Three Essays on the Macroeconomic Effects of International Capital Flows

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Abstract

This thesis presents three essays on the role of international capital flows in growth, real exchange rate behavior and the conduct of domestic monetary policy in four Asian economies. The first chapter develops an endogenous growth model based on an infinitely-lived optimizing representative agent. Data from the four Asian countries is used to test the implications of the model. Using applied time series econometric techniques, the results for Malaysia, Philippines and Thailand lend credence to the endogenous growth process, while it is rejected for Indonesia. Chapter 2 develops a three-good model for the internal real exchange rate to identify the fundamental determinants of the internal real exchange rates for exports and imports. The examination of the time series properties of the variables suggests that the internal real exchange rates in the ASEAN-4 countries were indeed driven by the fundamentals derived from the model. Furthermore, the results indicate that there was no misalignment between the actual and equilibrium real exchange rates. Movements in the real exchange rates were thus equilibrium responses to changes in the fundamentals. The third chapter estimates coefficients of capital flow offset to domestic monetary policy and sterilization and analyzes the implications for domestic monetary autonomy. The relative performance of the monetary model and the portfolio balance model is compared using quarterly data for the four countries. The empirical results show that the capital flow offset was less than complete and that sterilization turned out to be ineffective in three of the four countries.

Resumé

Cette thèse présente trois essais sur le rôle des capitaux étrangers dans la croissance économique, le taux de change et la conduite de la politique monétaire domestique pour 4 pays asiatiques. Le premier chapitre présente un modèle de croissance endogène base sur un agent représentatif éternel. Les implications du modèle sont testées avec des données de chaque pays asiatique. Les résultats des séries chronologiques pour la Malaisie, les Philippines et la Thaïlande tendent à soutenir l'hypothèse de la croissance endogène tandis que l'analyse des données indonésiennes suggère plutôt une rejection du modèle endogène.

Le deuxième chapitre développe un modèle avec trois biens pour que le taux réel interne de change puisse identifier les déterminants des taux réels des importations et des exportations. L'analyse des séries chronologiques suggère que les taux réels internes de change sont influencés par les facteurs fondamentaux compris dans le modèle. On peut donc affirmer que les changements des taux réels de change des pays sous considération sont en réponse à des changements de facteurs fondamentaux.

Le troisième chapitre estime l'effet de la politique monétaire domestique et de la stérilisation de l'effet des capitaux étrangers sur les flots de capitaux. On compare les performances relatives du modèle monétaire et du modèle d'équilibre de portefeuille en utilisant des données trimestrielles des quatre pays asiatiques. Les résultats suggèrent que le contre-balancement des flots de capital a été incomplet et que la stérilisation n'a que peu fonctionné dans trois des quatre pays.

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Introduction

This thesis explores the role of foreign capital in three important areas of the economies of recipient countries: growth, real exchange rate behavior and the conduct of domestic monetary policy. The study includes four members of the Association for Southeast Asian Nations: Indonesia, Malaysia, Philippines and Thailand (ASEAN-4). These countries were among the top recipients of foreign capital during the period 1970-96. Furthermore, they had been growing at remarkable rates before the financial crises of 1997-98. During the period 1980-1996, Malaysia, Thailand and Indonesia experienced an average growth rate of 8% while the Philippines grew at an average rate of about 5 %. Moreover, Malaysia and Thailand were considered to be the next generation of Asian "tigers". This group of countries is also said to have intervened regularly in their foreign exchange and money markets to maintain real exchange rates at internationally competitive levels. Given these characteristics, it would be interesting to examine whether or not the economies of the four members of ASEAN were suffering from structural weaknesses during the period prior to the financial crises. For example, was long term growth dependent on foreign capital? Were the Asian economies losing domestic and international competitiveness for their traded goods owing to the massive inflow of foreign capital? To what extent did foreign capital flows frustrate domestic monetary policy? Did the authorities undermine macroeconomic stability by pursuing vigorous sterilization policy in response to movements in foreign capital? Addressing these questions will no doubt contribute to an understanding of the macroeconomic consequences of foreign capital and, to some degree, clarify whether real factors contributed to the onset of the Asian crises of 1997-98.

Foreign capital can enhance growth in developing countries by accelerating capital accumulation or by raising efficiency. Foreign capital allows host countries to implement higher investment rates without lowering their consumption levels. Higher capital stocks induce learning by doing which raises productivity among domestic firms. An increase in the productivity of domestic firms can also occur because of spillovers from foreign-owned firms. However, foreign borrowing can also lead to the accumulation of debt which may have positive or negative effects on long term growth. If long term debt capital generates sufficient returns to pay interest to creditors and profits to owners, then it contributes positively to growth. If long term debt capital fails to generate enough returns to cover interest and other costs, for example, due to moral hazard, then its effect on growth will be negative. Publicly guaranteed private debt can generate such moral hazard. In this case, interest payments on long term debt could be a drag on the economy.

Another role of foreign capital is that it affects a key relative price variable, namely the real exchange rate. Since the real exchange rate links the domestic economy to the rest of the world, its behavior is an important component of development strategy for countries that promote export-led growth. An unwelcome effect of capital inflows is that they exert upward pressure on the real exchange rate. In the flexible exchange rate regime, capital inflows tend to appreciate the real exchange rate by appreciating the nominal exchange rate, at least over the period during which prices are sticky. In a fixed exchange rate world, capital inflows induce a real appreciation by expanding the domestic money supply and boosting aggregate demand, thereby raising the price of nontraded goods. This undermines the competitiveness of exports and price stability. The fall in export growth leads to greater current account deficits and a decline in growth performance. Whether or not the fundamentals-driven real exchange rate and the actual real exchange rate significantly deviate from each other during the period under consideration in the ASEAN-4 is an issue that merits study. The presence of such real exchange rate misalignment can be interpreted as a strong signal of structural weakness that would eventually lead to a crisis.

The third role of foreign capital flows to developing countries concerns their impact on the conduct of domestic monetary policy. The "impossible" trinity is familiar in the theory of international monetary economics: a fixed exchange rate, an open capital account and an independent monetary policy cannot exist side by side. It is well known that in a fixed exchange rate regime, capital movements may reduce the ability of the authorities to control the money supply. The tension between monetary policy autonomy and fixed exchange rates sharpens as capital movements approach perfect mobility. Under perfect capital markets monetary policy cannot be used to stabilizing income and employment. The impotence of monetary policy is driven by the behavior of investors to optimize returns by switching between domestic and foreign assets in response to return differentials. If capital mobility is less than perfect, then there is limited asset substitutability so that domestic monetary policy is not completely constrained by capital mobility. In this case monetary authorities have some degree of control over the money supply and the interest rate. In the absence of Ricardian equivalence, monetary authorities can use sterilization policy to influence domestic monetary conditions. However, as Obstfeld (1982) argued, even under limited substitutability sterilization may not work if agents are Ricardian. Calvo (1991) also argued that under some conditions sterilizing inflows may end up attracting more inflows. In order to persuade investors to hold domestic assets, the monetary authorities have to offer interest rates higher than the rates they receive on their foreign assets. The higher domestic interest rate implies an increased burden on the consolidated public sector budgetary accounts. More importantly, the relative rise in the domestic interest rate would attract more capital inflows, rendering the sterilization policy ineffective.

Chapter 1 uses an endogenous growth framework to examine empirically the effect of foreign capital on the long term growth performance. Three categories of long term foreign capital (foreign investment, foreign aid and long term debt capital) along with other determinants of growth relevant for the sampled countries are used in the empirical analysis. The objective of this chapter is to test whether or not there is time series evidence in favor of the endogenous growth theory in the selected Southeast Asian countries. Applied time series econometric techniques are utilized to conduct the empirical investigation regarding the relationship between the above variables and the growth rate of real per capita income. The analysis is carried out for the four countries using data from 1970-1996.

One of the fundamental tenets of the new growth theory is that it rejects the neoclassical assumption of diminishing returns to capital and attempts to explain technological progress by the generation of knowledge through private and/or public investment in R & D. Based on the new growth theory, research on the determinants of growth in developing countries has identified trade and foreign investment as important vehicles for the diffusion of technology. In this respect, foreign capital can be an important source of advanced technology for developing countries. Foreign capital enables low income countries to carry out investment levels higher than their domestic savings given that foreign capital acts as a supplement to domestic saving. The rise in investment rates enhances capital accumulation which leads to the use of new inputs and superior technology in the recipient country. The use of new inputs enhances growth. With regard to new inputs, output growth can result from the application of a wide variety of intermediate inputs. In the case of new technologies, output growth is the outcome of productivity improvement caused by spillovers to domestic firms. Feenstra and Markusen (1994) argue that foreign direct investment carries more force as a conduit for the transfer of new inputs and new technologies than other types of capital flows such as portfolio investment foreign aid and short term capital. Foreign capital flows in the form of direct investments also have the potential to serve as conduits for the transfer of managerial and marketing skills to developing countries. In other words, the activities of foreign firms participating in the domestic economy generate forces that intensify efficiency and competitiveness which domestic firms must observe in order to stay in the market.

The empirical investigation used times series data to test whether or not the new growth theory is relevant in describing the growth process in the ASEAN-4. Unit root and cointegration tests produced interesting results for each country in the sample.

For Indonesia we find that the growth rate of per capita income is stationary, indicating that its long run value is its mean. Aid to GDP ratio is also found to be stationary while the other growth determinants are found to contain unit roots. The implication of this is that the growth rate of real per capita income and its hypothesized determinants are not cointegrated. Thus, although equity capital, long term debt capital, openness to trade and public capital experienced permanent changes over the period under consideration, they failed to bring about permanent changes in the growth rate or per capita income in Indonesia. The data for Indonesia do not, therefore, support the endogenous growth process during the sampled period.

In view of the mixed features of the data, we further analyzed the Indonesian data using the method of vector autoregression (VAR). Given the stationarity of the dependent variable, the growth rate of real per capita income, this approach is pertinent for examining any interactions among the variables over the short to medium term period. The variables with unit roots were first-differenced before they were included in the VAR. Accordingly, the first difference of equity capital, debt capital, public capital, and openness to trade expressed as ratios to GDP, were included in the VAR along with aid to GDP ratio and the growth rate of per capita income. Granger causality tests confirm that positive causation runs from equity capital, public capital and openness to trade to the growth rate of per capita income both individually and jointly. However, long term debt capital is found to have adverse effects on growth.

For the other three countries, we find evidence in favor of the new growth theory. Permanent changes to foreign investment and trade openness cause permanent changes in the growth rate of per capita income. Thus, policies that promote foreign investment and trade openness would enhance growth in all three countries. Aid and public infrastructure have also contributed to growth. Long term debt capital, however, adversely affected growth in Thailand while it had positive but insignificant effects in Malaysia and Philippines.

Chapter 2 examines the behavior of the real exchange rates for the four countries. Two real exchange rates are defined: the internal real exchange rate for exports (Q_X) and the internal real exchange rate for imports (Q_M). Since the internal real exchange rate for exports is the ratio of the domestic price of exports to the domestic price of non-traded goods, it is a summary measure of domestic competitiveness. A rise in the ratio indicates an improvement in the competitiveness of traded goods relative to nontraded goods while a fall in the ratio implies deterioration in the competitiveness of traded goods production in the economy. The internal real exchange rate for imports, on the other hand, is the ratio of the domestic price of imports to the domestic price of non-traded goods. As long as developing countries' imports are largely made up of manufactured goods from industrial countries, changes in the internal real exchange rate for imports reflect changes in international competitiveness facing the developing countries. The fundamentals approach to real exchange rates is used to examine the behavior of the two real exchange rates. A distinction that is relevant for the study of real exchange rates is the difference between actual and equilibrium real exchange rates. While the actual real exchange rate is the real exchange rate that prevails at any one time in the life of the economy, the equilibrium real exchange rate is the rate that is consistent with the fundamentals. If the actual real exchange rate is equal to the equilibrium real exchange rate then it is in line with what is dictated by the fundamentals. If the actual real exchange rate significantly deviates from the equilibrium real exchange rate, then it is inconsistent with the fundamentals and unless corrected in time, is bound to lead to a crisis. The fundamentals used in this analysis were capital inflows, terms of trade, productivity and openness to trade. Time series analysis of the data shows that the internal real exchange rate for exports and its fundamentals are cointegrated. Likewise, the internal real exchange rate for imports and its fundamentals are also found to be cointegrated. This means that there was no indication of loss of competitiveness for traded goods in the domestic as well as in international markets. Furthermore, estimates of the error-correction model show that adjustment to equilibrium occurred in each country. The significance of the error correction model indicates that movements in the real exchange rate were equilibrium responses to changes in the fundamentals. The implication of this is that real exchange rates in the ASEAN-4 countries were dictated by fundamentals and that the data do not support the idea of real exchange rate misalignment during the pre-crisis period.

Chapter 3 analyzes the effect of capital flows on the conduct of domestic monetary policy in each of the four countries. In a fixed exchange rate world, unsterilized capital inflows may result in some loss of monetary control. If the monetary authorities are committed to keep a fixed exchange rate, capital inflows will lead to the accumulation of international reserves, which may result in an undesirable expansion of monetary aggregates. This leads to a rise in prices, an expansion in aggregate demand, an appreciation of the real exchange rate and deterioration in the current account.

The policy response to the undesired monetary growth, at least in some countries, has been sterilization of the capital inflows. The central bank carries out a transaction equal in size but opposite in sign to its foreign exchange intervention. However, sterilization can be self defeating by triggering higher interest rates and more inflows. In a fixed exchange rate world, the effect of capital flows on domestic monetary policy is affected by the degree to which capital is mobile. If capital is perfectly mobile, then capital flow offset is complete which implies that for every change in the domestic component of the monetary base, there will be an equivalent but opposite change in external transactions. In this case, monetary policy is powerless to influence domestic targets. If capital flow offset is less than perfect, domestic monetary policy is not completely constrained by capital flows and monetary authorities may have some degree of influence on their money supply and the interest rate. In this case, only part of the change in the money supply will be offset by capital movements and the rest will affect domestic targets.

We use both the monetary and the portfolio balance models to estimate offset and sterilization coefficients and compare the performance of each model for each country. OLS and TSLS methods are used for estimation. The monetary model is found to perform better in countries with no bond market and relatively open capital account (Indonesia) while the portfolio balance model performs better in countries with well functioning bond markets (Malaysia, Philippines and Thailand). In all cases, we find that the absolute value of the estimated offset coefficients were close to but less then 1, indicating that the capital accounts of these countries were strongly sensitive to changes in domestic monetary conditions. Thus, capital mobility undermined monetary autonomy in the ASEAN-4 countries. Despite the formidable difficulty posed by capital flows, sterilization policy was pursued by the authorities in all the four countries. While the authorities in Indonesia and Malaysia sterilized only small proportions of capital flows, those in Thailand and Philippines pursued vigorous sterilization. These differences can be used as indicators of the preferences of the authorities with regard to internal and external balance. Indonesia and Malaysia placed more emphasis on external balance while Philippines and Thailand were concerned more with internal balance. In order to assess the effectiveness of sterilization policy, we estimated an interest rate equation with a sterilization variable on the right hand side of the equation. The results show that the coefficient of the sterilization variable was correctly signed and statistically significant only for Thailand. In the remaining three countries, sterilization policy was largely ineffective.

The reader should note that each chapter of the thesis can be read independently. The appendices provided at the end of each chapter are relevant only for that chapter.

Variable names and definitions do not also carry over from one chapter to the other.

Chapter1: Foreign Capital and Growth in Developing Countries

1.1 Introduction

Economic growth is affected by many different factors. Natural resources, human resources, saving and investment, ideas and know-how, environmental and climatic conditions, government behavior, peace and stability, work ethic, cultural and social beliefs, legal and institutional settings and openness to trade all contribute to economic growth, with each factor having differing impacts across regions and over time. In developing counties where raw labor is abundant and saving per capita are low, the most commonly identified constraints to growth are trained workforce, capital accumulation and technology. Under certain conditions, foreign capital may ease the supply of these resources. In addition to supplementing domestic savings and enhancing capital accumulation, foreign capital can also be an important source of advanced technology for developing countries.

The main benefits of foreign capital for developing countries are higher growth, higher capital stock, employment expansion, skill transfers and consumption smoothing. Foreign capital enables low income countries to carry out investment levels higher than their domestic savings permit. This causes a rise in the rate of capital accumulation which leads to the use of new inputs and superior technologies in the recipient country. The use of new inputs and technologies enhances growth. With regard to new inputs, output growth can result from the application of a wide variety of intermediate inputs. In the case of new technologies, output growth is the outcome of productivity improvement caused by spillovers to domestic firms. Feenstra and Markusen (1994) argue that foreign direct investment carries more force as a conduit for the transfer of new inputs and new technologies than other types of capital flows such as portfolio investment, foreign aid and other short term capital. Lessard and Williamson (1985) documented the significance and beneficial effects of long term capital flows on economic development. Borenszstein et al. (1998) examined two important channels through which foreign investment affects growth. Foreign capital could contribute to growth by augmenting capital accumulation in the recipitent country as long as it does not crowd out equal amount of investment from domestic sources by competing in product or financial markets. Foreign capital could also accelerate growth if it results in a direct transfer of new technology to the host country. Foreign capital flows in the form of direct investment have also the potential to serve as conduits for the transfer of managerial and marketing skills to developing countries. In other words, the activities of foreign firms participating in the domestic economy generate forces that intensify efficiency and competitiveness which domestic firms must observe in order to stay in the market. Foreign capital flows can also help consumers in developing countries to keep consumption levels steady in the wake of fluctuating incomes through borrowing and lending in international markets.

Theoretically, foreign capital can have two roles in the process of capital accumulation. Foreign capital can be a substitute for domestic savings. Countries can increase their rates of investment without lowering consumption levels by borrowing abroad. Alternatively, foreign capital may act as a supplement to domestic savings. An economy with a high savings rate raises its domestic capital stock and thereby increases the marginal product of foreign capital. This tends to raise output and the stock of net external debt. Using a neoclassical model of growth, Verdier (2004) developed an empirical model with imperfect capital markets that emphasizes the complementary role of domestic savings in the process of debt accumulation. The empirical results showed that debt accumulation exhibited convergence and was positively correlated to domestic savings in three samples of size 24, 30 and 42 countries.

While foreign capital may enhance domestic capital accumulation, neoclassical models are not suitable for understanding its long term effect on economic growth. In these models, foreign capital augments domestic savings and its effect on growth is limited to the short run, the magnitude and duration of which depend on the transitional dynamics to the steady state growth path. Long term growth is driven by exogenous technological progress and/or labor force growth. The new growth theory, however, provides a framework for analyzing the presence or absence of a long term relationship between foreign capital and growth. De Mello (1996a) found time series evidence in favor of endogenous growth for five Latin American countries and De Mello (1997) provided an extensive survey of theory and empirical evidence on the relationship between foreign investment and long term growth. The point underscored is that foreign investment can positively affect long term growth in so far as it generates increasing returns in production and productivity spillovers. Using firm-level micro data, Ito and Krueger (2000) analyzed the link between foreign direct investment and productivity growth in East Asia. Other studies such as the World Bank (1993) have attributed the growth in Asia to the technology spillovers domestic firms receive from the expansion of manufacturing exports to advanced countries markets. While micro-level issues and export expansion may be useful for understanding technology transfers, previous studies have not considered the link between long term growth and foreign capital in South East Asia within the framework of the new growth theory. Moreover, since different types of foreign capital may have different effects on long term growth, disaggregating foreign capital into its components would greatly benefit the analysis of foreign investment and growth.

This chapter attempts to address the effect of foreign capital on long term growth from a macroeconomic perspective. Using the new growth theory, it develops an empirical model to examine the relationship between foreign capital and growth. The objective of this chapter is to test whether the endogenous growth framework describes the growth process in South East Asia using data from 1970-1996. It examines empirically, the effects of the components of long term capital flows (foreign investment, foreign aid, and long term debt capital) on long run growth using the new growth theory as an analytical framework. An attempt is thus made to test whether permanent changes in foreign capital inflows causes permanent changes in the rate of growth of real per capita income in the recipient countries while controlling for other growth determinants. Applied time series econometric techniques are utilized to determine the effect of foreign capital on long term growth. In particular, the method of unit roots and co-integration is employed to empirically measure the significance of the contribution of foreign capital to growth in the South East Asian countries of Indonesia, Malaysia, Philippines and Thailand.

These countries are included in the analysis for four important reasons. First, these countries belong to the Association of Southeast Asian Nations (ASEAN) which is a regional cooperation for trade. This would mean that these countries generally operate under more or less similar environment in regard to their relationship with each other and with the rest of the world. Second, they have been the largest recipients of foreign capital in the group of developing countries. Third, they pursued an outward oriented development strategy, albeit with different degrees of openness in their trade regimes. Finally, starting as low income countries in the late 1960s, these economies have transformed themselves into middle income countries by the mid-1990s, registering spectacular growth rates until they were hit by the 1997-98 East Asian financial crises. Since the study focuses on the period 1970-96, it aims to shed some light on the fundamental determinants of growth during the period prior to the crisis. It is hoped that this will partly contribute to the understanding of the Asian financial crisis by empirically assessing the role played by long term foreign capital in the growth process of the countries in the sample. The chapter is organized as follows: section two provides theoretical and empirical motivation. Section three develops the analytical framework for testing the hypothesis under consideration. Section four presents data analysis and empirical results. Section five contains summary of findings and concluding remarks.

1.2 Theory and Evidence

Although from different perspectives, both the neoclassical and new growth theories point to technology as a driving force of long term growth. In neoclassical growth models, as in Solow (1956), foreign capital is simply an addition to domestic savings.

Foreign capital, therefore, increases the rate of investment in the host country and with diminishing returns to physical capital, foreign capital can only affect the level of income, but not the long term growth rate of the economy. The effect of foreign capital on growth is limited to the short run transition period between steady states. Once the economy completes the transition period, it converges to its steady state growth path as if it had received no foreign capital in the past. Foreign capital, therefore, leaves no permanent effect on output growth. In these models, labor and technical progress which are treated as exogenous factors determine long term income growth. The saving rate, though treated as exogenous, has no effect on the long run growth rate. Capital accumulation is, therefore, not crucial for long term growth. It only affects growth outside steady states.

The policy implication of these models is that governments cannot influence the steady state growth rates of their economies. Economic policy is rather limited to the question of whether or not intervention reduces the length of the adjustment period the economy is displaced from its long run growth path.

An important offshoot of the neoclassical growth model is the growth accounting technique pioneered by Solow (1957) and Denison (1962, 1967). This technique is used to estimate the contributions of the factors of production and technical change to the growth rate of output in the context of time series or cross-country growth equations. The typical neoclassical growth model utilizes a production function with homogeneity of degree one that allows for capital labor substitutability and is subject to diminishing returns to factors. The generalized aggregate production function with the above properties takes the form

$$Y_{(t)} = A_{(t)}F(K_{(t)}, L_{(t)}, Z_{(t)}) \qquad (1)$$

where Y, A, K, L, Z (each subscripted with time) are output, technology, capital stock, labor and other ancillary variables, respectively. Taking logarithms and time derivatives of (1), the following growth accounting equation obtains:

$$g_Y = g_A + e_K g_K + e_L g_L + e_Z g_Z \qquad (2)$$

where the left hand side is the growth rate of output, the first term in the right hand side is the growth rate of technology, the second term is the growth rate of capital weighted by the elasticity of output with respect to capital, the third term is the growth rate of labor weighted by the elasticity of output with respect to labor and the last term is the growth rate of an ancillary term weighted by the elasticity of output with respect to such term. Equation (2) says that the growth rate of output is the sum of the growth rate of technology and the growth rates of inputs weighted by their elasticities. Another interpretation of (2) is that assuming competitive factor markets and factors receive their marginal products, the input elasticities, e_K, e_L, and e_Z are the shares in income of capital, labor and other ancillary variables, respectively.

From (2) the equation for technical progress is

$$g_A = g_Y - e_K g_K - e_L g_L - e_Z g_Z \qquad (3)$$

Equation (3) defines total factor productivity (TFP), which is commonly known as the Solow residual. The model assumes disembodied neutral technical change available to the economy at no cost. However, if disembodied technical change is assumed to depend on time only, a time trend can be added to the right hand side of equation (2). The residual then represents embodied technical change.[1]

The neoclassical model left many economists unsatisfied both on theoretical and empirical grounds. On the theoretical front, the model relegates the determinants of technical progress outside the scope of main-stream economics. On the empirical side, the model predicts that the elasticity of output with respect to capital should be equal to the share of capital in total output. While the average share of capital in total income is around 0.30, estimates from a cross section of countries indicate much higher value of 0.65[2]. The discrepancy between the share of capital in total income and the estimated capital elasticity coefficient from growth accounting called for explanation. As a response to this, research programs were redirected in two areas of work. One line of empirical work maintained the neoclassical model as the basic framework but redefined capital in broader terms to include both physical and human capital, giving rise to the so called 'augmented Solow model'. Mankiw, Romer and Weil (1992) estimated an augmented Solow model by including human capital as an explanatory variable in their model. Their empirical results showed that the Solow model improved its performance dramatically when human capital was included. Nonnman and Vanhoudt (1996) further extended the Mankiw, Romer and Weil (1992) augmented Solow model by including 'know-how' as an additional input in their production function. Know-how was measured by annual R & D spending as a percentage of GDP. Nonnman and Vanhoudt (1996) found that their model performed better than the augmented-Solow model of Mankiw,

[1] For details see Shaw (1992), Romer (1994), De Mello (1997) and Romer (2001).
[2] See, for example, Nonneman and Vanhoudt (1996), Mankiw etal (1992), Benhabib and Jovanovic (1991) and Romer (1990).

Romer and Weil (1992). Benhabib and Jovanovic (1991) estimated a different version of the augmented Solow model. Assuming that knowledge causes capital and not the other way round, they specified a model with knowledge that is subject to stochastic shocks and tested if there were externalities to capital and labor and if the model accounted for the variation in cross-country and time series growth rate. Their results indicated that there was no externality from knowledge to capital and labor. They concluded that the Solow model with no externality to capital and labor but with stochastic shocks to knowledge is consistent with long run data on output, capital and labor.

A growth accounting equation that includes foreign capital as an additional input can be derived from an aggregate production function augmented with foreign capital. The aggregate production function is cast in the tradition of the neoclassical growth theory in which the standard properties of the function are maintained. The equation can be used to estimate the relationship between foreign capital and growth. The foreign capital augmented production function takes the form

$$Y_{(t)} = A_{(t)}Q(K_{(t)}, L_{(t)}, F_{(t)}, Z_{(t)}) \tag{4}$$

where $F_{(t)}$ is foreign capital inflows per period and the rest of the notation is as in (3). All the explanatory variables in (4) are stocks except $F_{(t)}$ which is a flow variable. The appropriate foreign capital variable that should be included in (4) would have been an index of foreign owned capital stock. Another alternative is to convert all the variables in (4) into flows. In this case, the investment to GDP ratio is used as a proxy for the domestic capital stock and the foreign capital inflows are expressed as a ratio to GDP.[3] Similarly, labor and the relevant ancillary variables should be converted into flows to maintain consistency. Taking logarithms and time derivatives, the growth equation becomes:

$$g_y = g_A + \eta_K g_K + \eta_L g_L + \eta_F g_F + \eta_Z g_Z \qquad (5)$$

where g stands for the growth rate of its subscript, η is the elasticity of output with respect to the relevant factor. Assuming a constant returns Cobb-Douglas production function, (5) can be modified as

$$g_y = g_A + \eta_k g_k + \eta_f g_f + \eta_z g_z \qquad (5`)$$

where y, k, f, and z are in per capita terms. Two things immediately attract attention. One is the relationship between foreign capital and growth (given by η_f) and the other is the elasticity of output with respect to capital (η_k). If η_f is positive, the neoclassical model interprets this as a measure of the short term impact on growth in which foreign capital inflow increases the speed of adjustment toward steady state. Long term growth depends only on technical progress and the only avenue for foreign capital inflow to influence long term growth is if it induces a beneficial technological shock in which case it will be subsumed in g_A. With regard to capital elasticity, the estimated coefficient from growth equations such as (5) is found to be large compared to capital's share in output. This high capital elasticity coefficient has been accorded different interpretations. Romer(1990) considers it as evidence of endogenous growth. Mankiw, Romer and Weil (1992) explain the high capital elasticity as a phenomenon resulting from an omitted

[3] Investement to GDP ratio is not a good proxy for capital services. It could in principle be zero or negative while the service from the stock of capital is positive. However, the literature in growth theory uses this ratio as a proxy because of the difficulty associated with the measurement of capital services. See for example, Barro and Sala-i-Martin (1995).

variable, human capital, arguing that capital should be defined in broader terms to include other additional inputs. Benhabib and Jovanovic (1991) and Benhabib and Spiegel (1994) take the view that the additional inputs can generate externalities resulting in high capital elasticity coefficient. Young (1992; 1995), however, attributes the high capital elasticity to omitted variables and simultaneity bias. If the per capita capital stock and technological change (contained in the error term) are correlated, then the estimated capital elasticity will be higher than capital's share in output.

The presence of externality effects associated with additional inputs in the production function can be demonstrated using foreign capital and by imposing certain structures on the model. As an illustrative device, following de Mello (1997), consider a production function in which output is produced in the host country with labor and physical capital. Physical capital is of two types: domestic capital, K_t or foreign-owned capital in the host country, F_t due to, for example, foreign direct investment. Denote the stock of knowledge of the host country by H_t. Suppose also that the production function is Cobb-Douglas. Specifically, the production function of the host country in per capita terms is

$$y_{(t)} = A_{(t)}F(k_{(t)}, H) = A_{(t)}k_{(t)}{}^{\alpha} H_{(t)}^{1-\alpha} \tag{6}$$

where α is the proportion of total income accruing to domestic capital and A represents scale efficiency. Diminishing returns to domestic capital prevail when $\alpha < 1$.

Further, suppose that the stock of knowledge in the recipient country depends on domestic as well as foreign capital in the following fashion:

$$H_{(t)} = \left[k_{(t)} f_{(t)}^{\rho}\right]^{\gamma} \tag{7}$$

De Mello (1997 interprets the parameters ρ and γ, respectively as the marginal and intertemporal elasticities of substitution between domestic and foreign capital.

Inserting (7) in (6) gives the following:

$$y_t = A_t k_t^{\alpha+\gamma(1-\alpha)} f_t^{\rho\gamma(1-\alpha)} \tag{8}$$

The idea that foreign capital positively affects H can be justified on the grounds that foreign capital allows the recipient country to have access to a variety of tangible and intangible assets that increase the level of knowledge. Dunning (1981) argues that such benefits are expected to cause increasing returns and faster growth. Thus, if ρ and γ in equation (7) are positive then there is intertemporal complementarity between domestic and foreign capital. If $\gamma < 0$, however, there is intertemporal substitution between the two factors of production. The growth accounting equation corresponding to (8) is

$$g_{yt} = g_{At} + [\alpha + \gamma(1-\alpha)]g_{kt} + [\rho\gamma(1-\alpha)]g_{ft} \tag{9}$$

where g_k and g_f are the growth rates per period of domestic and foreign capital. As before, g_A is the growth rate of total factor productivity. In the presence of complementarity ($\gamma > 0$), the capital elasticity coefficient in (9) increases by $\gamma(1-\alpha)$. Hence, a high estimate of capital elasticity can be attributed to externalities generated by foreign capital. Benhabib and Jovanovic (1991) explained high capital elasticity coefficient by externality effects that would arise from the presence of foreign direct investment that leads to the introduction of new additional inputs and new knowledge to the host country.

The second line of research concerning economic growth focused on the development of a theory in which technical change is an endogenous variable that responds to economic forces. In contrast to the neoclassical theory, the new growth theory rejects the assumption of diminishing returns to capital and defines technical change as the accumulation of knowledge undertaken by profit maximizing forward-looking agents. In this model, the accumulation of knowledge has a public good element, there is increasing returns to the production of goods and diminishing returns to knowledge production. Romer (1986, 1987) developed the new growth theory based on increasing returns to knowledge. Knowledge is treated as an input in the production function and competitive equilibrium is shown to be consistent with increasing returns caused by externalities. Knowledge is produced in a research technology with diminishing returns; the production function for knowledge displays diminishing returns because doubling inputs will not double knowledge. According to the new growth model, the production of new knowledge by a firm has two effects. In the first place, it directly increases the firm's output. Moreover, assuming knowledge is not fully patentable, at least in the long run, the firm's new knowledge also increases the level of aggregate knowledge in the economy, with the result that other firms' production possibilities are expanded. If incomplete patent protection prevails, then knowledge created by one firm generates externalities for other firms and leads to an increase in output for all firms. This may result in increasing returns to knowledge in the production of goods at the economy level. Based on externalities, increasing returns in goods production and diminishing returns in knowledge production, the Romer model explains endogenous technical change in terms of knowledge creating investment activities of rational economic agents pursuing profits. The policy implication of the Romer model is that the governments can influence such agents with the right fiscal incentives.

Endogenous growth can also be generated from the learning-by-doing model proposed by Arrow (1962) in which long run growth is driven by the accumulation of knowledge. According to this model, knowledge accumulation is a by-product of the process of production of a new capital good. The rate of capital accumulation, thus, determines the rate of knowledge accumulation. Hence, long run growth is a function of capital accumulation. Romer (1990), Grossman and Helpman (1991a) and Aghion and Howitt (1992) further extended the new growth theory by modeling knowledge accumulation as a function of research and development (R & D) activities. These models explain technical advances or the creation of knowledge in terms of investments in R & D. The essential feature of these models is that human and physical capital resources are allocated to the R & D sector and the activities in this sector lead to the production of new knowledge which in turn determines long term growth. Lucas (1988) developed a model of endogenous growth using human capital and concluded that investment in education may have long term benefits to growth because of externality effects. Benhabib and Spiegel (1994) estimated a growth equation, with human capital as a separate input in their production function and obtained an insignificant human capital coefficient. Next, they specified an equation in which total factor productivity depended on the level of the stock of human capital and found a positive role for human capital in the process of economic growth. These findings have strengthened the idea that human capital is important for long run growth not as a direct input to production but as a factor that generates externalities.

Endogenous growth models are generally formulated in the context of closed economies. In such economies, spill-over effects from firm-level knowledge production generate increasing returns at the level of the economy. Unlike the neoclassical growth model, endogenous growth theory has strong implications for open economies. If there are spill-over effects from knowledge, then countries trading goods and/or capital with technologically advanced partners can benefit from the use of new inputs and new equipment developed in the advanced countries. In particular, developing countries can benefit greatly from importing a variety of inputs, equipment and new technology and also by attracting foreign capital, especially foreign direct investment. In this connection, trade and foreign capital are expected to enhance long term growth by causing technology transfers from the advanced countries to the developing ones. Trade and foreign capital can also accelerate long term growth by increasing capital accumulation which in turn, through learning-by-doing, leads to knowledge accumulation. Previous studies of technology diffusion and growth including Nelson (1966), Jovanovic and Rob (1989), Grossman and Helpman (1991), Segerstrom (1991), Easterly et al (1994) and Barro and Sala-i-Martin (1995) have demonstrated that technology diffusion is an important determinant of economic growth.

The empirical evidence surrounding endogenous growth models is at best mixed. Most of the empirical work is based on linear growth models. The basis of these models is Arrow's (1962) learning-by-doing model. The final form of these models takes the form $Y = AK$ which means that the elasticity of output with respect to capital is unity. Romer (1987), Rebelo (1991), Barro (1991b), Easterly (1991), and Jones (1995) have linear growth models for their growth analysis. These models are motivated by the idea that a broad definition of capital can generate endogenous growth. The implication of these models is that permanent changes in investment rates have permanent effects on growth. In this context, Jones (1995) tested this hypothesis in a time series context using OECD data and found no evidence supporting linear growth models of the type mentioned above. Dinopoulos and Thompson (2000), distinguish between the temporary effect on growth (TEG) and the permanent effect on growth (PEG) models. Their cross-country estimations results led them to conclude that trade and openness, by improving the knowledge generating capacity of human capital, enhanced long term growth. Borensztein, De Gregorio and Lee (1998) tested the effect of foreign direct investment on economic growth in the context of an endogenous growth framework. They found that foreign direct investment positively affected long term growth. They also tested whether or not foreign direct investment affected growth through augmenting domestic capital formation or through transfer of technology and found evidence in favor of the latter. Further, the effectiveness of foreign direct investment was higher in countries that have achieved a certain threshold level of human capital than those with low level of human capital.

In a similar vein, a number of studies have also found positive R&D spill-over effects and identified the mechanisms through which such effects were transmitted. Studies on R & D spill-over effects have identified trade and foreign direct investment as the main conduits for technology transfers. The transmission of R&D spill-over effects occurred within advanced countries as well as from advanced to developing countries. Coe and

Helpman (1995) found positive spill-over effects within industrial countries, transmitted through imports. Similarly, Coe, Helpman and Hoffmaister (1997) found R&D spill-over effects from advanced countries to developing countries channeled through trade. Lichtengerg and De la Potterie (1996) found evidence supporting international technology diffusion through foreign direct investment. Using industry level data, Keller (1997) found that technology diffusion among domestic firms and between domestic and foreign firms took place by being embodied in differentiated intermediate goods developed through R&D. The main thrust of this is that the empirical evidence on R&D transfers provides credence for endogenous growth theory in that developing countries that promote trade and investment with advanced countries can benefit from the associated transfer of technology and enjoy higher income growth and improved standard of living. The next section develops the empirical model that is used to examine the significance of the effect of foreign capital inflows on the long term growth rates of output in developing countries.

1.3 The Analytical Framework

Endogenous growth models can be derived from an inter-temporal utility maximization problem that is subject to constraints relating to the production technology, consumption and the evolution of the capital stock. Specifically, the infinitely lived representative agent maximizes a discounted standard concave utility function. Using the production function in (8), the utility maximization problem can be specified as:

$$Max \int_{t=0}^{\infty} \exp(-\beta t) u(c_t) dt \tag{10}$$

subject to:

$\dot{k}_t = A k_t^{\alpha+\gamma(1-\alpha)} f_t^{\rho\gamma(1-\alpha)} - c_t$, and

$k_0 \geq 0$

where c_t is consumption of the representative agent at time t and β is the marginal rate of time preference. u(.) is a CRRA utility function with an inter-temporal elasticity of substitution θ. For concreteness consider the following CRRA utility function:

$$u(c_t) = \frac{c_t^{1-\theta} - 1}{1-\theta} \tag{11}$$

where $\theta \neq 1$.

Inserting (11) for the utility function in (10) and solving the model gives the standard condition for the optimal consumption path:

$$\theta \frac{\dot{c}_t}{c_t} = A(\alpha + \gamma(1-\alpha)) k_t^{\alpha+\gamma(1-\alpha)-1} f_t^{\rho\gamma(1-\alpha)} - \beta \tag{12}$$

The first term on the right hand side is the marginal product of capital. Thus, equation (12) states that the growth rate of consumption per capita, in steady state, is a function of the return on capital, the discount rate β and the coefficient of relative risk aversion θ. Moreover, in steady state, since the dynamics of consumption, output and the capital stock are the same, (12) is also an expression for the growth rate of per capita output and per capita capital stock. Equation (12) is quite general and can be consistent with different types of growth models depending on the restrictions imposed on its parameters. Consider the following four restrictions:

i) $\alpha + \gamma(1-\alpha) > 1$ and $\rho\gamma(1-\alpha) < 1$

ii) $\alpha + \gamma(1-\alpha) > 1$ and $\rho\gamma(1-\alpha) > 1$

iii) $\alpha + \gamma(1-\alpha) < 1$ and $\rho\gamma(1-\alpha) > 1$, or $\alpha + \gamma(1-\alpha) > 1$ and $\rho\gamma(1-\alpha) < 1$

iv) $\alpha + \gamma(1-\alpha) = 1$

The restrictions given by (i) are the conditions for exogenous growth with diminishing returns while the conditions in (ii) are consistent with explosive growth. The conditions in (iii) imply a "crowding out" effect, that is, foreign capital and domestic capital are substitutes. This means that increases in foreign capital inflows are offset by an equal amount of decrease in domestic investment so that the overall effect on the domestic capital stock is zero[4].

Suppose that intertemporal complementarity between changes in domestic and foreign capital alleviates diminishing returns in domestic production. Assume further that as a

[4] The effect on long term growth of such a change in the structure of the capital stock depends on the effectiveness of foreign capital relative to domestic capital. If foreign capital is more efficient than domestic capital, it can generate growth rates that more than offset the decline from the fall in domestic investment.

result of such complementarity domestic production displays constant returns in the presence of foreign capital giving rise to the restriction in (iv) which implies that $\gamma = 1$. Equation (12) then simplifies to the following:

$$\frac{\dot{c}_t}{c_t} = \frac{1}{\theta}\left[Af_t^{\rho(1-\alpha)} - \beta\right] \tag{13}$$

Given a rate of return for capital that is equal to r, (13) can be reformulated as

$$\frac{\dot{c}_t}{c_t} = \frac{1}{\theta}\left[r - \beta\right] \tag{14}$$

Thus, if the restriction in (iv) holds per capita consumption, output and the capital stock will experience positive growth rates provided that the marginal product of capital is maintained above the marginal rate of time preference, which is effectively the utility discount rate. This is clearly stated in (13). In so far as $\lim_{f_t \to \infty} Af_t^{\rho(1-\alpha)} > \beta$, the marginal product of capital can be maintained above the marginal rate of time preference β, as foreign capital increases. Under this circumstance, foreign capital positively affects the long run growth rate of the economy. As indicated by (13), the long run growth rate of per capita output is affected by the rate of time preference, the productivity of domestic capital, the degree of complementarity between capital stocks containing domestic and foreign technologies and the coefficient of relative risk aversion but not by the domestic capital stock. Accordingly, permanent increases in foreign capital inflows such as foreign direct investment will lead to permanent increases in the growth rate of output. Therefore, government policies that encourage long term foreign capital inflows are beneficial for long term growth in the recipient economies. However, if domestic production is subject to diminishing returns, then increases in foreign capital will cause only temporary increases in output growth rates.

Linear endogenous growth models in which the capital elasticity of output is unity, commonly known as AK models, are motivated by the stylized fact of growth: constant capital/output ratios in the long run[5]. If the restriction $\rho(1-\alpha) = 1$ holds, equations (12) and (13) imply that the growth model given by (10) falls within the class of linear endogenous growth models. The growth rates of per capita output and per capita capital stock are constant and equal to the growth rate of per capita consumption given in (12) and (13) and permanent increases in foreign capital inflows cause permanent changes in output growth.

Equation (13) is the basis for the empirical relationship between long run growth and foreign capital espoused by the linear endogenous models of growth. The effectiveness of foreign capital in accelerating growth has been linked to the existence of a certain level and quality of infrastructure and human capital. Blomstrom et al (1994) and Bornsztein et al (1995) found evidence in support of the positive influences of public infrastructure and human capital. The rationale behind the public and human capital hypothesis is that better quality of infrastructure and educated labor force enable developing countries to fully exploit the benefits of foreign investment and other forms of foreign inflows. If these conditions are present, then foreign investment can generate long run growth through the catch-up effect and the development of endogenous technical change. In the absence of a sufficient level of infrastructure and human capital, foreign investment is at best likely to be limited to export processing zones with very little spill-over effects to domestic firms. The empirical relationship specified in (13) already incorporates the

[5] See for example Romer (1990), Jones and Mannuelli (1990) and Jones (1995) for an exposition of the AK growth models. For the stylized facts of growth see Kaldor (1961).

human capital factor but must be augmented so as to account for the effect of public capital on the long term growth rate of output.

1.3.1 Public infrastructure and economic growth

The relevance of public infrastructure facilities to the process of economic growth was pointed out in the literature in an attempt to explain the post 1970s slow down in productivity in the industrial countries. Aschauer (1988) found evidence that nonmilitary public capital stock was significantly related to long run growth in the U.S. economy and concluded that the slowdown in productivity was attributable to the decline in nonmilitary public investments. Demetriades and Mamuneas (2000), using data for OECD countries, found that public capital positively affected output supply and input demands. Based on short run and long run rates of return to public capital they concluded that there had been a significant under-investment in public infrastructure in the sampled countries. Delorme et al (1999), using an aggregate production frontier and a time series data for the private U.S. economy, found that technical efficiency was inversely related to infrastructure. However, the study failed to find a positive relationship between infrastructure and private output and concluded that infrastructure has an indirect positive effect on output but not a direct one.

1.3.2 Estimation equations

In light of the above, equation (13) as an expression for long term growth should include some measure of public capital as an explanatory variable. Therefore, in the modified version, long term growth is a function of foreign capital, public capital and other growth determinants. Foreign capital is decomposed into equity capital, foreign aid and long term debt capital. Equity capital is composed of foreign direct and portfolio investments. Foreign aid is the sum of pure grants, technical cooperation and official development assistance with a grant element of twenty five percent. Long term debt is debt with a maturity of a year or more. Public capital is the stock of social infrastructure mainly accumulated through government fixed capital investments. All right hand side variables are expressed as ratios to GDP. Accordingly, (13) can be specified as shown below as a long term growth equation encompassing all growth determinants in such a way as to make it suitable for empirical investigation.

$$g_t = \alpha_0 + \phi' X_t + \varepsilon_t \tag{15}$$

where g_t is the growth rate of per capita GDP at time t, ϕ' is the vector of parameters, X_t is a vector of growth determinants and ε_t is assumed to be a mean-zero stationary random term. The vector of growth determinants consists of foreign aid, equity capital, long term debt capital, public capital and openness to trade all expressed as a ratio to GDP. The above specification implies that the model given by (15) is dynamically stable. Short term shocks to the growth rate of GDP should ultimately be corrected to reflect the conditional expectation of the growth rate of GDP. In other words shocks that cause the growth rate of GDP to deviate from its equilibrium value in the short run should produce eventual convergence to its long run value. A specification that captures short term divergence and the process of convergence to long run values is the general error-correction model:

$$\Delta g_t = \psi(ec_{t-1}) + \sum_{i=1}^{q} \delta_i \Delta g_{t-i} + \sum_{i=1}^{q} \mu_i' \Delta X_{t-i} + \omega_t \tag{16}$$

where ω_t is an iid, mean-zero, stationary variable ec_{t-1} is the lagged error correction term given by $ec_{t-1} = g_{t-1} - \alpha_0 - \phi' X_{t-1}$ which is equal to the estimated equilibrium error obtained from (15).

1.4 Data, Estimation and Results

The empirical analysis is conducted on four East Asian countries: Indonesia, Malaysia, Philippines and Thailand. The data for these countries are for the period 1970-1996; all the data are obtained from the World Bank data bases. The information for GDP, GDP per capita growth rate, public capital, aid to GDP ratio, imports and exports are obtained from the 'World Development Indicators' data base while equity capital and long term debt capital are obtained from the 'Global Development Finance' data base.

Country growth rate in this study is measured by the annual percentage change in real per capita GDP for the relevant period. Information on capital flows is normally provided as net inflows and gross inflows. Net inflow is the difference between inflows and outflows while gross inflows refer only to capital inflows, that is, capital flows (foreign direct investment, portfolio investment, aid flows and long term debt) into the country.

Although some studies have used net inflows, this study uses only inflows. The rationale for this choice is that foreign capital is considered to be a vehicle for technology transfer to and a cause for positive spillover effects in the host country. Such effects are better captured by the use of gross inflows rather than net inflows. Moreover, capital outflows from the East Asian countries under study have not been that important to have had significant effects on growth over the specified period.

Given that the purpose of our empirical investigation is to measure the relative effect of the different categories of foreign capital and other variables on long term output growth, we now proceed to the estimation of equations (15) and (16). This calls for the examination of the time series properties of the variables involved.

1.4.1 The order of integration: Indonesia

The first step in the estimation process is to determine the order of integration of the variables involved. Macroeconomic data are usually characterized by a stochastic trend that could be eliminated by first differencing. Since the presence of a stochastic trend severely affects the properties of alternative estimators, determination of the order of integration is all the more important first step in the analysis of time series data. A non-stationary variable in levels is integrated of order 1, [i.e, I(1)], if it becomes stationary [i.e, I(0)] after it is differenced once. A variable may also be integrated of a higher order if it requires repeated differencing before achieving stationarity so that the number of differencing represents the order of integration. Variables that require no differencing to achieve stationarity are integrated of order zero. Variables that contain deterministic trends are known as trend stationary, that is, removal of the trend is sufficient to achieve stationarity.

The procedure for identifying the order of integration of macroeconomic series is to apply standard unit root tests to uncover the presence or absence of a unit root.

Accordingly, the Dicky-Fuller (DF), augmented Dicky-Fuller (ADF) and the Phillips-Perron (PP) tests are used to test the presence of a unit root. Although low power is a major concern in the presence of slow tapering of autoregressive coefficients of stationary series, the ADF performs well on this score even when the sample size is small[6].

Table 1.1 Indonesia: Time Series Properties of Growth Variables

	ADF		PP		Serial corr.
Variable	With trend	Without trend	With trend	Without trend	LM Test
ygr	-4.55 (0)	-4.63 (0)	-4.52 (3)	-4.61 (3)	2.51
eky	-2.54 (1)**	-0.49 (2)**	-1.96 (4)**	-1.47 (2)**	2.03
aky	-5.37 (1)	-6.65 (1)	-1.81 (1)**	-2.17 (1)**	1.87
ldky	-2.75 (0)**	-2.32 (0)**	-2.25 (2)**	-2.25 (2)**	1.01
sky	-2.01 (4)**	-2.14 (0)**	-1.55 (3)**	-2.14 (0)**	8.07
trdy	-2.75 (0)**	-2.65 (0)**	-2.75 (1)**	-2.64 (2)**	1.23

Note: ADF and PP stand for Augmented Dicky-Fuller and Phillips-Perron unit root test statistics. LM refers to the Bruesch Godfrey lagrange multiplier test for serial correlation. The numbers in parentheses next to the ADF test statistics are the number of lags included based on the Schwarz information criteria (SIC) and those beside the PP test statistics are the Bartlett Kernel based Newy-West truncation lags. The number of observations is 27. The variables are defined in appendix A.11

** (*) : indicate significance at 5% and 1%, respectively.

Source: Computed from the data from sources listed in appendix A.11

Table 1.1 shows the results of unit root tests[7] for Indonesia's variables. All the tests indicate that the growth rate variable (ygr) is stationary. The implication of the stationarity of the growth variable is that the long term value of the growth rate of per capita GDP is equal to its mean. The ADF and PP tests produced conflicting results with respect to the aid variable. In each case the ADF test confirms stationarity while the PP

[6] For detailed analysis of the power of unit roots in the presence of stationary but persistent series and small samples see Hamilton (1994).

[7] The augmented Dicky-fuller unit root tests are conducted using the general autoregressive form:

$$\Delta x_t = \alpha + \beta t + \rho x_{t-1} + \sum_{i=1}^{k} \gamma_i \Delta x_{t-i} + \varepsilon_t$$

While the Phillips-Perron test ignores the fourth term on the right hand side, estimates the equation and makes non-parametric correction for higher order auto-correlation. By estimating the spectrum of ε_t at frequency zero that is robust to heteroskedasticity and autocorrelation of unknown form, it controls for higher order serial correlation by correcting the t-statistic for the p coefficient obtained from the original regression. The Phillips-Perron test however suffers from size distortion and therefore is rarely used alone.

test indicates the presence of a unit root. All the other variables, in particular equity capital, long term debt capital, public capital and openness to trade, are found to be I(1).

1.4.2 Further analysis of the Indonesian data

In view of the mixed order of integration of the variables for Indonesia, a different approach has been adopted to analyze the data. One way of dealing with this kind of situation is to convert all variable into stationary ones and estimate a vector autoregression (VAR) system. This method is useful to detect whether or not there are interactions among the variables over the business cycle. Accordingly, a VAR is constructed using the growth rate of output per capita (ygr), the ratio of aid to GDP (aky) and the first differences of equity capital to GDP ratio (eky), trade to GDP ratio (trdy), public capital to GDP ratio (sky) and long term debt to GDP ratio (ldky).

The basic methodology involves estimating the modified variables for Indonesia in the framework of a vector autoregression (VAR) as specified below:

$$x_t = \beta_0 + \beta_1 x_{t-1} + \beta_2 x_{t-2} + \beta_3 x_{t-3} + \ldots + \beta_k x_{t-k} + \varepsilon_t \qquad (17)$$

where x is a kx1 vector containing each of the n variables included in the VAR,

Table 1.2 Indonesia: Vector Autoregression Estimates
t-statistics in [ ]

	Ygr	d(eky)	Aky	d(ldky)	d(trdy)	d(sky)
ygr(-1)	-0.207312	-0.011233	0.029335	-0.090917	0.620207	-0.153452
	[-0.95961]	[-0.14366]	[0.68604]	[-0.30416]	[1.10876]	[-1.01058]
ygr(-2)	-0.134209	0.010705	-0.009296	0.087353	0.441454	0.139260
	[-0.69205]	[0.15252]	[-0.24219]	[0.32555]	[0.87917]	[1.02167]
d(eky(-1))	-0.722494	0.214401	-0.013120	0.325891	-2.989764	-0.829823
	[-1.05256]	[0.86301]	[-0.09657]	[0.34314]	[-1.68221]	[-1.71999]
d(eky(-2))	3.608560	-0.761890	-0.222697	-0.387322	1.455096	0.556229
	[3.79674]	[-2.21486]	[-1.18384]	[-0.29454]	[0.59129]	[0.83264]
aky(-1)	1.491884	-0.059560	1.040183	-0.032939	12.70764	-0.313246
	[0.98696]	[-0.10887]	[3.47678]	[-0.01575]	[3.24685]	[-0.29484]
aky(-2)	-0.687792	-0.161083	-0.206307	-0.057020	-6.582032	0.151660
	[-0.69245]	[-0.44809]	[-1.04942]	[-0.04149]	[-2.55933]	[0.21724]
d(ldky(-1))	-0.115916	-0.152938	0.051120	-0.017137	0.095318	-0.079733
	[-0.47456]	[-1.72999]	[1.05741]	[-0.05071]	[0.15072]	[-0.46443]
d(ldky(-2))	-1.399360	0.246877	-0.059635	-0.435893	-2.221863	-0.804896
	[-3.64069]	[1.77465]	[-0.78389]	[-0.81965]	[-2.23257]	[-2.97937]
d(trdy(-1))	0.181390	0.050443	-0.020282	0.003229	-0.607383	0.030692
	[1.84857]	[1.42035]	[-1.04431]	[0.02378]	[-2.39066]	[0.44502]
d(trdy(-2))	0.222064	-0.022995	-0.022240	-0.006088	-0.115469	0.234922
	[2.00117]	[-0.57256]	[-1.01261]	[-0.03965]	[-0.40189]	[3.01203]
d(sky(-1))	-1.039728	0.102039	-0.024213	-0.507691	-1.002277	-0.446660
	[-3.52425]	[0.95563]	[-0.41467]	[-1.24377]	[-1.31210]	[-2.15404]
d(sky(-2))	-0.332810	-0.028624	0.032901	0.205608	0.599817	-0.163076
	[-1.12105]	[-0.26640]	[0.55994]	[0.50056]	[0.78033]	[-0.78153]
C	5.282135	0.423816	0.116045	-0.144904	-12.60098	0.150464
	[3.08348]	[0.68357]	[0.34226]	[-0.06114]	[-2.84099]	[0.12497]
R^2	0.754762	0.703269	0.918216	0.398803	0.711906	0.765617
S.E.E.	1.492287	0.540102	0.295358	2.064711	3.863840	1.048872
F-stat.	2.308256	1.777545	8.420463	0.497512	1.853320	2.449888

Source: Computed from the data sources indicated in appendix A.11

β_0 = a kx1vector of intercepts, β_i is an nxn matrix of parameters and ε_t is a kx1 vector of error terms. Estimates of the VAR specified in (17) are reported in table 1.2. The estimated VAR is of order 2. The lag length of k=2 was selected based on the Akaike information criterion (AIC). The characteristic roots have modulus less than unity, indicating that the VAR satisfies the stability condition. Looking at the estimated coefficients, we find that in the second column (the growth equation), equity capital and trade at two lags make significant positive contributions to the growth rate of output. Public capital is significant at lag one. Long term debt capital at lag two has a significant negative influence on growth. Most of the coefficients in the equations for the other variables are not statistically significant. For example, equity capital responds negatively to equity capital at lag two as is shown in column three, while all the other coefficients are not statistically different from zero.

The advantage of the VAR is that pair wise Granger causality tests can be conducted to identify the direction of causation, if any, among the variables included. Granger causality tests whether the lags of one variable enter into the equation of another variable. It measures whether current and past values of a variable, say y_t, help to forecast the future value of another variable, say x_{t+1} (Granger 1969 and Sims 1980). For example, in a regression of the form:

$$x_t = \alpha_0 + \sum_{j=1}^{k} \alpha_j x_{t-j} + \sum_{j=1}^{k} \beta_j y_{t-j} + v_t \qquad (18)$$

a chi-squared test on the restriction $\beta_j=0$ (j=1, ..., k) provides information whether Granger causality runs from y to x. Similarly, causation from x to y can be tested by running a regression of y on lagged values of y and x and testing the null of zero coefficients on x.

Granger causality in the above sense was carried out pair wise with the growth rate of per capita output (ygr), aid capital (aky), equity capital (eky), long term debt capital, openness to trade (trdy) and public capital (sky). The results are reported in appendix A.12. The results in the first part of the table where ygr is the dependent variable indicate that causality runs from equity capital (eky), long term debt capital (ldky), openness to trade (trdy) and public capital (sky) individually and jointly to the growth rate of per capita output (ygr) but not from aid to the growth rate of per capita output. The variables eky, ldky and sky are significant at the 1 percent level while trdy is significant at the 7 percent level. As is clear from the VAR estimates in table 1.2, all the above variables except ldky have positive influence on per capita output growth. Long term debt capital ldky, however, enters the growth rate equation negatively. The null of no causality from aid to per capital output growth could not be rejected at any conventional level of significance.

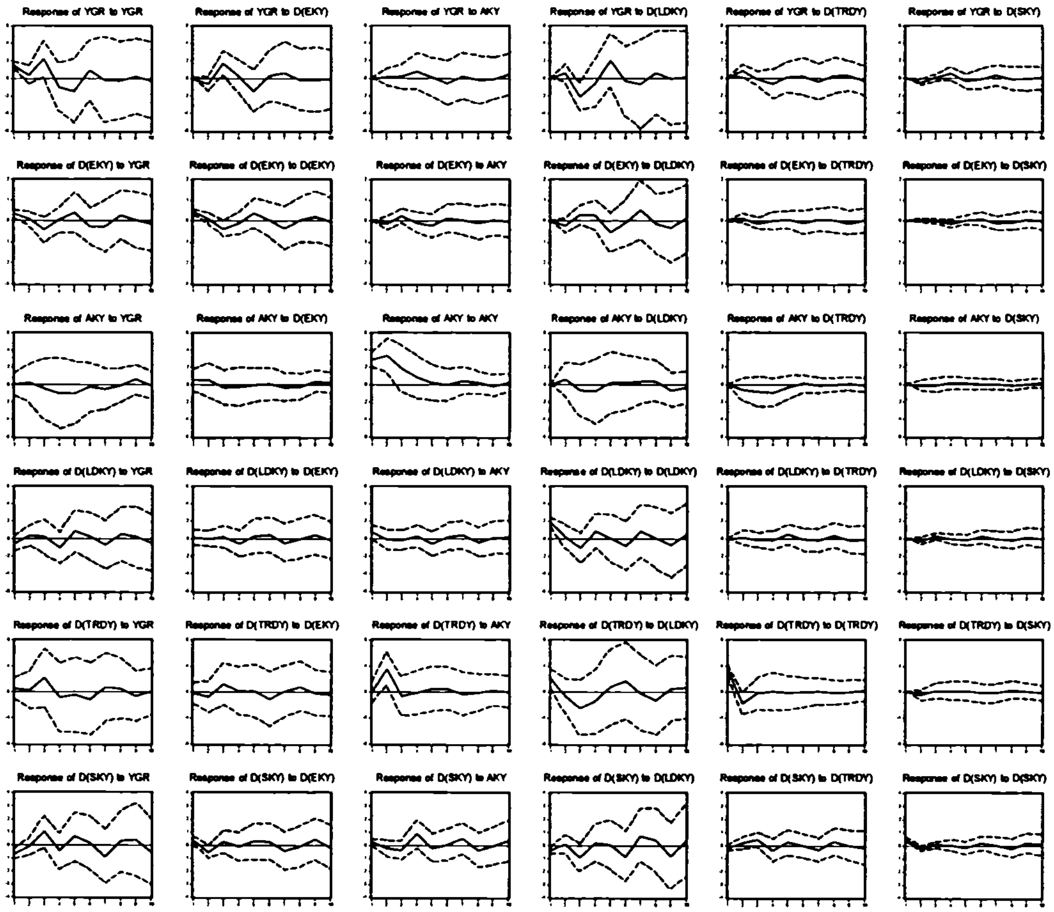
Looking at the causality tests with other dependent variables, we find that only long term debt capital is statistically significant at 5 percent level in the equation for equity capital. As can be seen from table 1.2 long term debt capital has a negative influence on equity capital. In the equation for trdy only aid (at 1 percent) and ldky (at 9 percent) are significant. The variables are however jointly significant at the 2 percent level. In the equation for sky, only trdy and ldky are significant at the the 1 percent and 2 percent levels of significance, respectively. Also variables in the equation for sky are jointly significant at the 1 percent level.

Another point that emerges from the Granger causality tests is that per capita output growth causes none of the variables in the VAR and equity capital causes none of the variables other than the growth rate of per capita output. In light of the failure of Granger causality in the other equations, further examination of the behavior of the Indonesian variables will focus on the growth equation although the results for the other equations have also been reported.

1.4.2.1 Assessing interactions among variables

Two important devices related to the VAR that help to examine the interaction among the variables are the impulse response function and variance decomposition. The impulse response function is a tool that helps to trace the impact of the various shocks on the variables included in the VAR. Technically the impulse response function is a vector moving average (VMA) representation of the vector autoregression. The VMA as a transformation of the VAR expresses each variable in terms of the current and past values of the shocks represented by the errors in each equation. The impulse response functions reveal the interaction among the variables in the VAR in response to the various shocks. Figure 1.1 presents the impulse response functions.

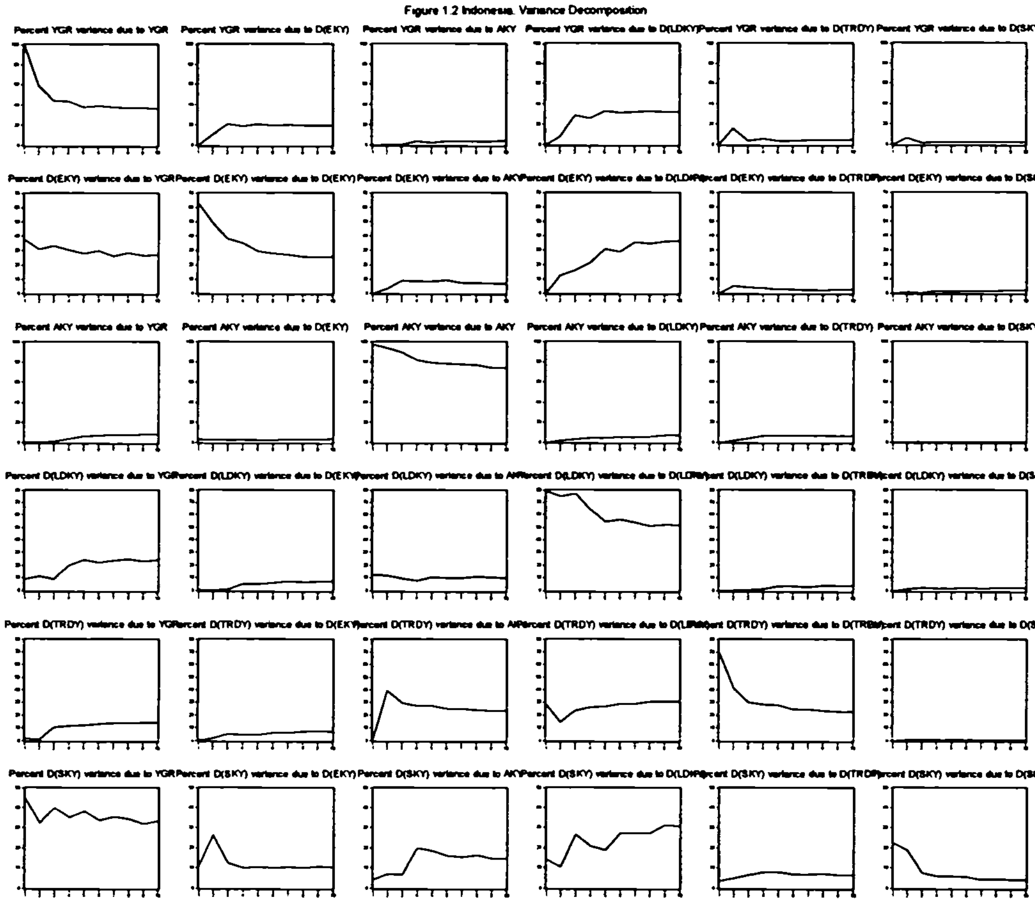
Figure 1.1 Indonesia: Response to Cholesky One S.D. Innovations ± 2 S.E.



As can be seen from the graphs, the impulses gradually die out as expected for a stationary VAR. The first row presents the response of the growth rate of output to shocks associated the other endogenous variables. For example, a shock to equity capital tends to lower growth on impact followed by an upward jump. In the next phase, growth starts to gradually decline but this decline turns around only to start its path of decay.

While the impulse response function traces the effect of a shock to one endogenous variable on the remaining endogenous variables, variance decomposition breaks down the variation in an endogenous variable into the component shocks to the VAR. Variance decomposition therefore provides information on the relative importance of each random shock in affecting the variables in the VAR. For example, the variation in the growth rate of output is separated into variations due to random innovations in each of the other variables in the VAR. Variance decomposition for our estimated VAR is presented in figure 1.2.

Figure 1.2 Indonesia: Variance Decomposition



Again the graphs in the first row are of interest. Note that the percentage variation in the growth rate of output caused by shocks to output growth itself declines over the ten year horizon. On the other hand, the percentage variation due to equity capital and long term debt capital increased over the given horizon. The openness variable also contributed to the variation in the growth rate of per capita output more than the aid and public capital variables. The variations accounted for by long term debt capital, equity capital, openness to trade, aid capital and public capital were approximately 30, 20, 5, 3, and 2 percent, respectively. The rest was accounted for by the variation in ygr itself.

1.4.2.2 Summary for Indonesia

Two important points can be made regarding the results of the empirical analysis for Indonesia. Based on the ADF unit root test results the aid variable turned out to be I(0). Both the ADF and PP unit root test results confirmed stationarity of the growth variable while all the remaining variables turned out to be integrated of order one. The variables for Indonesia, therefore, failed to satisfy the order condition for cointegration. While the ratios to GDP of equity capital, long term debt capital, public capital and trade experienced permanent changes over the sample period, the growth rate of per capita output remained stationary during the same period. In other words, permanent changes in these variables failed to bring about permanent changes in growth as is claimed by the endogenous growth model. Given the order of integration of the explanatory variables a necessary but not sufficient condition for the model to hold is that the growth rate variable should be integrated of order one while a sufficient condition would be the existence of cointegration among the variables. If the possibility of unaccounted offsetting factors to the changes in the I(1) variables is ruled out, then the endogenous growth model does not accurately describe the growth process in Indonesia during the period 1970-96.

The second point is that estimation of a VAR of order two provides interesting results regarding the interaction among the variables involved. In particular, with the exception of aky, pair wise Granger causality tests confirm causality from all the variables to growth. All the variables, however, jointly caused growth during the sample period. The impulse response functions indicated that while shocks to equity capital, trade, public and aid have positive influence on the growth, a shock to long term debt capital had a negative influence. The allocation of variation in growth to the right hand side variables using the variance decomposition technique revealed that a substantial proportion of the variation in growth was accounted for by long term debt capital, equity capital, and trade. This implies that these three variables were the important sources of variation in growth during the sample period. Thus, notwithstanding the absence of long term equilibrium relationship, the VAR estimates uncovered the variables that may have a strong impact on growth over the business cycle in Indonesia.

1.4.3 The order of integration: Malaysia, Philippines and Thailand

Continuing the investigation to determine the order of integration of the variables corresponding to the remaining three countries, we now examine the unit root properties of the variables for Malaysia, Philippines and Thailand. The test results are presented in tables 1.3, 1.4 and 1.5, respectively.

Unit root tests for Malaysian data indicate that the growth variable has a unit root. Both the ADF and PP tests confirm the unit root hypothesis. All the Foreign capital variables are also found to be integrated of order one. In particular, equity capital (eky), aid capital (aky) and long term debt capital (ldky) are I(1). In addition, public capital (sky) and openness to trade (trdy) are confirmed to be I(1).

Table 1.3 Malaysia: Time Series Properties of Growth Variables

Variable	ADF		PP		Serial corr. LM Test
	With trend	Without trend	With trend	Without trend	
ygr	-0.27 (3)**	-2.15 (3)**	-1.27 (3)**	-2.52 (3)**	2.34
eky	-2.34 (0)**	-2.00 (0)**	-2.34 (1)**	-2.00 (0)**	4.52
aky	-0.30 (2)**	-0.54 (2)**	-3.01 (2)**	-2.03 (5)**	3.10
ldky	-1.07 (0)**	1.85 (0)**	-2.12 (1)**	-3.14 (1)**	1.73
sky	-2.80 (1)**	-2.87 (1)**	-2.13 (0)**	-2.19 (0)**	4.12
trdy	-1.97 (2)**	0.45 (0)**	-2.03 (2)**	0.77 (5)**	2.58

Note: ADF and PP stand for Augmented Dicky-Fuller and Phillips-Perron unit root test statistics. LM refers to the Bruesch-Godfrey lagrange multiplier test for serial correlation. The numbers in parentheses next to the ADF statistics are the number of lags included based on the Schwarz information criterion (SIC) and those beside the PP statistics are the Bartlett Kernel based Newy-West truncation lags. The number of observations is 27 and the variables are defined in appendix A.11
** (*): indicate significance at 5% and 1%, respectively.
Source: Computed from the data from sources listed in appendix A.11

Table 1.4 Philippines: Time Series Properties of Growth Variables

Variable	ADF		PP		Serial corr. LM Test
	With trend	Without trend	With trend	Without trend	
ygr	-3.87 (0)*	-2.20 (0)**	-3.74 (7)*	-2.15 (8)**	3.71
eky	-2.67 (5)**	-1.91 (5)**	-3.47 (1)**	-2.23 (0)**	3.74
aky	-2.09 (0)**	-2.28 (0)**	-2.12 (2)**	-2.32 (2)	0.86
ldky	-3.60 (0)*	-2.03 (1)**	-3.60 (2)*	-3.60 (3)	0.37
sky	-2.74 (0)**	-2.78 (0)**	-2.70 (2)**	-2.72 (2)**	1.92
trdy	-1.02 (0)**	2.01 (2)**	-0.99 (4)**	1.24 (6)**	8.81

Note: ADF and PP stand for Augmented Dicky-Fuller and Phillips-Perron unit root test statistics. LM refers to the Bruesch-Godfrey lagrange multiplier test for serial correlation. The numbers in parentheses next to the ADF statistics are the number of lags included based on the Schwarz information criterion (SIC) and those beside the PP statistics are the Bartlett Kernel based Newy-West truncation lags. The number of observations is 27 and the variables are defined in appendix A.11
** (*): indicate significance at 5% and 1%, respectively.
Source: Computed from the data from sources listed in appendix A.11

The ADF tests for Philippines show that all the variables involved are I(1). The growth rate variable appears to contain a unit root with trend. The foreign capital variables, openness to trade, and public capital are found to b integrated of order one. The results from the PP unit root tests are consistent with the ADF test results.

Table 1.5 Thailand: Time Series Properties of Growth Variables

Variable	ADF With trend	ADF Without trend	PP With trend	PP Without trend	Serial corr. LM Test
ygr	-3.21 (1)**	-2.14 (1)**	-2.17 (0)**	-1.73 (0)**	3.15
eky	-2.92 (1)**	-1.07 (0)**	-2.28 (2)**	-0.99 (3)**	0.41
aky	-1.92 (4)**	-1.53 (3)**	-1.55 (1)**	-1.34 (1)**	1.01
ldky	-2.32 (0)**	-2.20 (0)**	-2.34 (1)**	-2.21 (1)**	1.86
sky	-2.19 (0)**	-1.20 (0)**	-2.12 (1)**	-1.01 (1)**	0.71
trdy	-1.46 (1)**	0.70 (0)**	0.57 (1)**	-1.33 (1)**	0.67

Note: ADF and PP stand for Augmented Dicky-Fuller and Phillips-Perron unit root test statistics. LM refers to the Bruesch-Godfrey lagrange multiplier test for serial correlation. The numbers in parentheses next to the ADF statistics are the number of lags included based on the Schwarz information criterion (SIC) and those beside the PP statistics are the Bartlett Kernel based Newy-West truncation lags. The number of observations is 27 and the variables are defined in appendix A.11

** (*): indicate significance at 5% and 1%, respectively.

Source: Computed from the data from sources listed in appendix A.11

Unit root tests on Thai data also reveal similar results. Both the ADF and PP tests confirm unit roots in the variables under consideration. The growth variable, the foreign capital variables, public capital and the measure of openness to trade are all found to be integrated of order one.

1.4.3.1 The cointegrating Rank

The next step in the analysis of the empirical relationship between growth and foreign capital is to determine the number of co-integrating equations for those countries whose variables are identified to be I(1). When the variables in equation (15) are integrated of order one, stationarity of the error term, ε_t implies that the growth rate of GDP and its hypothesized determinants are co-integrated[8]. Maximum likelihood testing procedures to determine the number of co-integrating equations in a given system have been documented by Johansen (1988), Johansen and Juselius (1990), Dicky et al (1994) and

[8]For details of co-integration and long run equilibrium relationships see Granger (1981) and Engle and Granger (1987), for multiple co-integration relations see Johansen (1995).

Charemza and Readman (1997). The number of co-integrating equations is given by the co-integrating rank which is a property of the system and for which a system estimator is needed to test for it[9]. Table 1.6 reports the results of Johansen's likelihood ratio tests for the co-integrating rank for Malaysia.

Table 1.6 Johansen's Test of Cointegration of ygr, trdy, sky, ldky, aky & eky for Malaysia, var (k=1) and n=26 (linear deterministic trend in the data).

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
R=0	0.76	82.35	68.52	76.07
R≤1	0.53	45.62	47.21	54.65
R≤2	0.43	25.82	29.68	35.65
Hypothesize no. of CE(s)	Eigenvalue	L-max Statistic	5 Percent Critical Value	1 Percent Critical Value
R=0	0.76	36.73	33.46	36.12
R≤1	0.53	19.79	27.07	32.24
R≤2	0.43	14.76	20.97	25.52

Note: The first row (r=0) in the trace test tests the null of no co-integration against the alternative of one or more co-integrating equations. The second row (r≤1) tests the null of at most one co-integrating equation against the alternative of two or more co-integrating equations. The procedure for the l-max test is similar except that the alternative hypotheses are fixed (r=1, r=2, etc.). Critical values are from Johansen and Juselius (1990).

Source: Computed from data from sources listed in appendix (A.11)

[9] Johansen (1988) has shown that co-integration is a restriction on the reduced form or VAR representation of the joint distribution of a set of k variables of an underlying model. For Illustration, suppose the endogenous variables of the VAR are given by X_t. Then the k-variable vector autoregression of finite order q, which in turn has a vector error-correction representation of the

form: $\Delta X_t = BX_{t-1} + \sum_{j=1}^{q} \Gamma_j \Delta X_{t-j} + \nu_t$ provides information on the number of cointegrating equations in the system. If the variables in X_t are all I(1) then the variables ΔX_{t-1} are stationary. For the variables to be co integrated and thus to induce an error-correction mechanism the matrix B must be of reduced rank. If r(B)=r<k, the rank of matrix B is less k, then the number of co-integrating equations is equal to r. Furthermore, the matrix B can be decomposed into the co-integrating matrix and the adjustment matrix as $B=A.C'$ where A_{kxr} is the adjustment matrix and C_{kxr} is the co-integrating matrix. If the variables $X_t \sim I(1)$ then $C'X_t \sim I(0)$ and the variables in X_t are co-integrated and the co-integrating vectors are the corresponding columns in C. Hence the rank of B, the co-integrating rank which is equal to the number of columns of C defines the number of co-integrating equations. If r=0 then there is no co-integration and the error-correction mechanism does not exist even though the variables are individually I(1). If r=k the variables are all I(0) and the issue of co-integration does not arise. The Johansen procedure for testing for co-integration is thus a maximum likelihood test on the rank of matrix B.

Table 1.7 Johansen's Test of Cointegration of ygr, trdy, sky, eky, aky & ldky for Philippines, var (k=1) and n=26 (linear deterministic trend in the data).

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
R=0	0.76	103.89	94.15	103.18
R≤1	0.57	61.99	68.52	76.07
R≤2	0.46	37.20	47.21	54.46
Hypothesize no. of CE(s)	Eigenvalue	L-max Statistic	5 Percent Critical Value	1 Percent Critical Value
R=0	0.76	48.90	39.37	45.10
R≤1	0.57	24.79	33.46	38.77
R≤2	0.46	18.03	27.07	32.24

Note: See Table 1.6
Source: Computed from data from sources listed in appendix A.11

Table 1.8 Johansen's Test of Cointegration of ygr, trdy, sky, eky, ldky & aky for Thailand, var (k=1), and n=26 (linear deterministic trend in the data).

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	5 Percent Critical Value	1 Percent Critical Value
R=0	0.84	85.30	68.52	76.07
R≤1	0.53	36.97	47.21	54.46
R≤2	0.34	17.17	29.68	35.65
Hypothesize no. of CE(s)	Eigenvalue	L-max Statistic	5 Percent Critical Value	1 Percent Critical Value
R=0	0.84	48.32	33.46	38.77
R≤1	0.53	19.80	27.07	32.24
R≤2	0.34	10.69	20.97	25.52

Note: See Table 1.6
Source: Computed from data from sources listed in appendix A.11

The co-integration test results for Malaysia indicate that the trace test confirms two co-integrating equations at the 5 percent level and one co-integrating equation at the one percent level while the l-max test favors the null of at most one co-integration equation at both levels of significance. The tests for Philippines support the null of one co-integrating equation at the 5 percent level of significance. In the case of Thailand, the null of one co-integrating equation is confirmed at both levels of significance.

1.4.4 Econometric analysis for Malaysia, Philippines and Thailand: the I(1) case

Before moving on to the analysis of the data for the trio, a highlight of the structure and performance of their economies is in order. During the sample period substantial structural changes have occurred in the three countries (see appendix A.13, table 1.1C). The share of industrial and manufacturing production saw significant increase while the share of agriculture declined over the period for the three countries. However, Malaysia and Thailand achieved profound structural changes while the Philippines was relatively weak in the transformation process. In terms of growth, while Malaysia and Thailand registered a spectacular performance, growth performance in the Philippines was much lower than those of the other members of the group (see appendix A.13, table 1.2C). The average growth rate of per capita income for Malaysia was about 4 percent from 1970-89 and approximately 6 percent from 1990-96. The corresponding figures for Thailand were about 5 and 7 percent. In the case of the Philippines growth of per capita income was approximately 1 percent during the first and the second sub periods[10]. These growth performances can be attributed, among other things, to the policy environment that these countries created during the sample period. Malaysia and Thailand had attractive regulation for the governance of foreign investment while the Philippines adopted less attractive investment policies. Similarly, trade policy was more open and transparent in Malaysia and Thailand than in the Philippines (see chapter 2 for details). Despite its

[10] According to the World Bank per capita income based classification of countries, Malaysia is in the upper middle income category while the other three are in lower middle income group with Thailand's per capita income greater than that of Indonesia and the Philippines. In terms growth performance, Indonesia compares with Malaysia and Thailand. The level of technical capacity is highest in Malaysia followed by Thailand, Indonesia and the Philippines in that order. See Jomo S. K. (1999).

resilience, the Philippines economy suffered from economic mismanagement, political corruption and instability. With this brief description of the structure of the economies of Malaysia, Philippines and Thailand, we now move to the analysis of the empirical results.

1.4.4.1 Long Run Model Parameters

Looking at the estimation results of the three countries, we find that the variables for Malaysia, the Philippines and Thailand are all integrated of order one. Moreover, system based tests for cointegration confirm that the variables are co-integrated thus establishing the absence of spurious regression. As indicated in table 1.10a, single-equation based Engel-Granger tests also provide strong evidence in favor of co-integration. This implies that there is a long run equilibrium relationship between growth and its hypothesized determinants in the countries for which co-integration was supported[11]. Moreover, the results suggest that an error-correction model can be used to estimate short run adjustment coefficients as well as the coefficient of the speed of adjustment to long run equilibrium. The long run model parameter estimates obtained from static regressions are reported in Table 1.10a.

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[11] The Johansen procedure is employed only to identify the number of cointegrating equations. Because of of its low power and instability in small samples, system estimation results using the Johansen method, though reported in appendix D.1, are not used for analysis here. Instead, the Engel-Granger two-step methodology (see Engel and Granger, 1987) of the single-equation approach is used to test for cointegration and to estimate the error-correction model. The first step is to estimate the long run coefficients and obtain estimated residual series from a static regression of the form $y_t = \alpha+\beta'\mathbf{x}_t+\varepsilon_t$, where $\mathbf{x}_t$ is a vector of right hand side variables and $[y_t\ \mathbf{x}_t]$ are found to be I(1) based on standard unit root tests. A test for a unit root on the estimated residual series ($\varepsilon_t^{\wedge}$) provides information on whether the variables used in the regression are co-integrated. If the estimated residuals are stationary then the variables are co-integrated. The critical values needed to test for a unit root in the estimated errors is more demanding because OLS introduces a bias by inducing stationarity in the errors. Hence, the standard Dicky-fuller critical values are adjusted to account for the bias (see Banerjee et al (1993), and Thomas (1997)). The Engel-Granger co-integration test results, obtained using the above procedure, are reported in table 1.8 and the evidence strongly favors co-integration in the respective variables of the countries under investigation. Once cointegration is established, the error correction model is estimated using the first difference of the variables and the lagged error term as an additional explanatory variable in the second step Eangle-Granger methodology which takes the form of equation (16) in the text. Note, however, that for comparative purposes, estimation results of the Johansen method are reported in appendix D.1 at the end of this chapter.

Table 1.10a: Cointegrating equations (static regression)
Dependent variable: ygr

Variable	Malaysia	Philippines	Thailand
c	2.72	-0.38	9.68
aky	1.52	0.37	5.58
eky	0.06	0.14	0.37
ldky	-0.11	0.09	-0.59
sky	0.16	0.36	1.03
trdy	0.02	0.03	0.15
adjR^2	0.55	0.80	0.75
Q(3)	0.19	1.06	1.39
ADF	-5.13 (0)	-6.46 (0)	-6.10 (1)
PP	-5.10 (1)	-11.45 (16)	-7.26 (4)

Note: The t-values associated with the estimated coefficients have non-standard distributions even asymptotically. The numbers in parentheses next to the ADF statistics are Schwarz criterion (SC) based lags while those next to the Phillips-Perron statistics are Newy-West truncation lags. The period of estimation is 1970-1996.
Source: Computed from data from sources listed in appendix A.11

Stock (1987) has shown that the estimated long run coefficients from the static regression are super consistent but have non-standard distributions even asymptotically. Inference on the long run coefficients using standard tables is, therefore, invalid. An alternative way of presenting the long run relationship is through what is known as the Bewley transformation. The Bewley transform is a linear transformation of the autoregressive distributed lag model (see Banerjee et al. 1993). This approach includes first difference and lagged first difference terms in the estimation and as shown by Inder (1993), including as much information as possible in the regression is likely to give the resulting estimators better properties. Estimating the Bewley transform by the method of instrumental variables (IV) gives estimators with t-values that are valid for inference on both the long run coefficients and the first difference and lagged first difference terms. The IV Estimation results of the Bewely transform are reported in Table 1.10b.

Table 1.10b: Instrumental variables (IV) estimation results of the Bewley transformation

	Malaysia		Philippines		Thailand	
Variable	Coeff.	t-value	Coeff.	t-value	Coeff.	t-value
c	2.52	1.68	-0.59	-1.44	-7.24	-1.64
aky	1.50	3.52	0.30	2.46	12.15	2.51
eky	0.05	2.62	0.17	2.75	0.38	3.30
ldky	-0.08	-1.15	0.08	1.61	-1.45	-2.62
sky	0.13	2.09	0.53	5.61	-1.47	-0.53
trdy	0.02	2.01	0.03	7.66	0.22	2.36
D(ygr)	0.58	9.43	0.49	3.44	0.60	3.92
D(ygr(-1))					0.75	4.36
D(aky)	-0.58	-1.08	-0.28	-2.68	-7.32	-2.40
D(aky(-1))					-5.22	-2.82
D(eky)	0.01	0.15	-0.11	-1.85	-0.30	-0.70
D(eky(-1))					0.11	0.21
D(ldky)	0.03	0.94	-0.04	-1.07	1.71	1.87
D(ldky(-1))					1.13	2.24
D(sky)	-0.03	-0.27	-0.21	-2.08	2.32	0.92
D(sky(-1))					0.59	0.55
D(trdy)	-0.02	-0.92	-0.02	-1.37	-0.35	-1.42
D(trdy(-1))					-0.33	-2.20
adjR^2	0.79		0.93		0.90	
Q(3)	3.79		0.21		1.90	
DW	2.00		2.06		2.40	

Note: The dependent variable is the growth rate of per capita income (ygr). The period of estimation is from 1970-96. The Bewley transform of the autoregressive distributed lag (ADL) model is estimated using the instrumental variables method. Lagged values of the level of the variables are used as instruments for the first difference and (lagged first difference of the corresponding variables. For example, ygr(-1) and ygr(-2) are used as instruments for d(ygr) and d(ygr(-1)), respectively.
Source: Computed from data sources indicated in appendix A.11

The long run coefficients for all three countries are of the expected sign. The coefficient of long term debt capital to GDP ratio (ldky) can take either positive or negative values. For example, if reverse resource flows are excessive due to high interest payments on long term debt, there may be a net reduction in growth. Another factor that might drive the coefficient below zero is that publicly guaranteed debt may be subject to moral hazard. A third reason is that government sponsored projects financed through public long term debt may turn out to be inefficient. This may therefore be the reason for the negative long term debt coefficient in Thailand. The coefficient for Malaysia is also negative although it is not statistically different from zero. Thus, in Malaysia and the Philippines, aid, equity capital, public capital and trade had permanent positive effect on the growth rate of per capital income during the period under consideration. In Thailand, aid, equity capital, trade and long term debt capital turned out to be statistically significant determinants of long term growth.

The results in table 1.10b indicate that equity capital affects growth significantly in all three countries. According to the endogenous growth model, the positive linkage between foreign investment and growth could arise either as a result of direct 'know-how' transfer or through enhancing domestic capital accumulation. The first channel implies that foreign capital raises growth by being more efficient than domestic capital while the latter signifies that foreign capital adds to growth by increasing domestic capital accumulation and enhancing the learning-by-doing process associated with it. In both cases equity capital raises the technological capability of the country and as a result increases its growth performance. The estimated results shown above indicate that foreign investment had a significant contribution to the growth performance of each of the three countries over the sample period. This finding lends credence to the endogenous growth model discussed earlier and is similar to previous studies conducted on countries in the region individually as well as in a panel setting.

Openness to trade is also positively related to growth. The estimated coefficients show that trade has been important for growth in all the three countries. Trade can accelerate growth by allowing countries to specialize in the production of intermediate inputs in which they have a comparative advantage as in Romer (1989). This leads to the availability of inputs at lower cost and raises the marginal product of capital and the equilibrium growth rate of the economy. Trade can also enhance growth through what is known as R&D spillover effects as in Grossman and Helpman (1991) and Edwards (1992). In this literature, trade and foreign investment are identified as the main conduits for the transfer of technology. One mechanism through which trade affects growth is through the importation of new intermediate inputs from advanced countries. Such inputs can be imported either by domestic firms or foreign firms. In either case new technology embodied in the imported intermediate product is diffused among domestic firms. The point is that openness to trade allows developing countries to absorb technology developed in the advanced countries at a faster rate thereby enabling them to maintain higher equilibrium growth rate. Thus, if trade is a mechanism for technology diffusion then a developing country is better off trading with an advanced country than with another developing country. Interestingly, the largest trade partners of Malaysia, the Philippines and Thailand during the specified period have been USA, Japan and EU.

With regard to aid and public capital, the former is important in all three countries while the latter turned out to be significant in the Malaysia and the Philippines. The literature[12] on aid and growth generally finds that aid contributes to growth in countries with good policies but it has no effect in countries with unsatisfactory policies. The significance of aid in the growth equations may thus, indicate that the authorities in these countries may

[12] For details see Boone (1994, 1996), and Dollar and Burnside (1998).

have put in place policies that are conducive for economic growth during the specified period.

The coefficient of long term debt capital is found to be negative and statistically significant for Thailand, negative and statistically not different from zero for Malaysia and positive but not statistically significant for the Philippines[13]. The negative link between growth and long term debt capital can be attributed to reverse resource flow, moral hazard, or inefficiency associated with lack of sufficient information regarding the return and overall feasibility of projects financed through long term debt. The ratios of total debt service to exports and GDP and interest payments to total expenditure are reported in appendix A.13 Tables (1.4C and 1.5C). Interest payment, however, does not reflect payment on long term debt alone. It also includes payments on short term debt and domestic debt. With regard to the ratio of total debt service to exports Indonesia had an average of approximately 30 percent (although the available data range is shorter than the others) the Philippines had approximately 27 percent followed by Thailand and Malaysia which had 18 percent and 12 percent, respectively. The debt service ratios and interest payments do not provide clear cut corroboration of the results, especially for Thailand. However, moral hazard and lack of information necessary for decision making in utilizing the borrowed funds could also be consistent with the results.

[13] The vector autoregression (VAR) estimates for Indonesia presented earlier showed that the coefficient of long term debt capital was negative and statistically significant, implying that increases in long term debt reduced growth performance in Indonesia during the sample period.

1.4.4.2 The Error Correction Model

Engle and Granger (1987) showed that variables that are known to be I(1) and cointegrated have an error correction representation. The error-correction model in general contains a mechanism for capturing short run dynamics as well as for correcting deviations from long run equilibrium. The specification given by equation (16) above captures this property and the estimated results for Malaysia, Philippines and Thailand indicate that the theoretical model is consistent with the data (Table 1.11).

With regard to the speed of adjustment, the coefficients of the lagged error terms ($et_{(-1)}$) for all three countries have the correct sign indicating the dynamic adjustment to equilibrium does occur. The coefficients on the co-integrating error terms ($et_{(-1)}$) are all statistically significant. The rate at which the deviations from the long run equilibrium are corrected is relatively fast. For example, in Thailand approximately 60 percent of the deviation from equilibrium during the previous period is corrected in the current period. The econometric diagnostic tests indicate that the model fits the data quite well.

Table 1.11: Two-Step ECM Estimates for Malaysia, Philippines and Thailand
Dependent Variable: Δygr

RHS Variables	Malaysia	Philippines	Thailand
C	-10.47 (-3.70)	-0.03 (-0.22)	-0.15 (-0.40)
Adjustment Speed:			
et(-1)	-0.54 (-3.35)	-0.42 (-4.52)	-0.63 (-2.46)
Short-Run Coefficients:			
Δygr(-1)	0.49 (1.70)	0.87 (2.80)	1.07 (3.13)
Δygr(-2)	0.55 (2.03	0.38 (1.73)	
Δtrdy(-1)	8.38 (3.17)	-0.01 (-0.25)	-0.11 (-0.89)
Δtrdy(-2)	5.19 (1.69)	-0.001 (-0.02)	
Δsky(-1)	0.06 (0.61)	-0.28 (-1.13)	-0.99 (-1.36)
Δsky(-2)	-0.06 (-0.60)	-0.05 (-0.24)	
Δaky(-1)	-1.02 (-1.49)	2.73 (2.25)	-5.26 (2.29)
Δaky(-2)	-0.50 (-0.79)	2.69 (2.34)	
Δeky(-1)	0.06 (0.70)	-0.47 (-3.17)	0.36 (0.77)
Δeky(-2)	0.05 (0.49)	-0.17 (-1.31)	
Δldky(-1)	-0.12 (-1.92)	0.06 (0.98)	0.44 (1.00)
Δldky(-2)	-0.07 (-1.53	0.02 (0.27)	
R^2	0.76	0.52	0.64
JB: Normality	X^2 (2)=0.003	X^2 (2)=0.72	X^2 (2)=0.78
S.Corr. LM	X^2 (3)=5.61	X^2 (3)=3.19	X^2 (3)=4.84
Engel's hetro.	X^2 (2)=0.61	X^2 (2)=0.42	X^2 (2)=0.22
Functional Form	X^2 (2)=4.01	X^2 (2)=2.36	X^2 (2)=1.20

Note: The numbers in parentheses next to the estimated coefficients are t-values. The period of estimation is 1970-1996. et(-1) is the lagged equilibrium error term. It is computed as $et_{t-1} = ygr_{t-1} - c - \alpha' x_{t-1}$ where $x_{(-1)}$ is a vector of the lagged values of regressors, α' is the vector of long run coefficients and C is the corresponding constant term (see table 1.10). In estimating the error correction model (ECM) the number of lags is selected based on SC and AIC. Accordingly, the models for Malaysia and Philippines use two lags, while that of Thailand uses one lag.
Source: Computed from data from sources listed in appendix A.11

The R^2 values are acceptable for this kind of models. Tests on normality, serial correlation, heteroskedasticity and functional form indicate that the model is satisfactory in terms of capturing long run behavior as well as short run dynamics in the growth process of the three countries.

1.4.4.3 Pooled Regression

In order to examine the average relationship between the variables for Malaysia, Philippines and Thailand we pooled the data and applied least squares estimation. The pooled regression estimates are presented in table 1.12. These results are estimates of what is known as the restricted model which uses the same constant across cross section members. To test whether the restriction of identical constant term is valid or not an unrestricted model was estimated with different constant terms for each cross section member (fixed effects). The results are reported in table 1.13. An F-test on the restrictions was carried out and the results indicate that the hypothesis of the same country effects is rejected at the 5 percent level. This implies that country effects are important and that the fixed effects model should be used to analyze the data for the group.

In such circumstance, the constant terms are expected to capture differences across countries. Thus, the regression estimates in table 1.13 indicate the country effects as well as the magnitude and direction of the explanatory variables included in the growth equation. Equity capital and trade positively affected growth while long term debt capital negatively influenced growth over the specified period. The ratios of foreign aid to GDP and public capital to GDP enter the growth equation positively but are not statistically different from zero.

Table 1.12: Pooled Regression for Malaysia, Philippines and Thailand
Restricted Model: (Common constant)
Equation: $ygr_{it} = c + \beta_1(eky_{it}) + \beta_2(aky_{it}) + \beta_3(sky_{it}) + \beta_4(trdy_{it}) + \beta_5(ldky_{it}) + \varepsilon_{it}$

	Coefficients	t-values
c	2.48	1.03
eky	0.50	1.79
aky	-0.40	1.36
sky	0.01	1.19
trdy	0.27	1.93
ldky	-0.37	-2.65
Adj.R^2	0.50	
SER	2.91	

Source: Computed from sources indicated in appendix A.11

Table 1.13: Pooled Least Squares Regression for Malaysia, Philippines and Thailand
Unrestricted Model (Fixed Effects)
Equation: $ygr_{it} = c_i + \beta_1(eky_{it}) + \beta_2(aky_{it}) + \beta_3(sky_{it}) + \beta_4(trdy_{it}) + \beta_5(ldky_{it}) + \varepsilon_{it}$

	Coefficients	t-values
eky	0.53	2.69
aky	0.39	0.47
sky	0.02	1.83
trdy	0.26	1.98
ldky	-0.42	-2.26
Fixed effects:		
MYS-c	0.39	2.13
PHL-c	0.27	3.03
THA-c	4.76	2.70
Adj. R^2	0.63	
SER	2.81	
Test of Restrictions: (a) $c_i=c$		
F-stat. = 7.43		

Note: The critical value from the F-table for F(2,72) is approximately 3.16. So the null hypotheses of identical constant (C) for all cross section members is rejected. Standard errors are White Heteroskedasticity Consistent.
Source: Computed from sources indicated in appendix A.11

1.5 Conclusion

The theoretical and empirical examination of growth data from Indonesia, Malaysia, Philippines and Thailand has produced some interesting results. In the theoretical analysis, an endogenous linear growth model was derived from a utility maximization problem of an infinitely lived household by imposing certain restrictions. The model proposed that in the long run both per capita output and per capita capital stock grew at the same rate as consumption and that permanent increases in foreign capital inflows lead to permanent increases in per capita output growth. Using annual data, the model was asked to describe the growth process in the above mentioned countries. Unit root and co-integration tests were applied to test the presence or absence of long term equilibrium relationships between the growth rate of per capita output and its hypothesized determinants.

The results for Indonesia show that the data do not support the endogenous growth process. The dependent variable, growth rate of per capita income is found to be stationary. With regard to the right hand side variables, while aid is stationary equity capital, openness and public capital are found to contain unit roots. Thus, although equity capital, openness to trade and public capital exhibited permanent changes, such changes did not bring about permanent changes in growth. Since the dependent variable is I(0) while some of the explanatory variables are I(1), such mixed time series properties of the variables led us to consider a vector autoregression (VAR) approach for further examination of the data. Accordingly, a VAR of order two was estimated by including the I(0) variables and the first differences of the I(1) variables in the system. Granger causality tests indicated that equity capital, long term debt capital, trade and public capital caused the growth rate of per capita output pair wise as well as jointly. While long term debt capital adversely affected growth, all the other variables had positive effects on growth. Furthermore, impulse response functions and variance decomposition exhibited strong interactions between growth and the variables involved in the VAR. The impulse response functions showed that shocks to equity capital, long term debt capital and trade had substantial effects on growth. Similarly, variance decomposition showed that over 50 percent of the variations in growth were accounted for by these variables.

The tests conducted on the data from the other three countries produced results that validate the endogenous linear growth model in describing the growth process in those countries. Co-integration was confirmed among the variables involved in the tests in the three countries. The evidence for Malaysia and the Philippines suggests that equity capital, aid, public capital and openness were important determinants of long term growth during the period under investigation. For Thailand aid, equity capital and openness to trade contributed positively to long term growth. Furthermore, long term debt capital negatively affected growth in Thailand during the specified period.

In order to examine the short run behavior of growth and the speed of adjustment to long run equilibrium in the three countries, a dynamic error-correction model was estimated using data from each of the three countries. For this purpose the lagged error terms generated from the static regression of the co-integrating vectors have been incorporated into the ECM for each country. The empirical results suggest that adjustment of divergence from long run behavior occurred in all three countries as indicated by the magnitude and statistically significant coefficients of the co-integrating error terms. Moreover, short run changes in growth in Malaysia mainly originated from one-period lagged changes in trade to GDP ratio and two-period lagged changes in growth indicating the significance of openness to trade in that country. In Philippines much of the short term variation in growth came from changes in equity capital and aid flows and lagged changes in growth. In Thailand short term fluctuations in growth rates arose from changes in aid flows and one-period lagged change in growth itself. Aid appears to be important in the Philippines and Thailand in the short run. This is not surprising given that these two countries are in the lower middle income category where growth may be constrained by limitation in the availability of financial resources needed for improving the macroeconomic environment. In this situation it is likely that fluctuations in foreign aid lead to fluctuations in growth in the short term.

The data for Malaysia, Philippines and Thailand were further examined by applying pooled regression. The estimated results of the pooled data underscored the importance of country specific effects. The estimation was thus carried out with individual constant terms. The results confirmed that equity capital trade and public capital positively affected long term growth while long term debt capital had an adverse effect during the specified period. The implication of the overall empirical finding is that growth strongly responds to foreign investment, aid flows, public infrastructure and openness to international trade. With regard to long term debt capital, developing countries should strictly monitor it to minimize its negative influence on growth either by placing quantitative limit on long term borrowing and/or by raising the efficiency of projects financed through it. Although long term debt is found to be at best growth neutral and at worst growth depressing, given the overall growth performances of the ASEAN-4, it is not clear that the build-up of long term debt was related to the financial crises that hit them in 1997-98.

The results of this analysis allow us to draw some policy implications. First, the analysis for Indonesia shows that there is strong positive causation running from trade openness, social infrastructure and foreign investment to growth. Although the link doe not constitute a long term equilibrium relationship, creating favorable conditions for foreign investment and trade can be important for growth over the business cycle. Thus Indonesian authorities can raise per capita output in the short to medium term period by providing incentives for foreign investment and increasing trade openness. The adverse effect of long term debt capital on growth implies that long term borrowing by the public or private sectors should be under strict scrutiny to ensure the efficient utilization and profitability of funds.

Second, the results for Malaysia, Philippines and Thailand corroborate that long term growth positively responds to several of the variables considered in the analysis. For Malaysia, strengthening its technological base and enhancing its international competitiveness should be important goals in the next phase of its growth process. Accordingly, the authorities in Malaysia should focus on the attraction of foreign investment and further intensification of the liberalization of foreign trade in order to enhance the transfer of new inputs and enable the economy to develop technological

capability. For the Philippines, growth positively responds to aid, foreign investment and openness to trade. As a result, further liberalization of foreign trade, enhanced efforts to attract foreign investment through fiscal and other incentives and concerted efforts to improve public infrastructure would make positive contributions to long term growth.
In the case of Thailand, aid, foreign investment and openness to trade would enhance long term growth. Reducing tariff and non-tariff barriers to trade can increases openness to international trade and fiscal and regulator incentives can be used to attract foreign investment.

Third, long term debt capital is found to have either no effect (in the case of Philippines, and Malaysia) or negative effect (in the case of Indonesia and Thailand) on growth. The authorities should, therefore, be cautious in publicly guaranteeing private debt and prudent in financing projects through long term debt.

Finally, other less developed countries can draw lessons from the experience of the four Southeast Asian countries included in this study. In order to foster long term growth, developing countries should generally focus on debt reduction/relief, aid and investment in public infrastructure followed by reforms that improve openness to trade and the regulatory framework and incentives for foreign investment.

Appendix A.11

The data were extracted from two World Bank electronic data bases. Data on GDP, aid to GDP ratio, per capita GDP growth rate, trade to GDP ratio, and public capital were taken from the "World development and Social Indicators" data base. The data on foreign direct investment, portfolio investment, and long term debt were taken from the "Global Development Finance".

The variables are defined as follows:

Real Per capital GDP growth rate (YGR). The annual percentage change of the ratio of real GDP to the size of the labor force.

Equity capital to GDP ratio (EKY). The sum of foreign direct investment and portfolio investment divided by GDP in each year.

Aid capital to GDP ratio (AKY). The sum of pure grants (grants plus technical cooperation) and official development assistance (ODA) with grant element of 25 percent divided by GDP in each year.

Long term debt capital to GDP ratio (LDKY). The sum of private and official long term debt outstanding in each year divided by GDP. Long term debt is debt with a maturity period of one or more years.

Trade to GDP ratio (TRDY). This is a measure of openness and it is computed as the sum of imports and exports of goods and services divided by GDP in each year.

Social capital to GDP ratio (SKY). This is a measure of public infrastructure. It is computed as the ratio of public investment divided by GDP in each year. Note that it does not measure the quality of infrastructure. However, it measures the quantitative amount of resources allocated to public investment projects each year.

Appendix A.12

Table1.1B Indonesia: Pairwise Granger Causality /Block Exogneity Wald tests

Dependent variable ygr				Dependent variable Δeky			
Exclude	χ2	DF	p-value	Exclude	χ2	DF	p-value
Δeky	14.42	2	0.001	Ygr	0.05	2	0.97
aky	1.59	2	0.45	Aky	3.13	2	0.21
Δldky	13.45	2	0.001	Δldky	6.20	2	0.04
Δtrdy	5.57	2	0.06	Δtrdy	3.25	2	0.20
Δsky	12.55	2	0.002	Δsky	1.15	2	0.56
all	26.73	10	0.003	All	12.86	10	0.23
Dependent variable aky				**Dependent variable Δldky**			
Exclude	χ2	DF	p-value	Exclude	χ2	DF	p-value
ygr	0.59	2	0.74	Ygr	0.23	2	0.89
Δeky	1.60	2	0.45	Δldky	0.16	2	0.92
Δldky	1.75	2	0.42	Aky	0.03	2	0.98
Δtrdy	1.59	2	0.45	Δtrdy	0.003	2	0.99
Δsky	0.62	2	0.73	Δsky	2.17	2	0.34
all	7.78	10	0.65	All	3.61	10	0.96
Dependent variable Δtrdy				**Dependent variable Δsky**			
Exclude	χ2	DF	p-value	Exclude	χ2	DF	p-value
Ygr	1.75	2	0.42	Ygr	2.44	2	0.30
Δeky	2.85	2	0.24	Δeky	3.09	2	0.21
Aky	13.37	2	0.001	Aky	0.13	2	0.94
Δldky	5.01	2	0.08	Δldky	9.06	2	0.01
Δsky	2.92	2	0.23	Δtrdy	9.43	2	0.009
all	22.07	10	0.01	All	26.36	10	0.003

Source: Computed from data sources indicated in appendix A.11

Appendix A.13

Table 1.1C: Structural Changes in the four Southeast Asian Countries (% of GDP)

Country	Period	Agriculture	Industry	Manufacturing	Services
	1969	46.96	17.93	10.17	35.11
INDONESIA	1970-1982	31.65	32.42	10.86	35.93
	1983-1996	20.42	38.96	19.71	40.62
	1969	29.05	24.35	11.36	46.60
MALAYSIA	1970-1982	25.27	31.92	16.92	42.81
	1983-1996	17.35	38.82	24.68	43.83
	1969	28.58	27.40	20.75	44.01
PHILIPPINES	1970-1982	28.33	35.54	25.66	36.13
	1983-1996	22.56	34.43	24.36	43.01
	1969	28.69	24.94	15.56	46.38
THAILAND	1970-1982	24.60	28.00	19.64	47.39
	1983-1996	14.06	35.86	25.96	50.08

Source: Computed form the World Development Indicators of the World Bank.

Table 1.2C Growth Rates of Output

Country	Period	Agriculture	Industry	Manufacturing	Services	GNP	GNP per capita
Indonesia	1970-89	4.01	9.48	13.10	7.91	6.88	4.63
	1990-96	3.13	10.51	11.27	7.82	8.18	6.36
Malaysia	1970-89	4.53	8.10	10.36	7.17	6.65	3.95
	1990-96	1.69	11.52	13.49	8.81	8.79	6.04
Philippines	1970-89	2.68	4.45	3.87	4.39	3.94	1.27
	1990-96	1.66	2.85	2.66	3.45	3.61	1.21
Thailand	1970-89	4.53	9.63	10.25	7.31	7.21	4.77
	1990-96	2.53	10.88	11.05	8.29	8.33	6.89

Source: Computed from the World Development Indicators of the World Bank

Table 1.3C: Growth Rates of Exports and Imports

Year	Indonesia		Malaysia		Philippines		Thailand	
	Export	Imports	Export	Imports	Export	Imports	Export	Imports
1974	6.56	32.16	15.93	36.83	Na	Na	na	na
1975	-2.42	11.65	-3.00	-17.10	Na	Na	-4.72	-1.84
1976	17.02	16.75	16.96	9.19	Na	Na	24.09	7.51
1977	9.45	4.45	4.16	15.78	16.41	6.50	11.17	19.70
1978	1.00	12.65	7.59	12.87	6.06	12.73	12.44	6.67
1979	2.29	11.10	17.97	20.43	4.29	16.11	10.43	20.90
1980	5.53	9.74	3.17	20.51	39.82	19.60	7.71	-0.16
1981	-18.05	33.80	-0.83	5.59	6.43	-0.79	9.16	0.56
1982	-9.01	1.41	10.68	13.75	-8.02	2.45	11.66	-14.63
1983	1.65	-2.70	12.34	9.00	4.46	-3.06	-5.98	32.76
1984	6.55	-7.51	13.78	6.51	3.84	-17.48	17.26	7.63
1985	-7.80	5.28	0.45	-9.84	-16.61	-14.20	9.79	-12.67
1986	15.21	4.17	11.79	-6.47	17.09	10.24	15.42	-0.93
1987	14.62	1.97	14.56	8.47	6.50	28.63	21.81	33.56
1988	1.05	-18.70	12.15	24.94	14.69	19.62	27.17	39.56
1989	10.41	11.57	17.93	26.57	10.71	15.18	21.54	21.59
1990	0.41	21.44	16.67	23.69	1.25	10.04	13.39	23.69
1991	19.89	16.74	15.15	24.46	5.76	-3.72	15.14	12.94
1992	15.21	8.78	5.19	1.21	3.91	11.63	13.81	8.97
1993	3.26	4.5	17.24	19.09	6.22	11.50	12.74	11.78
1994	9.10	14.50	22.48	27.67	19.79	14.50	14.22	14.34
1995	7.87	15.81	17.58	21.43	12.04	16.02	15.49	20.71
1996	8.24	17.25	7.15	4.19	15.40	16.74	-1.76	-0.86

Source: Computed from the World Development Indicators of the World Bank.

Table 1.4C: Debt Service Ratios (%)

Year	Indonesia		Malaysia		Philippines		Thailand	
	DS/X	DS/GDP	DS/X	DS/GDP	DS/X	DS/GDP	DS/X	DS/GDP
1974	NA	2.80	3.88	1.93	NA	NA	NA	NA
1975	NA	3.38	5.05	2.36	NA	NA	11.95	2.40
1976	NA	3.45	6.89	3.64	NA	NA	10.38	2.23
1977	NA	4.32	11.47	5.94	15.21	3.40	13.69	2.90
1978	NA	5.32	13.81	7.41	27.27	6.14	21.07	4.54
1979	NA	5.81	7.39	4.53	24.57	5.76	19.67	4.84
1980	NA	4.12	6.30	3.96	26.61	6.73	18.86	5.04
1981	14.04	3.90	8.25	4.74	33.61	8.36	20.27	5.47
1982	18.13	4.28	10.66	5.97	42.62	9.52	20.60	5.38
1983	18.82	4.57	11.56	6.64	36.43	9.25	23.99	5.57
1984	21.82	5.87	14.08	8.48	33.47	8.88	25.71	6.48
1985	28.83	7.03	30.37	18.63	31.57	8.48	31.92	8.53
1986	37.30	7.87	21.79	13.62	33.67	10.13	30.12	8.65
1987	36.99	9.73	21.22	15.02	35.97	10.37	21.94	6.96
1988	40.25	10.21	24.77	18.49	30.80	9.07	20.20	7.23
1989	38.44	10.15	15.05	12.15	25.41	7.70	16.37	6.17
1990	33.30	9.11	12.55	10.59	27.01	8.14	16.92	6.28
1991	34.25	9.36	7.39	6.55	22.97	7.45	13.01	5.07
1992	32.58	9.37	9.07	7.63	24.39	7.98	13.77	5.42
1993	33.59	9.27	8.74	7.84	25.58	8.86	12.99	5.25
1994	30.67	8.38	8.93	8.88	18.92	7.04	13.43	5.57
1995	29.91	8.53	7.03	7.27	16.07	7.02	11.60	5.22
1996	36.64	9.73	8.96	8.91	13.35	6.21	12.59	5.38

Note: DS stands for debt service and X stands for exports of goods and services.
Source: Computed from the World Development Indicators of the World Bank.

Table 1.5C: Interest Payments as Percent of Total Expenditure

Year	Indonesia	Malaysia	Philippines	Thaialnd
1974	1.88	9.58	Na	na
1975	1.50	9.95	Na	8.40
1976	2.70	11.02	Na	6.45
1977	3.32	10.61	4.42	6.54
1978	4.89	11.54	4.85	6.64
1979	5.74	12.22	7.63	7.72
1980	3.70	10.19	7.05	7.77
1981	3.26	9.24	6.27	9.57
1982	5.01	11.99	8.74	9.79
1983	7.30	15.81	11.20	12.38
1984	8.88	20.15	19.98	12.94
1985	7.79	23.24	22.89	14.16
1986	10.16	22.33	25.49	15.82
1987	13.18	24.82	34.06	16.24
1988	15.35	24.95	35.62	17.00
1989	14.81	23.29	32.92	16.56
1990	12.99	20.02	33.67	13.08
1991	11.04	18.98	31.29	9.70
1992	10.32	17.24	29.94	6.97
1993	11.54	16.94	28.08	5.00
1994	12.23	15.16	25.45	3.61
1995	10.69	13.47	21.26	2.12
1996	8.24	12.50	19.08	1.34

Source: Computed from the World Development Indicators of the World Bank.

Appendix A.14

Table 1.1D: Malaysia: Johansen's Estimates of Long Run and Adjustment Coefficients

	Ygr	aky	Eky	Ldky	sky	Trdy
Long Run Coefficients (β')						
	1.00	-8.57	0.96	-0.77	0.63	-0.14
	-0.33	1.00	0.10	-0.06	0.13	0.01
	-4.80	-16.81	1.00	1.36	0.42	-0.03
	3.12	12.54	1.16	1.00	0.02	0.13
	-0.49	-1.75	-0.70	-0.22	1.00	0.03
	-15.02	-25.68	-6.43	-2.58	1.59	1.00
Adjustment Coifficients (α)						
d(ygr)	0.07	-0.30	0.01	0.55	-0.11	0.01
d(aky)	-0.09	0.10	0.09	0.10	0.08	0.00
d(eky)	0.25	-0.36	-1.01	0.30	0.37	-0.03
d(ldky)	-0.67	-0.87	0.53	0.05	0.19	-0.08
d(sky)	0.32	0.58	-0.08	0.52	-0.43	-0.05
d(trdy)	-6.12	-0.18	-1.28	0.40	-1.22	0.11
Weak exogeneity test statistics						
Variable	Ygr	Aky	Eky	Ldky	sky	Trdy
$\chi^2(1)$	3.12.	1.98	0.41	2.54	0.91	25.17

Note: The cointegrating and adjustment coefficients are estimated using the Johansen method. One lag for each variable is included in the vector autoregression. The test for weak exogeneity is based on the assumption that the cointegrating rank is equal to one.

Table1.2D: Philippines: Johansen's Estimates of Log Run and Adjustment Coefficients

	Ygr	Aky	Eky	Ldky	Sky	Trdy
Long Run Coefficients (β')						
	1.00	-1.25	0.01	-0.51	0.03	-0.05
	0.13	1.00	-2.45	-0.16	-4.72	-0.20
	7.99	1.29	1.00	0.35	-0.57	-0.04
	0.20	-0.28	-173.15	1.00	-3.72	0.03
	10.14	-36.47	-12.17	-217.98	1.00	0.01
	-0.35	0.12	-0.24	-0.42	-0.42	1.00
Adjustment Coefficients (α)						
d(ygr)	0.09	-0.26	-0.06	-0.23	0.00	0.00
d(aky)	-0.10	-0.06	-0.24	-0.05	-0.02	0.04
d(eky)	0.15	0.60	-0.16	-0.28	-0.22	-0.03
d(ldky)	-0.83	-0.37	-0.23	-0.09	0.24	-0.11
d(sky)	0.12	0.08	-0.03	-0.01	0.17	0.01
d(trdy)	-1.84	0.15	2.40	-0.90	-0.20	0.04
Weak exogeneity test tatistics						
Variable	Ygr	aky	Eky	Ldky	Sky	Trdy
$\chi^2(1)$	0.13	0.43	-0.08	1.30	0.94	1.53

Note: The cointegrating and adjustment coefficients are estimated using the Johansen method. One lag for each variable is included in the vector autoregression. The test for weak exogeneity is based on the assumption that the cointegrating rank is equal to one.

Table1.3D: Thailand: Johansen's Estimates of Long Run and Adjustment Coefficients

	ygr	aky	eky	ldky	sky	trdy
Long Run Coefficients (β')						
	1.00	-10.24	-0.74	0.94	-0.09	-0.14
	-0.04	1.00	-0.44	-0.42	0.31	0.03
	0.39	-1.82	1.00	0.11	0.79	-0.15
	-0.48	-1.97	-0.52	1.00	3.85	-0.08
	-6.13	0.31	-2.39	-9.56	1.00	0.10
	235.38	721.16	-18.28	-74.32	-1039.33	1.00
Adjustment Coefficients (α)						
d(ygr)	0.84	0.07	-0.29	0.12	-0.68	0.01
d(aky)	-0.09	-0.01	-0.08	0.01	-0.04	0.00
d(eky)	-0.20	-0.46	0.14	0.15	0.05	0.06
d(ldky)	-0.60	-0.16	-0.14	-0.56	-0.12	0.08
d(sky)	-0.19	-0.09	0.27	-0.04	0.05	-0.14
d(trdy)	0.19	-2.12	-0.62	-1.11	0.32	-0.67
Weak exogeneity test statistics						
Variable	ygr	aky	eky	ldky	sky	trdy
$\chi^2(1)$	6.71	6.68	1.11	5.97	1.91	0.04

Note: The cointegrating and adjustment coefficients are estimated using the Johansen method. One lag for each variable is included in the vector autoregression. The test for weak exogeneity is based on the assumption that the cointegrating rank is equal to one.

Chapter 2: Capital Flows and Real Exchange Rate Behavior in Developing Countries

2.1 Introduction

In recent years, the relevance of the real exchange rate for development theory and structural adjustment and stabilization has received increasing emphasis in the literature. In the development and growth theory, the real exchange rate has been singled out as the key factor influencing the economic performance of developing countries. It has been underlined that in open economies where export led growth is a major ingredient of development strategy, success largely depends on the behavior of the exchange rate. The exchange rate in place determines the profitability and expansion of the export sector and hence the overall growth performance. Ito and Krueger (1999) have attributed the spectacular growth performance of East Asian countries, among other things, to an appropriate exchange rate policy. The exchange rate regime in these countries turned exporting into a profitable business and the resulting expansion in the sector set the pace for rapid growth. In other parts of the world such as Africa and some parts of Latin America, the unsatisfactory growth performance has been blamed on the failure to sustain an appropriate exchange rate policy.[14]

In structural adjustments and stabilization processes, the real exchange rate is also considered a key factor. Edwards (1988) has argued that a stable and appropriate level of the real exchange rate sends correct signals to economic agents and facilitates smooth adjustments in the balance of payments thereby ensuring macroeconomic stability and increased welfare. Harberger (1986) and Krugman (1994) demonstrated the need for real exchange rate movements in response to macroeconomic imbalances so as to maintain

[14] See, for example, World Bank (1984), Cline (1983), Corbo et al (1986) and Edwards (1989, 1994).

equilibrium. Mussa (1986), showed how trade and macroeconomic policies affect real exchange rates. Kahn and Montiel (1987) analyzed the dynamic effects of various shocks, such as fiscal policy, commercial policy and devaluation on the real exchange rate in the context of a small primary-commodity exporting economy. They showed that the real exchange rate changes in response to various policy induced shocks. A related aspect of real exchange rates is that they have become more volatile in both developing and developed countries. Edwards (1989) has shown that even developing countries that operated fixed nominal exchange regimes have experienced substantial fluctuations in their real exchange rates. Comparing the pre and post Bretton Woods system, Mussa (1982) and Frankel (1995) found that there has been increased volatility of the purchasing power parity (PPP) based real exchange rate over the floating period relative to the period of fixed exchange regimes.

In the analysis of real exchange rate behavior, a distinction needs to be made between nominal and real exchange rates. The nominal exchange rate, often used as a policy instrument, measures the relative price between two monies. The real exchange rate, on the other hand, measures the relative price between two goods. More importantly, the real exchange rate is a key relative price that relates the domestic economy to the rest of the world. Thus, the real exchange rate is an endogenous variable that responds to many different factors arising from different sources. These factors otherwise known as real exchange rate fundamentals may be exogenous or policy induced. Edwards (1988) outlined two main categories of exchange rate fundamentals. The first group, known as external real exchange rate fundamentals consists of (i) terms of trade, (ii) foreign capital flows, and (iii) world real interest rates. The second class known as domestic real exchange rate fundamentals are (i) trade taxes, (ii) exchange controls, (iii) other taxes and subsidies (iv) the composition of government expenditure. Technological progress which is subject to both internal and external influences is also mentioned as an important determinant of the real exchange rate.

Another distinction that is relevant for the study of real exchange rates is the difference between the actual real exchange rate and the equilibrium real exchange rate. While the actual real exchange rate is the real exchange rate that prevails at any one time in the life of the economy, the equilibrium real exchange rate is the rate that is consistent with the fundamentals. If the actual real exchange rate is equal to the equilibrium real exchange rate then it is in line with what is dictated by the fundamentals. If the actual exchange rate deviates from the equilibrium real exchange rate, then it is inconsistent with the fundamentals and unless corrected in time, is bound to lead to a crisis.

Understanding the behavior of the real exchange rate and its fundamental determinants is therefore crucial for promoting growth as well as maintaining macroeconomic stability in developing countries. Although economic theory[15] clearly demonstrates the link between the real exchange rate and foreign capital flows, previous empirical studies have tended to exclude capital flows from the analysis. This chapter examines the long run behavior of the real exchange rate in small open economies pursuing growth through export expansion and large inflows of foreign capital. In particular, it investigates whether or not the real exchange rate is driven by its fundamentals such as foreign capital

[15] See, for example, Salter (1959), Sjaastad and Menzur (1996) and Edwards (2000).

movements, terms of trade and productivity differentials. The analysis is carried out for the ASEAN-4 countries (Indonesia, Malaysia, Philippines and Thailand). The defining characteristics of these countries are that they have pursued an export led growth strategy, they have been among the recipients of large foreign capital and they have also been high growth performers in the developing world. In addition, these countries have experienced different types of external and internal shocks in their endeavors for economic transformation. Given these developments, it would be interesting to look into the long run behavior of the real exchange rate in these countries. In particular, identifying the long run determinants of the real exchange rate and empirically determining the response of the real exchange rate to these factors would contribute toward understanding real exchange rates in these countries. More importantly, the empirical analysis aims to establish whether or not these countries were characterized by real exchange rate misalignment during the period prior to the 1997-98 Asian financial crises. This chapter is organized as follows: part two provides an overview of the institutional and policy characteristics of four countries in our sample and a description of real exchange rate concepts and their measurement. Part three specifies a two-good model of the internal real exchange rate. Part four reviews the theory and empirical evidence on the link between capital flows and the real exchange rate. Part five develops an empirical model that identifies the fundamentals of the real exchange rate. The model is further used to estimate the relationship between the real exchange rate (the dependent variable) and its determinants. Part six presents data sources, estimation, analysis, and interpretation of the empirical results. Part seven provides the summary and conclusion.

2.2 Background

A number of theoretical and empirical studies have been carried out in the context of developed as well as developing countries to identify the short and long run determinants of the real exchange rate. This section covers three issues related to the behavior of real exchange rates in the countries under study. First, an overview of the four economies of Indonesia, Malaysia, Philippines and Thailand is presented followed by theoretical definitions and empirical measurement issues of the real exchange rate. While the brief accounts provided on each country attempt to bring out the salient features of their policies regarding exchange rate arrangements, foreign trade and foreign investment starting from the 1960s to the pre 1997-98 financial crisis, the descriptive part focuses on the different concepts and methodology of measurement of real exchange rates.

2.2.1 An Overview of the ASEAN-4 Countries[16]

The literature related to exchange rates in East Asia describes these countries as economies that engaged in active exchange rate management during the last three decades leading to the financial crisis of 1997-98 (Hernandez and Montiel 2001). With regard to trade policy there has been a considerable variation among these countries in terms of the degree of protection accorded to their tradable sectors. Regulations on foreign exchange transactions have also differed to a significant extent, indicating differences in the degree of liberalization of their financial sectors[17]. With regard to exchange rate policy, the IMF classification of exchange rate regimes for the four

[16] See "Trade Policy Review" by GATT various issues, Monteil (1997), Krueger (1999) and Ito (2000).
[17] See, for example, Ito and Krueger (1999), Ito (2000), and GATT, various issues.

countries as reported in table one below provides a concise summary of the type of exchange rate policy pursued by these countries.

2.2.1.1 Indonesia

Indonesia is one of the members of the ASEAN with the largest domestic market. The main source of revenue has been receipts from oil exports, although there has been a substantial diversification towards non-oil exports starting from the mid 1980s.

Table2.1 Official Exchange Rate Regimes in the ASEAN-4

Country	Period	Exchange Rate Regime
Indonesia	Nov. 1978-June 1997	Managed Floating
	Jan. 1986-Feb. 1992	Limited Flexibility
	Mar. 1990-Nov. 1992	Fixed
Malaysia	Dec. 1992-Sept. 1998	Managed Floating
Philippines	Jan. 1988-Dec. 2000	Independent floating
Thailand	Jan. 1970-Jun.1997	Fixed

Source: IMF Exchange Arrangements and Exchange Restrictions, various issues

During the period following the mid 1980s, the country shifted emphasis towards trade and foreign investment as the major tools of economic transformation. The main trading partners and sources of foreign finance have been the US, Japan and the EU. In general, Indonesia maintained relatively flexible exchange rate policy, moderately high protection and a favorable environment for foreign investment over the period under study.

2.2.1.1.1 Exchange Rate Arrangement

Exchange rate management in Indonesia has gone through a number of changes. Prior to the mid 1960s Indonesia applied multiple exchange rates on selected transactions. This was quickly abandoned and Bank Indonesia introduced a unified market based exchange rate regime at the beginning of the 1970s. After the devaluation of August 1971, the rupiah was then pegged to the US dollar for most of the 1970s. Bank Indonesia launched a "managed float" policy in November 1978 (GATT 1991). The rupiah began to be determined by the value of a basket of currencies of trading partners subject to periodic interventions. Bank Indonesia intervenes in the market by setting the middle reference rate of the rupiah against the US dollar by taking into account the behavior of currencies of its trading partners. The authorities in Indonesia pursued an exchange rate policy that is mainly concerned with maintaining a stable real exchange rate that is consistent with the attainment of international competitiveness (Tagaki 1999). In view of Indonesia's high inflation rate relative to its trading partners, the devaluations of March 1983 and September 1986 revealed the authorities' intention to maintain a stable real exchange rate.

The foreign exchange market of Indonesia generally functioned on the basis of market forces. Bank Indonesia traded unlimited amounts of foreign exchange or rupiah with authorized traders. The main actors in the market were licensed foreign exchange banks, non-bank financial institutions and licensed foreign exchange dealers. No taxes or subsidies were applied to foreign exchange transactions. The foreign exchange system allows for the unfettered allocation and transfer of foreign currency through the licensed dealers for the settlement of current account transactions. Foreign loans with maturity of one year or longer made by public enterprises required prior approval by the Ministry of Finance. All foreign borrowings had to be reported to Bank Indonesia and the Ministry of Finance.

2.2.1.1.2 Trade and Investment

Although Indonesia's tariff protection showed a gradual decline over the last two decades, the country remained a moderately high tariff economy during the 1990s. The average import tariff for 1983-85 was 37 percent. In 1990 the rate declined to 22 percent. The improvement in the degree of openness induced by the reduction in the average tariff rate was the result of a series of reforms by the government. The main components of the reforms were across-the-board reduction of tariffs, harmonization of tariffs and improvement of administrative structures of the trade regime. With the exception of imports from the members of the ASEAN which receive preferential tariff treatment under the ASEAN preferential trading arrangement (PTA), Indonesia applies the same tariff rates to imports originating from all other countries. Non-tariff barriers such as import licensing and quotas have also been effective in insulating the domestic market from import competition.

On the export side, Indonesia has implemented export regulations that included a wide range of restrictions and controls. The main instruments for intervention have been export taxes, prohibitions, quotas and licensing. Export restrictions have been applied on over 27 percent of Indonesia's tradable goods during the late 1980s. The proportion for agriculture and industry was 18 and 13 percent, respectively. Export licensing covered a wide range of goods. Export controls and bans have been implemented on selected commodities.

In order to increase exports other than oil and gas, Indonesia established the National Agency for Export Development (NAED) in 1971 and the Export Support Board in 1986. Both agencies were formed to provide incentives for non-oil and non-gas exporters. The former advises the government on export policies and regulations, and provides technical assistance for local manufacturers and exporters. The latter provides assistance in overseas marketing and promotion as well as production management with the objective of improving international competitiveness of Indonesian exports. Other export promotional schemes are export credits, export credit guarantees and export insurance, all provided at soft terms to promote exports.

Indonesia's investment environment has been favorable since the enactment of the Foreign Capital Investment Law of 1967 and the Domestic Investment Law of 1968. The Investment Coordinating Board (BKPM) was subsequently established in 1973 to serve as a one-stop agency for investors. It provided the necessary documentation services for investors. Foreign investment in most sectors, with few exceptions (notably banking), in line with government regulations, was required to be a joint venture with an Indonesian partner. The 1989 reforms introduced lease holds of up to 80 years for domestic as well as foreign investors. Subsequent deregulation measures introduced by the government also reduced the number of sectors restricted to foreign investors.

2.2.1.2 Malaysia

Malaysia has led the group in terms of per capita income and growth performance. Malaysia developed a strategy for economic transformation in the New Economic Policy (NEP) document. The main goal of the NEP was the distribution of wealth by promoting growth and employment in line with the ethnic composition of the population. Malaysia has promoted trade and investment to raise economic growth. The main trading partners and source of finance have been the US, Japan and the EU. Overall, the country pursued a pegged exchange rate system, maintained minimal protection, and liberalized its financial sector and regulatory framework to attract foreign capital.

2.2.1.2.1 Exchange Rate Arrangement

Malaysia formally signed to honor the obligations of Article VIII of the IMF in 1968 and agreed to maintain an exchange rate system that is free of restrictions on payment and transfers for current international transactions.

Exchange rate policy in Malaysia prior to the 1970s was a fixed rate system where by the then Malaysia dollar was quoted against the British currency. Malaysia switched to the US currency as its intervention currency in the early 70s and the ringgit was quoted against the US dollar at a fixed rate. By 1975 the ringgit was allowed to be determined by market forces. In order to realign the value of the ringgit, and speculative runs the authorities allowed the ringgit to be determined by market forces. Accordingly, the ringgit was allowed to "float" in relation to a basket of currencies belonging to Malaysia's trading partners. The central bank, however, intervened to maintain orderly market conditions and to avoid excessive fluctuations in the value of the ringgit. Commercial banks were free to determine exchange rates and to deal forward in currencies. During the last three decades leading to the Asian financial crisis of 1997-98, the objective of Malaysia's exchange rate policy was to maintain a sound macroeconomic environment for economic growth and to strengthen export competitiveness. Malaysia's inflation rate remained lower than that of its trading partners during the period under consideration.

2.2.1.2.2 Trade and Investment

After independence in 1957, Malaysia experimented with import substitution policies for a brief period and quickly reversed its growth strategies to embrace the open economy policy of the British colonial government. Compared to other developing countries, government intervention in Malaysia has been minimal. The focus of trade policy in Malaysia has been to maintain and strengthen export orientation and to improve competitiveness for its primary as well as manufactured products. According to (GATT 1993) Malaysia's rapid industrial development was mainly driven by foreign direct investment and imported capital.

Malaysia adopted both tariff and administrative measures to manage its trade regime. The main trade policy instrument influencing import flows has been the customs tariff, with administrative measures also playing an important role in influencing the behavior of firms. The simple average ad valorem tariff was 14 percent in 1993. The corresponding rates for agriculture and industry were 10.4 and 14.4 percent, respectively. Licensing and quantitative restrictions are applied on selected import products. The authorities regularly review the level of tariff protection to make the tariff structure more uniform and to reduce excessive protection.

A number of raw materials and mining products have been subjected to export duties. However, the amount of export taxes has declined over the years. Export licensing has also been applied on selected products that have deemed sensitive by the authorities. The other side of the government's policy with regard to exports has been one of supporting and stimulating the sector. The government provides support to companies in the form of adjustment and investment assistance for both industry and agriculture with out maintaining direct export subsidies. The main tools of intervention have been tax concessions, export financing and export promotion. The rise in spending on research and development has also been an important component of export expansion in Malaysia.

With regard to incentives for foreign capital, Malaysia has consistently maintained a suitable environment for foreign investment since 1968. Measures to promote foreign capital inflows included the liberalization of licenses and foreign investment guidelines, fiscal incentives, reduction in direct taxes, tariff rationalization, improvement in financial and credit conditions and strengthening of the export financing system. Guidelines for foreign ownership have also been linked to the proportion of exports, the level of technology and priority products for the domestic market. The procedures for foreign currency transactions and external borrowing have been relatively free. According to Faruqee (1992), there is strong evidence supporting the idea that liberalization measures have increased the degree of integration between Malaysia's financial markets and international financial markets, implying a strong linkage between domestic and world interest rates.

2.2.1.3 Philippines

The Philippines has been the lowest performer in growth within the group and there has been minimal structural change in the economy. The main factors behind the unsatisfactory performance were economic mismanagement and political corruption during the Marcus era. Despite the resulting uncertainty and inefficiency, the economy has been resilient and the Philippines maintained a respectable pace of economic change compared to other developing countries. The US and Japan have been the main trading partners and sources of foreign capital. In general, the Philippines increased the flexibility of its exchange rate system over the years, while, considerably intervening in the trade sector. Up until the early 1990s, the country maintained less attractive regulations for governing foreign investment.

2.2.1.3.1 Exchange Rate Arrangement

Prior to the early 1980s, the authorities in Philippines attempted to keep the peso exchange rate against the US dollar within a certain target range. After October 1984, the peso was, in principle, allowed to be determined by market forces. However, the central bank intervened with the stated objective of maintaining orderly market conditions, although other policy considerations could not be ruled out as reasons for intervention. Policy matters relating foreign exchange are decided by the Monetary Board and administered by the Central Bank. Foreign exchange trading was initially carried out on-floor at the Foreign Exchange Trading Center (FOREX) according to the rules established by the Banker's Association of the Philippines (BAP). Following the liberalization of the foreign exchange market in 1992, commercial banks started to trade foreign exchange through the Philippines Dealing System (PDS) and the role of market forces in determining the exchange rate of the peso gained strength.

2.2.1.3.2 Trade and Investment

The main objective of trade policy in the Philippines as stated by the authorities was to promote export production and the industrial sector while simultaneously achieving food self-sufficiency and increasing rural incomes. In 1981, the government introduced an import liberalization plan (ILP) to remove import restrictions and to implement a phased reduction of tariffs. The reform also reduced quantitative restrictions and enabled the country to move to a more transparent tariff based protection. The average tariff rate in the Philippines declined from 41 percent in 1980 to 20 percent in 1995. The average tariff rate for agricultural products ranged between 38 percent for raw products and 44 percent for processed products. The corresponding rates for industry were 11 percent and 27 percent. Despite the attempts to reform the sector, Philippines continued to impose restrictions and prohibitions on imports. To that effect, imports were classified into three groups depending on the degree of control involved: freely importable, regulated and prohibited. Overall, trade policy in the Philippines tended to favor the sectors competing with importable goods while imposing an implicit tax on the export sector. The average effective protection rate for importables and exportables in 1991 were 47 percent and -3 percent, respectively. Similarly, manufacturing had 48 percent, agriculture 42 percent and mining 25 percent.

With regard to the flow of foreign capital to the Philippines, the policy framework was provided by the Foreign Business Regulation Act of 1969 and the Export Incentives Act of 1970. Several amendments were made to the framework to improve the regulation of foreign investment entering the Philippines. The foreign investment regime was considerably reformed by the Foreign Investment Act of 1991 which improved foreign ownership regulations and the guide lines for sectoral participation of foreign investors. In addition to tax and other incentives, debt-equity swaps were used by the Philippines to promote foreign investment. Free dividend remittance and relatively less stringent conditions for repatriation of capital were also important instruments for attracting foreign capital into the Philippines. Controls on foreign exchange transactions were in place starting in 1967. Following the 1992 reform, the market started to operate relatively freely, paving the way for improved capital mobility.

2.2.1.4 Thailand

Thailand has performed well in terms of growth of per capita income during the period under study. It has managed to create a diversified export sector. The government's export-led strategy of development and its inclination for foreign capital have been instrumental in fostering structural change in favor of manufacturing. The main trading partners and sources of foreign capital have been the US, Japan and the EU. In general, Thailand maintained a pegged exchange rate system, regulated its import sector while promoting exports and created an attractive regulatory framework for foreign investment.

2.2.1.4.1 Exchange Rate Arrangement

Prior to 1984, the Thai baht was pegged against the US dollar. After devaluing the baht by about 15 percent in November of the same year, Thailand moved to a more flexible exchange rate policy by pegging the baht to a basket of currencies belonging to it major trading partners. The weights allocated to currencies in the basket were based on trade shares. The US dollar, which has been the intervention currency, had the largest weight in the basket. The baht has generally been allowed to move in line with the market, however, the authorities occasionally intervened in the foreign exchange market to avoid excessive fluctuations in the exchange rate.

Prior to 1990, regulations on exchange controls were relatively restrictive. Thailand imposed quantitative restrictions on transactions relating to invisible payments. Some exceptions were applied to the authority of commercial banks in approving applications for trade transactions. All capital transactions required prior approval by the Bank of Thailand. Thailand introduced major reform in 1990 to liberalize its foreign exchange operations. The new regulations eliminated the exceptions to trade transactions, relaxed the quantitative restrictions on service transactions, and delegated capital transactions to commercial banks with relaxed quantitative ceilings.[19] The significance of the 1990 reform was that it mainly affected the capital account. Commercial banks were authorized to carry out large amount of transactions in the categories of invisibles and the capital account with no limit on the number of transactions.

2.2.1.4.2 Trade and Investment

The crux of trade policy in Thailand can be summarized as one focused on protection of domestic economic activity, promotion of exports and provision of incentives to selected sectors. Manufacturing and agro-food processing are heavily protected sectors in Thailand.

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[19] See, for example, GATT (1991).

An important component of Thai trade policy to promote domestic output has been the regulation of imports. Measures to control imports included import taxes, licensing (mostly non-automatic) and local content schemes for selected industries. The government provided incentives by giving tariff exemptions and reductions to certain imports which significantly modified the average applied tariff over the years. Accordingly, the average applied import tax declined from 24 percent in 1963 to 11 percent in 1990.

On the export side, although Thailand imposed export taxes on a few items, the average incidence of export taxes has declined to a negligible level over the last three decades. In 1963 the average export tax was about 14 percent. In 1990 the rate decline to a little above zero. Overall, Thailand has managed to create a conducive environment for export expansion and development with an eye on the long term implication of resource transfers. Export incentives have included duty and tax rebates on inputs for exports and income from export oriented projects. Thailand has also improved the administrative system for granting concessions for the export sector.

With regard to foreign investment, the government of Thailand has recognized it as conduit for the transfer of technology to raise skills and improve product quality. The government, thus, maintained a favorable policy for foreign investment. The Alien Business Law of 1972 provided regulations for foreign investment which supplemented by the Investment Promotion Act of 1977. The former restricted foreign majority ownership to 49 percent and designated certain sectors as off-limits to foreign investors while listing those sectors that are open to them. Licenses for foreign investors in the permitted sectors were approved subject to certain conditions such as debt-financing, the number of Thai directors, and remittance of money. The latter provided incentives for foreign as well domestic investment. For foreign investors, land ownership for business, bringing in skilled workers and/or experts were permitted. Guarantees were also provided against restrictions on export of the output, nationalization and unfair competition from state enterprises and companies sheltered by protection. One particular feature of the investment regulations of Thailand has been that both foreign and domestic investment activities received similar incentives and facilities.

In summary, Indonesia and the Philippines maintained moderately high tariffs to protect their domestic market, while maintaining relative flexibility in their exchange rate regimes. In contrast, Malaysia and Thailand adopted an open foreign trade policy with favorable environment for foreign investment while pursuing relatively less flexible exchange rate systems. In general, these countries attracted a substantial amount of foreign capital during the period under consideration. They intervened in their foreign exchange markets to influence their exchange rates with significant differences in the degree of intervention. They adopted an open trade policy, again with varying degree of protection to their tradable sectors.

The next section presents the theoretical background for the two broad concepts of the real exchange rate: the external real exchange rate and the internal real exchange rate.

After a brief introduction of the two exchange rate concepts, the literature surrounding the external and internal real exchange rates is reviewed.

2.2.2 Real Exchange Rates: Theoretical Definitions and Empirical Measurement

In the economic literature, there are two broad ways of defining the real exchange rate for developing countries: the external and internal approaches. The terminology used for the former is the external real exchange rate. It is defined as the nominal exchange rate adjusted for price level differences between countries. In particular, the real exchange rate is the nominal exchange rate weighted by the ratio of the foreign price level (or cost level) to the domestic price level (or cost level). This concept of the real exchange rate originates from the purchasing power parity (PPP) theory of the exchange rate which compares the relative value of currencies by measuring the relative prices of foreign and domestic consumption and production baskets. .

The external real exchange rate, denoted R, is defined as:

$$R = \frac{EP_f}{P_d} \tag{1a}$$

where E, P_f and P_d are the nominal exchange rate, the foreign price level and the domestic price level, respectively.

The terminology used to describe the second concept is the internal real exchange rate. It is defined as the ratio of the price of tradable goods to nontradable goods within a single country. The internal real exchange rate proposed by Salter (1959), Cordon (1960), Swan (1963) and later developed by Dornbusch (1974, 1980) determines the real exchange rate within a simple general equilibrium framework of a small open economy. The production structure contains two goods: traded and non-traded. The nontraded good is produced and consumed only at home while the traded good is produced and consumed both at home and abroad. Only the latter is traded across international boundaries. Each class of goods is treated as a composite commodity, which means that the relative prices of goods within each category remain constant. The economy is small and has practically no influence on the prices of its traded goods which are determined in the world market. This makes it convenient to treat the production and consumption of traded goods as an aggregate without worrying about the terms of trade. In this case the real exchange rate is defined as the number of units of the non-traded good required to buy one unit of the traded good. The real exchange rate defined in this way is the internal real exchange rate. The expression for the internal real exchange rate, denoted Q, is thus given by:

$$Q = \frac{P_{Td}}{P_{Nd}} \tag{1b}$$

where P_{Td} and P_{Nd} are the domestic price indices for traded goods and non-traded goods, respectively.

2.2.2.1. The External Real Exchange Rate

There are two main variants of purchasing power parity theory: absolute and relative purchasing power parity. The absolute version states that the real exchange rate is unity. The relative purchasing power parity hypothesis, on the other hand, maintains that there can be a constant proportionality between the nominal exchange rate and the ratio of price levels. A weaker form of the relative PPP states that the real exchange rate is not constant but mean-reverting[20]. Mean-reversion loosely implies that deviations from the mean of a given variable are not permanent. Accordingly, the real exchange rate may diverge from its mean (the mean being any arbitrary constant) at any time but such divergence disappears quickly and the real exchange rate returns to its mean value. Absolute PPP theory is more restrictive than relative PPP. The former restricts the ratio of the foreign price level to the domestic price level adjusted by the nominal exchange rate to unity which implies perfect arbitrage in goods markets and identical baskets. The latter relaxes these constraints by requiring the same ratio to attain only constancy in which case some degree of imperfection in arbitrage and differences in the composition of the domestic and foreign bundles are allowed.

Both versions of PPP theory utilize expenditure prices rather than production prices because their main concern is the comparison of purchasing power in different countries. Although both approaches require baskets of goods, the absolute version requires standardized baskets, whereas the relative version requires representative baskets. A standardized basket means that the composition, in terms of goods, of the domestic and foreign baskets is identical. The weight allocated to each good in both baskets must also be the same. A representative basket, on the other hand requires that the range of goods

[20] Suppose the logarithms of the national price level, the foreign price level and the nominal exchange rate are p, p^* and e, respectively. Let $w = p - p^*$ and the logarithm of the real exchange rate be v. Then absolute purchasing power parity is given by $v_t = e_t - w_t = 0$ which implies that the real exchange rate is equal to unity and that the nominal exchange rate can be written as the ratio of national price levels. The relative version of PPP, on the other hand, is given by $dv_t = de_t - dw_t = 0$. This means that the real exchange rate must be constant for its growth rate to be zero. Furthermore, the rate of change of the nominal exchange rate is equal to the inflation differential between the domestic and foreign economies. Note that integrating the relative PPP equation requires adding an arbitrary constant. That arbitrary constant is the logarithm of the real exchange rate.

involved in the expenditure patterns of households and firms should receive comprehensive coverage both in the domestic and foreign economies. In addition, both traded and non-traded goods should be represented in the domestic and foreign baskets according to whatever proportions of actual expenditure are allocated to them. Since price information for representative baskets of goods is readily available in the form of price indices in most countries, many of the empirical studies on real exchange rates have focused on the relative version of purchasing power parity. In practical computation of the external real exchange rate, the foreign and domestic consumer price indices are used because they are regularly available and are broadly representative of both traded and non-traded goods.

One important point worth mentioning is that the PPP hypothesis does not make any general claim about the direction of causation between exchange rates and national price levels. Both exchange rates and national price levels are endogenous variables and, because of this, PPP is conceptually consistent with a process of two-way causation with exchange rates accommodating changes in national price levels and inflation rates reacting to changes in exchange rates.

Generally, the validity of PPP theory applied to all goods depends on assumptions regarding the behavior of traded and non-traded goods prices, competition, technology and the weights of aggregate price indices. Isard (1995) outlined the following conditions for the validity of the PPP hypothesis:

a) all tradable goods are subject to the law of one price,

b) factor price equalization and identical production functions drive the prices of non-traded goods into equality internationally and

c) identical weights are allocated to each good in the aggregate price indices of the two countries.

When applied to traded goods only, the PPP theory would be valid under conditions (a) and (c).

The validity of PPP theory, especially as a short run theory of real exchange rates, has been questioned because of serious doubts on the validity of the law of one price. Isard (1977) showed that for a narrow category of manufactured goods the common currency prices of products from different countries often exhibited failure to converge to one price in the wake of changes in the nominal exchange rates. This result contradicted the law of one price. Engel and Rogers (1998) provided evidence that, under flexible exchange rate regimes, the common currency prices of similar products included in consumer price data generated from different markets have shown significant differences depending on the distances between markets and on whether the markets are located in different countries. These differences may be attributable to product differentiation, pricing under imperfect competition, transport costs and trade barriers, all of which contribute to the weakening of international competition. In addition, labor contracts may lead to sticky wages and unit production costs. This means that firms may not adjust their prices in response to changes in the exchange rate. If price and wage adjustment mechanisms fail to ensure the law of one price among similar manufactured goods, then at the macroeconomic level any deviation of the real exchange rate from PPP is likely to be persistent, indicating that purchasing power parity would be unsuccessful in explaining real exchange rate behavior in the short run.

Although PPP as a theory of short run real exchange rate behavior lacks both theoretical as well as empirical support, it may still be a valid proposition for long run behavior. The forces of international competition may generate convergence in the common currency prices of similar manufacturing products in the long run. Under these conditions, the proposition that the real exchange rate is mean-reverting in the long run may be valid.[21] However, the hypothesis of PPP as a theory of long run real exchange rate behavior, especially when the relevant price indices include both tradable and non-tradable goods has been confronted with arguments disputing the validity of the conditions under which it is purported to hold (conditions a and b above). More precisely, it has been pointed out that production functions are not identical across countries. Consumer preferences are different and different countries have different factor endowments. Given these circumstances, it is hard not to expect international differences in relative prices and in the weights assigned to items included in price indices. Such international differences are likely to be more pronounced with respect to non-tradable goods. More importantly, there is no reason to believe that production functions and consumer preferences will undergo international convergence over time. Instead, technology and preferences may evolve differently in different countries which lead to permanent changes in the real exchange rates in contrast to the PPP hypothesis that the real exchange rate is mean-

[21] For a detailed review of the evidence see McDonald (1995, 1997).

reverting. In addition, other factors such as changes in the terms of trade, capital flows and trade policy affect the real exchange rate but are not incorporated in the PPP hypothesis.

The above views on the PPP theory can be traced back to Balassa's (1964) critical assessment of the PPP theory and Samuelsons's (1964) productivity bias hypothesis (here after the B-S hypothesis). According to Balassa, to the extent that differences in tastes do not offset differences in productive endowments, each country would be inclined to consume commodities with lower relative prices in large quantities which implies that the same class of goods would receive different weights in the general price levels of different countries. Balassa further elaborated on the divergence between exchange rates and national price levels. Namely, as long as the national price levels are driven by monetary factors, exchange rates will track national price levels. However, if the national price levels are driven mainly by structural factors, the exchange rate departures from the national price levels will be significantly persistent.

Subsequent empirical work by Frenkel (1984) found evidence corroborating Balassa's statement that PPP may have more credibility during periods of hyperinflation where monetary factors are more important in determining national price levels. With regard to international price differences, Kravis, Huston and Summers (1982) found empirical evidence in favor of international differences in the prices of traded and non-traded goods and services. Prices of services were found to have higher prices in countries with relatively high levels of income. Another reason for the persistent divergence of exchange rates from PPP is that there may be significant productivity differentials among countries. The B-S hypothesis underscored the importance of international differences in the productivity growth as a determinant of the secular divergence of real exchange rates from PPP.

According to the B-S hypothesis, changes in the relative prices of tradables and non-tradables are caused by differences in productivity growth rates in the two sectors. Productivity growth in the tradable sector is faster than in the non-tradable sector. Cross-country relative prices of tradables remain constant over time, i.e. the law of one price approximately holds for tradable goods. Intersectoral factor mobility and competition keep the real wage the same in both sectors. Under these conditions, countries with higher productivity growth rate in their tradable sector will experience increases in the relative price of their non-tradable goods, leading to a real exchange rate appreciation. The implication is that international differences in productivity growth could lead to permanent departures of the real exchange rate from purchasing power parity even if price index weights are consistent and there is long run convergence in the common currency price of tradable goods. These developments contributed to the shift in focus in defining the real exchange rate in terms of the prices of tradable goods and non-tradable goods.

2.2.2.2 The Internal Real Exchange Rate

The internal real exchange rate is an exchange rate concept that is widely used both in terms of theoretical and empirical applications in small and open developing countries. It is defined as the ratio of the domestic price indices of traded goods to non-traded goods within a country[22]. This concept of the real exchange rate captures the domestic relative price incentives in a particular economy with regard to the production and consumption of tradable goods as opposed to non-tradable goods. The real exchange rate in this case is an indicator of domestic resource allocation incentives within an economy. As shown in equation (1b), the internal real exchange rate is expressed as a ratio of the price index for trade goods to the price index of non-traded goods.

An increase in the internal real exchange rate represents a real depreciation, indicating that tradable goods are more profitable and that the tradable sector will expand relative to the non-tradable sector. With a slight modification, it can be shown that (1b) implicitly incorporates the nominal exchange rate as a determinant of the domestic currency price of tradables. Assuming the law of one price holds for tradable goods, the internal real exchange rate can be expressed as:

$$Q = \frac{EP_{Tf}(1+t)}{P_{Nd}} \tag{2.1}$$

where P_{fT} is the border price of tradable goods in terms of foreign currency including transport costs, E is the nominal exchange rate expressed as local currency units per unit of foreign currency and t stands for the average ad valorem net trade tax rate on tradable goods.

[22] This is the definition of the real exchange rate that is used in this study, that is, $Q=P_T/P_N$, where Q is the real exchange rate, P_T is the price index for tradable goods and P_N is the price index for non-tradable goods Other economists, especially those associated with the world bank have tended to define the real exchange rate as the ratio of the price of non-tradable goods to the price of tradable goods, see for example Elbadawi (1994).

Equation (2.1) is the direct result of the assumption that the law of one price holds for tradable goods. The law of one price states that competition among sellers and arbitrage in goods markets forces identical goods to have the same price after allowance for transaction costs such as transport costs. In practice, the law of one price limits the definition of tradable goods to those goods whose prices are determined fully by international prices and the nominal exchange rate. In this context, all other goods are treated as non-tradable whose prices are determined by other factors. If the law of one price fails to hold for tradable goods, it will difficult to relate the internal real exchange rate to the nominal exchange rate.

2.3 A Two-Good Model of the Internal Real Exchange Rate

This section outlines an analytical framework for determining the fundamentals underlying the behavior of the real exchange rate in a small open developing country. There are two goods: tradables and nontradables. Tradables are composed of importables and exportables and are treated as composite goods, i.e., the relative price of goods in the category remains the same. The economy is a price taker for its exportables and importables. Since imports and exports are indistinguishable, the terms of trade are assumed to have no effect on the real exchange rate. Non-tradable goods are goods that are not traded in the world market because of excessive costs associated in trading them. In this economy, there are two sectors and only one relative price. The model is based on Dornbusch (1983) and Montiel (1999).

2.3.1 Supply

Production is subject to constant returns and the analysis takes a long run view so that prices and wages are flexible and that the economy operates at full employment. The economy is assumed to be a price taker in the sense that it has no influence on the price of its tradable goods. Each sector produces output using a homogenous, perfectly mobile labor and a fixed sector-specific-factor. The economy is assumed to possess concave production frontier with the standard properties. The total supply of labor (L) is fixed but its sectoral allocation is endogenous. Outputs of the tradable and non-tradable sectors are denoted S_T and S_N. The internal real exchange rate, measured by P_T/P_N is denoted Q. The real wage is nominal wage (W) deflated by the price index in the respective sector. The level of employment is determined by profit maximization behavior: $\partial Q_j / \partial L_j = W/P_j$ which says that the marginal product of labor in the j^{th} sector is equal to the real wage in that sector. The corresponding labor demands in each sector as a functions of the real wage can be derived as $L_T(W/P_T)$ and $L_N(W/P_N)$. Thus, equilibrium in the labor market is given by

$$L_T(W/P_T, K_T) + L_N(W/P_N), K_N) = L \qquad (2.2)$$

where L_T and L_N stand for labor demands in the tradable and non-tradable sectors, respectively, W is the nominal wage, P_T and P_N are respectively, the prices of tradable and non-tradable goods and K_i is capital in the i^{th} sector, where (i = T, N). Solving equation (2.2) for the equilibrium wage gives

$$W = W(P_T, P_N; K_j) \qquad (2.3)$$

Log-differentiation of (2.2) expresses the real wage as a decreasing function of the real exchange rate using labor demand elasticities and labor shares as shown in equation 2.4:

$$\frac{\Delta W}{W} - \frac{\Delta P_T}{P_T} = -\pi\left(\frac{\Delta P_T}{P_T} - \frac{\Delta P_N}{P_N}\right) \tag{2.4}$$

where $\pi = \dfrac{\delta_N \sigma_N}{\delta_N \sigma_N + \delta_T \sigma_T}$, δ_j is the share of labor employed in sector j and σ_j is the elasticity of labor demand with respect to the real wage in the same sector. Equation (2.4) says that a real depreciation, i.e., an increase in the price of traded goods relative to the price of non-traded goods, lowers the real wage in terms of traded goods and raises the real wage measured in terms of non-traded goods. The impact on employment and output is straight forward. As the real wage in terms of traded goods falls, employment in that sector rises and output expands. Employment and output in the non-traded goods sector, however, decline in response to the depreciation of the real exchange rate because the depreciation raises the real wage in terms of non-traded goods. Thus, output supplies can be expressed using the real exchange rate and other relevant factors as:

$$S_T = S_T(Q, G),\ S'_T(Q)>0 \tag{2.5a}$$

$$S_N = S_N(Q, J),\ S'_N(Q)<0 \tag{2.5b}$$

$$P_{Td} = EP_{Tf}(1+t) \tag{2.5c}$$

where G and J stand for other factors such as trade policy and macroeconomic variables affecting output supplies in the traded and non-traded sectors, respectively.

2.3.2 Demand

The demand for traded and non-traded goods is derived from the utility maximization behavior of consumers. Utility is defined over traded and non-traded goods. Consumers maximize utility by choosing the two goods subject to a budget constraint. If the utility function is continuously differentiable, then the first order conditions for utility maximization define demand functions for the two goods in terms of relative prices and real spending. As a result, the demands for traded and nontraded goods can be expressed as functions of the internal real exchange rate and the level of real spending as shown below:

$$D_N = D_N(Q, Z) \quad (2.6a)$$

$$D_T = D_T(Q, Z) \quad (2.6b)$$

Given the level of real spending, a rise in the real exchange rate (depreciation) lowers the demand for traded goods owing to both the income and substitution effects. However, a depreciation of the real exchange rate has an ambiguous effect on the demand for non-traded goods. While the substitution effect raises the non-traded goods demand, the income effect reduces it. A change in real spending changes demands for traded and non-traded goods in the same direction.

As total demand is equal to total receipts in the economy, equilibrium in the non-tradable market ensures equilibrium in the balance of trade. This shows that the equilibrium variable is the real exchange rate and can be determined by solving for the nominal exchange rate in the foreign sector for a given domestic price or solving for the domestic price in the domestic market for a given nominal exchange rate. In both cases, the foreign price for traded goods is exogenously given and would therefore appear as an argument in the expression for the real exchange rate. The equilibrium conditions for the traded and non-traded goods markets are respectively,

$$S_T(Q,G) = D_T(Q,Z) \quad (2.7a)$$

$$S_N(Q,J) = D_N(Q,Z) \quad (2.7b)$$

For the non-traded goods market, the real exchange rate can be expressed as a function of the foreign price for traded goods, the level of real spending, trade policy and macroeconomic variables as shown in equation (2.8).

$$Q = Q(P_{Tf,} Z, G, J) \quad (2.8)$$

If income and spending are fixed, and the domestic market is in equilibrium, a trade surplus would result in an appreciation of the real exchange rate. The trade surplus leads to an expansion in income and a rise in spending on both traded and non-traded goods. The increase in spending on non-traded goods generates excess demand for non-traded goods. This creates an upward pressure on the price of non-traded goods. Because the price of traded goods is determined internationally, it is invariant to the change in spending. The result is an appreciation of the internal real exchange rate. Similarly, a trade deficit would lead to a depreciation of the internal real exchange rate.

As mentioned earlier, the internal real exchange rate indicates domestic incentives for both producing and consuming tradabes and non-tradables. The effect of trade policy should therefore be included in its computation. Measuring the internal real exchange rate with and without trade taxes would indicate the extent to which trade policy distorts domestic relative prices compared to relative international prices. In economies where import duties, quantitative restrictions, and exchange controls are rampant, there will be a considerable difference between the internal real exchange rates inclusive and exclusive of taxes.

As a summary guide for resource allocation in the economy, the internal real exchange rate plays an important role in the determination of the current account position of an open economy. An increase in the real exchange rate raises the profitability of producing tradable goods relative to non-tradable goods. This induces resources to flow out of the non-tradable sector into the tradable sector. On the consumption side, the incentives for substituting non-tradables for tradables increases. Overall, the rise in the internal real exchange rate switches domestic resources from the production of non-tradable goods while simultaneously switching domestic expenditure from tradables to non-tradables both of which lead to an improvement in the current account position of the economy.

2.3.3 Terms of Trade and the Internal Real Exchange Rate

The above definition of the real exchange rate is based on the two-good framework. This approach treats tradable goods as a single composite item despite the fact that the components of tradable goods - exportables and importables - are significantly different from each other, especially in the context of developing countries. In addition to differences in the type of goods entering the tradabels, the prices of these goods are subject to different magnitudes of fluctuations. By treating tradable goods as a homogenous group, the two-good approach assumes that the ratio of the price of exportables to the price of importables (the external terms of trade) is constant. Moreover, this approach abstracts from differences in taxes applied to exports and imports. Developing countries export a narrow range of goods whose prices are subject to large fluctuations while they import a diversified range of goods whose prices are relatively stable. This means that the assumption of constant terms of trade is untenable, especially in the context of developing countries. Trade taxes are also asymmetric with respect to imports and exports in developing countries. Therefore, the aggregation of tradable goods into a single composite good may be misleading when the terms of trade and trade policy are important determinants of the internal real exchange rate.

The inability of the two-good framework to handle terms of trade and trade policy has limited its usefulness as a tool for analyzing real exchange rates in developing countries. This shortcoming is overcome by extending the model to a three-good or multi-good framework. In the three-good framework, the tradable sector is broken down into two sectors: the exportable and importable sectors. Retaining the non-tradable sector, the economy has now three goods and two relative prices. The price of exportables relative to non-tradables gives the internal real exchange rate for exportables, Q_X. The other relative price is the price of importables in terms of non-tradables, which is the internal real exchange rate for importables, Q_M. In symbols,

$$Q_X = \frac{P_{Xd}}{P_{Nd}} = \frac{EP_{Xf}(1-t_x)}{P_{Nd}} \tag{3a}$$

$$Q_M = \frac{P_{Md}}{P_{Nd}} = \frac{EP_{Mf}(1+t_m)}{P_{Nd}} \quad (3b)$$

where P_{Xd} and P_{Md} are the respective domestic prices of exportables and importables. P_{Xf} and P_{Mf} are the respective foreign currency border prices of exportables and importables. P_{Nd} is the domestic price of non-tradables and t_x and t_m are taxes on exports and imports, respectively. In practice, the internal real exchange rate for exports is measured as a ratio of the unit value index for exports to the consumer price index (which is a proxy for the price of non-tradable goods). Similarly, the imports unit value index and the consumer price index are used in computing the internal import real exchange rate. The external terms of trade are given by the ratio of the border prices of exports to that of imports. The domestic terms of trade are the ratio of the domestic price of exports to that of imports. In the absence of trade taxes, the domestic and external terms of trade are identical.

2.3.3.1 Export and Import Real Exchange Rates

Using (3a) and (3b), the internal real exchange rate for exports can be defined as follows:

$$Q_X = DTTQ_M \quad (3c)$$

where DTT is the domestic terms of trade defined by the ratio of the domestic price of exportables to importables (P_{Xd}/P_{Md}). Both the export and import real exchange rates are indicators of price competitiveness in production and consumption for exportables and importables in relation to non-tradables. In this framework, locally produced importables and imports are considered substitutes and are therefore treated as a composite good. If there are no taxes and non-tax barriers to trade, the external terms of trade (P_{Xf}/P_{Mf}) are identical with the domestic terms of trade. However, the two measures of the terms of trade can move in different directions when there are changes in trade policy.

One limitation of the extension to the three-good framework is that there is no longer a unique internal real exchange rate for the economy. Edwards (1994) and Elbadawi (1994) use a geometric weighted average of the export and import real exchange rates to construct an internal real exchange rate index for the economy. However, in the presence of changes in the terms of trade, the underlying internal export and import real exchange rates may move in opposite directions and aggregating them into a single summary indicator in this way could be misleading. Another alternative used by Devarajan, Lewis and Robinson (1993) is the foreign currency price of non-tradabales (P_{Nd}/E) which is a common term in the definition of the internal real exchange rate for exports and imports and is not influenced by changes in the terms of trade. This index is considered a better indicator of the degree of competitiveness of the domestic price level when the terms of trade changes occur and there is frequent change in trade policy.

The internal real exchange rate for imports may also be another possible choice as a single measure of the internal real exchange rate in developing countries. The imports of developing countries include a widely diversified range of goods whose prices are relatively stable while their exports are a narrow range of mainly primary products with volatile prices. Thus, the prices of imports of developing countries broadly indicate the prices in their trading partners and the implied competitive environment facing their non-traditional sectors. Hence, with due attention to the significance and implication of changes in the internal exchange rate for exports, the internal real exchange rate for imports can be used as an indicator of the internal real exchange rate for the economy.

Having outlined the main theoretical and conceptual definitions of the real exchange rate, we now turn to the theory of real exchange rate behavior in developing countries.

2.4 Capital Flows and the Real Exchange rate

The role of foreign capital in developing countries has two major aspects. On the one hand, foreign capital accelerates economic growth. On the other hand, it creates new challenges for macroeconomic management. The challenge that foreign capital brings to developing countries concerns its impact on key macroeconomic variables and the resulting implication for macroeconomic stability and performance. In a flexible exchange rate world, increases in capital inflows, by increasing domestic demand, lead to nominal appreciation. Its transmission mechanism is that the capital inflows will be sold in the foreign exchange market to obtain domestic currency. This puts upward pressure on the domestic currency leading to a nominal appreciation. To the extent that monetary policy is tied to price stability, the nominal appreciation translates into a real appreciation.

Implicit in the above mentioned relationship between capital flows and the real exchange rate is that at least part of the capital inflows is spent on domestic goods and services that are not traded in the world market. In a fixed exchange rate system, the money supply and the price level play an important role in the adjustment process. Increases in capital inflows lead to increases in the domestic money supply as the central bank uses domestic currency to buy the foreign exchange that in part ends up being spent on domestic non-traded goods. The increase in domestic expenditures creates upward pressure on the prices of non-tradable goods. The prices of tradable goods are not affected by the increase in domestic expenditure because they are determined internationally. The increase in the prices of non-tradable goods leads to an appreciation of the real exchange rate. This may lead to deterioration in the international position of the economy. The real exchange rate appreciation could result in the loss of international competitiveness and a decline in net exports. Further, the accumulation of foreign debt through on going capital inflows may lead to a decline in international creditworthiness and a crisis in the foreign sector.

2.4.1 Review of the Theoretical Literature

Attempts to understand movements in the real exchange rate initially started with the analysis of the current account. Trade elasticities were used to determine the magnitude of the change of the real exchange rate that would be necessary to bring about external balance. The capital account began to appear as an independent determinant of real exchange rate movements following Salter's (1959) general equilibrium approach to the analysis of internal and external balance. One of the analytical results of Salter's paper is that the balance of payments deficit causes internal imbalance by creating an inflationary gap, as a result of part of the capital inflow being spent on domestic goods and services such as building and infrastructure. To maintain equilibrium, either nominal exchange rate appreciation or a rise in the domestic price level must be allowed. Under fixed exchange rates, it is the rise in domestic prices that leads to the real exchange rate appreciation. Mundell (1971) showed that for a small open economy change in the relative price of foreign to domestic goods (which is the real exchange rate) drives internal and external markets into equilibrium.

Dornbusch (1974) analyzed the determinants of the equilibrium real exchange rate using a model for an open dependent economy[23]. This model is based on a two-good economy with tradable and non-tradable sectors. The production of tradable goods is assumed to be a positive function of the real exchange rate while the production of non-tradable goods responds negatively to changes in the real exchange rate. The determinants of the demand for non-tradable goods are the real exchange rate and real expenditure. In this model, equilibrium in the domestic goods market, i.e. the equality of income and expenditure, determines the relative price of tradable goods in terms of non-tradable goods which is the real exchange rate. Capital flows in this model expand income and lead to more spending on non-traded goods resulting in an appreciation of the real exchange rate. Sachs (1981) examined the response of the real exchange rate to the current account in OECD countries and found that the majority of countries with current account deficits experienced real appreciation while most of the surplus countries underwent real depreciation. Since current account deficits reflect capital account

[23] A dependent economy is loosely defined as one that is a price taker in the world market for importables and exportables, and powerless to influence its terms of trade.. Details can be found in Salter (1959), Swan (1960) and Dornbusch (1974)

surpluses, and current account surpluses imply capital account deficits, this study indicates the importance of capital flows in explaining changes in real exchange rates.

Since equilibrium models of the real exchange rate do not distinguish between temporary and permanent changes in the fundamentals, they do not allow for differential effects of such changes on the real exchange rate. To the extent that these differences are important, short run equilibrium may not necessarily imply long run equilibrium. This means that the actual real exchange rate may be consistent with short run equilibrium conditions, but deviates substantially from long run equilibrium. For example, if there is a temporary increase in foreign capital inflows, the real exchange rate will appreciate to ensure short run equilibrium in the internal and external markets. However, this value of the real exchange rate may not be sustainable in the long run after adjustments in the long term stock of asset holdings of foreigners and domestic residents have reached equilibrium. Such distinction between permanent and temporary changes of the fundamentals is particularly useful for policy.

A number of authors have analyzed the temporary versus permanent changes to real exchange rate fundamentals. Williamson (1983), Harberger (1983), Mussa and Frenkel (1984) and Edwards (1984b) emphasized the need for making a distinction between permanent and temporary changes to the determinants of the real exchange rate. Focusing on sustainability, Hooper and Morton (1982) defined the real exchange rate as the rate which drives the current account to equilibrium in the long run. The long run equilibrium or "sustainable" current account, in turn, is determined by the rate at which foreign and domestic residents wish to accumulate or decumulate domestic currency denominated assets net of foreign currency denominated assets in the long run. Williamson (1994) defined the fundamental equilibrium real exchange rate as the rate that is expected to generate a current account surplus or deficit equal to the underlying capital flow over the cycle, given that the country is pursuing international balance as best as it can and not restricting trade for balance of payments reasons. Mussa and Frankel (1984) wrote that the equilibrium exchange rate is expected to be consistent with the requirement that on average (in present and future periods) the current account is balanced.

In order to take into account the effects on the real exchange rate of temporary and permanent changes in the fundamentals, researchers engaged in the construction of large macroeconomic models. General equilibrium macroeconomic models were considered appropriate for specifying the conditions for internal and external balance that provided the basis for computing the real exchange rate that is consistent with the specified conditions. Internal equilibrium is conditioned on the potential level of output and non-accelerating inflation rate while external equilibrium is determined by a current account balance that is consistent with long run capital flows. Haque and Montiel (1999) studied the impact of permanent and policy induced shocks on the real exchange rate using a general equilibrium macroeconomic model. Their model elaborated on the mechanism for the adjustment of the long run real exchange rate to permanent changes in the fundamentals: namely, domestic policy changes and external shocks taking into account full general equilibrium interactions.

One of the implications of the general equilibrium approach is that, contrary to the predictions of the purchasing power parity theory, the equilibrium real exchange rate is not just a fixed number, but one that changes in response to changes in macroeconomic variables and shocks that hit the economy. According to Edwards (1988), the equilibrium real exchange rate is that relative price of tradables to non-tradables that, for given long run equilibrium or sustainable values of other relevant variables such as trade taxes, international prices, capital and aid flows, and technology results in the simultaneous attainment of internal and external equilibrium. Internal equilibrium means that the non-tradable goods market clears in the current period and is expected to be in equilibrium in the future. External equilibrium, on the other hand, means that the current account in the present period and the balances expected in the future satisfy the inter-temporal budget constraint which states that the discounted value of the current account balances has to equal to zero. In other words, external equilibrium boils down to the consistency of current account balances (current and future) with sustainable capital flows.

As explained in Edwards (1988), several results emerge from this view of the equilibrium real exchange rate. First, the equilibrium real exchange rate changes in response to changes in variables that affect internal and external balances. This means that the equilibrium real exchange rate changes over time. Second, to the extent that there is inter-temporal substitution in consumption and production, the real exchange rate is not only affected by current values of the fundamentals but also by their expected future values. Third, the distinction between temporary and permanent changes to the fundamentals arises as an important factor in the determination of the equilibrium real exchange rate. Finally, and most importantly, this definition of the equilibrium real exchange rate implicitly rejects the idea of one single exchange rate for all times.

Instead it embraces the idea that there is a path of equilibrium real exchange rates over time. Based on this view of the real exchange rate, Edwards (1989) constructed a two-period real inter-temporal optimization model with consumers and producers to analyze the behavior of real exchange rates. The model determined a path of equilibrium real exchange rates.

The idea that the real exchange rate should be examined in an intertemporal context has two implications. First, the equilibrium real exchange rate is a function of fundamental economic variables. Second, the actual real exchange rate moves optimally in response to changes in the current and future values of the fundamentals and approaches the equilibrium real exchange rate path over time.[24] This observation on real exchange rate behavior led to the development of an empirical literature that employed reduced-form single-equation approaches to the estimation of equilibrium real exchange rates. Two widely used variants of the single-equation approach are the traditional regression and the cointegration methods. Both of these approaches express the equilibrium real exchange rate as a function of a set of fundamental explanatory variables. The difference between the two approaches lies in their econometric methodology.

[24] For an overview of the analysis of real exchange rate determination and the links between the actual and equilibrium real exchange rates see Edwards (1989) and Montiel (1997).

2.4.2 Review of the Empirical Literature

Using the traditional version, Edwards (1989, 1994) carried out an extensive study of the determinant of equilibrium exchange rates. In the first paper, Edwards used pooled data for a group of developing countries to estimate the equilibrium real exchange rate and found evidence in support of the fundamentals. The terms of trade, capital flows and trade policy were found to be significant determinants of the equilibrium real exchange rate. In the second paper, Edwards provided a detailed analysis of the role of real and monetary factors in the determination of the real exchange rate. With the actual real exchange rate as the dependent variable and a set of real and monetary factors as explanatory variables, Edwards used panel data for a group of 12 developing countries over the period 1962-84. The estimation was conducted using two-stage least squares on a fixed effect procedure with country-and time-specific terms. Ordinary least squares and instrumental variables (IV) techniques were used. The real fundamentals were the growth rate of total factor productivity, terms of trade, the share of government consumption in GDP, openness to trade and capital flows. The demand variables included the excess supply of domestic credit (in some cases the growth rate of domestic credit), and the ratio fiscal deficits to lagged monetary base. Also included in the equation was a lagged dependent variable to allow for adjustment of the actual real exchange rate to its long run value. With the exception of the productivity variable, the results confirmed the fundamentals hypothesis as opposed to the purchasing power parity theory. The evidence also suggested that the actual real exchange rate adjusted to its equilibrium value over long time lags.

Razin and Collins (1997) employed the above methodology on a large country panel. They found that the long run real exchange rate appreciated in response to terms of trade improvement and increases in net capital inflows. Further, their estimated results suggested that mis-alignment – defined as the difference between the actual and the equilibrium real exchange rate – has a non-linear relationship with long term growth, controlling for other growth determinants. In particular, they found that a large average devaluation of the domestic currency was negatively related to growth while moderate undervaluation was associated with positive growth.

Following the advances in time series econometrics, the empirical literature on real exchange rates in developing countries has used unit roots and cointegration extensively. The main objective of such empirical investigations was to look into the link between the real exchange rate and its fundamentals and detect if there existed a cointegrating relationship. Several empirical studies based on unit root econometrics have found evidence supporting the fundamentals hypothesis. Elbadawi (1994) used fundamentals including the terms of trade, an index of openness, net capital inflows as a share of GDP, the share of government spending on GDP and the growth rate of exports. The analysis used annual data from developing countries for the period 1967-90. Non-stationarity and cointegration were detected in the data, lending credence to the fundamentals approach.

Elbadawi and Soto (1994) distinguished between short term and long term capital flows in their investigation of the determinants of the real exchange rate. They found that short term capital flows were stationary and that only long term capital flows (the sum of foreign direct investment and long term portfolio flows) were significant determinants of the long run real exchange rate. Elbadawi and Soto (1995) employed similar methodology on a larger sample with the foreign nominal interest rate adjusted for country risk as an additional explanatory variable. The evidence favored the foreign interest rate, long term capital flows and openness to trade for all cases while cross country variations were observed in the terms of trade and government consumption. Cardensa (1997), reported in Montiel (1999), applied the cointegration methodology for Colombia using quarterly data from 1980:I to 1993:III. Only three variables were included:- namely average labor and total factor productivity in the traded and non-traded goods sectors (to capture the B-S effect), the terms of trade and disaggregated government spending as a share of GDP. The terms of trade and government spending were found to be significant while the productivity variable gave mixed results. Loayza and Lopez (1997) used the stock of international indebtedness and relative sectoral productivity for seven Latin American countries and used annual data from 1960-95. Non-stationarity in the real fundamentals and cointegration among them were confirmed. More precisely, improvement in the international creditor position and relative productivity in the traded goods sector tended to produce an appreciation of the equilibrium real exchange rate.

The cointegration approach to estimating the equilibrium real exchange rates has also been applied to industrial countries. Specifically, OECD data have been used to assess whether or not a cointegration relationship existed between the real exchange rate and its fundamental determinants. Balvers and Bergstrand (1997), using panel regression and

Bahmani and Rhee (1996), and Strauss (1996) using the Johansen procedure found evidence in favor of the B-S productivity differential hypothesis. Mark and Choi (1997) reported that productivity differential, the real interest rate and per capita income performed well in explaining departures of the real exchange rate from its long run value.

Another line of investigation has emphasized terms of trade shocks in explaining fluctuations in the real exchanger rates and departures from PPP during the flexible-rate periods. Mendoza (1995) examined the G-7 countries and a group of developing countries and found that terms of trade shocks explained almost fifty percent of the variability in actual real output, which in turn caused real exchange rate appreciation and real interest rate differentials. De Grigorio and Wolf (1994) reported that faster tradable productivity than non-tradable productivity and terms of trade improvements led to real exchanger rate appreciation in 14 OECD countries. Amano and Van Norden (1992) examined the Canada-US real exchange rate to test for the role of energy prices in the behavior of real exchange rates. They broke down the terms of trade into the price of energy exports and the prices of non-energy exports, each deflated by the price of manufactured imports. Their empirical results suggested that changes in energy prices predicted well the changes in real exchange rates between Canada and the US during the 1970s and 1980s. Lastrapes (1992) and Menzur (1991) underlined real disturbances as the major long run determinants of real exchange rate movements in the industrial countries.

Table 2.2: Selected Empirical Studies on the Real Exchange Rate and its Determinants

Bahmnai and Rhee (1996)	Korea[a]	1979:I-1993:IV	Mult. Cointegration
Balvers and Bergstrand (1997)	OECD	1988-1993	Panel Regression
Cardensa (1997)	Colombia	1980:I-1993:III	Cointegration
Dabos and Juan-Ramon (2000)	Mexico	1970:I-1998:IV	Cointegration
De Gregorio and Wolf (1994)	OECD	1970-1985	SUR
Edwards (1989)	DCs[b]	1965-1985	OLS, IV
Edwards (1994)	DCs[b]	1962-1984	Panel Regression
Elbadawi (1994)	Chile Ghana and India	1967-1990	Cointegration
Elbadawi and Soto (1995)	DCs[c]	1960-1990	Cointegration
Lastrapes (1992)	ACs[d]	1973:1-1989:12	VAR
Loaza and Lopez (1997)	Latin America[e]	1960-1995	Cointegration
Mark and Choi (1997)	ACs[f]	1961-1993	Panel Regression
Mendoza (1995)	DCs and G-7[g]	1960-1990	VAR
Menzur (1991)	DCs[h]	1961-1972 , 1973-1985	Panel Regression
Monteil (1997)	ASEAN-5[k]	1960-1994	Cointegration
Razin and Collins (1997)	DCs (52)	1967-1990	Panel Regression
Strauss (1996)	ACs[m]	1960-1990	Mult. Cointegration

Notes: DCs and ACs stand for developing countries and advanced countries, respectively.
a: Korea, Germany, Japan, US and UK.
b: Brazil, Colombia, El Salvador, Greece, India, Israel, Malaysia, Philippines, S. Africa, Sri lanka, Thailand and Yugoslavia.
c: Chile Cote D'Voire, Ghana, India, Kenya, Mali and Mexico.
d: US, West Germany, UK, Japan, Italy and Canada.
e: Argentina, Brazil, Chile, Colombia, Mexico, Venezuela and El Salvador.
f: US, UK, Canada Germany and Japan.
g: Argentina, Chile, Brazil, Mexico, Peru and Venezuela, Israel, Saudi Arabia and Egypt, Taiwan, India, Indonesia, Korea, Philippines and Thailand, Algeria Cameroon, Zaire, Kenya, Morocco, Nigeria, Sudan and Tunisia.
h: UK, Switzerland, Italy, Japan, Germany, Canada, Australia, Austria, Belgium, Denmark, Netherlands, Finland, Greece, Iceland, Ireland, Luxembourg, Norway, Spain, Sweden and US.
k: Indonesia, Malaysia, Philippines, Singapore and Thailand.
m: Belgium, Canada, Finland, France, US, UK and W. Germany

Source: Compiled by the author.

In view of the theoretical predictions and empirical evidence surrounding real exchange rates and its fundamentals, this section studies the ASEAN-4 countries to investigate empirically whether the fundamentals approach explains the movements in the real exchange rates. Specifically, it will explore further the role of capital flows, terms of trade and other relevant variables in explaining long term movements in the real exchange rate and to empirically examine whether or not an equilibrium relationship exists among the variables. Toward this end, an analytical framework for establishing the link between the long run real exchange rate and capital flows will be presented in the next section.

2.5 An Empirical Model of Capital Flows and the Real Exchange Rate

The model set out below seeks to specify the link between the real exchange rate and capital flows. The model is based on the dependent economy approach to real exchange rate analysis of Salter (1959), Dornbusch (1983), Elbadawi (1994), Edwards (1989, 1994), Sjaastad and Menzur (1996) and Montiel (1999). It attempts to capture the effects of real factors including capital flows, terms of trade, productivity growth and trade policy on the real exchange rate. The empirical model is developed in two steps. First, the theoretical foundation of the relationship between the real exchange rate and capital flows is presented. This will be followed by a derivation of estimating equations based on the analytical framework developed in the first step.

2.5.1 The Analytical Framework

The model is an extension of the two-good approach to the analysis of real exchange rates outlined earlier in section two. It considers a price taking open economy with three distinct goods. It is assumed that the country produces two goods: a non-traded good, N, and an export good, X. Agents in the country consume two goods: the non-traded good (or home good) and import, M. It is also assumed that agents do not consume the export good. This assumption is not restrictive because if agents do consume the export good, it is classified as a non-traded good. The domestic price indices for the non-traded good, the export good and import are P_{Nd}, P_{Xd} and P_{Md}, respectively.

Exports and the non-traded good are assumed to be imperfect substitutes in production. This implies that reallocation of goods between the two markets is costly. Supply functions for the outputs of the two sectors are derived from firms' profit maximization behavior. Thus, the first order conditions for profit maximization characterize the supply functions for exports and the non-traded goods.

On the demand side, consumers derive utility from the consumption of the non-traded good and the import good subject to a budget constraint. The non-traded good and the import good are assumed to be imperfect substitutes in consumption. Assuming monotonic preferences and a continuous utility function, the demand functions for the non-traded good and the import good can be characterized by the first order conditions for utility maximization. Based on this background, demand for imports and nontraded goods and supply of exports and nontraded goods can be derived. Since total demand is equal total revenue in the economy, equilibrium in the domestic nontradaded goods market ensures equilibrium in the traded goods market. One can, therefore, proceed to solve for the real exchange rate either using the nontraded goods market or the traded goods market (see appendix B.21 for derivation).

In what follows, we focus on the external sector to show the link between capital flows and the real exchange rate. Accordingly, the supply function for exports and the demand function for imports are formulated as general outcomes of firms profit maximization behavior and consumers utility maximization behavior, respectively. The specific functional forms are, however, suggested by Sjaastad and Manzur (1996). The value of imports of goods and services and exports of goods and services are denoted by $M.P_{Md}$ and $X.P_{Xd}$, respectively. Y is GDP and Y^e is expenditure on goods and services. Thus, $Y^e = Y + (M.P_{Md} - X.P_{Xd})$. Net capital inflow, denoted by K, is defined as the balance on the capital account. Hence, $K = Y^e - Y = (M.P_{Md} - X.P_{Xd})$ so that $Y^e = Y+K$. The ratios of net capital inflows to GDP and to the value of exports of goods and services are defined by KY = K/Y and KX = K/($X.P_{Xd}$), respectively. Expenditure on goods and services can now be expressed as $Y^e = Y(1+KY)$.

Because the variables involved are aggregate import demand and aggregate export supply they are expressed as functions of relative prices and income. In particular, Sjaastad and Manzur (1996) ignore the effect of secular economic growth in their specification in order to focus on the variability of the real exchange rate caused by capital inflows. Accordingly, they specify import demand and export supply in the following fashion:

$$\frac{M.P_{Md}}{Y^e} = f\left(\frac{P_{Md}}{P_{Nd}}, \frac{P_{Md}}{P_{Xd}}, \frac{Y^e}{Y}\right) \qquad (4)$$

$$\frac{X.P_{Xd}}{Y} = g\left(\frac{P_{Xd}}{P_{Nd}}, \frac{P_{Xd}}{P_{Md}}, \frac{Y}{Y^e}\right) \qquad (5)$$

According to the homogeneity postulate both f(.) and g(.) are homogenous of degree zero in P_M, P_X and P_N[25]. We modify these functions to allow for long term growth effects on the real exchange rate by including a productivity term denoted $\lambda = 1 + \varphi$ (where φ is the real change in productivity) in the import demand and export supply functions. With this modification, a log-linear approximation of (4) and (5) gives equations (6) and (7).

$$M.P_{Md} = A_1(P_{Md} / P_{Nd})^{(-\mu_N)}(P_{Md} / P_{Xd})^{(-\mu_X)}(Y^e / \lambda Y)^{(1+\varepsilon_M)} \lambda Y \qquad (6)$$

$$X.P_{Xd} = A_2(P_{Xd} / P_{Nd})^{(\eta_N)}(P_{Xd} / P_{Md})^{(\eta_M)}(\lambda Y / Y^e)^{\varepsilon_X} \lambda Y \qquad (7)$$

Since capital inflow is the difference between imports and exports, the model is closed with equation (8).

$$M.P_{Md} = X.P_{Xd}(1 + KX) \qquad (8)$$

In modeling exports of developing countries, the approach adopted here is motivated by considerations relating to the nature of the products, their share in world markets, and the impact on exports of domestic income and expenditure. In general, developing countries exports are mainly undifferentiated primary products and they constitute a very tiny part of world markets. It is, therefore, reasonable to assume infinitely elastic demand for such

[25] The homogeneity postulate is a statement about the effect on real commodity demands and supplies of changes in prices and income. Under general conditions real commodity demands and supplies are homogenous of degree zero in all prices and nominal income. In other words, if all prices and nominal income are raised by the same proportion, real commodity demands and supplies remain unchanged. The homogeneity postulate implies that we can use any nominal quantity as the numeraire such as a price index or a specific commodity price in formulating demand and supply functions for the relevant commodities.

export products and drop foreign income from export functions. As an alternative, export elasticities are used to specify export supply functions. Furthermore, since exports are the excess of domestic production over domestic consumption, we can include income and expenditure as arguments in the export supply function as shown in equation 7 above.

Equations (6-8) can be expressed in logarithmic form as follows:

$$m + p_{Md} = a_1 + y - (\mu_N + \mu_X) p_{Md} + \mu_N \cdot p_{Nd} + \mu_X p_{Xd} + (1 + \varepsilon_M) \ln(1 + KY) - \varepsilon_M \ln \lambda \qquad (6')$$

$$x + p_{Xd} = a_2 + y + (\eta_N + \eta_M) p_{Xd} - \eta_N \cdot p_{Nd} - \eta_M p_{Md} + (1 + \varepsilon_X) \ln \lambda - \varepsilon_X \ln(1 + KY) \qquad (7')$$

$$m + p_{Md} = x + p_{Xd} + \ln(1 + KX) \qquad (8')$$

where lower case letters indicate natural logarithms of the corresponding upper case letters. For example, g = lnG.

The parameters μ_N and μ_X are import demand elasticities with respect to the price of imports relative to non-tradable goods and the price of imports relative to exports, respectively; and η_N and η_M are export supply elasticities with respect to the relative price of exports in terms of the prices of non-tradable goods and of imports, respectively. All the elasticity parameters are expected to be positive as long as there is no complementarity. Stability requires that $\mu_N + \mu_M > 0$. In this context stability means that for given import and export prices, changes in the price of non-tradable goods produces shifts in expenditure and production in the right directions. ε_M and ε_X are the proportionate differences between average and marginal propesnsities to import and export, respectively[26].

Equations (6'-8') can be solved for any one of the price indices. Solving the system for the price index of non-tradable goods gives the following:

$$p_{Nd} = \varphi + \psi\left[(1+\varepsilon_X+\varepsilon_M)\ln(1+KY)\right] - \ln(1+KX) + \rho\ln\lambda + \phi p_{Md} + (1-\phi)p_{Xd} \qquad (9)$$

where $\psi = \frac{-1}{\mu_N+\eta_N}, \rho = \frac{1+\varepsilon_X+\varepsilon_M}{\mu_N+\eta_N}, \phi = \frac{\mu_N+\mu_X-\eta_M}{\mu_N+\eta_N}$

and $\varphi = \psi(a_1 - a_2)$.

Since $\mu_N + \eta_N > 0$ by the stability condition ψ is negative. Furthermore, the parameter ϕ, the elasticity of the price of non-tradable goods with respect to the price of imports is the well known "shift' parameter in the theory of incidence of protection.[27] The productivity term ρ can take positive or negative values. It will be positive if productivity increases lead to larger expansion in exports than in imports. It will be negative if imports grow faster than exports in response to increases in productivity. The resulting increase (decrease) in the price of non-tradable goods in terms of export prices and import prices leads to a real depreciation (appreciation) – an outcome required to restore equilibrium.

The term $\phi p_{Md} + (1-\phi)p_{Xd}$ in equation (9) is a weighted average of the import and export price indices. Hence, it is an appropriate price index for tradable goods. This implies that equation (9) is an implicit relationship between the internal real exchange rate and capital flows. The internal real exchange rate in natural logarithms is given by

[26] For an in depth explanation, see Sjaastad and Menzur (1996).
[27] For details see Sjaastad (1980), and Clements and Sjaastad (1984).

$q = p_{Td} - p_{Nd}$ where p_{Td} is the natural logarithm of the price index of tradable goods. Sjaastad and Menzur (1996) showed that the homogeneity postulate would be satisfied if $\partial p_{Td} / \partial p_{Md} = \phi$ and $\partial p_{Td} / \partial p_{Xd} = 1 - \phi$ so that $p_{Td} = \phi p_{Md} + (1-\phi) p_{Xd}$ and the natural logarithm of the internal real exchange rate is given by

$$q = \phi p_{Md} + (1-\phi) p_{Xd} - p_{Nd} \qquad (10)$$

Hence, inserting p_{Td} in equation (9) and rearranging terms yields

$$q = \varphi + \psi \left\{ \ln\left(\frac{1+KX}{1+KY} \right) - (\varepsilon_X + \varepsilon_M) \ln(1+KY) \right\} - \rho \ln \lambda \qquad (11)$$

Assuming that the εs are small, the third term in equation (11) can be dropped and ln(1+KX) and ln(1+KY) can be approximated by KX and KY, respectively. This simplifies equation (11) to the equation,

$$q = \varphi + \psi\{KX - KY)\} - \rho \ln \lambda \qquad (12)$$

Recalling that $KX = \frac{K}{X.P_{Xd}}$ and $KY = \frac{K}{Y}$, the internal real exchange rate can be written as:

$$q = \varphi + \psi_Y KY - \rho \ln \lambda \qquad (13)$$

where $\psi_Y = \psi\left(\frac{Y}{X.P_X} - 1 \right)$

The ratio ψ_Y/ψ measures the degree of openness of the economy where the lower the ratio the more open is the economy. Equation (13) specifies the theoretical relationship between the internal real exchange rate (p_T - p_N), capital flows as a ratio of GDP and productivity. The parameters ψ_Y and ρ measure the long run effects on the internal real exchange rate of changes in the ratio of capital flows to GDP and productivity, respectively. Equation (13) is difficult to estimate because of problems associated with the construction of price indices for tradable goods and non-tradable goods.

To see this, recall that the consumer price index p is a weighted average of tradable and non-tradable goods prices and can be expressed as:

$$p = \omega_N p_{Nd} + (1 - \omega_N) p_{Td} \tag{14}$$

Now, define the actual real exchange rate for the economy as q = p_T - p and use (14) to obtain q = w_N(p_T - p_N). Inserting this in (13) yields the following:

$$q = \omega_N (\varphi + \psi_Y KY - \rho \ln \lambda) \tag{15}$$

The real exchange rate also contains unknown weights of the price index for tradable goods, further transformation is thus necessary to make equation (15) suitable for estimation. This problem is addressed in the next section.

2.5.1.1. Derivation of Estimating Equations

In order to derive alternative estimating equations (see appendix A.2), without having to construct price indices for tradable and non-tradable goods, certain definitions and equations are needed. More specifically, the following relationships are essential:

a) $q_X = p_{Xd} - p$

b) $q_M = p_{Md} - p$

c) $b = p_{Xf} - p_{Mf}$

d) $KY = K / GDP = E(M.P_{Mf} - X.P_{Xf}) / GDP$

All variables are in natural logarithms with the exception of those in equation (d) with the exception of those in equation (d). The left hand sides of equations (a) and (b) are the real exchange rate for exports and the real exchange rate for imports, respectively. Equation (c) defines the external terms of trade as the ratio of the foreign price of exports to the foreign price of imports. The price of non-traded goods is proxied by the consumer price index, denoted by p in equations (a) and (b). The nominal exchange rate in (d) converts net capital inflows in foreign currency (the quantity in parenthesis) into domestic currency. Now, using the definition of the actual real exchange rate for the economy:

$$q = p_{Td} - p \qquad (16)$$

and plugging in the definition of the price index for tradable goods (equations 9 and 10) in (14) gives

$$q = (p_{Td} - p) = \phi p_{Md} + (1-\phi) p_{Xd} - p = (p_{Xd} - p) - \phi(p_{Xd} - p_{Md}) \qquad (17)$$

Noting that the real exchange rate for exports $q_X = p_{Xd} - p$ and the domestic terms of trade $dtt = p_{Xd} - p_{Md}$, the real exchange rate can be written as

$$q = q_X - \phi dtt \qquad (18)$$

Substituting (18) in (15) gives:

$$q_X = \omega_N(\varphi + \psi_Y KY - \rho \ln \lambda) + \phi dtt \qquad (19)$$

The relationship between the domestic and foreign prices of exports and imports are given by $p_{Xd} = e + p_{Xf} + \ln(1 - t_x)$ and $p_{Md} = e + p_{Mf} + \ln(1 + t_m)$ where t_x and t_m are average export and import tax rates, respectively and e is the natural logarithm of the nominal exchange rate. The internal terms of trade are related to the external terms of trade by the equation

$$dtt = p_{Xd} - p_{Md} = (p_{Xf} - p_{Mf}) + \tau = tte + \tau \qquad (20)$$

where tte stands for the external terms of trade and $\tau = \ln(1-t_x)-\ln(1+t_m)$. It is a summary measure of the stance of commercial policy. In other words, it is a measure of the degree of openness to international trade.

Inserting (20) in (19) results in equation (21):

$$q_X = \omega_N \varphi + \omega_N \psi_Y KY + \phi tte - \omega_N \rho \ln \lambda + \phi \tau \qquad (21)$$

Relabelling all parameters and introducing a stochastic error term gives the estimating equation for the export real exchange rate.

$$q_{Xt} = \theta_0 + \theta_1 KY_t + \theta_2 tte_t + \theta_3 ty_t + \theta_4 pl_t + v_t \qquad (22)$$

where ty = τ is a trade ratio used as a proxy for openness, $pl_t = \ln\lambda$, and v_t is an error term and the coefficients in (22) are related to those in (21) by the following:

$$\theta_0 = \omega_N \varphi, \theta_1 = \omega_N \psi_Y, \theta_2 = \phi = \theta_3, \theta_4 = \omega_N \rho$$

The marginal response of the export real exchange rate to changes in capital flows, $\psi_Y = \theta_1 / \omega_N$ and is predicted to be negative implying an appreciation of the internal real exchange rate for exports in response to a rise net capital inflows. δ_t represents the stance of trade policy and can be interpreted as a broad measure of openness. In practical estimations it may be proxied by the ratio of total trade (exports + imports) to GDP or the ratio of trade taxes to total trade[28]. Changes in trade taxes affect δ, which in turn affects the real exchange rate. We will return to this later.

[28] Openness is a change in the trade regime that encourages the movement of goods across international boundaries. It is affected by several variables such as protection rates, exchange rate misalignment, anti export bias, import restrictions and non-trade barriers. Price information on these variables are rarely available and as a result researchers have used trade ratios as measures of openness. The most frequently used measure is total trade to GDP ratio (some studies have used import to GDP ratio as a measure of openness). This approach attempts to measure the degree of openness by "outcome" rather than by the kind of trade regime that is in place. The problem is that the trade ratio can change in response to factors that have nothing to do with the trade regime in which case the trade ratio fails to measure openness. In

An alternative real exchange rate equation using the import real exchange rate as the dependent variable can also be derived by manipulating equation (17) to get (23).

$$q_M = q - (1-\phi)dtt \tag{23}$$

Using (20) in (23) and substituting the resulting expression in (15) yields

$$q_M = \omega_N \varphi + \omega_N \psi_Y KY - \omega_N \rho \ln \lambda - (1-\phi)(tte + \tau) \tag{24}$$

Relabelling parameters and introducing an error term results in the estimating equation for the import real exchange rate

$$q_{Mt} = \beta_0 + \beta_1 KY_t + \beta_2 tte_t + \beta_3 ty_t + \beta_4 pl_t + \xi_t \tag{25}$$

where ξ_t is an error term and the rest of the variables are defined above.

The coefficients on the capital flow variable θ_1 and β_1 in equations (22) and (25) are negative so that both the internal real exchange rates for exports and imports appreciate in response to sustained increases in the net capital flows to GDP ratio. With regard to the

addition, the trade ratio is not invariant with country size. The ratio tends to be small for large countries because such countries are likely to have a large non-tradable sector. Even in the case of small countries, slower or faster growth of output can distort its ability to measure openness. For example, increases (decreases) in the growth of output caused by factors unrelated to the external sector would lead to decreases (increases) in the ratio. Treating this as a change in the degree of openness is, however, misleading. In other instances, devaluation that is induced to correct a disequilibrium situation may reduce imports and may even raise exports while rendering the trade regime more open. This makes the import ratio or even total trade to GDP ratio inappropriate as a measure of openness. Another measure of openness is the ratio of trade taxes to total trade. This ratio tries to capture the amount of "burden" imposed on foreign trade. However, this ratio does not include the equivalence of effective protection rates, non-trade barriers and tariffs that are imposed to remove discrimination between domestic and foreign activities. For example, if a country's trade regime entails tariff escalation: no tariffs on imported inputs and high tariffs on finished consumer goods, it creates a bias against domestic production of inputs. Now, increasing the tariff on imported inputs is not necessarily reducing openness. This rather eliminates the bias against domestic inputs and makes the trade regime more neutral in that respect. Despite the above deficiencies, trade ratios are used as measures of openness in empirical studies because of easy availability of statistics on trade, trade taxes, and GDP. Although both the trade to GDP ratio and the trade taxes to total trade ratio are imperfect measures of openness, looking at the severity of the weaknesses, the latter is likely to better approximate the degree of openness than the former. Again if data on trade taxes is not sufficiently available, the next available measure is the trade to GDP ratio.

external terms of trade and trade policy it was pointed out earlier that the distinction between exports and imports is necessary when an economy faces variations in its external terms of trade or when the effect of domestic policies, such as trade taxes, on export and import prices are significantly different. Under these circumstances, changes in the terms of trade will have different effects on the internal real exchange rates for imports and exports. For instance, an improvement in the external terms of trade triggered by a rise in the foreign price of exports and a decline in the foreign price of imports induces an appreciation in the internal real exchange rate for imports ($\beta_2 < 0$). However, its effect on the internal real exchange rate for exports is ambiguous. While the terms of trade improvement raises the domestic relative price of exports, it also generates excess demand for non-traded goods, thereby raising their prices. The direction of movement of the internal real exchange rate for exports depends on the relative strength of these two opposing forces.

With respect to trade policy, assuming constant external terms of trade, a decrease in import taxes that is not accompanied by an offsetting change in the taxes or subsidies on exports may decrease the domestic price of imports and the import real exchange rate may appreciate ($\beta_3<0$) . This policy does not, however, have a direct effect on the domestic price of exports. But the domestic terms of trade (P_{Xd}/P_{Md}) will improve and the internal real exchange rate for exports depreciates ($\theta_3>$) owing to a shift in demand from domestic goods to cheaper imports and the resulting fall in domestic goods prices. An increase in export taxes unaccompanied by offsetting import taxes also affects both the internal real exchange rates for exports and imports in opposite directions. The tax induced decrease in the domestic price of exports appreciates the internal real exchange rate for exports. Although the export tax does not directly affect the domestic price of imports, it deteriorates the domestic terms of trade and depreciates the internal real exchange rate for imports (β_3>0). The productivity term γ is included in both the export and import real exchange rates to capture the B-S effect which predicts that θ_4 and β_4 are negative.

2.5.1.2 The Use of Two Real Exchange Rates

The preceding analysis suggests that there are two real exchange rates rather than just one real exchange rate for the economy. As mentioned earlier, the three-good approach gives up the convenience of having a single real exchange rate measure in order to incorporate terms of trade and trade policy effects in the analysis of real exchange rates. In addition, the two real exchange rates, the export and import real exchange rates, by themselves contain important information for the economy. The export real exchange rate indicates the degree of internal price competitiveness of exportables relative to non-tradables in the production and consumption sectors. Similarly, assuming import computing products are close substitutes for imports, the real exchange rate for imports indicates the domestic production and consumption incentives for importables relative to non-tradables.

Again as mentioned earlier, the literature on real exchange rates points out that three alternatives may be used as indicators of the internal real exchange rate for the economy: the import real exchange rate, the foreign currency price of non-tradable goods (P_N/E) or a weighted average of the import and export real exchange rates. The import real exchange rate is a general indicator of the competitive environment among trading partners. The foreign currency price index of non-tradable goods signals the competitiveness of the domestic economy in relation to the rest of the world. The weighted average of the two real exchange rates is plausible when trade policy is stable and import and export prices do not move in opposite directions. One way to compute the weighted average real exchange rate is to apply geometric averaging.

$$Q = Q_M^{\gamma} Q_X^{1-\gamma} \tag{26}$$

where γ is the share of importables in total traded goods[29]. However, caution should be exercised in using the internal real exchange rate as computed in (26). If there are frequent changes in trade policy and if shocks to imports and exports are asymmetric, the geometric averaging is not appropriate and the internal real exchange rate so obtained would be misleading.

2.6 Data, Estimation and Results

The empirical investigation on the link between the real exchange rate and its fundamentals is carried out for four countries: Indonesia, Malaysia, Philippines and Thailand. The data for Indonesia are from 1967-96 and the data for the other countries are from 1960-96. The analysis is, therefore, concerned with the development experience of these countries during the period prior to the financial crisis of East Asia. The data used in this analysis are obtained from the World Development and Social Indicators of the World Bank and the IFS of the IMF.

[29] Elbadawi (1994) and Edwards (1994) have used this technique to compute the internal real exchange rate for the economy.

Two real exchange rate variables are calculated from the data: the internal real exchange rate for exports and the internal real exchange rate for imports. The former is computed as the ratio of the price index for exports to the consumer price index. The consumer price index is used as the proxy for the price index of nontraded goods. The latter is calculated in a similar way as the ratio of the price index for imports to the consumer price index. The calculation of two real exchange rates stems from the hypothesis that the external terms of trade is a fundamental determinant of the real exchange rate. The other fundamentals that are considered to drive the long run behavior of the real exchange rate are capital flows, productivity, and openness to trade (see appendix A.5).

2.6.1 Determining the Order of Integration

As mentioned earlier, the purpose of this empirical investigation is to measure the degree to which the hypothesized fundamentals explain the long term movements of the real exchange rate. This requires estimation of equations (22) and (25). Since the data are annual time series, the first step in the estimation process is to examine the degree of integration of the relevant variables. As is well known, macroeconomic time series data are characterized by stochastic trend which could be removed by first differencing. The presence of stochastic trends severely affects the properties of alternative estimators which makes determination of the order of integration all the more important in the analysis of time series data. A non-stationary variable in levels is integrated of order one or I(1) if it becomes stationary, i.e., integrated of order zero or I(0), after it is differenced once. A variable may be said to exhibit higher order of integration if it requires repeated differencing before turning I(0). The number of differencing applied on a non-stationary variable in order to turn it into a stationary one is known as the order of integration of the non-stationary variable. Variables that require no differencing to achieve stationarity are integrated of order zero. Variables that contain deterministic trends are known as trend stationary for which removal of the trend is sufficient to achieve stationarity.

The order of integration of a variable is determined by running standard unit root tests on the variable. Accordingly, the Dicky-Fuller and Phillips-Perron tests are used to test the presence of a unit root. As the power of unit root tests is low in small samples, both the Dicky-Fuller and Phillips-Perron tests are implementd to verify the robustness of the results. The tests were implemented on both the levels and first differences. The unit root test results on the levels of the relevant variables corresponding to the four countries are reported below. The unit root tests on the first difference are not reported.

Table 2.3 Indonesia: Time Series Properties of Real Exchange Rates and their Fundamentals (1967-96)

	DF (ADF)		PP	
Variable	With trend	Without trend	With trend	Without trend
q_X	-1.32 (1)	-1.87 (0)	-1.27 (5)	-2.24 (10)
q_M	-2.55 (1)	-1.92 (0)	-2.40 (13)	-1.98 (3)
KY	-2.95 (0)	-2.85 (0)	-2.95 (0)	-2.85 (0)
pl	-2.61 (0)	-1.72 (0)	-2.62 (2)	-1.27 (3)
tte	-0.61 (9)	-3.54 (4)	-0.19 (4)	-2.50 (5)
ty	-1.21 (0)	-0.97 (1)	-1.54 (4)	-1.41 (4)

Note: ADF and PP stand for Augmented Dicky-Fuller and Phillips-Perron unit root test statistics. The numbers in parentheses next to the ADF statistics are the number of lags included based on the Schwarz information criteria (SC) and those beside the PP statistics are the Bartlett Kernel based Newy-West truncation lags. DF is ADF with zero lag. The variables are defined in appendix A.21
Source: Computed from sources indicated in appendix A.25

Table 2.3 presents the results of the Dicky-Fuller (Augmented Dicky-Fuller) and Phillips-Perron unit root tests for Indonesia. All the tests are significant at the 1% and 5% levels confirming the unit root hypothesis for the the logarithms of the internal real exchange rate for exports (q_X), the internal real exchange rate for imports (q_M), productivity (pl), the external terms of trade (tte), openness to trade (ty), and the level of net capital flows to GDP ratio (KY). In other words, all the variables for Indonesia are integrated of order one or I(1).

Table 2.4 Malaysia: Time Series Properties of Real Exchange Rates and their Fundamentals (1960-96)

	DF (ADF)		PP	
Variable	With trend	Without trend	With trend	Without trend
q_X	-1.63 (0)	-1.56 (0)	-1.82 (2)	-1.68 (2)
q_M	-1.37 (1)	-1.85 (1)	-1.05 (3)	-1.49 (0)
KY	-3.29 (0)	-3.38 (0)	-3.29 (0)	-3.38 (0)
pl	-0.86 (0)	-1.16 (0)	-1.29 (2)	-1.01 (2)
tte	-3.07 (0)	-3.23 (0)	-3.07 (0)	-3.23 (1)
ty	-1.15 (0)	-1.59 (0)	-0.85 (16)	-1.58 (0)

Note: See table 2.3

The unit root tests for Malaysia's variables are reported in table 2.4. All the tests favor the hypothesis of a unit root at the 1% and 5% levels of significance. Thus, the logarithms of the internal real exchange rates, productivity, external terms of trade, openness to trade, and the level of net capital inflows to GDP are found to be integrated of order one.

Table 2.5 Philippines: Time Series Properties of Real Exchange Rates and their Fundamentals (1960-96)

	DF (ADF)		PP	
Variable	With trend	Without trend	With trend	Without trend
q_X	-2.23 (0)	-2.22 (0)	-2.33 (1)	-2.22 (0)
q_M	-3.17 (0)	-3.44 (0)	-3.15 (1)	-3.37 (1)
KY	-2.78 (1)	-2.83 (10)	-2.34 (1)	-2.56 (1)
pl	-2.16 (1)	-2.19 (1)	-1.54 (0)	-2.24 (1)
tte	-1.95 (0)	-2.11 (0)	-2.37 (2)	-2.52 (2)
ty	-1.61 (0)	-0.11 (0)	-1.64 (2)	-0.13 (1)

Note: See table 2.3

The unit root tests for the Philippines are reported in table 2.5. The tests indicate that both the logarithm of the real exchange rate for exports and for imports are I(1). With regard to the fundamentals, the ratio of net capital inflows to GDP, the logarithms of productivity, external terms of trade and openness to trade are I(1) as indicated by both the Dicky-Fuller and Phillips-Perron unit root tests.

Table 2.6 Thailand: Time Series Properties of Real Exchange Rates and their Fundamentals(1960-96)

	DF (ADF)		PP	
Variable	With trend	Without trend	With trend	Without trend
q_X	-3.89 (1)	-2.75 (1)	-2.70 (8)	-2.72 (6)
q_M	-2.84 (0)	-1.19 (0)	-2.87 (3)	-1.25 (3)
KY	-2.13 (0)	-1.94 (0)	-2.04 (6)	-1.97 (5)
pl	-2.68 (1)	-1.08 (1)	-1.86 (2)	-0.99 (2)
tte	-1.99 (2)	-0.48 (2)	-3.07 (6)	-0.43 (6)
ty	-1.28 (0)	-0.01 (0)	-1.39 (4)	-0.03 (6)

Note: See table 2.3

Table 2.6 reports the unit root test results for Thailand. All the tests confirm the unit root hypothesis at 5% and 1% levels for the logarithms of the real exchange rate for exports and imports. The unit roots tests on the fundamentals indicate that these variable are also integrated of order one.

Overall, the (DF/ADF and PP) tests conducted to determine the time series properties of the variables for the four East Asian countries reveal that all the variables for Indonesia, Malaysia, and Thailand are I(1). The unit root tests on the variables for the Philippines also favor the I(1) case for all variables except the logarithm of the real exchange rate for imports which is found to be integrated of order zero or I(0).

Confirmation of the I(1) case for the variables in the sample countries implies that the respective variables may be cointegrated or there may be no cointegration among the variables at all. If the variables are cointegrated then this defines a long run equilibrium path for the economy. If they are not cointegrated, then a respecification in first differences would be appropriate to conduct the empirical analysis. This calls for the application of the Johansen maximum likelihood tests for cointegration to determine the cointegrating rank for each set of variables in each of the four countries.

2.6.2 Determining the Cointegrating Rank

The cointegrating rank is a property of the full system and given the order of integration of the variables in the four countries, a system estimator for each set of variables is required to test for it. The Johansen likelihood ratio test results for the cointegrating rank of each set of variables for the four countries are reported in Tables 2.7-2.10.

Table 2.7: Johansen's Maximum Likelihood Test of Cointegration Rank for Indonesia

CI Variables: q_X KY pl tte ty				VAR (k=1)			
H_0: no. of	Eigenvalue	Trace	5% c.v.	1% c.v.	L-max	5% c.v.	1% c.v.
R=0	0.83	101.85	68.52	76.07	49.87	33.46	38.77
R≤1	0.61	51.98	47.21	54.46	26.20	27.07	32.24
R≤2	0.45	25.78	29.68	35.65	16.92	20.97	25.52
R≤3	0.17	8.86	15.41	20.04	5.33	14.07	18.63
CI Variables: q_M KY pl tte ty				VAR(k=1)			
H_0: no. of	Eigenvalue	Trace	5% c.v.	1% c.v.	L-max	5% c.v.	1% c.v.
R=0	0.99	206.85	87.31	96.18	137.15	37.52	42.36
R≤1	0.65	68.91	62.99	70.05	29.29	31.46	36.65
R≤2	0.49	39.63	42.44	48.45	18.60	25.54	30.34
R≤3	0.41	21.02	25.32	30.45	14.84	18.96	23.65

Note: The critical values are taken from Osterwald-Lenum (1992). The trace statistic tests the null of r cointegrating relations against the alternative of n cointegrating relations, where n is the number of endogenous variables for (r = 0, 1,...,m-1). The maximum eigenvalue (L-max) statistic on the other hand tests the null of r cointegrating relations against the alternative of r+1 cointegrating relations and proceeds sequentially for r = 0, 1, ..., m-1. In each case the procedure is to sequentially test the null from r = 0 to r = m-1 until failure to reject arises. Thus, the first row (r=0) tests the null of no cointegration and the second row (r ≤1) tests the null of at most one cointegration vector.
Source: Computed from data sources indicated in appendix A.25

A lag length of one is used for the underlying VAR system. This is undoubtedly restrictive even for annual data but the consequence of using higher lag lengths is a sharp decline in the degrees of freedom. In these tests the null is that the number of cointegrating vectors linking the n non-stationary I(1) variables is at most r, where r < n. For Indonesia, table 2.7, comparing the estimated trace and l-max statistics with the asymptotic critical values for the internal real exchange rate for exports and the associated fundamentals, the hypothesis of no cointegration (r = 0) can be rejected in favor of at most one cointegrating vector at 5% and 1% critical values. Looking at the next row, the null of one cointegrating vector cannot be rejected in favor of more than one cointegrating vector. Similarly, for the internal import real exchange rate group, we find that the trace test indicates one cointegrating vector only at the 1% level while the l-max test confirms the null of one cointegrating vector at both levels of significance.

Table 2.8: Johansen's Maximum Likelihood Test of Cointegration Rank for Malaysia

CI Variables: q_X KY pl tte ty		VAR (k=1)					
H_0: no. of CE(s)	Eigenvalue	Trace	5% c.v.	1% c.v.	L-max	5% c.v.	1% c.v.
R=0	0.60	86.42	68.52)	76.07	32.30	33.46	38.77
R≤1	0.46	46.12	47.21	54.46	21.53	27.07	32.24
R≤2	0.32	24.59	29.68	35.65	13.64	20.97	25.52
R≤3	0.26	10.94	15.41	20.04	6.44	14.07	18.63
CI Variables: q_M KY pl tte ty,		VAR (k=1)					
H_0: no. of CE(s)	Eigenvalue	Trace	5% c.v.	1% c.v.	L-max	5% c.v.	1% c.v.
R=0	0.69	110.64	94.15	103.18	41.09	39.37	45.10
R≤1	0.49	69.55	68.52	76.07	23.50	33.46	38.77
R≤2	0.43	46.05	47.21	54.46	19.56	27.07	32.24
R≤3	0.36	26.49	29.68	35.65	15.72	20.97	25.52

Note: See table 2.7

Table 2.8 reports cointegration test results for Malaysia. The upper part of the table contains the results for the export real exchange rate group. Both the trace and l-max tests reject the null of no cointegration in favor of one cointegrating vector. Similarly, for the import real exchange rate group (lower part of table), both tests support the null of one cointegrating vector.

Table 2.9: Johansen's Maximum Likelihood Test for Cointegration Rank for Philippines

CI Variables: q_X KY pl tte ty				VAR (k=1)			
H_0: no. of CE(s)	Eigenvalue	Trace	5% c.v.	1% c.v.	L-max	5% c.v.	1% c.v.
R=0	0.64	75.68	68.52	76.07	36.33	33.46	38.77
R≤1	0.42	37.73	47.21	54.46	19.08	27.07	32.24
R≤2	0.27	18.65	29.68	35.65	10.90	20.97	25.52
R≤3	0.17	7.76	15.41	20.04	6.38	14.07	18.63
CI Variables: q_M KY pl tte ty				VAR (k=1)			
H_0: no. of CE(s)	Eigenvalue	Trace	5%	1%	L-max	5%	1%
R=0	0.74	126.50	94.15	103.18	47.48	39.37	45.10
R≤1	0.61	71.02	68.52	76.07	33.05	33.46	38.77
R≤2	0.49	45.97	47.21	54.46	23.71	27.07	32.24
R≤3	0.30	22.26	29.68	35.65	12.38	20.97	25.52

Note: See table 2.7

Table 2.10: Johansen's Maximum Likelihood Test for Cointegration Rank for Thailand

CI Variables: q_X KY pl tte ty				VAR (k=1)			
H_0: no. of CE(s)	Eigenvalue	Trace	5% c.v.	1% c.v.	L.max	5% c.v.	1% c.v.
R=0	0.83	146.23	114.90	124.75	61.38	43.97	49.51
R≤1	0.54	84.84	87.31	96.58	27.15	37.52	42.36
R≤2	0.49	57.70	62.99	70.05	23.83	31.46	36.65
R≤3	0.39	33.86	42.44	48.45	17.49	25.54	30.34
CI Variables: q_M KY pl tte ty				VAR (k=1)			
H_0: no of CE(S)	Eigenvalue	Trace	5% c.v.	1% c.v.	L.max	5% c.v.	1% c.v.
R=0	0.81	152.22	114.90	124.75	57.45	43.97	49.51
R≤1	0.60	94.77	87.31	96.58	32.12	37.52	42.36
R≤2	0.52	62.65	62.99	70.05	25.88	31.46	36.65
R≤3	0.41	36.77	42.44	48.45	18.73	25.54	30.34

Note: See table 2.7

For the Philippines cointegration tests were conducted both for the export and import real exchange rate groups. Table 2.9 reports the cointegration test results. Both the trace test and the l-max tests reject the null of no cointegration but they do not reject the null of one cointegrating vector in favor of two cointegrating vectors at the 5% level of significance for both groups of variables.

Table 2.10 contains the cointegration test results for Thailand. The upper part of the table reports cointegration test results for the export real exchange rate group. Both tests support the null of one cointegrating vector at the 5% and 1% levels of significance. The lower part of the table presents test results for the import real exchange rate group. The trace test indicates one (two) cointegrating vector(s) at the 1% and 5% levels, respectively. The l-max test however, confirms one cointegrating vector at both the 5% and 1% levels.

2.6.3 Alternative Estimators

The findings regarding the order of integration and cointegrating rank reported above call for the estimation of the cointegrating parameters. There are several potential methods for estimating the cointegrating parameters. The first is the Engel-Granger (1987) two-step methodology. The first step in this methodology is to apply OLS to a static regression relating the levels of the real exchange rate and its fundamentals (equations 22 and 25). If the residuals from the static regression are stationary, then the variables in the static regression are cointegrated. This constraint thus serves as a test for cointegration. The cointegrating parameters estimated in the static regression are super-consistent, approaching the true parameters at a rate proportional to the sample size (T) rather than the square root of the sample size ($T^{1/2}$) (Stock, 1987). Such asymptotic behavior of the estimators holds even when weak exogeneity is absent[30]. The second step in the Engel-Granger methodology is to estimate, using OLS, reduced-form error-correction equation with the lagged residuals from the static regression as equilibrium correction terms. This provides consistent estimates of the adjustment speed and short run parameters of the error-correction model[31]. The estimates of the cointegrating vector obtained from the first step in the Engel-Granger methodology are biased in small samples owing to the persistence in the residuals.

The Engel-Granger estimates of the cointegrating vector can be improved by accounting for short run dynamics (Banerjee et al 1993) and (Hendry 1995). The long run parameters of the cointegrating relation can be consistently estimated by applying OLS to an ECM transformation of the autoregressive distributive lag model. This method gives better results because the addition of dynamics in estimating the long run model reduces the degree of bias in the estimated coefficients.

A third estimator is the Johansen (1988) method which estimates a full vector autoregression using a systems approach. However, this method generally requires very

[30] Weak exogeneity is a concept which provides conditions under which analysis of the conditional model is sufficient to perform valid inference without necessarily studying the entire model. For details see Eangle et al (1983), Banerji et al (1993) Hendry (1995) and appendix A.4. Although our exogeneity tests on some individual fundamentals are not rejected, joint exogeneity of all the potential fundamentals is rejected.

[31] Engle and Granger (1987) demonstrated the equivalence of cointegration and error-correction for nonstationary variables. To illustrate, consider two time series Y_t and X_t. Suppose, $Y_t = \beta X_t + \varepsilon_t$. If Y_t and X_t are I(1) and there exists β such that ε_t is I(0), then Y_t has a reduced form error-correction representation of the form $\Delta Y_t = \alpha_0 + \gamma(Y_{t-1} - \beta X_{t-1}) + \sum_{i=1}^{n} \theta_i \Delta Y_{t-i} + \sum_{j=0}^{q} \lambda_i \Delta X_{t-j} + \mu_t$. It is this reduced form error-correction equation that is estimated by OLS in the second step of the Engle-Granger method. In this step the adjustment speed (γ) and the short run parameters θ_i and λ_j are consistently estimated.

large sample size for reliability. More specifically, it is found to have unsatisfactory performance in small samples and is also proved to be less robust than the single-equation method due to misspecification of system parameters such as lag lengths and serial correlation in errors (Hargreaves 1994, Maddala 1998).

As a result of these problems, estimation results of the Johansen method are reported in the appendix and are not used for analysis here. Instead, the single-equation approach of Hendry (1995) is used to estimate long run parameters as well as error-correction models of the real exchange rate.

2.6.4 Cointegrating Regressions

Specifications of the real exchange rates for exports and imports using a set of fundamentals derived from the theoretical model are estimated using OLS following the verification of the non-stationarity of the variables. The specification is such that the data would reject or confirm cointegration together with the appropriate sign and statistical significance of the fundamentals.

Table 2.11 presents the estimates of the cointegrating regressions (equations 22 and 25 in the text) for the countries under study. The test for cointegration is conducted by running unit root tests on the residuals from the cointegrating regressions. As indicated by the unit root tests, there is strong evidence of cointegration in each case. The calculated statistics reject the null of nonstationarity in favor of stationarity at standard levels of significance.[32]

The coefficients on the hypothesized fundamentals are correctly signed in all equations. The long run coefficients obtained in this way are, however, subject to small sample bias because of persistence in the residuals. Superior long run parameter estimates can therefore be obtained by specifying and estimating a model which accounts for short run dynamics which is the subject of the next section.

[32]The critical values for the unit root test on the residual series take into account the fact that the residual series is itself an estimated variable. This test therefore uses higher critical values than the test for for a unit root for ordinary series generated by some process. The reason for this is that OLS estimation tends to induce stationarity in the residual series.

able 2.11: Cointerating regressions

Country	Period	Estimates[1]
(1) Indonesia:	1967-96	(a) $q_{Xt} = 7.04-0.69(FY_t)-0.45pl_t+0.76(ty_t)+1.01(tte_t)$
		R^2=0.98, LM(3)=2.45, DW=1.98, DF=-6.79, PP=-6.78
		(b) q_{Mt} =7.22-0.71(FY_t)-0.29(pl_t)-0.73(ty_t)-0.06(tte_t)
		R^2=0.89, LM(3)=5.02, DW=2.07, DF=-5.17, PP=-5.61
(2) Malaysia:	1960-96	(c) $q_{Xt} = 0.28-1.68(FY_t)-0.37pl_t+0.43(ty_t)+1.42(tte_t)$
		R^2 = 0.90, LM(3)=1.32, DW=1.98, DF=-6.25, PP=-6.27
		(d) q_{Mt} =0.71-1.01(FY_t)-0.25(pl_t)-0.35(ty_t)-0.40(tte_t)
		R^2=0.81, LM(3)=5.64, DW=1.96, DF=-5.77, PP=-5.99
(3) Philippines:	1960-96	(e) $q_{Xt} = 9.76-0.54(FY_t)-1.31pl_t+0.61(ty_t)+0.78(tte_t)$
		R^2 = 0.90, LM(3)=1.24, DW=2.22, DF=-4.78, PP=-4.94
		(f) q_{Mt}=9.75-0.51(FY_t)-1.34(pl_t)-0.57(ty_t)-0.22(tte_t)
		R^2=85, LM(3)=6.36, DW=1.95, DF=-7.37, PP=-8.99
(4) Thailand:	1960-96	(f) $q_{Xt} = 5.49-0.27(FY_t)-0.02pl_t+0.67(ty_t)+0.21(tte_t)$
		R^2 = 0.91, LM(3)=4.23, DW=2.21, DF=-5.56, PP=-5.57
		(g) q_{Mt} =5.27-0.71(FY_t)-0.07(pl_t)-0.24(ty_t)-0.68(tte_t)
		R^2=0.94, LM(3)=1.19, DW=2.02, DF=-5.27, PP=-5.28

1 No t-ratios are reported because regressions involving non-staionary variables are known to understate standard errors. The unit root tests on the residuals generated from the cointegrating regressions are significant at the 5% level, indicating that the residuals are stationary and that the variables are cointegrated. All the regressions are used to generate the error-correction terms used in the second step Engle-Granger methodology of estimating ECMs for the respective countries (See tables 2.12-2.15).

Source: Computed from sources indicated in appendix B.25

2.6.5 Error-Correction Models

If as theory claims, the long run equilibrium real exchange rate is determined by the fundamentals then the fitted value from the cointegrating equation represents a long-run equilibrium for the real exchange rate. This implies that any deviation from this value must be transitory which would hold if the deviations generate forces that move the actual real exchange rate toward equilibrium. An empirical test for such mechanism can be carried out by estimating error-correction models. The next section presents error-correction estimates of the export and import real exchange rates for the four countries.

Tables 2.12-2.15 present error-correction estimates of the export and import real exchange rates for the four Asian countries under study. In each case, columns 1 and 2 correspond to the two-step Engle-Granger method and columns 3 and 4 contain estimates of the error-correction form of the autoregressive distributed lag model.

Table 2.12: Error-Correction Estimates for Indonesia

Dep. Variables	Δq_X	Δq_M	Δq_X	Δq_M
RHS Variables	1	2	3	4
Constant	0.04 (0.47)	-0.03 (-0.47)	2.76 (2.21)	4.79 (2.53)
ec_{t-1}	-0.54 (-2.64)	-0.32 (-4.96)	-0.40 (-2.34)	-0.64 (-3.56)
FY_{t-1}			-4.71 (-2.02)	-0.76 (-0.58)
pl_{t-1}			-0.73 (-0.42)	-1.04 (-3.54)
ty_{t-1}			0.11 (1.96)	-0.91 (-2.42)
tte_{t-1}			-0.65 (-1.46)	-0.73 (-2.31)
Δqx_{t-1}	0.21 (1.35)	0.64 (2.97)		
Δqx_{t-2}	0.50 (2.53)	0.65 (2.96)	0.35 (1.64)	
ΔFY_t	-2.57 (-3.06)		-3.23 (-3.11)	
ΔFY_{t-1}		1.79 (3.39)	2.11 (1.21)	-1.98 (-2.63)
ΔFY_{t-2}	0.98 (0.80)	0.60 (1.24)	2.40 (2.06)	
Δpl_t	-0.42 (-0.24)	1.64 (1.82)		
Δpl_{t-1}		-1.21(-1.92)		
Δpl_{t-2}			-1.24 (-0.69)	-2.61 (-3.41)
Δty_t	-0.47 (-1.20)	-0.65 (-3.15)		
Δty_{t-1}		0.61 (2.67)		
Δty_{t-2}	-0.53 (-1.84)	0.48 (2.22)	-0.46 (-1.46)	-0.40 (-1.81)
Δtte_t	0.17 (0.47)	-0.07 (-1.86)		0.40 (1.34)
Δtte_{t-1}			-0.27 (-0.61)	-0.09 (-0.56)
Δtte_{t-2}	-0.31 (-0.83)			-0.88 (-4.18)
R^2	0.68	0.77	0.69	0.79
DW	1.87	1.81	1.65	2.41
Q(3)	3.50	0.83	2.65	3.27
EH ($\chi^2(1)$)	0.16	0.04	0.03	1.01
JB ($\chi^2(2)$)	0.46	0.25	0.32	0.64
FF($\chi^2(1)$)	0.13	3.01	0.10	2.76

Note: The numbers in parentheses are t-values. Q(3) is the Ljung-Box test for serial correlation at lag 3, which is more appropriate with lagged dependent variables in the model, EH is Engle heteroschedasticity, JB is Jarque-Bera normality test and FF is functional form Ramsey reset test. ec_t is the error-correction term. In columns 1 and 2 ec_{t-1}s are the lagged residuals from the corresponding cointegrating regressions in table 4.1. Columns 3 and 4 are ECM transformations of the autoregressive distributive lag model. For estimation purposes, the error-correction terms in 3 and 4 were defined as q_{Xt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1} and q_{Mt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1}, respectively.
Source: Computed from data sources indicated in appendix B.25

Although the values of the coefficients of the error-correction terms obtained from the second step Engle-Granger method and the ECM form of the ADL are broadly similar, we focus on the latter in discussing the estimates of the error-correction models. Moreover, the ECM-ADL is used to derive long run model parameters (see appendix

B.23 for derivation). With regard to model adequacy, the diagnostic tests in each case indicate that the error-correction models for the export and import real exchange rates are satisfactory. The error correction terms are correctly signed and significant, supporting the null of cointegration in each case.

Table 2.12 presents estimates of the error-correction model for the export and import real exchange rates for Indonesia. The coefficients of the error-correction terms

-0.40 and -0.64 for the export and import real exchange rats, respectively are of the correct sign and significant. The coefficient of the error-correction term, measures the speed of adjustment of the real exchange rate to its equilibrium level. Accordingly, in the case of the internal real exchange rate for exports, the model suggests that 40% of the deviation from equilibrium in the previous year is corrected in the current year. Similarly, for the internal real exchange rate for imports 60% of the deviation from equilibrium last year is corrected in the current year.

With regard to short run dynamics, we find that in the case of the export real exchange rate the short run impact effect of only the capital flow variable is statistically significant; whereas in the case of the import real exchange rate, productivity and terms of trade are also significant.

Table 2.13: Error-Correction Estimates for Malaysia

Dep. Variables	Δq_X	Δq_M	Δq_X	Δq_M
RHS variables	1	2	3	4
Constant	-0.03 (-0.28)	0.04 (2.25)	0.12 (0.78)	-2.44 (-2.43)
ec_{t-1}	-0.35 (-2.81)	-0.33 (-2.84)	-0.47 (-4.94)	-0.26 (-4.14)
FY_{t-1}			-2.30 (-6.14)	-2.52 (-3.89)
pl_{t-1}			-0.51(-0.32)	-0.31 (-3.85)
ty_{t-1}			0.02 (5.38)	-0.39 (0.98)
tte_{t-1}			0.11(-1.83)	-0.48 (-2.97)
Δq_{Xt-1}	0.36 (2.05)		0.24 (1.68)	
Δq_{Xt-2}				
ΔFY_t				
ΔFY_{t-1}	-0.61 (-2.04)			-1.18 (-2.60)
ΔFY_{t-2}	-0.49 (-1.31)	-0.60 (2.51)		
Δpl_t	0.13 (1.11)	0.07 (1.06)		
Δpl_{t-1}		-0.28(-0.98)		-0.01 (-1.61)
Δpl_{t-2}	0.19 (1.41)	-0.91 (-2.71)	-0.18 (-2.51)	-0.37 (-1.47)
Δty_t	-0.47 (-1.20)		0.07 (-0.64)	
Δty_{t-1}		0.03 (0.41)		-0.03 (-0.79)
Δty_{t-2}		0.48 (2.22)		
Δtte_t	0.84 (5.48)	0.08 (1.32)	0.84 (7.06)	
Δtte_{t-1}	-0.47 (-2.25)		0.49 (2.56)	-0.28 (-1.75)
Δtte_{t-2}		-0.30 (-2.78)		
R^2	0.74	0.49	0.85	0.73
DW	1.82	1.68	2.23	2.31
Q(3)	2.64	4.20	1.05	1.51
EH ($\chi^2(1)$)	0.06	1.21	0.07	0.52
JB ($\chi^2(2)$)	1.29	0.48	0.52	1.84
FF($\chi^2(1)$)	0.25	1.48	0.27	0.87

Note: The numbers in parentheses are t-values. Q is the Ljung-Box tests for serial correlation which is more appropriate with lagged dependent variables in the model, EH is Engle heteroschedasticity, JB is Jarque-Bera normality test and FF is functional form Ramsey reset test. ec_t is the error-correction term. In columns 1 and 2 ec_{t-1}s are the lagged residuals from the corresponding cointegrating regressions in table 4.1. Columns 3 and 4 are ECM transformations of the autoregressive distributive lag model. For estimation purposes, the error-correction terms in 3 and 4 were defined as q_{Xt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1} and q_{Mt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1}, respectively.
Source: Computed from data sources indicated in appendix B.25

Table 2.13 corresponds to Malaysia. The adjustment speed coefficients of the export and import real exchange rates are approximately -0.50 and -0.30, respectively.

In the case of the export real exchange rate, the short run impact of productivity and terms of trade statistically significant. However, in the case of the import real exchange rate only the capital inflow variable contributes to the process of adjustment to equilibrium.

Table 2.14 reports the error-correction estimates for the Philippines. As shown in columns 3 and 4 the error-correction terms enter the models with the correct sign -0.40 for the export real exchange rate and -0.50 for the import real exchange rate. The coefficients are also statistically significant. Dynamic correction following a shock to the real exchange rates in the Philippines proceeds at more or less moderate speed. This is not surprising given the strong correlation between the export and import real exchange rates in the Philippines (see appendix B.26).

The short run impact effects of the fundamentals on the export real exchange rate are generally appreciable and statistically significant. However, the import real exchange rate appears to respond only to the openness variable in the dynamic adjustment process.

Table 2.14: Error-Correction Estimates for the Philippines

Dependent	Δq_X	Δq_M	Δq_X	Δq_M
RHS variables	1	2	3	4
Constant	0.02 (1.53)	0.03 (2.11)	0.67 (1.14)	0.04 (0.06)
ec_{t-1}	-0.37 (-3.11)	-0.30 (-2.02)	-0.42 (-3.52)	-0.51 (-3.38)
FY_{t-1}			-1.35 (-2.27)	-1.43 (-2.04)
pl_{t-1}			-0.47 (-2.70)	-0.71 (-1.11)
ty_{t-1}			-0.11 (2.12)	-0.61 (-2.51)
tte_{t-1}			0.22 (-1.73)	-0.87 (-1.86)
Δq_{Xt-1}				
Δq_{Xt-2}		-0.15 (-1.16)	-0.14 (-1.12)	-0.23 (-1.65)
ΔFY_t	-1.93 (-3.22)	0.40 (0.71)	-2.01 (-3.65)	
ΔFY_{t-1}	-0.28 (-0.58)	0.24 (0.47)		0.81(1.29)
ΔFY_{t-2}				0.61 (1.10)
Δpl_t	-1.58 (-3.15)		-2.29 (-4.43)	
Δpl_{t-1}		0.79 (1.57)		
Δpl_{t-2}		-0.59 (-1.41)	-0.59 (-1.42)	-0.31 (-0.72)
Δty_t			0.83 (4.57)	-0.36 (-1.74)
Δty_{t-1}				-0.75 (-2.82)
Δty_{t-2}		-0.52 (-2.47)		
Δtte_t	0.62 (3.65)	-0.29 (-1.56)	0.74 (4.15)	-0.36 (-1.86)
Δtte_{t-1}		0.17 (0.86)		
Δtte_{t-2}	0.17 (1.12)			-0.32 (-1.54)
R^2	0.65	0.54	0.77	0.65
DW	1.82	1.89	2.35	2.13
Q(3)	2.84	3.16	2.19	5.19
EH ($\chi^2(1)$)	1.84	0.66	0.45	2.18
JB ($\chi^2(2)$)	0.42	3.47	0.48	0.98
FF($\chi^2(1)$)	2.02	2.73	5.01	1.37

Note: The numbers in parentheses are t-values. Q is the Ljung-Box tests for serial correlation which is more appropriate with lagged dependent variables in the model, EH is Engle heteroschedasticity, JB is Jarque-Bera normality test and FF is functional form Ramsey reset test. ec_t is the error-correction term. In columns 1 and 2 ec_{t-1} is the lagged residual from the corresponding cointegrating regression in table 4.1. Columns 3 and 4 are ECM transformations of the autoregressive distributive lag model (see appendix D). For estimation purposes, the error-correction term in 3 and 4 were defined as q_{Xt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1} and q_{Mt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1}, respectively.
Source: Computed from data sources indicated in appendix B.25

Table 2.15 presents the error-correction models for Thailand. As shown in columns 3 and 4 the coefficients of the error-correction terms for the export and import real exchange rates are the same -0.70 and -0.40, respectively. This means that approximately 70% of the deviation of the export real exchange rate from equilibrium last year is corrected this year. Similarly, the adjustment speed for the import real exchange rate is

40%. The remaining proportions are accounted for by short run impact effects of the fundamentals.

Table 2.15: Error-Correction Estimates for Thailand

Dependent	Δq_X	Δq_M	Δq_X	Δq_M
RHS variables	1	2	3	4
Constant	0.03 (1.30)	0.02 (1.03)	3.85 (4.34)	1.90 (3.51)
ec_{t-1}	-0.41 (-3.24)	-0.41 (-3.63)	-0.68 (-5.03)	-0.41 (-3.43)
FY_{t-1}			-1.02 (-4.40)	-1.13 (-6.14)
pl_{t-1}			-0.74 (-3.38)	-0.45 (-1.94)
ty_{t-1}			-0.51 (-4.28)	-0.44 (2.33)
tte_{t-1}			-0.39 (-2.19)	-0.73 (-2.72)
Δq_{Xt-1}	0.57 (3.98)	0.67 (4.22)	0.80 (4.35)	0.60 (3.17)
Δq_{Xt-2}		0.13 (0.83)		0.24 (2.08)
ΔFY_t		0.16 (0.59)		
ΔFY_{t-1}	-0.56 (-1.74)		-0.41 (-0.96)	
ΔFY_{t-2}		0.18 (0.53)		0.30 (0.93)
Δpl_t	-0.64 (-2.15)	-0.56 (-1.91)		-0.55 (-1.58)
Δpl_{t-1}	0.48 (1.39)	0.61 (1.74)		0.79 (2.16)
Δpl_{t-2}	-0.63 (-1.97)	-0.70 (-2.15)	-0.72 (-2.01)	-0.43 (-1.71)
Δty_t	-0.06 (-0.53)		0.29 (1.85)	
Δty_{t-1}	0.21 (1.42)	0.12 (1.01)	0.34 (2.01	
Δty_{t-2}	0.20 (1.64)	0.19 (1.30)	0.31 (2.76)	0.11 (0.81)
Δtte_t	0.39 (3.81)	-0.62 (-6.06)	0.28 (2.64)	-0.59 (-5.57)
Δtte_{t-1}	-0.13 (-1.03)	0.53 (4.06)	-0.23 (-1.58)	0.62 (4.20)
Δtte_{t-2}	-0.27 (-2.38)	-0.19 (-0.97)	-0.28 (-2.40)	
R^2	0.81	0.89	0.86	0.89
LM(3)	0.31	2.46	1.88	5.80
Q(3)	4.81	1.18	2.45	2.62
EH ($\chi^2(1)$)	1.34	0.15	1.98	1.04
JB ($\chi^2(2)$)	1.12	1.23	1.58	2.19
FF($\chi^2(1)$)	1.62	1.68	3.11	3.84

Note: The numbers in parentheses are t-values. Q is the Ljung-Box tests for serial correlation which is more appropriate with lagged dependent variables in the model, EH is Engle heteroschedasticity, JB is Jarque-Bera normality test and FF is functional form Ramsey reset test. ec_t is the error-correction term. In columns 1 and 2 ec_{t-1}s are the lagged residuals from the corresponding cointegrating regressions in table 4.1. Columns 3 and 4 are ECM transformations of the autoregressive distributive lag model. For estimation purposes, the error-correction terms in 3 and 4 were defined as q_{Xt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1} and q_{Mt-1}-FY_{t-1}-pl_{t-1}-tte_{t-1}-ty_{t-1}, respectively.

Source: Computed from data sources indicated in appendix B.25

As can be seen in table 2.15, productivity, openness to trade and terms of trade are statistically significant in the export real exchange rate equation. While the import real exchange rate responds to the productivity and terms of trade variables.

Our estimated adjustment speed coefficients of the four countries are comparable to results obtained by others using a similar framework. Using similar methodology Baffes et al. (1999) found an adjustment speed coefficients of -0.3 and -0.76 for Cote d'Voir and Burkina Faso, respectively. A similar study for Mexico by Dabos and Jaun-Ramon (2000) based on quarterly data found an adjustment speed coefficient of -0.41. Using annual data and a single real exchange rate, Montiel (1997) estimated error-correction models and found adjustment speed coefficients of -0.58 for Indonesia, -0.40 for Malaysia, -0.67 for the Philippines and -0.32 for Thailand. Using a partial adjustment model Edwards (1989), however, found an adjustment speed of -0.19 for a group of 12 developing countries which is much smaller in absolute value than the others.

2.6.6 Long Run Parameters

To estimate the long run parameters consistently, we estimated, using OLS, an unrestricted ECM (a transformation of the autoregressive distributed lag model). Following (Hendry, 1995) we estimated a dynamic model by subsequent elimination of insignificant variables. The results are reported in columns 3 and 4 in the country tables of the error-correction estimates. The steady state long run relationship between the real exchange rate and its fundamentals is extracted by driving all changes to zero as is the case in steady state. As a demonstration, we take the Indonesian export real exchange rate and solve for the long run parameters.

Table 2.16: Solved Long Run Equations[1] (using columns 3 and 4 of Tables 2.12-2.15)

Indonesia:	(1) $q_X = 6.90 - 10.75KY - 0.18pl + 1.31tte + 0.55ty$
	(-4.61) -(0.64) (2.98) (1.49)
	(2) $q_M = 7.48 - 0.19KY - 0.63pl - 0.14tte - 0.42ty$
	(-3.02) (-(2.17) (-2.06) (-2.74)
Malaysia:	(1) $q_X = 0.26 - 3.89KY - 0.09pl + 1.23tte + 1.05ty$
	(-6.47) (-1.51) (5.46) (3.35)
	(2) $q_M = 9.38 - 9.69KY - 0.96pl - 0.51tte - 0.85ty$
	(-6.16) (-7.22) (-3.92) (-2.28)
Philippines:	(1) $q_X = 1.60 - 2.21KY - 0.12pl + 1.52tte + 0.74ty$
	(-3.75) (-0.71) (2.25) (5.69)
	(2) $q_M = 0.08 - 1.81KY - 0.45pl - 0.71tte - 0.21ty$
	(-2.59) (-1.62) (-3.73) (-1.89)
Thailand:	(1) $q_X = 5.66 - 1.34KY - 0.09pl + 0.42tte + 0.25ty$
	(-2.91) (-0.59) (2.33) (2.27)
	(2) $q_M = 4.63 - 9.51KY - 0.10pl - 0.78tte - 0.07ty$
	(-5.98) (-0.56) (-2.89) (1.93)

[1] The error-correction models in columns 3 and 4 for each country are first estimated using OLS and the resulting estimated equations are solved by imposing steady state conditions where all change ceases to occur as illustrated in the text (see also appendix B.23)

From table 2.12 column 3 the equation for the export real exchange rate is

$$\Delta q_X = 2.76 - 0.40ec_{t-1} - 4.71KY - 0.73pl_{t-1} - 0.65tte_{t-1} + 0.11ty_{t-1} + \ldots$$

As mentioned earlier, ec_{t-1} was defined for estimation purposes as:

$q_{X_{t-1}} - KY_{t-1} - pl_{t-1} - tte_{t-1} - ty_{t-1}$ (See appendix B). Inserting this definition in the above equation yields:

$$\Delta q_X = 2.76 - 0.40[q_{X_{t-1}} - KY_{t-1} - pl_{t-1} - tte_{t-1} - ty_{t-1}] - 4.71KY_{t-1} - 0.47pl_{t-1} - 0.12tte_{t-1} + 0.18ty_{t-1} + \ldots$$

In steady state X_{t-1}=X and ΔX_t=0 so that the long run relation emerging from the above equation after collecting like terms is

$$0 = 2.76 - 0.40q_X - 4.3KY - 0.07pl + 0.52tte + 0.22ty$$

This simplifies to the following long run relation between the export real exchange rate and its fundamentals for Indonesia:

$$q_X = 2.76 - 10.75KY - 0.18pl + 1.30tte + 0.55ty$$

Returning to the interpretation of the estimated long run parameters of the model, we find that the estimated coefficients are of the expected sign. The results are broadly consistent with the theoretical model. The estimated long run equations indicate that capital inflows, terms of trade and openness influenced the long run behavior of export and import real exchange rates in all four countries.

With regard to the labor productivity variable, it is shown that labor productivity matters only in the import real exchange rate equations for Indonesia and Malaysia. Again in line with the model, the estimated elasticities for Indonesia and Malaysia indicate that the import real exchange rate experienced a long run appreciation in response to improvements in labor productivity. Labor productivity does not influence the long-run behavior of the export real exchange rates in all four countries. One reason for such an outcome may be that exports from these countries are traditional and primarily labor intensive. Labor productivity may therefore be unimportant in determining the relative price of exports in these countries. Alternatively, average labor productivity may not be the appropriate variable to represent the concept of the sectoral productivity differential which enters the B-S theory of real exchange behavior. The variable is nevertheless included in the analysis for two reasons. The first and obvious reason is the lack of a better alternative. The second reason is that the export and import real exchange rates and their fundamentals achieved cointegration when the labor productivity variable is included.

The coefficients on the external terms of trade variable indicate that it is an important determinant of the equilibrium real exchange rates for exports and imports in all four countries. Improvements in the terms of trade depreciate (appreciate) the real exchange rates for exports (the real exchange rate for imports) in the long-run. Although theoretically the sign on the coefficient of the change in the external terms of trade is ambiguous (could be positive or negative), our results are consistent with the empirical literature on developing countries concerning the effects of changes in the external terms of trade on the internal real exchange rates for exports and imports. In general this literature finds that deterioration in the terms of trade appreciates the real exchange rate for exports but depreciates the real exchange rate for imports.

The long term responses of the export and import real exchange rates to openness to trade are also consistent with the model. Openness to trade is expected to capture the effect of trade liberalization on the real exchange rates for exports and imports. Greater liberalization is a reduction in the average taxes in exports and imports. For a given domestic price, a fall in export taxes increases the degree of openness and depreciates the export real exchange rate. A rise in export taxes will have the opposite effect. A decrease in import taxes will, on the other hand, increase the degree of openness but appreciate the real exchange rate for imports. Our empirical results for the four countries support this relationship and indicate that the openness variable is generally an important determinant of the long-run real exchange rates for exports and imports.

Generally, our results indicate that the set of fundamentals derived from our model are important in the determination of the long term behavior of the export and import real exchange rates in the four countries. Moreover, the analysis shows the advantage of constructing separate real exchange rates for exports and imports. In addition to showing the importance of the capital inflow variable as a fundamental determinant of the equilibrium real exchange rates for exports and imports, it also brings out the separate effects of the terms of trade and trade policy on the export and import real exchange rates.

2.7 Conclusion

The analysis of real exchange rate behavior in developing countries based on separate internal real exchange rate measures for exports and imports is useful, particularly under conditions of sustained inflows of foreign capital, changing terms of trade and increases in the degree of trade liberalization. Moreover, in general, changes in the terms of trade and trade policy have different implications for the export and import real exchange rates. The real exchange rate generally responds to shocks arising from capital inflows, terms of trade, trade policy and other relevant factors. The paths for the actual real exchange rates for the four countries indicate that the two real exchange rates responded differently to shocks (appendix B.26). In the Philippines, the two real exchange rates seem to be tightly correlated throughout the whole period. In Indonesia and Thailand correlation gets stronger only after the 1980s. In Malaysia, the two real exchange rates follow a similar pattern. In light of this, the central issue is whether or not the shock driven departures of the actual export and import real exchange rates from their underlying equilibrium value represent significant depreciation or appreciation of the respective real exchange rates.

Two things are necessary to address this problem. First, based on theory, the fundamentals that are expected to determine the long-run behavior of the real exchange rate need to be identified. Second, estimates of the long-run equilibrium real exchange rates for exports and imports need to be generated for each country. The basic theoretical model considered in this study suggests the fundamentals involved in the empirical analysis. The long run equilibrium values of the real exchange rate can be generated by exploiting the time series properties of the variables involved. These values are initially generated by estimating simple static cointegrating equations among the real exchange rate and its fundamentals. The long-run values of the real exchange rate are further improved by estimating an error-correction transformation of the autoregressive distributive lag model with two lags and by solving the estimated equations under steady state conditions. The main findings of the empirical investigation are presented below.

For each country in the sample, cointegrating relationships relating the export real exchange rate and the import real exchange rate to the fundamentals suggested by our model were confirmed. The directions in which the fundamentals affected the real exchange rates for exports and imports were consistent with those suggested by the model. While increases in capital inflows caused an appreciation in both rates, improvements in the terms of trade and openness depreciated the export real exchange rate and appreciated the import real exchange rate. In specifications of the export and import real exchange rates where fundamentals are generally allowed to affect the export and import real exchange rates and where sample sizes are as small as this one, stationary residuals were obtained from the corresponding regressions. This implies that the long-run equilibrium real exchange rate for exports and imports is relevant for understanding the real exchange rate behavior in these countries over the period under study.

The estimated long-run equilibrium real exchange rates for exports and imports exhibited substantial variability over the sample period indicating differences in their responses to the different factors (see appendix B.2). Indonesia's equilibrium real exchange rate for exports tended to depreciate over the period with some fluctuations in the mid 1970s and mid 1980s. Its equilibrium import real exchange rate, however, had three phases. It appreciated up to 1976 and then continued to depreciate up to 1990. There was a slight appreciation during 1991-96. For Malaysia, the equilibrium export real exchange rate appreciated in the mid 1960s followed by a sustained depreciation up until 1980 and a moderate appreciation during the remaining period. In the Philippines, the equilibrium real exchange rate for exports depreciated up until the mid 1970s and continued to appreciate there after. Its equilibrium real exchange rate for imports however sustained moderate depreciation up to the mid 1970s and slight appreciation thereafter. In

Thailand, the equilibrium rate for exports appreciated over the period with notable fluctuations during the early 1970s. The equilibrium rate for imports, however, appreciated during the 1960s and continued to depreciate during the rest of the period.

In general, the real exchange rate performance in these countries as represented by both export and import real exchange rates is consistent with long-run equilibrium. In line with the prediction of the theory, the gap between the actual and equilibrium real exchange rates generates forces that would eliminate it. The sign, magnitudes and significance of the error-correction terms indicate that such self-correcting mechanism is indeed present for each country.

Appendix B.21

Derivation of the Relationship among the Internal Real Exchange Rate, Capital Inflows, Productivity and the Terms of Trade

The model used to derive the theoretical relationship between the internal real exchange rate and capital inflows is from Sjaastad and Manzur (1996). As described in the text, the basic equations are the demand function for imports and the supply function for exports. The third equation is an equilibrium condition that specifies imports in terms of exports and capital inflows. The three equations are specified as follows:

$$MP_{Md} = A_1 \left(\frac{P_{Md}}{P_{Nd}} \right)^{-\mu_N} \left(\frac{P_{Md}}{P_{Xd}} \right)^{-\mu_X} \left(\frac{Y^e}{\lambda Y} \right)^{1+\varepsilon} \lambda Y \text{ (Import demand function)} \qquad \text{(A.1.1)}$$

$$XP_{Xd} = A_2\left(\frac{P_{Xd}}{P_{Nd}}\right)^{\eta_N}\left(\frac{P_{Xd}}{P_{Md}}\right)^{\eta_M}\left(\frac{\lambda Y}{Y^e}\right)^{\varepsilon_X}\lambda Y \quad \text{(Export supply function)} \qquad (A.1.2)$$

$$MP_{Md} = XP_{Xd}(1+KX) \qquad \text{(Equilibrium condition)} \qquad (A.1.3)$$

The log-linear form of the above, using lower case letters for natural logarithms, gives:

$$m + p_M = a_1 - (\mu_N + \mu_X)p_M + \mu_N p_N + \mu_X p_X + (1+\varepsilon_M)\ln(1+KY) - \varepsilon_M \ln\lambda + y \qquad (A.1.4)$$

$$x + p_X = a_2 + (\eta_N + \eta_M)p_X - \eta_N p_N - \eta_M p_M - \varepsilon_X \ln(1+KY) + (1+\varepsilon_X)\ln\lambda + y \qquad (A.1.5)$$

$$m + p_M = x + p_X + \ln(1+KX) \qquad (A.1.6)$$

where $KX=K/XP_X$, $KY = K/Y$ and $Y^e/Y = 1+KY$

Substituting A.1.6 in A.1.4 and solving for p_N obtains:

$$p_{Nd} = -\frac{1}{\mu_N + \eta_N}\begin{pmatrix} a + (\eta_M - \mu_N - \mu_X)p_{Md} + (\mu_X - \eta_N - \eta_M)p_{Xd} + (1+\varepsilon_M+\varepsilon_X)\ln(1+KY) - \\ \ln(1+KX) - (1+\varepsilon_M+\varepsilon_X)\ln\lambda \end{pmatrix}$$

The price of tradable goods is a weighted average of the price of imports and the price of exports. Thus $p_{Td} = \left(\frac{\mu_N + \mu_X - \eta_M}{\mu_N + \eta_N}\right)p_{Md} + \left(\frac{\eta_N + \eta_M - \mu_X}{\mu_N + \eta_N}\right)p_{Xd}$ and inserting p_T in the equation for the price of non-tradables and rearrange terms expresses the internal real exchange rate in terms of capital flows:

$$p_{Td} - p_{Nd} = \varphi + \psi\left(\ln\left(\frac{1+KX}{1+KY}\right) - (\varepsilon_M + \varepsilon_X)\ln(1+KY)\right) - \rho\ln\lambda$$

where $\varphi = -a\psi$, $\psi = -(1/\mu_N + \eta_N)$, $a = a_1 - a_2$ and $\rho = (1+\varepsilon_M+\varepsilon_X)/(\mu_N + \eta_N)$

Ignoring the εs and approximating ln(1+KX) and ln(1+KY) by KX and KY, respectively the above equation can be simplified as:

$$q = \varphi + \psi(KX - KY) - \rho \ln \lambda \qquad (A.1.7)$$

where $q = p_T - p_N$

The quantity in parentheses can be further simplified using the following relationships: $KX = K/XP_X$, $KY = K/Y$ so that $KX = (Y/XP_X)KY$; substituting this for KX in (A.1.7) gives

$$q = \varphi + \psi\left(\frac{Y}{XP_X} - 1\right)KY - \rho \ln \lambda \qquad (A.1.8)$$

Denoting $\psi(Y/XP_X)-1$ by ψ_Y and inserting in (A.1.8) expresses the real exchange rate in terms of capital inflows and productivity.

$$q = \varphi + \psi_Y KY - \rho \ln \lambda \qquad (A.1.9)$$

This is equation (11) of the text. It specifies capital inflows and productivity as the determinants of the real exchange rate. The ratio ψ_Y/ψ measures the degree of openness of the economy. A sustained expansion in exports lowers the ratio which implies that as the ratio declines the economy tends to improve its openness to international trade.

Appendix B.22

Derivation of Estimating Equations for the Internal Export and Import Real Exchange Rates

The derivation of the estimating equations for the export and import real exchange rates makes use of the following definitions:

$$q_{Xd} = p_{Xd} - p, q_{Md} = p_{Md} - p, tte = p_{Xf} - p_{Mf}, KY = K/GDP = E(MP_{Mf} - XP_{Xf})/GDP$$

The variables are described in the text.

Now define the actual real exchange rate for the economy as

$$q = p_{Td} - p \tag{A.2.1}$$

Defining the consumer price index p as a weighted average of the price of tradables and the price of non-tradables ($p = \omega_N p_{Nd} + (1-\omega_N) p_{Td}$), (A.2.1) can be expressed as:

$$q = \omega_N (p_{Td} - p_{Nd}) \tag{A.2.2}$$

Substituting the right hand side of (A.1.9) for the quantity in parentheses in (A.2.2) leads to

$$q = \omega_N (\varphi + \psi_Y KY - \rho \ln \lambda) \tag{A.2.3}$$

We can also express (A.2.1) using the definition of the price of tradables as a weighted average of the prices of imports and exports ($p_T = \phi p_M + (1-\phi) p_X$):

$$q = p_{Td} - p = \phi p_{Md} + (1-\phi) p_{Xd} - p = (p_{Xd} - p) - \phi(p_{Xd} - p_{Md}) \tag{A.2.4}$$

$$q = q_{Xd} - \phi dtt \tag{A.2.5}$$

Using (A.2.4) in (A.2.3) and denoting lnλ by g leads to the equation,

$$q_X = \omega_N (\alpha + \psi_Y KY - \rho \ln \lambda) + \phi dtt \tag{A.2.6}$$

The relationship between domestic and world prices of exports and imports is given by

$$p_{Xd} = e + p_{Xf} + (1 - t_X)$$

$$p_{Md} = e + p_{Mf} + (1 + t_M)$$

where t_X and t_M are average export and import tax rates, respectively.

The domestic terms of trade are related to the external terms of trade by the equation,

$$dtt = p_{Xd} - p_{Md} = (p_{Xf} - p_{Mf}) + \tau = ett + \tau \qquad \text{(A.2.7)}$$

where h = ln(1-t_X)-ln(1+t_M)

Equation (A.2.7) expresses the domestic terms of trade as a function of an exogenous variable (the external terms of trade) and a policy variable (trade tax).

Substituting the expression for dtt in (A.2.5) leads to

$$q_X = \omega_N \varphi + \omega_N \psi_Y KY + \phi tte - \omega_N \rho \ln \lambda) + \phi \tau \qquad \text{(A.2.8)}$$

Redefining all parameters and introducing an error term gives the estimating equation for the internal export real exchange rate (equation 22 in the text).

$$q_{X_t} = \theta_0 + \theta_1 KY_t + \theta_2 tte_t - \theta_3 pl_t + \theta_4 ty_t + \varepsilon_t \qquad \text{(A.2.9)}$$

where ty is a proxy for τ, pl stands for lnλ and ε_t is an error term.

Similarly, an estimating equation for the import real exchange rate can be derived using equations (A.2.3) and (A.2.4). The equation for the actual real exchange rate (A.2.4) can be written as

$$q = p_{Td} - p = \phi p_{Md} + (1 - \phi) p_{Xd} - p$$
$$q = \phi p_{Md} - p_{Md} + p_{Xd} - \phi p_{Xd} + p_{Md} - p$$
$$q = q_{Md} + (1 - \phi)(p_{Xd} - p_{Md})$$
$$q = q_{Md} + (1 - \phi) dtt$$

Substituting the last expression for q in (A.2.3) and solving for q_M gives the equation,

$$q_M = \omega_N \varphi + \omega_N \psi_Y KY - \omega_N \rho \ln \lambda) - (1-\phi)dtt \qquad \text{(A.2.10)}$$

Relabelling parameters, substituting the expression for the domestic terms of trade and using the notations for the capital inflow and productivity variables obtain:

$$q_{M_t} = \theta_0 + \theta_1 KY_t + \theta_2 tte_t - \theta_3 pl_t + \theta_4 ty_t + \varepsilon_t \qquad \text{(A.2.11)}$$

Appendix B.23

Error-Correction Transformation of the Autoregressive Distributive Lag Model

Consider a two-variable four-lag autoregressive distributive lag model such as

$$W_t=\gamma_1 W_{t-1}+\gamma_2 W_{t-2}+\gamma_3 W_{t-3}+\gamma_4 W_{t-4}+\gamma_0 Z_t+\gamma_1 Z_{t-1}+\theta_2 Z_{t-2}+\theta_3 Z_{t-3}+ \theta_4 Z_{t-4}+c+ \varepsilon_t \qquad \text{(A.3.1)}$$

where c is a constant.

Subtracting W_{t-1} on both sides of (1) and adding and subtracting some specific terms on the RHS of (1) yields:

$$W_t-W_{t-1}= \gamma_1 W_{t-1}- W_{t-1}+(\gamma_2 W_{t-1}- \gamma_2 W_{t-1}) + (\gamma_3 W_{t-1}- \gamma_3 W_{t-1}) + (\gamma_4 W_{t-1}- \gamma_4 W_{t-1})+\gamma_2 W_{t-2}+$$

$$(\gamma_3 W_{t-2}- \gamma_3 W_{t-2})+(\gamma_4 W_{t-2}- \gamma_4 W_{t-2})+\gamma_3 W_{t-3}+ (\gamma_4 W_{t-3}- \gamma_4 W_{t-3})+\gamma_4 W_{t-4}+\theta_0 Z_t+$$

$$(\theta_0 Z_{t-1}- \theta_0 Z_{t-1})+ \theta_1 Z_{t-1}+(\theta_2 Z_{t-1}- \theta_2 Z_{t-1})+(\theta_3 Z_{t-1}- \theta_3 Z_{t-1}) +(\theta_4 Z_{t-1}- \theta_4 Z_{t-1})+$$

$$+\theta_2 Z_{t-2}+(\theta_3 Z_{t-2}- \theta_3 Z_{t-2})+ (\theta_4 Z_{t-2}- \theta_4 Z_{t-2})+ \theta_3 Z_{t-3}+(\theta_4 Z_{t-3}- \theta_4 Z_{t-3})+ \theta_4 Z_{t-4}+c+ \varepsilon_t$$

Rearranging and collecting terms simplifies this to

$$W_t-W_{t-1}=(\gamma_1+\gamma_2 +\gamma_3+\gamma_4-1)W_{t-1}-\gamma_2(W_{t-1}-W_{t-2})- \gamma_3(W_{t-1}-W_{t-2})- \gamma_4(W_{t-1}-W_{t-2})- \alpha_3(W_{t-2}-W_{t-3})-$$

$$\gamma_4(W_{t-3}-W_{t-4})+\theta_0(Z_t-Z_{t-1})- (\theta_0+ \theta_1+ \theta_2+ \theta_3+ \theta_4)Z_{t-1}- \theta_2(Z_{t-1}-Z_{t-2}) - \theta_3(Z_{t-1}-Z_{t-2}) - \theta_4(Z_{t-1}-Z_{t-2})-$$

$$\theta_3(Z_{t-2}-Z_{t-3})- \theta_4(Z_{t-2}-Z_{t-3})-\theta_4(Z_{t-3}-Z_{t-4})+c+\varepsilon_t \qquad \text{(A.3.2)}$$

Using Δ as the change operator, we get:

$\Delta W_t=(\Sigma\gamma -1)+\Sigma\theta\, Z_{t-1}-(\gamma_2+\gamma_3+\gamma_4)\Delta W_{t-1}-(\gamma_3+\gamma_4)\Delta W_{t-2}-\gamma_4\Delta W_{t-3}+\theta_0 Z_t-(\theta_2+\theta_3+\theta_4)\Delta Z_{t-1}-$

$(\theta_3+\theta_4)\Delta Z_{t-2}-\theta_4\Delta Z_{t-3}+c+\varepsilon_t$ (A.3.3)

$\Delta W_t=(\Sigma\gamma -1)[W_{t-1}-(\Sigma\theta/(1-\Sigma\gamma))\, Z_{t-1}]-(\gamma_2+\gamma_3+\gamma_4)\Delta W_{t-1}-(\gamma_3+\gamma_4)\Delta W_{t-2}-\gamma_4\Delta W_{t-3}+$

$\theta_0\Delta Z_t-(\theta_2+\theta_3+\theta_4)\Delta Z_{t-1}-(\theta_3+\theta_4)\Delta Z_{t-2}-\theta_4\Delta Z_{t-3}+c+\varepsilon_t$

Since the long run parameters are not known we need further transformation. This is accomplished by adding and subtracting $(\Sigma\gamma -1)W_{t-1}$ on the right hand side of (A.3.3).

$\Delta W_t=(\Sigma\gamma -1)[W_{t-1}-Z_{t-1}]+(\Sigma\gamma+\Sigma\theta-1)Z_{t-1}-(\gamma_2+\gamma_3+\gamma_4)\Delta W_{t-1}-(\gamma_3+\gamma_4)\Delta W_{t-2}-\gamma_4\Delta W_{t-3}+$

$\theta_0\Delta Z_t-(\theta_2+\theta_3+\theta_4)\Delta Z_{t-1}-(\theta_3+\theta_4)\Delta Z_{t-2}-\theta_4\Delta Z_{t-3}+c+\varepsilon_t$ (A.3.4)

This can be simplified as:

$\Delta W_t=\alpha[W_{t-1}-Z_{t-1}]+\beta_1 Z_{t-1}-\beta_2\Delta W_{t-1}-\beta_3\Delta W_{t-2}-\beta_4\Delta W_{t-3}+$

$\beta_5\Delta Z_t-\beta_6\Delta Z_{t-1}-\beta_7\Delta Z_{t-2}-\beta_8\Delta Z_{t-3}+c+\varepsilon_t$ (A.3.5)

where $\alpha=\Sigma\gamma -1$

$\beta_1=\Sigma\gamma+\Sigma\theta-1$, $\beta_2=\gamma_2+\gamma_3+\gamma_4$, $\beta_3=\gamma_3+\gamma_4$, $\beta_4=\gamma_4$, $\beta_5=\theta_0$

$\beta_6=\theta_2+\theta_3+\theta_4$, $\beta_7=\theta_3+\theta_4$, $\beta_8=\theta_4$

Equation (A.3.5) is the error-correction form of the autoregressive distributive lag model given by (A.3.1). Since (A.3.5) is a linear transformation of (A.3.1) we note that the long run parameters in both models are the same. An extension of equation A.3.5 (for more variables) is estimated in Tables 4.21 to 4.24 in the text. The basic equations used to generate the error-correction models are equations 22 and 25 in the text.

Appendix B.24

Weak Exogeneity

Most of econometric analysis uses exogenous variables to model some endogenous variable without explicit modeling of the exogenous variables. The concept of weak exogeneity specifies conditions under which analysis of the conditional model is valid for efficient inference without studying the entire model. For simplicity, consider a standard parametric model $\mathcal{H}_\Psi$ for the joint distribution of

$Y_t=(Q_t, W_t)$

where Q_t is a vector of real exchange rates and W_t is a vector of fundamentals.

The joint density can be expressed as,

$r(q_t,w_t; \psi)$ where $\psi= (\psi_1, \psi_2, \psi_3,\ldots, \psi_k)'\in\Psi\in \Re^k$.

Let $\delta=g(\psi)$ where $\delta\in\Delta$ and $\psi\in\Psi$

This function reparametrizes ψs into δs within the permissible parameter space Ψ. Note that in the joint density given above w_t is endogenous. Nontheless, the joint density can always be decomposed into a conditional density and a marginal density and it may be that the model for q_t does not depend on whatever model determines w_t. Decomposing the joint density into conditional and marginal densities yields:

$r(q_t,w_t; \psi)=r(q_t|w_t; \delta_1)\ r_w(w_t, \delta_2)$ where $r(q_t|w_t; \delta_1)$ is the conditional distribution of Q_t given $W_t=w_t$ and $r_w(w_t, \delta_2)$ is the marginal density of W_t.

Under certain conditions, analysis of the conditional distribution can provide all the information necessary to determine the parameters of interest in the joint density, i.e., the parameters of the system can be learned from the conditional density alone.

Suppose the parameters of interest in the joint distribution are denoted by $\theta \sqsubseteq \psi$,

Hendry (1995) specifies two conditions under which w_t is weakly exogenous with respect to $\delta_1 \sqsubseteq \Delta$:

1) $\theta = f(\delta_1)$, δ_1 alone provides all the information we need to determine θ.

Note that if δ_2 contains information useful to determine θ then one has to analyze both the conditional and marginal densities to determine θ, that is, the relevant model for determining θ is the joint density.

2) δ_1 does not depend on δ_2 (the variation of δ_1 is free of δ_2)

This condition excludes the possibility that ψ_2 gives information indirectly about θ. This condition enables us to treat w_t as given and analyze only the conditional model.

Exogeneity of the fundamentals with respect to δ_1 fails either when parameters in the marginal distributions of the fundamentals contain information that is vital for determining the parameters of the system and/or the parameters of the conditional density depend on the parameters of the marginal densities of the fundamentals. Exogneity is testable, although this will be at the expense of moving toward a system approach. In a cointegration test of the real exchange rate and its fundamentals, a restriction on the adjustment parameters serves as a test for exogeneity. Johansen (1992) explains the procedure for the test. Simply put, this test is a restriction on the Johansen cointegration test. The joint distribution of the real exchange rate and its fundamentals can be represented by a k-variable vector autoregression of finite order m which in turn has a vector error correction representation of the form:

$$\Delta y_t = \Phi y_{t-1} + \sum_{i=1}^{m} \Gamma_i \Delta y_{t-i} + \mu_t$$

where y_t=[q, KY, pl, tte ty]. Assume for simplicity that the cointegrating test indicates only one cointegrating vector so that the rank of Φ is one. Φ can then be written as αβ' where α represents the adjustment coefficients and β' represents the cointegrating coefficients. A restriction that the adjustment coefficients on the ith row are zero is a test for exogeneity of the ith endogenous variable. The test can be carried out individually for each hypothesized fundamental or jointly for a group of fundamentals.

Appendix B.25

Data Description and Variable Definition

The sample period for Indonesia is 1967-1996. The sample period for the other members of the group is 1960-1996. All the data for each country are extracted from the world development indicators data set of the World Bank with the exception of the bilateral US dollar nominal exchange rates which are obtained from the IFS.

Real Exchange Rates Q_X, Q_M

Two separate real exchange rates are constructed: the internal real exchange rate for exports (Q_X) and the internal real exchange rate for imports (Q_M). The internal real exchange rates for exports and imports are defined as EP_{Xf}/CPI and EP_{Xf}/CPI, respectively; where P_{Xf} is the export price index in US dollars, P_{Mf} is the import price index in US dollars, CPI is the consumer price index and E is the nominal exchange rate (local currency price of a US dollar), so that a rise in the real exchange rate is a depreciation. The export and import price indices are constructed using national accounts data. The internal export and import real exchange rates are expressed in logarithms using lower case letters q_X and q_M.

Capital Inflows KY

Net capital inflows are defined as the difference between imports of goods and services and exports of goods and services. The capital inflow variable is the ratio of net capital inflows to gross domestic product. This variable is expressed in levels and is representd by KY.

Productivity PL

The Belassa-Sameulson effect is supposed to be measured by the productivity differential between the traded and non-traded goods sectors. Because of lack of information on the sectoral productivities, average labor productivity index is used as a proxy for productivity. It is calculated as a ratio an index of GDP to an index of the labor force. This variable is expressed in logarithms and is denoted pl.

External Terms of Trade TTE

The external terms of trade for each country are defined as the ratio of the export price index in US dollars to the import price index in US dollars P_{Xf}/P_{Mf}. This variable is expressed in logarithms and is denoted tte.

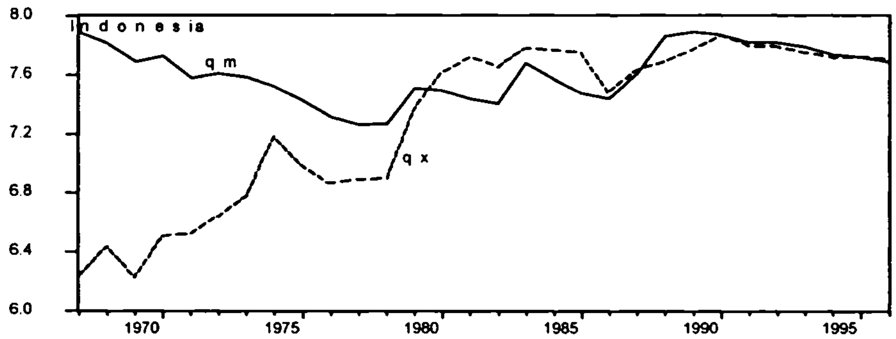
Openness to Trade TY

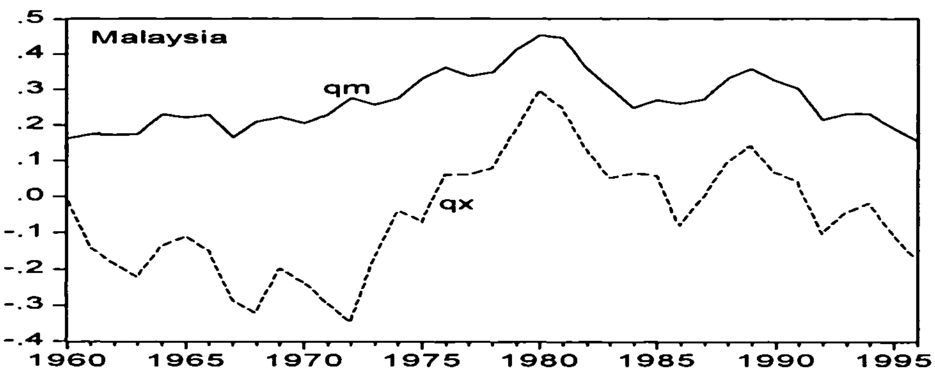
The variable that derived in the model and expected to capture the effect of liberalizing trade on the long run behavior of the real exchange rates for exports and imports were the ratio of export taxes to total exports and the ratio of import taxes to total imports, respectively. In that framework, a rise in export taxes would have led to an appreciation of the export real exchange rate while a rise in import taxes would have caused a depreciation in the import real exchange rate. However, this variable was not available for the full sample period. As an alternative, total trade to GDP ratio is used a measure openness. Total trade is exports of goods and services plus imports of goods and services. A sustained rise in the ratio of total trade to GDP implies increased openness. A reduction in export taxes, other things being equal, increases the degree of openness which in turn causes the export real exchange rate to depreciate in the long run. A reduction in import taxes, other things being equal, leads to increased openness which causes the import real exchange rate to appreciate in the long run. This variable is expressed in logarithms and denoted by ty.

Appendix B.26

Actual Real Exchange Rates

Figure 2.1: Real Exchange Rates for Exports and Imports



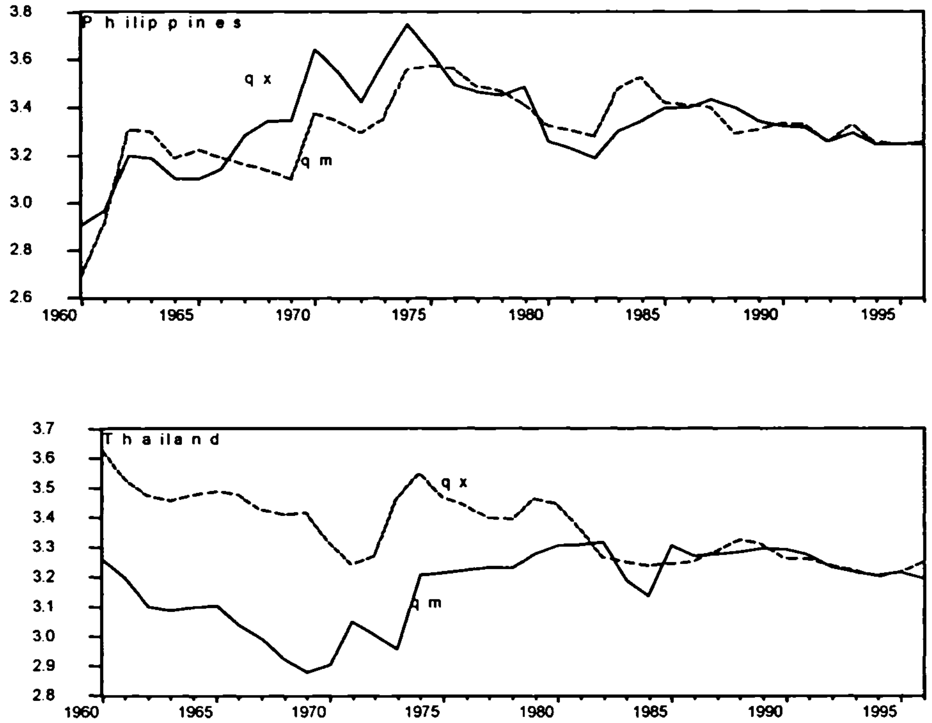


Note: An increase represents depreciation.

q_m=log of real exchange rate for imports

q_x=log of real exchange rate for exports

Figure 2.2: Real Exchange Rates for Exports and Imports



Note: An increase represents a depreciation.

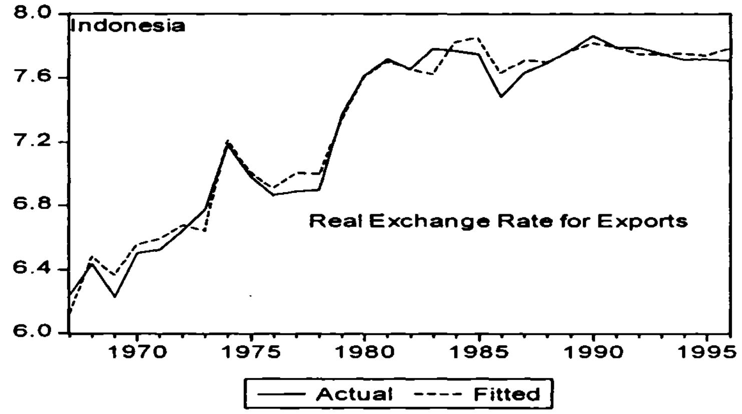
q_x = log of real exchange rate for exports

q_m = log of real exchange rate for imports

Appendix B.27

Actual and Long-Run Equilibrium Real Exchange Rates

Figure 2.3: Actual and Fitted Values of the Cointegrating Regressions



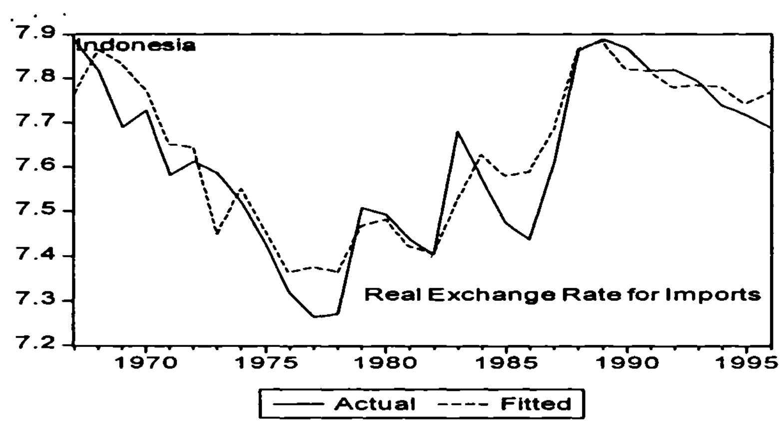
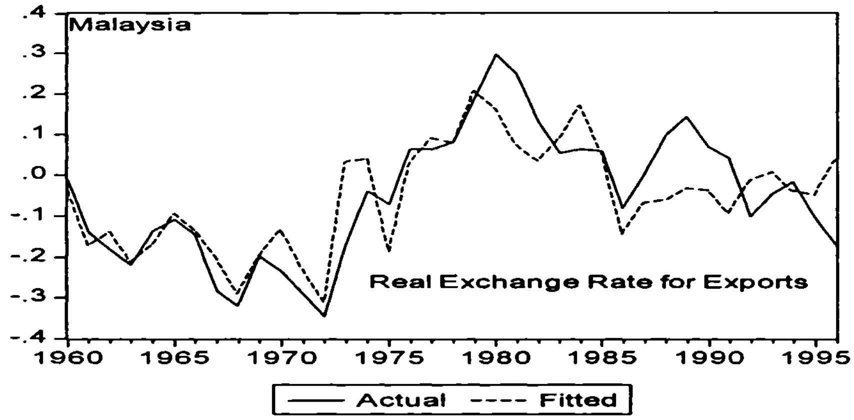


Figure 2.4: Actual and Fitted Values of the Cointegrating Regressions



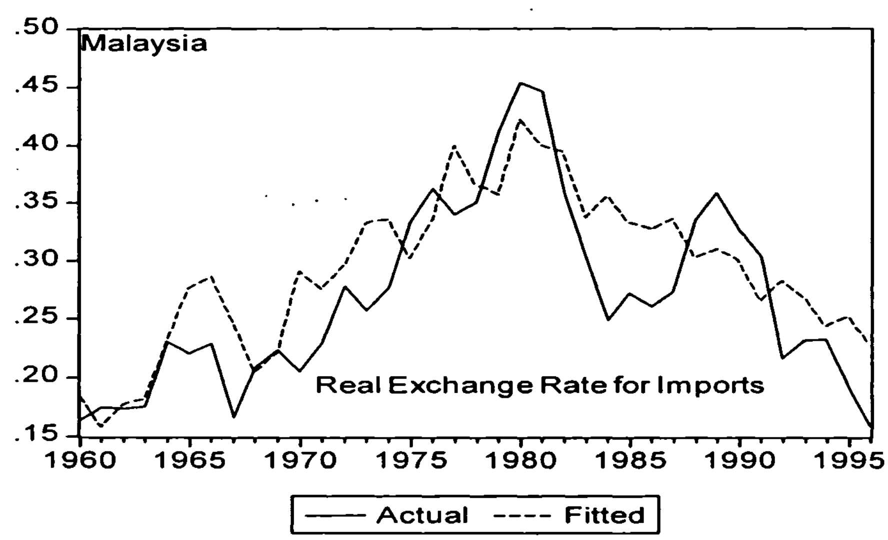
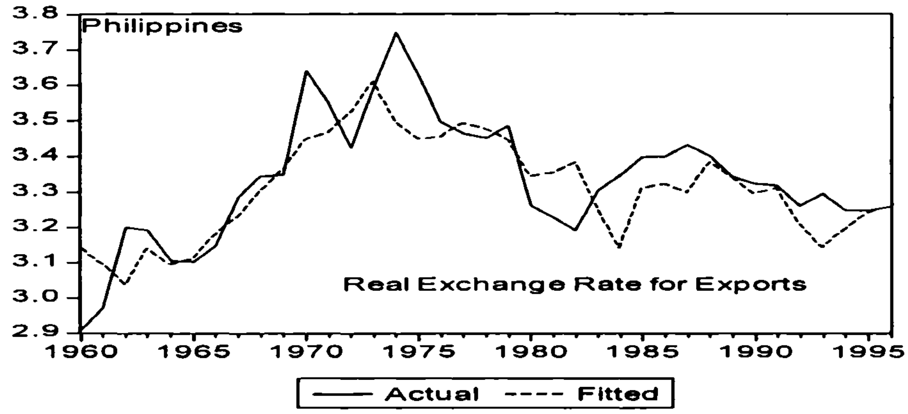


Figure 2.5: Actual and Fitted Values of the Cointegrating Regressions



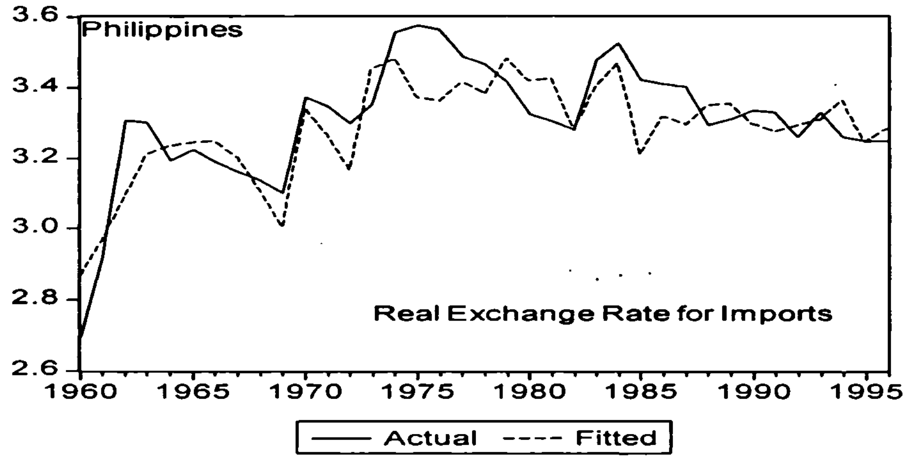
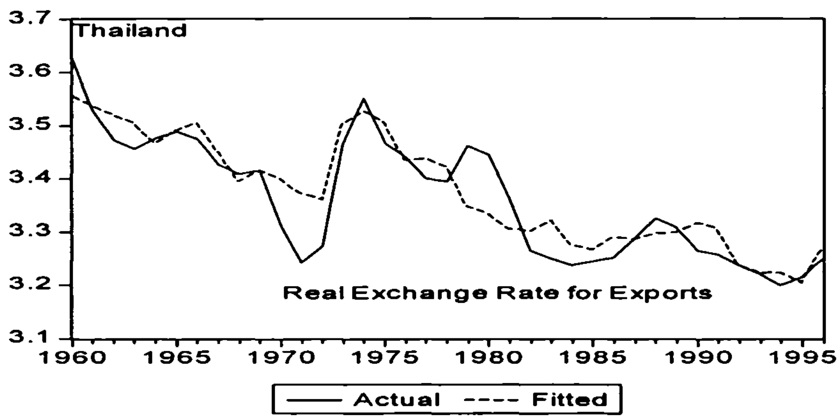
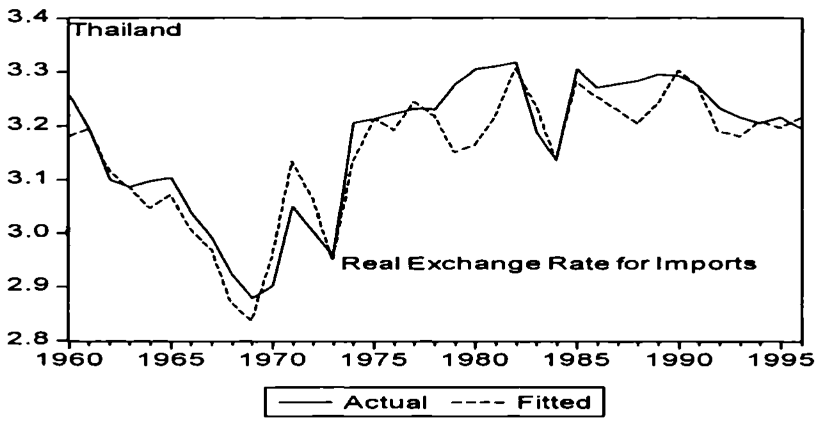


Figure 2.6: Actual and Fitted Values of the Cointegrating Regressions





Appendix B.28

Table 2.1B: Johansen's Estimates Long Run and Adjustment Coefficients for Indonesia

Normalized Cointegrating Coefficients (β'):

q_M	FY	pl	tte	ty
1.0000	0.7404	-1.6318	0.0321	22.3051
3.7659	1.0000	-0.9652	-3.6863	28.8363
-2.1398	0.8640	1.0000	-3.6123	25.5946
50.8854	-5.9755	-6.5399	1.0000	-113.0278
-0.0416	0.0281	0.2096	-0.0789	1.0000

Adjustment Coefficients (α):

$D(q_M)$	-0.0484	0.0384	-0.0171	-0.0316	0.0002
D(FY)	0.2669	0.7270	-0.1957	-0.1608	0.0925
D(pl)	-0.0121	-0.0056	-0.0032	0.0038	0.0002
D(tte)	-0.0190	0.0266	-0.0180	0.0312	-0.0038
D(ty)	-0.0149	-0.0221	0.0102	0.0090	-0.0033

Exogeneity Test

	q_M	FY	pl	tte	ty
Chi-sq(1)	4.99	0.57	10.39	0.96	1.41

Normalized Cointegrating Coefficients (β'):

q_X	FY	pl	tte	ty
1.0000	0.7403	-1.6318	1.0320	22.3042
3.7670	1.0000	-0.9658	-7.4529	28.8354
-2.1400	0.8647	1.0000	-0.9829	25.6136
-1.0200	0.1198	0.1310	1.0000	2.2656
-0.0417	0.0281	0.2096	-0.0372	1.0000

Adjustment Coefficients (α):

$D(q_X)$	-0.0674	0.0650	-0.0352	-0.0004	-0.0036
D(FY)	0.2668	0.7270	-0.1956	-0.1607	0.0926
D(pl)	-0.0121	-0.0056	-0.0032	0.0038	0.0002
D(tte)	-0.0190	0.0266	-0.0180	0.0312	-0.0039
D(ty)	-0.0149	-0.0221	0.0102	0.0090	-0.0033

Exogeneity Test

	q_X	FY	pl	tte	ty
Chi-sq(1)	4.84	0.57	10.39	0.96	1.41

Source: Computed using data from the sources indicated in appendix A.25

Table 2.2B: Johansen's Estimates of Long Run and Adjustment Coefficients for Malaysia

Normalized Cointegrating Coefficients (β'):

q_M	FY	pl	tte	ty	
1.0000	22.0688	-0.3430	2.9597	0.7183	
0.1980	1.0000	0.1097	-0.8414	-0.3592	
1.8578	4.1218	1.0000	-3.5108	-1.7145	
1.0797	-2.3644	-0.6049	0.9365	1.0000	
-2.3433	-5.0025	0.1053	1.0000	1.0759	
Adjustment Coefficients (α):					
D(LQM1)	0.0122	0.0115	-0.0058	0.0111	-0.0021
D(KY)	0.0187	0.0076	-0.0001	-0.0119	-0.0004
D(LALPI)	0.0003	-0.0066	0.0023	-0.0009	-0.0048
D(TTE)	0.0026	0.0427	-0.0105	-0.0197	0.0027
D(LOPN4)	0.0411	-0.0228	0.0421	-0.0113	-0.0062

Exogeneity Test

	q_M	FY	pl	tte	ty
Chi-sq(1)	1.96	4.42	0.003	7.66	2.61

Normalized Cointegrating Coefficients (β'):

q_X	FY	pl	tte	ty	
1.0000	2.2749	-0.8215	-17.8614	-0.7258	
-0.0324	1.0000	0.0734	0.1034	-0.1103	
-1.8091	-21.5944	6.7679	1.0000	-3.2115	
-2.7699	-3.6302	1.0000	-5.5973	-0.7769	
-2.5346	-2.2775	1.3804	2.5791	1.0000	
Adjustment Coefficients (α):					
D(q_X)	0.0029	0.0017	-0.0201	0.0227	0.0041
D(FY)	-0.0029	-0.0186	-0.0009	-0.0096	0.0007
D(pl)	0.0324	-0.0539	-0.0047	0.0049	-0.0007
D(tte)	0.0402	0.0130	-0.0127	0.0186	0.0023
D(ty)	0.0262	-0.0094	-0.0232	0.0012	-0.0024

Exogeneity Test

	q_X	FY	pl	tte	ty
Chi-sq(1)	0.05	0.13	2.04	7.66	5.11

Source: Computed using data from the sources indicated in appendix A.25

Table 2.3B: Johansen's Estimates of Long Run and Adjustment Coefficients for the Philippines

Normalized Cointegrating Coefficients (β')

q_M	FY	pl	tte	ty	
1.0000	5.5674	-3.5100	0.5707	1.9658	
0.1867	1.0000	-0.0152	-0.0663	-0.1077	
0.4088	4.0806	1.0000	-1.0539	-0.5363	
0.0431	-3.4026	0.1886	-0.0227	-0.1616	
-0.7835	-2.8249	-3.6826	1.0000	0.8247	
-18.2332	41.2220	-24.0322	-9.5459	1.0000	
Adjustment Coefficients (α):					
$D(q_M)$	-0.0630	-0.0413	-0.0196	0.0035	0.0127
D(FY)	0.0030	-0.0118	0.0045	0.0083	0.0003
D(pl)	0.0001	0.0078	0.0008	0.0072	0.0035
D(tte)	0.0086	-0.0215	-0.0191	0.0444	0.0006
D(ty)	-0.0335	-0.0433	-0.0324	0.0114	0.0138

Exogeneity Test

	q_M	FY	pl	tte	ty
Chi-sq(1)	2.84	0.89	0.13	4.46	0.22

Normalized Cointegrating Coefficients (β)

q_X	FY	pl	tte	ty	
1.0000	2.0194	0.4633	1.1372	-0.4651	
0.2329	1.0000	3.0368	-2.5393	0.7297	
1.4862	17.7224	-10.7204	1.0000	5.3393	
-2.1775	-5.7042	-2.8676	-5.9080	1.0000	
0.2435	19.2210	1.0000	0.1498	-2.7403	
Adjustment Coefficients (α):					
$D(q_X)$	0.0442	0.0302	-0.0156	-0.0193	-0.0072
D(FY)	0.0032	0.0004	-0.0070	0.0019	0.0034
D(pl)	-0.0088	0.0128	0.0022	0.0030	0.0016
D(tte	-0.0208	0.0013	-0.0013	-0.0246	-0.0017
D(ty)	-0.0198	0.0364	-0.0342	0.0146	0.0043

Exogeneity Test

	q_X	FY	pl	tte	ty
Chi-sq(1)	1.2	1.21	8.56	5.43	3.29

Source: Computed using data from the sources indicated in appendix A.25

Table 2.4B: Johansen's Estimates of Long Run and Adjustment Coefficients for Thailand

Normalized Cointegrating Coefficients (β'):

q_M	FY	pl	tte	ty	
1.0000	0.9769	2.5271	2.3747	0.7343	
-0.1261	1.0000	-0.1721	-0.0864	0.0302	
-0.2626	0.9097	1.0000	0.7461	-1.3282	
0.4078	-0.3686	3.5332	1.0000	-1.2368	
-9.2773	-22.7093	-4.0085	1.7343	1.0000	
Adjustment Coefficients (α):					
D()q_M)	0.0122	-0.0208	-0.0268	-0.0034	-0.0079
D(FY)	0.0017	0.0119	-0.0011	-0.0061	0.0011
D(pl)	0.0042	0.0089	0.0046	0.0042	-0.0036
D(tte)	-0.0482	0.0218	0.0257	0.0008	-0.0007
D(ty)	-0.0282	0.0441	-0.0016	0.0096	0.0043

Exogeneity Test

	q_M	FY	pl	tte	ty
Chi-sq(1)	3.57	15.67	2.86	0.8	13.57

Normalized Cointegrating Coefficients (β'):

q_X	FY	pl	tte	ty	
1.0000	16.6087	-18.4790	10.4052	-8.2456	
-0.1375	1.0000	10.8157	-4.9397	1.1561	
-0.5991	2.2223	1.0000	-19.0020	28.9377	
0.0219	-2.0234	-0.4720	1.0000	4.8687	
-28.2131	-128.5916	21.4887	49.3365	1.0000	
Adjustment Coefficients (α):					
D(LQXW)	-0.0382	-0.0013	-0.0084	0.0046	-0.0019
D(KY)	0.0017	0.0117	-0.0033	-0.0001	0.0053
D(LALPI)	0.0036	0.0084	0.0023	0.0016	-0.0061
D(LETT)	-0.0501	0.0220	0.0070	0.0249	-0.0044
D(LOPN4)	-0.0318	0.0377	-0.0058	-0.0032	-0.0070

Exogeneity Test

	q_X	FY	pl	tte	ty
Chi-sq(1)	7.79	14.05	0.56	0.23	2.78

Source: Computed using data from the sources indicated in appendix A.25

Chapter 3: Capital Flows and Monetary Policy in Developing Countries

3.1 Introduction

The importance of capital flows from developed countries to developing economies has been increasing over time to the extent that capital flows have become a dominant feature of some developing countries. There are several reasons for the growth of capital flows to developing countries. First, the revolution in communications and trading technology in the developed countries has enhanced the degree of integration, mainly by reducing transaction costs, in financial markets around the world. Second, the advance in financial innovation led to the introduction of new financial instruments that reduce administrative costs and increase returns. Third, the increase in the size of wealth relative to income in the developed countries contributed to the growth of capital flows to the developing countries. Finally, there has been a shift in policy towards increased openness to trade on the part of developing countries. Many developing countries have reduced both tariff and non-tariff barriers to trade to increase competition and raise efficiency in their domestic markets. Developing countries have also promoted trade in assets by relaxing exchange controls and reducing barriers to capital movements through the liberalization and restructuring of their financial institutions.

Some authors have emphasized the first three (external) factors as the main determinants of capital flows to developing countries. Calvo, Leiderman, and Reinhart (1993), Frenandez-Arias (1996), Frenandez-Arias and Montel(1996) and Frenkel and Okungwu (1996) all concluded that external factors were the major cause of the rise in capital inflows. Others have downplayed the significance of external factors in favor of domestic factors. Among the writers in this category are Chuhan, Claessens, and Mammingi (1995), Hernandez and Rdolph (1995), Schadler, Carkovic, Bennett, and Kahn (1993). According to these authors, extensive domestic reform programs that led to the liberalization of product and financial markets were the causes for the phenomenal growth in capital flows to developing countries[33].

The important point to note is that both external and internal developments, although with differing degrees of influence, have shaped financial markets in such a way as to provide investors with opportunities to consider alternative returns and risks for their funds from a wide range of markets and financial instruments and these incentives have significantly contributed to the growth of capital flows to developing countries. Given the developments in financial market integration and the growing economic interdependence among countries, capital inflows are likely to increase their presence in the economies of emerging markets and many other developing countries. During the period 1986-96, capital inflows to developing countries have increased by about 9 times in nominal terms[34]. In 1997, the crisis in Asia led to a sudden decline in capital flows. However, according to the World Bank (2001) there has been a resumption in capital inflows to developing countries after the crisis. Another important development with regard to capital inflows was that net private capital inflows

[33] The intertemporal approach to the current account has also been used to explain cross-boarder capital movements. One class of models uses the difference in time preference as a determinant of international borrowing and lending. For details see Buiter (1981). Another category of models distinguish between permanent and temporary shocks to income to explain capital mobility across economies. See, for example, Johnson (1986) and Otto (1992).
[34] IMF, World Economic Outlook, May 1999 and October 1999.

increased dramatically during the 1990s. Moreover, a large proportion of the private inflows went to Asia, followed by Latin America[35].

While such large inflows may accelerate growth in developing countries through augmenting capital accumulation or by bringing new technology, they can also have detrimental effects on the economy. As the recent Asian financial meltdown demonstrated, heavy capital flows can be a source of trouble for developing countries. One of the unwelcome effects of capital inflows is the upward pressure that they exert on the exchange rate. In a flexible exchange rate regime, capital inflows tend to appreciate the real exchange rate by appreciating the nominal exchange rate, at least over the period in which prices are sticky. In a fixed exchange rate world, capital inflows induce a real appreciation by expanding the domestic money supply and boosting aggregate demand thereby raising the price of non-tradable goods. This undermines the competitiveness of exports and price stability. The fall in export growth leads to widening current account deficits.

The negative consequence of capital flows on external competitiveness and the current account can be placed in perspective by examining the link between capital inflows and the domestic money supply. In a fixed exchange rate regime, unsterilized capital inflows may result in some loss of monetary control. If the monetary authorities are committed to keep a fixed exchange rate, capital inflows will lead to the accumulation of international reserves, which may result in an undesirable expansion of monetary aggregates. Kemin and Wood (1998) analyzed the link

[35] See, for example, Ito (1999), Edwards (2000)

between capital flows and monetary aggregates in Mexico and found evidence in support of the positive influence of capital inflows on the money supply and aggregate demand. They concluded that the undesirable monetary growth was the mechanism through which capital inflows led to a rise in prices, an expansion in aggregate demand, real exchange rate appreciation and deterioration in the current account in Mexico.

The policy response to the undesired monetary growth, at least in some countries, has been sterilization of the capital inflows. The central bank carries out a transaction equal in size but opposite in sign to its foreign exchange intervention. In the foreign exchange market, it buys foreign currency denominated assets (capital inflows) for money while simultaneously selling domestic assets for money. Under certain conditions, these two transactions will neutralize each other so that the money supply remains unchanged. The only outcome of these transactions is a shift in the composition of central bank holdings of assets in favor of foreign assets. Sterilization is not, however, without cost. Calvo (1991) persuasively argued that sterilization is not a viable policy option for developing countries. In order to persuade investors to hold domestic assets, the monetary authorities should offer interest rates higher than the rates they receive on their foreign assets. The high domestic interest rate implies an increased burden on the consolidated public sector budgetary accounts. More importantly, the relative rise in the domestic interest rate would attract more capital inflows, rendering the sterilization policy ineffective.

There are two important issues[36] involved in considering the effect of capital inflows on domestic monetary policy. The first concerns the extent to which capital inflows constrain domestic monetary policy. If capital is perfectly mobile, then capital flows will completely offset domestic monetary policy, so that for every change in the domestic component of the monetary base, there will be an equivalent but opposite change in capital flows. In this circumstance, monetary policy cannot influence domestic targets and hence it is ineffective as a tool for stabilizing income and employment. The impotence of monetary policy is driven by the behavior of investors to optimize returns by switching between domestic and foreign assets in response to return differentials. Thus a restrictive monetary policy would induce investors to switch from foreign to domestic assets causing capital inflows and a rise in the money supply. The increase in the money supply negates the initial monetary policy initiative. Similarly, an expansionary monetary policy would trigger capital outflows and a fall in the money supply, again countering the initial expansion in the money supply. In both cases the money supply remains unchanged and so will the interest rate. Monetary policy is thus powerless to influence domestic targets.

The second issue concerns whether or not monetary authorities have some degree of monetary control in the face of capital inflows. If capital mobility is less than perfect, then domestic monetary policy is not completely constrained by capital inflows and monetary authorities have some degree of influence on their money supply and interest rate. In this case only part of the change in the money supply will be offset

[36] For an overview of the literature see Kouri and Porter (1974), Kouri (1975), Herring and Marston (1978), Obstfeld (1982, 1983) and Frenkel and Dominguez (1993)

by capital movements and the rest will influence domestic targets.

Although the theoretical literature on monetary policy in open economies has shown significant developments, there has been little empirical work to test the predictions of the theory in the context of developing countries. Moreover, despite the enormous difference that information on the degree of monetary policy independence would bring to the efficiency of macroeconomic management and performance, systematic empirical treatment of the issue of domestic monetary autonomy in developing countries is lacking. In particular, it would be interesting to examine the extent to which the authorities in economies with relatively open capital accounts and pegged currencies enjoy monetary autonomy and employ monetary policy for pursuing domestic goals.

This chapter aims to investigate the effect of capital inflows on domestic monetary policy when the monetary authorities are committed to maintaining a fixed exchange rate. Using data from selected developing countries and a variant of the monetary model of the balance of payments, as a framework of analysis, an attempt is made to examine empirically the extent to which domestic monetary policy is frustrated by capital inflows. By estimating the offset coefficient, an attempt is made to obtain a summary measure of the degree of influence of capital flows on domestic monetary policy. Further, we examines the scope for monetary policy independence in developing countries by estimating a monetary policy reaction function to determine the extent to which monetary authorities pursued sterilization measures to counter capital flows. This chapter is organized as follows: The next section presents an overview of the financial systems of the four ASEAN countries included in the study. Section three deals with the theory and empirical evidence surrounding capital mobility and domestic monetary policy while section four presents the empirical model for estimating the offset and sterilization coefficients for the countries included in the study. This section also presents an interest rate model for assessing the effect of sterilization on domestic monetary variables. Section five analyzes the econometric results and section six provides summary and conclusions.

3.2 Overview

This part briefly reviews the financial systems of the four countries (Indonesia, Malaysia, the Philippines and Thailand) during 1962-96, excluding the Asian crisis of 1997-98 and the post crisis period. The brief account aims to put in perspective the environment in which the respective central banks functioned and the implications for the conduct of monetary policy. In general, financial reforms preceded the emergence of money and capital markets, although the former grew faster then the latter. The degree of central bank independence varied from relatively more independent in Malaysia to least independent in the Philippines. The conduct of monetary policy matched the degree of central bank independence. It was subservient to fiscal policy in the Philippines while maintaining some degree of stability in other three countries.

3.2.1 Indonesia

Indonesia maintained control on bank deposit and lending rates throughout the 1960s and 1970s. Interest rate reform came in the early 1980s when deposit and lending rates were lifted and to promote competition and efficiency, the Bank of Indonesia relaxed entry requirements of domestic and joint venture banks during the late 1980s. While Indonesia has had no government bond market a small corporate bond market began to operate during the late 1980s. The balanced "budget rule" of the Indonesian government was the main factor hampering the creation of the government bond market. The bank of Indonesia, however, introduced its own debt instruments called Bank of Indonesia Paper (SBIs and SBPUs) in the market[37].

In general, the securities market was small and of less significance as an alternative source of finance. The private sector thus depended heavily on bank finance. The government was heavily involved in the banking system. During the period prior to the financial reforms in 1980, state-owned banks dominated the banking system. A peculiar feature of the pre-reform financial system of Indonesia was that a government controlled banking system co-existed with an open capital account. The Economic Stabilization Council chaired by the president with the central bank governor a member has been responsible for monetary policy. The Monetary Board chaired by the minister of finance aided the council in planning monetary policy. Generally, because of the government's conservative fiscal stance (balanced budget), the council formalized a block on central bank provisions of credit to government.

The conduct of monetary policy[38] in Indonesia during the 1960s and the 1970s was guided by the government's development objectives. The central bank, the Bank of

[37] See Montgomery (1997) and Dekle and Pradhan (1997)
[38] See Simon (1994)

Indonesia, was used to finance officially prioritized sectors using its rediscount facility for commercial banks and direct lending to the organizations. Despite the open capital account and the government's development mandates, monetary policy showed some signs of independence. The central bank was generally successful in containing inflation. The central bank imposed reserve requirements on banks, controlled credits and interest rates. The main monetary policy tools during the pre reform period were aggregate credit and government spending. Further, monetary targeting evolved from the use of a single aggregate such as M_1 to monitoring a range of aggregates: broad money, domestic credit and reserve money. The Bank of Indonesia also monitored the real value of the rupiah relative to its major trading partners. The main instruments of monetary policy comprised open market operations involving SBIs and SBPUs, reserve requirements and foreign exchange operations.

3.2.2 Malaysia

During the period prior to 1990, Malaysia's financial sector was dominated by banks, with most of the required finance for the economy originating from commercial banks. Initially foreign banks played significant roles in the financial system, but their presence was successively diminished over time. During this period government controlled banks increased their role in the financial system.

Financial liberalization in Malaysia started with the decontrol of interest rates. During the 1960s and early 1970s commercial bank lending and deposit rates were subjected to some restrictions. With the implementation of the reform in 1972 interest rate ceilings on commercial bank deposits exceeding one year were lifted, followed by the elimination of interest rate ceilings on all finance company deposits in 1973. With the exception of loans to priority sectors, all interest rates were left to the market by 1978. These changes were further incrementally intensified during the 1980s and 1990s. While Malaysia maintained a relatively open capital account to keep its interest rates close to the market it also had the desire to enhance its monetary autonomy. One reason that brought the currency board with Singapore and Brunei to an end in 1967 was Malaysia's desire for greater monetary independence.[39]

Malaysia has the second largest bond market in the region after Singapore. The private sector thus depended on this market for a substantial portion of its financing requirements. However, Malaysian Financial Institutions were, to a large extent, not involved in international financial intermediation. As a result banks accounted for only a small portion of international bond issue and syndicated borrowing. The public sector was the major borrower in the international market.

Bank Negara Malaysia, the central bank of Malaysia, was the primary regulator and policy maker. The central bank used reserve requirements to regulate bank loans. Traditionally, required reserve ratios were linked to deposit types and institutions. In 1989, statutory required reserve ratio was aligned to 4.5 percent for banks and finance

[39] For details see IMF, 1996, *World Economic Outlook*, and K.S. and Hamilton-Hart (2001)

companies. Monetary policy[40] in Malaysia targeted M_1 prior to the 1980s and moved to M_2 during the 1980s and partly the 1990s. In recent years there has been a shift to monitoring money, domestic credit growth and the exchange rate and targeting short term market interest rates. The targeting of interest rates started to be employed seriously after 1990[41]. The main instruments of monetary policy have been reserve requirements, interbank lending, shifting of government deposits to Bank Negara and sales of Bank Negara Malaysia Bills.

3.2.3 The Philippines

The financial system in the Philippines was characterized by the presence of large government-owned financial institutions including commercial banks. Overall, commercial banks dominated the financial market as the main sources of finance for private enterprises. The operation of government-owned banks was, however, directed to the promotion of development. The central bank had also a development mandate. The goal of the central bank was to channel credit to priority sectors. During the period prior to 1980, the main tool for selective credit allocation was central bank rediscount facility.

The bond market in the Philippines consisted of government treasury bills, central bank papers and papers issued by government-owned institutions. The largest investors in the bond market were private corporations and commercial banks. Interest rates were under official control through the 1970s with ceilings on loan and deposit rates. Financial reforms were introduced in the Philippines in 1980 in cooperation with the IMF and the

[40] Dekle and Pradhan (1997) and Tseng et al (1991)
[41] See Bank Negara Malaysia, *Annual Report*, 1994.

World Bank. The reform lifted interest rate ceilings on deposit and lending rates and introduced universal banking. The Philippines maintained exchange controls and officially pegged the peso to the US dollar until the late 1960s. After 1970, the exchange rate ceased to be officially pegged and exchange controls were removed. Following the financial reforms in 1980, the government, in cooperation with the IMF and the World Bank facilitated external borrowing and international capital inflows to the Philippines[41].

Prior to 1993 when a new central bank was established, monetary policy was conducted in a difficult environment. The central bank faced conflicting demands in the wake of political and economic instability. The central bank was burdened with the financing of the fiscal deficit. In the face of expansionary fiscal deficits, monetary policy accommodated the fast growth in credit extended by domestic banks (Arora 2000).

In the mid 1980s, monetary policy shifted away from controls and toward indirect instruments. Interest rate controls and credit ceilings were gradually removed and replaced by open market tools and reserve requirements as the main instruments of monetary policy. The central bank targets for monetary policy evolved over time. During the 1960s until the mid 1980s, the central bank targeted credit aggregates. After the mid 1980s, it switched to base money as its monetary policy target. The main instruments of monetary policy were rediscounting and the required reserve ratio, although after 1993, the central bank included open market operations and liquidity ratio to the list of instruments.

[41] See for details K.S. and Hamilton-Hart (2003).

3.2.4 Thailand

The domestic banking system in Thailand was subject to controls on deposit and lending rates and had limited access to capital markets to raise funds through debt instruments. The Bank of Thailand also regulated credit allocation by enforcing a monthly credit plan that spans for six months on commercial banks. In general the central bank encouraged banks to lend to the productive sectors and restrain from lending to areas that might trigger inflationary pressure in the economy[43].

During the period prior to the 1990s domestic financial intermediaries were the main sources of finance for the private sector of which commercial bank lending was the largest (Callen and Reynolds 1997). The Bank of Thailand also used reserve requirements to regulate commercial bank lending. Until 1991, the required reserve ratio was maintained at 7 % of total deposits. Later it was replaced with liquidity ratio of 7 % of deposits in securities (including nongovernmental securities) and cash. The capital market was very small and as a result, bond and equity financing were insignificant for the private sector. The main reasons for the sluggish change in the capital market were strong fiscal positions that led to short supply and slow turnover of government bonds which culminated in the absence of a benchmark interest rate interest rate for the market, lack of rating agency and the absence of an efficient trading and settlement system.

Thailand introduced banking deregulation in the late 1980s in which the range of permissible activities and asset holdings expanded. The aim was to promote competition

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[43] See for example, Bank of Thailand, *Quarterly Bulletin* (various issues) and Callen and Reynolds (1997).

and efficiency in the banking system. Ceilings on time deposits and lending rates were also removed in the early 1990s as part of the interest rate liberalization measures introduced by the Bank. These changes opened opportunities for Thai banks to use domestic as well as international financial markets to meet the growing demand for loans. Traditionally, small amounts of government and corporate bonds were traded in the market, but during the 1980s, the financial market comprised mainly of repos (repurchase agreements). Further, successive measures were taken to liberalize the capital account and by 1991 most of the controls on capital out flows were removed.

In Thailand, growth, inflation and the balance of payments were the goal variables of monetary policy. Based on the objectives set for these variables, monetary policy was conducted by targeting a range of monetary aggregates. The main target of monetary policy[44] was M_2, while credit and reserve aggregates were also closely monitored. The primary monetary policy instrument was open market operations in the repurchase market where government bonds were traded. The Bank of Thailand also used its rediscount facility to allocate resources to priority sectors, the major beneficiary of which was the export sector. However, in recent years, the Bank of Thailand has moved toward targeting the interbank rate and aggregate private credit with repurchase operations and the credit plan as monetary policy instruments.

Having reviewed the main features of the financial sectors and the conduct of monetary policy in the four countries, we now move to the relevant theory on monetary policy and international capital mobility.

[44] See, for example, Dekle and Pradhan (1997), Tivakul (1995) and Tseng et al. (1991).

3.3 Monetary Policy, Fixed Exchange Rates and Capital Mobility

3.3.1 Monetary Policy under Fixed Exchange Rates

One of the fundamental results of the exchange rate literature is that there is an inherent tension between the utilization of monetary policy for internal balance and the objective of maintaining fixed exchange rates. Regardless of the degree of capital mobility, monetary policy cannot bring about a permanent change in output and employment when the exchange rate is fixed. An expansionary monetary policy will lead to the decumulation of international reserves while a restrictive monetary policy will lead to the accumulation of international reserves perhaps beyond a manageable level. The basis[45] of these results is the monetary theory of the balance of payments as expounded by Mundell (1968), Johnson (1972, 1973), and Swoboda (1973). If the exchange rate is fixed, using monetary policy for domestic stabilization generates forces that exert pressure on the exchange rate. The reason is that under certain conditions, the growth in domestic credit that is required to bring about changes in domestic targets leads to an external imbalance that reveals itself as an excess demand for foreign exchange. Since the monetary authorities are committed to maintaining a fixed exchange rate, they intervene in the foreign exchange market to eliminate the excess demand by selling

[45] Kearney (1990) extended the basic Mundell-Johnson type model by analyzing the issues in the context of optimizing economic agents. The optimizing models gave results very similar to the basic model. In particular monetary policy was found to be ineffective under fixed exchange rates.

foreign exchange, triggering a monetary contraction until the money supply is restored to its initial level.

The final outcome of these transactions is that the money supply, interest rates and income remain unchanged while the composition of the domestic and foreign asset holdings of the monetary authorities varies in favor of the former. This invariance of domestic variables to monetary policy will hold as long as the change in the composition of assets has no bearing on the behavior of the public, the monetary authorities do not take any other policy measures, the interest parity condition holds and the country is too small to affect the international interest rate. The important point to note is that in the situation specified above, monetary policy is powerless to affect domestic target variables when the exchange rate is fixed. Thus, in the medium to long time runs, when all the payments and monetary mechanism of adjustments have worked themselves out, the money supply is endogenous; that is, there is only one money stock that is consistent with payments equilibrium and the mechanism forces the money stock to converge to its equilibrium value. In other words, the rate of change of the money supply is a function of the excess supply of foreign reserves. Denoting the money supply by M and the excess supply of foreign reserves by FR, the endogeneity of the money supply can be expressed using the following equation:

$$\frac{dM}{dt} = g(FR), g' > 0$$

In this case, the role of the money supply is to determine the level of international reserves. The fixed exchange rate regime is thus a monetary policy rule which requires increasing the money supply when the balance of payments is in surplus and reducing the money supply when the balance of payments is in deficit. The implication of this is that the fixed exchange rate policy enforces some discipline on the monetary authorities by ruling out independent monetary expansion. However, it may also lead to undesirable developments in the external sector, especially for countries that face sustained balance of payments surpluses or deficits. Countries that continuously run balance of payments surpluses will see their international reserves continuously accumulate beyond manageable levels while those that run deficits may end up running out of international reserves implying that fixed exchange rates are inherently unsustainable. Thus, three points need to be emphasized in this regard. First, when the exchange rate is fixed, monetary policy is not available for domestic stabilization purposes. Second, by tying monetary policy to external balance (divorcing it from domestic economic conditions) the fixed exchange rate regime could serve as major tool for maintaining stable prices. Finally, the fixed exchange rate system is indefensible in the long run because it could in principle lead to a situation where the money stock is backed either by foreign reserves or by domestic credit. As long as the monetary authorities care about the level of these monetary aggregates, they are bound to abandon the fixed rate system or at least allow devaluation or revaluation of their currency.

3.3.2 Monetary Policy and Perfect Capital Mobility

In discussing the effectiveness of monetary policy under fixed exchange rates, we did not explicitly refer to the capital account, not because it was unimportant but because it was not necessary for the conclusions reached. In addition, the endogeneity of the money supply and the powerlessness of monetary policy to cause permanent changes in output were results obtaining in long run equilibrium. However, capital mobility is integral to the adjustment mechanism of payments imbalances in economies with open capital accounts in the short run as well as in the long run. Indeed, one of the significant contributions of the monetary theory of the balance of payments is its explicit modeling of the capital account in the analysis of payments equilibrium. In terms of the effect of capital mobility on monetary policy autonomy, depending on the degree of capital mobility, the speed of the payments processes and the monetary adjustment spelt out above increase with no effect on the equilibrium outcome of the system. Hence, with capital mobility, adjustment periods are reduced and the ineffectiveness of monetary policy is enhanced.

Under perfect capital mobility[46], the domestic interest rate cannot deviate from the world interest rate even in the short run and monetary policy is powerless to influence domestic variables. To illustrate the mechanism through which capital flows affect monetary and exchange market equilibrium when the exchange rate is fixed, suppose that the domestic interest rate is determined by the demand for and supply of bank reserves. Further, assume there is no currency in the system so that the liability of the monetary authorities consists only of bank reserves whereas the asset side contains foreign assets and domestic credit. Since assets equal liabilities in the balance sheet of the monetary authorities, the supply of reserves is equal to the sum of foreign assets and domestic credit. The demand for reserves is a function of the required reserve ratio and the level of demand deposits held by the public which in turn are determined by real income, the domestic interest, the

[46] Perfect capital mobility is a joint assumption of perfect substitutability and perfect capital markets. Perfect asset substitutability is an assumption about the characteristics of financial assets and/or the preference of the participants who trade them, while perfect capital markets is an assumption about the absence of restrictions on the behavior of agents participating in the market and the speed of the adjustment of capital markets to equilibrium. For details see Kearney (1990)

foreign interest rate and wealth. If there is perfect capital mobility, this means that banks face a horizontal supply curve for reserves at the world interest rate.

Now, consider an open market purchase of bonds by the central bank. In the first place, the rise in bank reserves will exert downward pressure on the domestic interest rate. This will induce both domestic and foreign investors to substitute foreign bonds for domestic bonds. The resulting capital outflows will create pressure for the exchange rate to depreciate. Since the monetary authorities are committed to keep the exchange rate fixed, they prevent the depreciation by selling foreign exchange which leads to a contraction in bank reserves. The capital outflows would continue until the initial level of bank reserves is attained. The ultimate result is that the level of reserves remains constant, and the interest rate and the level of income are unaffected. The effect of the open market operation is simply to change the composition of domestic and foreign asset holdings of the monetary authorities--a conclusion that was arrived at in the fixed exchange rate case.

The use of other monetary policy instruments (required reserves, government deposits, discount loans) does not change the results. Under perfect capital mobility, regardless of the type of instruments, monetary policy is completely ineffective in affecting interest rates or the money supply. Movements in the domestic assets of the monetary authorities are completely offset by equivalent but opposite movements in their foreign assets. There is a negative correlation between changes in foreign assets and changes in domestic assets of the monetary authorities. Hence, when capital is perfectly mobile, the offset coefficient--the fraction of any policy-induced change in domestic assets that is offset through the capital account-- is negative one. Any increase in the money supply flows out through the capital account while any excess demand for money is eliminated by capital inflows[47].

3.3.3 Monetary Policy and Imperfect Capital Mobility

The complete neutralization of any domestic monetary policy initiatives by induced changes in the balance of payments accounts depends on the degree of capital mobility. Complete neutralization occurs when capital is perfectly mobile. However, if capital is imperfectly mobile, the consequences to domestic monetary policy are substantially different. Imperfect capital mobility is understood as limited interest sensitivity of capital flows. In this case, the offsetting movement in the capital account in response to changes in monetary policy is incomplete. If domestic bonds are not perfect substitutes for foreign bonds, changes in their relative supplies will not induce an equivalent change in the capital account. The offset coefficient in this case lies in the interval (-1, 0). More importantly, the monetary authorities will be able to enjoy some degree of autonomy.

Theoretical work on the offset behavior based on portfolio balance models include Marston and Herring (1977), Kouri and Porter (1974), Argy and Kouri (1974), and Neumann (1978). Others have used the monetary theory of the balance of payments to analyze the link between domestic monetary conditions and external balance transactions. Included in this category are Soboda (1976), Frenkel (1976), Johnson (1976), Aghevli

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[47] See, for example, Mundell (1968) Kouri and Porter (1974), Argy and Kouri (1974), Marston and Herring (1977), Soboda (1976), Neuman (1978).

and Kahn (1977), Argy (1977), Aliber (1990), Kearney (1990), Glick and Hutchison (1994) and Turnovsky (1994). The monetary approach emphasized that under imperfect capital mobility, domestic monetary policy measures are partially offset by opposite transactions in the balance of payments. The implication is that monetary policy can be used for stabilizing income and employment during the business cycle.

Within the portfolio balance framework, Obstfeld (1982b), Henderson (1983), and Stockman (1983) have argued that imperfect asset substitutability does not guarantee monetary policy autonomy if agents are Ricardian. Even when assets are imperfect substitutes, monetary autonomy may not be possible if agents factor into their decision making process the budget constraints of the government and the central bank. In this case, changes in monetary variables may not produce wealth effects required for affecting domestic targets[48]. Assuming that the Ricardian equivalence proposition holds, Pasula (1996) reached similar conclusion using a stochastic optimizing model. Ricardian equivalence, interesting as it is, is nevertheless a proposition that one would like to test rather than assume.

Because capital mobility frustrates monetary policy by robbing the authorities of their control over domestic credit and the interest rate, the institutionalization and implementation of several exchange and capital control measures by many developing

[48] If the central bank holds all its foreign assets in the form of interest bearing foreign bonds, an open market purchase of domestic bonds will reduce the future tax liabilities of agents while the resulting fall in foreign reserves reduces the fall in interest earnings of the government. The Ricardian agent incorporates this loss in interest in her decision as an offsetting term to the reduction in future tax liabilities. The wealth effect is zero and hence there is no monetary policy autonomy. If the central bank holds a constant fraction of foreign currency reserves, monetary policy will generate wealth effects and thereby influence domestic targets. For details see Sockman (1983), and Pasula (1996).

countries come as no surprise. The main goal of these controls is to slow down and if possible to prevent capital movements in order to be able to reduce the loss of control by the authorities over the relevant monetary aggregates and the interest rate. Capital controls have taken different forms in different countries. In some countries, strong quantitative restrictions are imposed while in others taxes on capital movements are levied. Higher reserve requirements on foreign loans, prohibition of interest payments on foreign holdings of bank deposits, direct control on bank lending and selective credit allocation have also been used in several countries to slow down capital movements. While these are some of the prominent measures utilized to limit the capital flows themselves, monetary authorities in open developing countries have also engaged in a systematic neutralization of the monetary effects of foreign capital flows.

Monetary authorities could in principle conduct a sterilized intervention to insulate domestic monetary conditions from the effects of transactions arising in the balance of payments. Note, however, that sterilization in practice would quickly turn out to be impossible to implement when capital is perfectly mobile. This happens because sterilization induces more capital flows which lead to more sterilization so that within a finite time the amount of funds required for sterilization will quickly rise to unmanageable levels. Nevertheless, if capital mobility is imperfect, the monetary authorities can sterilize their foreign exchange transactions to reduce the impact of foreign disturbances on the domestic economy.

The extent of sterilization of balance of payments transactions depends on the policy preferences of the authorities. If they care only about external balance, sterilization will not take place and domestic monetary conditions will bear the full impact of developments in the balance of payments. On the other hand, if the authorities are committed to the fulfillment of their domestic economic goals such as high employment, high growth and stable prices, then complete sterilization of foreign exchange transactions takes precedence. When sterilization is complete, the sterilization coefficient -- a measure of the responsiveness of the domestic source component of the monetary base to changes in foreign exchange reserves -- is equal to -1. This means for every dollar sale (purchase) of foreign exchange, the central bank carries out an equivalent purchase (sale) of domestic assets through its open market operations. Thus, if the authorities allow foreign exchange transactions to affect domestic monetary conditions, with no concern for domestic objectives, the sterilization coefficient will be zero while incomplete sterilization would give rise to a coefficient between 0 and -1. In the absence of Ricardian behavior on the part of agents, smaller absolute values of the offset coefficient and larger absolute values of the sterilization coefficient would imply that monetary authorities enjoy some degree of monetary policy autonomy.

Most of the empirical work on monetary independence under fixed exchange rates with capital mobility was done for the industrial countries during the Bretton Woods era. Accordingly, Kouri and Porter (1974) and Kouri (1975), used reduced form equations of the portfolio balance model to estimate offset and sterilization coefficients for Australia, Germany, Italy and the Netherlands during the 1960s and obtained evidence that the authorities in these countries had some degree of monetary policy autonomy. Neumann (1978) conducted a similar study for Germany for the same period and found stronger evidence of monetary policy independence during the fixed exchange rate era. Marston and Herring (1977), and Obstfeld (1980a) obtained offset estimates from structural models and found that the coefficients were much smaller than those obtained from the reduced form equations. The discrepancy between the two types of estimates was attributed to the effect of speculative disturbances and the sterilization bias. Kwack (1994) estimated a domestic credit reaction function to measure the sterilization coefficient for Korea for the 1980s and found that Korean authorities sterilized over 80 percent of their foreign asset accumulation during the specified period.

In the following section, two reserve flow equations are derived using the monetary theory of the balance of payments and the portfolio approach to the balance of payments[49]. First, the monetary approach to the balance of payments is presented followed by the portfolio approach to the analysis of the balance of payments.

3.4 Empirical Models for Capital Flow Offset and Sterilization

The first model to be outlined shortly is the monetary theory of the balance of payments. This theory proposes that the fundamental determinants of the balance of payments of a country are the demand for and supply of money in that country. Balance of payments deficits and surpluses are the result of decisions by residents to accumulate or run down

[49] The portfolio balance model allows for imperfect substitutability of assets and to that extent might have been more appropriate. However, lack of well developed secondary market for government debt has limited its applicability for analyzing monetary policy issues in developing countries. In addition, the monetary model is a stock equilibrium approach which is more plausible for this type of analysis. It also requires less information and is relatively easier to implement.

their stock of money balances.[50] In the monetary model of the balance of payments, it is the adjustment to the desired level of money balances on the part of agents that leads to balance of payment deficit or surplus.

3.4.1 The Monetary Approach

A small country that faces world prices and interest rates can buy and sell goods and financial assets without affecting their prices if there is no restriction on the movement of goods and assets. In such an economy, any excess supply of money will find itself out of the country either through the purchase of foreign goods or investing in foreign markets. This leads to a decline in international reserves, i.e., a balance of payments deficit is created. Similarly, any excess demand for money will lead to a rise in international reserves (assuming that the domestic component of the money supply remains unchanged) and hence a balance of payments surplus. In either situation, the change in international reserves could arise either from changes in the current account, the capital account or both.

The main concern of the monetary approach in the context of an open economy is to establish the relationship between the domestic component of the monetary base and the balance of payments, while controlling for other determinants of domestic credit. Although the monetary approach is general enough to accommodate the effects of discrepancies in one market on all other markets including feedbacks, the approach used here is concerned with long-run relationships. The theoretical development of the long run version of the monetary approach to the balance of payments is due to Johnson

[50] See Johnson and Frenkel (1976), Mundell (1968,1971), Mussa (1974), Frenkel and Rudriguez (1975).

(1972). The model assumes that prices and interest rates are exogenous under the small-country assumption. Output is also exogenous under the long run full employment assumption. Further, the money supply is assumed to adjust instantaneously to the demand for money and the exchange rate is fixed.

As a point of departure for specifying the empirical model, consider the balance sheet of the monetary authorities (including foreign exchange authorities) given in Table 3.1:

Table 3.10 Balance sheet of the monetary authorities

Assets	Liabilities
F	H
AOA	AOL

F = international reserves held by the monetary authorities

AOA = all other assets of the monetary authorities

H = the monetary base

AOL = all other liabilities of the monetary authorities

By definition, the monetary base is

$$H = F + (AOA - AOL) = F + D \tag{1}$$

where D is the stock of domestic credit extended by the monetary authorities.

Denoting the domestic money stock by M we have

$$M = qH \tag{2}$$

Where q is the money multiplier

Using (1) and (2) the money stock is given by

$$M = q(F + D) \tag{3}$$

The next step is to specify a demand for money function. Following Aghevli and Khan (1977) and Edwards and Khan (1985), the demand for money is specified as

$$L = L(P, Y, R, \pi) \quad (4)$$

Where

L = demand for nominal money balances

P = the domestic price level

Y = the level of real income

R = domestic nominal interest interest rate

π = the rate of inflation, defined as (dp/p) (1/p).

Assuming constant elasticities and adding a constant term, (4) can be expressed as follows:

$$\ln L = \ln C + \varepsilon_P \ln P + \varepsilon_Y \ln Y + \varepsilon_R \ln R + \varepsilon_\pi \ln \pi \quad (5)$$

$$\varepsilon_p = 1, \;\; \varepsilon_y > 0 \; \varepsilon_r < 0 \; \varepsilon_\pi < 0$$

Money market equilibrium is ensured by the equality of equations (3) and (5).

$$\ln q + \ln(F + D) = \ln C + \varepsilon_P \ln P + \varepsilon_Y \ln Y + \varepsilon_R \ln R + \varepsilon_\pi \ln \pi \quad (6)$$

By differentiating and rearranging terms, we obtain

$$\frac{dF}{F}\frac{F}{F+D} = \varepsilon_P d\ln P + \varepsilon_Y d\ln Y + \varepsilon_R d\ln R + \varepsilon_\pi d\ln \pi - d\ln q - \frac{dD}{D}\frac{D}{F+D} \quad (7)$$

Equation (7) is the standard reserve flow equation and in terms of growth rates it takes the following form;

$$\frac{F}{F+D} g_F = \varepsilon_P g_P + \varepsilon_Y g_Y + \varepsilon_R g_R + \varepsilon_\pi g_\pi - g_q - \frac{D}{F+D} g_d \quad (8)$$

Adding an error term to (8) and replacing the elasticity terms by coefficient parameters, we obtain the empirical model for estimating the reserve flow equation.

$$\frac{F}{F+D} g_F = \alpha_0 + \alpha_1 g_P + \alpha_2 g_Y + \alpha_3 g_R + \alpha_4 g_\pi + \alpha_5 g_q + \alpha_6 \frac{D}{F+D} g_d + \mu \qquad (9)$$

According to the theory, the coefficient on price (α_1) should be equal to one if there is no money illusion. The sign of the coefficient on real income (α_2) should be positive while that of the interest rate α_3 is expected to be less than 0. The coefficient on inflation (α_4) is expected to be negative since higher inflation would require lowering the money supply. The coefficient on the money multiplier (α_5) should be negative because an increase in the money multiplier increases the money supply which requires a fall in foreign reserves. The coefficient on the weighted domestic credit growth (α_6) should be equal to negative one. The parameter, α_6 is known as the offset coefficient in the literature. The offset coefficient measures the degree to which changes in the domestic component of the monetary base are neutralized by changes in foreign component of the base.

The monetary theory of the balance of payments suggests that under fixed exchange rates monetary policy is completely nullified by developments in the balance of payments and, hence, is unable to influence domestic target variables. The monetary approach assumes that the authorities do not engage in sterilization measures to insulate domestic monetary conditions. However, if the authorities pursue sterilization policies, then changes in international reserves will cause changes in domestic credit. In this case, a sterilization equation, which can be viewed as the reaction function of the monetary authorities, may be specified as follows:

$$\frac{D}{F+D}g_D = \beta_0 + \beta_1 g_P + \beta_2 g_Y + \beta_3 g_R + \beta_4 g_\pi + \beta_5 g_q + \beta_6 \frac{R}{F+D} g_F + \xi \qquad (10)$$

In this circumstance, estimating (9) using OLS will lead to an inefficient and inconsistent coefficient on the domestic credit variable because of the simultaneity bias. In other words, the coefficient on the domestic credit variable will be biased towards negative one. To see this, suppose excess supply of money develops in the money market, say because the government increases domestic credit. This translates into excess demand for foreign exchange and a capital outflow because of the downward pressure on the domestic interest rate. If the monetary authorities sterilize part of the outflow by increasing domestic credit, say by some ratio r, then there will still be an excess supply of money in the market, which will lead to a second round proportionate increase in capital outflows. The authorities continue to offset part of the outflow by increasing domestic credit by r^2 and so on. The point is that sterilization creates a simultaneity bias in the reserve flow equation and, as a result, the OLS estimate of the domestic credit coefficient in equation (9) will be biased. Another way of looking at this is to examine the relationship between the domestic credit and the error term in equation (9). Suppose in a realization of foreign reserves, the error term μ is positive so that foreign reserves have increased. The rise in foreign reserves will lead to a fall in domestic credit if the authorities engage in sterilization. Thus, domestic credit and the error term μ are not orthogonal to each other. As a result, the coefficient of domestic credit in equation (9) will pick up from the error term and its value will be biased towards negative one. In these circumstances, the appropriate estimation procedure to avoid the simultaneity bias is to apply the instrumental variables (IV) technique. One class of IV estimators is the two stage least squares (2SLS) method. The reserve flow equation and the monetary reaction function are therefore estimated as a system using the two-stage least squares technique.

3.4.2 The Portfolio Balance Approach

The second model used to generate another reserve flow equation is the portfolio approach to the balance of payments. The portfolio approach still retains the distinctive characteristic of the monetary approach --emphasis on stock equilibrium. However, it explicitly relaxes the assumption of perfect substitutability between domestic and foreign bonds which is implicitly assumed in the monetary approach. The model therefore, introduces bonds into the analysis to develop a reserve flow equation. Similar models have been constructed by Branson (1968), Kouri and Porter (1974), and Taylor (1994). While the first two are models of capital flows, the third is a model of overall changes in foreign reserves. The model to be developed here is close to the latter.

Since the subject under consideration is the analytical exposition of the mechanism for equilibrium formation in financial markets in a small open economy, we assume that the output market is continuously around equilibrium, perhaps with short term deviations. For simplicity it is also maintained that any feed back from the financial sector to the real sector is ruled out.

We begin by specifying the structure of assets in a small open economy. There are three assets: domestic bonds (B), foreign bonds (Z), and money (M). Domestic bonds are issued in the past by the government to finance its deficits. It is assumed that the government cannot use open market operations to finance external deficits/surpluses The supply curve of foreign bonds is horizontal at the foreign interest rate.

The monetary approach to the balance of payments implicitly assumes that international capital is perfectly mobile. This assumption has two components: the first is that of instantaneous portfolio adjustment, i.e. at each point in time actual portfolio holdings are equal to desired portfolio holdings. The second is that domestic and foreign bonds are perfect substitutes. The portfolio balance model is an alternative approach to balance of payments determination. The model relaxes the perfect substitutability assumption while keeping the fundamental stock flow distinction of the monetary approach.

The asset demand functions are generally specified following Tobin (1968) and Dornbusch (1975). However, they have been modified to suite them to the level of financial development in developing countries. In developing countries financial markets are characterized by limited range of financial assets. The public may thus engage in substitution between money and goods. In such circumstances, it would be more appropriate to represent the opportunity cost of holding money by both the return on alternative assets, the rate of interest, and the implicit rate of return on goods, the inflation rate. Similarly, the inflation rate is also included in the demand functions for domestic and foreign bonds.

Demand for Money:

$$M^d = m(i, i^*, y, \pi)W \qquad (11)$$

$$m_i < 0, m_{i^*} < 0, m_y > 0, m_\pi < 0$$
$$\eta_i < 0, \eta_{i^*} < 0, \eta_y > 0, \eta_\pi < 0$$

Demand for domestic bonds:

$$B^d = b(i, i^*, y, \pi)W \tag{12}$$

$$b_i > 0, b_{i^*} < 0, b_y < 0, b_\pi < 0$$
$$\omega_i > 0, \omega_{i^*} < 0, \omega_y < 0, \omega_\pi < 0$$

Demand for foreign bonds:

$$Z^d = f(i, i^*, y, \pi)W \tag{13}$$

$$f_i < 0, f_{i^*} > 0, f_y < 0, f_\pi < 0$$
$$\delta_i < 0, \delta_{i^*} > 0, \delta_y < 0, \delta_\pi < 0$$

The m_j's, b_j's and f_j's are first derivatives with respect to the j^{th} argument and j = (r, r^*, y and π) while the η_j's ω_j's and δ_j's represent elasticities. The variables are defined as follows:

i= domestic nominal interest rate;

π=the rate of change of the domestic price level;

i^* =foreign nominal interest rate

y=domestic real income

$W=M+B^d+Z^d$ is private sector net wealth

The variables that enter the asset demand functions and the predicted signs of the partial derivatives are standard in portfolio balance theory. It is, however, important to recognize that real income enters the functions through the transaction demand for money and the resulting portfolio reallocation. The functions are homogenous with respect prices and real wealth. The homogeneity assumption gives rise to some adding up restrictions and imparts some structure on the general model.

Assume that the money multiplier is constant. Then the money supply can be specified as a behavioral equation.

$$M = q(R + D) \tag{14}$$

$$\lambda_R = q(R/M) > 0, \lambda_D = q(D/M) > 0$$

λ_R and λ_D are supply elasticities with respect to reserves and domestic credit and q is the money multiplier. Assuming that foreign bonds are not held as reserves the level of domestic bonds is

$$H = B + D \tag{15}$$

where B stands for domestic bonds held by the private sector and D represents domestic credit which is also the amount of domestic bonds held by the monetary authorities.

Making use of the homogeneity properties of the asset demand functions, we get the following adding up restrictions:

$$\begin{aligned} & m + b + f = 1 \\ & m_j + b_j + f_j = 0 \\ & m\eta_j + b\omega_j + f\delta_j = 0 \\ & j(= r, r^*, y, \pi) \end{aligned} \tag{16}$$

Differentiating logarithmically with respect to time the demand and supply side of the money market and imposing equilibrium yields the following equations

$$g_M = \eta_r g_r + \eta_{r^*} g_{r^*} + \eta_y g_y + \eta_\pi g_\pi + g_W \quad \text{(money demand)} \tag{17}$$

$$g_M = g_R\lambda_R + g_D\lambda_D \qquad \text{(money supply)} \tag{18}$$

Using (7) and (8) we get

$$g_R\lambda_R + g_D\lambda_D = \eta_r g_r + \eta_{r^*} g_{r^*} + \eta_y g_y + \eta_\pi g_\pi + g_W \qquad \text{(money market equilibrium)} \tag{19}$$

Applying a similar procedure to the demand and the supply side of the bond market obtains

$$g_B = \omega_r g_r + \omega_{r^*} g_{r^*} + \omega_y g_y + \omega_\pi g_\pi + g_W \qquad \text{(bond demand)} \tag{20}$$

$$g_H = 0 = g_B - \theta g_D \qquad \text{(bond supply)} \tag{21}$$

where $\theta = D/B$. Using (20) and (21) we get

$$-\theta g_D = \omega_r g_r + \omega_{r^*} g_{r^*} + \omega_y g_y + \omega_\pi g_\pi + g_W \qquad \text{(domestic bond market equilibrium)} \tag{22}$$

Note that (21) deals with outstanding bonds so that the assumption of a balanced government budget is implicit in it.

Using (19) and (22) to eliminate the domestic interest rate and given the adding up restrictions we have the equation for the growth rate of foreign reserves:

$$g_R = \alpha g_D + \beta g_{r^*} + \gamma g_y + \psi g_\pi + \phi g_W \tag{23}$$

$\beta<0$, $\phi>0$

Data for the wealth variable in (23) is not readily available even in developed countries let alone in developing countries. To estimate (23) either we drop wealth as in Kouri and Porter (1974) or find a way to represent it somehow as in Taylor (1994). The second option is pursued in this study. The monetary authorities' bond function is specified as

$$D = m(r, r^*, y, \pi)W - R \tag{24}$$

Differentiating (24) with respect to time, using the domestic bond market to eliminate the domestic interest rate and solving for foreign reserves yields:

$$dR/dt = \sigma_1(dD/dt) + \sigma_2(di^*/dt) + \sigma_3(dy/dt) + \sigma_3(d\pi/dt) + \sigma_5(dW/dt) \quad (25)$$

which is the equation for the overall balance of payments.

Similarly, differentiating the foreign bond demand function logarithmically with respect time and using bond market equilibrium to eliminate the domestic interest rate we get the equation for the growth rate of foreign bonds which is the equation for the capital account:

$$-dZ/dt = \varphi_1(dD/dt) + \varphi_2(di^*/dt) + \varphi_3(dy/dt) + \varphi_3(d\pi/dt) + \varphi_5(dW/dt) \quad (26)$$

The equation for the current account balance is given by

$$\begin{aligned} CB &= dR/dt - KB = dW/dt \\ CB &= dR/dt + dZ/dt = dW/dt \end{aligned} \quad (27)$$

where CB and KB are the current account and capital account balances, respectively.

Now suppose that nominal income and wealth have a stable relationship of the following form:

$$\begin{aligned} &Y = \mu W \\ &(dW/dt)/W = CB/W \\ &g_W = CB/(1/\mu)Y = \mu(CB/Y) \end{aligned} \quad (28)$$

Inserting (28) in (23) yields the portfolio balance equation for the growth rate of foreign reserve.

$$g_{Rt} = \psi_1 g_{Dt} + \psi_2 g_{r^*t} + \psi_3 g_{yt} + \psi_4(CB/Y) + \psi_5 g_{\pi t} + \varepsilon_t \quad (29)$$

$$-1 < \psi_1 < 0, \psi_2 < 0, \psi_3 > 0, \psi_4 > 0, \psi_5 < 0$$

Equation (29) can be estimated using OLS if simultaneity bias is not a problem.

However, as mentioned earlier, the method of instrumental variables is appropriate when bias is present, i.e., the errors and domestic credit are contemporaneously correlated. The offset coefficient is ψ_1 and it varies between zero (no capital mobility) and minus one (perfect capital mobility). Note that exogeneity of CB/Y is crucial for estimating (26). The inclusion of the current account on the right hand side of the equation for overall balance of payments is justified on the assumption that output is at or near steady-state in which case the current account will be determined primarily by the level of domestic absorption (Taylor 1994). The underlying assumption is that individuals will change the level of absorption in order to attain their long-run target level of the stock of wealth. To the extent that this is so, CB/Y will be exogenous to the growth rate of international reserves.

Once it is established that there is room for independent domestic monetary policy the natural question is whether attempts by the authorities to prevent foreign reserve flows from affecting the domestic money supply through sterilized interventions have been effective in the sample countries. The next section deals with this issue.

3.5 Sterilization and Domestic Monetary Conditions

When capital is imperfectly mobile, the monetary authorities can insulate the domestic economy from the influence of external transactions through sterilized intervention. The main purpose of sterilization is therefore to maintain some autonomy in monetary policy so that the authorities will be able to influence domestic target variables such as income and prices. The effectiveness of sterilization implies that the monetary authorities have practically some degree of control over their money supply which is the basis for monetary autonomy.

One way to evaluate the effectiveness of sterilization measures is to investigate their impact on domestic intermediate variables that exhibit strong relationship with the target variables. One such macroeconomic variable is the domestic interest rate. The effect of sterilization is, therefore, assessed by estimating an interest rate model that incorporates a sterilization variable as an additional explanatory variable. The model to be used is a variant of Edwards and Khan (1985). This model incorporates the main features of most developing countries that are liberalizing their financial sectors while still maintaining certain characteristics of closed economies. The general form of the model specifies the domestic interest rate as function of domestic and international factors as shown below.

$$i_t = f\left[i_t^f, (de_t / dt), rr_t, r_t, \pi_t^e, y_t, v_t \right] \qquad (30)$$

where i_t and i_t^f are the domestic and foreign nominal interest rates

de_t/dt is the expected rate of change of the exchange rate

r_t is the domestic real interest rate

π_t^e is the expected inflation

y_t is domestic real income

rr_t is the required reserve ratio

v_t is a sterilization variable

Equation (30) can be derived from an underlying demand for and supply of bank reserves. From the balance sheet of the monetary authorities (table 3.1) the supply of bank reserves is positively related to the sum of domestic credit and foreign assets. Under a fixed exchange rate regime, the foreign asset component changes when the sum of the current and capital accounts of the balance of payments is not zero. Thus, changes in international reserves reflect the authorities' intervention in the foreign exchange market to defend the exchange rate the domestic consequence of which is a change in bank reserves. The capital account is interest sensitive, while the current account less net interest receipts, i.e. the trade balance is insensitive to interest rates and can be treated as exogenous to the interest rate. Now the change in foreign assets is responsive to interest rate differentials and the link between changes in foreign assets and bank reserves makes the latter responsive to interest rates. For example, a higher interest rate on domestic securities by triggering a capital inflow increases central bank holdings of foreign assets which in turn results in a rise in bank reserves. Therefore, in an open economy with fixed exchange rates the supply of bank reserves as a function of the domestic interest rate is upward sloping.

The demand for bank reserves is related to the level of demand deposits by the required reserve ratio and demand deposits are related to domestic income, wealth, the domestic interest rate, the foreign interest rate, and change in the exchange rate. Thus, the equilibrium solution to the demand for and supply of bank reserves determines the domestic interest rate as a function of the required reserve ratio, the foreign interest rate, change in the exchange rate, domestic income, domestic wealth, and the interest insensitive component of the change in foreign assets. This component of the change in foreign assets is used as a sterilization variable in the interest rate function in (30).

A partial log-linear form of (30), assuming lagged response of the domestic interest rate to changes in the foreign interest rate, gives the following reduced-form specification of the interest model.

$$i_t = \beta_o + \beta_1 i_t^f + \beta_2 \ln y_t + \beta_3 \pi_t^e + \beta_4 \ln BR_{t-1} + \beta_5 i_{t-1} + \beta_6 v_t + \mu_t \qquad (31)$$

BR_{t-1} is the level of bank reserves lagged one period, and μ_t is an error term.

Equation (31) can be estimated using the OLS. The coefficient on v measures the degree to which sterilization affects the domestic interest rate. If the OLS estimate of β_6 is positive and statistically significant, then sterilization is effective and the authorities can influence domestic target variables using monetary policy.

3.6 Data, Estimation and Results

The empirical investigation on the effect of capital inflows on the conduct of domestic monetary policy involves four Southeast Asian countries: Indonesia, Malaysia, Philippines and Thailand. Quarterly data for the four countries were extracted from the International Financial Statistics (IFS) of the IMF. The variables involved in the empirical analysis of each country are defined in the appendix corresponding to this section. The data for Indonesia are from 1982:I to 1996:IV, the data for Malaysia are from 1972:I to 1996:IV, the data for the Philippines are from 1962:I to 1996:IV and the data for Thailand are from 1969:I to 1996:IV. Although the data selection is primarily based on availability, consideration of the exchange rate regimes of these countries is also a factor. During the period under consideration, while maintaining relatively open capital account, these countries operated exchange rate regimes characterized by pegs and adjustable pegs indicating relative exchange rate fixity rather than relative flexibility[51].

3.6.1 Offset and Sterilization Coefficients

Two approaches are employed to derive reserve flow equations to estimate offset coefficients for the four countries. The authorities are assumed to target domestic credit[52], and a reaction function is estimated to determine sterilization coefficients. The estimating equations are derived based on the monetary approach to the balance of payments and the portfolio approach to the balance of payments. The results are compared to determine the performance of each model. In this circumstance simultaneity in each model is possible but not inevitable. The Hausman test[53], denoted HAUS, is therefore, implemented to determine whether or not simultaneity bias is important to warrant instrumental variable (IV) estimation. However, since the Hausman test is a

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[51] After the Asian financial crisis of 1997, Indonesia, the Philippines and Thailand , with the help of (or is it a push from) the IMF, have moved toward emphasizing flexible exchange rate regimes and monetary autonomy. Malaysia, however, did not get on board with the new policy of flexible exchange rates and full liberalization of the capital account. For details see Jomo (ed) 2003.

[52] An alternative reaction function for the monetary authorities used in some studies is an interest rate equation. This option was not pursued here for two main reasons. First, a survey of the practice of monetary policy in the four countries indicates that the authorities generally targeted a broad range of monetary aggregates (one of which is domestic credit) during the sample period. Secondly, targeting the interest rate is problematic because it has a market component to its determination which the authorities cannot control.

[53] Consider the following system of equations (1) $X = \alpha_0 + \alpha_1 Y + \alpha_2 Z + \alpha_3 W + \mu$

(2) $Y = \beta_0 + \beta_1 X + \beta_2 Z + \beta_3 W + \varepsilon$

where X and Y are endogenous variables, Z and W are exogenous variables and μ and ε are error terms. Simultaneity bias in the first equation exists if Y and μ are correlated and in the second equation it exists when X and ε are correlated. To implement the Hausman test for the first equation first estimate the reduced form equation: $Y = \beta_{10} + \beta_{12} Z + \beta_{13} W + \varepsilon$ and save the fitted values from this equation as Yfit. Then estimate the equation $X = \alpha_{20} + \alpha_{21} Y + \alpha_{22} Z + \alpha_{23} W + \alpha_{24}(YFIT) + \mu_2$. The Hausman test is a standard t-test on α_{24}. If α_{24} is statistically different from zero then correlation between Y and μ is confirmed and simultaneity bias is important and IV method gives consistent estimates but not OLS. Similarly, the procedure can be repeated to test the significance of simultaneity bias in the second equation. For a detailed exposition see Hausman (1978) and Berndt (1991).

large sample test and given the small size of our sample, we also compared OLS (not reported) and IV estimation results to see if there is important difference between the two regardless of the outcome of the Hausman test. For example, if the Hausman test turns out to be not statistically significant, we still estimate both by OLS and TSLS and compare the estimates if there is important difference between them. This helps to assess the degree of simultaneity bias in the system when there is uncertainty about the test. If simultaneity is absent there should be little difference between the OLS and IV estimation results. In all of the estimations, the OLS and IV methods of estimation gave results that are substantially different from each other even when the test was not significant. In the presence of simultaneity bias, the IV estimation method generates efficient and consistent estimates of the offset and sterilization coefficients but not the OLS. Thus, the empirical results reported below are estimated using the two-stage least squares method of IV estimation technique[54]. Further, the effectiveness of sterilization intervention by the monetary authorities is assessed by estimating an interest rate equation with a sterilization variable on the RHS together with other relevant variables.

3.6.1.1 Indonesia

The estimated results of the monetary and portfolio balance models for Indonesia are presented in table 3.20. The overall fit of the monetary model is relatively good. All the estimated coefficients in this model have the expected signs. The coefficient on the

[54] The IV estimation method, however, introduces another problem: the availability and choice of instruments. It is not always clear where instrumental variables are to be extracted. In this case, the lagged values of growth rates of domestic credit and foreign assets are used as its instrument while all the other variables are instruments for themselves. This procedure assumes that bias is introduced to the offset coefficient due to sterilization during the same quarter. The fitted values of the growth rates of domestic credit and foreign assets from reduced form equations were also used as alternative instruments. They gave similar results as the lagged values.

inflation rate is, however, much less than the value predicted by theory. The estimated offset coefficient,-0.36 indicates that the capital flow offset to domestic monetary actions was partial rather than complete. During each quarter capital flows neutralized 36 percent of changes in domestic credit. This implies that, under the assumption that agents are not Recardian, there has been a potential for independent monetary policy in Indonesia during the sample period.

Table 3.20 Indonesia: Two Stage Least Squares Estimate of the Offset and Sterilization Coefficients

MABP

a) Offset Coefficient

GF =3.46-0.36GD+0.27GP+0.58GX-0.001GGP+0.21GK-0.13GI
(3.21) (-5.76) (3.53) (1.98) (-1.18) (3.68) (-8.07)
+0.51S1+0.26S2+0.04S4
(1.26) (1.54) (2.13)

$adjR^2$=0.62 SER=3.58 DW=2.21 Q(12)=4.11 HAUS=2.54

b) Sterilization Coefficient

GD=-5.01-0.15GF+0.34GP+0.09GX-0.01GGP-6.96GK-0.05GI+3.16S1+0.15S2+0.43S4
(-0.83) (-2.13) (2.49) (2.52) (-(1.33) (-1.63) (-0.61) (1.79) (1.86) (0.32)

$adjR^2$=0.54 SER=4.45 DW=1.95 Q(12)=4.91) HAUS=3.41

PBABP

c) Offset Coefficient

GF=4.06-0.70GD+0.04GX+1.65CABY-0.06GFRI+0.83GP+0.21S1+0.8S2-0.12S4
(1.18) (-2.29) (1.06) (0.96) (-1.89) (2.61) (1.03) (1.51) (-1.08)

$adjR^2$=0.37 SER=1.81 DW=1.97 Q(12)=2.17 HAUS=2.45

d) Sterilization Coefficient

GD=2.97-0.11GF+0.43GX+0.22CABY-0.03GFRI+0.79GP-3.28S1+0.61S2+0.75S4
(0.63) (-2.84) (1.57) (1.41) (-2.38) (1.87) (-0.86) (2.17) (2.31)

$adjR^2$=0.31 SER=4.55 DW=1.89 Q(12)=0.75 HAUS=3.17

Note: SER is standard error of regression, Q(12) is the Ljung-Box statistic for serial correlation of up to 12 lags and HAUS is the Hausman test for simultaneity bias.
Source: Computed from sources indicated in appendix A.31

Estimates of the reaction function show that the monetary authorities attempted to sterilize part of the inflows. The estimated sterilization coefficient is -0.15. The small value (in absolute terms) of the coefficient indicates that the authorities did not aggressively pursue sterilized intervention as a tool for attaining domestic policy objectives. They sterilized only 15 percent of the change in international reserves, despite the indicated magnitude of the offset coefficient. The rest was simply allowed to influence domestic monetary aggregates. If the authorities are concerned more about external balance than domestic objectives, they would allow a large proportion of the capital flows to affect domestic monetary conditions. Indonesian authorities seem to have placed priority over external balance during the sample period.

Estimations of the reserve flow equation and the reaction function of the monetary authorities derived from the portfolio balance model are also reported in the lower part of table 3.20. Judging by the R^2, the overall fit of the model is not satisfactory. Thus, the monetary model performs better than the portfolio balance model in explaining the link between capital flows and the conduct of monetary policy in Indonesia. This is not surprising given that Indonesia had consistently maintained the most open capital account in the group while the level of development of its capital market has been very low. It has the smallest bond market in the group. Indonesia's persistence in maintaining a balanced budget compared to the other members of the group curtailed the development of its bond market. Therefore, the low performance of the portfolio model and better performance of the monetary model in Indonesia reflect in part the low level of development of its bond market and the high degree of openness of its capital account.

3.6.1.2 Malaysia

A similar procedure was implemented for Malaysia to generate estimates of the offset and sterilization coefficients. The estimation results are reported in table 3.21. Both the monetary and portfolio balance models perform better than that of Indonesia.

Table 3.21 Malaysia: Two Stage Least Squares Estimate of the Offset and Sterilization Coefficients

<u>MABP</u>

a) Offset Coefficient

GF =-10.13-0.56GD+0.83GP+2.25GX-0.004GGP-0.17GK-0.18GI
(-0.70) (-4.26) (1.98) (2.32) (-2.26) (-1.97) (-2.66)
+2.07S1+1.48S2+4.13S4
(2.13) (1.89) (2.43)

$adjR^2$=0.51 SER=4.29 DW=1.91 Q(12)=0.59 HAUS=2.94

b) Sterilization Coefficient

GD=4.71-0.11GF+0.62GP+0.21GX-0.02GGP-0.01GK-0.03GI+1.06S1+1.82S2+0.85S4
(2.39) (-2.32) (1.27) (1.28) (-2.01) (-1.12) (-1.28) (3.15) (2.05) (2.86)

$adjR^2$=0.49 SER=3.79 DW=2.14 Q(12)=0.91) HAUS=4.67

<u>PBABP</u>

c) OffsetCoefficient

GF=0.95-0.76GD+0.67GX+0.31CABY-0.07GFRI+0.68GP+0.01S1+0.18S2-0.09S4
(1.71) (-2.87) (1.62) (2.32) (-2.71) (1.77) (1.47) (1.09) (-1.52)

$adjR^2$=0.69 SER=3.73 DW=1.99 Q(12)=0.24 HAUS=2.08

d) Sterilization Coefficient

GD=2.49-0.31GF+3.45GX+0.86CABY-0.09GFRI+0.54GP+1.69S1+2.37S2+1.78S4
(4.81) (-8.94) (3.97) (2.84) (-4.32) (1.93) (3.85) (1.98) (2.03)

$adjR^2$=0.68 SER=4.05 DW=1.98 Q(12)=1.51 HAUS=2.48

Note: SER is standard error of regression, Q(12) is the Ljung-Box statistic for serial correlation of up to 12 lags and HAUS is the Hausman test for simultaneity bias.
Source: Computed from sources indicated in appendix A.31

The first two equations are estimates of the reserve flow equation and reaction function based on the monetary model. The estimated offset coefficient for Malaysia is -0.56.

This means that a 10 percent increase in the domestic component of the monetary base triggers approximately 6 percent decrease in the foreign asset component. This indicates that Malaysian capital flows were moderately sensitive to interest rates although the fit of the model is not that encouraging. According to this model, the potential for utilizing monetary policy for attaining domestic goals existed during the sample period. The coefficients on the dummies indicate that international reserves exhibited seasonality, particularly in the first and fourth quarters.

The fit of the reaction function is similar to the fit of the reserve flow equation. According to this model the authorities sterilized only 11 percent of the change in international reserves in each quarter. This is similar to the outcome in Indonesia. The monetary authorities in Malaysia did not engage heavily in sterilization activities. They simply allowed most of the changes in the balance of payments to affect domestic monetary conditions. One interpretation of this is that the authorities may have been concerned more with external balance than internal balance over the sample period. The seasonal dummies in the reaction function are statistically significant which implies that variations in the domestic credit were motivated by monetary stability rather than other goals of internal balance. It is however, important to note that given the low fit of the model the above interpretations should be treated with extreme caution, especially when quantification is involved.

Looking at the estimates of the portfolio balance model for Malaysia (the lower part of table 3.21) we find that the portfolio balance model has overall fit of 0.69, which is relatively better than the fit of the monetary model. The estimates of this model indicate that international reserves are interest sensitive. For example, if the authorities increase domestic credit by 10 percent, the resulting downward pressure on the domestic interest rate triggers capital outflows which in turn lead to a fall in international reserves by about 7 percent. Accordingly, during each quarter approximately 70 percent of changes in the domestic money supply (engineered by the monetary authorities) were nullified by an offsetting movement in capital flows.

Estimates of the reaction function of the monetary authorities indicate that the sterilization coefficient has the expected sign and is statistically significant. The sterilization coefficient, -0.31 is still relatively low (in absolute value), indicating that sterilization policy was mildly used by the authorities in Malaysia.

During each quarter, approximately 30 percent of the changes in international reserves were sterilized. Again, given the high interest-interest sensitivity of Malaysian capital flows as indicated by the offset coefficient, the authorities' reluctance to pursue sterilization aggressively is consistent with the trade off between capital account openness and monetary control when the exchange rate is not flexible.

Compared to the monetary model, the portfolio balance model performs better in fitting the Malaysian data. The reason for this marked difference in performance reflects, among other things, the condition in the capital market of Malaysia. The country has maintained relatively open capital account starting in the early 70s. In terms of bond market development, Malaysia stands out in the group. In fact, Malaysia has the second largest bond markets in the region, after Singapore. It has the required infrastructure and regulatory system and has worked well.

3.6.1.3 The Philippines

Both monetary and portfolio balance models were also estimated for the Philippines. The results are reported in table 3.22. The performance of the monetary model is relatively weak. In any case the estimated reserve flow equation shows that international reserves are highly sensitive to changes in domestic credit. The offset coefficient, -0.71, indicates that during each quarter, capital flows neutralized approximately 70 percent of the changes in domestic credit.

Estimates of the reaction function of the monetary authorities are also presented in table 3.22. The sterilization coefficient, -0.43, indicates that during each quarter the authorities sterilized approximately 40 percent of the growth in international reserves. Attempts by the authorities to maintain control over monetary policy were substantial during the specified period. This figure is much higher than those of Indonesia and Malaysia. The seasonal dummies indicate that capital flows did not exhibit seasonality in their movements.

Table 3.22 Philippines: Two Stage Least Squares Estimate of the Offset and Sterilization Coefficients

MABP

a) Offset Coefficient

GF =-3.85-0.71GD+0.46GP+0.87GX-0.003GGP-0.001GK-0.11GI
(1.49) (-2.58) (1.19) (3.53) (-1.52) (-1.81) (-1.76)
-0.81S1+2.12S2+0.36S4
(1.16) (1.03) (1.36)
adjR^2=0.41 SER=6.74 DW=1.87 Q(12)=5.01) HAUS=2.09

b) Sterilization Coefficient

GD=5.91-0.43GF+0.21GP+1.11GX-0.003GGP-0.04GK-0.15GI+0.63S1-0.81S2-0.93S4
2.67) (-2.07) (1.75) (1.61) (-1.61) (-1.80) (-3.23) (1.69) (-1.09) (-0.91)

adjR^2=0.32 SER=9.53 DW=1.79 Q(12)=4.53 HAUS=1.48

PBABP

c) Offset Coefficient

GF=0.09-0.62GD+0.005GX+3.92CABY-0.20GFRI+0.94GP+1.42S1-1.68S2-2.01S4
(1.12) (-3.86) (2.61) (4.31) (-2.17) (2.63) (1.13) (1.25) (-1.63)
adjR^2=0.74 SER=0.85 DW=2.15 Q(12)=3.27 HAUS=4.08

d) Sterilization Coefficient

GD=0.13-0.52GF+0.0002GX+0.63CABY-0.07GFRI+0.73GP+0.001S1-0.17S2+0.39S4
(0.71) (-2.64) (1.56) (2.24) (-3.32) (1.88) (0.59) (-1.58) (1.61)
adjR^2=0.75 SER=0.23 DW=1.87 Q(12)=2.09 HAUS=2.08

Note: SER is standard error of regression, Q(12) is the Ljung-Box statistic for serial correlation of up to 12 lags and HAUS is the Hausman test for simultaneity bias.
Source: Computed from sources indicated in appendix A.31

The portfolio model estimate of the reserve flow equation and the reaction function of the monetary authorities are reported in the lower part of the table. The performance of the model in terms of overall fit is also relatively good. The offset coefficient, -0.62, is smaller in absolute value than that obtained from the monetary model and indicates that in each quarter changes in international reserves approximately neutralized 60 percent of the growth in domestic credit. This meant that the potential for independent monetary policy existed and that the authorities may have used it extensively as indicated by the sterilization coefficient.

Looking at the estimation results of the reaction function, we find that the sterilization coefficient for the Philippines is relatively large (in absolute value). The results indicate that the authorities in the Philippines sterilized approximately 50 percent of the growth in international reserves. All the seasonal dummies in the reaction functions of both the monetary and portfolio balance models are not statistically significant, indicating that the authorities were less concerned with seasonal fluctuations that may have been inimical to monetary stability. Indeed, the historical record shows that during the period under consideration, the priority of the central bank of the Philippines was more in the direction of development financing rather than monetary stability.

3.6.1.4 Thailand

The estimated results of the monetary and portfolio balance models are reported in table 3.23. Looking at the overall performance we find that both models fit the data well. The offset and sterilization coefficients of the monetary model are -0.91 and -0.63, respectively. The offset coefficient is large in absolute value, indicating the limited power of Thai authorities to control the domestic money supply. Despite the restriction imposed by capital mobility, the monetary authorities sterilized about 60 percent of capital flows.

The portfolio balance model estimates are reported in the lower part of the table. The offset coefficient, -0.69, implies that capital inflows neutralized approximately 70 percent of the growth in domestic credit.

Table 3.23 Thailand: Two Stage Least Squares Estimate of the Offset and Sterilization Coefficients

MABP

a) Offset Coefficient

GF =0.22-0.91GD+0.83GP+0.03GX-0.0001GGP-0.002GK-0.56GI
(0.97) (-2.81) (2.19) (2.94) (-1.92) (-1.87) (-3.53)
+0.35S1+0.57S2+1.01S4
(1.68) (1.34) (1.21)

adjR^2=0.82 SER=0.74 DW=2.19 Q(4)=1.21) HAUS=1.95

b) Sterilization Coefficient

GD=0.12-0.63GF+0.62GP+0.02GX-0.0002GGP-0.002GK-0.31GI+0.11S1+1.07S2-0.46S4
(1.84) (-2.26) (3.05) (2.43) (-1.22) (-1.87) (-2.72) (1.68) (1.28) (-1.39)

adjR^2=0.75 SER=0.63 DW=2.15 Q(4)=1.33 HAUS=1.48

PBABP

c) Offset Coefficient

GF=-3.61-0.69GD+3.88GX+0.92CABY-0.17GFRI+0.91GP-0.31S1-0.83S2+0.79S4
(-1.70) (-2.92) (2.20) (3.56) (-3.43) (3.12) (-2.61) (-2.54) (3.45)

adjR^2=0.73 SER=0.67 DW=2.05 Q(12)=2.13 HAUS=3.52

d) Sterilization Coefficient

GD=2.47-0.81GF+0.36GX+1.13CABY-0.03GFRI-0.57GP+2.431S1+3.59S2-2.85S4
(2.81) (-2.25) (2.56) (2.46) -3.72) (-1.88) (2.18) (2.62) (-3.61)

adjR^2=0.54 SER=2.79 DW=1.94 Q(12)=1.39 HAUS=3.18

Note: SER is standard error of regression, Q(12) is the Ljung-Box statistic for serial correlation of up to 12 lags and HAUS is the Hausman test for simultaneity bias.
Source: Computed from sources indicated in appendix A.31

Estimates of the reaction function of the monetary authorities show that the Thai authorities were heavily engaged in sterilized intervention during the sample period. According to this model the authorities in Thailand sterilized about 80 percent of the growth in international reserves. Despite the relatively fast mobility of Thai capital flows, as indicated by the offset coefficient, the monetary authorities consistently attempted to control the domestic money supply.

The statistical significance of the seasonal dummies in the reserve flow equation indicates that the movement of international reserves exhibited seasonality during the sample period. For example, foreign reserves tended to fall in the first and second quarters while they rose in the fourth quarter. The seasonal dummies in the reaction function of the portfolio balance model are also statistically significant. This implies that a lot of the variation in monetary policy instruments was motivated by the defense of monetary stability rather than the active pursuit of other policy goals.

3.6.2 Assessing the Effectiveness of Sterilization Policy

As the reaction functions demonstrate, each country engaged in sterilizing intervention during the period under consideration. The sterilization coefficients for each country (whether from the monetary or portfolio balance models) were statistically significant and indicated the extent to which movements in foreign reserves were prevented from affecting the domestic money supply in each country. For example, while Indonesia and Malaysia showed less interest in sterilization, Philippines and Thailand aggressively pursued sterilization policy. The natural question that follows this is whether sterilization was effective in bringing about the desired change in the domestic money supply and the interest rate.

In order to evaluate the effectiveness of sterilization, we estimated the interest rate equation (31) for each country with a sterilization variable on the right hand side (the non-interest sensitive component of foreign reserves) to test whether or not sterilizing intervention was effective in affecting domestic monetary conditions. The results are reported in table 3.24.

Looking at the results for Indonesia, although the fit of the model is not satisfactory we find that the domestic interest rate responds to the foreign interest rate, the logarithm of real income and the one period lag of itself. The coefficient of the sterilization variable is 0.0001. It has the expected sign but it is not statistically significant. The implication is that sterilization in Indonesia did not help the authorities to influence domestic economic variables such as the interest rate. However, given the poor performance of the model in terms of overall fit, this interpretation should be treated with caution.

The estimates of the interest rate equation for Malaysia (table 3.24) indicate that the model fits the data well. The domestic interest rate is responsive to changes in the foreign interest rate, the logarithm of domestic real income, the inflation rate and its one period lag. The estimated coefficient of the sterilization variable, 0.002, has the expected sign but it is not statistically different from zero. The evidence derived from the estimated interest rate model seems to confirm that the small sterilization attempts by Malaysian authorities to influence domestic variables such as the interest rate remained unsuccessful.

Table 3.24: OLS Estimates of the Interest Rate Equation

Indonesia:

DI =5.19+0.51FI+0.10LRY-0.37LBR(-1)+0.04GP+0.31DI(-1)+0.0001BT
(-2.57) (2.96) (2.42) (1.51) (1.16) (2.46) (1.82)

adjR^2=0.42 SER=2.88 DW=2.01 Q(4)=1.67

Malaysia:

DI =-4.01+0.11FI+1.67LRY-0.16LBR(-1)-0.21GP+0.93DI(-1)+0.002BT
(-2.57) (2.96) (2.42) (0.75) (-2.84) (4.28) (1.15)

adjR^2=0.87 SER=0.50 DW=1.77 Q(4)=3.92

Philippines:

DI =30.28+0.004FI+1.09LRY-0.36LBR(-1)+0.03GP+0.82DI(-1)+0.0003BT
(0.67) (2.06) (2.47) (-2.27) (1.78) (5.43) (1.35)

adjR^2=0.83 SER=1.29 DW=2.18 Q(4)=1.39

Thailand:

DI =29.28+0.02FI+1.11LRY-0.79LBR(-1)+0.07GP+0.91DI(-1)+0.001BT
(1.17) (1.93) (2.14) (-2.34) (2.84) (4.56) (2.62)

adjR^2=0.88 SER=1.22 DW=1.87 Q(4)=1.76

Source: Computed from sources indicated in appendix A.31

Estimates of the interest rate equation for the Philippines show that the model fits the data relatively well. The sterilization coefficient 0.0003 is not statistically different from zero. This indicates that although the authorities engaged heavily in sterilized intervention, their efforts were largely ineffective in influencing the domestic monetary variables.

Proceeding to the assessment of the effectiveness of sterilization policy in Thailand, we find that the model fits the data quite well. Moreover, all the variables are correctly signed and with the exception of the foreign interest rate, all are statistically significant. The coefficient of the sterilization variable, 0.001, indicates that sterilization policy in Thailand was effective in influencing domestic monetary conditions over the period under study.

3.7 Conclusion

The investigation concerning offsetting capital flows and sterilization policy in the four Asian countries provides empirical results with clear implications for the conduct of monetary policy under fixed exchange rates and capital mobility. The monetary model and portfolio balance model were used to empirically estimate offset and sterilization coefficients. When comparing the performance of the two models, a stark contrast was observed between Indonesia and Malaysia. Indonesia has had an open capital account but its bond market is almost non-existent. Malaysia, on the other hand, has a well developed bond market. The monetary model performed better in the former but the portfolio balance model was superior in the latter. A very sharp contrast also emerged in the case of the Philippines. Although, it suffered administrative inefficiencies and corruption later, the Philippines had started with a well structured financial system in the early 1970s. The relative performance of the portfolio model reflects this aspect of its financial system. In the case of Thailand both models turned out to be competitive in their performance. Both models did relatively well in fitting the data. Not much can be said about this result other than perhaps treating the Thai financial system as an intermediate case. This result may suggest that the Thai bond market exhibits strong substitutability between domestic and foreign assets so that the two models become indistinguishable.

Going back to the estimated results, we find that none of the estimated offset coefficients from the monetary model satisfy the prediction of the model. The model assumes perfect substitutability of domestic and foreign assets and predicts the offset coefficient to be -1. However, the estimated values of the offset coefficients for the four countries turned out to be greater than minus one. This outcome may be attributed to instability in the demand for money and/or lags in portfolio adjustments by households. The results from the portfolio balance model are, however, consistent with the predictions of the model. The model assumes limited substitutability and predicts that the offset coefficient lies in the interval (-1 0). As expected all the estimated offset coefficients from this model fall within this interval. The magnitudes of the offset coefficients indicate that capital inflows had strong offsetting effect on domestic monetary policy which to some degree implies moderately high integration of domestic and world financial markets. For example, in Thailand about 70% of the change in domestic credit was offset by a change in international reserves. This implies that Thai authorities had limited potential for conducting independent monetary policy during the period under study. Similarly, the results for the other countries indicate that capital inflows posed relatively formidable difficulties for conducting independent monetary policy.

Despite the limited availability of monetary policy to pursue domestic objectives, the authorities in each country pursued sterilization policy. However, there appear to be differences in the degree of sterilization activities among the four countries. The estimates of the assumed reaction functions indicate that the monetary authorities may have had different preferences when it comes to a choice between external balance and domestic objectives. Indonesia and Malaysia showed more interest in external balance by their very mild engagement in sterilizing intervention. Moreover, they might have been cognizant of the difficulty posed by capital flows. On the other hand, Thailand and the Philippines seemed to have placed priority on domestic policy goals at the expense of external balance and appeared to be reluctant to consider the strong sensitivity of their capital accounts to changes in domestic credit. The estimated sterilization coefficients indicate that both countries sterilized a substantial proportion of their inflows. Thus, they were willing to accept fluctuations in their international reserves in order to pursue short term domestic goals.

An empirical assessment of the effectiveness of sterilization policy in each country was carried out by estimating an interest rate model that captures the attributes of a small open economy. The variable used to evaluate the degree to which the monetary authorities succeeded in affecting domestic variables was the trade balance. This part of the current account is insensitive to interest rate changes and can be treated as exogenous to the interest rate. If the monetary authorities increase foreign reserves through sterilization (the domestic consequence of which is a fall in domestic assets) and the resulting rise in the non-interest sensitive component of foreign reserves has a significant positive influence on the domestic interest rate then sterilization is effective, otherwise it is not. Estimates of the interest rate equation indicated that sterilization policy was successful only in Thailand. The monetary authorities were able to prevent transactions in the external sector from affecting domestic credit during the sample period. Although the sterilization coefficients were statistically significant in all the remaining three countries, the coefficient of the sterilization variable was not statistically different from zero. Hence, the monetary authorities in the remaining three countries did not succeed in insulating domestic monetary conditions from the effects of transactions in the balance of payments.

The empirical exercise in this section suggests that countries with open capital accounts and fixed exchange rates may potentially have some degree of control over their money supply as long as capital flow offset is less than complete. However, the degree to which the authorities can conduct independent monetary policy depends on the sensitivity of the capital account to changes in domestic monetary conditions, summarized by the offset coefficient. Our estimated results show that all the four countries had only small windows for monetary autonomy. The policy implication is that these countries and other developing countries that are in similar situations should be cautious in utilizing monetary policy for domestic goals even in the short run. The implication for sterilization policy is even stronger. Clearly, sterilized intervention failed to achieve its intended objective in three of the four countries. Thus, more caution should be exercised in the choice of sterilization as was the case in Indonesia and Malaysia. In the case of the Philippines, the authorities should have reduced their sterilization activities given the high mobility of foreign capital. Although the empirical test shows that sterilization was successful in Thailand that might have come at the expense of destabilizing its external balance.

Conclusion

This study examined the role of foreign capital in three areas of the macro economies of selected Asian countries. The first chapter developed a linear endogenous growth model which proposed that permanent changes to foreign capital flows would bring about permanent changes to per capita income growth. It is shown that in the case of Indonesia, the data do not support the endogenous growth hypothesis. Further examination of the Indonesian data using stationary VAR analysis and Ganger causality tests shows that causation runs from foreign investment, long term debt capital, public capital and trade openness to per capita income growth. While debt capital negatively affected growth, all the other variables had positive effects on growth.

In the case of Malaysia, Philippines and Thailand we find that the results favor the new growth theory. The empirical evidence suggests that foreign aid, foreign investment, public capital, and openness to trade contributed to long term per capita income growth in Malaysia and Philippines. In Thailand, while foreign aid, foreign investment and trade had positive effects, long term debt capital had significant negative effects on long term per capita income growth. In Malaysia and Philippines, the effect of long term debt capital turned out to be statistically not different from zero. Estimates of error-correction models for the three countries indicate that dynamic adjustments in response to divergences from long run behavior took place in all three countries. This is clearly corroborated by the statistically significant coefficients of the cointegrating error terms.

The data for Malaysia, Philippines and Thailand were further examined by applying pooled regression. Country specific effects turned out to be important in the preliminary tests so that the estimation was thus carried out with individual constant terms. We find that per capita income growth responds positively to foreign investment, public capital and trade and negatively to long term debt capital. The overall implication of the empirical results is that governments in developing countries should focus on building infrastructure, attracting foreign investment and liberalizing trade to promote growth. On the other hand, caution needs to be exercised with regard to long term borrowing from abroad and the resulting build-up of external debt.

With regard to the implications for the financial crises of 1997-98, in Malaysia and Philippines growth responded positively to foreign investment and trade openness while the effect on growth of long term debt capital was not statistically different from zero. In the case of Indonesia and Thailand, the build-up of foreign debt had unfavorable effects on growth. Although the empirical analyses show that long term debt is at best growth neutral and at worst growth-depressing, it is not clear that these countries were destined for crises as far as their overall growth performance is concerned.

In the second chapter we derived two real exchange rate equations from a three-good model: the internal real exchange rate for exports and the internal real exchange rate for imports. With the help of export supply and import demand functions, the real exchange rate fundamentals were identified as capital inflows, productivity, terms of trade and openness to trade. By exploiting the time series properties of the variables involved, we find that the changes in the actual export and import real exchange rates were equilibrium responses to movements in the fundamentals. The real exchange rate performance as represented by both export and import real exchange rates was consistent with long run equilibrium. In line with the prediction of the theory, the gap between the actual and the equilibrium real exchange rates generated forces that eliminated it. Our results confirm the existence of such a self-correcting mechanism for each of the four countries. The implication of these results is that there was no evidence of a continuous decline in the competitiveness of traded goods in the domestic economy as shown by the behavior of the internal real exchange rate for exports. Similarly, the behavior of the internal real exchange rates for imports indicates that there was also no evidence of deterioration of competitiveness of traded goods in international markets for each of the four countries. Thus, the data for each of the four countries in our sample do not support real exchange rate misalignment over the period prior to the financial crises of 1997-98.

In the third and final chapter we consider the scope for domestic monetary policy autonomy and the extent to which authorities in the ASEAN-4 exercised control over their money supply in the face of substantial capital flows and relatively fixed exchange rates. The analysis shows that the countries in our sample had some limited degree of monetary policy autonomy over the period under consideration. In each case, the absolute value of the offset coefficient was less than one, indicating the potential for monetary autonomy. However, the magnitude of the estimated offset coefficients show that the capital accounts of these countries were strongly sensitive to changes in domestic monetary conditions which in effect constrained monetary policy autonomy.

In view of the less than perfect capital flow offset, we estimated reaction functions for the monetary authorities to determine sterilization coefficients corresponding to each country. We find that Indonesia and Malaysia had relatively small sterilization coefficients. The limited sterilization activities in these countries might be indicators of preference on the part of the authorities to maintain external balance as opposed to internal balance. Alternatively, Indonesia and Malaysia may have recognized the limits set by capital mobility on domestic monetary policy. On the contrary, Thailand and Philippines seem to have placed more emphasis on domestic policy goals, as demonstrated by the high proportion of inflows sterilized in these two countries. In assessing the effectiveness of sterilization policy, we find that the sterilization variable enters significantly only in the Thai interest rate equation. This indicates that only Thailand was able to affect domestic target variables through sterilization policy. In the other three countries, sterilization policy, whether mild or strong, was largely ineffective. The overall implication of the study is that the offset coefficients indicate that the potential for domestic monetary autonomy did exist in all the four countries primarily due to imperfect substitutability between domestic and foreign assets. Sterilizing interventions were partial in Indonesia and Malaysia and were not extensively employed to induce serious macroeconomic imbalances reminiscent of the Asian financial crises.

However, in the Philippines and Thailand, heavy sterilization activities might have exacerbated the situation in their external balances.

Overall, our empirical findings demonstrate that foreign investment and aid contributed significantly to the rise in living standards in Southeast Asia. Growth also responded to openness and public infrastructure. The results for long term debt, however, were not encouraging. With regard to the real exchange rate, the data for each country did not support misalignment. It was also shown that the capital flow offset was significant but less than complete indicating limited availability of domestic monetary policy. The authorities in all the four countries engaged in sterilization activities with different degrees of emphasis on internal and external balances. However, sterilization turned out to be effective only in Thailand.

Appendix C.31

Definitions of Variables and Data Sources

All the data are from the International Financial Statistics (IFS) of the International Monetary Fund (IMF).

In estimations for all four countries, seasonal dummies have been included. Accordingly, in the tables of estimated results in the text, S_j stands for a seasonal dummy which takes the value 1 during the j^{th} quarter and 0 otherwise.

Indonesia

Variables in the Monetary Model

GF: The growth rate foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GP: The inflation rate based on the consumer price index

GX: The growth of trend industrial output extrapolated from annual data.

GGP: The growth rate of the inflation rate.

GK: The growth rate of broad money multiplier

GI: The growth rate of the domestic deposit rate

Variables in the Portfolio Balance Model

GF: The growth rate foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GX: Growth rate of trend real industrial out put extrapolated from annual data.

CABY: The ratio of current account balance to nominal GDP extrapolated from annual data

GUSRR: The growth rate of real US three-month treasury bill rate calculated as the difference between the nominal treasury bill rate and the US inflation rate.

GP: The inflation rate based on the consumer price index

Variables in the Interest Rate Model

DI: The domestic money market rate.

FI: US three-month treasury bill rate

LRY: The logarithm of real GDP

LBR(-1): The logarithm of lagged bank reserves

GP: The inflation rate

DI(-1): One period lag of the domestic money market rate.

BT: Trade Balance

Malaysia

Variables in the Monetary Model

GF: The growth rate net foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GP: The inflation rate based on the consumer price index

GX: The growth of trend industrial output extrapolated from annual data.

GGP: The growth rate of the inflation rate.

GK: The growth rate of broad money multiplier

GI: The growth rate of the domestic bank deposit rate

Variables in the Portfolio Balance Model

GF: The growth rate net foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GX: Growth rate of trend real industrial out put extrapolated from annual data.

CABY: The ratio the current account balance to nominal GDP extrapolated from annual data

GUSRR: The growth rate of real US three-month treasury bill rate calculated as the difference between the nominal treasury bill rate and the US inflation rate.

GP: The inflation rate based on the consumer price index

Variables in the Interest Rate Model

DI: The domestic bank deposit rate.

FI: US three-month treasury bill rate

LRY: The logarithm of real GDP

LBR(-1): The logarithm of lagged bank reserves

GP: The inflation rate

DI(-1): One period lag of the domestic bank deposit rate.

BT: Trade balance

The Philippines

Variables in the Monetary Model

GF: The growth rate net foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GP: The inflation rate based on the consumer price index

GX: The growth of trend industrial output extrapolated from annual data.

GGP: The growth rate of the inflation rate.

GK: The growth rate of broad money multiplier.

GI: The growth rate of the discount rate.

Variables in the Portfolio Balance Model

GF: The growth rate net foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GX: Growth rate of trend real industrial out put extrapolated from annual data.

CABY: The ratio the current account balance to nominal GDP extrapolated from annual data

GUSRR: The growth rate of real US three-month treasury bill rate calculated as the difference between the nominal treasury bill rate and the US inflation rate.

GP: The inflation rate based on the consumer price index

Variables in the Interest Rate Model

DI: The discount rate.

FI: US three-month treasury bill rate

LRY: The logarithm of real GDP

LBR(-1): The logarithm of lagged bank reserves

GP: The inflation rate

DI(-1): One period lag of the discount rate rate.

BT: Trade balance

Thailand

Variables in the Monetary Model

GF: The growth rate foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of domestic credit (IFS line 32) weighted by its share in the monetary base.

GP: The inflation rate based on the consumer price index

GX: The growth of trend industrial output extrapolated from annual data.

GGP: The growth rate of the inflation rate.

GK: The growth rate of broad money multiplier.

GI: The growth rate of the discount rate.

Variables in the Portfolio Balance Model

GF: The growth rate foreign assets (IFS line 31n) weighted by its share in the monetary base.

GD: The growth rate of net domestic credit (IFS line 32) weighted by its share in the monetary base.

GX: Growth rate of trend real industrial out put extrapolated from annual data.

CABY: The ratio the current account balance to nominal GDP extrapolated from annual data

GUSRR: The growth rate of real US three-month treasury bill rate calculated as the difference between the nominal treasury bill rate and the US inflation rate.

GP: The inflation rate based on the consumer price index

Variables in the Interest Rate Model

DI: The discount rate.

FI: US three-month treasury bill rate

LRY: The logarithm of real GDP

LBR(-1): The logarithm of lagged bank reserves

GP: The inflation rate

DI(-1): One period lag of the discount rate rate.

BT: Trade balance

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