. This is due to the positive impact on private wealth. The effect on the saving rate becomes more ambiguous. Given that households are myopic, an increase in public debt will raise consumption since households shift the burden from present to future generations. A decline in government saving will lead to a decline in national saving, S :

$$\frac{dW}{dD_G} \Big|_S \Big|_{Non-Ricardian} < 0. \quad (4.13)$$

This result would also hold if households form rational expectations about future liabilities but are liquidity constrained. This constraint would prevent households from acting on these expectations by adjusting their consumption-saving behaviour. Nevertheless, in an open economy the increase in public debt may increase the domestic interest rate and lead to an increase in foreign saving. High public debt may also result in households' transferring funds abroad instead of saving domestically due to the expected high future tax burden. This would increase the costs of capital formation at home. However, the effect of public debt on the domestic investment rate is generally ambiguous. A higher public debt may crowd out private capital formation by reducing the availability of credits to the private sector or by raising interest rates. Given this, the overall effect on the domestic investment rate might become negative:

$$\frac{dK}{dD_G} \Big|_I \Big|_{crowd-out} < 0. \quad (4.14)$$

When public debt is used for investment in infrastructure projects this may

complement private investment and the following holds:

$$\frac{dK}{dD_G} \Big|_{\text{complementary effect}} > 0. \quad (4.15)$$

Nevertheless, a high public debt burden could discourage foreign investment in the economy since the government may resort to restrictions on external payment obligations on investment income. The next section will empirically analyse the effects of GDP per capita, demographic factors and public debt on saving and investment in the economies of developing and industrialised countries.

4.3 Empirical Approach

The theoretical assumptions are empirically analysed in this section. It will present the statistical inference of a country's wealth and capital stock, approximated by its saving and investment rate. A country's net foreign asset position is approximated by the difference between the country's saving and investment rates (see equation (4.4)). To recall, GDP per capita, public debt and demography are able to influence the net foreign asset position of a country. In the context of this study it will be investigated in which ways the three variables determine the saving and investment rates of the economy and thereby affect net foreign assets. The chapter concentrates on the post 1980s period, which reflects an environment of higher capital mobility due to liberalised capital accounts. The sample consists of 31 developing countries and 22 industrialised countries (see Tables 4.1 and 4.2). Most of the industrialised countries hold net foreign assets while the developing countries in the sample mainly hold net foreign liabilities. Hence, the net foreign asset position affects the evolution of public debt differently in developed and less developed countries. Additionally, liquidity

constraints and other sources of violation from Ricardian equivalence in developing countries may induce differences in the relation of saving, investment and public debt in the two groups. As explained above by inequalities (4.5) and (4.6) income per capita has different effects on the saving and investment behaviour, depending on whether a country is richer or poorer. There are clearly different demographic structures present in the industrialised and developing countries under consideration. It follows that for example differences in life expectancy and retirement patterns in industrialised and developing countries affect saving and investment in a different manner. Thus, to control for a potentially different relationship between debt, output per capita and demographic factors on saving and investment in industrial and developing countries and to allow for differences in the data quality this chapter splits the sample into long-standing members of the OECD and less developed countries.⁷

4.3.1 Data

To estimate the relationship between the variables the following data are used. The investment rate is estimated as the gross rate of capital formation over GDP and is derived from the World Development Indicators (WDI) (2002). The saving rate follows as the residual from the current account identity, calculated by the current account balance plus the investment rate of country i .⁸

⁷For a similar argument see Lane and Milesi-Ferretti (2002a). Alternatively, one might use a dummy variable to distinguish between the two groups of countries in a complete sample. However, in this chapter the sample split is utilised for the reasons outlined above. Additionally, the estimation technique chosen in section 4.3.3 makes a dummy variable approach more difficult.

⁸The reason why saving is constructed as a residual follows from the fact that comprehensive expenditure data do not exist. Hence, it is not possible to directly observe national saving or to calculate it as a difference between income and consumption measures. Note, however,

Data on the countries' current account balance are also obtained from the WDI. The wealth per person of a country is approximated by its GDP per capita in 1995 US dollars and measured in logs (WDI). The stock of public debt as a ratio of GDP is obtained from Lane and Milesi-Ferretti (2002a). To ensure a parsimonious model, the demographic variables are calculated by a method of cubic polynomials, suggested by Fair and Dominguez (1991) and applied by Higgins (1998) as well as Lane and Milesi-Ferretti (2002a).⁹ This technique allows to incorporate the demographic information into the statistical analysis and has the advantage of capturing the entire age distribution. The polynomial approach represents twelve population age cohorts: 0-14, 15-19, 20-24, ..., 65+. Note that the estimated coefficients have no structural interpretation; nevertheless, the implicit age distribution coefficient α_j can be easily recovered from the estimated polynomials. The source of the demographic variables is Lane and Milesi-Ferretti (2002a), who utilise the United Nation's (2000) Demographic Year Book, 1948-1997, and data by Herbertson and Zoega (1999).

4.3.2 Nonstationarity and Cointegration

As a precursor to the regression analysis the data series described above are tested for unit roots and cointegration.¹⁰ To test the null hypothesis that the data generating process in question is stationary the paper applies Hadri's (2000) approach.¹¹ Table 4.3 and 4.4 report results for the industrial and developing that any bias in the current account or investment measurement will be passed on to savings.

⁹For a precise explanation of this approach the reader is referred to appendix C.

¹⁰The tests discussed are performed using the NPT 1.2 package by Chiang and Kao (2001).

¹¹Hadri (2000) proposes a residual based Lagrange Multiplier (LM) test for the null hypothesis that the time series for each i is stationary against the alternative of a unit root in panel data. Consider the following model: $y_{i,t} = r_{i,t} + z'_{i,t}\gamma_i + \varepsilon_{i,t}$. $z_{i,t}$ is the deterministic component, $r_{i,t} = r_{i,t-1} + u_{i,t}$ the random walk and $\varepsilon_{i,t}$ a stationary process. The equation can be rewritten as $y_{i,t} = z'_{i,t}\gamma_i + e_{i,t}$, where $e_{i,t} = \sum_{j=1}^t u_{i,j} + \varepsilon_{i,t}$. If $\hat{e}_{i,t}$ are the residuals

country sample.¹² The test clearly rejects the null of stationarity in both samples.¹³ Given that the time series properties of the data are not stationary, one has to consider the long-run relationships between the different time series to see whether there are cointegration relations between the variables of interest. The null hypothesis that the residuals are nonstationary, hence, that the data are not cointegrated, is used. Pedroni's (1999) and Kao's (1999) multivariate cointegration tests are applied.¹⁴¹⁵ The test statistics are presented in Table 4.5

for the two country sets. As it is clear from Table 4.5 there exists a cointegration

from the estimated regression, the error variance can be defined as $\hat{\sigma}_e^2 = \frac{1}{NT} \sum_{i=1}^N \sum_{t=1}^T \hat{e}_{i,t}^2$.

By denoting $s_{i,t} = \sum_{j=1}^T \hat{e}_{i,j}$ as the partial sum process of residuals, the LM statistic can be defined as $\frac{\frac{1}{N} \sum_{i=1}^N \frac{1}{T^2} \sum_{t=1}^T s_{i,t}^2}{\hat{\sigma}_e^2}$.

¹²The test is applied for fixed and time effects. Using only fixed effects returns similar results.

¹³The chapter also tested the alternative null hypothesis that the series is nonstationary using Levin and Lin (1992). The test accepts the null of nonstationarity. For a discription of the test statistic please refer to chapter 3.

¹⁴Pedroni (1999) proposes tests for the null hypothesis of no cointegration. Therefore, he suggests to estimate the residuals from the hypothesized cointegration regression, which takes the most general form: $y_{i,t} = \alpha_i + \delta_i t + x'_{i,t} \beta_i + e_{i,t}$. Next, he estimates the first differenced equation $\Delta y_{i,t} = \Delta x'_{i,t} \beta_i + \eta_{i,t}$ and calculates the long-run variance, L_i^2 , of $\hat{\eta}_{i,t}$ using any kernel estimator such as the Newey-West (1987) estimator. Using the residuals of the original cointegration equation, $\hat{e}_{i,t}$, one has to estimate $\hat{e}_{i,t} = \rho_i \hat{e}_{i,t-1} + u_{i,t}$ and collect the residuals of $\hat{u}_{i,t}$ to compute the long-run variance $\hat{\sigma}_i^2$. The term $\hat{\lambda}_i = (\hat{\sigma}_i^2 - \hat{s}_i^2)$ can be computed by using the simple variance of $\hat{u}_{i,t}$. The null for no cointegration can then be written as $H_0 : \rho_i = 1$.

Pedroni's t_ρ cointegration statistic can be calculated as $\frac{\sum_{i=1}^N \sum_{t=1}^T L_i^{-2} (\hat{e}_{i,t-1} - \Delta \hat{e}_{i,t} - \hat{\lambda}_i)}{(\hat{\sigma}_{N,T}^2 \sum_{i=1}^N \sum_{t=1}^T L_i^{-2} \hat{e}_{i,t-1}^2)^{\frac{1}{2}}}$.

¹⁵Kao (1999) presents a Dicky-Fuller (DF) type test, which can be calculated from the estimated residuals of equation $y_{i,t} = x'_{i,t} \beta_i + z'_{i,t} \gamma_i + e_{i,t}$ as $\hat{e}_{i,t} = \rho \hat{e}_{i,t-1} + v_{i,t}$. $\hat{e}_{i,t} = \tilde{y}_{i,t} - \tilde{x}'_{i,t} \beta_i$, with $\tilde{y}_{i,t} = x_{i,t} - \sum_{s=1}^T \left(z'_t \left(\sum_{t=1}^T z_t z'_t \right) z_s \right) y_{i,s}$ and $\tilde{x}_{i,t} = x_{i,t} - \sum_{s=1}^T \left(z'_t \left(\sum_{t=1}^T z_t z'_t \right) z_s \right) x_{i,s}$, with $z_t = (z_{1,t}, \dots, z_{N,t})'$. In order to test the null hypothesis of no cointegration the null can be written as $H_0 : \rho = 1$. The OLS estimate of ρ and the

t-statistic are given as: $\hat{\rho} = \frac{\sum_{i=1}^N \sum_{t=2}^T \hat{e}_{i,t} \hat{e}_{i,t-1}}{\sum_{i=1}^N \sum_{t=2}^T \hat{e}_{i,t}^2}$ and $t_\rho = \frac{(\hat{\rho}-1) \sqrt{\sum_{i=1}^N \sum_{t=2}^T \hat{e}_{i,t-1}^2}}{s_e}$, where $s_e = \sqrt{\frac{1}{NT} \sum_{i=1}^N \sum_{t=2}^T (\hat{e}_{i,t} - \rho \hat{e}_{i,t-1})^2}$.

relation between saving and the explanatory variables and between investment and these variables.

4.3.3 Estimation by Dynamic OLS

Having identified that the data series follow a common trend, Stock and Watson's (1993) procedure is utilised and the long-run relation between the variables is estimated by dynamic OLS (DOLS).¹⁶ DOLS allows the estimation of the long-run relationship of the variables even if the regressors are not strictly exogenous. The regressors of interest might be endogenous since movements in saving or investment, represented by shifts in the error term, affect the evolution of income per capita, debt and perhaps demography.¹⁷ The application of DOLS ensures that the variables in levels for the estimation of the β parameters in equation (4.16) are strictly exogenous. This exogeneity is obtained by including past and future changes of income per capita, debt and demography. The number of leads and lags is chosen to be of order 1 (-1,1).¹⁸ Saving and

¹⁶Kao and Chiang (1999) find that DOLS outperforms the fully modified OLS as well as the OLS estimators in finite samples. Hayashi (2000, p. 658) points out that the DOLS estimator is asymptotically equivalent to other efficient estimators such as the nonlinear least square estimator by Philips and Loretan (1991).

¹⁷To see this more clearly consider the cointegrating regression $y_{i,t} = \alpha_i + x'_{i,t}\beta_i + e_{i,t}$. The $x_{i,t}$ evolve by the following equation: $x_{i,t} = x_{i,t-1} + \varepsilon_{i,t}$. The error term and the I(1) regressor $x_{i,t}$ in the cointegrating regression can be correlated because

$$\begin{aligned} Cov(x_{i,t}, e_{i,t}) &= Cov(x_{i,0} + \Delta x_{i,1} + \dots + \Delta x_{i,t}, e_{i,t}) \\ &= Cov(\Delta x_{i,1} + \dots + \Delta x_{i,t}, e_{i,t}), \text{ since } Cov(x_{i,0}, e_{i,t}) = 0 \\ &= Cov(\Delta \varepsilon_{i,1} + \dots + \Delta \varepsilon_{i,t}, e_{i,t}), \text{ since } \Delta x_{i,t} = \varepsilon_{i,t} \\ &= Cov(\varepsilon_{i,t}, e_{i,t}), \text{ since } \varepsilon_{i,t}, e_{i,t} \text{ i.i.d.} \end{aligned}$$

Note that $Cov(\varepsilon_{i,t}, e_{i,t}) \neq 0$. Thus, shifts in saving or investment can affect the regressors of interest.

¹⁸A model estimated by (-2,2) gives similar results to the one reported below.

investment are estimated in two separate equations of the following form:

$$y_{t,i} = \mu + \beta' \mathbf{X}_{t,i} + \gamma'_1 \Delta \mathbf{X}_{t,i} + \gamma'_2 \Delta \mathbf{X}_{t+1,i} + \gamma'_3 \Delta \mathbf{X}_{t-1,i} + v_{t,i}. \quad (4.16)$$

$y_{t,i}$ is country i 's ratio of either saving or investment to GDP in year t . $\mathbf{X}_{t,i}$ is a vector containing the explanatory variables, namely debt, GDP per capita, and the three demographic polynomials. The β s are the parameters in the DOLS equation which estimate the long-run relationship between saving or investment and debt, GDP per capita as well as the demographic age factors. All variables are corrected for fixed and time effects to take into account unobserved country specific effects and common global movements. The fixed effects also have the advantage of controlling for unobserved variables that could lead to long-standing differences in saving and investment rates between countries.¹⁹ However, the DOLS method does not always produce residuals free from autocorrelation. Shifts in saving and investment impact at least upon output per capita and debt. The estimation of equation (4.16) eliminates the correlation of $\mathbf{X}_{t,i}$ with $v_{t,i}$. However, it does not remove the serial correlation in $v_{t,i}$, which is due to the relationship of saving and investment with income per capita, debt and demography. This affects the asymptotic distribution and makes the statistical inference more complicated (Hayashi, 2000, pp. 650).²⁰ To ensure a correct statistical inference the long-run variance of the error term $v_{t,i}$ has been esti-

¹⁹The fixed effects are calculated by the deviation from county i 's individual mean while the time effects follow as the deviation of country i from period t 's mean.

²⁰To clarify this point reconsider the cointegrating regression $y_{i,t} = \alpha_i + x'_{i,t} \beta_i + e_{i,t}$. Again, the $x_{i,t}$ evolve by the following equation: $x_{i,t} = x_{i,t-1} + \varepsilon_{i,t}$.

Since movements of saving or investment, represented by shifts in $e_{i,t}$, affect the regressors of interest it follows that $Cov(\varepsilon_{i,t}, e_{i,t}) \neq 0$. The derivation of the asymptotic distribution is not the same as when $\varepsilon_{i,t}$ and $e_{i,t}$ are serially uncorrelated, because the error term $v_{t,i}$ of equation (4.16) can be serially correlated even when $\mathbf{X}_{t,i}$ are exogenous. However, the

mated by a first order autoregressive process.²¹ The estimated long-run variance allows to rescale the standard errors from equation (4.16) to obtain a consistent statistical inference.²² Note that the estimation also takes account of possible heteroskedasticity by applying White's (1980) consistent estimates. One might think that a joint estimation by GLS or seemingly unrelated regression (SUR) might be applicable. However, all explanatory variables are the same for the saving and investment equation. In this case estimation by GLS (SUR) reproduces identical point estimates (see Zellner, 1962). Nevertheless, the estimated standard errors might be smaller. Thus, in Tables 4.6 and 4.8 the statistical inference is reported for both the DOLS and 'dynamic' SUR estimations.

Industrial Countries: Table 4.6 details the industrial countries' estimates of the saving and investment relationship. The estimated cointegrated saving equation is able to explain 32 percent of the variation in the saving rate, given a country's GDP per capita, debt and demographic factors.²³ However, the individual null hypothesis that the β parameters associated with the explanatory accommodation of the variance of $v_{t,i}$ by its long-run variance ensures that the t -values based on the rescaled standard errors are asymptotically normal (Hayashi, 2000, p.656).

²¹The autoregressive process of the error term is assumed to be of order one. However, to ensure a correct specification, the long-run variance has also been estimated by a second order autoregressive process. The statistical inference does not change significantly. Note that the order of autoregression is also arbitrarily chosen in Stock and Watson's (1993) paper.

²²The rescaled standard errors are calculated as follows: Firstly, fit an AR(1) process to the estimated residuals, $v_{t,i}$, from the DOLS regression of the form $\hat{v}_{t,i} = \eta \hat{v}_{t-1,i} + e_{t,i}$. Secondly, from the square sum of $\hat{e}_{t,i}$ the long-run variance can be estimated by $\lambda_v^2 = \frac{\hat{\sigma}_e^2}{1-\eta}$. Thirdly, the rescaled standard errors follow by multiplying the standard errors of equation (4.16) by $\frac{\sqrt{\lambda_v^2}}{s}$, where s is the standard error of the DOLS regression. The Wald statistic has to be multiplied by the square of $\left(\frac{s}{\lambda_v}\right)$ (Hayashi, 2000, pp. 656)

²³The estimation of the coefficient of correlation instead of the R^2 term gives similar results. Therefore, the chapter only reports on the R^2 . The R^2 term includes all leads and lags.

variables are equal to zero cannot be rejected. Equally, a Wald test of the null hypothesis that the β parameters are jointly equal to zero cannot be rejected.

The estimation of the investment equation shows a strong positive relationship between output per capita and the investment rate. An increase in a country's GDP per capita by 20 percent means that the country's investment rate in relation to GDP increases by around 2.5 percentage points. This result represents supporting evidence for the correlation between income per capita and the investment rate as a driving force in promoting a country's capital stock in the long-run. Overall, a Wald test of the joint null hypothesis that the β parameters of GDP per capita, public debt and demographic factors are equal to zero can be rejected at the 5 percent level. The estimated parameter of public debt is statistically significant under the dynamic SUR estimation. A one percentage point increase in public debt reduces the investment rate of industrialised countries by 0.02 percentage points. The age distribution coefficients, α_j , illustrate that the maximal impact is found for the age group $j=0-14$ years. This might reflect a high demand for social infrastructure by the young people in the economy. A one percentage point increase in the share of the youngest in the economy is associated with a 0.23 percentage point increase in the investment rate. By contrast, a one percentage point rise in the age cohort 50-54 implies a fall in the investment rate by 0.2 percentage points. For a complete picture of the effects of the age distribution on the saving and investment rate the reader is referred to Figures 4.1 and 4.3.

In the next step, Figures 4.9 to 4.16 and 4.17 to 4.24 examine how well the panel specification, which assumes equality of the slope coefficients within industrial countries, matches the investment and saving dynamics at the indi-

vidual country level.²⁴ The first set of graphs (4.9 to 4.16) suggests that the regression specification matches the time series behaviour of the investment rate well for Japan, Germany, Ireland, France and Canada but does not do as well for New Zealand and Australia or the United States. For the latter country the strong growth performance and, hence, improvement in GDP per capita might explain the diverging pattern of the actual and fitted values in Figure 4.15. The analysis of the saving rate, Figures 4.17 to 4.24, demonstrates that only the fitted values for Japan and Ireland are able to fit the actual data. For the other countries the fitted values do not explain the actual time series data well.

Since the net foreign asset position is positively affected by a rise in saving and negatively affected by an increase in investment (see equation (4.4)), it is possible to make predictions about whether saving or investment initiate changes in a country's external wealth. From Table 4.6 it becomes clear that an increase in public debt by 20 percentage points leads to a decline in savings by 0.32 percentage points and a reduction in the capital formation by 0.48 percentage points. The example shows that the investment rate declines more strongly than the saving rate. Leaving other factors unchanged, overall the net foreign asset position would not deteriorate strongly. This result is in line with Lane and Milesi-Ferretti (2002a) who find that an increase in debt is domestically absorbed to a large extent. By contrast, an increase in income per capita has a three times stronger impact on investment than saving for industrial countries. With respect to income, the investment channel seems to be the driving force in determining the external wealth of rich countries. This result, however, is not consistent with the findings by Lane and Milesi-Ferretti (2002a). They find a

²⁴Only selected countries are reported. However, graphs for all other countries are available on request. The graphs were constructed by using the β coefficients from the DOLS estimation. Using the coefficients from the panel OLS regressions provide similar results.

strong positive correlation between income per capita and the net foreign asset position. It must be pointed out that this study establishes positive effects of GDP per capita on both saving and investment. The investment rate is the only variable to be influenced statistically significantly by GDP per capita. Moreover, equation (4.4) suggests that the investment rate influences net foreign assets negatively. Consequently, in this context the impact of GDP per capita on the investment rate translates into a negative influence on the net foreign asset position. Putting it differently, decomposing the effect of GDP per capita on the net foreign asset position via saving and investment illustrates that the long-run net foreign asset position is mostly affected via the investment behaviour of industrialised countries. The contradicting findings to Lane and Milesi-Ferretti (2002a) may result from the different channel, through which this study explores the net foreign asset position; namely the impact of GDP per capita, public debt and demography on net foreign asset position via savings and investment.

Lane and Milesi-Ferretti (2002a) also establish Australia as an important outlier in their industrial country sample for 1980-1998. In order to analyse whether Australia also has an exceptional position with reference to saving and investment, Table 4.6 reports the statistical results without Australia. The exclusion has minor effects on the overall explanatory power of the saving and investment regression when considering the DOLS estimation. However, the negative point estimate of public debt increases. Indeed, Lane and Milesi-Ferretti (2002a) point out that Australia weakens the conditional correlation between the net foreign asset position and debt to GDP. Under dynamic SUR the estimated parameter of public debt has a negative and statistically significant impact on the saving and investment rates. All estimated parameters of the variables in levels of the saving rate are jointly statistically significant when

Australia is excluded and one considers the dynamic SUR estimation.

Developing Countries: Table 4.7 reports results on the evolution of net foreign assets since the developing country sample in this chapter is not the same as in Lane and Milesi-Ferretti's (2002a) work. The authors estimate an unbalanced panel for the period 1980 to 1998 and therefore analyse a different sample size compared to this study. The chapter focuses on the DOLS (-1,1) panel estimation with fixed time and country effects. The net foreign asset position of developing countries relative to their GDP is measured by cumulated current account balances (*CumCA*) and as a robustness check by the sum of stocks of external assets and liabilities (*CumFL*). The latter is calculated by adjusted cumulative capital flows.²⁵ The estimated net foreign asset equation is able to explain 43 (54) percent of the cross-country variation given the *CumCA* (*CumFL*) measurement. As established by Lane and Milesi-Ferretti (2002a) public debt is a very important explanatory variable. Overall, a Wald test of the joint null hypothesis that the β parameters of GDP per capita, public debt and demographic factors are equal to zero has to be rejected at the 1 percent level. However, no individual statistical significance is established for the parameters of GDP per capita and demography. This even holds when Singapore is excluded from the sample. Yet, the exclusion of Singapore improves the explanatory power of the *CumFL* regression and it is able to explain 58 percent of the variation in the data. The differences in the results compared with Lane and Milesi-Ferretti (2002a) are due to the estimation of a balanced panel for the period 1980-1998, which induces a different sample size, as mentioned above, and a different number of included countries.

²⁵For a more detailed explanation see Lane and Milesi-Ferretti (2001). All data are obtained from Lane and Milesi-Ferretti (2002a).

Table 4.8 reports the panel estimation for the developing country sample of the saving and investment analysis. Looking at the estimated saving equation, 24 percent of the cross-country variation are explained by public debt, output per capita and demography. The joint null hypothesis that the β parameters of GDP per capita, public debt and demographic factors are equal to zero has to be rejected at the 1 percent level. The individual null hypothesis that the β parameter of public debt equals zero has to be rejected at the 10 percent level. A 50 percentage point increase in domestic public debt decreases the total saving rate in developing countries by 1.5 percentage points. The result implies a deviation from the Ricardian equivalence. The negative impact on the saving rate might be due to liquidity constraints on household and corporate borrowing, which are clearly present in less developed countries. In contrast to the industrial country sample a statistically strong positive relationship between income per capita and the saving rate of developing countries is established. The point coefficient of 0.13 means that a 20 percent improvement in domestic GDP per capita raises the saving rate by 2.6 percentage points. This suggests that the saving-income relationship is dominated by the income effect in less developed countries in the long-run. Demographic factors are a very important explanatory factor in defining a country's saving rate. Table 4.8 shows that the joint null hypothesis that the β parameters of the three demographic polynomials equal zero has to be rejected at the 1 percent level. Figure 4.4 provides the distribution of the twelve age cohorts. The maximal impact is found in the age group 40-44. The implicit α_{40-44} coefficient means that a ten percentage point rise in the population share in this group increases the saving rate by nine percentage points. A very strong negative impact is found for the age group of over 65 (α_{65+}). A one percentage point decrease in the share of the over 65 improves

the saving rate by three percentage points. This finding stands in contrast to the industrial country sample (Table 4.6).

The investment equation is able to explain 18 percent of the variation in the data. A Wald test of the joint null hypothesis that the β parameters of GDP per capita, public debt and demographic factors are equal to zero has to be rejected at the 1 percent level. As for the industrial countries, GDP per capita has a strong explanatory power. A ten percent increase in income per capita raises the investment rate by 1.1 percentage points. The joint null hypothesis that the β parameters of the three demographic polynomials are equal to zero cannot be rejected. Nevertheless, Table 4.8 shows that the strongest positive impact is found for the age cohort 25-29. Similar to the saving equation a strong negative impact is found for the population share over 65. A ten percentage point increase in the share of the 65+ population decreases the investment rate by 14.7 percentage points. Comparing the results with the industrial country sample, it becomes obvious that older age groups (65+) have a much stronger negative impact on the investment rate than in more developed countries. Another interesting finding is that the investment rate increases within the entire young population in developing countries (Figure 4.2). There is no statistically significant evidence that public debt is able to crowd out new capital formation in the long-run.

Figures 4.25 to 4.32 and 4.33 to 4.40 compare the actual and fitted values of the investment and saving rate for individual developing countries over the time horizon 1980 to 1998. It is assumed that the slope coefficients within developing countries are the same. The investment dynamics at the individual country level are presented first. Figures 4.25, 4.27 and 4.30 to 4.32 show that the panel coefficients are able to match the time series pattern of South Korea, Morocco,

South Africa, Brazil and Mexico well but do not achieve the same for small open economies such as Malaysia, Jordan or Botswana. The regression model in Table 4.8 only predicts minor effects of public debt on the investment rate. However, the strong decline in debt in Malaysia seems to promote investment in the long-run in this country and, therefore, makes it difficult to match the actual data in this particular case. The actual and fitted values of the saving rate are illustrated in Figures 4.33 to 4.40. Remarkably, the overall fit of the saving dynamics for the developing countries is very good. This is especially true for South Korea, Malaysia, Morocco, Jordan and South Africa. The good match of the time series pattern for the individual countries is derived from statistical significance of public debt, income per capita and the demographic factors in the savings equation.

To answer the question whether saving or investment drives the external wealth of a country Table 4.8 must be considered. The demographic factors are more pronounced for saving than investment. In this respect, the net foreign asset position is mostly influenced by changes in the saving rate in developing countries. Saving and investment are positively affected by an increase in income per capita, suggesting that income per capita drives the external position of developing countries via both, saving and investment. The net foreign asset position is negatively affected by debt to GDP, which can be seen from the stronger decline in the saving rate relative to investment. This finding is supported by Lane and Milesi-Ferretti (2002a). Their empirical evidence shows that a high 'pass-through' from net government liabilities to net external liabilities in developing countries occurs. Table 4.7 also confirms this finding.

As discussed above, previous econometric studies point towards Singapore as an important outlier in the developing country sample. In general, an outlier

like Singapore is not necessarily negative. Variations in the data generate the basis for identifying relationships. However, if an outlier is non-representative due to factors which differentiate it from the rest of the sample, it should be excluded. Since Singapore has an extraordinary position as a financial centre, results excluding Singapore are reported in the second part of Table 4.8. Interestingly, the goodness of fit of the saving and investment equation clearly improves after the exclusion of Singapore from the sample. All estimated parameters of the variables in levels are jointly statistically significant in both regression specifications, while the point estimates remain stable after the exclusion of Singapore. However, when comparing the point estimates of GDP per capita it becomes apparent that an increase of output per capita by ten percent leads to a rise in savings by 1.26 percentage points and an increase in capital formation by 1.27 percentage points. The example shows that the impact on the investment and saving rates are more or less equal. However, leaving other factors unchanged, overall the net foreign asset position would deteriorate slightly. Lane and Milesi-Ferretti (2002a) also find a negative impact of GDP per capita on the net foreign asset position for the developing countries. As a country becomes relatively richer it increases its net external liabilities, as illuminated in Tables 4.7 and 4.8.

4.3.4 Estimation of an Error Correction Specification

The previous section focused on the long-run relation between saving and investment. This section analyses the short-run dynamics of the saving and investment rate by shifting the attention to their adjustment mechanisms. Due to the cointegrated relationships of saving or investment with public debt, income per capita as well as demography, the desired change of saving or investment,

$\Delta y_{t,i}$, can be estimated by an error correction model. This is represented by the following equation:²⁶

$$\Delta y_{t,i} = \mu + \rho' \Delta \mathbf{X}_{t,i} - \theta \epsilon_{t-1,i} + \phi \Delta y_{t-1,i} + u_{t,i}. \quad (4.17)$$

$\epsilon_{t-1,i}$ represents the error correction term of an estimated panel OLS regression, which takes into account fixed time and country specific effects. The $\mathbf{X}_{t,i}$ have the same interpretation as above. The feedback coefficient θ provides the key to the long-run relation by capturing the behaviour of the adjustment term $\epsilon_{t-1,i}$. A lower value of θ implies that country i is able to maintain a saving or investment rate in excess or below of its long-run value. Hence, a country is able to smooth the adjustment process of saving or investment. A high value of θ reflects a rise in the speed of adjustment towards its long-run value. The correlation of saving or investment with the three explanatory factors is given by the impact parameters ρ' . The ρ' capture the contemporaneous correlation in equation (4.17) in response to shocks which have hit the economy in the past. Higher ρ' coefficients imply a short-run importance of debt, GDP per capita and demography in explaining the dynamics of saving and investment. The specification of the regression also includes the lagged changes in either saving or investment. Tables 4.9 to 4.12 illustrate the results for the industrial country and developing country sample respectively.

At this point it is worthwhile to discuss the question of causality. To address this issue the chapter follows Enders (1995) and compares error correction models which either contain saving and GDP per capita, public debt as well as demography or investment and the variables of interest as dependent variables.

²⁶It is assumed that the slope coefficients are the same within the groups of developing and industrial countries.

The speed of adjustment is estimated by using the lagged error term from the panel regression with saving or investment as the dependent variable.²⁷ In general, all cointegrated variables will respond to a deviation from the long-run equilibrium. However, the smaller the response of one of the adjustment parameters to a shock to the system, the less it is affected by the movements of other variables in that system. It is also possible that some of the adjustment parameters are zero, which can be seen as weakly exogenous, as defined by Engle, Hendry and Richard (1983). In this case the other variables are responsible for all the adjustment. For the industrial countries it is found that either saving or investment together with GDP per capita adjust similarly to shocks to the system while for the other two sets of variables the error correction terms are not statistically significant. Thus, GDP per capita as well as saving and investment do not evolve independently. In the investment specification of the developing country sample investment responds to changes in the system. The other error correction terms are statistically insignificant. The analysis of the adjustment parameters under the saving specification illustrates that the saving rate as well as public debt and GDP per capita adjust alike to shocks to the system while the adjustment of demography remains statistically insignificant. Hence, saving responds to changes in public debt and GDP per capita and vice versa.

Industrial Countries: Hendry (2001) emphasises the importance of testing for misspecifications in the error correction model. He suggests to investigate the properties of the error term with respect to autocorrelation and normality. To test for autocorrelation in the errors this chapter applies a Lagrange Multiplier (LM) test for the null hypothesis of no autocorrelation in the errors from

²⁷Since cointegration between the variables exists, any residuals from an equilibrium relationship could have been used.

the estimated model. Baltagi (2001) suggests such an LM test. Under the null hypothesis the test statistic is asymptotically distributed as a chi-square with one degree of freedom.²⁸ For the saving equation the LM test equals 1.014 while the LM test of the investment equation is equal to 0.718. Thus, in both cases the null hypothesis of no autocorrelation cannot be rejected. Additionally, it is of interest to determine whether the residuals are non-normal. However, to the knowledge of the author such a test statistic for panel data is not available. Therefore, to give some intuition about the distribution of the residuals Figures 4.73 and 4.74 depict the distribution of the error terms in the saving and investment equations.²⁹ The errors seem to be well behaved and bell shaped.

Table 4.9 reports the estimated error correction model of industrial countries for the saving and investment rates. 32 percent of the short-run variations in the data are explained by the specification of savings. A Wald test of the joint null hypothesis that the ρ parameters of GDP per capita, public debt and demographic factors are equal to zero has to be rejected at the 1 percent level. Especially GDP per capita and public debt play an important role in explaining short-run deviations in the industrial countries' saving rate. Table 4.9 demonstrates that the change in debt to GDP is very important in explaining short-run deviations in saving. The statistically significant negative point

²⁸Baltagi (2001, pp. 81) provides such an LM test. The log-likelihood function is: $L(\rho, \theta, \sigma_v^2, \delta) = \text{constant} - \frac{1}{2} \log |\Omega| - \frac{1}{2\sigma_v^2} \sum_{i=1}^N [\mathbf{u}_i' V_\delta^{-1} \mathbf{u}_i]$, where $u_{t,i} = v_{t,i} + \delta v_{t-1,i}$, $\mathbf{u}_i = (u_{1,i}, u_{2,i}, \dots, u_{T,i})'$, $V_\delta = \frac{\Omega_\delta}{\sigma_v^2}$ and $\Omega = \mathbf{I}_N * \Omega_\delta$ is the variance-covariance matrix of $\mathbf{u}_i'$. ρ and θ are the 'regressors' of the error correction model outlined in equation (4.17). After some derivations Baltagi (2001) shows that the LM test for the $H_0 : \delta = 0$ can be written as $LM = [NT^2/(T-1)] (\mathbf{u}_i' \mathbf{u}_{-1,i} / \mathbf{u}_i' \mathbf{u}_i)^2$, which is asymptotically distributed as $\chi_{(1)}^2$ under the H_0 .

²⁹The distribution of the errors from the other equations discussed below takes on similar shapes and is therefore not illustrated.

estimate implies a departure from the Ricardian equivalence in more developed countries in the short-run. This contrasts with the finding on the long-run saving rate. The positive coefficient of GDP per capita implies that a two percent increase in the growth rate of income per capita is associated with a raise in the short-run saving rate in industrial countries by 0.5 percentage points. Demography plays a statistically important role in explaining short-run deviations in the saving rate of industrial countries. Figure 4.7 provides the distribution of the age cohorts in the short-run. A comparison between Figures 4.3 and 4.7 shows an almost inverse relationship between the age coefficients in the short and long-run. The analysis of the error correction coefficient θ illustrates that more developed countries adjust towards their long-run saving rate by a half-life of 1.5 years. Thus, there is not a high persistence in the deviations of their saving rate from the long-run trend.

The deviations of the investment rate from its long-run trend expose a half-life of around four years. The relative persistency is also confirmed by the lagged investment variable in the regression specification. Overall, the regression is able to explain 47 percent of the variations in the short-run investment rates. The joint null hypothesis that the ρ parameters of all variables (public debt, income per capita and demography) are equal to zero has to be rejected at the 1 percent level. Movements in the demographic distribution of industrial countries play a very important role in explaining short-run deviations of investment from equilibrium. A joint test that the three parameters of the demographic variables are equal to zero has to be rejected at the 1 percent level. Figure 4.5 illustrates the short-run changes in the different age cohorts. As before, the positive impact on the investment rate is the highest for the youngest people in the economy. In contrast to the long-run findings, the proportionate increase of the oldest peo-

ple in the economy influences new capital formation negatively in the short-run. Another important finding is that a positive change in public debt increases the short-term rate of investment. Thus, a short-run rise in public debt by 2.5 percentage points has positive implications for capital formation in industrial countries and raises the investment rate by one percentage point. This finding stands in contrast to the long-run investment rate depicted in Table 4.6. Investment is also positively correlated with income per capita. When the growth rate of income per capita changes by five percent the short-run investment rate increases by two percentage points. Thus, fast-growing industrial countries are able to promote their short-run capital formation relative to industrial countries which show a weaker growth performance.

The short-run changes in the net foreign asset position of industrial countries are clearly influenced by saving and investment via public debt, demography and income per capita. However, demographic changes seem to feed through the investment channel of long-standing OECD members. This is in stark contrast to the long-run findings illustrated in Table 4.6, where demographic factors seem to have no explanatory power. Short-run changes in public debt have negative effects on the net foreign asset position. The findings in Table 4.9 suggest a negative impact of short-run changes in output per capita on the net external position. The effect feeds through both, saving and investment of industrial countries.

Figures 4.41 to 4.56 present actual and fitted values of changes in the rate of saving and investment for selected industrial countries. The first set of graphs suggests that the regression specification matches the time series behaviour of the investment rate well for all selected countries. The same is true in Figures 4.49 to 4.56 for changes in the saving rate of industrial countries. However,

the actual and fitted values diverge more strongly for Australia and France compared with the other selected countries.

Following the analysis of the long-run relationship, the second part of Table 4.9 reports the empirical findings without Australia, which is an outlier in the industrial country sample. Again the LM test for the saving and investment equation equals 2.374 and 1.126 respectively. There is no evidence of autocorrelation in the errors. The exclusion of the small open economy weakens the demographic effects on savings but increases the negative point estimate of public debt in the savings regression. Excluding Australia increases the speed of adjustment of the investment rate towards its long-run value. Moreover, in the investment equation the positive effect of public debt on new capital formation is now reduced. However, the individual null hypothesis that the ρ parameter of public debt equals zero has to be rejected at the 5 percent level. In the last step of the industrial countries analysis Table 4.10 excludes the demographic factors from the short-run saving equation. The LM test equals 0.685 and 2.687 respectively with and without Australia. The null hypothesis of no autocorrelation cannot be rejected. Excluding the demographic factors from the short-run saving equation reduces the explanatory power. The error correction model explains only 30 percent of the variations in the data. However, the speed of adjustment remains relatively stable compared to the estimated model above. This finding is also valid when Australia is excluded from the sample. The point estimates of GDP per capita and debt to GDP remain statistically significant at the 1 percent level.

Developing Countries: Table 4.11 reports the results of the error correction model for the developing country sample. The LM test statistic for the saving

and investment equation for the developing country sample equals 1.917 and 2.19 respectively. Again, the null hypothesis of no autocorrelation cannot be rejected. Figures 4.75 and 4.76 illustrate the distribution of the error terms under the saving and investment equation for the developing countries. In both figures the errors are centered around their zero mean and are bell shaped.³⁰ The regression specification of the saving rate is able to explain 32 percent in the variation of the data in developing countries. Overall, a Wald test of the null hypothesis that the ρ parameters of GDP per capita, public debt and demographic factors are jointly equal to zero has to be rejected at the 1 percent level. The error correction coefficient θ shows a point estimate of around -0.6 and points towards a very quick adjustment process of the saving rate. After an initial deviation it would return to its long-run value within a half-life of 10 months. The short-run estimates of public debt and income per capita confirm the long-run findings depicted in Table 4.8. A rise in the growth rate of GDP per capita positively influences the saving behaviour. An increase in output growth per capita by two percent improves the domestic saving rate in developing countries by 0.27 percentage points. Public debt also exerts a statistically significant impact on saving in the short-run. A ten percentage point change in debt to GDP is associated with a decrease of the domestic saving rate in developing countries by around 0.6 percentage points. In contrast to the long-run findings, demographic factors seem to have no statistically important impact on the short-run behaviour of the saving rate. Nevertheless, Figure 4.8 exhibits a distribution of the age coefficients similar to the long-run (Figure 4.4).

In line with the long-run findings, the demographic variables play a minor

³⁰The distribution of the errors from the other developing country equations discussed below take on similar shapes and are therefore not illustrated.

role in the short-run investment equation. Figure 4.6 illustrates the age distribution coefficients in the short-run. A comparison with Figure 4.2 reveals that the different age cohorts impact on the investment rate in a similar way. Yet, a Wald test of the joint null hypothesis that the ρ parameters of GDP per capita, public debt and demographic factors are equal to zero has to be rejected at the 1 percent level. The investment equation is able to explain 32 percent in the variation of developing countries' capital formation rate. In contrast to the long-run specification a positive and statistically important impact of public debt on capital formation is established in Table 4.11. In the short-run, a positive change of debt to GDP by two percentage points improves new capital formation by 0.54 percentage points. This is an important finding and is in line with the findings for the industrial country sample. The results seem to support the view that an increase in public debt does not crowd out new capital formation in the economy.

The findings also have implications for the behaviour of the net foreign asset position in the short-run. Similar to the findings for industrial countries, the external wealth position of developing countries is clearly influenced by short-run changes in the investment and saving rate via public debt and income per capita. With respect to income per capita the main contributor to changes in the short-run net external wealth is the investment rate. This is in line with the results of the long-run analysis. However, in contrast to the long-run findings, public debt influences the net foreign asset position through both, saving and investment in developing countries.

Next, Figures 4.57 to 4.64 and 4.65 to 4.72 illustrate how well the panel specification of equation (4.17) matches the actual time series behaviour of changes in the investment and saving rates of developing countries. South Korea, Morocco,

Jordan and Mexico are able to match the actual movements of the investment rate quite well. The comparison between the actual and fitted values of changes in the saving rate points to the fact that the fitted values from the regression equation (4.17) are able to explain the time series pattern for most of the selected developing countries well but do not so well for Botswana and South Africa.

Similar to the DOLS estimation, Singapore is excluded from the developing country sample in Table 4.11. The LM test statistic equals 1.867 under the saving and 1.852 under the investment equation. Thus, in both cases there is no evidence of autocorrelation. The investment equation clearly improves after the exclusion and is now able to explain 33 percent of the short-run variations in the data. The same is true for the explanatory power of the saving equation. The point estimates are stable in both regressions and a Wald test of the joint null hypothesis that the ρ parameters of GDP per capita, public debt and demographic factors are equal to zero has to be rejected at the 1 percent level. It can be noted that the positive point estimate of public debt gains statistical significance.

The demographic factors are less important and the individual null hypothesis that the ϕ parameter of the lagged dependent variable of the saving equation equals zero cannot be rejected. Therefore, Table 4.12 estimates the error correction model without those variables. Under this form the LM test statistic of the saving equation equals 0.671. The LM test of the investment equation equals 2.116. Again, the null hypothesis of no autocorrelation has to be accepted. Looking at the saving and investment equation without Singapore, the LM test statistic returns values of 0.849 and 1.177. No autocorrelation is present. The exclusion of lagged savings and demography weakens the statistical significance

of the debt to GDP coefficient in the investment equation. However, the individual null hypothesis that the estimated coefficient equals zero has to be rejected at the 10 percent level when estimated with and without Singapore. The exclusion of the demographic factors increases the relative persistency in the investment equation relative to the results obtained from Table 4.11. This is illustrated by the decline in the point estimate of the error correction term. In the saving equation the exclusion of the demographic factors and the lagged dependent variable increases the statistical importance of debt to GDP term while the impact of output per capita is weakened.

4.4 Conclusion

The aim of this chapter is to investigate the short and long-run impact of public debt, income per capita as well as demographic factors on national wealth, domestic capital formation and, hence, the net foreign asset position of countries. Several conclusions emerge. Public debt, income per capita and demographic factors have a persistent influence on the long-run saving rate in developing countries.

Income per capita has positive effects on saving and investment in the short and long-run in developing countries while it only affects industrial countries' investment rate in the long-run. Developing countries' saving rate in the long-run clearly depends on the demographic distribution in those countries. The level of government debt is also an important determinant of national savings in less developed countries. The long-run elasticity is larger than for industrial countries, which is in line with the view that departures from Ricardian equivalence are likely to be larger for developing countries which are subject to financial constraints. The level of government debt affects the investment

rates in industrial countries negatively. The short-run findings point towards a significant influence of public debt on the direction of savings and investment in industrial countries. Interestingly, in both samples public debt has a complementary effect on domestic capital formation and negatively affects the saving behaviour of domestic households. In contrast to the long-run findings demographic factors have an important role in determining industrial countries' investment rates. This is also the case for the domestic saving rate. While the rate of capital formation generally decreases in the share of elderly people in developing countries, this effect is less pronounced for the industrial country sample. GDP per capita also has a positive short-run effect on national savings and investment in developing and industrial countries.

The regression analysis clearly demonstrates the importance of public debt, output per capita and demographic variables in determining saving and investment in industrial and developing countries. In the long-run, the three variables influence the net foreign asset position of developed countries via investment while developing countries' net foreign assets are influenced through savings. However, in the short-run both, saving and investment rates, appear to be affected by output per capita, public debt and demographic factors. Hence, the three factors are able to influence the net foreign asset position in industrial and developing countries via both saving and investment rates.

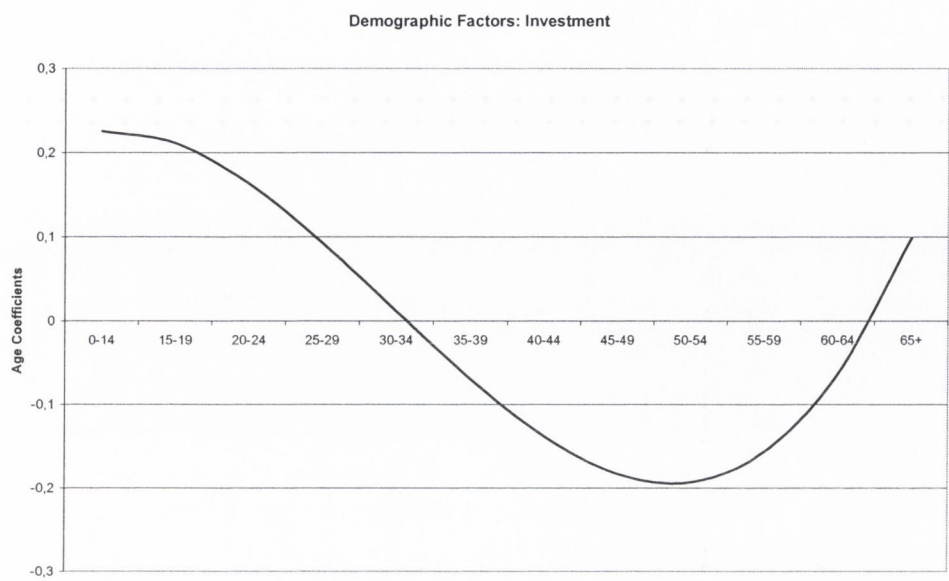


Figure 4.1: Age Distribution Coefficients of the Industrial Country Sample in the Long-Run: Investment.

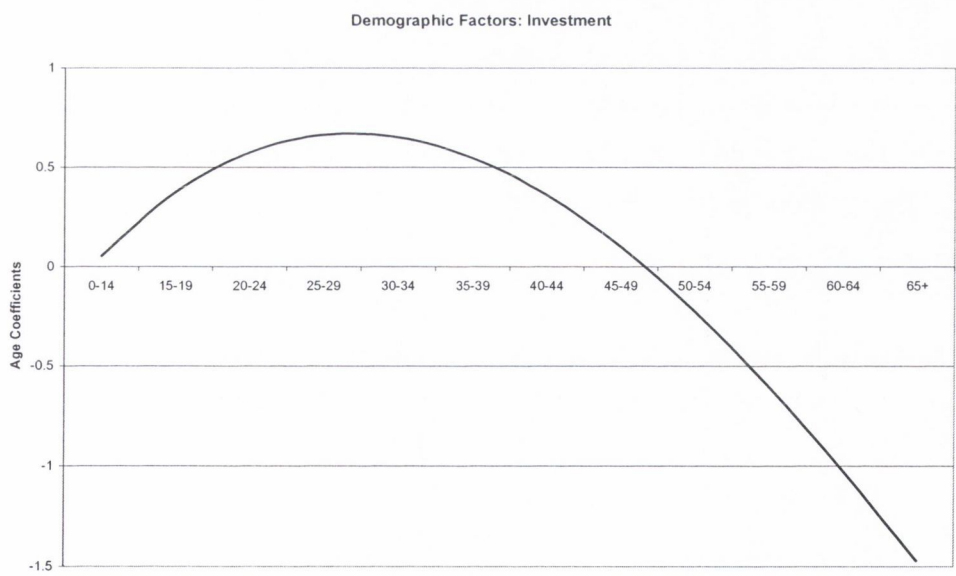


Figure 4.2: Age Distribution Coefficients of the Developing Country Sample in the Long-Run: Investment.

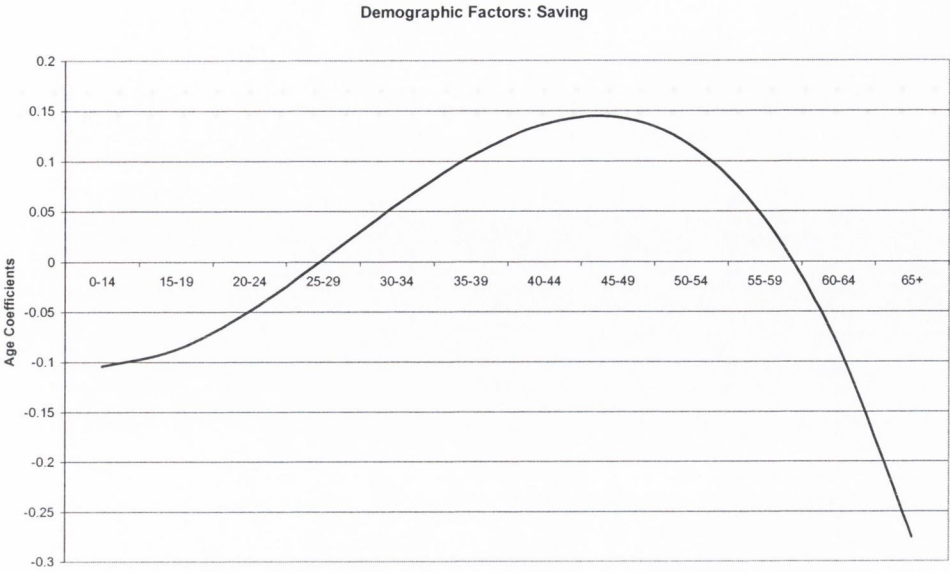


Figure 4.3: Age Distribution Coefficients of the Industrial Country Sample in the Long-Run: Saving.

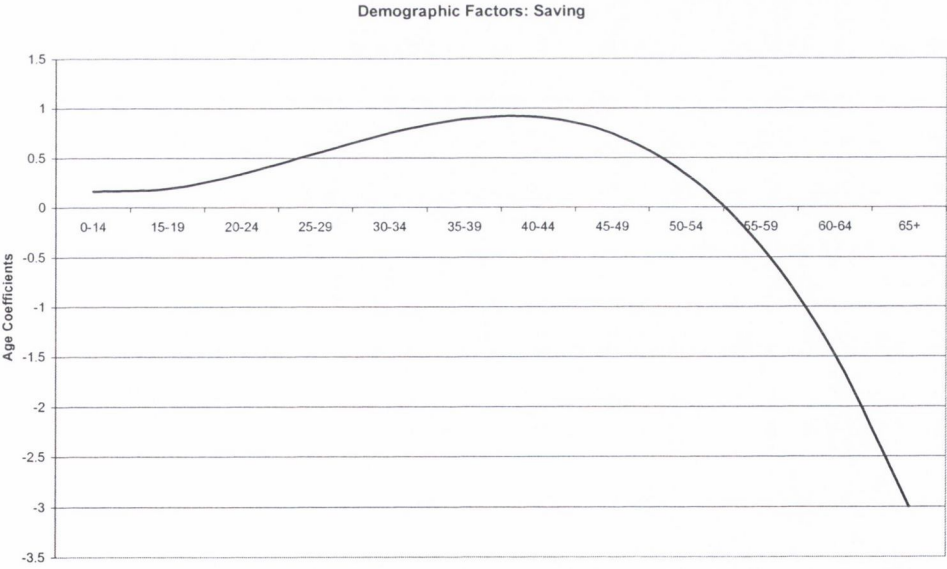


Figure 4.4: Age Distribution Coefficients of the Developing Country Sample in the Long-Run: Saving.

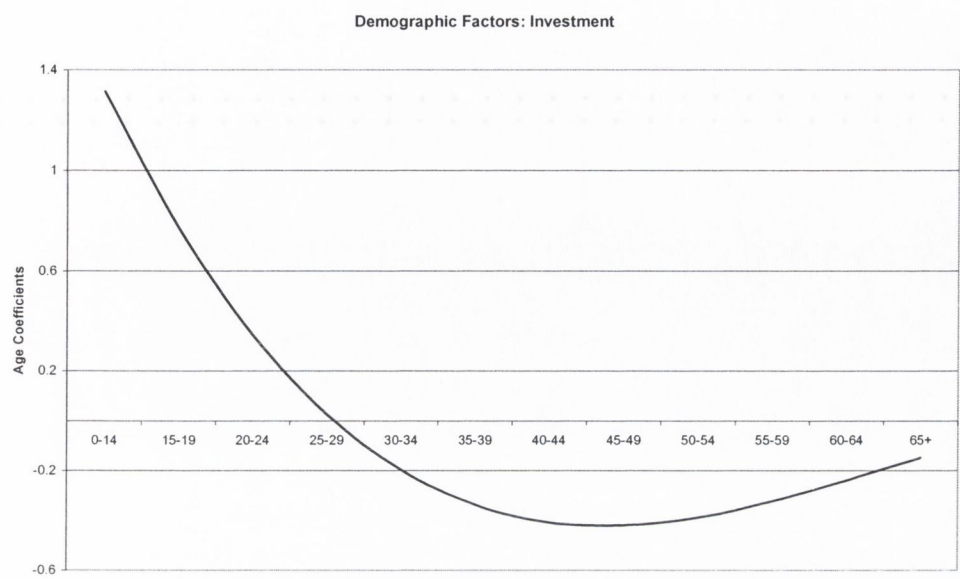


Figure 4.5: Change in the Age Distribution Coefficients of the Industrial Country Sample in the Short-Run: Investment.

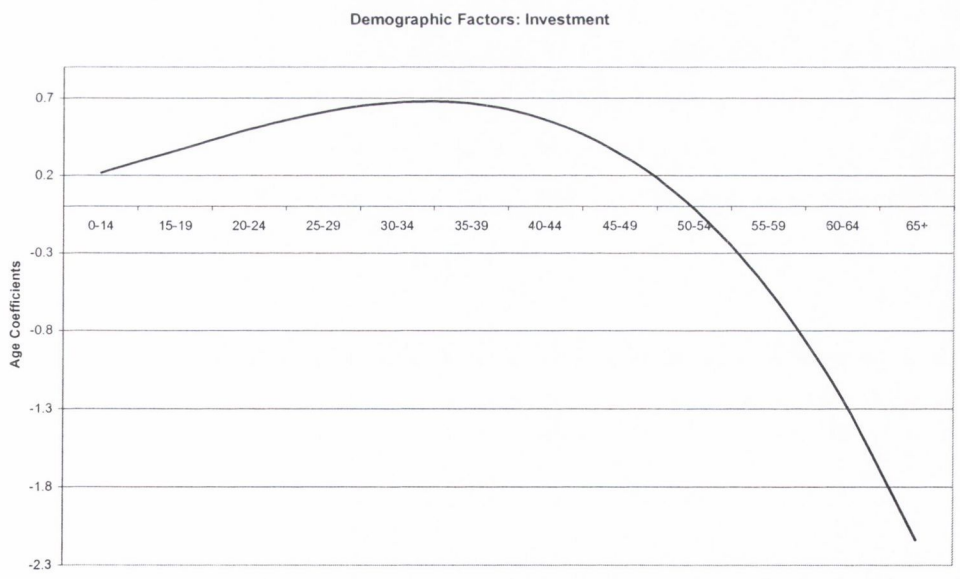


Figure 4.6: Change in the Age Distribution Coefficients of the Developing Country Sample in the Short-Run: Investment.

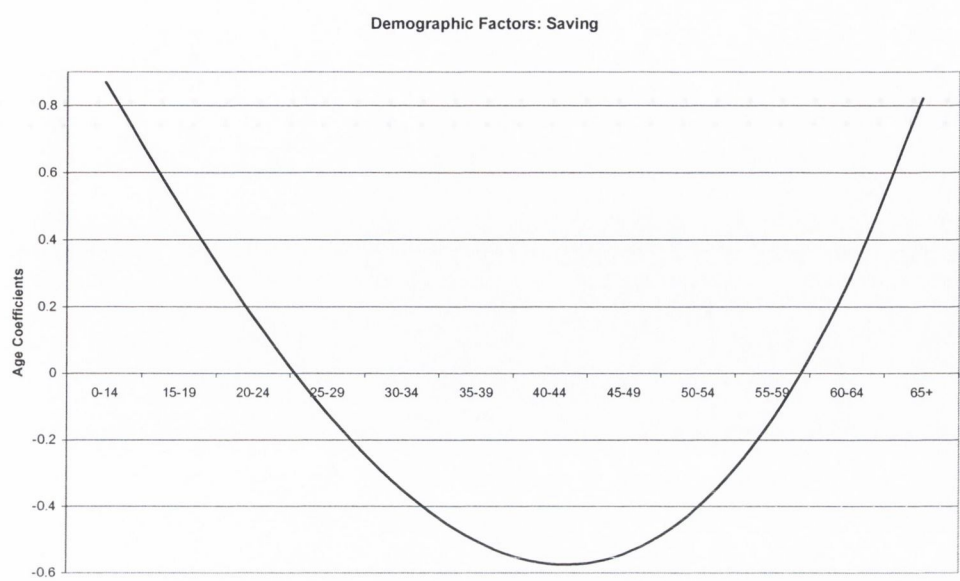


Figure 4.7: Change in the Age Distribution Coefficients of the Industrial Country Sample in the Short-Run: Saving.

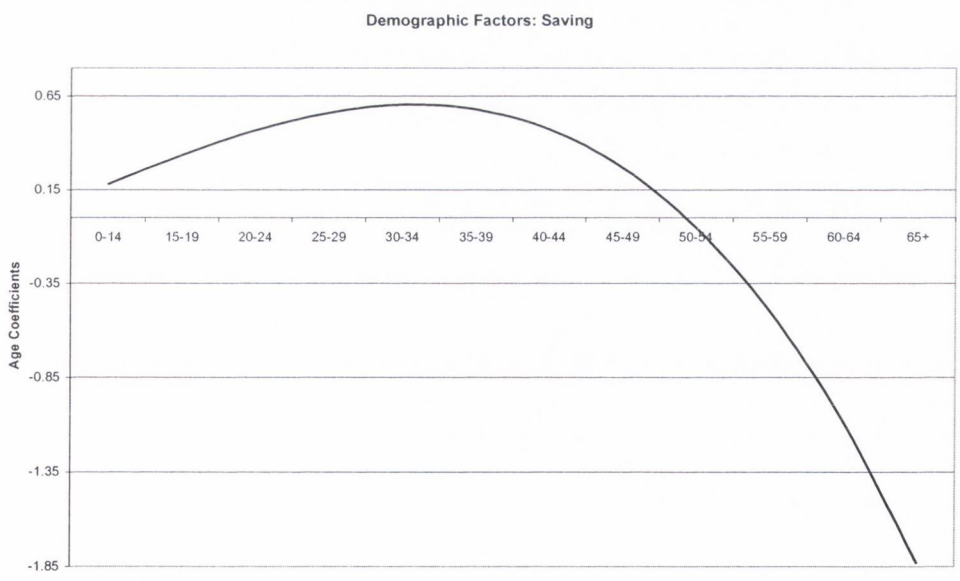


Figure 4.8: Change in the Age Distribution Coefficients of the Developing Country Sample in the Short-Run: Saving.

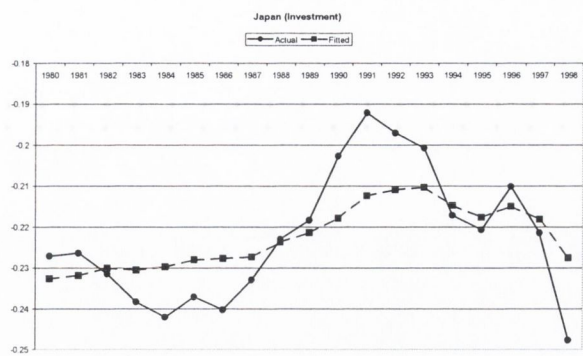


Figure 4.9: Japan: Actual and Fitted Values, Investment Rate.

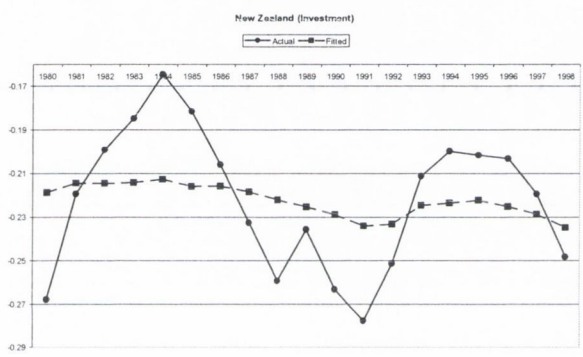


Figure 4.10: New Zealand: Actual and Fitted Values, Investment Rate.

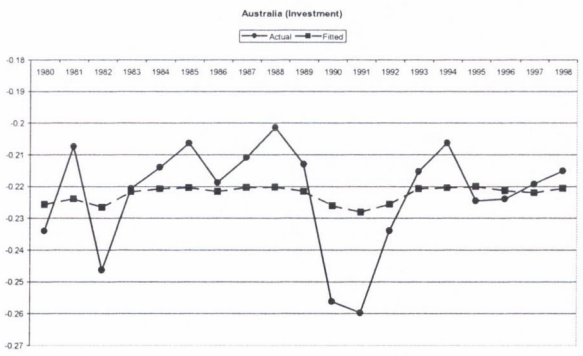


Figure 4.11: Australia: Actual and Fitted Values, Investment Rate.

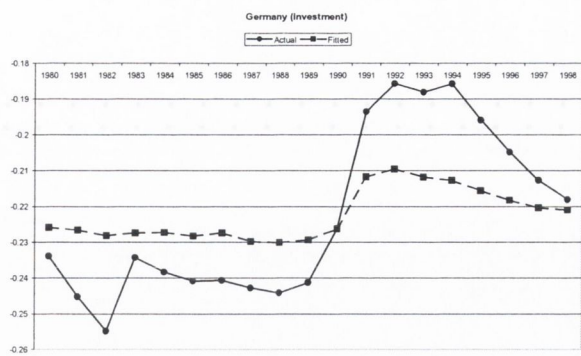


Figure 4.12: Germany: Actual and Fitted Values, Investment Rate.

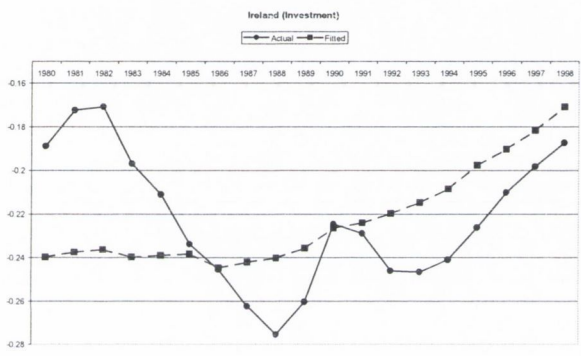


Figure 4.13: Ireland: Actual and Fitted Values, Investment Rate.

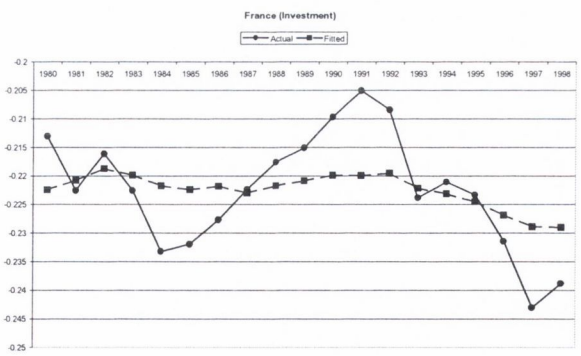


Figure 4.14: France: Actual and Fitted Values, Investment Rate.

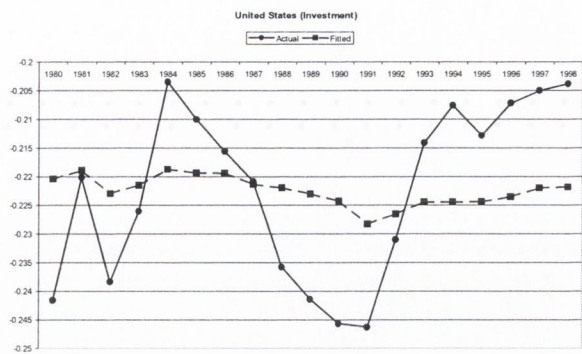


Figure 4.15: United States: Actual and Fitted Values, Investment Rate.

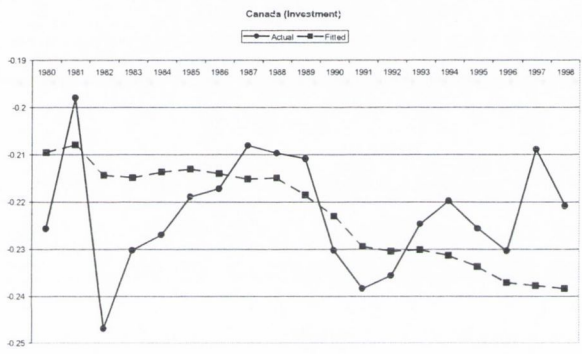


Figure 4.16: Canada: Actual and Fitted Values, Investment Rate.

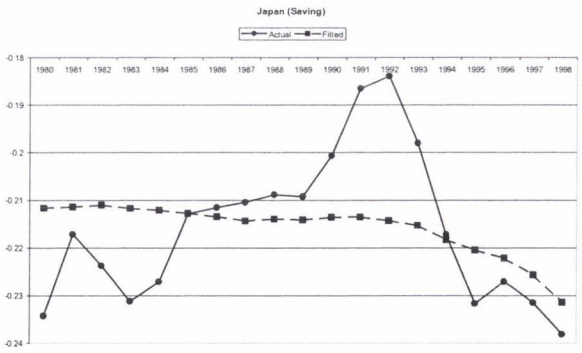


Figure 4.17: Japan: Actual and Fitted Values, Saving Rate.

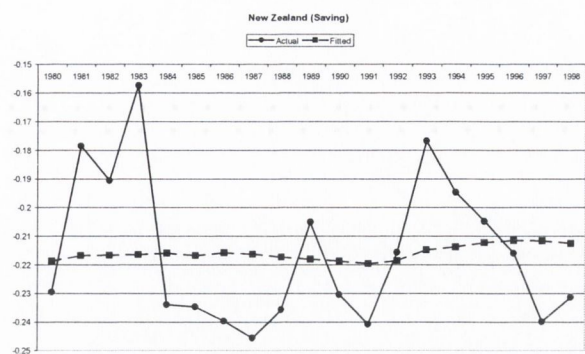


Figure 4.18: New Zealand: Actual and Fitted Values, Saving Rate.

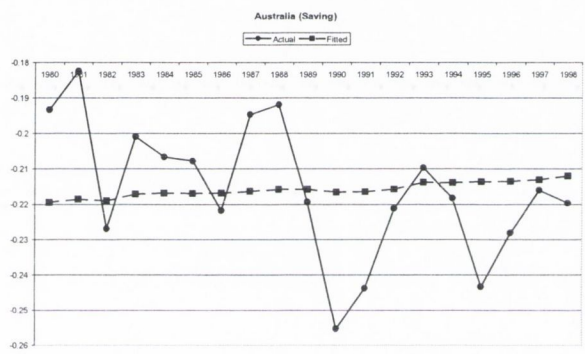


Figure 4.19: Australia: Actual and Fitted Values, Saving Rate.

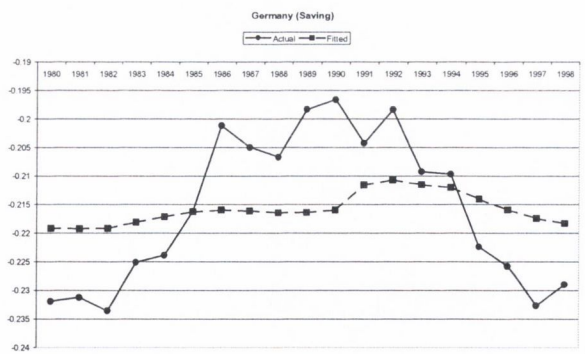


Figure 4.20: Germany: Actual and Fitted Values, Saving Rate.

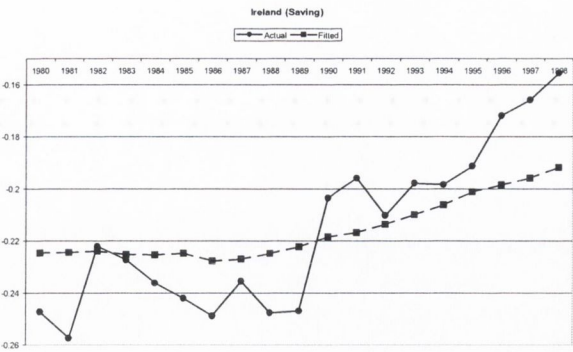


Figure 4.21: Ireland: Actual and Fitted Values, Saving Rate.

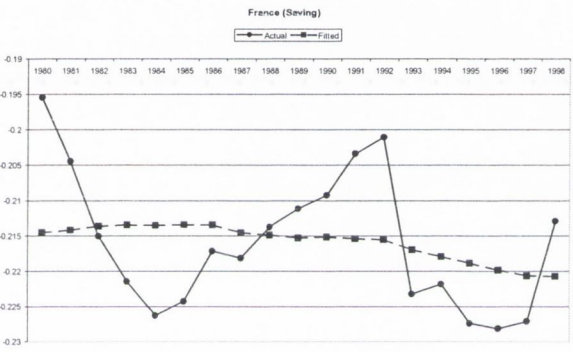


Figure 4.22: France: Actual and Fitted Values, Saving Rate.

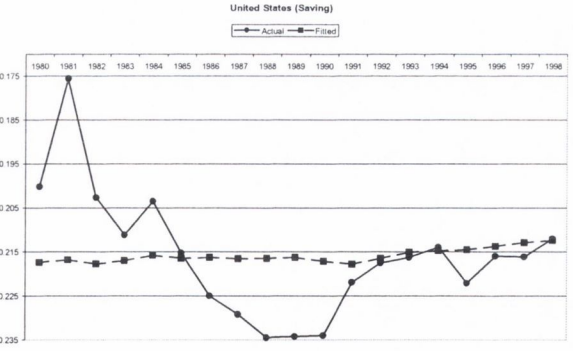


Figure 4.23: United States: Actual and Fitted Values, Saving Rate.

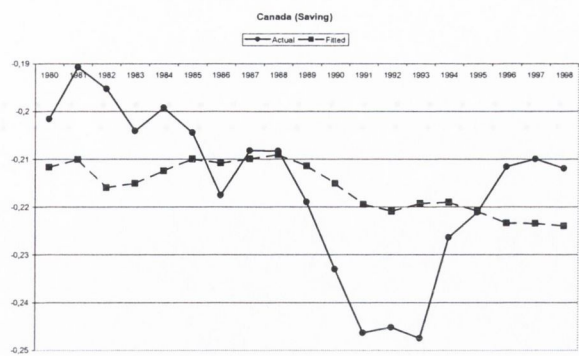


Figure 4.24: Canada: Actual and Fitted Values, Saving Rate.

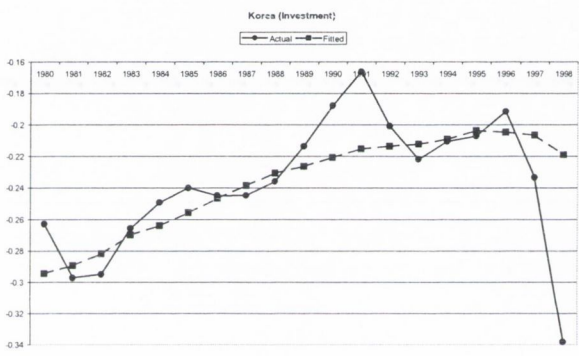


Figure 4.25: South Korea: Actual and Fitted Values, Investment Rate.

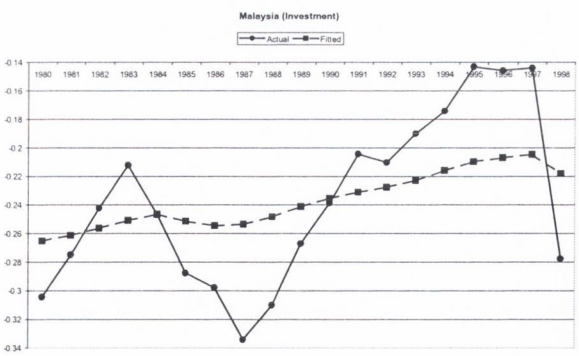


Figure 4.26: Malaysia: Actual and Fitted Values, Investment Rate.

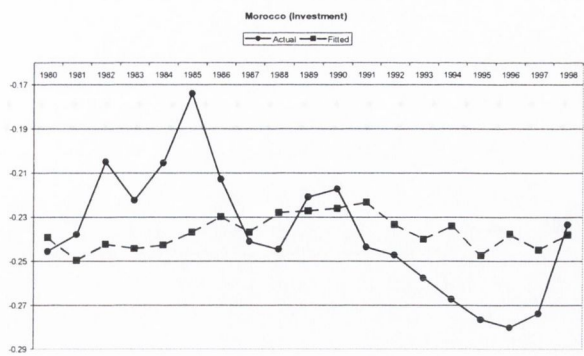


Figure 4.27: Morocco: Actual and Fitted Values, Investment Rate.

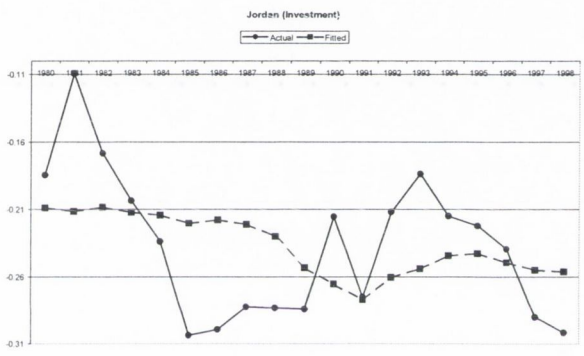


Figure 4.28: Jordan: Actual and Fitted Values, Investment Rate.

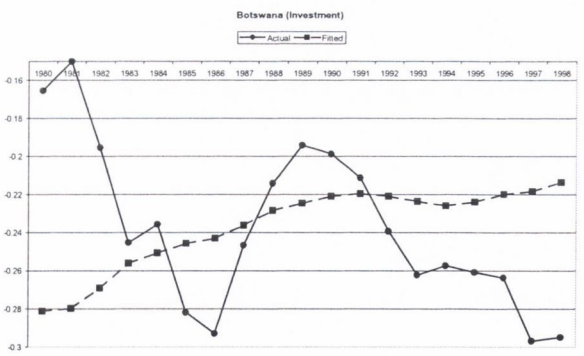


Figure 4.29: Botswana: Actual and Fitted Values, Investment Rate.

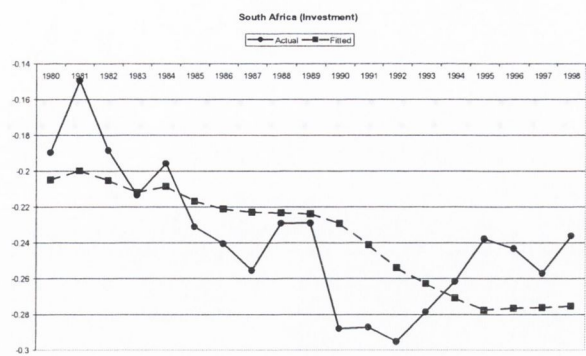


Figure 4.30: South Africa: Actual and Fitted Values, Investment Rate.

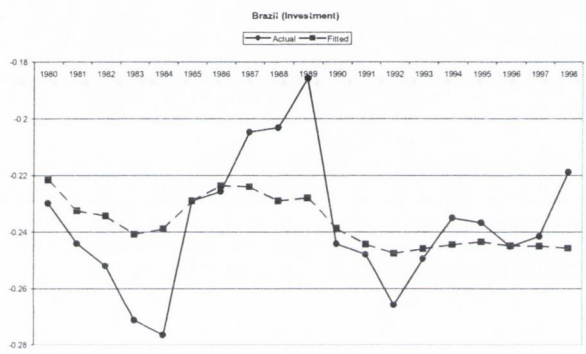


Figure 4.31: Brazil: Actual and Fitted Values, Investment Rate.

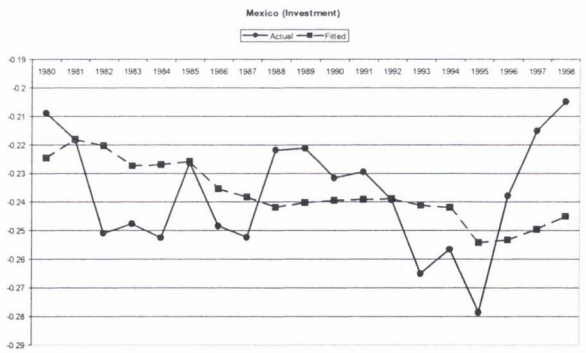


Figure 4.32: Mexico: Actual and Fitted Values, Investment Rate.

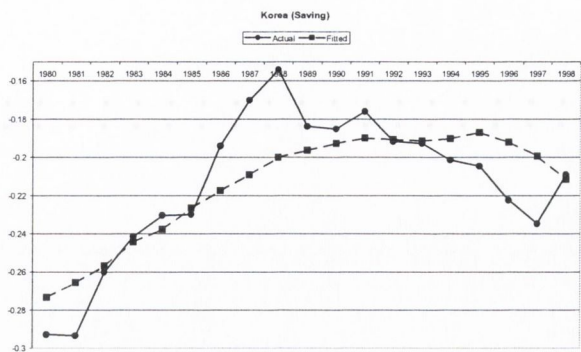


Figure 4.33: South Korea: Actual and Fitted Values, Saving Rate.

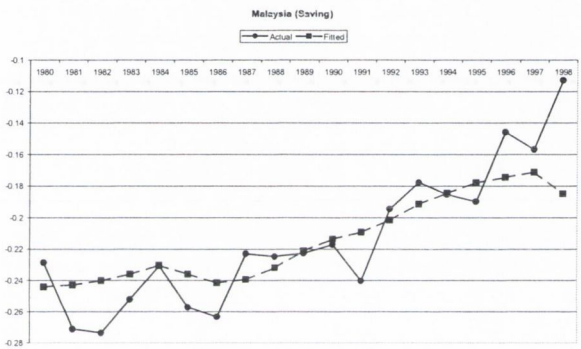


Figure 4.34: Malaysia: Actual and Fitted Values, Saving Rate.

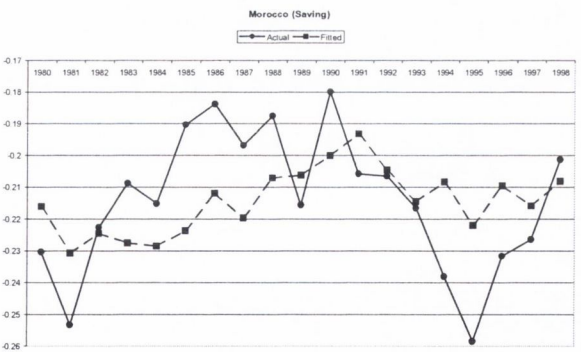


Figure 4.35: Morocco: Actual and Fitted Values, Saving Rate.

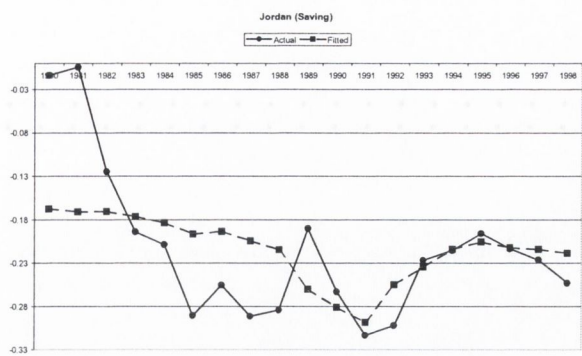


Figure 4.36: Jordan: Actual and Fitted Values, Saving Rate.

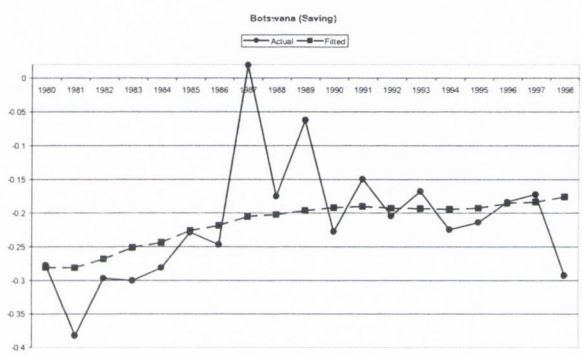


Figure 4.37: Botswana: Actual and Fitted Values, Saving Rate.

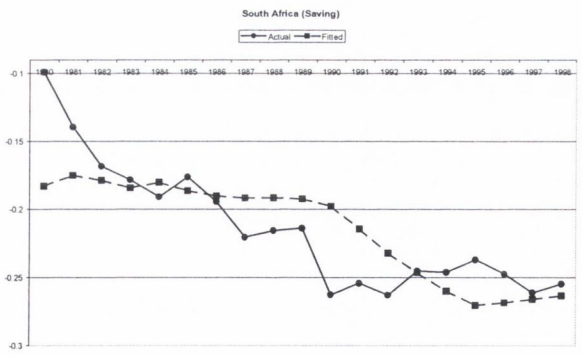


Figure 4.38: South Africa: Actual and Fitted Values, Saving Rate.

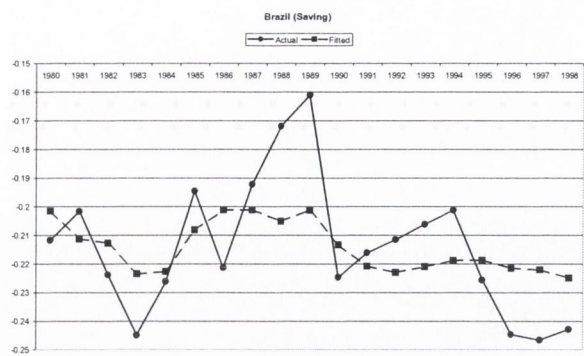


Figure 4.39: Brazil: Actual and Fitted Values, Saving Rate.

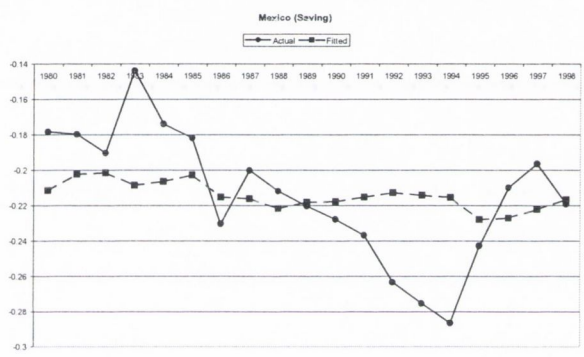


Figure 4.40: Mexico: Actual and Fitted Values, Saving Rate.

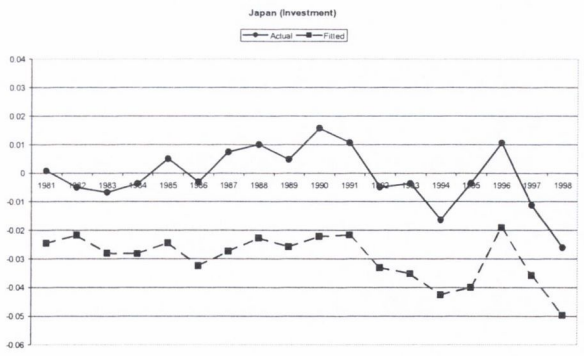


Figure 4.41: Japan: Actual and Fitted Values, Investment Rate (ECM).

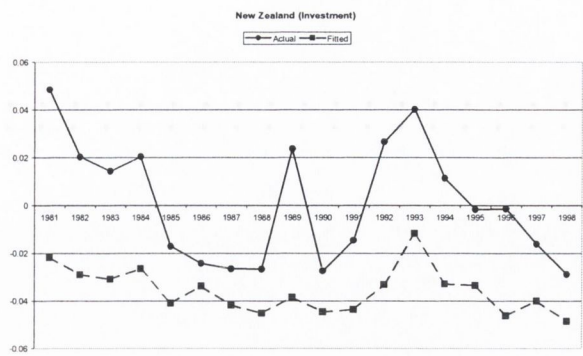


Figure 4.42: New Zealand: Actual and Fitted Values, Investment Rate (ECM).

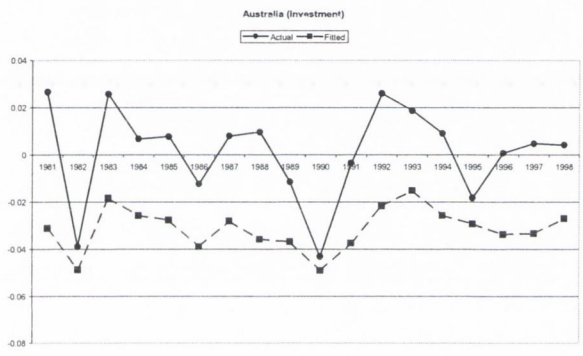


Figure 4.43: Australia: Actual and Fitted Values, Investment Rate (ECM).

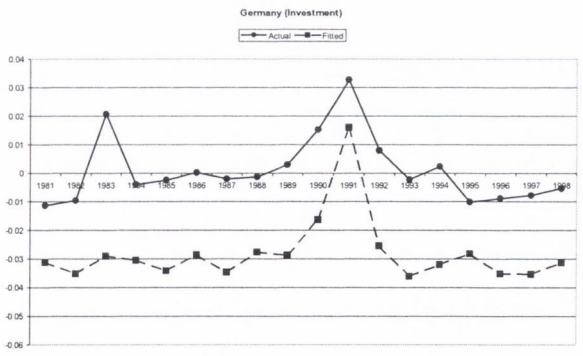


Figure 4.44: Germany: Actual and Fitted Values, Investment Rate (ECM).

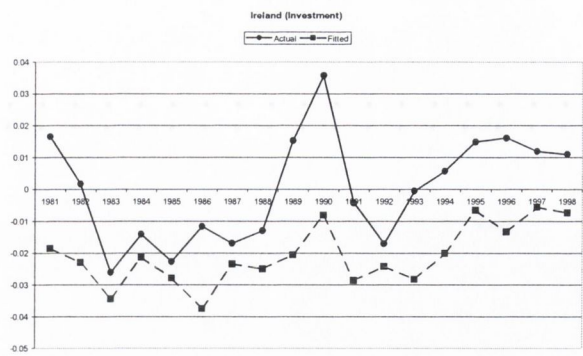


Figure 4.45: Ireland: Actual and Fitted Values, Investment Rate (ECM).

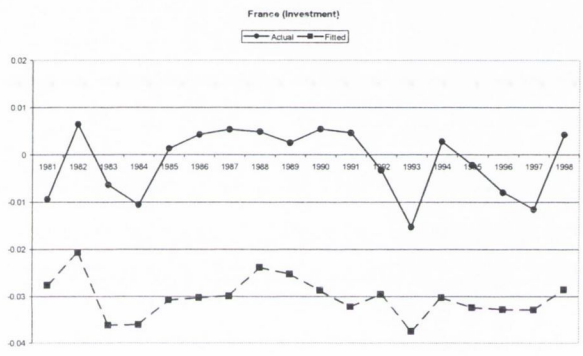


Figure 4.46: France: Actual and Fitted Values, Investment Rate (ECM).

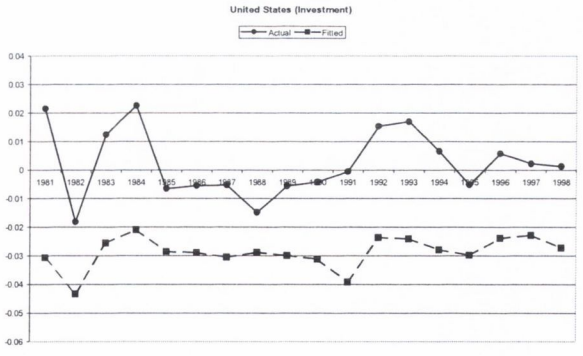


Figure 4.47: United States: Actual and Fitted Values, Investment Rate (ECM).

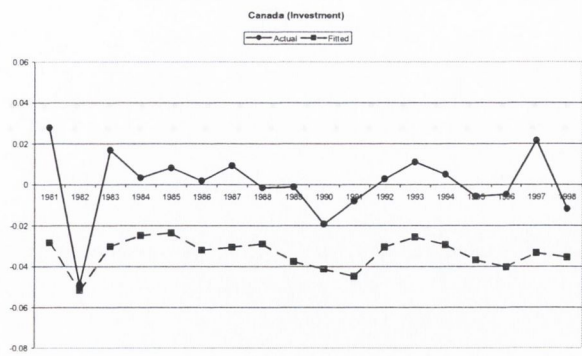


Figure 4.48: Canada: Actual and Fitted Values, Investment Rate (ECM).

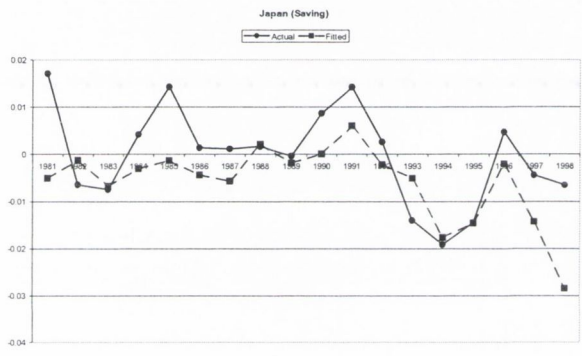


Figure 4.49: Japan: Actual and Fitted Values, Saving Rate (ECM).

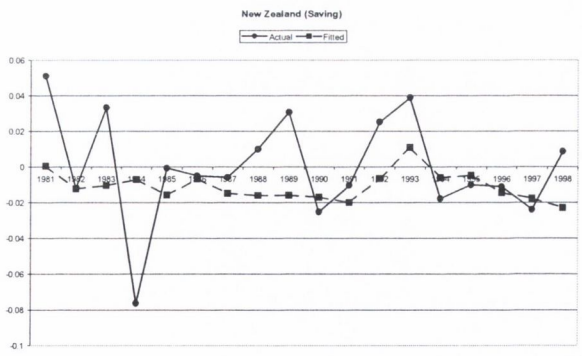


Figure 4.50: New Zealand: Actual and Fitted Values, Saving Rate (ECM).

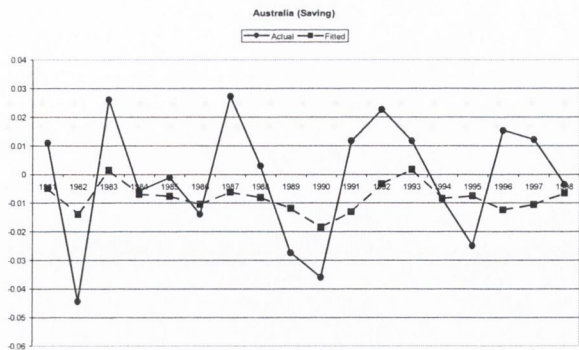


Figure 4.51: Australia: Actual and Fitted Values, Saving Rate (ECM).

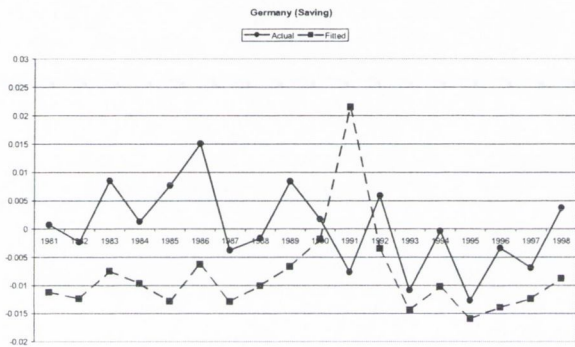


Figure 4.52: Germany: Actual and Fitted Values, Saving Rate (ECM).

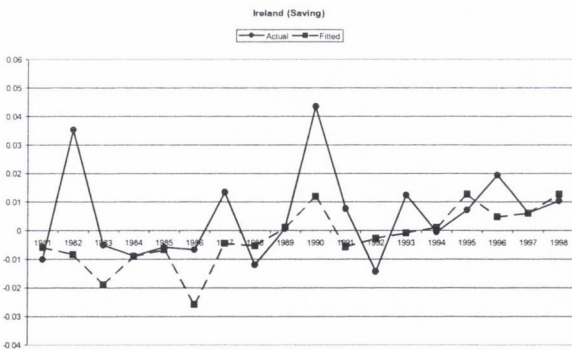


Figure 4.53: Ireland: Actual and Fitted Values, Saving Rate (ECM).

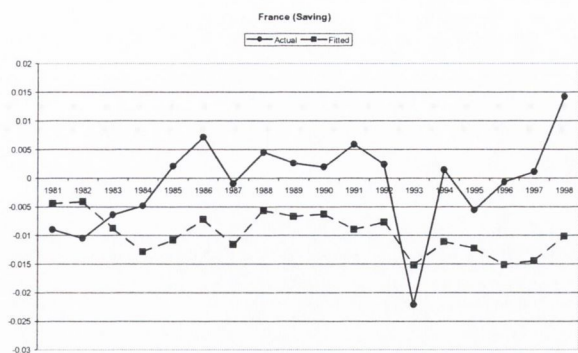


Figure 4.54: France: Actual and Fitted Values, Saving Rate (ECM).

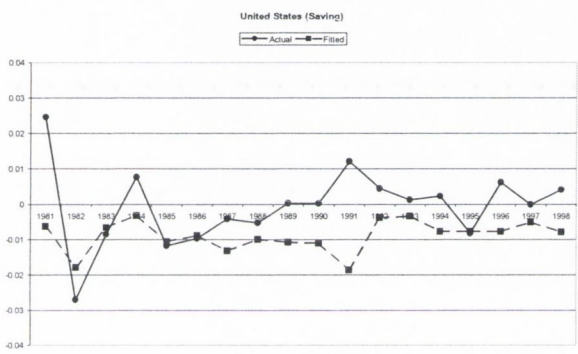


Figure 4.55: United States: Actual and Fitted Values, Saving Rate (ECM).

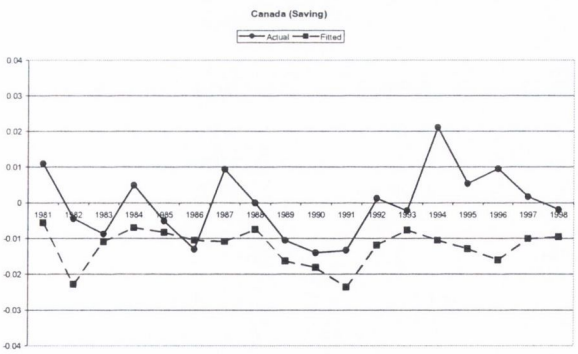


Figure 4.56: Canada: Actual and Fitted Values, Saving Rate (ECM).

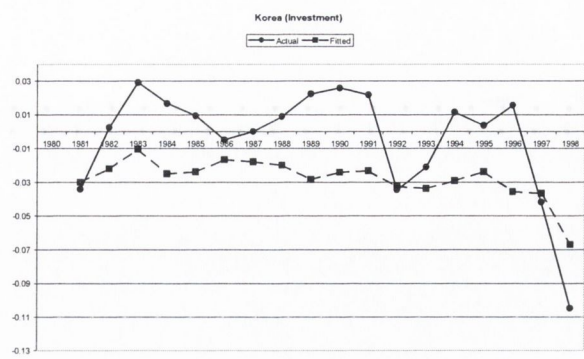


Figure 4.57: South Korea: Actual and Fitted Values, Investment Rate (ECM).

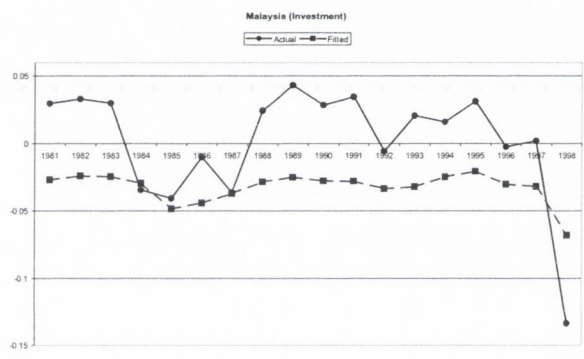


Figure 4.58: Malaysia: Actual and Fitted Values, Investment Rate (ECM).

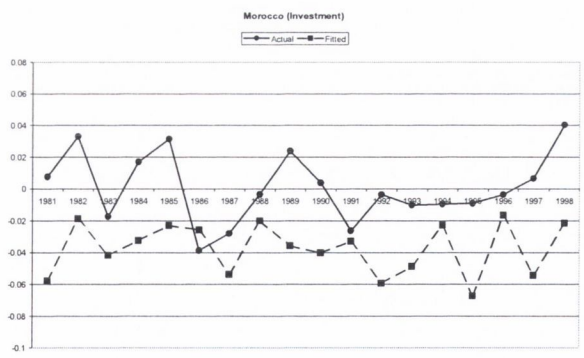


Figure 4.59: Morocco: Actual and Fitted Values, Investment Rate (ECM).

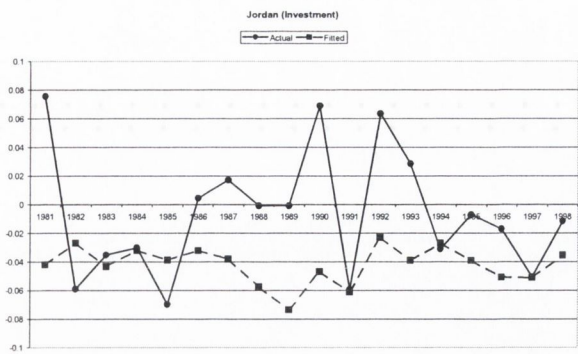


Figure 4.60: Jordan: Actual and Fitted Values, Investment Rate (ECM).

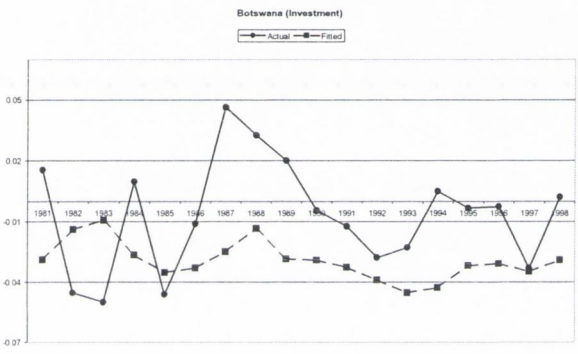


Figure 4.61: Botswana: Actual and Fitted Values, Investment Rate (ECM).

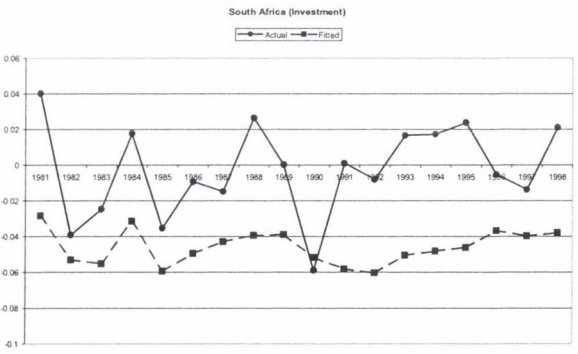


Figure 4.62: South Africa: Actual and Fitted Values, Investment Rate (ECM).

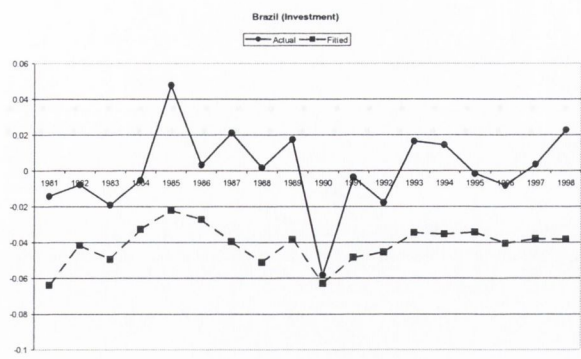


Figure 4.63: Brazil: Actual and Fitted Values, Investment Rate (ECM).

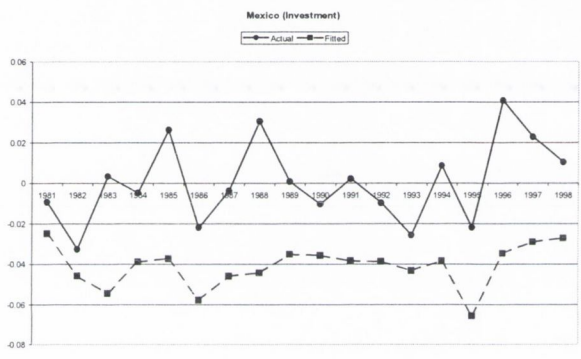


Figure 4.64: Mexico: Actual and Fitted Values, Investment Rate (ECM).

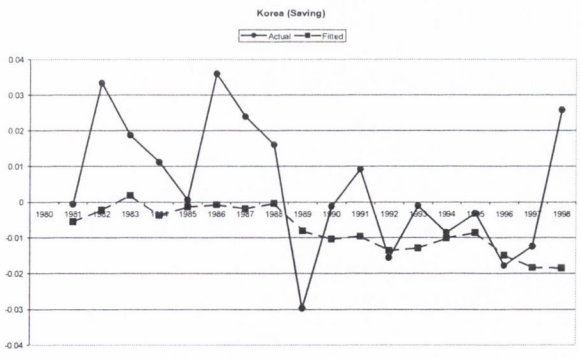


Figure 4.65: South Korea: Actual and Fitted Values, Saving Rate (ECM).

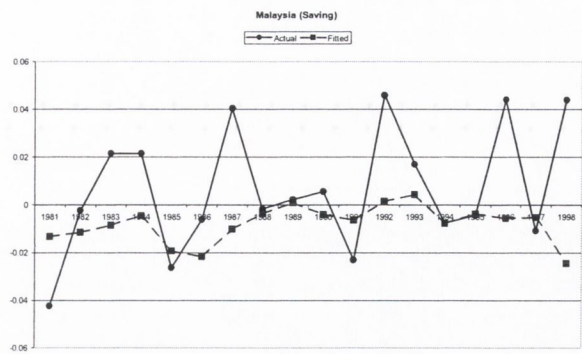


Figure 4.66: Malaysia: Actual and Fitted Values, Saving Rate (ECM).

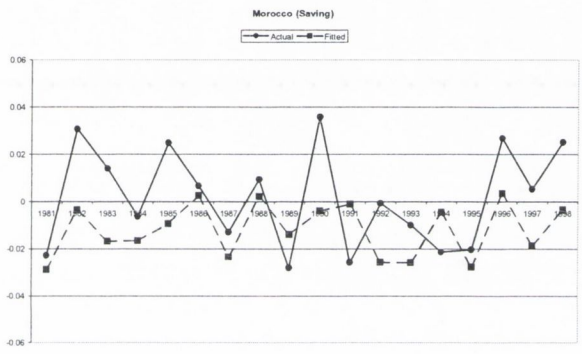


Figure 4.67: Morocco: Actual and Fitted Values, Saving Rate (ECM).

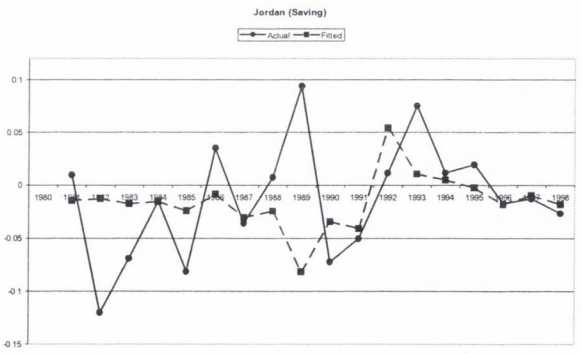


Figure 4.68: Jordan: Actual and Fitted Values, Saving Rate (ECM).

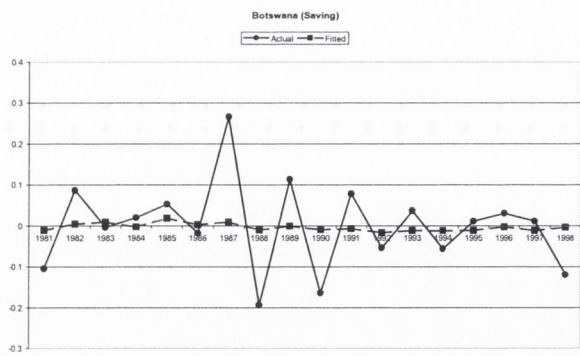


Figure 4.69: Botswana: Actual and Fitted Values, Saving Rate (ECM).

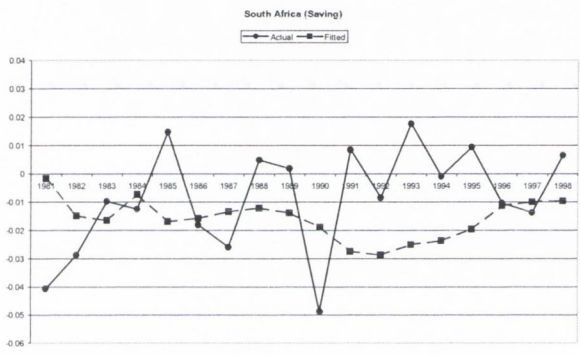


Figure 4.70: South Africa: Actual and Fitted Values, Saving Rate (ECM).

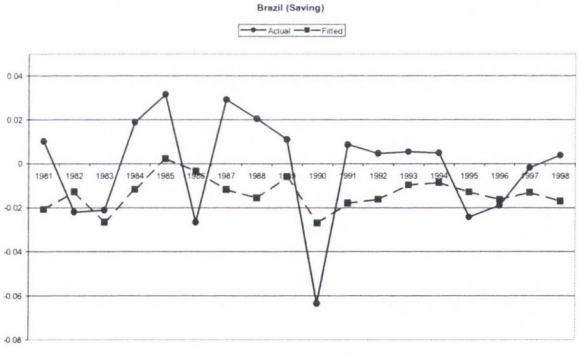


Figure 4.71: Brazil: Actual and Fitted Values, Saving Rate (ECM).

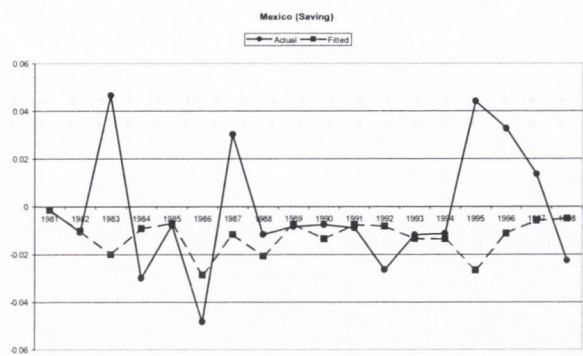


Figure 4.72: Mexico: Actual and Fitted Values, Saving Rate (ECM).

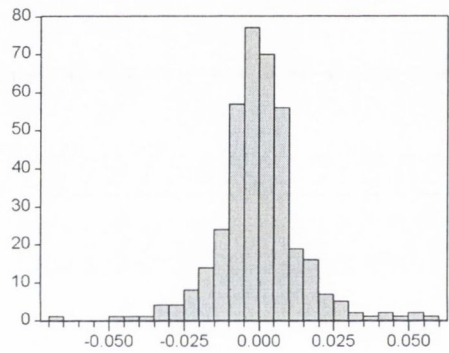


Figure 4.73: Industrial Countries: Distribution of the Error Term in the Saving Equation.

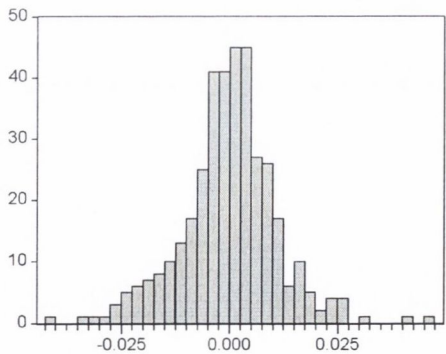


Figure 4.74: Industrial Countries: Distribution of the Error Term in the Investment Equation.

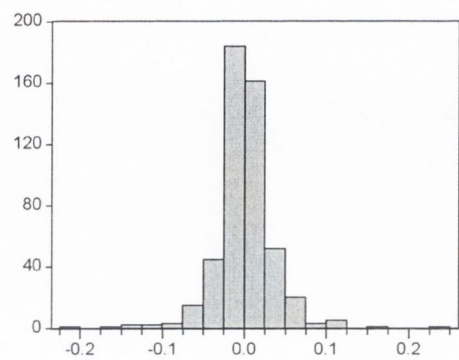


Figure 4.75: Developing Countries: Distribution of the Error Term in the Saving Equation.

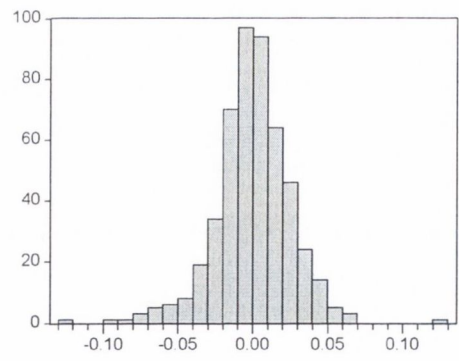


Figure 4.76: Developing Countries: Distribution of the Error Term in the Investment Equation.

Developed Countries		
Australia	Germany	Norway
Austria	Greece	Portugal
Belgium	Iceland	Spain
Canada	Ireland	Sweden
Denmark	Italy	Switzerland
Finland	Japan	United Kingdom
France	Netherlands	United States
	New Zealand	

Table 4.1: Industrial Countries

Asia	Middle East/ North Africa	Sub Saharan Africa	Latin America
India	Morocco	Botswana	Brazil
Indonesia	Israel	Mauritius	Colombia
Korea	Jordan	South Africa	Costa Rica
Malaysia	Tunisia	Zimbabwe	Ecuador
Pakistan	Turkey		El Salvador
Philippines			Guatemala
Singapore			Jameica
Sri Lanka			Mexico
Thailand			Panama
			Paraguay
			Trinidad and Tobago
			Uruguay
			Venezuela

Table 4.2: Developing Countries

Variables	Hadri	(DGP heterogeneous)	
		criticalProb.	
Saving	8.3935	0.0000	(reject)
Investment	6.6912	0.0000	(reject)
Debt	13.1051	0.0000	(reject)
GDP per Capita	13.8197	0.0000	(reject)
Demographic 1	21.3099	0.0000	(reject)
Demographic 2	22.3479	0.0000	(reject)
Demographic 3	23.2359	0.0000	(reject)

Table 4.3: Panel Unit Root Test: Industrial Countries. *Note: The null hypothesis is that the series is stationary.*

Variables	Hadri	(DGP heterogeneous)	
		criticalProb.	
Saving	9.68424	0.0000	(reject)
Investment	7.41427	0.0000	(reject)
Debt	12.5751	0.0000	(reject)
GDP per Capita	20.563	0.0000	(reject)
Demographic 1	30.2705	0.0000	(reject)
Demographic 2	29.2088	0.0000	(reject)
Demographic 3	28.4483	0.0000	(reject)

Table 4.4: Panel Unit Root Test: Developing Countries. *Note: The null hypothesis is that the series is stationary.*

Pedroni (1999)			
Industrial Countries		Developing Countries	
Saving:	-27.846 (0.0000)	Saving:	-43.775 (0.000)
Investment:	-23.808 (0.000)	Investment:	-34.853 (0.000)
Kao (1999)			
Saving:	-4.173 (0.000)	Saving:	-7.582 (0.000)
Investment:	-5.782 (0.000)	Investment:	-6.18 (0.000)

Table 4.5: Residual Based Cointegration Tests. *Note: The null hypothesis is that there is no cointegration (unit root in the errors). The critical probabilities are in parentheses. The dependent variable is either saving or investment and the independent variables are debt, GDP per capita and the three demographic factors.*

Explanatory Variables	Dependent Variable		Dependent Variable (without Australia)	
	<i>Saving</i>	<i>Investment</i>	<i>Saving</i>	<i>Investment</i>
Debt to GDP	-0.016 (0.639) (1.421)	-0.024 ₊ (1.004) (1.894)	-0.021 ₊ (0.784) (1.757)	-0.026 ₊ (1.015) (1.945)
GDP per Capita	0.035 (0.669) (1.488)	0.121 ^{***} ₊₊₊ (2.449) (4.623)	0.026 (0.481) (1.078)	0.118 ^{**} ₊₊₊ (2.277) (4.363)
Demographic 1	-0.034 (0.101) (0.226)	0.057 (0.177) (0.334)	-0.032 (0.093) (0.208)	0.061 (0.185) (0.354)
Demographic 2	0.021 (0.315) (0.701)	-0.028 (0.451) (0.852)	0.021 (0.314) (0.705)	-0.028 (0.444) (0.851)
Demographic 3	-0.002 (0.446) (0.991)	0.002 (0.557) (1.052)	-0.002 (0.443) (0.993)	0.002 (0.543) (1.041)
$\chi^2_{(3)}$ (Demographic)	0.740 <i>0.606</i>	0.589 <i>1.076</i>	0.613 <i>0.154</i>	0.533 <i>0.113</i>
$\chi^2_{(5)}$ (All Variables)	3.549 <i>6.064</i>	13.93 ^{**} <i>17.936</i> ₊₊₊	3.426 <i>9.26</i> ₊	13.118 ^{**} <i>18.91</i> ₊₊₊
α max.	0.144 (45-49)	0.225 (0-14)	0.152 (45-49)	0.218 (0-14)
α min.	-0.276 (65+)	-0.193 (50-54)	-0.263 (65+)	-0.190 (50-54)
adj. R ²	0.32	0.36	0.32	0.35
Observations	352	352	336	336
Countries	22	22	21	21

Table 4.6: Regression Results (DOLS): Industrial Countries. *Note: Time Period 1980-98. Statistical Results reported with DOLS and DSUR Standard Errors. t-statistics for DSUR Standard Errors in emphasised Parenthesis. t-Statistics in absolute values. ***,+ ++ Significance at the 1 percent; **,++ at the 5 percent; *+ at the 10 percent level. + refers to DSUR estimation.*

Explanatory Variables	Dependent Variable		Dependent Variable (without Singapore)	
	CumCA	CumFL	CumCA	CumFL
Debt to GDP	-0.666*** (4.148)	-0.842*** (4.803)	-0.704*** (5.127)	-0.871*** (6.636)
GDP per Capita	-0.026 (0.103)	-0.151 (0.551)	-0.158 (0.728)	-0.279 (1.344)
Demographic 1	-5.483 (1.673)	3.561 (0.995)	-0.545 (0.170)	1.553 (0.507)
Demographic 2	1.128 (1.691)	0.717 (0.984)	0.124 (0.189)	-0.318 (0.509)
Demographic 3	-0.060 (1.553)	-0.036 (0.862)	-0.007 (0.190)	-0.018 (0.501)
$\chi^2_{(3)}$ (Demographic)	3.35	4.34	0.046	0.238
$\chi^2_{(5)}$ (All Variables)	26.442***	26.75***	31.72***	41.01***
α max.	3.246 (50-54)	1.347 (55-59)	0.399 (50-54)	1.66 (65+)
α min.	-2.77 (25-29)	-2.45 (25-29)	-0.47 (65+)	-0.711 (45-49)
α (POP<15)	0.535	-0.117	-0.025	-0.621
α (POP>64)	-2.07	0.388	-0.47	1.66
adj. R ²	0.43	0.54	0.42	0.58
Observations	496	496	480	480
Countries	31	31	30	30

Table 4.7: Regression Results (DOLS): Developing Countries' Net Foreign Assets. *Note: Time Period 1980-98. t-Statistics in absolute values. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level.*

Explanatory Variables	Dependent Variable		Dependent Variable (without Singapore)	
	<i>Saving</i>	<i>Investment</i>	<i>Saving</i>	<i>Investment</i>
Debt to GDP	-0.030* (1.835) (2.478) +++	-0.008 (0.321) (0.697)	-0.032* (2.011) (2.743) +++	-0.0004 (0.018) (0.038)
GDP per Capita	0.133*** (5.270) (7.114) +++	0.109*** (2.915) (6.324) +++	0.126*** (5.036) (6.868) +++	0.127*** (3.519) (7.243) +++
Demographic 1	-0.267 (0.81) (1.094)	0.522 (1.318) (6.324)	0.008 (0.023) (1.472)	-0.152 (0.286) (0.031)
Demographic 2	0.122* (1.809) (2.443) +++	-0.071 (0.709) (1.537)	0.076 (1.013) (1.383)	0.078 (0.715) (1.473)
Demographic 3	-0.010*** (2.621) (3.539) +++	0.002 (0.283) (0.614)	-0.008* (1.914) (2.611) +++	-0.007 (1.068) (1.199)
$\chi^2_{(3)}$ (Demographic)	17.020*** 18.415+++	4.34 1.46	21.22*** 22.57+++	3.736 4.323
$\chi^2_{(5)}$ (All Variables)	65.188*** 30.69+++	15.45*** 24.28+++	70.47*** 37.62+++	19.89*** 18.68+++
α max.	0.911 (40-44)	0.664 (25-29)	0.99 (35-39)	0.602 (40-44)
α min.	-3.000 (65+)	-1.472 (65+)	-3.088 (65+)	-1.903 (65+)
adj. R ²	0.24	0.18	0.25	0.21
Observations	496	496	480	480
Countries	31	31	30	30

Table 4.8: Regression Results (DOLS): Developing Countries. *Note: Time Period 1980-98. Statistical Results reported with DOLS and DSUR Standard Errors. t-statistics for DSUR Standard Errors in emphasised Parenthesis. t-Statistics in absolute values. ***,+++ Significance at the 1 percent; **,++ at the 5 percent; *+ at the 10 percent level. + refers to DSUR estimation.*

Explanatory Variables	Dependent Variable		Dependent Variable (without Australia)	
	<i>Saving</i>	<i>Investment</i>	<i>Saving</i>	<i>Investment</i>
Error Correction Term	-0.346*** (7.960)	-0.125*** (2.945)	-0.357*** (9.496)	-0.271*** (7.977)
Δ_{t-1} Lagged Dep. Variable	-0.041 (1.046)	-0.136*** (3.541)	-0.018 (0.405)	0.179*** (4.265)
Δ Debt to GDP	-0.071*** (3.926)	0.039** (2.469)	-0.078*** (4.258)	0.037** (2.322)
Δ GDP per Capita	0.250*** (6.915)	0.412*** (12.368)	0.227*** (6.099)	0.391*** (11.377)
Δ Demographic 1	-0.394 (1.039)	-0.749** (2.293)	-0.306 (0.809)	-0.772** (2.345)
Δ Demographic 2	0.004 (0.052)	0.073 (1.208)	-0.009 (0.127)	0.074 (1.221)
Δ Demographic 3	0.002 (0.588)	-0.002 (0.655)	0.003 (0.727)	-0.002 (0.635)
$\chi^2_{(3)}$ (Demographic)	6.93*	18.52***	6.21	18.56***
$\chi^2_{(5)}$ (Debt, GDP, Demo.)	94.22***	163.52***	86.49***	140.79***
adj. R ²	0.32	0.47	0.31	0.46
Observations	374	374	357	357
Countries	22	22	21	21

Table 4.9: Regression Results (ECM I): Industrial Countries. *Note: Time Period 1980-98. t-Statistics in absolute values. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level.*

Explanatory Variables	Dependent Variable	Dependent Variable
	<i>Saving</i>	(without Australia) <i>Saving</i>
Error Correction Term	-0.364*** (10.48)	-0.353*** (10.044)
Δ_{t-1} Lagged Dep. Variable	-	-
Δ Debt to GDP	-0.066*** (3.702)	-0.075*** (4.135)
Δ GDP per Capita	0.246*** (6.919)	0.217*** (5.972)
Δ Demographic 1	-	-
Δ Demographic 2	-	-
Δ Demographic 3	-	-
$\chi^2_{(2)}(Debt, GDP)$	88.76***	80.32***
adj. R ²	0.30	0.29
Observations	374	357
Countries	22	21

Table 4.10: Regression Results (ECM II): Industrial Countries. *Note: Time Period 1980-98. t-Statistics in absolute values. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level.*

Explanatory Variables	Dependent Variable		Dependent Variable (without Singapore)	
	<i>Saving</i>	<i>Investment</i>	<i>Saving</i>	<i>Investment</i>
Error Correction Term	-0.587*** (13.703)	-0.236*** (5.750)	-0.609*** (13.957)	-0.252*** (5.969)
Δ_{t-1} Lagged Dep. Variable	-0.055 (1.651)	-0.158*** (4.175)	-0.048 (1.429)	-0.169*** (4.429)
Δ Debt to GDP	-0.063*** (3.988)	0.027** (2.057)	-0.065*** (4.091)	0.028** (2.141)
Δ GDP per Capita	0.133*** (3.637)	0.303*** (9.984)	0.125*** (3.50)	0.321*** (10.442)
Δ Demographic 1	0.161 (0.222)	0.11 (0.184)	0.539 (0.695)	-0.623 (0.971)
Δ Demographic 2	-0.004 (0.026)	0.02 (0.161)	-0.063 (0.399)	0.164 (1.258)
Δ Demographic 3	-0.003 (0.290)	-0.004 (0.516)	-0.0006 (0.067)	-0.011 (1.506)
$\chi^2_{(3)}$ (Demographic)	3.217	5.77	5.018	5.03
$\chi^2_{(5)}$ (Debt, GDP, Demo.)	49.53***	107.5***	50.36***	116.24***
adj. R ²	0.32	0.32	0.33	0.33
Observations	527	527	510	510
Countries	31	31	30	30

Table 4.11: Regression Results (ECM I): Developing Countries. *Note: Time Period 1980-98.*
t-Statistics in absolute values. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level.

Explanatory Variables	Dependent Variable		Dependent Variable (without Singapore)	
	<i>Saving</i>	<i>Investment</i>	<i>Saving</i>	<i>Investment</i>
Error Correction Term	-0.578*** (14.80)	-0.209*** (5.002)	-0.586*** (14.809)	-0.237*** (5.635)
Δ_{t-1} Lagged Dep. Variable	-	-0.162*** (4.089)	-	-0.169*** (4.364)
Δ Debt to GDP	-0.071*** (4.478)	0.022* (1.708)	-0.074*** (4.625)	0.024* (1.847)
Δ GDP per Capita	0.111*** (3.089)	0.288*** (9.630)	0.101*** (2.751)	0.306*** (10.078)
Δ Demographic 1	-	-	-	-
Δ Demographic 2	-	-	-	-
Δ Demographic 3	-	-	-	-
$\chi^2_{(2)}(Debt, GDP)$	47.61***	98.54***	46.25***	107.87***
adj. R ²	0.30	0.30	0.31	0.32
Observations	527	527	510	510
Countries	31	31	30	30

Table 4.12: Regression Results (ECM II): Developing Countries. *Note: Time Period 1980-98.*
t-Statistics in absolute values. *** Significance at the 1 percent, ** at the 5 percent, * at the 10 percent level.

5 Chapter Five

Concluding Remarks

This thesis concentrates on the macroeconomic effects of increased capital mobility in international capital markets. The focal points of attention encompass the relationship between capital flows and infrastructure, saving and investment in relation to net foreign assets and the choice between different exchange rate regimes. Each research aspect is investigated separately and individually presented in chapters two to four.

Chapter two explores the link between the level of infrastructure evident in and capital inflows to developing countries. It concentrates on a set of infrastructure variables and their relationship to capital stocks and flows. The findings for the average stock of foreign capital liabilities and its sub-components can be summarised as follows. Considering the infrastructure variables separately, roads do not seem to contribute to the attraction of new international capital. By contrast, air-departures and international telephone circuits have a positive and statistically significant impact upon the average total liability stock for the period 1990-95. Air-departures also show a positive and statistically significant influence on FDI, while international telephone circuits have a positive impact on the attraction of new debt. Overall, the joint impact of the chosen infrastructure variables on the stock of capital inflows is not statistically significant. An exception is provided by the sub-component of FDI, which is statistically significantly impacted on by infrastructure. An individually positive relationship exists for air-departures and FDI inflows. Overall, for the flow data joint significance of the infrastructure variables is found for FDI. In summary, especially information and transport technology are able to explain cross-country varia-

tions in FDI and debt positions of countries. The established evidence suggests new directions for theoretical work in modelling international capital flows by incorporating an infrastructure component into formal analyses. In future work it might be interesting to include data on new information technology, e.g. internet access, and to establish their partial correlation with international capital flows.

Chapter three compares the economic performance of small open developing countries which are subject to different exchange rate regimes. In particular, the chapter analyses the hypothesis that flexible exchange rates are able to cushioning external shocks better than fixed exchange rates. The chapter focuses on external shocks in form of the world real interest rate and world output and concentrates on the adjustment process of developing countries' real GDP, trade balance and real exchange rate. An intertemporal model, which allows for market imperfections, is established. For empirically relevant preference specifications it confirms the argument that floating exchange rates are superior to fixed exchange rates in insulating the economy against external shocks. The empirical results of the panel vector autoregression support the predictions that the real exchange rate is able to smooth the effects of external shocks. Hence, real output growth and net exports adjust more quickly to external shocks in form of the world real interest rate and world output. Future research could concentrate on analysing how fixed and floating exchange rate regimes affect developing countries' adjustment process to other external shocks. Since most developing countries are net debtors it is of interest to investigate a shock in form of external debt. Furthermore, the question which exchange rate regime insulates developing countries better against internal or nominal shocks could be empirically answered.

In chapter four the main determinants of long-term capital movements are analysed. The chapter establishes the impact of public debt, GDP per capita and demography on the net foreign asset position via saving and investment rates in developing and industrialised countries. Public debt, GDP per capita and demographic factors are able to explain the long-run saving rate in developing countries while GDP per capita is an important factor in determining the rate of investment in developing and industrial countries. In the short-run, it is mainly public debt and domestic output per capita which drive changes in saving and investment. However, demographic factors are also able to explain short-run movements in industrial countries' saving and investment rate. In the long-run, the three variables influence the net foreign asset position of developed countries via investment. By contrast, the developing countries' net foreign asset position is impacted on through the saving rate. In the short-run, both, saving and investment, appear to be equally affected by output per capita, public debt and demographic factors. Future research could analyse the net foreign asset position from other perspectives. One possibility is to analyse the trade balance and its relationship to the net foreign asset position in developing and industrial countries. This relationship becomes vital if foreign investors become less willing to invest in a country. Any net foreign debt would have to be repaid by running trade surpluses. Thus, the interaction between net foreign assets and the trade balance might be able to shed further light on fast current account reversals.

All in all, it has become evident that international capital markets represent a research area full of relationships and observations to be investigated and questioned. In the future, it will remain important to study the properties of international capital flows since both industrial and developing countries' economies are

greatly influenced by the interconnectedness created through trade, investment and, hence, capital flows.

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A Appendix

This appendix relates to section 3.6 of chapter three and provides the solutions to a temporary world output shock, in form of a fall in foreign traded good prices, $\hat{P}_T^* < 0$, and a temporary deviation of the world real interest rate, illustrated by an increase of $\hat{\epsilon}$. The system $\mathbf{m} = \mathbf{A} * \mathbf{x}$ takes the following form under a world output shock: Under the **fixed** exchange rate regime vector $\mathbf{m}$ equals $\left[(1 - \gamma)(1 - \sigma)r\hat{P}_T^*, 0, 0, r(\sigma\gamma + (1 - \gamma))\hat{P}_T^*, 0, r\hat{P}_T^*, 0 \right]'$. The matrix $\mathbf{A}$ is followed by

$$\mathbf{A} = \begin{bmatrix} (1+r) & (1-\sigma)r & 0 & 0 & 0 & 0 & 0 \\ -(1-\gamma) & -1 & 0 & (1-\gamma) & 0 & 0 & 0 \\ 0 & -\gamma(1-\sigma) & 0 & (1-\gamma)(1+\sigma) & 0 & 0 & 0 \\ 1 & 0 & \sigma r & 0 & 0 & 0 & 0 \\ -1 & -(1-\sigma) & 0 & 0 & \sigma & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & r \\ 1 & 0 & 0 & 0 & 0 & r & 0 \end{bmatrix}$$

and vector $\mathbf{x}$ equals $\left[\tilde{C}_T, \tilde{E}, \hat{M}, \tilde{C}_N, \tilde{M}, \hat{C}_T, \hat{C}_N \right]'$. Under **floating** exchange rates $\mathbf{m} = \left[(1 - \gamma)(1 - \sigma)r\hat{P}_T^*, 0, 0, -(r\sigma\gamma + \sigma + r(1 - \gamma))\hat{P}_T^*, r\hat{P}_T^*, 0 \right]'$ while

$$\mathbf{A} = \begin{bmatrix} (1+r) & (1-\sigma)r & -(1-\sigma)r & 0 & 0 & 0 \\ -(1-\gamma) & -1 & 0 & (1-\gamma) & 0 & 0 \\ 0 & -\gamma(1-\sigma) & 0 & (1+\sigma)(1-\gamma) & 0 & 0 \\ 0 & (1-\sigma)(1-\gamma) & (r\sigma\gamma + \sigma + r(1-\gamma)) & 0 & 0 & 0 \\ (1-\gamma) & 0 & -r & 0 & 0 & r(1-\gamma) \\ 1 & 0 & 0 & 0 & r & 0 \end{bmatrix}$$

Vector $\mathbf{x}$ takes the form $\left[\tilde{C}_T, \tilde{E}, \hat{E}, \tilde{C}_N, \hat{C}_T, \hat{C}_N \right]'$.

Given equation (3.55), the solution to the world output shock under **pegs** has the following form

$$\hat{E} = \gamma\hat{P}_T^*$$

$$\tilde{E} = -\Upsilon_1(\sigma - 1)r\hat{P}_T^*$$

$$\hat{C}_T = -\Upsilon_2(\sigma - 1)\hat{P}_T^*$$

$$\tilde{C}_T = \Upsilon_2(\sigma - 1)r\hat{P}_T^*$$

$$\hat{C}_N = \hat{Y}_N = -\Upsilon_3\hat{P}_T^*$$

$$\tilde{C}_N = \tilde{Y}_N = \Upsilon_4(\sigma - 1)^2 r \hat{P}_T^*$$

For completeness the short and long-run money equations are given by

$$\hat{M} = -\Upsilon_5 \hat{P}_T^*$$

and

$$\tilde{M} = \Upsilon_6(\sigma - 1)r\hat{P}_T^*$$

Under **floats** the following solution is found:

$$\hat{E} = \hat{P}_T^*$$

$$\tilde{E} = 0$$

$$\hat{C}_T = 0$$

$$\tilde{C}_T = 0$$

$$\hat{C}_N = \hat{Y}_N = 0$$

$$\tilde{C}_N = \tilde{Y}_N = 0$$

Given a shock to the world real interest rate the system of equation (3.55) takes the following form under **pegs**: Vectors **m** and **x** equal $[\sigma\hat{e}, 0, 0, 0, 0, 0, 0]'$ and $[\tilde{C}_T, \tilde{E}, \hat{M}, \tilde{C}_N, \tilde{M}, \hat{C}_T, \hat{C}_N]'$ respectively. Matrix **A** equals

$$\mathbf{A} = \begin{bmatrix} (1+r) & (1-\sigma)r & 0 & 0 & 0 & 0 & 0 \\ -(1-\gamma) & -1 & 0 & (1-\gamma) & 0 & 0 & 0 \\ 0 & -\gamma(1-\sigma) & 0 & (1-\gamma)(1+\sigma) & 0 & 0 & 0 \\ 1 & 0 & \sigma r & 0 & 0 & 0 & 0 \\ -1 & -(1-\sigma) & 0 & 0 & \sigma & 0 & 0 \\ 1 & 0 & 0 & 0 & 0 & 0 & r \\ 1 & 0 & 0 & 0 & 0 & r & 0 \end{bmatrix}$$

Under **floats** vectors **m** and **x** take the form $[\sigma\hat{e}, 0, 0, 0, 0, 0, 0]'$ and

$[\tilde{C}_T, \tilde{E}, \hat{E}, \tilde{C}_N, \hat{C}_T, \hat{C}_N]'$. Matrix **A** takes the form

$$\mathbf{A} = \begin{bmatrix} (1+r) & (1-\sigma)r & -(1-\sigma)r & 0 & 0 & 0 \\ -(1-\gamma) & -1 & 0 & (1-\gamma) & 0 & 0 \\ 0 & -\gamma(1-\sigma) & 0 & (1+\sigma)(1-\gamma) & 0 & 0 \\ 0 & (1-\sigma)(1-\gamma) & (r\sigma\gamma + \sigma + r(1-\gamma)) & 0 & 0 & 0 \\ (1-\gamma) & 0 & -r & 0 & 0 & r(1-\gamma) \\ 1 & 0 & 0 & 0 & r & 0 \end{bmatrix}.$$

Again, following equation (3.55) the solutions to a temporary rise in the world real interest rate take the following form in the **fixed exchange rate** economy:

$$\hat{E} = 0$$

$$\tilde{E} = -\Upsilon_7 \hat{e}$$

$$\hat{C}_T = -\Upsilon_8 \hat{e}$$

$$\tilde{C}_T = \Upsilon_8 r \hat{e}$$

$$\hat{C}_N = \hat{Y}_N = -\Upsilon_9 \hat{e}$$

$$\tilde{C}_N = \tilde{Y}_N = \Upsilon_{10}(\sigma - 1)r \hat{e}$$

The short and long-run money equations follow as

$$\hat{M} = -\Upsilon_{11} \hat{e}$$

and

$$\tilde{M} = \Upsilon_{12} r \hat{e}$$

Under **floating exchange rates** the solutions are

$$\hat{E} = -\Psi_1(\sigma - 1)\hat{e}$$

$$\tilde{E} = -\Psi_2 \hat{e}$$

$$\hat{C}_T = -\Psi_3 \hat{e}$$

$$\tilde{C}_T = \Psi_3 r \hat{e}$$

$$\hat{C}_N = \hat{Y}_N = -\Psi_4 \hat{e}$$

$$\tilde{C}_N = \tilde{Y}_N = \Psi_5 (\sigma - 1) r \hat{e}$$

Υ_i and Ψ_j are functions of the model's parameter σ, r and γ . The Υ_i and Ψ_j , where $i = 1, \dots, 12$ and $j = 1, \dots, 5$, are all greater than zero, > 0 .

B Appendix

This appendix discusses the adjustment process under fixed and flexible exchange rates to temporary shocks to foreign prices and the world real interest rate. It applies to cases (1) and (2) of section 3.3.6 in chapter three.

The temporary **shock in world output** is modelled by a decline in the price for the foreign tradable good, $\hat{P}_T^*$. Figures 3.1 to 3.6 depict the effect of this shock. In the first case under consideration, (1) $\sigma > 1$, the real exchange rate depreciates in the short-run under both floats and pegs. However, as Figure 3.1 shows, the rate of the real depreciation is stronger under floating exchange rate regimes. The strong real depreciation completely insulates the floating exchange rate economy against the external shock. This is due to the fact that the nominal exchange rate acts as a shock absorber and inversely mirrors changes in the external variable. The fall in foreign tradable good prices leads the nominal exchange rate to depreciate (rise) by the same amount. As a consequence, the home price for traded goods remains unchanged. No further adjustment of the long-run real exchange rate, output and the trade balance is required. Under pegs the nominal exchange rate is not able to cushion the external shock and the price fall in foreign traded goods decreases domestic traded good prices. Hence, consumption of nontraded goods becomes relatively more expensive and production in the nontraded goods sector declines in the short-run as illustrated in Figure 3.5. The negative impact on nontraded consumption spills over into the traded good sector since the elasticity of substitution between traded and nontraded goods is low in relation to the intertemporal elasticity. It follows that the negative short-run traded good consumption is accompanied by a trade balance surplus under pegs (Figure 3.3). However, in the long-run, the current account needs to be balanced. Hence, the long-run consumption of tradable goods must rise to allow for a trade balance deficit. The deficit is required to decumulate the short-term net foreign assets. Figure 3.4 illustrates this mechanism. Hence, the pegging country is required to run a trade deficit to spend the outstanding assets and thereby needs to consume a higher amount of traded goods. The increase in long-run tradable consumption requires a real appreciation of the long-run real exchange rate (Figure 3.2). The production and consumption of nontraded goods improves in Figure 3.6. This is due to a positive wealth effect since households are required to decumulate foreign assets to spend their assets

by consuming more goods. The wealth effect influences the desire to consume more nontraded goods in the long-run. This effect is stronger than the desire to reduce labour supply when consumption increases.

In the second case, (2) $\sigma = 1$, the short-run depreciation of the real exchange rate (Figure 3.1) and its negative stimulus on short-run nontraded goods consumption under pegs (Figure 3.5) does not affect the tradables, neither in the short nor in the long-run. Accordingly, the current account remains balanced and there are no long-run effects for the nontraded good production and the real exchange rate. For the floating exchange rate economy the same holds as under case (1).

Figures 3.7 to 3.12 demonstrate the adjustment of the economy under different exchange rate regimes to a temporary **increase in the world real interest rate**, $\hat{e}$. In case (1), $\sigma > 1$, the intertemporal substitution effect dominates and the fall in the nontraded good consumption is stronger under the floating regime, as Figure 3.11 indicates. The more pronounced deterioration in nontraded good consumption is due to the real exchange rate appreciation under floats (Figure 3.7). Equation (3.26) and the assumption of constant foreign traded good prices imply that an appreciation of the real exchange rate is followed by a nominal appreciation. The fall in the nominal exchange rate reduces the price of traded goods (LOOP condition) and, therefore, makes nontraded good consumption relative more expensive under floats. However, the elasticity of substitution between nontraded and traded goods is low in relation to the intertemporal elasticity, $\sigma > 1$, and, hence, the negative effect of nontradable consumption spills over into the consumption for traded goods. A trade balance surplus is generated in the short-run. Figure 3.9 shows that the positive trade balance effect is stronger under floating exchange rates. As Figure 3.10 demonstrates, the trade surplus in the first period allows households to run a trade balance deficit and, hence, a positive consumption in traded goods in the long-run. The rise in long-run tradable consumption requires a long-run real appreciation, which is depicted in Figure 3.8. The appreciation of the real exchange rate is more pronounced under the floating exchange rate regime than under pegs. The positive long-run consumption of tradable goods spills over into the nontraded good sector and increases consumption and production. Figure 3.12 shows that the effect is similar under both exchange rate regimes.

For case (2), where $\sigma = 1$, the short-run real exchange rate does not respond

to a temporary change in the world real interest rate. Figure 3.7 shows that this result holds for both regimes under consideration. Consequently, the fall in short-run consumption coincides in the floating and pegging exchange rate regime (Figure 3.9 and 3.11). Accordingly, the current account changes in the short and long-run, Figure 3.9 and 3.10, are identical under both regimes. No long-run effects appear in the nontradable goods production (Figure 3.12) and the long-run real exchange rate remains unchanged, as illustrated in Figure 3.8.

C Appendix

The appendix explains in more detail the demographic specification of chapter four. As in Lane and Milesi-Ferretti (2002) the population is divided into $J = 12$ age cohorts. The age variables enter the saving and investment equation as $\sum_{j=1}^{12} \alpha_j p_{tj}$. p_{tj} is the population share of cohort j in period t . A key restriction is that $\sum_{j=1}^{12} \alpha_j = 0$. The age coefficient α_j can be obtained from a cubic polynomial

$$\alpha_j = \delta_0 + \delta_1 * j + \delta_2 * j^2 + \delta_3 * j^3.$$

The zero sum restriction of the α -coefficients allows to obtain δ_0 by the following equation:

$$\delta_0 = -\frac{\sum_{j=1}^{12} j}{J} * \delta_1 - \frac{\sum_{j=1}^{12} j^2}{J} * \delta_2 - \frac{\sum_{j=1}^{12} j^3}{J} * \delta_3.$$

The δ_1 , δ_2 and δ_3 can be obtained by estimating a model in the following way

$$\delta_1 DEM_{1t} + \delta_2 DEM_{2t} + \delta_3 DEM_{3t},$$

with

$$\begin{aligned} DEM_{1t} &= \sum_{j=1}^{12} j p_{tj} - \frac{\sum_{j=1}^{12} j * \sum_{j=1}^{12} p_{tj}}{J}, \\ DEM_{2t} &= \sum_{j=1}^{12} j^2 p_{tj} - \frac{\sum_{j=1}^{12} j^2 * \sum_{j=1}^{12} p_{tj}}{J} \text{ and} \\ DEM_{3t} &= \sum_{j=1}^{12} j^3 p_{tj} - \frac{\sum_{j=1}^{12} j^3 * \sum_{j=1}^{12} p_{tj}}{J}. \end{aligned}$$

From the estimated δ_1 , δ_2 and δ_3 the δ_0 can be recovered and all four coefficients can be utilised to calculate the α_j .