Essays in Open Economy Macroeconomics

by

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Abstract

This thesis addresses three issues in international macroeconomics. Chapter 2 provides an empirical investigation of both the short- and long-term determinants of current accounts for eight largest emerging Asian economies. The analysis is carried out within a cointegrated VAR framework. In this chapter, I show that current account behaviours in emerging Asian economies are heterogeneous. Initial stock of net foreign assets and degree of openness to international trade are important factors in explaining the long-run behaviour of current accounts. Moreover, the current accounts of all sample economies have a self-adjusting mechanism except China. Short-run current account adjustment towards long-run equilibrium path is gradual, with the disequilibrium term being the main determinant of the short-run current account variations. Chapter 3 analyzes current account sustainability for each of the sample economies included in chapter 2 in the context of the intertemporal budget constraint approach. Both strong and weak form tests of current account sustainability are performed in the study. Based on more generalized sustainability conditions, all the sample economies are found to be on a sustainable current account path. In addition, I find that accounting for endogenously identified structural breaks increases the instances of cointegration between an economy's exports and imports, which are more in favour of current account sustainability. Chapter 4 uses a three-country general equilibrium model to investigate the importance of consumption bias in generating equity portfolio bias. I find that the optimal holdings of non-traded goods equities are only affected by the separability between traded and non-traded goods, while the optimal holdings of traded goods equities are determined by the household's preferences over domestic and foreign traded goods. In addition, the calibration results suggest that, within a three-country framework, the optimal holdings of the two foreign traded goods equities depend on the amount of the domestic traded goods each foreign country consumes. The sensitivity analysis suggests that the results of the three-country model are very robust in the presence of plausible and large variation in the parameters values.

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Dedication

To my mom and dad

Chapter 1

Introduction

This thesis is divided into two parts. The first part of the thesis consists of two chapters and focuses on the empirical analysis of the determinants and the sustainability of current account positions in eight largest emerging Asian economies. The second part of the thesis contains a single chapter and provides a theoretical investigation of the linkages between equity home bias and consumption home bias. Both parts are implicitly linked through international trade.

The first essay is divided into two chapters, namely chapter 2 and chapter 3. Chapter 2 provides a purely empirically investigation of both the short- and long-term determinants of current accounts in eight largest emerging Asian economies. This particular study is motivated by the following reasons. Due to the existence of large and persistent global current account imbalances in the last two decades, economists and policymakers have paid more attention to the issue of current account. Understanding the elements that influence the current account balance in both short-run and long-run can have important policy implications. Moreover, existing theoretical models in the literature offer different predictions about the elements determining the current account balance and the sign and magnitude of the relationships between the current account fluctuations and its determinants. Therefore, undertaking an empirical analysis could help discriminate among competing theories. Although there has been a growing body of empirical literature on the behaviour of current account balances in emerging Asia, most of the studies have been carried out in a multi-country framework and ignore the heterogeneous current account behaviour in individual emerging Asian economy. However, findings from these studies could be biased and limited since these studies could only provide a generalized picture for emerging Asia and explain the 'average' behaviour of current accounts in the emerging Asian economies.

Therefore, in chapter 2, I try to go beyond these generalizations by adopting a cointegrated autoregressive (VAR) approach and empirically investigating the factors that may influence the behaviour of current account for each of the selected emerging Asian economies and assess their dynamics over time. In particular, I investigate the role of initial stock of net foreign assets, degree of openness to international trade, real effective exchange rate and domestic relative income in explaining both the short- and long-run behaviours of the current account in each sample economy.

The first part of the thesis continues in chapter 3 where I empirically examine the form of current account sustainability that each sample economy had over the period 1990-2009. The motivations of this study are as follows. The sustainability of a country's current account position is one of the most discussed topics in the field of open macroeconomics in recent times due to the existence of large and persistent current account imbalances in the world economy. Researchers claim that persistent current account imbalances can have serious impacts on domestic economy due to the undesirable consequences of a sharp forced adjustment by the private and public sector if such tendencies are expected to continue. For example, persistent current account deficits may lead to an increase in domestic interest rates in order to attract foreign capital. Moreover, the corresponding accumulated external debts due to persistent deficits also imply an increase in interest payments which can impose an excess burden on future generations. Since most of the selected emerging Asian economies have large and persistent current account imbalances, therefore, testing for the sustainability of the current account in these economies is important.

Chapter 3 analyzes current account sustainability in the context of the intertemporal budget constraint approach for each selected sample economy. Unlike the previous studies in the literature which had a focus on examining the strong form of current account sustainability which requires a cointegration between an economy's exports and imports and also a unity slope parameter between the two variables, I perform both strong and weak form tests of current account sustainability in this chapter. Moreover, while the previous studies in the literature normally consider one or two structural breaks in their cointegration analysis of current account sustainability, the issue of multiple structural breaks is addressed in my study. In particular, the multiple structural breaks are endogenously identified in this chapter.

In the second part of the thesis, chapter 4 provides a theoretical investigation of the linkages between equity home bias and consumption home bias. This study is motivated due to the following reasons. Although the debate on the impact of consumption home bias, which is due to the existence of the non-traded goods, on portfolio home bias has already lasted for a long time in the international economics literature and the literature on this topic is fairly extensive, researchers still hold different opinions on the importance of non-traded goods for portfolio home bias and no clear consensus has been made so far. Most previous studies are suffered from one potential problem, which is that the degree of equity home bias that can be attributed to the presence of non-traded goods is very sensitive to assumptions about the key parameters in the models. However, Collard *et al.* (2008) has recently developed a two-country general equilibrium model, which allows for differentiated home and foreign traded goods and non-separable utility function. Their study confirms the role of consumption home bias in explaining the home bias in equity portfolios. More importantly, they claim that, unlike other previous studies, their results are robust in the presence of plausible and large variation in the key parameters values of the model. Although the findings in the Collard *et al.*'s (2008) paper is encouraging, especially they claim that their results are invariant to the changes in their model's key parameters, their model only considers two symmetric countries. It would be interesting to extend their model into a three-country model and also introduce some asymmetries into the model to see the robustness of their model results.

Therefore, in chapter 4, I use a three-country general equilibrium model, which is developed based on the two-country framework proposed by Collard *et al.* (2008), to investigate the role of consumption bias in generating equity portfolio bias. The analysis is firstly carried out in a three-country baseline model where households across the three countries have symmetric preferences in their consumptions of traded goods. Next, I extend the baseline model by simply assuming asymmetric household's preferences over domestic and foreign traded goods across the three countries. The contribution of this study is twofold. The primary contribution is a robustness check of Collard *et al.*'s (2008) findings in a three-country model. The secondary contribution is a new insight about international equity portfolio holdings with non-traded goods in a model with asymmetric household's preferences towards traded goods that produced by different countries. In addition, the three-country model tends to capture a more generalised picture for the world portfolio holdings in steady state. Although the model does not incorporate other important features such as production function, sticky prices and incomplete financial markets, it does provide some important implications of non-traded goods for portfolio home bias and serve as a stepping stone to more sophisticated models.

The remainder of this thesis is organised as follows. Chapter 2 contains a complete analysis on both the short- and long-term determinants of current account for eight largest emerging Asian economies. Chapter 3 examines the form of current account sustainability each sample economy had in the past two decades. Chapter 4 investigates the importance of consumption bias in generating equity portfolio bias in a three-country model developed on the basis of Collard *et al.*'s (2008) two-country model. Chapter 5 presents the conclusion.

Chapter 2

An Empirical Analysis of Current Account Determinants in Emerging Asian Economies

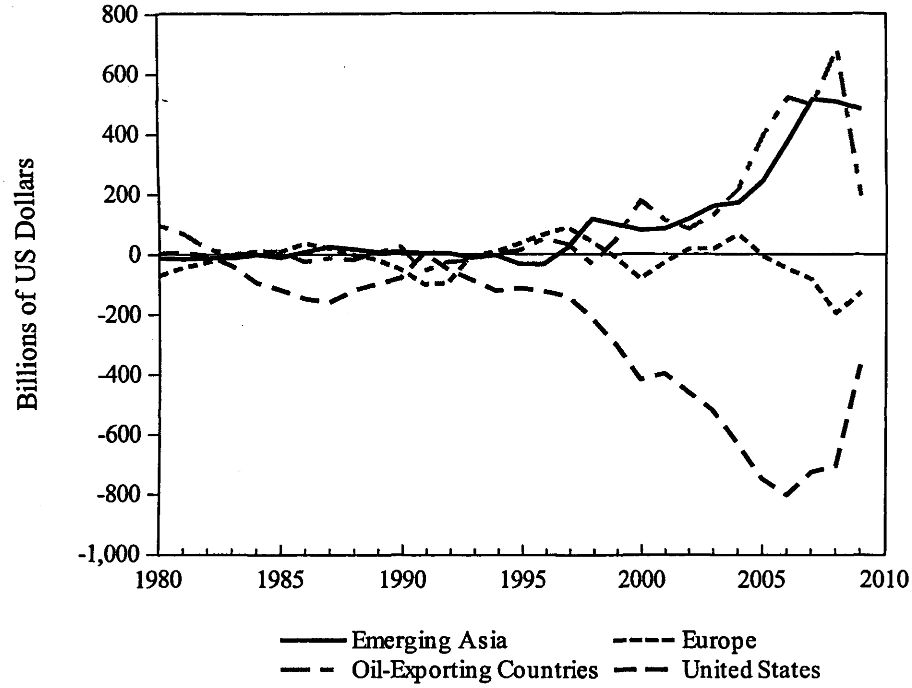
2.1 Introduction

Due to the existence of large and persistent global current account imbalances in the last two decades, economists and policymakers have paid more attention to the issue of current account. Determinants of current account balances are of considerable interest in open economy macroeconomics. The behaviour of the current account balance contains important information about an economy's economy performance, and also provides valuable macroeconomic policy recommendations. There are several theoretical models existing in the literature that try to explain the behaviour of the current account balance. Each of them gives different predictions about the elements determining the current account balance and the sign and magnitude of the relationships between the current account fluctuations and its determinants. Therefore, undertaking an empirical analysis could help discriminate among competing theories. Understanding the elements that influence the current account balance in both short-run and long-run can have important policy implications.

As shown in figure 2.1 on the next page, before the 1997 Asian financial crisis, the current account balances of emerging Asia[1], Europe[2] and Oil-exporting countries[3] were very close to

[1] Emerging Asia includes China, Hong Kong, India, Indonesia, Korea, Malaysia, Philippines, Singapore, Thailand, Taiwan and Vietnam.
[2] Europe contains the 27 member states in the European Union in 2009.
[3] Oil-exporting countries are Algeria; Angola; Azerbaijan; Bahrain; Congo; Ecuador; Equatorial Guinea; Gabon; Iran; Kazakhstan; Kuwait; Libya; Nigeria; Norway; Oman; Qatar; Saudi Arabia; Syrian Arab Republic;

Figure 2.1: Global Current Account Balances



Data Source: International Monetary Fund (IMF), World Economic Outlook Database, October 2009.
Note: 2009 data are IMF estimates.

zero. Although United States (US) kept running a current account deficit during that period, the size of the deficits was relatively small. However, the US current account deficit started to widen sharply as import growth surged right after the Asian crisis. Meanwhile, emerging Asia and oil-exporting countries started to run large current account surpluses. This phenomenon has been known as 'global imbalances' in the recent years. From figure 2.1, it is clear that the global imbalances have narrowed considerably in 2009 according to the IMF estimates. IMF predicts that the large US current account deficit would be reduced by nearly a half in 2009 due to the sub-prime mortgage crisis, which was triggered by a dramatic rise in mortgage delinquencies and foreclosures in 2008 in the US. On the other hand, due to a dramatic decrease in the value of oil revenues, the current account surpluses would diminish sharply for the oil-exporting countries in 2009. However, the IMF estimates predict only a small fall in the current account surplus of emerging Asia. Therefore, by the end of 2009, the remaining large current account surplus of emerging Asia would become the main counterpart to the current account deficits of US and Europe. After looking at the world picture of the global current account imbalances, it is clear that emerging Asia a whole has been an important and

Turkmenistan; United Arab Emirates; Venezuela and Yemen.

growing contributor to the recent global imbalances. Therefore, the analysis in this chapter has a special focus on the emerging Asia economies.

Although there has been a growing body of empirical literature on the behaviour of current account balances in emerging Asia, most of the studies have been carried out in a multi-country framework[4]. To be more specific, the methodological approaches that have been adopted widely in the existing empirical literature have a major focus on cross-section and panel data analysis. The main limitation with this kind of estimation approach is that the corresponding results can only provide a generalized picture for emerging Asia economies and could only be able to explain the 'average' behaviour of current accounts in these economies. In this chapter, I try to go beyond these generalizations by adopting a linear vector autoregressive (VAR) approach and empirically investigating the factors that may influence the behaviour of current account in each selected emerging Asian economy and assess their dynamics over time.

The objective of this chapter is to examine the both the long-run and short-run impacts of initial stock of net foreign assets, degree of openness to international trade, real exchange rate and relative income on current account for eight selected emerging Asian economies since the 1980s. The eight sample economies include China, Hong Kong, India, Korea, Malaysia, Philippines, Singapore and Thailand. Given the non-stationary nature of the data used in this study, this chapter adopts a cointegrated VAR approach to analyze current account balances and a set of macroeconomics determinants. Johansen and Juselius (1990) cointegration test is first applied to detect cointegration(s) between current account balances and potential explanatory variables within a VAR framework. In the presence of cointegration(s), the long-run impacts of all the explanatory variables on current account are analyzed based on the estimated cointegrating parameters, while the short-run impacts of all the explanatory variables on current account is investigated according to the estimation of a vector error correction model (VECM).

In general, I show that current account behaviours in emerging Asian economies are heterogeneous. The key findings of the study can be summarized as follows. First, for most selected emerging Asian economies, initial net foreign asset positions and the degree of

[4] See for examples: Khan and Knight (1983), Debelle and Faruqee (1996), Chinn and Prasad (2003).

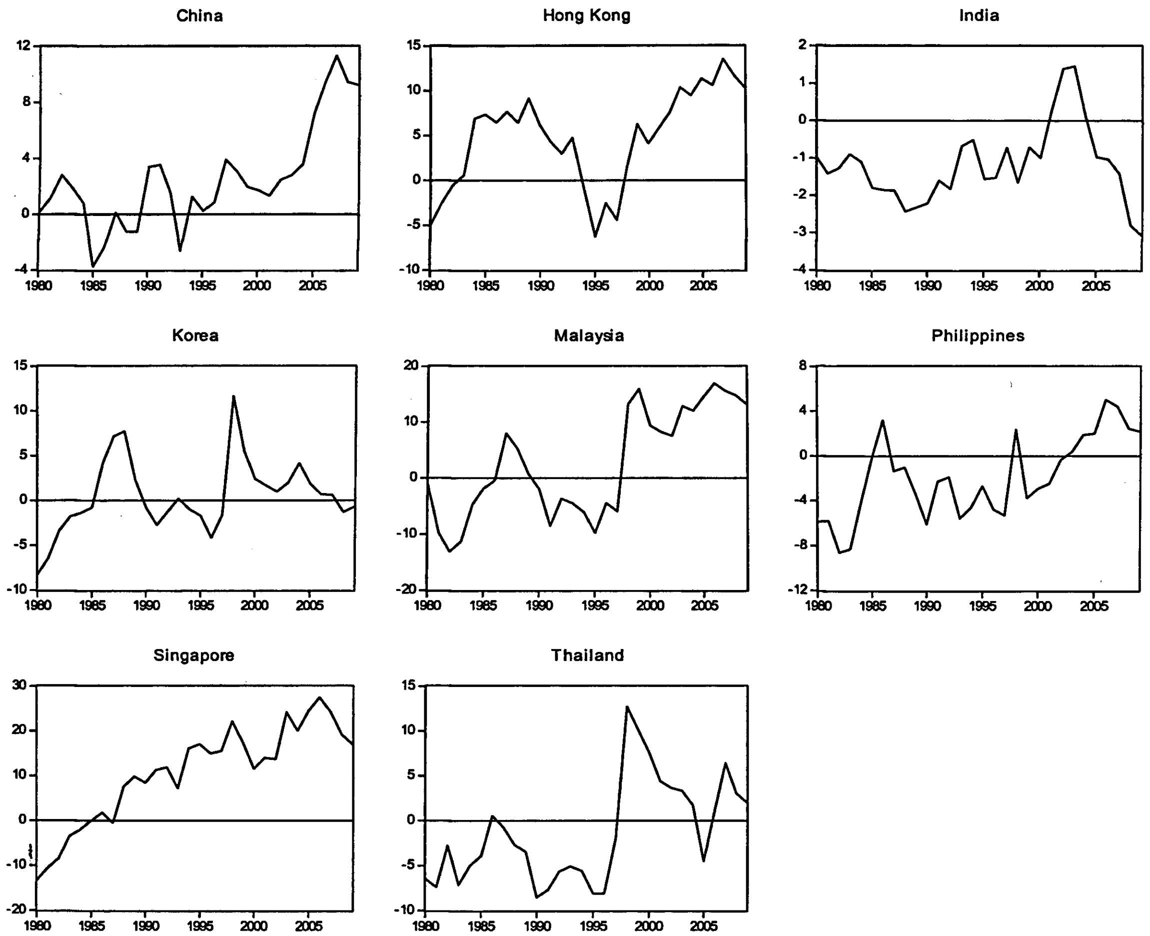
openness to international trade have significant long-run impacts on current account balances for most of the sample economies. The effects of these two factors have on current account are different across the sample economies. However, they have less important roles to play in causing changes in current account balances in the short-run for most of the sample economies. Second, there is a significant negative long-run relationship exists between the movements of real effective exchange rate and current account balance for most of the sample economies. However, the lack of adjustment of real effective change rate to the long-run disequilibrium term of current account indicates structural rigidities for all the sample economies expect India. Third, current accounts of all sample economies have a self-adjusting mechanism except China. Finally, short-run current account adjustment towards long-run equilibrium path is, on average, gradual, with the disequilibrium term being the main determinant of the short-run current account variations.

The structure of this chapter is as follows. Section 2.2 presents some stylised facts on current account balances of the eight selected emerging Asian economies. Section 2.3 provides a brief review of the empirical literature. Section 2.4 discusses some theoretical issues and also presents the empirical framework used in this study. Section 2.5 provides a description of the data used in this study and analyzes the time series properties of the data. Section 2.6 discusses the empirical methodology employed by this study. Section 2.7 outlines the empirical results. Finally, section 2.8 concludes.

2.2 Current Account Positions of Eight Emerging Asian Economies

Although emerging Asia as a whole kept running large and persistent current account surplus since the Asian crisis, a generalised picture does not allow us to observe important differences in the behaviour of current account balances within the region. Hence, it becomes necessary to look at the current account behaviour for each individual economy in emerging Asia. In this paper, I intend to focus on 8 largest economies in emerging Asia: China, Hong Kong, India, Korea, Malaysia, Philippines, Singapore and Thailand. These economies are selected for two reasons. First, according to the recent IMF report, these 8 sample economies jointly account for over 85% of the emerging Asian GDP and around 14% of the world's GDP in 2009.[5] It is obvious that the selected economies play a much more significant role in the regional economy. Second, since the empirical study in this paper requires quarterly data, therefore, only these 8 economies are selected. Although Indonesia, Taiwan Province of China and Vietnam are also considered as the largest economies in the region, these three economies are excluded from the sample due to the limited quarterly data.

Figure 2.2: Current Account Balance (% in GDP)



Data source: International Monetary Fund (IMF), World Economic Outlook Database, October 2009.

Figure 2.2 presents the current account balance as a percentage of each economy's GDP for the 8 sample economies in emerging Asia over the period 1980-2009. By looking at the figure, it is clear that current account developments in the selected emerging Asian economies are quite heterogeneous during the sample period. China kept running a small amount of current

[5] IMF, 2010 Source: World Economic Outlook (October 2009).

account surplus for most of the time, but the surplus has increased sharply in the past few years. Hong Kong and Singapore are the economies that tended to run relatively large and sustained current account surplus for most of the sample period. In cases of Korea, Malaysia, Philippines and Thailand, the current account position was seriously affected by the Asian crisis, which had a shift from deficit to large surplus around the time when crisis happened but narrowed down within a few years afterwards, except in the case of Malaysia. While most of the selected economies were running current account surplus, India is the only economy that ran a current account deficit on average over the whole review period.

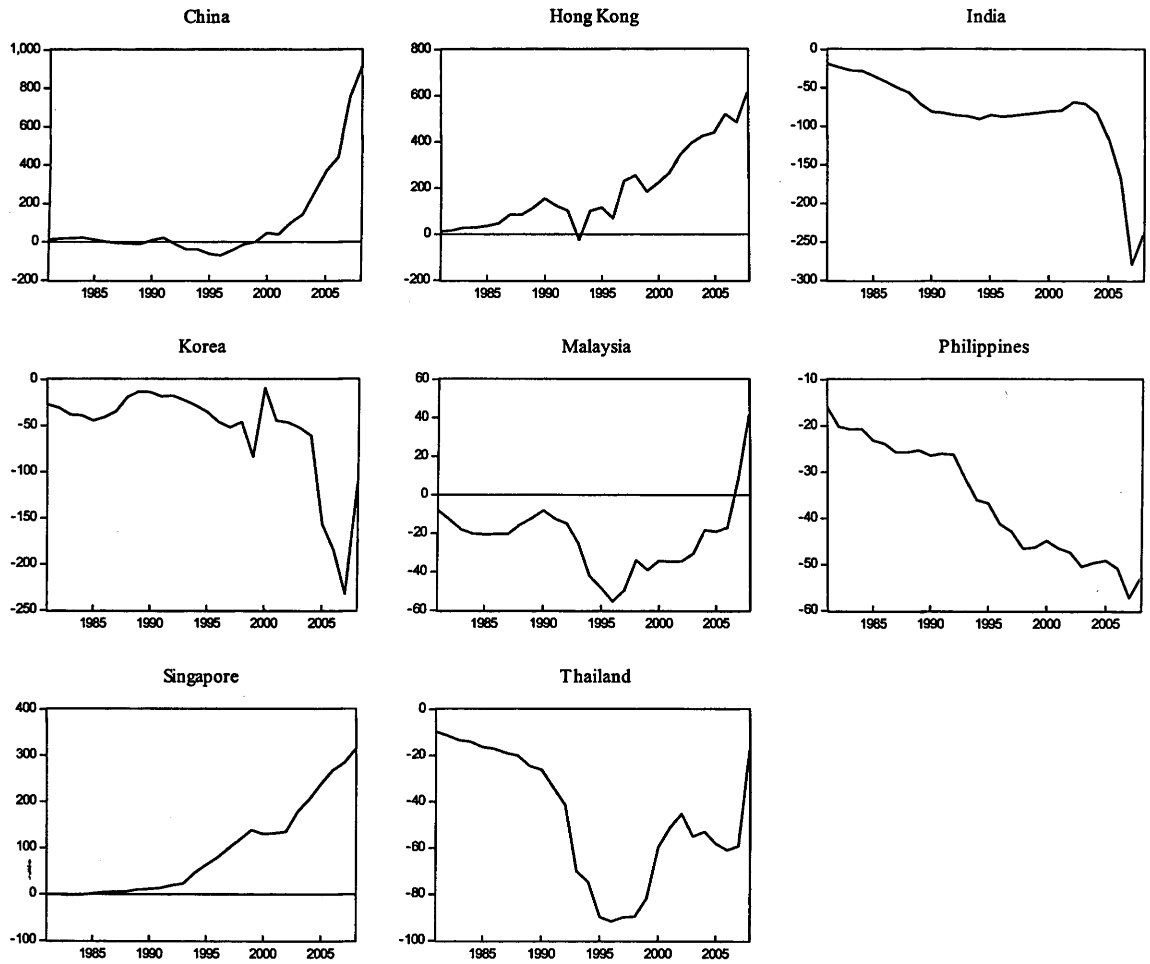
Based on both figure 2.1 and 2.2, it becomes more obvious that the large increase in the current account surplus for emerging Asia as whole since the 1997 Asian crisis occurred in two distinct phases. In the immediate post-Asian crisis period, the increase in the current account surplus in emerging Asia can be seen as the result of sudden shifts in the current account balances of the crisis affected economies from current account deficits to large surpluses. Later, especially after 2004, the increase in the region's surplus was largely caused by a dramatic increase in the China's current account surplus since the surpluses in most of the crisis affected economies had narrowed down and India had an increased deficit.

Furthermore, examining an economy's financial account can be helpful in understanding more about its current account position since it is the mirror image of the current account. For an example, when an economy invests more than it saves, the difference between investments and savings is met with foreign capital inflows shown on an economy's financial account and a current account deficit arises correspondingly. In the traditional accounting of balance of payments, financial account is calculated as the change in net foreign assets (NFA), which indicate the rate at which an economy is accumulating external assets. Figure 2.3 on the next page shows the NFA positions for each of the selected emerging Asian economies over the period 1981-2008.

According to the figure, all the selected economies were exposed to large NFA movements in and out of the economy after 1992, which was mainly due to the global integration and liberalization of financial markets in the early 1990s. China did not accumulate any large amount of net foreign assets or liabilities before the early 2000s, but had dramatically stimulated its NFA accumulations by accelerating its foreign exchange reserves since 2003.

These large changes in the NFA are reflected in the current account surpluses over the period 2003-2008 as shown in Figure 2. Hong Kong and Singapore are the economies that tended to accumulate their NFAs for most of the sample period and have speeded up the accumulation process in recent years. Before the Asian crisis, the accumulated net foreign liabilities in Korea, Malaysia, Philippines and Thailand were corresponding to the current account deficits in that period. However, figure 2.3 shows large reductions in those countries' net foreign

Figure 2.3: Net Foreign Assets (Billions of US Dollars)



Data Source: updated and extended version of the External Wealth of Nations Mark II database developed by Lane and Milesi-Ferretti (2007).

Note: 2008 data are estimates, which are calculated by using the method developed by Lane and Milesi-Ferretti (2007).

liabilities in the immediate post-Asian crisis period, which were primarily caused by the substantial foreign direct investment outflows and enormous losses in foreign exchange reserves. These reductions are reflected as increases in those countries' current account balances. In the case of India, the economy kept accumulating net foreign liabilities over the whole sample period and has accelerated the accumulation speed dramatically in past few years. As a result, India's current account had been in deficit on average during the same period.

After examining the financial account in each economy under consideration, it is apparent that current account developments in those emerging Asian economies are clearly reflected in their NFA positions. A current account surplus always implies a paralleled increase of the NFA, while a current account deficit is accompanied with a reduction of the NFA. I also find that rapid NFA accumulation has been a feature in all economies exposed to the Asian crisis. However, the more recent pronounced NFA accumulation in emerging Asia as a whole has been largely due to China.

Several conclusions can be drawn in this section. First, current account developments in the Asian economies have been heterogeneous during the last few decades. It is clear that there is no single common pattern of current account behaviour throughout the sample economies in emerging Asia. Second, current account surpluses in emerging Asia are a recent development rather than an embedded structural feature of the emerging Asian economies since they became apparent only after the Asian crisis. Third, current account developments in those emerging Asian economies are clearly reflected in their NFA positions. Fourth, China has played a remarkable role in building up the current account surpluses and NFA accumulation in emerging Asia in more recent years. These results reinforce the importance of investigating in detail the behaviour of current account in each individual emerging Asian economy.

2.3 Empirical Literature Review

In the early stage, the empirical literature concentrates more on analysing the current accounts in developed economies rather than in developing economies or emerging Asian economies mainly due to the lack of data. After the 1997 Asian financial crisis, the literature has a tendency to focus more on the behaviour of current account balances in emerging Asian economies, especial after the emergence of global current account imbalances. Despite the heterogeneous current account behaviour in each emerging Asian economies, most of the empirical studies have been carried out in a multi-economy framework. This section reviews some of these studies below, which have examined the current account determinants in developing (including emerging Asia economies) using different estimation approaches and giving different findings.

Khan and Knight (1983) investigate the evolution of the current account balances for 32 non-oil developing countries over the period 1973-1980 by using a pooled time series cross section data and adopting an Ordinary Least Square (OLS) estimation approach. Their results indicate that both internal factors (the increase in fiscal deficits and the appreciation in real effective exchange rates) and external factors (the deterioration in terms of trade, the decline of economic growth and the increase in foreign real interest rates) are important in explaining the deterioration of the current account of the countries under review.

Debelle and Faruqee (1996) try to explain both short-run dynamics and long-run variations of the current account by using a panel data of 21 industrial countries over the period 1971-1993 and also an extended cross section data that includes an additional 34 industrial and developing countries. They adopt a saving-investment perspective to motivate empirical specifications that contain the structural determinants of current accounts. Their work finds that relative income, government debt and demographic factors play a significant role on the long-run variation of the current account in the cross section, while fiscal surplus, terms of trade and capital controls do not. Also, by estimating partial-adjustment and error-correction models using panel data, they find that fiscal policy has both short-run and long-run impacts on the current account in the time series. Furthermore, they find that the real exchange rate, the business cycle and the terms of trade also have short-run effects on the current account.

Calderon, Chong and Loayza (2002) attempt to extend the work of Debelle and Faruqee (1996) by applying more advanced econometric techniques to control for joint endogeneity and by distinguishing between within-economy and cross-economy effects. They used a panel data of 44 developing countries over the period 1966-1995 to examine the empirical links between current account deficits and a broad set of economic variables proposed in the literature. By adopting a reduced-form approach rather than holding a particular structural model, they find that current account deficits in developing countries are moderately persistent. Higher domestic output growth, increase in the terms of trade and the real exchange rate appreciation tend to worsen the current account deficit. On the other hand, increases in the public and private savings, higher growth rates in industrial countries and higher international interest rates have favourable impacts on the current account balance.

Chinn and Prasad (2003) investigate the medium-term determinants of current accounts by adopting a structural approach that highlights the roles of the fundamental macroeconomic determinants of saving and investment. Their basic data set has annual data for 18 industrial and 71 developing countries and covers the period 1971-1995. Both cross-section and panel regression techniques are used in their study to examine the properties of current account variation across countries and over time. They find that initial stocks of net foreign assets and government budget balances have positive effects on current account balances. In addition, they also find that measures of financial deepening are positively correlated while indicators of openness to international trade are negatively correlated with current account balances among developing countries.

Gruber and Kamin (2007) assess some of the explanations that have been put forward for the global pattern of current account imbalances that has emerged in recent years, particularly the large U.S. current account deficit and the large surpluses of the developing Asian economies. Their work is based on the work of Chinn and Prasad (2003), using a panel data of 61 countries over the period 1982-2003 and including the standard current account determinants (per capita income, relative growth rates, fiscal balance, demographic factors and international trade openness). They find that the Asian surpluses can be well explained by a model that incorporates, in addition to standard determinants, the impact of financial crises on current accounts. However, their model fails to explain the large U.S. current account deficit even when the model is augmented by measures of institutional quality.

Chinn and Ito (2007, 2008) also attempt to explain the upswing since 1997 from current account deficit to surplus in Asian countries by using a framework of the work by Chinn and Prasad (2003). They find that the standard determinants, such as demographics and income variables, used in the work of Chinn and Prasad (2003) alone cannot explain the upswing in Asian countries' current account. Therefore, they augment Chinn and Prasad (2003) specification with indicators of financial development and legal environment that are likely to affect saving and investment behaviour and economic growth. They find that the interaction of legal environment with financial development plays a significant role in explaining capital outflows from Asia. They reject the saving glut hypothesis. On the contrary, their results suggest that it is the lack of investment opportunities rather than excess saving that helps explain current account improvement in Asian countries over the last decade.

In general, most of the above studies have used the intertemporal approach to examine the current account determinants from a saving-investment perspective for different groups of economies over different time horizons. However, evidence from the above studies is still inconclusive on the issue of current account determinants in developing economies or emerging Asian economies since studies provide conflicting results on same sets of variables.

2.4 Theoretical Issues and Empirical Framework

2.4.1 The Intertemporal Approach to the Current Account

The economic theory underpinning this chapter stems from the intertemporal approach to the current account, which was initially proposed by Sachs (1981) and Buiter (1981) and further extended by Obstfeld and Rogoff (1995). Empirical applications of the intertemporal model have followed two directions. On one hand, several studies have tried to establish evidence in favour of the baseline model using different testing strategies (e.g. see Bergin and Sheffrin, 2000; Nason and Rogers, 2006). On the other hand, a number of papers have examined the long-run relationship between the current account and its fundamental macroeconomic determinants by applying standard econometric techniques (e.g. see Debelle and Faruquee, 1996; Chinn and Prasad, 2003; Gruber and Kamin, 2007). The study in this chapter draws upon the second stem of the research.

Originally, the current account was thought of as the net export balance of a country (i.e. the trade elasticity approach). Consequently, relative international prices and their determinants were viewed as central to the dynamics of the current account. Although the trade elasticity approach has the benefit of straightforward empirical predictions, which are often found to be helpful in examining the short-run implications of exchange rate changes on the current account balance, due to its partial-equilibrium nature (i.e. this approach only looks at the traded goods market and ignores the interaction of other various markets in an economy), the elasticity approach is inherently limited in its ability to explain long-run or equilibrium current account positions.

Alternatively, the intertemporal approach to the current account views the current account (CA) as the difference between domestic saving (S) and domestic investment (I):

$$CA = S - I$$

and focused on macroeconomic factors that determine the two variables, S and I. The intertemporal approach recognizes that saving and investment decisions result from forward looking calculations based on the expected values of various macroeconomic factors. It tries to explain the current account developments through closer examination of intertemporal consumptions, saving and investment decisions. This approach has achieved a synthesis between the trade and financial flow perspectives by recognizing how macroeconomic factors influence future relative prices and how relative prices affect saving and investment decisions (Obstfeld and Rogoff, 1995). In addition to this, the basic insight of the intertemporal approach to the current account is that the current account can act as a shock absorber that enables a country to smooth consumption and maximize welfare in the presence of temporary shocks in a country's cash flow or net output.

While the basic permanent income model has been very helpful in explaining current account movements at business cycle frequencies, the consumption smoothing perspective has generally had less to say on sustained current account imbalances and trend developments.[6] Nevertheless, the model can be used to analyze longer-term variation in current account balances, as illustrated by the relation between the current account, investment and the stage of economic development in the permanent income model.

In particular, the intertemporal approach suggests that the stage of economic development is an important factor in explaining current account developments in the long-run. To be more specific, a small open economy that is initially capital and income poor, provided it has

[6] In the permanent income model, long-run developments are generally limited to consumption-tilting effects resulting from changes in the rate of time preference, which are difficult to measure. As a result, tests of the present value model have examined de-trended current account series (for example, Ghosh and Ostry, 1995).

access to international capital markets, will run current account deficits for a sustained period of time to build its capital stock while maintaining its long-run rate of consumption. During the adjustment, a relatively high marginal product of capital will attract capital inflows and raise external indebtedness. Eventually, as output grows toward its long-run level and the return on capital converges to its value abroad, the current account will improve toward (zero) balance as net exports move sufficiently into surplus to pay the interest obligations on the accumulated external debt.

The intertemporal approach indicates that, for growing economies, long-run growth can complicate the analysis by allowing for possibility of non-zero current account balances in steady state. Assuming that the stock of net foreign assets does not outpace growth in the overall economy indefinitely, the level of current account (measured as a share of GDP) required to stabilize net external indebtedness can be determined. In particular, given that the current account (CA) equals the change in net foreign assets (NFA), a stable ratio of NFA to GDP (denoted by Y) implies that in steady state:

$$CA/Y = g * NFA/Y$$

where $g = \Delta Y/Y$. During the transition to this 'long-run' position, various other factors could influence this relationship (e.g., see Calderon *et al.*, 2000). Furthermore, if there are real exchange rate trends, the proportional factor 'g' would also take account of the long-run rate of appreciation to account for differing valuation effects on NFA and Y. Consequently, structural determinants of the current account could be viewed in terms of the factors that underpin the desired net foreign asset position in the long-run. Equivalently, one could view this stock-flow equilibrium relationship in terms of the underlying determinants of saving and investment behaviour.

Moreover, one thing worth noticing here is that there could also be systematic differences between debtor and creditor countries in the relationship between current accounts and NFA. Kraay and Ventura (2000) suggest that the sign of the current account response to transitory income shocks depends on the share of foreign assets in a country's total assets. Under some plausible assumptions, they show that the current account response to a transitory income shock is equal to the increase in savings generated by the shock times the share of foreign assets in the country's total assets. This "new rule" implies that favourable income shocks lead to current account deficits in debtor countries and current account surpluses in creditor countries. Obstfeld and Rogoff (1998, pp. 76–78) also note that, if the world real interest rate were above its 'permanent' level, the current account surplus would be higher than usual for creditor countries as agents in those countries saved more to smooth into the future their unusually high income. The effect would be reversed for debtor countries.

The intertemporal approach also suggests that real exchange rate has a role to play in explaining the long-run current account developments through the degree of the propensity to save. In particular, an appreciation of the real exchange rate increases the purchasing power in terms of imported goods of current and future income, as well as the value of the accumulated monetary and property assets of domestic agents. This effect tends to raise consumption and reduce the propensity to save, which can cause a decrease in the current account balance.

Finally, in the absence of freely mobile capital, the intertemporal approach suggests that one could approach current account determination by focusing more explicitly on the developments in its counterpart – the capital account. In an open economy, the capital account can be affected by country characteristics that reflect macroeconomic policies. For instance, the degree of openness to international trade could reflect policy choices, including tariff regimes. According to the literature, countries that are more open to international trade tend to attract more foreign capital to finance expenditure relative to income, contributing to current account deficits. Consequently, countries that maintain a relatively open capital account are likely to have larger current account imbalances than otherwise. Therefore, the degree of openness to international trade may have important long-run implications for overall current account positions.

2.4.2 The Empirical Framework

Based on the above discussion, the general function for current account balances used in this chapter is specified as follow

$$ca = f\left(nfa, open, reer, rel\_y\right) \tag{2.1}$$

where the dependent variable, *ca*, is the current account balance to GDP ratio; *nfa* is the initial net foreign assets position to GDP ratio; *open* is the indicator of openness to international trade; *reer* is the real effective exchange rate; *rel_y* is the level of domestic real income relative to foreign real income.

Although no single theoretical model can capture the entire range of empirical relationships between current account and the explanatory variables identified in equation (1) that are analyzed in this study, it is still useful to examine the predictions of different theoretical models about some of these relationships.

1) <u>Initial Stock of NFA</u>

The initial stock of NFA is measured as the one period lagged NFA stock to GDP ratio to avoid endogeneity problems with the current account. According to the intertemporal approach, initial stock of NFA serves as an important initial condition since the current account is the sum of the trade balance and the return on an economy's stock of NFA.

In general, initial stock of NFA can influence current account balance in two ways. First, an economy with a higher initial stock of NFA obviously can benefit from a higher level of investment income from abroad. From the saving-investment perspective, an increase in the foreign income flow has a positive effect on current account balance. It therefore creates a positive relationship between initial stock of NFA and current account balance. Second, since the sum of current account and capital account must equal zero *ex post* in a flexible exchange rate regime, an economy with an initially higher level of NFA can afford a higher trade deficit for an extended period and still remain solvent. This potentially leads to a negative relationship between initial stock of NFA and current account balance.

Overall, standard open economy macroeconomic models predict that the first effect should be stronger. Empirically, the first effect would be expected to dominate (see for examples, Chinn and Prasad, 2003 and Lee *et al.*, 2008).

2) <u>Trade Openness</u>

The trade openness is measured as the sum of exports and imports to GDP ratio. It not only measures the degree of an economy's openness to international trade, but also reflects some of the macroeconomic policies that could be relevant for the long-run current account developments. For examples, trade openness could be indicative of attributes such as liberalized international trade, receptiveness of technology transfers, and ability to service external debt through export earnings.

Moreover, this variable also measures the degree of various trade restrictions, which are likely to impede a flow of goods and services from abroad. An economy with more trade restrictions is likely to send an adverse signal to foreign investors. On the other hand, an economy with less trade restrictions and more exposure to international trade tends to be relatively more attractive to foreign capital (Chinn and Prasad, 2003). Consequently, trade openness is likely to be associated negatively with the current account balance.

In general, the common empirical literature usually expects a negative relationship between trade openness and current account balance.

3) Real Effective Exchange Rate (REER)

The REER can affect the current account balance in two ways. On one hand, from a saving-investment perspective, an increase in the REER can decrease an economy's overall saving ratio because it increases the purchasing power of the domestic currency on foreign goods and services, thereby encouraging domestic residents to purchase more imported goods and to travel and consume abroad. The increase in spending on foreign goods and services will cause real consumption to rise relative to output, thus lowering the saving ratio. Since current account is increasing in savings, a decrease in the saving ratio will lead to a decrease in an economy's current account balance.

On the other hand, the consumption smoothing hypothesis suggests that the current account acts as a buffer to smooth consumption in the face of shocks to national cash flow (i.e. output less investment). In response to an increase in the REER, an open economy would prefer to run a current account surplus and invest abroad rather than allow consumption to increase. As a result, a home currency appreciation can result in an improvement of the current account (Herrmann and Jochem, 2005).

After all, the link between the REER and the current account balance can only be determined empirically.

4) Domestic Relative Income

The relative income is measured as the ratio of domestic real output to U.S. real output. This variable captures the stage of development effects. The stages of development hypothesis for balance of payments (Debelle and Faruqee, 1996) suggest that, at an early stage of the development process where the relative income level is low, an economy runs current account deficits as it usually imports capital due to its external financing requirement. However, at a later stage of the development process with high relative income, the economy normally runs current account surpluses in order to repay the previously accumulated external liabilities and also exports capital to less developed economies.

In general, the relationship between relative income and current account balances is expected to be positive.

2.5 Data and Preliminary Analysis

Quarterly time series data are used in this study for all the sample economies, which include China, Hong Kong, India, Korea, Malaysia, Philippines, Singapore and Thailand. However, since quarterly data for initial stock of NFA are unavailable for all sample economies, quarterly data for this variable are the interpolated results of the annual time series by using the cubic spline interpolation method for all selected economies. The main data source is the IMF's International Financial Statistics (IFS) databank. Variables exhibit strong seasonality for which I account by seasonal adjustment.[7] More detailed data sources and variable definitions are provided in Data Appendix.

Sample size is different across sample economies due to each economy's data availability. For Singapore, the sample period is 1980Q1-2009Q1. For Hong Kong, India and Philippines, the sample period is 1981Q1-2009Q1. For Korea, the sample period is 1981Q1-2008Q1. For China and Malaysia, the sample size is 1985Q1-2009Q1. Finally, for Thailand, the sample

[7] Variables are adjusted by using the Census XII multiplicative seasonal adjustment method used by the US Bureau of Census.

size is 1988Q1-2009Q1. More detailed data sources and variable definitions are provided in the data appendix.

The time properties of the data are examined by applying the Augmented Dickey–Fuller (1979) (hereafter ADF) test to both levels and first differences of the time series for all the sample economies. The ADF test constructs a parametric correction for higher-order correlation by assuming that the time series follows an autoregressive (AR) process up to a k^{th} order.

$$\Delta y_t = c + \beta t + \alpha y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \tag{2.2}$$

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \tag{2.3}$$

$$\Delta y_t = \alpha y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \tag{2.4}$$

Equation (2.2) is used to test for the null of a unit root against a trend-stationary alternative in y_t, where y refers to the examined time series. Equation (2.3) tests the null of a unit root against a mean-stationary alternative, and equation (2.4) tests the null of a unit root against zero-mean stationary alternative. The purpose of including the lagged first differences, Δy_{t-j}, into the right-hand side of the three test equations is to accommodate serial correlation in the residual terms, ε_t. The lag length of Δy_{t-j} can be selected by conventional information-based criteria. In this study, the Akaike Information Criterion (AIC) is used to choose the lag length.

Table 2.1 on the next page reports the results of ADF test for all the time series used in this study. Panel A and B reports the results of the ADF test on the level series. The results indicate that, at 5% significance level or lower, the null hypothesis of a unit root cannot be rejected for all the time series at levels. Panel C reports the results of the ADF test on the first differences of all the variables. The null hypothesis of a unit root is rejected when the ADF test is applied to the first difference for all the variables at 5% significance level or even 1% significance level, except that the null hypothesis is rejected at 10% significance level in the case of India's relative income. Therefore, the overall conclusion from the ADF test is that, for all the sample economies, all the variables are unit root non-stationary processes and

Table 2.1: Augmented Dickey-Fuller (ADF) Test Results

Panel A: ADF Tests on Levels - Intercept and Trend

	Current Account to GDP ratio (*ca*)	Initial NFA to GDP ratio (*nfa*)	Trade Openness (*open*)	Real Effective Exchange Rate (*reer*)	Relative Income (*rel_y*)
China	-2.06 [0.562]	-0.54 [0.980]	-2.59 [0.287]	-2.79 [0.205]	-2.82 [0.196]
Hong Kong	-1.96 [0.617]	-1.69 [0.748]	-2.79 [0.205]	-1.77 [0.714]	-1.76 [0.718]
India	-3.14 [0.110]	-2.53 [0.316]	-1.85 [0.671]	-0.89 [0.952]	-0.17 [0.993]
Korea	-2.99 [0.140]	-1.23 [0.898]	-1.78 [0.707]	-2.43 [0.359]	-1.89 [0.652]
Malaysia	-2.61 [0.279]	-1.81 [0.690]	-0.42 [0.986]	-2.24 [0.460]	-1.66 [0.762]
Philippines	-1.72 [0.734]	-2.05 [0.567]	-0.36 [0.999]	-2.18 [0.497]	-1.12 [0.919]
Singapore	-2.15 [0.510]	-2.66 [0.254]	-2.46 [0.344]	-2.10 [0.537]	-1.79 [0.703]
Thailand	-2.57 [0.295]	-0.96 [0.943]	-1.91 [0.642]	-1.05 [0.930]	-2.48 [0.336]

Panel B: ADF Tests on Levels - Intercept Only

	Current Account to GDP ratio (*ca*)	Initial NFA to GDP ratio (*nfa*)	Trade Openness (*open*)	Real Effective Exchange Rate (*reer*)	Relative Income (*rel_y*)
China	-0.86 [0.798]	-1.38 [0.998]	-1.80 [0.380]	-2.11 [0.242]	-2.39 [0.145]
Hong Kong	-1.52 [0.518]	-0.74 [0.828]	-1.62 [0.465]	-1.60 [0.478]	-1.66 [0.449]
India	-1.84 [0.359]	-2.54 [0.109]	-0.71 [0.992]	-1.72 [0.416]	-2.24 [0.999]
Korea	-2.55 [0.106]	-2.16 [0.220]	-0.81 [0.810]	-2.40 [0.141]	-2.22 [0.199]
Malaysia	-1.69 [0.429]	-1.07 [0.722]	-2.38 [0.150]	-1.34 [0.604]	-1.86 [0.346]
Philippines	-1.12 [0.707]	-0.87 [0.792]	-1.17 [0.683]	-2.50 [0.117]	-1.61 [0.473]
Singapore	-2.30 [0.171]	-0.45 [0.984]	-2.45 [0.130]	-2.09 [0.248]	-1.03 [0.738]
Thailand	-1.78 [0.383]	-0.82 [0.807]	-1.02 [0.740]	-1.23 [0.655]	-2.55 [0.107]

Panel C: ADF Tests on 1st Differences - Intercept Only

	Current Account to GDP ratio (*ca*)	Initial NFA to GDP ratio (*nfa*)	Trade Openness (*open*)	Real Effective Exchange Rate (*reer*)	Relative Income (*rel_y*)
China	-9.05 [0.000]***	-2.91 [0.045]**	-3.11 [0.029]**	-8.43 [0.000]***	-5.06 [0.000]***
Hong Kong	-6.19 [0.000]***	-3.82 [0.004]***	-4.07 [0.002]***	-7.38 [0.000]***	-3.06 [0.033]**
India	-7.04 [0.000]***	-7.53 [0.000]***	-6.68 [0.000]***	-3.70 [0.005]***	-2.87 [0.052]*
Korea	-10.88 [0.000]***	-4.66 [0.000]***	-7.75 [0.000]***	-4.78 [0.000]***	-5.61 [0.000]***
Malaysia	-11.24 [0.000]***	-3.45 [0.012]**	-3.21 [0.023]**	-3.66 [0.007]***	-3.54 [0.009]***
Philippines	-6.70 [0.000]***	-3.13 [0.027]**	-5.88 [0.000]***	-5.36 [0.000]***	-3.04 [0.034]**
Singapore	-4.37 [0.001]***	-5.28 [0.000]***	-4.14 [0.001]***	-6.46 [0.000]***	-5.47 [0.000]***
Thailand	-4.13 [0.002]***	-3.47 [0.012]**	-5.75 [0.000]***	-3.98 [0.003]***	-5.87 [0.000]***

Notes: 1. Null hypothesis in both ADF tests is specified as 'the tested variable has a unit root'.
2. Critical values for the ADF test with a trend are: -4.011, -3.439 and -3.139 at the 1%, 5% and 10% significance levels respectively. Critical values for the ADF test without a trend are: -3.481, -2.884 and -2.574 at the 1%, 5% and 10% significance levels respectively.
3. ** and *** denote the rejection of the null hypothesis at 5% and 1% significance level respectively; numbers in square bracket denote test probability values.

integrated of order one, I(1).

2.5 Methodology

Based on the preliminary analysis of the data presented in the last section, all the variables in this study are non-stationary and follow a I(1) process. As a general rule, non-stationary time series should not be used in regression models in order to avoid the problem of spurious regression. However, Engle and Granger (1987) pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination does exist, the non-stationary time series are said to be cointegrated and the stationary linear combination can be interpreted as a long-run equilibrium relationship among the variables. Give the above consideration, I first use the Johansen and Juselius (1990, hereafter JJ) cointegration test, which is a vector autoregressive (hereafter VAR) based approach, to examine the underlying cointegrating relationship(s) among the variables specified in equation (1). The JJ's approach involves estimation of a *K*-dimensional VAR model of *p* order (VAR(*p*)), which can be described as follow

$$X_t = \mu + \Gamma_1 X_{t-1} + \Gamma_2 X_{t-2} + ... + \Gamma_p X_{t-p} + \varepsilon_t \qquad (2.5)$$

In this study, $X_t = (ca_t, nfa_t, open_t, reer_t, rel\_y_t)$ and is a (5×1) column vector; μ is a constant term; Γ_i represents a (5×5) parameter matrix where $i = (1, 2..., p)$; and finally ε_t represents a (5×1) matrix of Gaussian errors. Equation (2.5) is estimated by using the maximum likelihood method.

Compared with a single equation residual based approach, the JJ's test is superior in two main aspects. First, all the variables in the VAR system as described in equation (2.5) are assumed to be endogenous in the JJ's test, even if some of them do not act as dependent variables. As a result, it avoids the problem of normalizing the cointegrating vector on one of the variables or of imposing a unique cointegrating vector as in a single equation residual based test (for example, Engle-Granger (1987) 2-step cointegration test). Second, the JJ's approach can address the multi-cointegration problem when there are more than two variables involved in the test, whereas a single equation residual based test is only capable to find one cointegrating relationship despite the number of variables involved in the test. This second advantage of the JJ's test is especially important to this study given that there are five variables involved in the analysis of current account behaviour. Last but not least, Cheung and Lai (1993) point out that the power of the JJ test is better than that of the EG test. Due to all these reasons, this study applies the JJ test to test the cointegrating relationship(s) between current account balance and the explanatory variables specified in equation (2.1).

Johansen and Juselius (1990) and Johansen (1995) suggest that if X_t consists of k terms integrated of order one, equation (2.5) can be re-arranged as a vector error correction model (VECM) as below:

$$\Delta X_t = \mu + \Psi_1 \Delta X_{t-1} + \Psi_2 \Delta X_{t-2} + ... + \Psi_{p-1} \Delta X_{t-p+1} + \Pi X_{t-p} + \varepsilon_t \quad (2.6)$$

In equation (2.6), μ is a constant term; ΔX_t represents the first differenced X_t (i.e. $\Delta X_t = X_t - X_{t-1}$), $\Psi_i = -(I - \Gamma_1 - \Gamma_2 - ... - \Gamma_i)$, $\Pi = -(I - \Gamma_1 - \Gamma_2 - ... - \Gamma_p)$, where I is the identity matrix and $i = (1, 2..., p-1)$. If Π includes r linearly independent columns where $r<k$ and k is the number of variables in X_t, equation (2.6) convergences to a long-run equilibrium described by $\Pi = \alpha\beta'$, where α and β are both ($5 \times r$) matrices. Matrix β includes the coefficients defining the long-run relationship, while matrix α consists of loading factors, which can be interpreted as the coefficients of the speed of adjustment toward the long-run equilibrium. Equation (2.6) can be re-written as:

$$\Delta X_t = \mu + \Psi_1 \Delta X_{t-1} + \Psi_2 \Delta X_{t-2} + ... + \Psi_{p-1} \Delta X_{t-p+1} + \alpha\left(\beta' X_{t-p}\right) + \varepsilon_t \quad (2.7)$$

In equation (2.7), βX_{t-p} can yield a maximum of (k-1) cointegration relationships provided all X_t are I(1). The number of cointegrating vectors r is given by the rank of Π. The test itself produces two separate test statistics, Trace statistics (λ_{trace}) and Maximum Eigenvalue statistics (λ_{max}), which are calculated using the maximum likelihood estimates of the VAR(p) model. Both of the test statistics can be used to determine the number of cointegrating vectors, r, in the system.

In the JJ's test procedure, it is important to select the deterministic component in the cointegrated VAR models before estimating and drawing inferences on the VECM as described in equation (2.6). There are five possible combinations of deterministic components that are contained in the JJ test procedure (see Johansen, 1995). The most restrictive model (Model 1) contains no deterministic components and the least restrictive model (Model 5) contains quadratic trends in levels. The five models are nested so that Model 1 is contained in Model 2 and so on. As suggested by Hansen and Juselius (1995), this study uses a method called the 'Pantula principle' to determine the deterministic components in the VAR models. The 'Pantula Principle' suggests the following procedures: start from the most restrictive model (Model 1) and then compare the rank test statistic, either Trace statistics or Maximum Eigenvalue statistics, with the critical values of the test. If the model is rejected, continue to Model 2, which restricts the constant to the cointegration equation. If this model is also rejected, go to Model 3 where there is an unrestricted constant. In the case of rejection, proceed to Model 4, which includes linear trends in both the variables and the cointegration equation. If this is also rejected, repeat the procedure for Model 5. If all five models are rejected, repeat the procedure for the next rank. Continue until the null hypothesis cannot be rejected for the first time.

If current account and all the explanatory variables specified in equation (2.1) are found to be cointegrated, the long-run impacts of all the explanatory variables on current account will be analysed based on the estimated cointegrating vector(s). However, a potential problem arises here in this study is that, since the dimension of the vector of variables, X_t, as specified in equation (2.5) is equal to five, the cointegrating vector, r, may not be unique. In the presence of multiple cointegrating vectors, the resulting estimates are not directly interpretable unless some identifying restrictions are imposed. If this is the case, the identification problem will be addressed later in this chapter.

Given the presence of cointegration(s), the VECM as described by equation (2.6) is used to examine the short-run impacts of all the explanatory variables on current account for each sample economy. The VECM is a powerful model and reveals information beyond the long-run cointegrating relationship(s). The purpose of VECM is to focus on the short-run dynamics of the endogenous variables in the system, while making them consistent with their long-run cointegrating relationship(s). If a number of variables are found to be cointegrated with at least one cointegrating vector, then there always exists a corresponding error correction representation which implies that changes in the dependent variable can be formulated as a function of the level disequilibrium in the cointegration relationship and fluctuation in other explanatory variables.

This chapter focuses on two main things when estimating the VECM. One thing is the speed of adjustment of current account to deviation from its long-run equilibrium, which can be evaluated through the estimated coefficient of the error correction term that derived from the cointegrating vector. The other thing is the short-run impact of all the explanatory variables specified in equation (2.1) on current account. This can be done by analysing the FILM estimates of the current account equation from the VECM.

In addition, a uni-directional short-run Granger causality test is applied in the short-run analysis to shed some light on the short-run causality between current account and other explanatory variables defined in this study. This test involves a *F*-test on the joint significance of the sum of lags of each explanatory variables. For simplicity, assuming there is just one cointegrating vector, the Granger causality test equation in this study can be specified as follow

$$\Delta ca_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta ca_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta nfa_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta open_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta reer_{t-i} + \sum_{i=1}^{p} \beta_{5i} \Delta rel\_y_{t-i} + \beta_6 ect_{t-1} + \varepsilon_t \quad (2.8)$$

where all the variables are in their first differences, ect_{t-1} is the error correction term derived from the cointegrating vector, β_0 is a constant, ε_t is a random error, and p represents the number of lags included in the test. To see whether the initial stock of NFA (*nfa*), has a short-run causal relationship with the current account (*ca*), the null hypothesis of this particular test is given by

$$H_0 : \sum_{i=1}^{p} \beta_{2i} = 0$$

where the test statistics follows a *F*-distribution. If the null is rejected, it implies that the initial stock of NFA Granger causes the current account in the short-run, *vice versa*. Following the same rationale, I can test for the other explanatory variables.

2.6 Empirical Results

2.6.1 Lag Order Selection for VAR

It is well known that the VAR analysis may depend critically on the lag order selection of the

VAR model. Sometimes, different lag orders can seriously affect the substantive interpretation of VAR estimates when those differences are large enough (see e.g. Hamilton and Herrera 2004, Kilian 2001). Therefore, selecting the right lag order for each VAR is a very important preliminary step in this empirical study.

The most common strategy in empirical studies is to select the lag order by some pre-specified criterion and to condition on this estimate in constructing the VAR estimates. There are four most commonly used lag order selection criteria in the literature, which are the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC), the Hannan-Quinn Criterion (HQC) and the general-to-specific sequential Likelihood Ratio test (LR). However, these criteria may draw different conclusions on the lag order. Ivanov and Kilian (2005) use Monte Carlo simulations to compare these four criteria. Their study concludes that for monthly VAR models, the AIC tends to produce the most accurate structural and semi-structural estimates for realistic sample sizes, while the HQC appears to be the most accurate criterion for quarterly VAR models, if sample sizes are larger than 120. However, if sample sizes are smaller than 120, then the SIC becomes the most accurate criterion. For persistence profiles based on quarterly VECMs with known cointegrating vector, their results suggest that the SIC is the most accurate criterion for all realistic sample sizes.

Table 2.2: Lag Order Selection for Each Estimated VAR

Lag	China	Hong Kong	India	Korea	Malaysia	Philippines	Singapore	Thailand
0	-13.96	-1.67	-10.86	-8.02	-4.56	-15.41	-1.87	-6.78
1	-23.30	-13.61	-21.94	-19.93	-15.25+	-25.14	-15.49+	-16.31+
2	-23.65+	-14.42+	-21.63	-20.19+	-15.08	-25.27+	-15.34	-16.23
3	-22.98	-14.18	-21.61	-20.04	-15.15	-24.52	-14.52	-15.45
4	-23.29	-14.56	-21.93+	-19.38	-14.50	-24.06	-13.65	-14.99
5	-22.72	-13.00	-21.80	-18.84	-14.02	-23.38	-13.14	-14.69
6	-21.88	-12.36	-20.98	-18.16	-13.18	-22.89	-12.48	-13.93
7	-21.26	-11.66	-20.36	-17.67	-12.29	-22.06	-11.88	-13.15
8	-20.45	-10.91	-19.87	-16.75	-11.69	-21.40	-11.09	-12.59

Note: + indicates lag order selected by the Schwarz Information Criterion.

Given that only quarterly VAR/VECM models are estimated in this analysis and the largest sample size is 117, the SIC is used here to select the lag length for each estimated VAR. Table 2.2 above reports the results for the lag length selection based on the SIC. The results presented in table 2.2 suggest that the optimal lag length should be 1 for Malaysia, Singapore and Thailand and 2 for China, Hong Kong, Korea and Philippines. In the case of India, the suggested optimal lag length is 4.

In addition, to ensure that the selected lag lengths are appropriate, two multivariate diagnostic tests are applied to the unconditional VAR models to examine whether the estimated residuals deviate from being Gaussian. To be more specific, the presence of serial correlation in the residuals is tested by using the multivariate Lagrange Multiplier (hereafter LM) test by adopting same lag length as suggested by the SIC for each estimated VAR. Meanwhile, Jarque-Bera (henceforth JB) normality joint test is applied to check the normality of the error terms from the unconditional VAR models. Table 2.3 below reports the results of these two diagnostic tests.

Table 2.3: Lag Order Selection for Each Estimated VAR

	LM Test		Normality Test
	Lag Length in the Test	Test Statistics	Test Statistics
China	2	25.26 [0.447]	1034.60 [0.000]***
Hong Kong	2	37.13 [0.156]	21.31 [0.016]**
India	4	28.10 [0.302]	26.16 [0.004]***
Korea	2	33.57 [0.117]	17.69 [0.041]**
Malaysia	1	31.36 [0.177]	113.22 [0.000]***
Philippines	2	30.23 [0.216]	196.62 [0.000]***
Singapore	1	25.96 [0.409]	70.51 [0.000]***
Thailand	1	35.23 [0.084]*	81.86 [0.000]***

Notes: 1. Null hypothesis in the LM test is specified as 'there is a serial correlation in the residual term up to the n^{th} order' where n refers to the number of lags included in the test.
2. Null hypothesis in the JB's normality test is specified as 'the residual term is normally distributed'.
3. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively; numbers in square bracket denote test probability values.

The LM test results suggest that there is no serial correlation in all cases at 5% significance level. In other words, there are no deviations from the basic assumptions of residual independence. On the other hand, the JB joint test results indicate that all the estimated VARs seem to exhibit residual non-normality at 5% significance level or lower.[8] However, since the asymptotic properties of the JJ test depend only on the independent and identically distributed (i.i.d.) assumption of the residuals, non-normality of the error terms is not crucial for inference. Furthermore, in a simulation study, Gonzalo (1994) also shows that the JJ's maximum likelihood approach is robust to non-normality and even heteroscedasticity.

2.6.2 Cointegration Rank

Table 2.4 on the next page reports the results of the JJ cointegration tests for each sample economy. According to the reported test results, λ_{trace} suggests that there is only one cointegrating relationship among all the variables at 5% significance level for all the economies. Meanwhile, λ_{max} also indicates a single cointegrating vector among all the variables at 5% significance level for most sample economies, except Hong Kong and Singapore where the null is rejected marginally below 5% but comfortably at 10 % significance level. Overall, both test statistics confirm that there is a unique long-run relationship existing between the current account balance and the explanatory variables specified in equation (2.1) at 10% significance level for all the sample economies. Since there is only one cointegrating vector for all sample economies, identification problem is out of the consideration in this study.

2.6.3 Long-Run Determinants of Current Account

Given that the cointegration rank is equal to 1 for all the sample economies, the next step is to normalise the unique cointegrating vector. Wickens (1996) points out that the sign and the significance of loading factors, α, are important for normalisation. He indicates that the loading factor associated with the normalised variable must be negative and significant for the error correcting behaviour. Therefore, normalisation of the unique cointegrating vector in this study is accomplished based on the strategy suggested by Wickens (1996).

[8] As noted during the test, the null hypothesis that the residuals have a normal distribution is rejected mainly due to excess kurtosis. Paruolo (1997) has demonstrated that in instances where normality is rejected for this reason, rather than skewness, the JJ's results are not affected.

Table 2.4: Johansen – Juselius Cointegration Test Results

Panel A: Trace Statistics: λ_{trace}

	Lag Length	$H0: r=0$ $H1: r=1$	$H0: r\leq 1$ $H1: r=2$	$H0: r\leq 2$ $H1: r=3$	$H0: r\leq 3$ $H1: r=4$	$H0: r\leq 4$ $H1: r=5$
China	2	78.25	41.37	21.40	9.96	1.19
		[0.039]**	[0.403]	[0.636]	[0.644]	[0.925]
Hong Kong	2	75.52	42.25	22.81	6.37	1.23
		[0.016]**	[0.152]	[0.256]	[0.652]	[0.268]
India	4	115.93	41.58	20.93	8.42	1.59
		[0.000]***	[0.171]	[0.362]	[0.421]	[0.208]
Korea	2	76.04	42.10	20.56	6.49	0.05
		[0.015]**	[0.156]	[0.386]	[0.637]	[0.827]
Malaysia	1	98.80	58.81	29.83	13.33	4.42
		[0.008]***	[0.124]	[0.512]	[0.712]	[0.681]
Philippines	2	79.37	42.62	19.31	8.30	2.48
		[0.032]**	[0.346]	[0.769]	[0.799]	[0.682]
Singapore	1	75.82	42.86	22.77	10.34	0.59
		[0.015]**	[0.136]	[0.258]	[0.256]	[0.439]
Thailand	1	81.88	46.81	20.85	9.78	3.44
		[0.020]**	[0.189]	[0.672]	[0.661]	[0.503]

Panel B: Max-Eigen Value: λ_{max}

	Lag Length	$H0: r=0$ $H1: r=1$	$H0: r\leq 1$ $H1: r=2$	$H0: r\leq 2$ $H1: r=3$	$H0: r\leq 3$ $H1: r=4$	$H0: r\leq 4$ $H1: r=5$
China	2	36.88	19.97	11.43	8.77	1.19
		[0.028]**	[0.415]	[0.710]	[0.459]	[0.925]
Hong Kong	2	33.28	19.44	16.44	5.14	1.23
		[0.059]**	[0.382]	[0.200]	[0.724]	[0.268]
India	4	74.34	20.65	12.51	6.83	1.59
		[0.000]***	[0.298]	[0.498]	[0.510]	[0.208]
Korea	2	33.94	21.54	14.07	6.44	0.05
		[0.049]**	[0.245]	[0.360]	[0.557]	[0.827]
Malaysia	1	39.99	28.98	16.50	8.91	4.42
		[0.032]**	[0.125]	[0.500]	[0.734]	[0.681]
Philippines	2	36.75	23.31	11.01	5.82	2.48
		[0.029]**	[0.204]	[0.749]	[0.808]	[0.682]
Singapore	1	32.96	20.09	12.43	9.74	0.59
		[0.064]*	[0.335]	[0.505]	[0.229]	[0.439]
Thailand	1	35.07	25.96	11.06	6.35	3.44
		[0.047]**	[0.104]	[0.744]	[0.748]	[0.503]

Note: *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively numbers in square bracket denote the MacKinnon-Haug-Michelis (1999) probability values.

Table 2.5 on the next two pages reports the normalised cointegrating vectors and the associated loading factors. Panel A reports the results when normalisation is made on the current account balances, *ca,* for all the sample economies. It is clear that, based on the sign

Table 2.5: Estimated Johansen – Juselius Cointegrating Vectors

Panel A

	Normalized cointegrating coefficients, β	Loading Factors/Adjustment coefficients, α				
		Δca	Δnfa	$\Delta open$	$\Delta reer$	Δrel_y
China	$ca = 0.294nfa - 0.615open - 0.395reer - 0.079rel\_y + 2.07$	0.011	0.164	-0.452	0.007	-0.033
	(0.049) (0.136) (0.067) (0.651)	(0.032)	(0.054)	(0.196)	(0.171)	(0.011)
	[0.000]*** [0.002]*** [0.000]*** [0.925]	[0.825]	[0.004]***	[0.021]**	[0.971]	[0.006]***
Hong Kong	$ca = 0.015nfa + 0.150open - 0.099reer - 0.144rel\_y$	-0.492	1.724	0.175	-0.183	-0.118
	(0.003) (0.042) (0.033) (0.083)	(0.111)	(0.724)	(0.270)	(0.102)	(0.066)
	[0.008]*** [0.671] [0.054]* [0.213]	[0.000]***	[0.018]**	[0.607]	[0.166]	[0.134]
India	$ca = 0.076nfa + 1.058open - 0.056reer - 0.291rel\_y$	-0.205	0.795	0.198	-0.333	-0.402
	(0.017) (0.171) (0.024) (0.064)	(0.064)	(0.156)	(0.061)	(0.092)	(0.113)
	[0.000]*** [0.000]*** [0.027]** [0.000]***	[0.009]***	[0.000]***	[0.001]***	[0.000]***	[0.000]***
Korea	$ca = 0.041nfa - 0.026open - 0.251reer - 0.137rel\_y - 1.26$	-0.144	0.010	0.153	-0.074	-0.173
	(0.026) (0.122) (0.061) (0.055)	(0.055)	(0.075)	(0.077)	(0.119)	(0.043)
	[0.238] [0.857] [0.004]*** [0.067]*	[0.001]***	[0.900]	[0.124]	[0.625]	[0.001]***
Malaysia	$ca = -0.048nfa - 0.250open - 0.410reer - 0.547rel\_y$	-0.309	-0.289	-0.723	0.052	-0.316
	(0.012) (0.079) (0.155) (0.141)	(0.079)	(0.161)	(0.216)	(0.069)	(0.073)
	[0.001]*** [0.090]* [0.168] [0.091]*	[0.001]***	[0.132]	[0.015]**	[0.562]	[0.002]***
Philippines	$ca = -0.195nfa - 0.050open - 0.031reer + 0.023rel\_y + 0.09$	-0.195	-0.160	-3.298	1.028	0.880
	(0.040) (0.011) (0.010) (0.013)	(0.097)	(0.068)	(0.955)	(0.752)	(0.288)
	[0.004]*** [0.005]*** [0.097]* [0.206]	[0.063]*	[0.091]*	[0.006]***	[0.268]	[0.010]**
Singapore	$ca = -0.057nfa + 0.130open - 0.292reer + 0.793rel\_y$	-0.194	-0.743	0.569	-0.031	0.016
	(0.011) (0.042) (0.175) (0.106)	(0.073)	(0.199)	(0.158)	(0.020)	(0.025)
	[0.001]*** [0.057]* [0.267] [0.001]***	[0.002]***	[0.002]***	[0.011]***	[0.193]	[0.581]
Thailand	$ca = -0.045nfa + 0.436open + 0.517reer - 0.505rel\_y$	-0.348	0.142	0.271	0.081	-0.082
	(0.017) (0.098) (0.190) (0.114)	(0.076)	(0.254)	(0.102)	(0.084)	(0.039)
	[0.204] [0.083]* [0.148] [0.032]**	[0.000]***	[0.770]	[0.018]**	[0.390]	[0.109]

(Table 2.5 continued)

Panel B: China's Case

Revised normalized cointegrating coefficients, β	Loading Factors/Adjustment coefficients, α				
	Δnfa	Δca	$\Delta open$	$\Delta reer$	Δrel_y
$nfa = 3.396ca + 2.088open - 1.343reer + 0.269rel\_y + 7.04$	-0.048	-0.003	0.133	-0.002	0.009
(1.332) (0.326) (0.147) (2.306)	(0.016)	(0.009)	(0.058)	(0.051)	(0.003)
[0.072]* [0.002]*** [0.000]*** [0.925]	[0.004]***	[0.769]	[0.021]**	[0.971]	[0.006]***

Note: 1. Standard errors are in parentheses. P-values are in square brackets.
2. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

and significance of the loading factors, normalising the unique cointegrating vector on *ca* is appropriate for all sample economies expect for China where normalisation on *ca* is implausible due to the wrong sign (i.e. positive) and insignificance of the loading factor associated with *ca*. As a result, the unique cointegrating vector is normalised on the initial stock of net foreign assets, *nfa*, for China since normalisations on the other variables including the REER, trade openness and relative income can result either wrongly signed and insignificant loading factors or implausible values for the normalised cointegrating vectors.

Panel B reports the revised normalisation results for China. Results in Panel B show that, after normalising on *nfa*, the associated loading factor is correctly signed and statistically significant at 1% significance level. The cointegrating vectors are all correctly signed and significant at 10% significance level except that the coefficient associated with relative income, *rel_y*, is correctly signed but statistically insignificant. Therefore, the magnitude of the normalised cointegrating vectors, β, also confirms that normalising on *nfa* is appropriate for China. Since normalisation on *ca* is implausible for China, China is treated as a special case and will be discussed separately after the analysis of the other seven sample economies' long-run results.

The normalised cointegrating vectors reported in table 2.5 panel A suggest that the initial stock of NFA, trade openness, REER and domestic relative income have different long-run impacts on the current account balances across the seven sample economies. First of all, the coefficient of initial level of NFA stocks is statistically significant in the ca_t cointegrating equation at 1% significance level for all sample economies except for Korea and Thailand. However, the sign of this coefficient is different across economies. In the cases of Hong Kong and India, the initial stock of NFA has a positive impact on the long-run current account developments. This implies that, for these two economies, when initial stock of NFA is high, current account balance increases in the long-run due to large net investment earnings from abroad. This is consistent with both the prediction of the intertemporal approach and the result found by most of the studies in the existing empirical literature using cross section or panel estimation approach.

On the other hand, the initial stock of NFA has a negative effect on the current account balance in the long-run for Malaysia, Philippines and Singapore, which is contradictory with the common finding in the empirical literature. However, from an intertemporal perspective, this negative relationship can be interpreted in a way that economies with a relatively high initial level of NFA can afford to run current account deficits for an extended period and still remain solvent. In the cases of Malaysia, Philippines and Singapore, this negative effect dominates the positive effect resulted from large net investment earnings from abroad when initial stock of NFA is high. For Korea and Thailand, the initial stock of NFA does not have a significant role in explaining the long-run current account developments.

Second, the coefficient of trade openness is statistically significant at 10% significance level for all selected economies except for Hong Kong and Korea. In the cases of Malaysia and Philippines, the estimated coefficient shows a negative relationship between the trade openness and the current account balance in the long-run, which coincides with both the prediction of the intertemporal approach and the finding of Chinn and Prasad (2003). This result suggests that trade liberalisation policies can reduce the current account balances in the long-run. As the intertemporal approach pointed out, a higher degree of trade openness indicates a more liberalized trade system that makes an economy more attractive to foreign direct investments. Consequently, an economy's capital account will increase but its current account will decrease.

Nevertheless, the coefficient of trade openness enters positively into the cointegrating equation for India, Singapore and Thailand, which contradicts with the findings in the common empirical literature and violates the prediction of the intertemporal approach.

However, Lane (2000) postulates that a higher degree of trade openness is often associated with greater output volatility, which calls for the need to accumulate substantial net foreign assets for the purpose of income smoothing and risk diversification by incurring current account surplus. Also, a more liberalized trade system with less trade restrictions may lead to lower domestic prices and depreciated real exchange rates (Edwards and Ostry (1990) and Goldfajn and Valdes (1999)), which help to improve the current account balances.

Third, the estimated coefficient of REER is statistically significant at 10% significance level for all the sample economies except for Malaysia and Singapore, which implies that the REER does not have an impact on the long-run current account developments in these two economies. Furthermore, the estimated coefficient of REER enters negatively into the cointegrating equation for most of the sample economies. This result is supported by the common literature, which suggests that an increase in the REER can reduce the propensity to save and therefore cause a decrease in an economy's current account balance.

However, one thing worth noticing there is that the estimated coefficient of REER appears to be positive in the case of Thailand, which is inconsistent with the common finding in the empirical literature. However, this could be explained by the smooth consumption hypothesis. Obstfeld and Rogoff (1995) argue that the current account can act as a buffer to smooth consumption when there are shocks to domestic savings. For example, in response to a real effective exchange rate appreciation, an open economy would prefer to run a current account surplus and invest abroad rather than allow consumption to increase. A real appreciation in the domestic currency would therefore result in an improvement of the current account (Herrmann and Jochem, 2005). However, this positive coefficient is statistically insignificant in the case of Thailand.

Finally, the coefficient of domestic relative income appears to be statistically significant at 10% significance level for all the sample economies except for Hong Kong and Philippines. On one hand, in the case of Singapore, the estimation result suggests a positive long-run relationship existing between the domestic relative income and current account balances. This result the intertemporal approach suggests that the stage of economic development is an important factor confirms the role of stage of economic development in explaining the long-

run current account developments as suggested by the intertemporal approach. It also coincides with the empirical findings of Chinn and Prasad (2003).
On the other hand, the domestic relative income has a negative long-run impact on the current account in the cases of India, Korea, Malaysia and Thailand. This result rejects the 'stages of development' hypothesis, which expects that less developed economies run current account deficits due to their high demands in foreign capitals. In particular, the estimation results indicate that if the domestic income in these four economies is 1% below the U.S. income level, their current account balances would improve by approximately 0.137 (Korea) to 0.547 (Malaysia) of a percentage point. However, this finding is consistent with the findings of Aristovnik (2007) for countries in the Middle East and North Africa (MENA) region.

Next, let us now turn back to the China's case. According to the results reported in table 2.5 panel A, the loading factor associated with *ca* is wrongly signed and statistically insignificant for China when normalisation is made on *ca*. This result implies that the current account balances in China is weakly exogenous in the VAR system. This surprising finding suggest that, at least in the long-run, current account is not driven by any other variables in the system, but instead is likely to influence them by itself. Since the unique cointegrating vector is normalised on *nfa* in the case of China, the underlying implication for policy analysis is that current account can be used as a policy instrument in China to control its stock of net foreign assets.

Further, table 2.5 panel B reports the results when normalisation is made on *nfa* for China. The results indicate that all the cointegrating coefficients are statistically significant at 10% significance level or lower expect the coefficient of domestic relative income. Moreover, all the cointegrating coefficients are with the expected signs as predicted by the common literature.

To be more specific, first, an increase in the China's current account balance has a positive effect on the NFA since the NFA position reflects the cumulative addition of all prior current account balances. Second, trade openness is also positively associated with the NFA position, which can be interpreted in a way that, an economy with less trade restrictions and more exposure to international trade tends to be relatively more attractive to foreign capital and therefore increases the NFA. Third, a negative relationship is found between the REER and

NFA. Indeed, an increase in the REER in this study implies an appreciation in the home currency that can worsen the current account and thus decrease the accumulation of NFA. Finally, the positive relationship between domestic relative income and the NFA can be explained in several ways. According to the traditional stages of development hypothesis for balance of payments, when an economy moves from a low to an intermediate stage of development, the economy typically imports capital from abroad. As a result, the NFA increases. On the other hand, as suggested by Lane and Milesi-Ferretti (2001), if an economy grows richer is due to a decrease in the domestic marginal product of capital, domestic investment would fall and home investors would look for oversea investment opportunities.

Figure 2.4: Estimated Johansen-Juselius Cointegrating Vectors

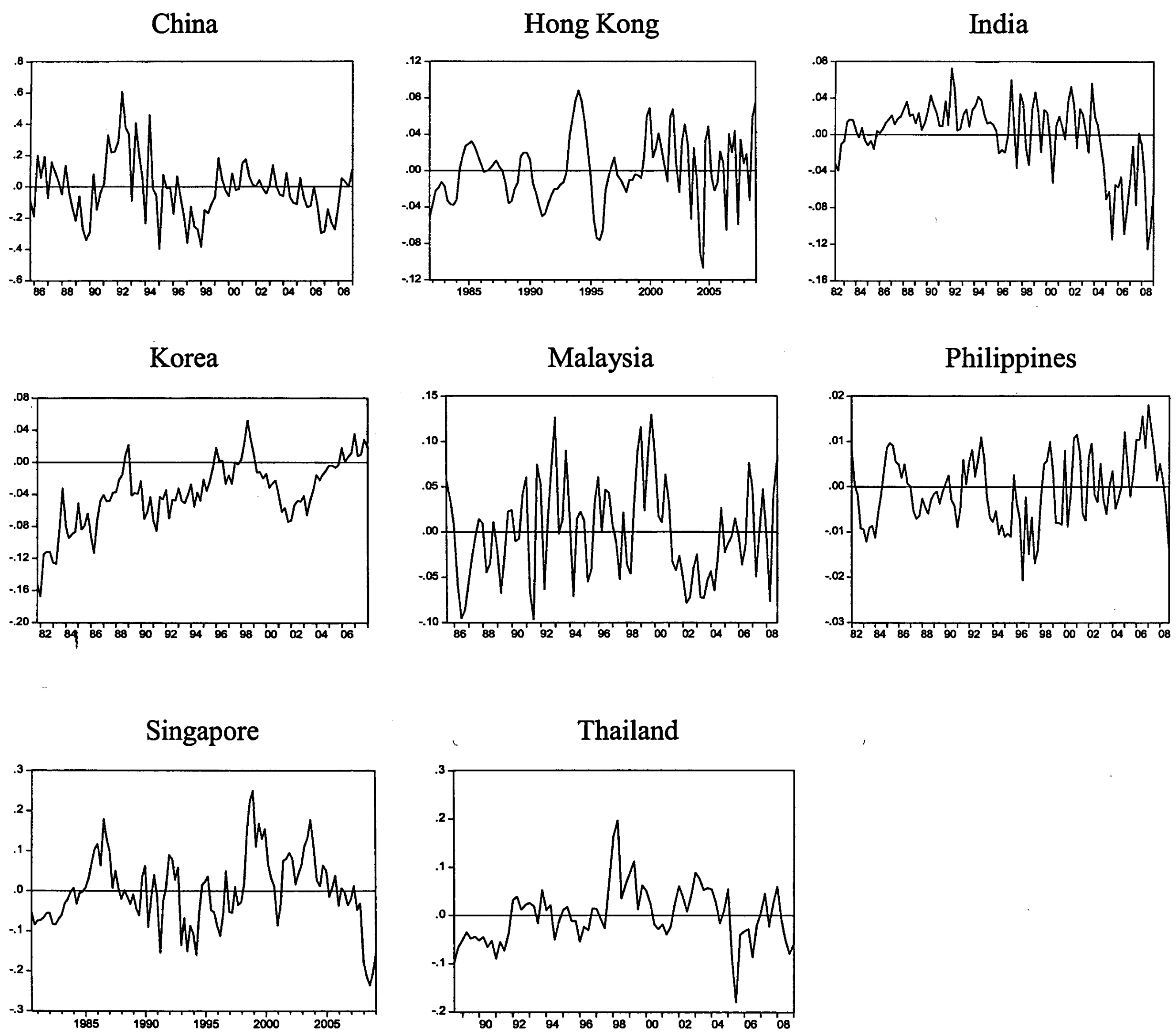


Figure 2.4 above presents the estimated cointegrating vectors obtained by the JJ's approach. For all the sample economies the estimated cointegrating vector is normalised on *ca* except that the estimated cointegrating vector is normalised on *nfa* in the case of China. It clearly reveals that, toward the end of the sample period, most of the other sample economies have had their current account positions close to the long-run equilibrium positions (i.e. the zero line in figure 2.4), while China has had its initial NFA position close to its long-run equilibrium position. However, the figure suggests that India and Singapore had relatively large current account deviations from their current account equilibrium values (i.e. depart from the zero line in figure 2.4). To find out whether these large deviations in the long-run can be explained by a slow adjustment toward an otherwise healthier long-run position in these two economies, I now turn my attention to the short-run dynamics of current account immediately in the next section.

2.6.4 Short-Run Dynamics of Current Account

In this section, the linear VECM described by equation (2.6) is used to investigate the short-run dynamics of each sample economy's current account. The VECM is estimated by the Full Information Maximum Likelihood (FIML) method. A focus has been clearly made on the Δca_t equation of each VECM in the analysis in order to find out the effects of the explanatory variables have on the current account in the short-run and also whether the current account can successfully self-adjust each time it diverges from its long-run equilibrium value. Table 2.6 on the next page presents the estimated results of the parsimonious form of the Δca_t equations for all sample economies except for China. Again, China is treated as a special case and will be discussed separately towards the end of this section.

As reflected in the results reported in the table 2.6 panel A, the short-run effects of *nfa, open, reer* and *rel_y* on current account are very different across the seven sample economies. First of all, the initial stock of NFA shows no significant short-run effect on the current account for most of the seven sample economies. However, in the cases of Hong Kong and Thailand, the initial stock of NFA has a significant negative contemporaneous effect on these two economies' current account balances. Second, the short-run effect of the trade openness appears to be significant in only three economies. To be more specific, it has a positive short-

Panel A: Estimation of Δca_t Equation

	Hong Kong	India	Korea	Malaysia	Philippines	Singapore	Thailand
α							0.009 [0.018]**
Δca_{t-1}		-0.475 [0.000]***	-0.225 [0.049]**		-0.288 [0.012]**	-0.248 [0.015]**	-0.266 [0.097]*
Δca_{t-2}		-0.366 [0.004]***					
Δca_{t-3}		-0.387 [0.005]***					
Δnfa_{t-1}							-0.062 [0.022]**
Δnfa_{t-2}	-0.019 [0.059]*						
$\Delta open_{t-1}$		-0.393 [0.001]***		0.105 [0.013]**			-0.445 [0.000]***
$\Delta open_{t-2}$		-0.434 [0.008]***					
$\Delta open_{t-3}$		-0.566 [0.003]***					
$\Delta reer_{t-1}$			-0.118 [0.054]*				-0.775 [0.000]***
$\Delta reer_{t-2}$							
$\Delta reer_{t-3}$		-0.163 [0.016]**					
$\Delta reer_{t-4}$		-0.150 [0.036]**					
Δrel_y_{t-1}							-0.559 [0.005]***
Δrel_y_{t-2}							
ect_{t-1}	-0.492 [0.000]***	-0.205 [0.009]***	-0.144 [0.001]***	-0.309 [0.001]***	-0.195 [0.063]*	-0.194 [0.002]***	-0.348 [0.000]***

Panel B: Diagnostic Tests of Δca_t Equation (p-values)

	Hong Kong	India	Korea	Malaysia	Philippines	Singapore	Thailand
LM test for autocorrelation	0.13	0.23	0.11	0.53	0.19	0.15	0.18
JB's Normality Test	0.08*	0.10	0.19	0.49	0.60	0.19	0.52
LM F-test for ARCH	0.31	0.15	0.13	0.70	0.13	0.64	0.29
White's test for heteroscedasticity	0.15	0.17	0.26	0.17	0.76	0.60	0.11

Note: 1. All the insignificant variables are removed from the system to leave the conditional VECM in its parsimonious form.

2. P-values are in square brackets. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.
3. The ect_{t-1} is derived from the long-run cointegrating vector normalised on ca_t.
4. The null hypothesis in ARCH test is 'the residual does not have autoregressive conditional heteroscedasticity'; the null hypothesis in the White's test is 'the residual does not have heteroscedasticity'.

run effect on the Malaysia's current account and a negative on the India and Thailand's current account balances. Third, REER has an expected negative contemporaneous effect on the short-run current account adjustment for India, Korea and Thailand. Finally, the short-run effect of the domestic relative income appears to be significant only in the case of Thailand where the effect is negative. These findings suggest two things. One thing is that the initial position of NFA and the degree of trade openness have less important roles to play in the short-run dynamics of current account than they would do in the long-run. The other thing is that, for most of the sample economies, given the significance of the lagged terms of Δca and the insignificance of the lagged terms of Δnfa, $\Delta open$, $\Delta reer$ and Δrel_y, this implies that the major determinant of the short-run current account adjustment is the latter's tendency to return to its long-run equilibrium position.

The estimated error correction term, ect_{t-1}, reported in table 2.6 panel A can shed more light on the short-run dynamics of the current account. When a gap between the current account and its equilibrium level arises, the current account will tend to converge to its equilibrium level. Depending on the cause of the gap, the adjustment requires that the current account either moves progressively toward a new equilibrium level, or returns from its temporary deviation to the original equilibrium value. The results show that the error correction term is statistically significant at 10% for all for seven sample economies. This implies that, for these economies, their current accounts can successfully converge to their own long-run equilibrium positions each time when there is a shock in the external sector. The estimated coefficient values of the ect_{t-1} suggest that the speeds of the current account adjustment are quite different across the seven sample economies. The size of the error correction has a range from -0.144 (Korea) to -0.492 (Hong Kong), suggesting slow to moderate speed of adjustment. To be more specific, for Korea, about 14.4% of the current account deviation would be eliminated every quarter, implying that in the absence of further shocks the whole current account gap would be closed within two years. On the other hand, given a higher speed of adjustment rate in Hong Kong, in the absence of further shocks the entire current account gap would be closed roughly about half a year.

Further analysis on the short-run dynamics of the current accounts is carried out by testing the hypothesis of weak exogeneity for nfa, $open$, $reer$ and rel_y. The test is performed by imposing zero restriction on the ect_{t-1} term in each of the five equations constituting the

VECM system given by equation (2.6). Since the ect_{t-1} term is derived from the long-run cointegration relationship that normalised on *ca*, the significance of the ect_{t-1} term will indicate the long-run causal relationship between the long-run fluctuations of the current account and the short-run dynamics of all the other variables in the VECM system. The test results are presented in the earlier table 2.5 panel A.

Concentrating on the right-hand-side section of table 2.5 panel A (i.e. loading factors/adjustment coefficients) and ignoring the China's case which will be discussed separately later on, the estimated loading factors suggest that the initial stock of NFA is weakly exogenous only in Korea, Malaysia and Thailand; trade openness is weakly exogenous only in Hong Kong and Korea; REER is weakly exogenous in all seven sample economies except India, and domestic relative income is weakly exogenous only in Hong Kong, Singapore and Thailand.

The above results have two important implications. First, in the majority of the seven sample economies, excessive volatility of the current account resulting from the short-run fluctuations of the current account is smoothed out by modifying the stock of NFA, degree of trade openness and domestic income throughout the long-run. Second, the weakly exogenous REER term in most of the sample economies indicates structural rigidities for these emerging Asian economies, as the REER term is a measure of an economy's international competitiveness. On the other hand, the non-weakly exogenous REER in India suggests that India has a higher degree of adaptability to changing external sector conditions and a competitive advantage relative to the rest of the selected economies in emerging Asia. The diagnostic tests results reported in table 2.6 panel B on earlier page indicate that, for all the seven sample economies, there are no signs of autocorrelation, heteroscedasticity, and residuals are normally distributed at 5% significance level.

Now, let us look at the China's case. Although current account does not react to long-run disequilibria in *nfa, openness, reer* and *rel_y*, it may still react to changes in these variables in the short-run. Table 2.7 panel A below reports the estimated results of the parsimonious form of the Δca_t equation for China.

Table 2.7: China's Case: Estimated Δca_t and Δnfa_t Equations of the VECM System

Panel A

$$\Delta ca_t = -\underset{[0.014]^{**}}{0.049}\,\Delta reer_{t-1}$$

Diagnostic Tests	p-value
LM F-test for autocorrelation:	0.83
Jarque-Bera Chi-square test for normality:	0.09*
LM F-test for ARCH:	0.91
White's Chi-square test for heteroscedasticity:	0.95

Panel B

$$\Delta nfa_t = -\underset{[0.007]^{***}}{0.048}\,ect_{t-1} + \underset{[0.027]^{**}}{0.384}\,\Delta ca_{t-1} + \underset{[0.000]^{***}}{0.762}\,\Delta nfa_{t-1} - \underset{[0.028]^{**}}{0.079}\,\Delta open_{t-1} - \underset{[0.000]^{***}}{0.112}\,\Delta reer_{t-2}$$

Diagnostic Tests	p-value
LM F-test for autocorrelation:	0.23
Jarque-Bera Chi-square test for normality:	0.14
LM F-test for ARCH:	0.55
White's Chi-square test for heteroscedasticity:	0.16

Note: 1. All the insignificant variables are removed from the system to leave the conditional VECM in its parsimonious form.
2. P-values are in square brackets. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.
3. The ect_{t-1} is derived from the long-run cointegrating vector normalised on nfa_t.

As noticed earlier, the ect_{t-1} term does not significantly enter into the Δca_t equations at 10% significance level in the case of China. This implies that, in the case of China, deviations from the long-run equilibrium value of the current account cannot be corrected through a self-adjusting mechanism in the short-run. Moreover, the estimated results suggest that the China's current account is only influenced by the REER in the short-run. To be more specific, an increase in the REER is likely to decrease the current account balance in the short-run. This effect is like to be due to the temporary loss in the international competitiveness.

Moreover, table 2.7 panel B on the previous page reports the estimated results of the parsimonious form of the Δnfa_t equation for China. The results suggest that the current account is a significant factor in the short-run fluctuations of NFA. This finding implies that, in the dynamic system, China alters its initial stock of NFA in response to the current account fluctuations in the short-run in order to correct for deviations from the long-run path, but not the other way around. At 5% significance level, the diagnostic tests results reported in table 2.7 indicate no signs of autocorrelation, heteroscedasticity and non-normality for the estimated residual term in the corresponding equations.

Finally, table 2.8 above presents the results of the uni-directional short-run Granger causality tests for all the eight sample economies.

Table 2.8: Uni-directional Short-run Granger Causality Test

Test equation:

$$\Delta ca_t = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta ca_{t-i} + \sum_{i=1}^{p} \beta_{2i} \Delta nfa_{t-i} + \sum_{i=1}^{p} \beta_{3i} \Delta open_{t-i} + \sum_{i=1}^{p} \beta_{4i} \Delta reer_{t-i} + \sum_{i=1}^{p} \beta_{5i} \Delta rel\_y_{t-i} + \beta_6 ect_{t-1} + \varepsilon_t$$

	China	Hong Kong	India	Korea	Malaysia	Philippines	Singapore	Thailand
Δnfa_{t-i}	[0.870]	[0.095]*	[0.352]	[0.537]	[0.585]	[0.712]	[0.896]	[0.022]**
$\Delta open_{t-i}$	[0.989]	[0.761]	[0.001]***	[0.587]	[0.013]**	[0.986]	[0. 906]	[0.000]***
$\Delta reer_{t-i}$	[0.061]*	[0.738]	[0.000]***	[0.150]	[0.922]	[0.650]	[0.332]	[0.000]***
Δrel_y_{t-i}	[0.163]	[0.441]	[0.005]***	[0.416]	[0.508]	[0.538]	[0.328]	[0.005]***

Note: *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively; numbers in square bracket denote chi-square probability values.

The results suggest that initial stock of NFA Granger causes current account only in the cases of Hong Kong and Thailand; trade openness has a short-run causal relationship with current account in the cases of India, Malaysia and Thailand; REER has a short-run causal relationship with current account in the cases of China, India and Thailand; and relative income Granger causes current account only in the cases of India and Thailand. Overall, most of the explanatory variables do not have a significant short-run causal relationship with current account for most of the selected economies. However, these Granger causality tests results need to be interpreted with cautions due to two main limitations of the test. First, this test is only able to identify 'temporal' causality rather than theoretical causality. Second, the test focuses on the relationship between lagged values of each of the explanatory variables and current values of current account. However many economic relationships involve simultaneous interaction of variables and this simultaneous causal dimension is not picked up at all.

2.7 Discussion

In general, the empirical evidence found in this chapter suggests that the initial stock of net foreign assets, degree of openness to international trade, real exchange rate and relative income have different impacts on the current account balances of the eight selected emerging Asian economies, which implies that these emerging Asian economies are heterogeneous. Moreover, this heterogeneity is an indication of structural differences among the emerging Asian economies toward business cycle heterogeneity, which could be explained by the fundamental structural differences embedded in the selected sample economies.

For example, although China and India are both categorized as low income economies, their economy structures are fundamentally different from each other where the former is following a socialist economy and the latter is following a mixed economy. Moreover, in contrast to India's neglect of the basic infrastructure, China is investing its surplus in railroad, power, road and water management in a concerted way. There is no question that China still lacks adequate infrastructure, but it has understood clearly the importance of modernizing its basic infrastructure to generate employment, adequate utilization of its vast population and attract more foreign direct investments.

On the other hand, Indian policy makers give the impression that India's strategy to accelerate growth is to leapfrog past technologies through its information technology (IT) acumen. India's services sector has seen a steady increase in growth rates, share of GDP and contribution to GDP growth. However, it is widely recognized that IT cannot move a slow moving economy, burdened with a massive shortfall of infrastructural development, crippling poverty and very high unemployment. Also, Indian policy makers focus more on the domestic demand side rather than the supply side. Consequently, the Indian imports were, on average, higher than its exports over the past few decades, which caused long-lasting current account deficits.

Furthermore, although Hong Kong and Singapore are both high income economies and they do share some similarities (i.e. for examples, both had once been British colonies that served as trading ports; each country developed a flourishing manufacturing sector after World War II and a financial services sector during the 1980s), there are vital differences embedded in the two economies. In general, these structural differences are believed to be the direct result of the contrasting levels of government intervention in these two economies. For instance, while the Hong Kong government has emphasised a policy of laissez faire, the Singaporean government has, since the early 1960s, pursued the accumulation of physical capital via forced national saving and the solicitation of a veritable deluge of foreign investment. However, the forced national savings were wasted over the years by Singapore's policy of 'industrial targeting'. Singapore is a victim of its own targeting policies, which are increasingly driving the economy ahead of its learning maturity into the production of goods in which it has lower and lower productivity. Singapore has had one of the most rapid rates of intra-manufacturing structural change in the world economy. As a consequence, Singapore had one of the lowest returns to physical capital in the world.

The days in which Singapore can continue to sustain accumulation driven growth can be thus clearly numbered.

On the other hand, although Hong Kong's economic system does not strictly adhere to the laissez faire doctrine, it is, by most standards, free of governmental controls (i.e. the government has long supported the predominance of the private sector and there are virtually no restrictions on capital, labor and enterprise). As a result, Hong Kong's more laissez faire policy has made its economy once again the freest in the world. At the same time, Hong Kong has achieved enviable economic growth without compulsory saving, industrial targeting, or other policies that not only impinge on economic freedom but also do nothing in the long run to foster growth.

Finally, structural differences are also lying under the Korea, Malaysia, Philippines and Thailand's economies. For examples, having almost no natural resources and always suffering from overpopulation in its small territory, which deterred continued population growth and the formation of a large internal consumer market, Korea adapted an export-oriented economic strategy to fuel its economy. Meanwhile, the economy of Malaysia is a growing and relatively open state-oriented and newly industrialized market economy. The state plays a significant but declining role in guiding economic activity through macroeconomic plans. Manufacturing has a large influence in the country's economy. Also, Malaysia is the world's largest Islamic banking and financial centre. For Philippines, food processing, textiles and garments and electronics assembly are its important industrial sectors. As a newly industrialized nation, Philippines is still an economy with a large agricultural sector. In the case of Thailand, its economy is heavily export-dependent, with exports accounting for more than two thirds of its GDP and tourism is an important component of its GDP (i.e. 8% in year 2010).

Overall, I find that economic structures are quite heterogeneous across the selected emerging Asian economies even though some of them fall into the same income level category, which is measured by GDP per capita. This heterogeneity may, to some extent, explain why the same set of explanatory variables can have different impacts on each sample economy's current account.

2.8 Conclusion

This chapter provides an empirical analysis of the long-run determinants of current account and also the short-run dynamics of current account adjustment for eight largest emerging Asian economies. Quarterly data from 1980 to 2009 is used in the study. Given the non-stationary nature of the data used in this study, this chapter adopts a cointegrated VAR approach to analyze current account balances and a set of macroeconomics determinants. In the presence of a unique cointegration, the long-run determinants of current account are analyzed based on the estimated cointegrating parameters, while the short-run dynamics of current account is investigated according to the estimation of a linear VECM.

The main findings of this study can be summarized as follows. First, current account behaviours in emerging Asian economies are heterogeneous. This heterogeneity is an indication of structural differences among the emerging Asian economies toward business cycle heterogeneity. Second, there is a strongly significant long-run relationship among the current account, initial stock of NFA, trade openness, REER and domestic relative income for all the sample economies. Compared with the REER and domestic relative income, the initial stock of NFA and the degree of trade openness are more important factors in explaining the long-run behaviour of current account in most of the sample economies. Third, current accounts of all sample economies have a self-adjusting mechanism, the only exception being China. On average, the short-run current account adjustment toward long-run equilibrium path is gradual, with the disequilibrium term (ect_{t-1}) being the main determinant of the short-run current account variations.

In addition, compared with other selected economies, I find that China has been a very special case in this study. To be more specific, China's current account is not driven by its initial position of NFA, degree of trade openness, REER and relative income in the long-run. However, it still reacts to changes in the REER in the short-run. Moreover, in the case of China, current account is found to be a significant factor in both the long-run and short-run fluctuations of the initial stock of NFA. This finding implies that current account can be used as a policy instrument in China to control its initial stock of NFA, but not the other way around.

Last but not least, this chapter analyses the short-run dynamics of current account adjustment based on a linear VECM. However, it should be noted that current account adjustment process could be non-linear. This opinion has been recently expressed by Clarida *et al.* (2006), Arghyrou and Chortareas (2008) and de Mello and Mogliani (2010).[9] They suggest that linear VECM tend to poorly approximate the non-linear current account adjustment. Moreover, non-linear methods may shed more light on the adjustment mechanism of current account imbalances and could demonstrate how robust the linear framework is. Therefore, an interesting avenue for future research is to both test for and estimate the non-linear current account adjustment for consider the sample economies selected in this chapter using more appropriate software.[10]

[9] Clarida *et al.* (2006) use a threshold autoregressive model to assess the current account dynamics for the G7 countries; Arghyrou and Chortareas (2008) test for nonlinear effects in the current account dynamics of the EMU (European Monetary Union) countries using a smooth-threshold error correction model; and de Mello and Mogliani (2010) estimate the determinants of the Brazil's current account in a smooth-transition vector-autoregressive setting.

[10] The author has tried to test and estimate two non-linear current account adjustment models (i.e. including both the logistic smooth threshold model and the quadratic logistic smooth threshold model) using Eviews 6.0 in this study. Unfortunately, due to some unsolved technical bugs of the software, Eviews 6.0 cannot provide consistent and reliable results for the estimations of these two non-linear models. Therefore, an appropriate software is essential to the analysis of the non-linear current account adjustment models in future research.

Chapter 2 Data Appendix

Data Description and Sources

ariable	Descriptor	Units	Database
a	Current account balance (*ca*>0 surplus; *ca*<0 deficit)	Ratio to GDP	IFS[1]
fa	One period lagged net foreign asset position	Ratio to GDP	Annual data is obtained from "Updated and extended version of the External Wealth of Nations Mark II database developed by Lane and Milesi-Ferretti (2007)"[2]
en	Trade openness; Sum of exports and imports	Ratio to GDP	IFS
er	Natural logarithm of real effective exchange rate (trade-weighted)[3]	Index number (2000Q1=100)	IFS, BIS[4]
l_y	Domestic relative income level; rel_y = y/y^*, where:		
	y Natural logarithm of domestic real GDP[5]	Real GDP volume index (2000Q1=100)	IFS, OECD[6]
	y^* Natural logarithm of US real GDP[7]	Real GDP volume index (2000Q1=100)	IFS, OECD[8]

International Monetary Fund's (IMF): International Financial Statistics 2009 online database.

2008 data are calculated using the same method as in Lane-Milesi-Ferretti (2007). Quarterly data are interpolated results by using cubic spline interpolation method.

For China, Hong Kong, India, Malaysia, Philippines, Singapore and Thailand are Consumer-Price-Index (CPI) based REER, while for Korea is Unit-Labour-Cost (ULC) based REER.

Bank for International Settlements: 2009 online statistics for effective exchange rate indices.

In the case of China, Index of Industrial Production (IIP) is used instead of real GDP volume index.

Organisation for Economic Co-operation and Development: 2009 online database for China's IIP data.

In order to be consistent with the measure of both domestic and foreign output, Index of Industrial Production (IIP) of US is used instead of real GDP volume index in the case of China.

Organisation for Economic Co-operation and Development: 2009 online database for US's IIP data.

Chapter 3

Current Account Sustainability in Eight Emerging Asian Economies

3.1 Introduction

The sustainability of a country's current account position is one of the most discussed topics in the field of open macroeconomics in recent times. Due to economic globalization, technological innovation and financial deregulation happened in the past thirty years, current account imbalances have been widening considerably in the world economy, especially since the early 1990s. These large current account imbalances are more severe between United States (US), on one hand, and the emerging Asia and oil-exporting countries, on the other.

Gourinchas and Rey (2005) and Mendoza, Quadrini and Rios-Rull (2007) suggest that these widening global imbalances are not necessarily a bad thing, to the extent that they may simply reflect increased financial integration and a more efficient allocation of global savings across countries. It is the growing gap between the external positions of surplus and deficit countries that has risen concern about the sustainability of such imbalances and also the risks that disruptive movements in exchange rates and capital flows could pose for global growth. Although the US sub-prime mortgage crisis and a dramatic decrease in the value of oil revenues helped to narrow down the current account imbalances sharply in 2008, the emerging Asia kept running large and persistent current account surplus. Right now, the remaining large current account surplus of emerging Asia would become the main counterpart to the current account deficits of US. Emerging Asian countries are now facing an enormous challenge to reduce the large current account imbalances.

Although short-run disequilibria in current account may not be harmful, persistent current account imbalances can have serious impacts on domestic economy due to the undesirable consequences of a sharp forced adjustment by the private and public sector if such tendencies are expected to continue. For example, persistent current account deficits may lead to an increase in domestic interest rates in order to attract foreign capital. Moreover, the corresponding accumulated external debts due to persistent deficits also imply an increase in interest payments which can impose an excess burden on future generations.

Researchers claim that the mean-reverting behaviour of current account has two main important implications for international macroeconomics. First, a stationary current account is consistent with sustainability of the external debts. In this case, the government would have no incentive to make drastic policy changes in the near future. Second, stationarity of the current account theoretically validates the modern intertemporal model as the model combines the assumptions of perfect capital mobility and consumption smoothing behaviour to postulate that the current account acts as a buffer to smoothing consumption in the event of shocks. Therefore, testing the sustainability of the current account in an economy is important.

In recent years, more researchers have realized the importance of testing the current account sustainability. Many of them have investigated the mean-reverting behaviour of current account by using single equation unit root tests and/or cointegration tests. However, due to differences in methodology, approach and sample size, previous studies provide mixed results in favor of the sustainability in the existing literature. In general, studies that adopt conventional unit root and/or cointegration techniques usually reject the mean-reverting proper of current account. One possible reason to explain this is that conventional unit root tests ignore the presence of structural breaks or dummy shifts in the examined time series. Perron (1989, 1990) and Perron and Vogelsang (1992) have shown that when a time series has structural breaks or dummy shifts in the mean or trend, the unit root hypothesis is often accepted before structural breaks are taken into account, while it is rejected after structural breaks or dummy shifts are considered. Therefore, it is important to consider possible structural breaks or shifts when researchers examine the mean-reverting property of current account.

The objective of this chapter is to investigate empirically the long-run sustainability of the current account in eight largest emerging Asian economies including China, Hong Kong, India, Korea, Malaysia, Philippines, Singapore and Thailand since the beginning of 1990s. This chapter analyses current account sustainability in the context of the intertemporal budget constraint approach. Unlike the previous studies in the literature who had a focus on examining the strong form of current account sustainability which requires a cointegration between an economy's exports and imports and also a unity slope parameter between the two variables, the study in this chapter performs both strong and weak form tests of current account sustainability for each sample economy. The current study is carried out in four stages. First, the time series properties of EX_t and MM_t of each sample economy are examined using unit root tests both with and without structural break. Second, the long-run cointegrating relationship between EX_t and MM_t is investigated without accounting for any structural shifts in current account balances. At the third stage, the stability of the cointegrating relationship between EX_t and MM_t is tested and possible shifts in the cointegrating relationship are endogenously identified. Finally, accounting for the identified dummy shifts obtained from the previous stage, the cointegrating relationship between EX_t and MM_t is re-examined and the long-run effect of each dummy shift had on each sample economy's current account balances is analyzed.

In this chapter, I show that whether or not one can find sustainability depends not only on the definition, but also on the econometric techniques applied. The key findings in this chapter can be summarized as follows. First, a strong form test of current account sustainability and cointegration tests without allowing any dummy shift in the long-run cointegrating relationship between exports and imports usually suggest unsustainability of current account. Second, multiple shifts in current account balances are found for all the sample economies. Most of these shifts are linked to either some crucial global economic events or some important domestic policy changes. Third, according to the more generalized sustainability conditions used in this chapter, all the sample economies are found to be on a sustainable current account path. Hong Kong and Philippines have strong form of current account sustainability irrespective of the presence of dummy shift in the cointegration analysis, while Korea and Singapore only have weak form of sustainability when dummy shifts in the cointegrating relationship between exports and imports are ignored but have strong form of current account sustainability when these dummy shifts are taken into consideration. For the rest of the sample economies, they always have the weak form of current account sustainability irrespective of the presence of dummy shifts in the cointegration analysis. Finally, I find that the results based on the procedures accounting for structural shifts are more in favor of current account sustainability. This is mainly because accounting for endogenously identified dummy shifts increases the instances of cointegration between an economy's export and imports.

In general, the study in this chapter contributes the current empirical literature in four important ways. First, while the previous studies in the literature normally consider one or two structural breaks (or dummy shifts) in their cointegration analysis of current account sustainability, the issue of multiple dummy shifts is addresses in this chapter. In particular, these multiple dummy shifts are endogenously identified.

Second, conclusions made in these studies on an economy's current account sustainability could be limited and biased due to the ignorance of the weak form of current account sustainability. This study overcomes this problem by implementing both strong and weak form tests of current account sustainability and tries to provide a broader view on the current account sustainability issues in the selected sample economies.

Third, although several studies have examined the sustainability of current account positions for some emerging Asian economies (for examples, Korea, Malaysia, Philippines and Thailand), few of them have paid enough attention to the cases in China and India. However, since these two economies have become more important in Asia, it is necessary to understand the sustainability of their current account imbalances.

Last but not least, unlike the traditional literature, this study also pays attention to the issue of current account sustainability for those large trade surplus emerging Asian economies, for example, China. Most researchers concern more about the sustainability of current account deficits since they believe that unsustainable current account deficit imply that there is a high probability that an economy would default on its debt payments and therefore causes currency crisis (Edwards, 2002). However, the sustainability of an economy's current account surplus can also provide straight policy implications on a nation's economic progress and also the world economic development in the future. For example, in the case of China, rising trade surpluses often worsen China's trading relations with its major trading partners and thus threaten its growth sustainability. Therefore, if the current large trade surplus in China is not sustainable, the Chinese government should rebalance its growth from external sources to domestic sources and run smaller trade surpluses in the future. On the other hand, the sustainability of the current global current account imbalances is partly conditional on the willingness of emerging Asian economies, especially East Asian economies, to hoard international reserves and to maintain large net saving positions. In other words, whether the large US deficit can be sustainable in the future will partly depend on the sustainability of the current account surpluses in emerging Asian economies.

The remainder of this chapter is organized as follows: Section 3.2 presents some stylized facts on the development of current account imbalances in the eight sample economies over the period 1990-2009. Section 3.3 presents the underlying theoretical model that is commonly adopted in the empirical literature to test current account sustainability. Section 3.4 provides a brief empirical literature review of current account sustainability. Section 3.5 discusses the econometric methodology used in this chapter. Section 3.6 describes the data and sample periods and section 3.7 presents the empirical results. Section 3.8 provides the robustness test results. Finally, section 3.9 concludes.

3.2 Some Stylized Facts

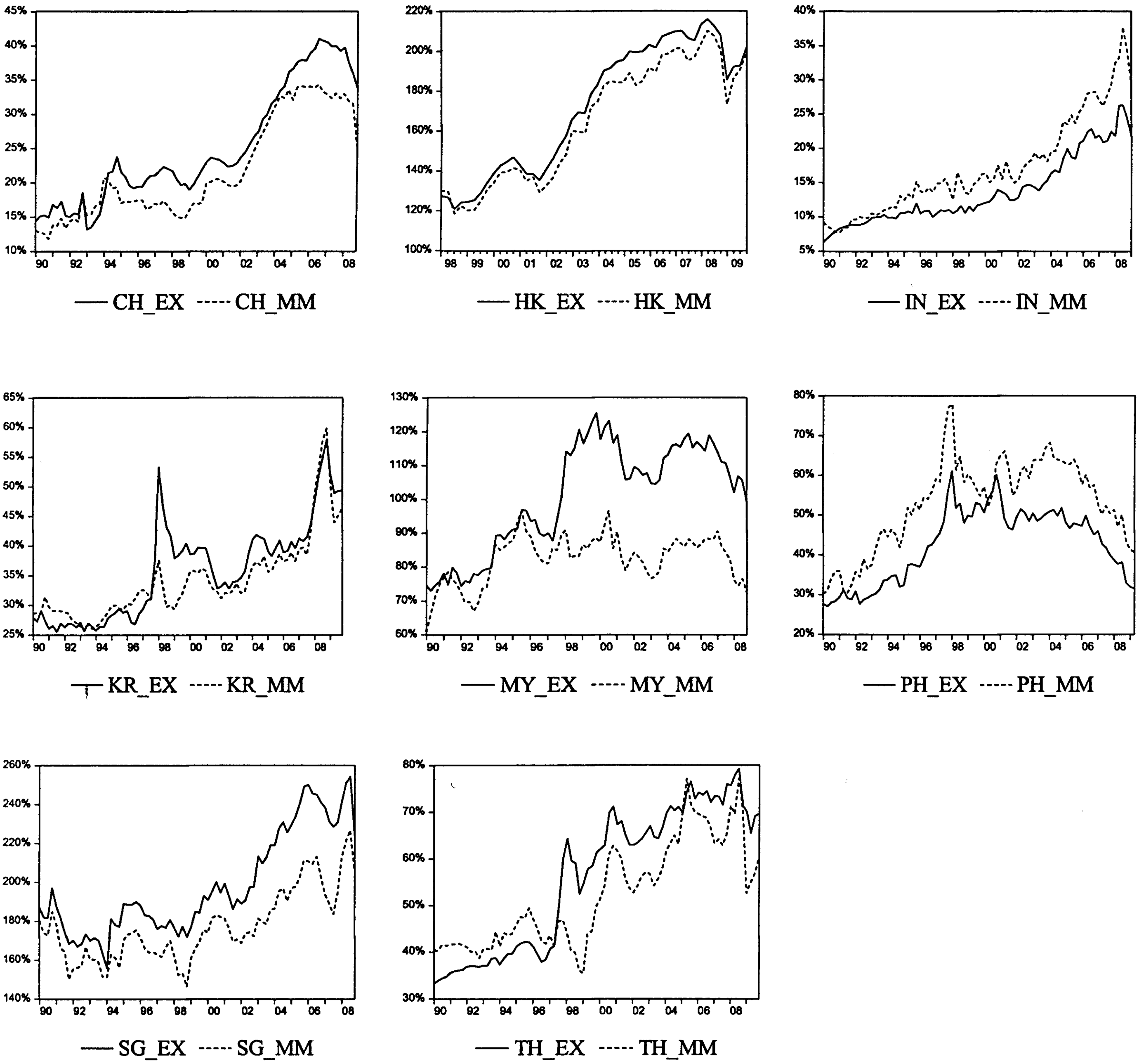
External current account positions began to diverge in the early 1990s when many emerging Asian economies, for examples, China and India, rushed to reform. Those emerging Asian economies hoped that external financing could reduce the scarcity of savings in their domestic markets. However, this has not been the case. Financial globalization does let to deeper financial diversification, a growing importance of foreign direct investment, but to no significant increase in the net resources available to finance the growth of emerging economies. Meanwhile, faster growing emerging economies more than self financed their growth, running overtime significant current account surpluses. For example, China accelerated its GDP growth from about 7% at the end of the 1990s to around 11% at the beginning of year 2010. During the same period, China increased its current account to GDP ratio from approximately 3% to 10%, hoarding most of the recent surpluses in the form of international reserves.

Global current account imbalances began to rise more rapidly in the second half of the 1990s, an upward trend that came to a temporary end with the global crisis in 2008. During this period, US kept running large and persistent current account deficits, while most emerging Asian economies kept running persistent current account surpluses. Most emerging Asian economies invested their excessive savings in the US market. One reason to explain the flow of savings from emerging market to developed market is the lack of financial and capital market development in emerging Asian economies. Those immature domestic financial or capital markets prevent the effective channeling of domestic savings into worthwhile investment projects at home. Another possible reason to explain the large and persistent current account surpluses in Asia is the export-let development strategy that adopted by emerging Asian economies, especially East Asian economies in the past years. This strategy is supported by exchange rate policies that linked domestic currencies to the US dollar and has succeeded in increasing the mobilization and employment of millions of workers.

Figure 3.1 on the next page presents the proportions of exports and imports (including net incomes and transfer payments) to GDP for all the selected sample economies in emerging Asia over the period 1990-2009, except that the sample period is 1995-2009 in the case of Hong Kong. It is evident at the first glance that there is a co-movement between exports and imports for most of the sample economies. The proportions of exports and imports to GDP in China, Hong Kong, India, Korea, Singapore and Thailand started to grow rapidly at the beginning of the 2000s and decreased a lot right after the US sub-prime mortgage crisis happened in 2008. On the other hand, the proportion of exports to GDP in Malaysia had a tremendous increase after the 1997 Asian financial crisis and remained at a high level thereafter, while the proportion of imports was kept at a relatively low level throughout the sample period. In the case of Philippines, the proportions of exports and imports to GDP grew quickly during the period 1990-2000, but then they started to decline afterward.

As shown in the figure, while the proportions of exports to GDP in most of the sample economies were higher than the proportions of imports to GDP in most of the sample periods, the proportions of exports to GDP in India and Philippines were always lower than the proportions of imports. Since current account balance is calculated as the difference between exports and imports (including net incomes and transfer payments), Figure 3.1 implicitly implies that while most of the sample economies were running current account surpluses, India and Philippines had current account deficits more often than not. Moreover, the current account imbalances (the gap between the proportions of exports and imports to GDP) in China, India, Korea, Malaysia and Thailand became more severe by the end of their sample periods.

Figure 3.1: Exports and Imports (plus net incomes and transfer payments) (% in GDP)



Data source: International Monetary Fund (IMF), International Financial Statistics.

Note: MM = Imports + Net Incomes + Transfer Payments.

3.3 Theoretical Framework

This study adopts the micro-founded intertemporal optimizing approach developed in the 1980s. The use of this approach has facilitated the analysis of the sustainability of current account imbalances in the current literature. The intertemporal approach considers current account from the saving-investment perspective and highlights the role of forward-looking expectations in explaining current account behaviours. Under this approach, since it assumes that infinitely lived representative agents can smooth their consumptions over time by lending or borrowing abroad, a country is therefore considered as a reflection of consumption and investment decisions that span over long-term horizons. When it analyses current account, this approach uses intertemporal budge constraint and assumes perfectly flexible prices in domestic market. The main advantage of this approach is that it deals with current and capital account behaviour simultaneously through direct and portfolio investment flows across countries along with trade in goods and services.

In particular, this study adopts the theoretical framework developed by Husted (1992), which was first proposed by Trehan and Walsh (1991) and Hakkio and Rush (1991), to test current account sustainability. Within this framework, an open economy has the following features: absence of government; ability to produce and export a composite good; with consumers having access to international funds implying a long-run relationship between exports and imports. This small open economy faces a budget constraint for each period t, which can be written as

$$C_t = Y_t + B_t - I_t - (1 + r_t)B_{t-1} \tag{3.1}$$

where C_t, Y_t, B_t I_t denote consumption, output, net international borrowing (could be either positive or negative) and investment in current period t, respectively; r_t is the one period world interest rate and $(1 + r_t)B_{t-1}$ the country's net debt from the previous period t-1.

Since equation (3.1) must be satisfied in every time period, letting $TB_t = Y_t - C_t - I_t$ denote the trade balance in current period t and also forward iterating equation (3.1), I could get following equations

$$\begin{aligned}
B_{t+1} &= -TB_{t+1} + (1 + r_{t+1})B_t \\
B_{t+2} &= -TB_{t+2} + (1 + r_{t+2})B_{t+1} \\
&= -TB_{t+2} - (1 + r_{t+2})TB_{t+1} + (1 + r_{t+2})(1 + r_{t+1})B_t \\
&\vdots \\
B_{t+n} &= -TB_{t+n} - (1 + r_{t+n})TB_{t+n-1} - \dots \\
&\quad - (1 + r_{t+n})(1 + r_{t+n-1})\dots(1 + r_{t+2})TB_{t+1} \\
&\quad + (1 + r_{t+n})(1 + r_{t+n-1})\dots(1 + r_{t+1})B_t
\end{aligned} \tag{3.2}$$

Rearranging the equation for B_{t+n}, I could obtain the following expression

$$\begin{aligned}
B_t = {} & \frac{TB_{t+n}}{(1+r_{t+n})(1+r_{t+n-1})\dots(1+r_{t+1})} + \frac{TB_{t+n-1}}{(1+r_{t+n-1})\dots(1+r_{t+1})} + \dots + \frac{TB_{t+1}}{1+r_{t+1}} \\
& + \frac{B_{t+n}}{(1+r_{t+n})(1+r_{t+n-1})\dots(1+r_{t+1})}
\end{aligned} \tag{3.3}$$

If n approaches infinity, equation (3.3) could be rewritten as

$$B_t = \sum_{i=1}^{\infty} \lambda_i TB_{t+i} + \lim_{n\to\infty} \lambda_n B_{t+n}, \quad \lambda_i = \prod_{j=1}^{i} \frac{1}{1+r_{t+j}} \tag{3.4}$$

Equation (3.4) is the intertemporal budget constraint of the country, which states that, when the second term on the right-hand side vanishes, net international borrowing of the country in current period t has to be equal to the present value of all its future trade balances. Therefore, the current account sustainability condition or long-run budget constraint requires that

$$\lim_{n\to\infty} \lambda_n B_{t+n} = 0 \tag{3.5}$$

This condition (3.5), also known as the transversality condition, is satisfied when the present value of the expected stock of debt equals zero when n goes to infinity.

However, if this condition is not satisfied and $B_t > \sum_{i=1}^{\infty} \lambda_i TB_{t+i}$, it implies that the country borrows too much to refinance maturing external debts by new loans. In this case, the country's debts could be in "bubbles" and therefore the current account cannot be sustainable. On the other hand, if $B_t < \sum_{i=1}^{\infty} \lambda_i TB_{t+i}$, it implies that the country should borrow more or save less in order to increase the welfare.

In order to construct a testable empirical model, Husted (1992) followed Hakkio and Rush's work (1991) and introduced a number of simplifying assumptions.[11] He finally put forward a simple empirically testable model that stipulates a long-run relationship between exports and imports, which is described as follow

$$EX_t = \alpha + \beta\, MM_t + \varepsilon_t \qquad (3.6)$$

where EX_t is the exports of goods and services, and MM_t is the imports of goods and services plus net interest payments and net transfers, ε_t is the usual error term, and α and β are the cointegrating parameters.

Both the value of the coefficient β and the existence of cointegration between EX_t and MM_t can shed light on the sustainability of an economy's current account position. Based on the works of Hamilton and Flavin (1986), Hakkio and Rush (1991), Trehan and Walsh (1991) and Corsetti and Roubini (1991), a current account position is sustainable if and only if $\beta = 1$ and EX_t and MM_t are cointegrated. However, Quintos (1995) argues that this condition is necessary and sufficient for a strong form of current account sustainability, but it is not necessary for a weak form of sustainability. Moreover, Ahmed and Rogers (1995), Arghyrou and Luintel (2007) and Baharumshah and Lau (2010) support Quintos' view and argue that a strong form of the test is not strictly required for validity of the intertemporal budget constraint.

[11] For full derivation of the Husted's (1992) model, please refer to appendix A1.

To demonstrate Quintos' ideas regarding both weak and strong forms of current account sustainability, let us first assume that the world interest rate is stationary with unconditional mean r, then equation (3.1) can be expressed as

$$Z_t + (1+r)B_{t-1} = EX_t + B_t \tag{3.7}$$

where $Z_t = IM_t + (r_t - r)B_{t-1}$. Following Hakkio and Rush (1991), equation (3.7) can be solved forward to obtain

$$IM_t + rB_{t-1} = EX_t + \sum_{j=0}^{\infty} \lambda^{j-1}(\Delta EX_{t+j} - \Delta Z_{t+j}) + \lim_{j\to\infty} \lambda^{j+1}\Delta B_{t+j} \tag{3.8}$$

or

$$MM_t - EX_t = \sum_{j=0}^{\infty} \lambda^{j-1}(\Delta EX_{t+j} - \Delta Z_{t+j}) + \lim_{j\to\infty} \lambda^{j+1}\Delta B_{t+j} \tag{3.9}$$

where $MM_t = IM_t + rB_{t-1}$. For equation (3.8) or (3.9) to impose a constraint analogous to the intertemporal budget constraint faced by a country, it must hold that

$$E_t \lim_{j\to\infty} \lambda^{j+1}\Delta B_{t+j} = 0 \tag{3.10}$$

in either equation (3.8) or (3.9). If equation (3.10) is satisfied, then intertemporal budget balance holds.

To test equation (3.10), the procedure in the literature is to test for the stationarity of ΔB_t, or alternatively to test for cointegration in the previously mentioned regression equation (3.6)

$$EX_t = \alpha + \beta MM_t + \varepsilon_t \tag{3.6}$$

and to test that $\beta = 1$. Note that Hakkio and Rush (1991) relaxed this condition by showing that cointegration and $0 < \beta \leq 1$ are necessary conditions for a strict interpretation of current account sustainability (i.e. that equation (3.10) holds). Quintos (1995) argues that the condition $0 < \beta \leq 1$ is a necessary and sufficient condition for current account sustainability and that cointegration is only a sufficient condition.

In Quintos (1995), she has proved the following theorem.

Theorem 3.1

Assume that interest rates are constant at *r*. If ΔB_t is stationary, then the limit term in equation (3.10) behaves like

$$E_t \lim_{T\to\infty} \exp(-Tk) = 0 \qquad (3.11)$$

for some constant *k*. If ΔB_t is non-stationary, then equation (3.10) behaves like

$$E_t \lim_{T\to\infty} \exp(-Tk)T^{1/2} = 0 \qquad (3.12)$$

Proof

Write the limit term in equation (3.10) as

$$\begin{aligned}\lim_{T\to\infty} \lambda^T \Delta B_T &= \lim_{T\to\infty} \exp(T\ln(\lambda))\Delta B_T \\ &= \lim_{T\to\infty} \exp(-Tk)\Delta B_T\end{aligned} \qquad (3.13)$$

where $k = -\ln(\lambda)$. Then the result follows by noting that $\Delta B_t = Op(1)$ if ΔB_t is stationary and $\Delta B_t = Op(T^{1/2})$ if it is I(1) (i.e. assuming that an invariance principle holds for ΔB_t).

Theorem 3.1 show that stationary of ΔB_t is a sufficient condition for the bubble term to go to 0. However, the bubble term in equation (3.11) goes to 0 faster than that in equation (3.12) when cointegration does not hold. In Quintos (1995), she calls equation (3.11) and (3.12) the 'strong' and 'weak' requirement for current account sustainability, respectively. Condition (3.11) corresponds to Hamilton and Flavin's (1986) requirement for current account sustainability.

However, Quintos (1995) mentions in her paper that although her results show that $0 < \beta < 1$ is sufficient for a country's current account to be sustainable, it is inconsistent with a country's ability to rebalance its current account imbalances in the long run, especially current account deficits. In other word, although intertemporal budget balance is satisfied in the strict sense since the bubble term goes to 0, the condition $0 < \beta < 1$ has serious policy implications because a country that continues to spend more than it earns (i.e. current account deficits) has a high risk of default and would have to offer higher interest rates to service its debt.

In summary, the current account sustainability conditions derived in Quintos' analysis are as follows:

(i) if $0 < \beta < 1$ in equation (3.6) then the intertemporal budget constraint is satisfied in the weak sense, irrespective of whether EX_t and MM_t are cointegrated;

(ii) if $\beta = 1$ and EX_t and MM_t are not cointegrated, then the intertemporal budget constraint is still satisfied in the weak sense;

(iii) if $\beta = 1$ and EX_t and MM_t are cointegrated, then this implies strong form sustainability;

(iv) finally, $\beta = 0$ implies that current account imbalance is unsustainable.

Based on Quintos's more flexible testing strategies, strong sustainability requires EX_t and MM_t to be cointegrated with a unit slope on MM_t. By contrast, weak sustainability refers to the case when the slope coefficient, β, lies between zero and one, regardless of whether the two variables are cointegrated or not. Since Quintos' approach is more general in the sense that it can nest all the other approaches used in the previously mentioned studies, therefore, this study uses her approach to test the current account sustainability for each sample economy.

3.4 A Brief Empirical Literature Review

A growing literature has tested the mean-reverting behaviour of current account, which is a direct implication of the intertemporal approach to the current account.

Most of these studies have examined the sustainability of current account imbalances using an indirect approach, which was developed by Trehan and Walsh (1991), Hakkio and Rush (1991) and Husted (1992). The main implication of this indirect approach is that if real exports and imports are integrated of order one, then cointegration between them is a necessary and sufficient condition for the economy to satisfy its intertemporal budget constraint.

There are two empirical frameworks that examine the long-run relationship between the exports and imports. One framework applies panel unit root and/or cointegration techniques. There are a number of alternative procedures have been proposed to test for the presence of unit roots in panels that combine the information from the time series dimension with that from the cross section dimension. Studies that adopt panel unit root techniques often support the mean-reverting hypothesis. For example, Wu (2000) and Im, Pesaran and Shin (2003) find evidence of mean reversion in the current accounts of major industrialized countries. Lau, Baharumshah and Haw (2006) apply the panel technique to current accounts in the five crisis affected countries of Southeast Asia and found that their current accounts were mean reverting during both the pre- and post-crisis periods.

However, those panel techniques suffer from one major flaw, which is due to the heterogeneous nature of the alternative hypothesis in the unit root test. People need to be cautious when interpreting the test results, because the null hypothesis of a unit root in each cross section may be rejected when only a fraction of the series in the panel is stationary. Due to this reason, this study analyses the mean-reverting behaviour of current account within the other framework which employs a time series perspective. This framework normally uses single equation unit root tests and/or cointegration tests to test the sustainability of current account imbalances. Studies within this framework provide mixed results in favour of current account sustainability.

For example, Husted (1992) uses US quarterly trade data to test the cointegration between exports and imports and finds no evidence of cointegration for the period 1967-1989. However, he finds evidence to support the sustainability of US current account deficits when he carries out a sub-sample analysis with structural break in 1983. Wu, Fountas and Chen (1996) and Fountas and Wu (1999) both test the sustainability of the current account deficits in US over the period 1967-1994 by using various econometric tests and found that the real current account deficits to GDP ratios is not sustainable in US. Bahmani-Oskooee and Rhee (1997) use quarterly data for the period 1972-1988 to model exports and imports for Korea and found evidence of cointegration. Arize (2002) examines the mean-reverting properties of current account for 50 OECD and developing countries by using quarterly data for the period 1973-1998 and found that for 35 of the 50 countries there was evidence of cointegration between exports and imports. Tang (2003) investigates the presence of the relationship between exports and imports for five ASEAN economies and found that exports and imports are cointegrated only in the cases of Malaysia and Singapore. Andreosso-O'Callaghan and Kan (2007) test the current account sustainability for Korea, Indonesia, Philippines and Thailand by using quarterly data for the period 1982-1994 and find no evidence of cointegration between exports and imports for all four countries. De Mello and Padoan (2010) use both annual and quarterly data for the period 1992-2007 to examine the cointegration relationship between exports and imports in the case of Mainland, China and find evidence to support the sustainability of the large current account surpluses.

One thing worth noticing is that most of the above studies concentrate on testing the strong form of current account sustainability. In these studies, an economy's current account position is claimed to be unsustainable if there is no cointegration found between a country's EX_t and MM_t. As a result, conclusions made in these studies may be biased in the sense that they simply ignore the weak form of current account sustainability. However, this study overcomes this problem through the adoption of the previously described Quintos' (1995) approach.

3.5 Methodology

In this chapter, the analysis of current account sustainability of each sample economy is carried out in four stages. First, the univariate time series properties of EX_t and MM_t are examined for each sample economy. The order of integration of these two variables are established through a set of unit root tests, which includes the conventional Augmented Dickey-Fuller (ADF) test, Philips-Perron (PP) test, Ng-Perron (NP) modified PP Z_t test, Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test and also the Zivot and Andrews (ZA) test.[12] The first four tests assume no structural change in the examined time series during the sample period, while the last test allows for one unknown structural break/shift in the estimated variable. Second, after the examination of the order of integration of the data, the cointegrating relationship between EX_t and MM_t as specified in equation (3.6) is firstly analyzed without accounting for any dummy shift in the cointegrating relationship between EX_t and MM_t. At this stage, the Stock and Watson (1993) dynamic ordinary least squares (DOLS) technique is employed. Third, a sequential Wald test developed by Quintos (1995) is applied to test the stability of the cointegrating relationship between EX_t and MM_t and endogenously detect for possible shifts in the cointegrating relationship. Finally, the cointegrating relationship between EX_t and MM_t is re-examined by the Stock and Watson (1993) DOLS approach in the presence of identified dummy shifts in the cointegrating relationship for each sample economy.

[12] Since the ADF, PP, NP and KPSS tests are very well known and widely used in the literature, therefore, the description of these tests are not included in the main text of this chapter. For people who are interested in the details of these tests, please refer to appendix A2.

3.5.1 Zivot and Andrews (1992) Unit Root Test

Once the assumption of no structural break/shift in the examined time series violates, the conventional ADF, PP, NP and KPSS tests can be distorted since they tend to support the unit root hypothesis even if the time series is a stationary process if the structure break is simply ignored. To overcome this problem, Zivot and Andrews (1992, hereafter ZA) developed a unit root test, which allows for a single endogenously determined break/shift in the intercept and/or the trend function. The ZA test tests the null of unit root against the alternative of a one-time structural break/shift with three models: Model A allows a one-time change in the level of the series, Model B permits a one-time change in the slope of the trend function of the series and Model C admits both changes. One thing worth noticing is that the break/shift is restricted to the alternative hypothesis only. The regression equations corresponding to the three models are as following.

$$\text{Model A: } \Delta y_t = c + \alpha y_{t-1} + \beta t + \phi DU_t + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \qquad (3.14)$$

$$\text{Model B: } \Delta y_t = c + \alpha y_{t-1} + \beta t + \theta DT_t + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \qquad (3.15)$$

$$\text{Model C: } \Delta y_t = c + \alpha y_{t-1} + \beta t + \phi DU_t + \theta DT_t + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \qquad (3.16)$$

Where DU_t is an indicator dummy variable for a mean shift occurring at each possible break date (TB), while DT_t is corresponding trend shift variable. Moreover,

$$DU_t = \begin{cases} 1.........\text{if t>TB} \\ 0.....otherwise \end{cases} \text{ and } DT_t = \begin{cases} t-TB.........\text{if t>TB} \\ 0.............otherwise \end{cases}.$$

The null hypothesis in all the three models is $\alpha = 0$, which implies that the time series y_t contains a unit root with a drift that excludes any structural break/shift. The alternative hypothesis is $\alpha < 0$, which means that y_t is a trend-stationary process with a single break/shift occurring at an unknown point in time. The ZA method regards

every point as a potential break-date and runs a regression for every possible break-date sequentially. From amongst all possible break-points, the procedure selects as its choice of break-date the date which minimizes the one-sided t-statistic for testing $\hat{\alpha} = 1$, where $\hat{\alpha} = \alpha - 1$ .Perron (1989) suggested that most economic time series can be adequately modeled using either model A or model C. As a result, the subsequent literature has primarily applied model A and/or model C.
literature has primarily applied model A and/or model C.

3.5.2 Cointegration Test without Structural break/Dummy Shift

In this chapter, the dynamic ordinary least squares (hereafter DOLS) approach is used to investigate the form of current account sustainability for each sample economy in the absence of a structural break or dummy shift. The DOLS approach is a single equation based method. It is first proposed by Saikkonen (1991) and Phillips and Loretan (1991) and further developed by Stock and Watson (1993). The DOLS procedure has certain advantages over the Johansen's (1988) maximum likelihood procedure, which is commonly used in the literature. First, Stock and Watson (1993) prove that, as opposed to the Johansen's maximum likelihood based estimator, the DOLS procedure does not require that all the individual series in a long-run relationship be integrated of order one, that is, I(1), as it is also applicable to systems involving variables of different orders of integration. Second, Maddala and Kim (1998) suggest that the least squares methods perform better than the Johansen's test in small samples (i.e. less than 120 observations). Since the study in this chapter deals with small sample sizes (see section 3.6 for detailed sample sizes), therefore, it is better to apply the DOLS method than to use the Johansen's approach. Moreover, one reason that the Johansen's approach has been widely used in the literature is because of its ability to address the issue of multi-cointegration. However, since there are only two variables involved in the cointegration analysis in the current study (i.e. EX_t and MM_t), the issue of multi-cointegration does not arise. As a result, the DOLS method used in this chapter is asymptotically equivalent to the Johansen's approach.

In a I(1) case with a single cointegrating vector, the DOLS approach simply involves regressing one of the variables onto contemporaneous levels of the remaining variables, leads and lags of their first differences, and a constant, using ordinary least squares. Accordingly, the DOLS regression used in this chapter can be modelled as follow

$$EX_t = \alpha + \beta\, MM_t + \sum_{-k}^{k} \theta_k \Delta MM_{t-k} + \varepsilon_t \qquad (3.17)$$

where EX_t is the exports of goods and services, and MM_t is the imports of goods and services plus net interest payments and net transfers, ΔMM_t is the first difference of MM_t and ε_t is a random error term. The α and β are the cointegrating parameters, and –k and k indicate the number of lag and lead terms. The estimated cointegrating vector, $\hat{CV}_t$, between EX_t and MM_t is given by $\hat{CV}_t = EX_t - \hat{\alpha} - \hat{\beta} MM_t$. This $\hat{CV}_t$ term can also be interpreted as a measure of current account disequilibrium. If $\hat{CV}_t$ is stationary, then EX_t and MM_t are cointegrated in the long-run, otherwise they are not. The stationarity of $\hat{CV}_t$ can be examined by any conventional unit root test.

One thing worth noticing here is that, as pointed out by Stock and Watson (1993), the error term ε_t in equation (3.17) can be serially correlated and typically follows an autoregressive (AR(p)) process, which can be described as

$$\varepsilon_t = \phi_1 \varepsilon_{t-1} + \phi_2 \varepsilon_{t-2} + \ldots + \phi_p \varepsilon_{t-p} + \mu_t \qquad (3.18)$$

where μ_t is the random error term and assumed to be Gaussian white noise. In this case, DOLS estimates can be statistically inefficient or even give misleading inferences. To overcome this serial correlation problem, dynamic generalised least squares (hereafter DGLS) method should be used as an appropriate estimator since it allows for an autoregressive error under the feasible generalised least squares (FGLS).

Therefore, if ε_t is serially correlated in any sample economy's regression in the current study, DGLS is applied instead of DOLS.

3.5.3 Quintos' (1995) Approach to Structural Break/Dummy Shift Identification

Quintos (1995) developed an approach to endogenously search for multiple structural breaks or dummy shifts in a long-run cointegrating relationship. Her approach involves a sequential Wald test on the parameter δ in the regression equation

$$EX_t = \alpha + \beta\, MM_t + \sum_{-k}^{k} \theta_k \Delta MM_{t-k} + \delta(D_t MM_t) + v_t \qquad (3.19)$$

where

$$\begin{aligned} D_t &= 1 \text{..........if } t \in T_1 = (1,...,m) \\ &= 0 \text{..........if } t \in T_2 = (m+1,...,T) \end{aligned}$$

and *m* denotes the time of the structural break or dummy shift. The null hypothesis, δ = 0, is sequentially tested over T-2λ regressions, where λ refers to a trimming percentage and its value is set to 15% in the current study as suggested in the Andrews' (1993) paper. In this approach, the Wald test on δ is chi-square (χ^2) distributed. If the null hypothesis is rejected at a time point *m*, it implies that time *m* is not a statistically significant structural break date or a dummy shift date, *vice versa.*

3.5.4 Cointegration Test with Structural Break/Dummy Shift

To re-examine the cointegrating relationship between EX_t and MM_t in the presence of identified structural breaks or dummy shifts, I estimate a DOLS model, which can be specified as

$$EX_t = \alpha + \beta\, MM_t + \sum_{-k}^{k} \theta_k \Delta MM_{t-k} + \sum_{j=1}^{k} \phi_j (D_t MM_t) + v_t \qquad (3.20)$$

and the slope dummy for each identified shift point, D_t, is defined as

$$D_t = 0 \text{.........if } t \in T_1 = (1,...,m-1)$$
$$= 1 \text{.........if } t \in T_2 = (m,...,T)$$

where m denotes the structural break date or the date of the dummy shift that endogenously identified by the Quintos's (1995) approach.

Equation (3.20) is a modified version of equation (3.17). In equation (3.20), ϕ_j is a total multiplier, which picks up the long-run effect of each endogenously identified structural break or dummy shift on a sample economy's current account sustainability, and v_t is a random error term. Since α and β still represent the cointegrating parameters, the estimated cointegrating vector between EX_t and MM_t can still be given by $\hat{CV}_t = EX_t - \hat{\alpha} - \hat{\beta} MM_t$. Unlike the former $\hat{CV}_t$ term defined in equation (3.17), the new $\hat{CV}_t$ term accounts for identified structural breaks or dummy shifts in current account balances. Cointegration between EX_t and MM_t is still tested through any conventional unit root test on the new $\hat{CV}_t$ term. If the new $\hat{CV}_t$ term is stationary, then EX_t and MM_t are cointegrated in the long-run, otherwise they are not.

The null of the overall slope of unity (i.e. $H_0 : \beta + \sum_{j=1}^{k} \phi_j = 1, \text{ for j=1,...,k}$) is tested, where k refers to all the statistically significant structural breaks or dummy shifts identified for each sample economy, to analyze the long-run slope coefficient between EX_t and MM_t. In the absence of a cointegration between EX_t and MM_t, if $0 < \beta + \sum_{j=1}^{k} \phi_j < 1$ or $\beta + \sum_{j=1}^{k} \phi_j = 1$, a sample economy's current account position is weakly sustainable. If $\beta + \sum_{j=1}^{k} \phi_j = 1$ and EX_t and MM_t are cointegrated, the economy has strong form of current account sustainability.

Furthermore, to examine the long-run effect of each structural break or dummy shift that had on the current account of each sample economy, the null of the total multiplier of zero (i.e. $H_0 : \phi_j = 0, \text{ for j=1,...,k}$) is tested through a conventional Wald test. If the null is rejected, it implies that the corresponding dummy shift has a significant and long lasting effect on a sample economy's current account sustainability.

3.6 Data

The data used in this study consist of quarterly observations on exports of goods and services (EX_t), imports of goods and services (M_t), net transfer payments (NTP_t) and net interest payments (NIP_t) for all the sample economies, which include China, Hong Kong, India, Korea, Malaysia, Philippines, Singapore and Thailand. The main data source is the IMF's International Financial Statistics (IFS) databank. The measure of imports involves $MM_t=M_t+NTP_t+NIP_t$ (see Husted, 1992). Both EX_t and MM_t are measured as the proportions to GDP. All variables are expressed in percentages. Variables exhibiting strong seasonality are seasonally adjusted.

Sample size is different across sample economies due to each economy's data availability. For China, Singapore and Malaysia the sample period is 1990Q1-2008Q4. For Korea and Thailand, the sample period is 1990Q1-2009Q4. For Hong Kong, the sample period is 1998Q1-2009Q4. For India, the sample period is 1990Q1-2009Q1. Finally, for Philippines, the sample period is 1990Q1-2009Q2.

3.7 Empirical Results

3.7.1 Unit Root Tests

To examine order of integration of the quarterly data, the ADF, PP, NP and KPSS unit root tests are firstly applied both on levels and first differences of EX_t and MM_t for all eight sample economies. The results are presented in table 3.1 and 3.2.

Table 3.1 Unit Root Tests without Structural Break/Shift on the Level Series

Panel A: Each Test Equation Includes Both Intercept and Trend Terms

Variables	ADF		PP		NP		KPSS	
	Lag	Test Stats	Lag	Test Stats	Lag	Test Stats	Lag	Test Stats
CN_EX	2	-2.35	4	-1.91	2	-2.83*	6	0.19**
CN_MM	6	-1.80	4	-1.31	6	-1.27	6	0.17**
HK_EX	0	-1.02	1	-1.18	2	-2.54	5	0.14*
HK_MM	0	-2.15	1	-2.23	0	-1.88	5	0.12*
IN_EX	0	-2.25	4	-2.08	0	-2.13	6	0.26***
IN_MM	0	-2.77	2	-2.73	0	-2.25	6	0.24***
KR_EX	1	-3.27*	1	-2.92	0	-2.38	6	0.07
KR_MM	4	-1.62	1	-2.83	4	-2.05	6	0.16**
MY_EX	8	-0.93	4	-0.98	8	-2.08	6	0.21***
MY_MM	0	-2.56	4	-2.80	0	-1.32	6	0.18**
PH_EX	0	-0.46	8	-0.04	0	-0.63	6	0.28***
PH_MM	0	-1.18	7	-0.82	0	-1.01	6	0.26***
SG_EX	0	-2.75	1	-2.73	0	-1.90	6	0.22***
SG_MM	4	-3.32*	0	-3.16*	4	-1.34	5	0.23***
TH_EX	1	-2.48	1	-2.10	1	-2.65	6	0.16**
TH_MM	1	-3.13	2	-2.88	1	-3.03	5	0.11*

Notes:

1. In all these tests, except KPSS, the unit root null hypothesis is tested against the alternative of stationary. In the KPSS test, the hypotheses are the opposite.
2. In the ADF and NP tests, the lag lengths are selected by minimizing the Akaike Information Criteria. In the PP and KPSS tests, the lag lengths are the bandwidth that selected by the Newey-West method and Bartlett kernel.
3. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

Table 3.1 Panel A above reports the results of all four tests on all the level series when there are both intercept and trend terms included in each test equation, while Panel B presents the test results on the level series when there is only an intercept term included in the test equation.

Results in Panel A shows that, at 10% significance level, all four tests unequivocally indicate that all the time series are non-stationary on levels except for *CN_EX, KR_EX* and *SG_MM*. However, the non-stationarity of *CN_EX* is only rejected by the NP test at 10% significance level. Moreover, the non-stationarity of *KR_EX* on level is supported by both the PP and NP tests and the non-stationarity of *SG_MM* on level is also revealed by the NP and KPSS tests.

Table 3.1 (continued)

Panel B: Each Test Equation Includes Intercept Only

Variables	ADF		PP		NP		KPSS	
	Lag	Test Stats	Lag	Test Stats	Lag	Test Stats	Lag	Test Stats
CN_EX	2	-1.20	4	-0.92	2	-0.45	6	1.03***
CN_MM	2	-1.46	4	-1.21	6	-0.36	6	0.98***
HK_EX	0	-1.01	0	-1.02	6	-1.55	5	0.82***
HK_MM	0	-0.78	1	-0.72	0	-0.01	5	0.83***
IN_EX	0	-1.04	4	-0.45	0	-0.67	6	1.09***
IN_MM	6	-2.46	7	-0.06	0	-0.44	6	1.09***
KR_EX	1	-1.50	0	-1.13	1	-1.04	6	0.96***
KR_MM	4	-0.32	2	-1.25	4	-0.22	6	0.94***
MY_EX	8	-1.98	4	-1.74	8	-0.78	6	0.86***
MY_MM	4	-2.32	4	-3.29**	0	-1.02	6	0.36*
PH_EX	0	-1.48	4	-1.46	0	-0.88	6	0.59**
PH_MM	0	-2.01	5	-1.95	0	-0.96	6	0.58**
SG_EX	0	-1.00	2	-0.93	0	-0.87	6	0.97***
SG_MM	4	-0.59	0	-1.39	4	-0.58	6	0.89***
TH_EX	4	-1.18	2	-1.32	4	-0.31	6	1.16***
TH_MM	4	-1.04	1	-1.62	4	-0.56	6	1.03***

Notes:

1. In all these tests, except KPSS, the unit root null hypothesis is tested against the alternative of stationary. In the KPSS test, the hypotheses are the opposite.
2. In the ADF and NP tests, the lag lengths are selected by minimizing the Akaike Information Criteria. In the PP and KPSS tests, the lag lengths are the bandwidth that selected by the Newey-West method and Bartlett kernel.
3. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

On the other hand, results in table 3.1 panel B on the previous page suggest that all time series are non-stationary on levels at 10% significance level except that the non-stationary of *MY_MM* is rejected by the PP test at 5% significance level.

Table 3.2 Unit Root Tests without Structural Break on the First Differences

Variables	ADF		PP		NP		KPSS	
	Lag	Test Stats	Lag	Test Stats	Lag	Test Stats	Lag	Test Stats
DCN_EX	6	-2.67*	3	-7.83***	6	-8.35***	3	0.09
DCN_MM	1	-3.61***	4	-7.98***	1	-1.53	3	0.16
DHK_EX	0	-5.56***	1	-5.54***	4	-2.65***	0	0.20
DHK_MM	0	-6.63***	4	-6.64***	0	-3.34***	4	0.09
DIN_EX	0	-8.53***	11	-8.69***	0	-4.03***	10	0.11
DIN_MM	6	-3.43**	8	-9.84***	9	-5.42***	9	0.17
DKR_EX	0	-7.46***	3	-7.40***	0	-4.32***	2	0.04
DKR_MM	3	-5.95***	6	-5.80***	3	-12.14***	3	0.05
DMY_EX	7	-3.01**	4	-8.32***	7	-2.31**	4	0.26
DMY_MM	3	-4.82***	4	-8.30***	9	-0.18	4	0.28
DPH_EX	0	-8.34***	5	-8.34***	0	-4.35***	5	0.52**
DPH_MM	0	-8.93***	6	-9.01***	0	-4.35***	7	0.44*
DSG_EX	0	-8.10***	0	-8.10***	2	-1.05	0	0.09
DSG_MM	3	-6.95***	1	-7.31***	6	-3.79***	1	0.11
DTH_EX	3	-6.06***	3	-7.31***	3	-50.99***	2	0.09
DTH_MM	3	-6.02***	2	-7.86***	3	-15.71***	2	0.05

Notes:

1. Each test equation has an intercept term only.
2. In all these tests, except KPSS, the unit root null hypothesis is tested against the alternative of stationary. In the KPSS test, the hypotheses are the opposite.
3. In the ADF and NP tests, the lag lengths are selected by minimizing the Akaike Information Criteria. In the PP and KPSS tests, the lag lengths are the bandwidth that selected by the Newey-West method and Bartlett kernel.
4. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

Furthermore, table 3.2 above shows the results of all four tests on the first differences of all the time series. The ADF and PP tests both suggest that all the variables are stationary on their first differences at 10% significance level. On the other hand, the

NP test suggests that *CN_MM, MY_MM* and *SG_EX* may not be stationary on the differences at 10% significance level, while the KPSS test results indicate that *PH_EX* and *PH_MM* are not stationary on their first differences at 10% significance level. Overall, without allowing for a structural break/shift, only half of the examined time series can be classified as I(1) with certainty, which include *HK_EX, HK_MM, IN_EX, IN_MM, KR_MM, MY_EX, TH_EX* and *TH_MM.* However, the majority of tests still support the I(1) hypothesis for the rest time series.

Table 3.3 Zivot-Andrews Unit Root Test with One Structural Break

Panel A: Test Results on Level Series

Variables	Model C		
	Break Time	Lag	Test Stats
CN_EX	1997Q4	4	-2.23
CN_MM	1994Q2	6	-2.13
HK_EX	2003Q4	2	-3.81
HK_MM	2003Q4	0	-3.67
IN_EX	2001Q3	4	-3.56
IN_MM	2001Q3	6	-3.75
KR_EX	2001Q2	1	-4.18
KR_MM	2006Q1	4	-4.17
MY_EX	1997Q4	8	-4.72
MY_MM	1993Q4	4	-3.79
PH_EX	1997Q3	0	-3.58
PH_MM	1997Q3	0	-3.35
SG_EX	2003Q1	0	-3.43
SG_MM	1998Q1	4	-4.09
TH_EX	1997Q3	1	-5.63***
TH_MM	2005Q1	4	-3.38

Panel B: Test Results on First Differences

Variables	Model A		
	Break Time	Lag	Test Stats
CN_EX	2005Q4	3	-4.61*
CN_MM	1999Q1	1	-4.84**
HK_EX	2002Q4	4	-4.65*
HK_MM	2002Q1	0	-6.97***
IN_EX	2002Q2	3	-6.73***
IN_MM	2004Q3	5	-7.30***
KR_EX	1998Q2	0	-8.25***
KR_MM	1998Q2	3	-6.51***
MY_EX	2000Q1	0	-8.95***
MY_MM	1995Q4	4	-5.56***
PH_EX	1998Q2	0	-9.24***
PH_MM	1998Q2	0	-9.82***
SG_EX	1994Q2	0	-8.27***
SG_MM	1994Q2	3	-7.32***
TH_EX	1997Q3	3	-7.01***
TH_MM	1999Q2	3	-6.73***

Notes:

1. The null hypothesis in the ZA test is specified as 'I(1) without structural break', and the alternative hypothesis is 'I(0) with one endogenous break in the trend function (for model C) or in the drift (for model A).
2. Model C implies shift in the intercept and the slope; Model A implies shift in the intercept only.
3. For model C, the 1%, 5% and 10% asymptotic critical values are -5.57, -5.08 and -4.82; for model A, the 1%, 5% and 10% asymptotic critical values are -5.34, -4.80 and -4.58.
4. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

Next, the ZA unit root test with one structural break is applied on both levels and first differences for all the variables. Table 3.3 on the previous page summarise the test results.

The results in table 3.3 panel A indicate that the null hypothesis of unit root cannot be rejected for all the level variables except for *TH_EX*. Meanwhile, the test results the null of unit root is rejected for all the variables when they are in their first differences. As a result, the results of the ZA test suggest that all the variables are I(1) except that *TH_EX* seems to be I(0) with a single endogenous break/shift in the trend function.

To sum up the unit root test results, the conclusions heavily depend on the actual test procedure used and the existence of structural breaks. All the unit root tests classify *HK_EX, HK_MM, IN_EX, IN_MM, KR_MM, MY_EX, TH_EX* and *TH_MM* as I(1) with certainty. Although these tests cannot support the same, I(1) or I(0), hypothesis for the rest of the examined time series, empirical evidence from most of these tests still support the idea that all the rest variables are most likely to be I(1). Therefore, cointegration analysis can be meaningfully performed for all sample economies.

3.7.2 Cointegration Test Without Structural Break/Dummy Shift

In this section, the cointegrating relationship between EX_t and MM_t is analysed by the DOLS approach without accounting for any structural breaks or dummy shifts in the cointegrating relationship. Table 3.4 on the next page reports the cointegration results in the absence of a structural break or dummy shift along with the results of some diagnostic tests for all the sample economies. DGLS estimator is used for all sample economies since the error term ε_t specified in equation (3.17) is serially correlated.

Table 3.4 DOLS Cointegration Test without Structural Break/Dummy Shift

Estimated equation: $EX_t = \alpha + \beta MM_t + \mu_t$	**China**	**Hong Kong**	**India**	**Korea**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**
Estimation Method	DGLS	DGLS	DGLS	DGLS	DGLS	DGLS	DGLS	DGLS
α	1.948 (0.631)	-2.168 (6.890)	1.789 (0.889)**	9.792 (11.539)	29.844 (41.162)	-2.328 (8.379)	72.717 (89.33)	45.908 (21.419)**
MM_t	1.084 (0.121)***	1.058 (0.039)***	0.686 (0.055)**	0.784 (0.319)**	0.969 (0.473)**	0.837 (0.147)***	0.878 (0.171)***	0.433 (0.224)*
Chi-Square-Wald test, H_0: β=0	79.67 [0.00]***	728.40 [0.00]***	151.16 [0.00]***	6.03 [0.01]**	4.19 [0.04]**	32.26 [0.00]***	26.31 [0.00]***	3.71 [0.05]*
Chi-Square-Wald test, H_0: β=1	0.48 [0.48]	2.18 [0.15]	31.64 [0.00]***	0.45 [0.50]	0.004 [0.948]	1.22 [0.27]	0.502 [0.48]	6.36 [0.01]**
ADF test on $\hat{CV}_t$, lag length in { }	-1.86 {0}	-3.56** {0}	-3.44** {1}	-2.11 {0}	-1.26 {0}	-3.38** {0}	-1.14 {1}	-1.90 {0}
Misspecification Tests					*p*-values			
LM F-test for 4th order autocorrelation	0.13	0.67	0.37	0.16	0.33	0.39	0.13	0.52
JB's Chi-square test for normality	0.00***	0.98	0.94	0.00***	0.64	0.27	0.90	0.00***
LM F-test for ARCH	0.52	0.45	0.73	0.80	0.84	0.03**	0.92	0.00***
White's Chi-square test for heteroscedasticity	0.00***	0.85	0.00***	0.04**	0.63	0.05*	0.22	0.55
Inference on Current Account Sustainability	***Weak form***	***Strong form***	***Weak form***	***Weak form***	***Weak form***	***Strong form***	***Weak form***	***Weak form***

Note:
1. Standard errors are in parentheses; Chi-square probability values are in square brackets.
2. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.
3. Asymptotic critical values of the ADF test on CV_t are −4.07, −3.37, −3.03 at 10%, 5% and 1% significance level respectively. Values are taken from MacKinnon (2010) tables.

For China, Korea, Malaysia and Singapore, the slope parameter, β, is significantly different from zero. The null hypothesis that β=1 is not rejected at 10% significance level. However, the ADF test suggests that the cointegrating vector, $\hat{CV}_t$, specified in equation (3.17) is not stationary. Therefore, current account imbalances in these four economies are only weakly sustainable. In the case of India, β is significantly different from zero and having a value between 0 and 1. However, the null hypothesis that β=1 is rejected at 1% significance level. The ADF test suggests that $\hat{CV}_t$ is stationary, which implies that EX_t and MM_t are cointegrated. These results indicate that current account deficit in India is also weakly sustainable. For Thailand, β is significantly different from zero, but the null hypothesis that β=1 is rejected at 5% significance level. The ADF test indicates that $\hat{CV}_t$ is not stationary. However, current account imbalance in Thailand is still weakly sustainable since β has a value between 0 and 1. And finally, for Hong Kong and Philippines, β is significantly different from zero and null hypothesis that β=1 is not rejected at 10% significance level. Moreover, the ADF test suggests that $\hat{CV}_t$ is stationary at 5% significance level. These results indicate that Hong Kong and Philippines satisfy not only the necessary condition of fulfilling their intertemporal budget constraints, but also the sufficient condition. Consequently, these two economies have strong form of current account sustainability. Although a number of diagnostic tests appear to be problematic in some sample economies, this may be attributed to unaccounted structural breaks or dummy shifts in the cointegration analysis.

Overall, without accounting for any structural breaks or dummy shifts in the cointegrating relationship, the DOLS approach suggests that EX_t and MM_t are cointegrated only the cases of Hong Kong, India and Philippines. However, according to the DOLS estimates, all the sample economies satisfy their intertemporal budget constraints in either weak or strong sense. In particular, Hong

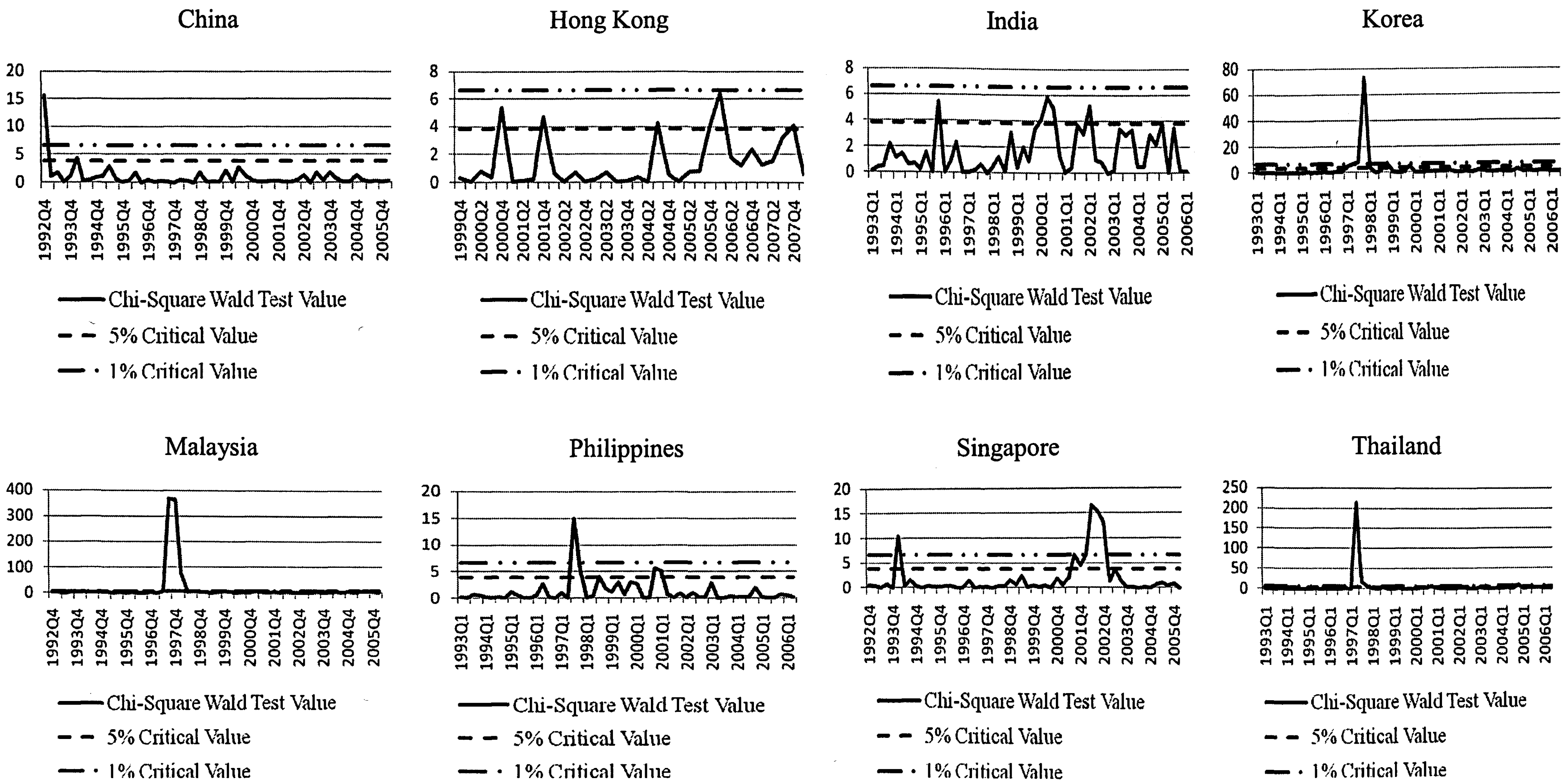
Kong and Philippines are the only two sample economies who have strong form of current account sustainability.

3.7.3 Identification of Structural Breaks/Dummy Shifts

Figure 3.2 on the next page shows the sequentially computed Wald tests under the null of stable cointegrating parameters as specified in equation (3.20). As previously mentioned, the trimming percentage, λ, is set to 15% for the sequential Wald tests. Therefore, the tests are carried out over a period of 1992Q4-2006Q1 for China, 1999Q4-2008Q1 for Hong Kong, 1993Q1-2006Q1 for India, 1993Q1-2006Q4 for Korea, 1992Q4-2006Q4 for Malaysia, 1993Q1-2006Q2 for Philippines, 1992Q4-2006Q1 for Singapore and 1993Q1-2006Q4 for Thailand.

The sequential Wald test suggests that China has two break points, which are significant at 5% significance level or even lower. These two break points occurred in 1992 and 1994. For Hong Kong, six break points are found by the test. Two of them occurred during the period 2000-2001, while the other four happened in the sustained period 2004-2007. India shows five clear break points on the plot, where one of them appears towards the end of year 1995 and the rest seem to occur during the period 2000-2002. Korea shows three break points, which happened during the period 1997-1999. Six significant break points are found for Malaysia. All the break points appear during the period 1997-1999. Philippines shows five break points, where three of them occurred during the period 1997-1998 and the rest of them appear during the period 2000-2001. In the case of Singapore, seven break points are found. One break point appears in the early year 1994, while the other six break points occurred during the period 2001-2002. Finally, for Thailand, there are five

Figure 3.2 Sequential Chi-square Wald Tests for Potential Structural Breaks or Dummy Shifts in Current Account



break points. Four breaks points appear during the period 1997-1998, while the last break happened in year 2004.

It is apparent that, in most cases, the identified break dates correspond to some important economic events happened in the sample economies. Therefore, all these identified breaks should be clarified as 'dummy shifts' rather than structural breaks in this study in the sense that they are caused by some large economic events and only temporarily interrupting the normal relationship between EX_t and MM_t rather than some overall regime changes.

For example, for China, the dummy shift happened in year 1992 may be related to China's economy regained momentum in the early 1990s. At the beginning of year 1992, China's paramount leader at the time, Deng Xiaoping, visited southern China and made a series of political pronouncements designed to give new impetus to and reinvigorate the process of economic reform. The 14th National Communist Party Congress later in the year backed up Deng's renewed push for market reforms, stating that China's key task in the 1990s was to create a 'socialist market economy'. Continuity in the political system but bolder reform in the economic system was announced as the hallmarks of the ten-year development plan for the 1990s. On the other hand, the shift happened in year 1994 corresponds to the 1994 inflation in China, which occurred at a time when the government was vigorously conducting macroeconomic contraction. The 1994 inflation was related to the over-investment that occurred in the previous years, which was mainly due to the loosened credit constraints set by the China's central bank at the beginning of year 1990. The over-investment created widespread shortages of construction materials including steel, cement and lumber. Their prices surged accordingly. This accumulated price pressure spilled over into consumer products in year 1993 and finally led to an annual inflation rate of 24.1% in year 1994. After The a series of actions to fight this high inflation that announced and implemented by the Chinese government, including tightening credit, strict regulation of local capital fund raising, tightening fixed asset investment scale, re-examining various newly established financial institutions and controlling capital and cash holdings of all financial organisations, the high inflation started to ease by the end of year 1994.

Moreover, for Korea, Malaysia, Philippines and Thailand, the shifts in cointegrating relationship between EX_t and MM_t happened during the period 1997-1999 correspond to the 1997 Asian financial crisis, which started with the devaluation of Thailand's Baht and took place in July 1997. The devaluation of the Thai Baht was soon followed by that of the Philippine Peso and the Malaysian Ringgit. This series of devaluations marked the beginning of the Asian financial crisis and set the first sub-period of the currency crisis. In the early November 1997, Hong Kong's stock market collapsed. This sent shock waves that were felt not only in Asia, but also in the stock markets of Latin America, especially those in Brazil, Argentina and Mexico. These financial and asset price crises also set the stage for this second sub-period of large currency depreciations. This time, not only the currencies of Thailand, the Philippines and Malaysia were affected, but that of Korea also suffered. In fact, the sharp depreciation of Korea's Won beginning in early November added a new and more troublesome dimension to the crisis given the magnitude of the depreciation of its currency which took place in less than two months. The effects of the crisis lingered through year 1998. Only until year 1999, the economies of these four Asian countries began to recover.

Finally, for Hong Kong, India, Philippines and Singapore, the dummy shifts occurred in the period 2000-2002 may reflect the global economy slowdown started from the mid-2000. Between the mid-2000 and early 2002, the world economy experienced its most significant slowdown since the early 1990s. This deceleration was primarily caused by the downturn in economic activity in the US, the rise in petrol prices during 2000, the adjustment in global equity markets and the 'bursting of the technology bubble'. The world economy continued to deteriorate in year 2001, particularly in the aftermath of the tragic events of September 11th. In year 2001, consumer and business confidence weakened everywhere, and global growth declined significantly from 4.7% recorded in year 2000 to 2.4%. As the slowdown affected nearly every major region of the world, it was accompanied by a substantial decrease in trade growth, which reached only 1% compared to 12.4% in the previous year. Output dropped from 3.9% to 1.1% in the industrialized countries, from 6.3% to 4.9% in the countries in transition, and from 5.8% to 4% in the developing countries. Hong Kong and Singapore were hardest hit by this global slowdown in global trade and activity, given their high degree of exposure to the technology sector, while growth also slowed significantly in Philippines. Meanwhile, India was affected not only by the global slowdown, but also by a range of domestic shocks, including the effects of drought, energy price increases and the devastating earthquake in Gujarat. The recovery in most regions began in the first quarter of 2002, with the US in the lead.

Based on the sequential Wald test results, it is clear that the cointegrating relationships between EX_t and MM_t have been through multiple dummy shifts in all the sample economies. However, these dummy shifts cannot fall too close to each other. In this study, the exact dummy shifts for each sample economy are selected according to the following steps. First, the most significant (i.e. with the highest Chi-square statistic in the sequential Wald test) dummy shift is selected. Second, after picking up the most significant dummy shift, I search for the second most significant dummy shift and select it. Meanwhile, I define a period of three years as the neighbourhood of a break point and represent it by a single shift. Finally, repeat step two until all the endogenously identified dummy shifts are considered. Following this rule, the final dummy shift identified for China is 1992Q4. The dummy shifts are 2000Q4 and 2006Q1 for Hong Kong, and 1995Q4 and 2000Q2 for India. For Korea, the dummy shift happened in 1997Q4, while it happened in 1997Q3 for Malaysia. The dummy shifts are 1993Q3 and 2000Q4 for Philippines, 1994Q1 and 2002Q2 for Singapore, and 1997Q2 and 2000Q4 for Thailand.

3.7.4 Cointegration Analysis With Dummy Shifts

In this section, I analyze the cointegration relationship between EX_t and MM_t in the presence of identified dummy shifts for each sample economy.

Table 3.5 on the next page presents the cointegration results in the presence of an identified dummy shift for China along with the results of some diagnostic tests. The total multiplier associated with the shift of 1992Q4 is positive and statistically significant at 5% significance level. This implies that a series of political pronouncements made in early 1992, which were designed to give new impetus to and reinvigorate the process of economic reform, has a long-run positive effect on improving the China's current account. In other words, China's re-opening in year 1992 is one of the most important reasons that caused the existence of persistent and large current account surpluses in China during the last two decades. The null of the overall slope of unity (i.e. $H_0 : \beta + \sum_{j=1}^{k} \phi_j = 1$) is not rejected for China. Moreover, the ADF test suggests that $\hat{CV}_t$ is not stationary at 10% significance level, which implies that EX_t and MM_t are not cointegrated. Therefore, China's current account imbalance is only weakly sustainable.

Table 3.5 DOLS Cointegration Analysis with Dummy Shift for China

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \mu_t$	
Estimation Method	DGLS
α	1.552 (1.754)
MM_t	0.939 (0.112)***
$D_1 MM_t$ (D_1=1 in 1992Q4-2008Q4, 0 otherwise)	0.168 (0.078)**
F-Wald test, H_0: $\beta+\phi_1 = 0$	213.31 [0.00]***
F-Wald test, H_0: $\beta+\phi_1 = 1$	2.01 [0.16]
ADF test on $\hat{CV}_t$, lag length in { }	-2.01 {0}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.94
JB's Chi-square test for normality	0.11
LM F-test for ARCH	0.81
White's Chi-square test for heteroscedasticity	0.14
Inference on Current Account Sustainability	***Weak form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

Table 3.6 on the next page shows the results for Hong Kong. The total multiplier associated with the shift in late 2000 is statistically insignificant at 10% significance level. This suggests that the global economy slowdown started from the mid-2000 did not have a lasting effect on Hong Kong's current account. On the other hand, the shift happened in 2006Q1 is significantly negative effect on Hong Kong's current account balances, which can be explained by the implementation of the China's 11th Five-Year plan in early 2006. Unlike the previous ten Five-Year plans, the 11th Five-Year plan has far-reaching impacts on Hong Kong's economy since economic ties between Hong Kong and Mainland, China had become increasing close. The 11th Five-Year plan had a focus on foreign capital utilization.

Table 3.6 DOLS Cointegration Analysis with Dummy Shifts for Hong Kong

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \phi_2(D_2 MM_t) + \mu_t$	
Estimation Method	DGLS
α	-7.436 (5.355)
MM_t	1.084 (0.040)***
$D_1 MM_t$ (D_1=1 in 2000Q4-2009Q4, 0 otherwise)	0.018 (0.012)
$D_2 MM_t$ (D_2=1 in 2006Q1-2009Q4, 0 otherwise)	-0.020 (0.008)**
F-Wald test, H_0: $\beta + \phi_2 = 0$	1076.42 [0.00]***
F-Wald test, H_0: $\beta + \phi_2 = 1$	2.82 [0.11]
ADF test on $\hat{CV}_t$, lag length in { }	-4.06** {0}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.43
JB's Chi-square test for normality	0.82
LM F-test for ARCH	0.65
White's Chi-square test for heteroscedasticity	0.74
Inference on Current Account Sustainability	***Strong form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

One of the important targets set in the plan is to encourage foreign investors to continuously invest in the mainland and Hong Kong. Meanwhile, the government promised that it would provide a more open and harmonious environment to the foreign investors. Hong Kong's foreign direct investments and foreign capital inflows had increased accordingly. As a result, this led to an increase in Hong Kong's capital account but a decrease in its current account. The null of the overall slope of unity is not rejected. Further, the result of the ADF test on $\hat{CV}_t$ suggests that EX_t and MM_t are cointegrated. Consequently, Hong Kong has strong form of current account sustainability.

For India, the results in table 3.7 below indicate that both of the identified dummy shifts are statistically significant. The estimated total multiplier suggests that the shift of 1995Q4 has a negative effect on India's current account. One possible explanation to this negative effect could be the adoption of Capital Account Convertibility (CAC) compelled by the International Monetary Fund (IMF) in the late year 1994 in Indian economy. This CAC refers to the abolition of all limitations with respect to the movement of capital from India to different countries across the globe. The adoption of CAC not only increased the total financial mobility in India, but also enabled relaxation of its Capital Account. As a result, more foreign capitals

Table 3.7 DOLS Cointegration Analysis with Dummy Shifts for India

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \phi_2(D_2 MM_t) + \mu_t$	
Estimation Method	DOLS
α	2.09 (0.551)***
MM_t	0.697 (0.059)***
$D_1 MM_t$ (D_1=1 in 1995Q4-2009Q1, 0 otherwise)	-0.084 (0.026)***
$D_2 MM_t$ (D_2=1 in 2000Q2-2009Q1, 0 otherwise)	0.081 (0.018)***
F-Wald test, H_0: $\beta + \phi_1 + \phi_2 = 0$	473.94 [0.00]***
F-Wald test, H_0: $\beta + \phi_1 + \phi_2 = 1$	92.24 [0.00]**
ADF test on $\hat{CV}_t$, lag length in { }	-4.87*** {1}
Misspecification Tests	*p*-value
LM F-test for 4^{th} order autocorrelation	0.11
JB's Chi-square test for normality	0.98
LM F-test for ARCH	0.41
White's Chi-square test for heteroscedasticity	0.16
Inference on Current Account Sustainability	***Weak form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

flew into the country and led to deterioration in the India's current account. The positive and significant total multiplier associated with the shift of 2000Q2 is interesting. Although the shift date is quite close to the start point of the global economy slowdown in year 2000, the shift in the case of India is not due to the global crisis since the shift of 2000Q2 has a positive effect on current account. This structural shift is more likely related to structural changes in the Indian economy after the reform occurred following the Indian crisis in 1990-1991, which caused a rise in export of services. The Wald test rejects the null of the overall slope being unity. However, the overall slope coefficient is statistically significantly different from zero but less than unity (i.e. $0<\beta+\sum_{j=1}^{k}\phi_j<1$). Indian EX_t and MM_t are cointegrated since $\hat{CV}_t$ is stationary at 1% significance level. Thus, current account deficit in India is only weakly sustainable.interesting. Although the break date is quite close to the start point of the global economy slowdown in year 2000, the break in the case of India is not due to the global crisis since the shift of 2000Q2 has a positive effect on current account. This structural shift is more likely related to structural changes in the Indian economy after the reform occurred following the Indian crisis in 1990-1991, which caused a rise in export of services. The Wald test rejects the null of the overall slope being unity. However, the overall slope coefficient is statistically significantly different from zero but less than unity (i.e. $0<\beta+\sum_{j=1}^{k}\phi_j<1$). Indian EX_t and MM_t are cointegrated since $\hat{CV}_t$ is stationary at 1% significance level. Thus, current account deficit in India is only weakly sustainable.

Table 3.8 and table 3.9 on the next page reports the estimation results for Korea and Malaysia respectively. Since these two economies only have one single dummy shift and the dates of these two shifts are very close to each other, therefore, I analyze these two economies together. The shift of 1997Q4 in Korea and the shift of 1997Q3 in Malaysia both show a positive and significant effect in terms of current account sustainability, which is consistent with the 1997 Asian financial crisis.

Table 3.8 DOLS Cointegration Analysis with Dummy Shift for Korea

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \mu_t$	
Estimation Method	DGLS
α	14.092 (7.623)*
MM_t	0.515 (0.250)**
$D_1 MM_t$ (D_1=1 in 1997Q4-2009Q4, 0 otherwise)	0.181 (0.064)***
F-Wald test, H_0: $\beta+\phi_1 = 0$	10.185 [0.00]***
F-Wald test, H_0: $\beta+\phi_1 = 1$	1.94 [0.16]
ADF test on $\hat{CV}_t$, lag length in { }	-3.08* {0}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.12
JB's Chi-square test for normality	0.12
LM F-test for ARCH	0.92
White's Chi-square test for heteroscedasticity	0.14
Inference on Current Account Sustainability	***Strong form***

Table 3.9 DOLS Cointegration Analysis with Dummy Shift for Malaysia

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \mu_t$	
Estimation Method	DGLS
α	8.644 (40.17)
MM_t	1.112 (0.459)**
$D_1 MM_t$ (D_1=1 in 1997Q3-2008Q4, 0 otherwise)	0.086 (0.039)**
F-Wald test, H_0: $\beta+\phi_1 = 0$	6.58 [0.01]**
F-Wald test, H_0: $\beta+\phi_1 = 1$	0.18 [0.67]
ADF test on $\hat{CV}_t$, lag length in { }	-1.76 {0}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.66
JB's Chi-square test for normality	0.50
LM F-test for ARCH	0.86
White's Chi-square test for heteroscedasticity	0.91
Inference on Current Account Sustainability	***Weak form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

In the immediate post-Asian crisis period, there were large reductions in those countries' net foreign liabilities, which were primarily caused by the substantial foreign direct investment outflows due to a loss of demand and confidence throughout the Asian region and enormous losses in foreign exchange reserves. As a result, the reductions in both Korea and Malaysia's capital accounts are reflected as increases in their current account balances. For both Korea and Malaysia, the null of the overall slope of unity is not rejected. However, the ADF test on $\hat{CV}_t$ shows cointegration between EX_t and MM_t of Korea, but not for Malaysia. Therefore, Korea has strong form of current account sustainability, while Malaysia only has weak form of current account sustainability.

Table 3.10 DOLS Cointegration Analysis with Dummy Shifts for Philippines

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \phi_2(D_2 MM_t) + \mu_t$	
Estimation Method	DGLS
α	-2.000 (9.773)
MM_t	0.827 (0.196)***
$D_1 MM_t$ (D_1=1 in 1997Q3-2009Q2, 0 otherwise)	0.004 (0.048)
$D_2 MM_t$ (D_2=1 in 2000Q4-2009Q2, 0 otherwise)	0.002 (0.035)
F-Wald test, H_0: $\beta = 0$	17.74 [0.00]***
F-Wald test, H_0: $\beta = 1$	0.76 [0.38]
ADF test on $\hat{CV}_t$, lag length in { }	-3.40** {0}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.42
JB's Chi-square test for normality	0.27
LM F-test for ARCH	0.13
White's Chi-square test for heteroscedasticity	0.11
Inference on Current Account Sustainability	***Strong form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

Table 3.10 presented on the previous page reports the results for Philippines. Interestingly, both of the previously identified structural breaks, one in 1997Q3 and the other in 2000Q4, turned out to be statistically insignificant in the estimated equation. This implies that both the 1997 Asian financial crisis and the global economy slowdown started from mid-2000 did not have lasting effects on Philippines' current account. The null of the overall slope of unity is not rejected. Furthermore, the ADF test on $\hat{CV}_t$ suggests EX_t and MM_t are cointegrated. Thus, Philippines has strong form of current account sustainability.

Table 3.11 DOLS Cointegration Analysis with Dummy Shifts for Singapore

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \phi_2(D_2 MM_t) + \mu_t$	
Estimation Method	DGLS
α	5.357 (14.345)
MM_t	1.038 (0.091)***
$D_1 MM_t$ (D_1=1 in 1994Q1-2008Q4, 0 otherwise)	0.030 (0.014)**
$D_2 MM_t$ (D_2=1 in 2002Q2-2008Q4, 0 otherwise)	0.076 (0.014)***
F-Wald test, H_0: $\beta + \phi_1 + \phi_2 = 0$	236.26 [0.00]***
F-Wald test, H_0: $\beta + \phi_1 + \phi_2 = 1$	2.78 [0.12]
ADF test on $\hat{CV}_t$, lag length in { }	-4.54*** {3}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.22
JB's Chi-square test for normality	0.87
LM F-test for ARCH	0.26
White's Chi-square test for heteroscedasticity	0.16
Inference	***Strong form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

For Singapore, the estimation results reported in table 3.11 on the previous page indicate that both of the identified structural breaks show positive and significant effects on Singapore's current account. The shift of 1994Q1 is consistent with the widening gap between domestic savings and investment started from the early year 1994. According to the Asian Development Bank Annual Report 1995, the domestic saving as a percentage of GDP increased from 48.5% in early 1993 to 51.3% in the early year 1994, while the domestic investment as a percentage of GDP decreased from 38.4% to 32.2% during the same period. The increased saving rate was primarily the result of high mandatory saving through the Central Provident Fund (CPF), slow growth in private consumption and a government budgetary surplus. On the other hand, the decreased investment rate was mainly due to increased investments abroad. As a result, Singapore's current account surplus as a percentage of GDP increased sharply from 9.0% in the early year 1993 to 17.3% in the early year 1994. This widening gap between domestic savings and investment maintained throughout the late 1990s and 2000s. On the other hand, the shift of 2002Q2 can be explained by the global recovery from the crisis happened in the period 2000-2001. After the worldwide electronics slump in year 2001, world demand had increased for electronics, pharmaceuticals, other manufactured goods, and financial services. Since electronics and chemicals are the two major exports of Singapore, an increased world demand for these goods helped Singapore increased its exports and improved its current account balances. The null of the overall slope of unity is not rejected. Meanwhile, the ADF test indicates that $\hat{CV}_t$ is stationary at 1% significance level suggesting cointegration between Singaporean EX_t and MM_t. As a result, Singapore's persistent current account surplus is only weakly sustainable.

Finally, table 3.12 on the next page reports the estimation results for Thailand. The total multiplier associated with the shift of 2000Q4 is statistically insignificant at

10% significance level, which suggests that the global economy slowdown started from the mid-2000 did not have a lasting effect on Thailand's current account. On the other hand, the shift of 1997Q2 shows a positive and significant effect in terms

Table 3.12 DOLS Cointegration Analysis with Dummy Shifts for Thailand

Estimated equation: $EX_t = \alpha + \beta MM_t + \phi_1(D_1 MM_t) + \phi_2(D_2 MM_t) + \mu_t$	
Estimation Method	DGLS
α	22.118 (5.184)***
MM_t	0.385 (0.121)***
$D_1 MM_t$ (D_1=1 in 1997Q2-2009Q4, 0 otherwise)	0.405 (0.025)***
$D_2 MM_t$ (D_2=1 in 2000Q4-2009Q4, 0 otherwise)	-0.029 (0.037)
F-Wald test, H_0: $\beta + \phi_1 = 0$	46.21 [0.00]***
F-Wald test, H_0: $\beta + \phi_1 = 1$	3.25 [0.07]*
ADF test on $\hat{CV}_t$, lag length in { }	-5.72*** {0}
Misspecification Tests	*p*-value
LM F-test for 4th order autocorrelation	0.32
JB's Chi-square test for normality	0.38
LM F-test for ARCH	0.14
White's Chi-square test for heteroscedasticity	0.46
Inference	***Weak form***

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

of current account sustainability, which is consistent with the 1997 Asian financial crisis. This finding is consistent with the previous findings in both Korea and Malaysia. During the Asian financial crisis, Thailand not only had an enormous losses in its foreign exchange reserves caused by the heavily devaluation of Thailand's Baht, but also lost a lot of foreign capitals due to a tremendous loss of confidence in the Thail market. Accordingly, Thailand's current account position was seriously affected by the crisis and had a shift from deficit to large surplus around the time when crisis happened. The null of overall slope of unity is rejected by the Wald test at 10% significance level. However, the overall slope coefficient is statistically significantly different from zero but less than unity. Moreover, the ADF test on $\hat{CV}_t$ shows cointegration between EX_t and MM_t for Thailand. Therefore, Thailand has weak form of current account sustainability.confidence in the Thai market. Accordingly, Thailand's current account position was seriously affected by the crisis and had a shift from deficit to large surplus around the time when crisis happened. The null of overall slope of unity is rejected by the Wald test at 10% significance level. However, the overall slope coefficient is statistically significantly different from zero but less than unity. Moreover, the ADF test on $\hat{CV}_t$ shows cointegration between EX_t and MM_t for Thailand. Therefore, Thailand has weak form of current account sustainability.

Overall, all the sample economies still satisfy their intertemporal budget constraints in the presence of endogenously determined dummy shifts. Most of the identified dummy shifts have statistically significant effects on the current account balances. Further, all these significant dummy shifts can correspond to either some crucial global economic events or some important policy changes in the domestic market. One more thing worth noticing here is that, for Korea, Singapore and Thailand, EX_t and MM_t are not cointegrated when dummy shifts are ignored from the estimated equation, but they are cointegrated after taking the identified shifts into consideration, which is clear evidence in favour of improved current account sustainability. Therefore, accounting for possible dummy shifts (or structural breaks) in the analysis of current account sustainability is essential.

3.8 Robustness Test – Engle-Granger (1987) Cointegration Test

An alternative cointegration test is applied in this section in order to check the robustness of the DOLS test results presented in this chapter. Since all the time series under consideration in this study (i.e. EX_t and MM_t) are integrated at the same order, I(1), I choose to use the Engle-Granger (1987) (hereafter EG) 2-step cointegration test as a test of robustness. The EG 2-step test is the most commonly employed single equation approach to the analysis of cointegration in the econometrics literature, especially when the time series under consideration are integrated of the same order.

3.8.1 EG 2-Step Cointegration Test without Dummy Shift

To test for cointegration between EX_t and MM_t in this chapter, the EG approach simply requires two steps. In the first step, it requires to run the following Ordinary Least Squares (hereafter OLS) regression

$$EX_t = \alpha + \beta MM_t + u_t \qquad (3.21)$$

where α and β are the cointegrating parameters and μ_t is a residual term. In the second step, the approach requires to run the ADF unit root test on the residual term μ_t to determine if it is stationary. If the residual term μ_t is stationary (i.e. I(0)), then EX_t and MM_t are said to be cointegrated in the long-run.

Furthermore, the null hypothesis of β =1 is tested using the Wald coefficient test. If $0 < \beta \leq 1$ and EX_t and MM_t are not cointegrated, a sample economy's current account position is weakly sustainable. If β =1 and EX_t and MM_t are cointegrated, the economy has strong form of current account sustainability.

Table 3.13 on the next page reports the EG 2-step cointegration test results in the absence of a dummy shift along with the results of some diagnostic tests for all the sample economies. A number of interesting observations emerge from table 3.13. First, the estimated coefficient β is significantly different from zero at 1% significance level for all the sample economies. Second, the Wald coefficient test indicates that the null hypothesis of $\beta = 1$ is not rejected at 10% significance level for China, Hong Kong, Korea and Malaysia, whereas the null is rejected at 5% significance level for India, Philippines, Singapore and Thailand. Finally, the ADF test results suggest that the residual term μ_t is stationary (i.e. I(0)) in the cases of Hong Kong, India, Philippines and Singapore, which implies that EX_t and MM_t are cointegrated only in these four economies but not in the rest of the sample economies. In summary, all the empirical results suggest that, in the absence of a dummy shift, only Hong Kong has a strong form of current account sustainability while all the rest of the sample economies have weak form of current account sustainability.

In general, the EG 2-step test results presented here support the general findings of the DOLS results presented in section 3.7.2 in two ways. First, without accounting for any dummy shifts, both EG and DOLS tests indicate that EX_t and MM_t are only cointegrated in, at most, half of the sample economies. Second, both tests suggest that all the sample economies satisfy their intertemporal budget constraints in either weak or strong sense and most of the sample economies only have weak form of current account sustainability.

Table 3.13 EG 2-Step Cointegration Test without Dummy Shift

Estimated equation: $EX_t = \alpha + \beta MM_t + \mu_t$	**China**	**Hong Kong**	**India**	**Korea**	**Malaysia**	**Philippines**	**Singapore**	**Thailand**
Estimation Method	OLS	OLS	OLS	OLS	OLS	OLS	OLS	OLS
α	0.669 (0.781)	-4.974 (2.798)*	1.807 (0.287)***	0.180 (2.258)	19.471 (15.97)	-2.879 (2.04)	44.193 (63.78)	6.048 (4.062)
MM_t	1.116 (0.034)***	1.072 (0.016)***	0.693 (0.015)***	1.042 (0.064)***	1.026 (0.193)***	0.747 (0.037)***	0.963 (0.049)***	0.819 (0.076)***
Chi-Square-Wald test, H_0: β=0	1077.61 [0.00]***	4123.68 [0.00]***	2011.16 [0.00]***	206.07 [0.00]***	57.35 [0.00]***	391.42 [0.00]***	767.48 [0.00]***	246.69 [0.00]***
Chi-Square-Wald test, H_0: β=1	0.86 [0.19]	0.28 [0. 68]	395.50 [0.00]***	0.41 [0.52]	1.03 [0.12]	44.72 [0.00]***	55.94 [0.00]***	6.25 [0.02]**
ADF test on μ_t, lag length in { }	-1.83 {0}	-3.57** {0}	-3.53** {1}	-2.65 {1}	-1.58 {0}	-3.11* {0}	-3.78** {2}	-2.48 {0}
Misspecification Tests					*p*-values			
LM F-test for 4th order autocorrelation	0.00***	0.02**	0.00***	0.00***	0.00***	0.00***	0.00***	0.00***
JB's Chi-square test for normality	0.38	0.92	0.31	0.08*	0.29	0.21	0.51	0.03**
White's Chi-square test for heteroscedasticity	0.64	0.78	0.23	0.91	0.45	0.15	0.26	0.16
Inference on Current Account Sustainability	***Weak form***	***Strong form***	***Weak form***	***Weak form***	***Weak form***	***Weak form***	***Weak form***	***Weak form***

Note:

1. Standard errors are in parentheses; Chi-square probability values are in square brackets.
2. *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.
3. Asymptotic critical values of the ADF test on μ_t are −4.07, −3.37, −3.03 at 1%, 5% and 10% significance level respectively. Values are taken from MacKinnon (2010) tables.

However, one thing worth noticing here is that the diagnostic test for autocorrelation appears to be problematic for all the sample economies when EG 2-step procedure is applied. Given the presence of autocorrelation, the OLS estimates obtained from the first step of the EG test can be unbiased but inefficient. Normally, autocorrelation problem can simply arise due to incorrect dynamic structure of the estimated regression equation (i.e. the estimated OLS regression equation (3.25) in the first step of the EG test is a static model rather than a dynamic one). On the other hand, according to the DOLS estimation results presented in table 3.4, autocorrelation problem does not arise when the DOLS approach is applied. Therefore, this suggests that the use of the DOLS approach is more appropriate in estimating the cointegrating relationship between EX_t and MM_t in the absence of a dummy shift (or a structural break) since it overcomes the autocorrelation problem and offers more robust results.

3.8.2 EG 2-Step Cointegration Test with Dummy Shifts

To apply the EG 2-step cointegration test to re-examine the cointegrating relationship between EX_t and MM_t in the presence of identified dummy shifts, it requires the following two steps. In the first step, I estimate an OLS model, which can be specified as

$$EX_t = \alpha + \beta\, MM_t + \sum_{j=1}^{k} \varphi_j (D_t MM_t) + e_t \qquad (3.22)$$

and the slope dummy for each identified shift, D_t, is defined as

$$\begin{aligned} D_t &= 0 \text{.........if } t \in T_1 = (1, ..., m-1) \\ &= 1 \text{.........if } t \in T_2 = (m, ..., T) \end{aligned}$$

where m denotes the dummy shift date that is endogenously identified by the Quintos's (1995) approach. Equation (3.22) is a modified version of equation (3.21).

In equation (3.22), α and β still represent the cointegrating parameters. Moreover, φ_j is a total multiplier, which picks up the long-run effect of each endogenously identified dummy shift on a sample economy's current account sustainability, and e_t is the residual term. In the second step, the ADF test is applied to the residual term e_t to test its stationarity. If the residual term e_t is found to be I(0) then EX_t and MM_t are said to be cointegrated in the presence of endogenously identified dummy shifts.

Furthermore, the null of the overall slope of unity (i.e. $H_0 : \beta + \sum_{j=1}^{k} \varphi_j = 1$, for j=1,...,k) is tested, where k refers to all the statistically significant dummy shifts identified for each sample economy, to analyze the long-run slope coefficient between EX_t and MM_t. In the absence of a cointegration between EX_t and MM_t, if $0 < \beta + \sum_{j=1}^{k} \varphi_j < 1$ or $\beta + \sum_{j=1}^{k} \varphi_j = 1$, a sample economy's current account position is said to be weakly sustainable. If $\beta + \sum_{j=1}^{k} \varphi_j = 1$ and EX_t and MM_t are cointegrated, the economy has strong form of current account sustainability.

The previously identified dummy shifts for each sample economy is listed in table 3.14 below. Table 3.15 on the next four pages reports the EG 2-step cointegration test results in the presence of dummy shifts along with the results of some diagnostic tests for each sample economy.

Table 3.14 Identified Dummy Shift(s) for Each Sample Economy

Sample Economy	Dummy Shift(s)
China	1992Q4
Hong Kong	2000Q4, 2006Q1
India	1995Q4, 2000Q2
Korea	1997Q4
Malaysia	1997Q3
Philippines	1997Q3, 2000Q4
Singapore	1994Q1, 2002Q2
Thailand	1997Q2, 2000Q4

Table 3.15 EG 2-Step Cointegration Test with Dummy Shift(s)

1. China

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1 MM_t) + e_t$		
Estimation Method	OLS	
α	0.923	(0.930)
MM_t	1.077	(0.083)***
$D_1 MM_t$ (D_1=1 in 1992Q4-2008Q4, 0 otherwise)	0.030	(0.058)
Chi-square-Wald test, H_0: $\beta = 0$	165.48	[0.00]***
Chi-square-Wald test, H_0: $\beta = 1$	0.85	[0.36]
ADF test on e_t, lag length in { }	-1.84	{0}
Misspecification Tests	*p*-value	
LM F-test for 4th order autocorrelation	0.00***	
JB's Chi-square test for normality	0.27	
White's Chi-square test for heteroscedasticity	0.30	
Inference	***Weak form***	

2. Hong Kong

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1 MM_t) + \varphi_2(D_2 MM_t) + e_t$		
Estimation Method	OLS	
α	-4.136	(4.835)
MM_t	1.052	(0.038)***
$D_1 MM_t$ (D_1=1 in 2000Q4-2009Q4, 0 otherwise)	0.025	(0.011)**
$D_2 MM_t$ (D_2=1 in 2006Q1-2009Q4, 0 otherwise)	-0.015	(0.007)*
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 0$	1824.40	[0.00]***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 1$	2.50	[0.12]
ADF test on e_t, lag length in { }	-3.95**	{0}
Misspecification Tests	*p*-value	
LM F-test for 4^{th} order autocorrelation	0.02**	
JB's Chi-square test for normality	0.65	
White's Chi-square test for heteroscedasticity	0.80	
Inference	***Strong form***	

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

(Table 3.15 Continues)

3. India

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1 MM_t) + \varphi_2(D_2 MM_t) + e_t$		
Estimation Method	OLS	
α	2.839	(0.462)***
MM_t	0.619	(0.047)***
$D_1 MM_t$ (D_1=1 in 1995Q4-2009Q1, 0 otherwise)	-0.058	(0.024)**
$D_2 MM_t$ (D_2=1 in 2000Q2-2009Q1, 0 otherwise)	0.099	(0.019)***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 0$	1127.98	[0.00]***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 1$	382.24	[0.00]***
ADF test on e_t, lag length in { }	-4.89***	{1}
Misspecification Tests	*p*-value	
LM F-test for 4^{th} order autocorrelation	0.18	
JB's Chi-square test for normality	0.11	
White's Chi-square test for heteroscedasticity	0.12	
Inference	***Weak form***	

4. Korea

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1 MM_t) + e_t$		
Estimation Method	OLS	
α	13.839	(2.068)***
MM_t	0.472	(0.072)***
$D_1 MM_t$ (D_1=1 in 1997Q4-2009Q4, 0 otherwise)	0.255	(0.026)***
F-Wald test, H_0: $\beta + \varphi_1 = 0$	180.08	[0.00]***
F-Wald test, H_0: $\beta + \varphi_1 = 1$	25.35	[0.00]***
ADF test on e_t, lag length in { }	-3.58**	{1}
Misspecification Tests	*p*-value	
LM F-test for 4^{th} order autocorrelation	0.00***	
JB's Chi-square test for normality	0.01**	
White's Chi-square test for heteroscedasticity	0.11	
Inference	***Weak form***	

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

(Table 3.15 Continues)

5. Malaysia

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1 MM_t) + e_t$		
Estimation Method	OLS	
α	24.346	(6.32)***
MM_t	0.748	(0.079)***
$D_1 MM_t$ (D_1=1 in 1997Q3-2008Q4, 0 otherwise)	0.293	(0.014)***
F-Wald test, H_0: $\beta + \varphi_1 = 0$	193.21	[0.01]***
F-Wald test, H_0: $\beta + \varphi_1 = 1$	0.31	[0.56]
ADF test on e_t, lag length in { }	-4.71***	{6}
Misspecification Tests	*p*-value	
LM F-test for 4th order autocorrelation	0.00***	
JB's Chi-square test for normality	0.15	
White's Chi-square test for heteroscedasticity	0.06*	
Inference	***Strong form***	

6. Philippines

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1 MM_t) + \varphi_2(D_2 MM_t) + e_t$		
Estimation Method	OLS	
α	10.91	(2.136)***
MM_t	0.524	(0.052)***
$D_1 MM_t$ (D_1=1 in 1997Q3-2009Q2, 0 otherwise)	0.142	(0.024)***
$D_2 MM_t$ (D_2=1 in 2000Q4-2009Q2, 0 otherwise)	-0.05	(0.016)***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 0$	247.14	[0.00]***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 0$	98.75	[0.00]***
ADF test on e_t, lag length in { }	-4.08**	{0}
Misspecification Tests	*p*-value	
LM F-test for 4th order autocorrelation	0.00***	
JB's Chi-square test for normality	0.21	
White's Chi-square test for heteroscedasticity	0.09*	
Inference	***Weak form***	

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

(Table 3.15 Continues)

7. Singapore

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1\ MM_t) + \varphi_2(D_2\ MM_t) + e_t$		
Estimation Method	OLS	
α	28.251	(8.879)***
MM_t	0.895	(0.054)***
$D_1\ MM_t$ (D_1=1 in 1994Q1-2008Q4, 0 otherwise)	0.035	(0.009)***
$D_2\ MM_t$ (D_2=1 in 2002Q2-2008Q4, 0 otherwise)	0.096	(0.011)***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 0$	510.84	[0.00]***
F-Wald test, H_0: $\beta + \varphi_1 + \varphi_2 = 1$	0.29	[0.58]
ADF test on e_t, lag length in { }	-4.86***	{0}
Misspecification Tests	*p*-value	
LM F-test for 4^{th} order autocorrelation	0.00***	
JB's Chi-square test for normality	0.19	
White's Chi-square test for heteroscedasticity	0.17	
Inference	***Strong form***	

8. Thailand

Estimated equation: $EX_t = \alpha + \beta MM_t + \varphi_1(D_1\ MM_t) + \varphi_2(D_2\ MM_t) + e_t$		
Estimation Method	DGLS	
α	29.489	(3.327)***
MM_t	0.199	(0.078)**
$D_1\ MM_t$ (D_1=1 in 1997Q2-2009Q4, 0 otherwise)	0. 429	(0.022)***
$D_2\ MM_t$ (D_2=1 in 2000Q4-2009Q4, 0 otherwise)	-0.018	(0.027)
F-Wald test, H_0: $\beta + \varphi_1 = 0$	72.54	[0.00]***
F-Wald test, H_0: $\beta + \varphi_1 = 1$	25.22	[0.00]***
ADF test on e_t, lag length in { }	-5.86***	{0}
Misspecification Tests	*p*-value	
LM F-test for 4^{th} order autocorrelation	0.02**	
JB's Chi-square test for normality	0.26	
White's Chi-square test for heteroscedasticity	0.14	
Inference	***Weak form***	

Note: Standard errors are in parentheses; Chi-square probability values are in square brackets; *, ** and *** denote the rejection of the null hypothesis at 10%, 5% and 1% significance level respectively.

Table 3.15 offers a number of interesting observations. First, the estimated coefficient β is significantly different from zero at 5% significance level for all sample economies. Second, the null of the overall slope of unity (i.e. $H_0 : \beta + \sum_{j=1}^{k} \varphi_j = 1$, for j=1,...,k and k refers to the statistically significant dummy shifts only) is not rejected at 10% significance level for China, Hong Kong, Malaysia and Singapore, whereas the null is rejected at 1% significance level for all the rest of the sample economies. Third, the ADF test results indicate that the residual term e_t is stationary (i.e. I(0)) for all the sample economies at 10% significance level except for China. This implies that EX_t and MM_t are cointegrated in all these economies except in China. Finally, the estimation results suggest that most of the identified dummy shifts that correspond to either some crucial global economic events or some important policy changes in the domestic market have statistically significant effects on the current account balances. This finding is consistent with the general finding of the DOLS test presented in section 3.7.4.

In summary, the empirical results suggest that, in the presence of dummy shifts, Hong Kong, Malaysia and Singapore have strong form of current account sustainability while all the rest of the sample economies have weak form of current account sustainability. One thing worth noticing here is that, for Malaysia and Singapore, EX_t and MM_t are not cointegrated when dummy shifts are ignored from the OLS regression equation, but they are cointegrated after taking the dummy shifts into consideration, which is clear evidence in favour of improved current account sustainability.

The EG 2-step cointegration test presented in this section once again supports the findings of the DOLS cointegration test presented in section 3.7.4. Both tests suggest that accounting for endogenously identified dummy shift(s) increases the instances of cointegration between EX_t and MM_t, which increases the number of sample economies who have strong form of current account sustainability. However, residual autocorrelation still seems to be a problem for all the sample economies except for India when the EG 2-step test is applied with dummy shifts. This again suggests that it is more appropriate to apply the DOLS approach in estimating the cointegrating relationship between EX_t and MM_t in the presence of dummy shifts.

3.8.3 Summary of the Robustness Test

Overall, the robustness test confirms all the general findings of the DOLS tests. Furthermore, compared with the EG 2-step cointegration test, the DOLS approach offers more robust and efficient estimates since it overcomes the residual autocorrelation problem, which is done by simply transforming the static OLS regression used in the EG test to a dynamic OLS model (i.e. by introducing some lag and lead terms of MM_t into the static OLS model).

3.9 Conclusion

The purpose of the study in this chapter is to investigate empirically the current account sustainability of eight emerging Asian economies in the context of the intertemporal budget constraint approach over the period 1990-2009. This study employs the theoretical background developed by Trehan and Walsh (1991), Hakkio and Rush (1991) and Husted (1992), and uses various unit root and cointegration techniques to analyze the form of current account sustainability for each sample economy. In particular, this study employs an approach to endogenously detect for multiple dummy shifts in the underlying cointegrating relationship between an economy's EX_t and MM_t.

The key findings in this chapter can be summarized as follows. First, cointegration tests without any dummy shifts fail to reject the null hypothesis of no cointegration between EX_t and MM_t for most of the selected sample economies in emerging Asia. However, according to the generalized sustainability conditions derived in Quintos' (1995) paper, all the sample economies still satisfy their intertemporal budget constraints in either weak or strong sense. Moreover, Hong Kong and Philippines are the only two economies who have strong form of current account sustainability when dummy shifts are ignored from the cointegration analysis.

Second, multiple dummy shifts are found for all the selected economies. Most of the endogenously identified dummy shifts can be linked to either some crucial global economic events or some important domestic policy changes. Also, most of the identified dummy shifts have significant and long lasting effects on the current account position of respective sample economies.

Third, for Korea, Malaysia and Thailand, the dummy shift happened in the 1997 Asian financial crisis had a significant positive effect on these economies' current account position. To be more specific, there was a sudden reversal in these economies' current account balances, from deficit to surplus, in the immediate post-Asian crisis period. However, this dummy shift did not have a lasting effect on Philippines current account position. On the other hand, the global economy slowdown in 2000-2001 did not have a significant long-run effect on any of the selected Asian economies.

Finally, accounting for endogenously identified dummy shifts increases the instances of cointegration between EX_t and MM_t. In particular, Singapore has weak form of sustainability when identified dummy shifts are ignored but strong form of sustainability when shifts are taken into consideration. Therefore, failure of finding a cointegration between EX_t and MM_t in some earlier studies could be explained by either their inability to account for dummy shifts or structural breaks in the analysis or the dummy shifts or structural breaks were selected exogenously.

There are several implications embedded in these empirical results. First, the empirical results imply that the macroeconomic structural differences exist among the selected emerging Asian economies since the economies under consideration have different form of current account sustainability and react to global economic events differently. Second, the weak form of current account sustainability found for China in this chapter may reflect the sustainability of the US current account position to some extent. In particular, if there is no future shock, the empirical results suggest that China will finally get all its lending back at some point in the future. Given that China lends most of its money to the US, the empirical results implicitly suggest that the US will pay back all its debt to China eventually in the absence of a unexpected shock. If this is the case, to some extent, China can continuously lend to the US and the US can continuously borrow from China to finance its large deficits. However, since China only has the weak form of current account sustainability, its current account position could easily become unsustainable in the presence of any unexpected future shocks. If this is true, China will stop lending to the US and the US needs to borrow from other countries to continue finance its debt. Last but not least, the empirical evidence suggests that India's persistent current account deficit since the liberalization of the Indian economy in the early 1990s is only weakly sustainable. This implies that the current account deficit process in India and its undiscounted international debt may be mildly explosive in the future, which may pose difficulty for the Indian government in financing its debt.

Chapter 3 Appendix

A1. Full Derivation of Husted's (1992) Model

A small open economy faces a budget constraint for each period t, which can be written as

$$C_t = Y_t + B_t - I_t - (1+r_t)B_{t-1} \tag{A3.1}$$

where C_t, Y_t, B_t I_t denote consumption, output, net international borrowing (could be either positive or negative) and investment in current period *t*, respectively; r_t is the one period world interest rate and $(1+r_t)B_{t-1}$ the country's net debt from the previous period *t-1*.

To construct a testable empirical model, Husted (1992) followed Hakkio and Rush's work (1991) and assumed that the world interest rate is stationary with unconditional mean equal to *r*. Equation (A3.1) thus can be rewritten as

$$\begin{aligned} Y_t - C_t - I_t &= EX_t - IM_t = -B_t + (1+r_t)B_{t-1} \\ EX_t + B_t &= IM_t + (1+r_t)B_{t-1} + r_t B_{t-1} - r_t B_{t-1} \\ EX_t + B_t &= IM_t + (r_t - r)B_{t-1} + (1+r)B_{t-1} \end{aligned}$$

(A3.2)

where EX_t and IM_t denote exports and imports of goods and services in current period *t* respectively. Rearranging equation (A3.2) for B_t,

$$\begin{aligned} B_t &= Z_t - EX_t + (1+r)\, B_{t-1} \\ B_{t+1} &= Z_{t+1} - EX_{t+1} + (1+r)\, B_t \\ &= Z_{t+1} - EX_{t+1} + (1+r)\,(Z_t - EX_t) + (1+r)^2\, B_{t-1} \\ &\dots \dots \\ B_{t+n} &= \sum_{j=0}^{n} (1+r)^{n-j}\,(Z_{t+j} - EX_{t+j}) + (1+r)^{n+1}\, B_{t-1} \end{aligned}$$

where $Z_t = IM_t + (r_t - r)B_{t-1}$. Also,

$$B_{t-1} = \sum_{j=0}^{n}(1+r)^{-j-1}(EX_{t+j} - Z_{t+j}) + (1+r)^{-n-1}B_{t+n}$$

$$= \sum_{j=0}^{n}\lambda^{j+1}(EX_{t+j} - Z_{t+j}) + \lambda^{n+1}B_{t+n} \qquad \text{, where } \lambda = \frac{1}{1+r}$$

or, if n approaches infinity,

$$B_{t-1} = \sum_{j=0}^{n}\lambda^{j+1}(EX_{t+j} - Z_{t+j}) + \lim_{n\to\infty}\lambda^{n+1}B_{t+n} \qquad \text{(A3.3)}$$

Upon further manipulation, equation (A3.3) can be written as

$$\begin{aligned}
B_{t-1} &= \sum_{j=0}^{n}\lambda^{j+1}(EX_{t+j} - Z_{t+j}) + \lim_{n\to\infty}\lambda^{n+1}B_{t+n} \\
&= \lambda(EX_t - Z_t) + \lambda^2(EX_{t+1} - Z_{t+1}) + \lambda^3(EX_{t+2} - Z_{t+2}) + \ldots + \lim_{n\to\infty}\lambda^{n+1}B_{t+n} \\
&= \lambda(EX_t - Z_t) + \lambda^2(EX_{t+1} - Z_{t+1}) - \lambda^2(EX_{t+1} - Z_{t+1}) + \lambda^2(EX_{t+1} - Z_{t+1}) \\
&\quad + \lambda^3(EX_{t+2} - Z_{t+2}) - \lambda^3(EX_{t+2} - Z_{t+2}) + \lambda^3(EX_{t+2} - Z_{t+2}) \\
&\quad + \ldots + \lim_{n\to\infty}\lambda^{n+1}B_{t+n} \\
&= \lambda(EX_t - Z_t) + \lambda\sum_{j=1}^{\infty}\lambda^j(\Delta EX_{t+j} - \Delta Z_{t+j}) + \lambda\sum_{j=1}^{\infty}\lambda^{j+1}(EX_{t+j} - Z_{t+j}) \\
&\quad + \ldots + \lim_{n\to\infty}\lambda^{n+1}B_{t+n} \\
&= \lambda(EX_t - Z_t) + \lambda\sum_{j=1}^{\infty}\lambda^j(\Delta EX_{t+j} - \Delta Z_{t+j}) + \lambda B_{t-1} + (1-\lambda)\lim_{n\to\infty}\lambda^{n+1}B_{t+n}
\end{aligned}$$

From the above equation,

$$\frac{1-\lambda}{\lambda}B_{t-1} = EX_t - Z_t + \sum_{j=1}^{\infty}\lambda^j(\Delta X_{t+j} - \Delta Z_{t+j}) + \frac{1-\lambda}{\lambda}\lim_{n\to\infty}\lambda^{n+1}B_{t+n}$$

and

$$Z_t + rB_{t-1} = EX_t + \sum_{j=1}^{\infty}\lambda^j(\Delta EX_{t+j} - \Delta Z_{t+j}) + r\lim_{n\to\infty}\lambda^{n+1}B_{t+n} \qquad \text{(A3.4)}$$

Since Husted (1992) assumed that EX_t and Z_t are I(1) processes given by

$$EX_t = \alpha_1 + EX_{t-1} + \varepsilon_{1t}, \quad Z_t = \alpha_2 + Z_{t-1} + \varepsilon_{2t}$$

with ε_{1t} and ε_{2t} stationary processes, I can thus obtain the following

$$Z_t + rB_{t-1} = EX_t + \sum_{j=1}^{\infty} \lambda^j (\alpha_1 - \alpha_2 + \varepsilon_{1,t+j} - \varepsilon_{2,t+j}) + r \lim_{n\to\infty} \lambda^{n+1} B_{t+n}$$

$$= EX_t + \frac{\alpha_1 - \alpha_2}{r} + \sum_{j=1}^{\infty} \lambda^j (\varepsilon_{1,t+j} - \varepsilon_{2,t+j}) + r \lim_{n\to\infty} \lambda^{n+1} B_{t+n} \qquad \text{(A3.5)}$$

As defined previously, $Z_t = IM_t + (r_t - r)B_{t-1}$. Therefore, the left-hand side of equation (A3.5) is equal to $IM_t + r_t B_{t-1}$. Assuming $\lim_{n\to\infty} \lambda^{n+1} B_{t+n} = 0$, and letting

$$\alpha = \frac{\alpha_2 - \alpha_1}{r}, \quad \varepsilon_t = \sum_{j=1}^{\infty} \lambda^j (\varepsilon_{2,t+j} - \varepsilon_{1,t+j}), \quad MM_t = IM_t + r_t B_{t-1}$$

Thus, equation (A3.5) can finally be simply expressed as

$$EX_t = \alpha + \beta\, MM_t + \varepsilon_t \qquad \text{(A3.6)}$$

Notably, Since $|\lambda| < 1$, the infinite-order moving-average error term in equation (A3.6), ε_t, is stationary. Equation (A3.6) is the testable empirical model used in this chapter to test current account sustainability.

A2. Conventional Unit Root Tests without Structural Break

(1) The Augmented Dickey-Fuller (ADF) Test

The Augmented Dickey–Fuller (1979) test constructs a parametric correction for higher-order correlation by assuming that the time series follows an autoregressive (AR) process up to a k^{th} order.

$$\Delta y_t = c + \beta t + \alpha y_{t-1} + \sum_{j=1}^{k} \gamma_j \ \Delta y_{t-j} + \varepsilon_t \qquad \text{(A3.7)}$$

$$\Delta y_t = c + \alpha y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \qquad \text{(A3.8)}$$

$$\Delta y_t = \alpha y_{t-1} + \sum_{j=1}^{k} \gamma_j \Delta y_{t-j} + \varepsilon_t \qquad \text{(A3.9)}$$

Equation (A3.7) is used to test for the null of a unit root against a trend-stationary alternative in y_t, where y refers to the examined time series. Equation (A3.8) tests the null of a unit root against a mean-stationary alternative, and equation (A3.9) tests the null of a unit root against zero-mean stationary alternative. Specifically, the null and alternative hypotheses can be written as

$$\mathrm{H}_0 : \alpha = 0 , \ \mathrm{H}_1 : \alpha < 0$$

and evaluated using the conventional t-ratio for α. Under the null hypothesis of a unit root, this statistic does not follow the conventional t-distribution; thus we need to rely on the specific critical values generated by Dickey and Fuller (1979) and more recently by Mackinnon (1991, 1996). The purpose of including the lagged first differences, Δy_{t-j}, into the right-hand side of the three test equations is to accommodate serial correlation in the residual terms, ε_t. The lag length of Δy_{t-j} can be selected by conventional information-based criteria, for examples, the Akaike Information Criterion (AIC), the Schwarz Information Criterion (SIC) and the Hannan-Quinn Criterion (HQC).

(2) The Philips-Perron (PP) Test

In addition to the Augmented DF test, Phillips and Perron (1988) propose an alternative method of controlling for serial correlation when testing for a unit root. Specifically, the PP method estimates the non-augmented DF test equation as follows

$$\Delta y_t = \alpha y_{t-1} + x_t'\delta + \varepsilon_t \tag{A3.10}$$

where $x_t'\delta$ controls for all the three cases of none, constant, and constant with trend. In order to account for the serial correlation, they modify the t-ratio of the α coefficient so that serial correlation does not affect the asymptotic distribution of the test statistic. The PP test is based on the following statistic:

$$\tilde{t}_\alpha = t_\alpha \left(\frac{\gamma_0}{f_0} \right)^{1/2} - \frac{T(f_0 - \gamma_0)(se(\hat{\alpha}))}{2 f_0^{1/2} s} \tag{A3.11}$$

where $\hat{\alpha}$ is the estimate and t_α the t-ratio of α, $se(\hat{\alpha})$ is coefficient standard error, and s is the standard error of the test regression. In addition, γ_0 is a consistent estimate of the error variance in (4.14). The remaining term, f_0, is an estimator of the residual spectrum at frequency zero. When conducting the PP test, you should choose the specification of the test equation (e.g., whether to include a constant, a constant and a linear time trend, or neither) and also choose a method for estimating f_0 (e.g., kernel-based sum-of-covariances, or on autoregressive spectral density estimation).

(3) The Ng-Perron (NP) Test

The ADF and PP tests are not only known to have low power against the alternative hypothesis that the examined time series is stationary with a large autoregressive root, but also to have severe size distortion when the examined time series has a large negative moving average root. Based on some of their own work (Perron and Ng, 1998) and also the work by Elliott, Rothenberg and Stock (1996), Ng and Perron (2001) developed new tests to deal with both of finite sample power and size problems. There are four test statistics involved in the NP test. These test statistics are modified forms of PP Z_α and Z_t statistics, the Bhargava (1986) R_1 statistic and the ERS point optimal statistic. There are two important features embedded in the NP test. The first feature is that the examined time series is demeaned or detrended by applying a Generalized Least Squares (GLS) estimator in the tests. This step improves the power of the unit root tests when there is a large autoregressive root and reduces size distortions when there is a large negative moving average root in the differenced time series. The second feature is that the NP tests use modified lag selection criteria since the standard lag selection procedures used in specifying the ADF test equation tend to choose a relatively small lag length when there is a large negative moving average root. The NP test assumes a unit root under its null hypothesis, which is the same as in the ADF, PP and ERS point optimal tests.

(4) The Kwiatkowski–Phillips–Schmidt–Shin (KPSS) Test

The Kwiatkowski–Phillips–Schmidt–Shin (1992) test differs from the previous four unit root tests in that the examined time series is assumed to be stationary around a deterministic trend under the null. The KPSS test equation can be represented as follows:

$$\begin{aligned} y_t &= \beta' \mathrm{D}_t + \mu_t + u_t \\ \mu_t &= \mu_{t-1} + \varepsilon_t, \varepsilon_t \sim \mathrm{WN}(0, \sigma_\varepsilon^2) \end{aligned} \qquad \text{(A3.12)}$$

In equation (A3.12), D_t contains deterministic components (constant or constant plus time trend), u_t is I(0) and may be heteroscedastic. Notice that μ_t is a pure random walk with innovation variance σ_ε^2. The null hypothesis that y_t is I(0) is formulated as $H_0 : \sigma_\varepsilon^2 = 0$, which implies that μ_t is a constant. Although not directly apparent, this null hypothesis also implies a unit moving average root in the autoregressive moving average (ARMA) representation of Δy_t. The KPSS test statistic is the Lagrange multiplier (LM) statistic for testing $\sigma_\varepsilon^2 = 0$ against the alternative that $\sigma_\varepsilon^2 > 0$ and is given by

$$KPSS = \left(T^{-2} \sum_{t=1}^{T} \hat{S}_t^2 \Big/ \hat{\lambda}^2 \right) \qquad \text{(A3.13)}$$

where $\hat{S}_t = \sum_{j=0}^{t} \hat{u}_j$, $\hat{u}_j$ is the residual of a regression of y_t on D_t and $\hat{\lambda}^2$ is a consistent estimate of the long-run variance of u_t using $\hat{u}_t$. The KPSS test is intended to complement unit root tests, such as the ADF test. By testing both the unit root hypothesis and the stationarity hypothesis, one can distinguish series that appear to be stationary, series that appear to have a unit root, and series for which the data (or the tests) are not sufficiently informative to be sure whether they are stationary or integrated.

Chapter 4

Equity Home Bias and International Trade in Goods

4.1 Introduction

Why do home investors overwhelmingly prefer to hold home equity assets? Why do households seem to have a strong preference for consumption of their home goods? The first phenomenon is well known as the 'home bias in portfolio puzzle' in the finance literature, while the second one is also well known as the 'home bias in consumption puzzle' in the macroeconomics literature. Although there is still no fully convincing explanations for each of the two puzzles, increasing empirical evidence has suggested that home bias in consumption may be connected to home bias in portfolio.

Lane (2000), Aizenman and Noy (2004) and Heathcote and Perri (2004) find that, if everything else is equal, countries with higher import shares have larger stocks of foreign assets by using panel data for a cross-section of countries. Moreover, Aviat and Coeurdacier (2004), Lane and Milesi-Feretti (2004) and Portes and Rey (2005) suggest that a country's portfolios are strongly correlated with its trading partners by looking at bilateral data on trade in goods and asset holdings. More interestingly, Aviat and Coeurdacier (2004) indicate that the causality relationship between a country's degree of trade openness and its foreign asset holdings is only uni-directional. To be more specific, reducing trade barriers between countries can enhance cross-border asset holdings.

Besides the empirical evidence found in the literature, a lot of theoretical works have also suggested that consumption home bias may lead to portfolio home bias. In particular, a growing theoretical literature has suggested that the existence of non-traded goods is the fundamental reason that causes home bias in consumption which leads to home bias in portfolio holdings. Stockman and Dellas (1989) made an early contribution to this literature. In a two-country endowment general equilibrium (hereafter GE) model with separable utility function between traded and non-traded goods, Stockman and Dellas (1989) argue that the presence of consumption bias caused by the existence of non-traded goods can induce a similar bias in portfolio holdings. Although the theoretical literature after the work of Stockman and Dellas (1989) is fairly extensive, researchers still hold different opinions on the importance of non-traded goods for portfolio home bias and no clear consensus has been made so far. Moreover, most of these previous studies are suffered from one potential problem, which is that the degree of equity home bias that can be attributed to the presence of non-traded goods is very sensitive to assumptions about the key parameters in the models.

Recently, Collard *et al.* (2008) has developed a two-country general equilibrium model, which extends the earlier work of Stockman and Dellas (1989) by allowing for differentiated home and foreign traded goods and non-separable utility function. Their study confirms the role of consumption home bias in explaining the home bias in equity portfolios and also suggests that the degree of international trade in goods is the main determinant of international equity portfolios. Their model predicts that investors can achieve full international risk diversification if the share of wealth invested in foreign equity matches their country's degree of openness, which is measured as a country's imports of GDP share.

To check whether the empirical evidence offers support the implication of their model, I simply run a linear regression between the two shares, where using the share of foreign portfolio equity holdings as the dependent variable and the imports to GDP share as the independent variable.[13] The estimation results are reported in figure 4.1.

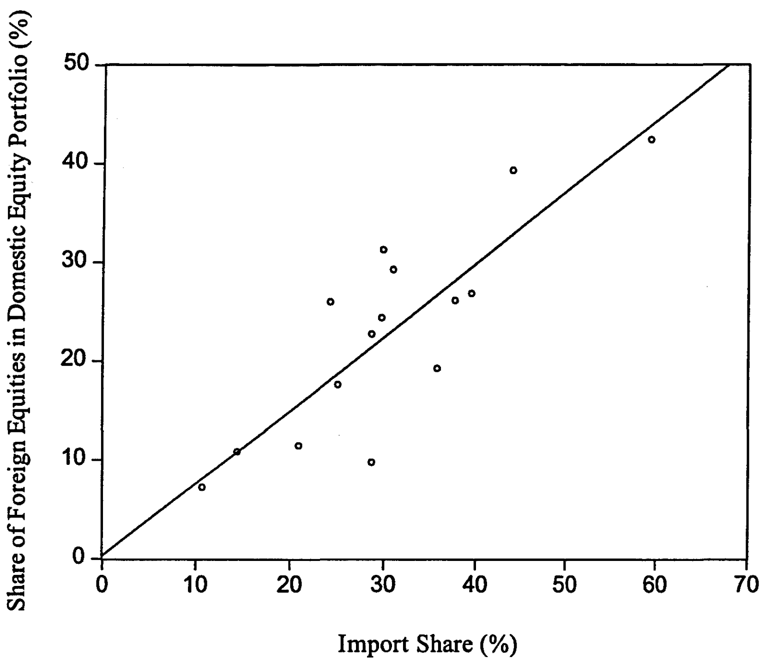
As in figure 4.1 the match between the two shares in most developed countries are very good. A similarly good match also obtains in individual years, in sub-periods and so on. This suggests that the estimation result is very robust. The fit of the regression is lower when very open economies, such as Ireland, are included in the sample. This is due to the fact that the reported degree of openness overstates the true one due to re-exporting.

Nevertheless, there are good reasons for suspecting that the match between the two shares shown in figure 4.1 may be implausibly good. This could be due to the existence of important discrepancies between the measures of trade and wealth in the data and in their model. For example, gross trade flows and value added coincide in their model but not in the data. A great deal of trade involves intermediate products, and some of these goods are used in the production of exportable goods. Subsequently, the imports share needs to be adjusted for

[13] Sample countries used in this regression include Australia, Austria, Canada, Denmark, France, Germany, Italy Japan, Netherlands, New Zealand, Norway, Spain, Sweden, UK and US.

Figure 4.1: Foreign Equity Assets and Imports to GDP Shares

(average 1992-2007, 15 developed countries)



Note: The regression line is $FEA_i = \underset{(4.298)}{0.322} + \underset{(0.130)}{0.868}\, IM_i$, where FEA_i represents a country's share of foreign equities in the domestic equity portfolio and is calculated as $\text{Foreign Assets}/(\text{Stock Market Capitalization - Foreign Liabilities + Foreign Assets})$.[14] Moreover, IM_i is a country's import to GDP share. This regression has R^2=0.74. Standard errors are in the parenthesis.

re-exports in order to arrive at an empirical measure of openness that corresponds to that in their model. On the asset side, there are two problems with the wealth share used here. First, their model abstracts from the most important form of equity for households, namely, housing. The second problem is that their model abstracts from multinational firms. Investing in domestic firms that operate abroad and/or own

[14] I have used data on foreign portfolio equity assets and liabilities from Lane-Milesi-Feretti (2007) and data on market capitalization from the World Development Indicators (WDI) to compute the FEA shares for the sample countries.

foreign assets is an indirect way for domestic investors to obtain international portfolio diversification. Hence, focusing only on the direct domestic and foreign equity components of the portfolio overestimates the degree of portfolio home bias. All these problems can only be dealt with in the future when more detailed and reliable data become available.

Besides the relatively strong support from the empirical evidence, more importantly, Collard *et al.* (2008) claim that, unlike other previous studies, their results are robust in the presence of plausible and large variations in the key parameters values of the model. Although the findings in the Collard *et al.*'s (2008) paper is encouraging, their model only considers two symmetric countries. It would be interesting to extend their model into a three-country model and also introduce some asymmetries into the extended model to see the robustness of their model results.

The main objective of this chapter is to investigate the importance of consumption bias, especially the existence of non-traded goods, in generating equity portfolio bias in a three-country GE model, which is developed based on the two-country framework proposed by Collard *et al.* (2008). In the model setup, the three countries are assumed to be the United States (US), the European Union (EU) and Asia. The analysis is firstly carried out in a three-country baseline model where households across the three countries have symmetric preferences in their consumptions of traded goods. In the baseline model, each country is an endowment economy with two sectors: a traded goods sector and a non-traded goods sector. Each country specializes in the production of its traded goods. Current period productivity levels in both sectors are subject to the productivity levels of domestic and foreign countries in the previous period and also some stochastic disturbances. Household's preferences are defined over the consumption of four goods: a domestic non-traded goods and a basket of domestic and foreign traded goods. In order to finance their consumptions, households trade separately equities on the traded goods and non-traded goods sectors in a frictionless financial market. To be more specific, households not only trade equities issued by firms that produce traded goods in all three countries, but also trade domestic non-traded goods equity. Next, I extend the baseline model by simply assuming asymmetric household's preferences over domestic and foreign traded goods across the three countries. In particular, I assume that the US and Europe are 'mirror symmetric' in their preferences for each other's traded goods, but attach the same weight to Asian traded goods. Meanwhile, Asia weighs the US and European traded goods equally.

The key findings of this chapter can be summarized as follows. First, both the baseline and extended models suggest that the optimal holdings of non-traded goods equities are only affected by the separability between traded and non-traded goods, but not the household's preferences in traded goods. Second, household's preferences in traded goods play an important role in determining the optimal holdings of traded goods equities. To be more specific, for all the three countries, the optimal portfolio of traded goods equities is fully internationally diversified in the absence of consumption bias in traded goods. However, in the presence of a consumption bias in traded goods, a foreign consumption bias can induce a home bias in the sub-portfolio of traded goods equities while a home consumption bias tends to introduce a foreign bias in the sub-portfolio of traded goods equities. Third, the extended model suggests that, in a three-country framework, the optimal holdings of the two foreign traded goods equities depend on the amount of domestic traded goods each foreign country consumes. If both foreign countries consume the same amount of domestic traded goods, it is optimal for domestic investors to hold the two foreign traded goods equities in equal shares. On the other hand, if foreign country A consumes more domestic traded goods than foreign country B does, then, it is optimal for domestic investors to hold a smaller share in the foreign country A's traded sector but a larger share in the foreign country B's traded sector, *vice versa*. Fourth, the sensitivity analysis suggests that the results of both the baseline and extended models are very robust in the presence of plausible and large variation in the parameters values. Finally, the empirical evidence suggests that the theoretical implication offered by the model is only supported by the developed country data.

The contribution of this study is twofold. The primary contribution is a robustness check of the Collard *et al.*'s (2008) findings in a three-country model. The secondary contribution is a new insight about international equity portfolio holdings with non-traded goods in a model with asymmetric household's preferences towards traded goods that produced by different countries. Also, the three-country model tends to capture a more generalised picture for the world portfolio holdings in steady state. Although the model does not incorporate other important features such as production function, sticky prices and incomplete financial markets, it does provide some important implications of non-traded goods for portfolio home bias and serve as a stepping stone to more sophisticated models.

The remainder of this chapter is organized as follows. Section 4.2 presents some stylised facts on the degree of portfolio home bias in both developed and developing countries. Section 4.3 briefly discusses the related literature that analyses home bias in portfolio choice from the presence of non-traded goods perspective. Section 4.4 presents the baseline model setup as well as the solution to asset holdings. Section 4.5 discusses baseline model parameterization issues. Section 4.6 describes and discusses the main results of the baseline model. Section 4.7 introduces the extended model and discusses the calibration results of the extended model. Section 4.9 offers a discussion of the relation between the theoretical implication offered by the three-country model explored in this chapter and the empirical evidence and section 4.10 concludes.

4.2 Home Bias in International Equity Holdings

Equity home bias refers to one of the most pervasive empirical observations in international economics that investors tend to invest most of their wealth in domestic assets and ignore well diversified international portfolios even though they can offer great diversification benefits. Capital market segmentation in the 1980s might explain the emergence of equity home bias, but it can no more explain the equity home bias that can still be observed nowadays. Lane and Milesi-Feretti (2003) find that cross-border asset trade has increased significantly after the opening up of the stock market in both developed countries and emerging economies since the 1980s, but the degree of equity home bias still keeps at a very high level worldwide.

Before illustrating the degree of equity home bias in both developed and developing countries, it is necessary to firstly clarify the method of calculating equity home bias used in this study. There are different ways to measure the degree of equity home bias. One commonly used approach in the literature to calculate equity home bias is to subtract the optimal weight of domestic equity holdings that predicted from a world Capital Asset Pricing Model (CAPM) from its actual weight of domestic equity holdings. The world CAPM predicts that investors should hold a world market portfolio where the weight of each asset is equal to its relative share in the world market capitalization. Therefore, the optimal weight of domestic equity holdings as suggested by the world CAPM should be calculated as:

$$\text{Optimal Weight of Domestic Equity Holdings} = \text{Domestic Market Capitalization in World Market} = \frac{\text{Domestic Market Capitalization}}{\text{World Capitalization}} \quad (4.1)$$

Moreover, the equity home bias can thus be calculated as:

$$\begin{aligned}\text{Equity Home Bias} &= \text{Actural Domestic Equity Holdings} - \text{Optimal Weight of Domestic Equity Holdings} \\ &= \text{Actural Domestic Equity Holdings} - \frac{\text{Domestic Market Capitalization}}{\text{World Capitalization}}\end{aligned} \quad (4.2)$$

Table 4.1 one the next page presents the average values of the imports to GDP share and the degree of home bias in equity holdings for 30 selected countries over the period 1992-2007. Data on portfolio holdings are from the updated and extended version of the External Wealth of Nations Mark II database developed by Lane and Milesi-Ferretti (2007), while data on imports to GDP shares and market capitalizations are from the World Development Indicators database held by the World Bank. Equity home bias is calculated by using the formula provided in Equation (2).

There are several interesting findings from table 4.1. First, the table clearly shows that equity holdings in all the selected countries are significantly home biased. The equity home bias is the highest in Thailand, where nearly all equity portfolios are invested in the domestic stocks. On the other hand, equity home bias in US is the lowest among all the countries, where 42.05 percent of the total equity investments are domestic. Second, equity home bias is lower in the developed countries and

Table 4.1: Imports as a Percentage of GDP and Home Bias in Equity Portfolios, 30 Selected Countries, 1992-2007 Average

Country	% Imports to GDP	% Foreign in Total Equity Holdings	% Domestic in Total Equity Holdings	% Market Capitalization in World Market	Equity Home Bias
Australia	20.34	13.38	86.62	1.67	84.94
Austria	42.60	41.88	58.12	0.21	57.91
Brazil	10.63	2.06	97.94	0.99	96.95
Canada	34.94	22.74	77.26	2.79	74.47
China	23.48	0.79	99.21	2.03	97.18
Denmark	38.33	29.74	70.26	0.39	69.87
France	24.37	19.91	80.09	4.06	76.03
Germany	29.79	33.78	66.22	3.65	62.57
Hong Kong	149.56	16.74	83.26	1.96	81.30
India	15.26	0.40	99.60	0.94	98.66
Indonesia	27.89	1.03	98.97	0.22	98.74
Italy	23.33	29.36	70.64	1.84	68.81
Japan	10.08	7.80	92.20	13.98	78.22
Korea	32.95	3.20	96.80	1.10	95.70
Malaysia	91.31	1.37	98.63	0.77	97.87
Mexico	28.05	5.01	94.99	0.67	94.32
Netherlands	57.88	48.71	51.29	1.82	49.47
New Zealand	29.70	25.79	74.21	0.13	74.08
Norway	30.47	35.06	64.94	0.32	64.62
Philippines	49.09	2.76	97.24	0.19	97.05
Russia	25.36	0.63	99.37	0.62	98.75
Saudi Arabia	27.94	1.54	98.46	0.49	97.97
Singapore	163.92	36.81	63.19	0.66	62.53
South Africa	24.98	8.68	91.32	1.13	90.20
Spain	27.10	10.65	89.35	1.79	87.56
Sweden	36.36	28.81	71.19	1.03	70.16
Thailand	54.12	0.48	99.52	0.40	99.12
Turkey	23.73	2.17	97.83	0.24	97.59
United Kingdom	28.30	26.61	73.39	8.47	64.92
United States	13.76	12.48	87.52	45.47	42.05
Total				**100.00**	

Data sources: 1. Import shares: International Monetary Fund (IMF), World Economic Outlook Database, October 2009.

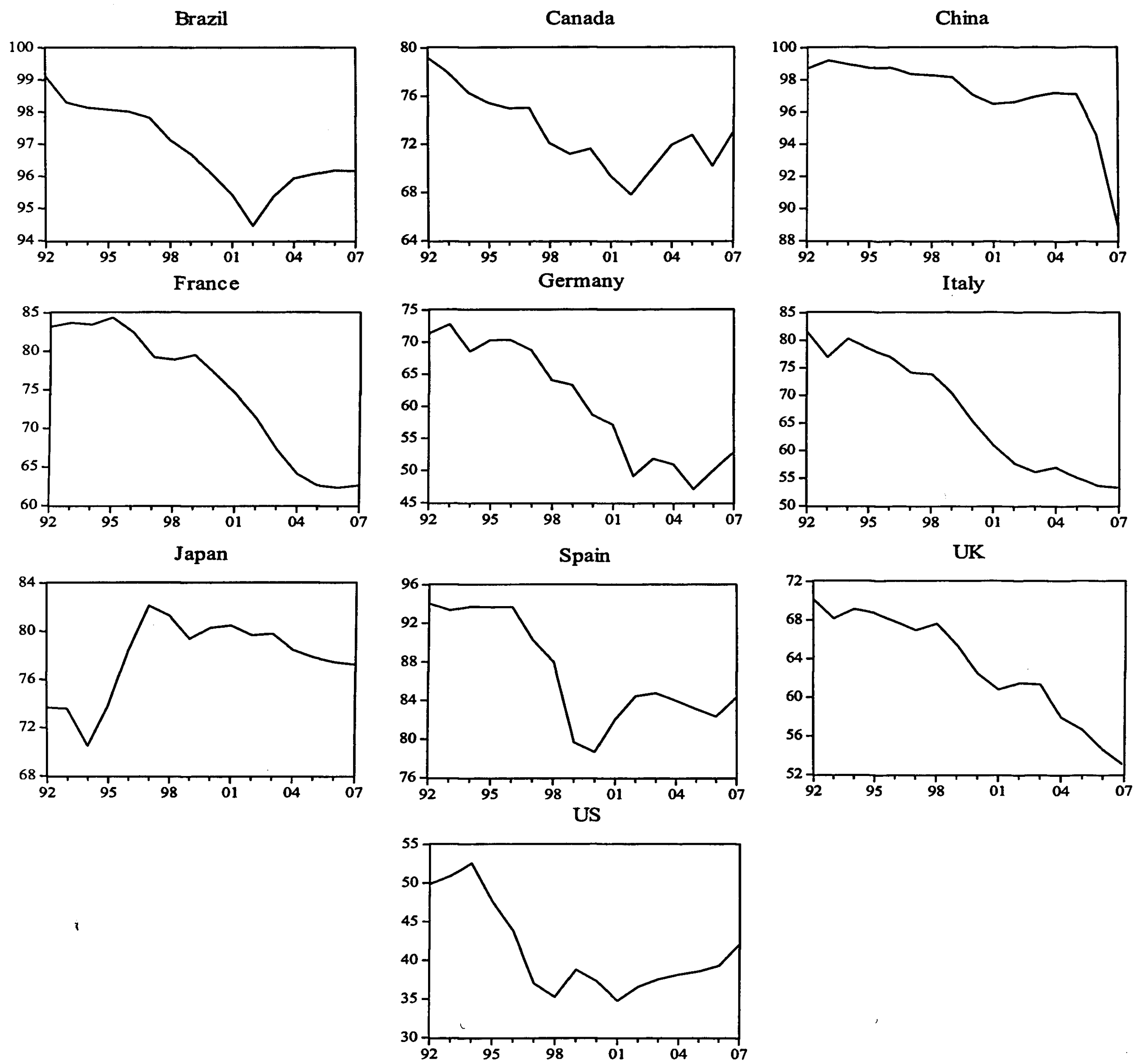
2. Foreign and domestic equity holdings: updated and extended version of the External Wealth of Nations Mark II database developed by Lane and Milesi-Ferretti (2007).

3. Market capitalisation: World Bank online database.

higher in developing countries and emerging economies. One interesting thing to note here is that although the stock markets are very volatile in emerging economies, domestic investors in those economies still tend to invest most of their wealth in the domestic assets. This implies that either the domestic investors bear a substantial amount of unrewarded country-specific risk, or the international investors are unwilling to cash in an expected return for a risk that is diversified away. Finally, the match between the share of imports to GDP and the share of foreign portfolio equity holdings in total domestic equity portfolio is very high in developed countries, such as Austria, UK and US, but is relatively low in developing countries, especially emerging economies, for examples, China, India and Thailand. However, it is not surprising that the match of the two shares is low in developing countries given the widespread use of capital controls and the presence of severe official and unofficial financial impediments in those countries. Moreover, the low match of the two shares in very open economies, for examples, Hong Kong and Singapore, can be explained by the fact that their reported degree of openness (i.e. represented by their imports to GDP shares in the table) overstates the true one due to high volumes of re-exporting.

Figure 4.2 on the next page presents the evolution of equity home bias in the world top 10 economies in terms of nominal GDP that ranked by both the IMF and World Bank at year 2009. Equity home bias in China, France, Germany, Italy and UK has clearly decreased in the past two decades, which implies more international diversification in investors' portfolios. This decreasing trend has obviously accelerated since the late 1990s for all these countries except for China where the trend really took off after year 2005. In the case of China, its equity market has been in existence since year 1990 but with very limited foreign access and is less developed compared with the equity markets in other Asian countries, for examples,

Figure 4.2: Evolution of the Equity Home Bias (Measured in %) in 10 Countries, Over the Period 1992-2007



Note: Calculated figures using equation (4.1) and (4.2), same data sources as in table 4.1.

Japan and Korea. After the bearish performance that China's equity market had for the period 1992-2005, a bullish market emerged in China at the beginning of year 2006 and accelerated dramatically from the middle of that year. This caused a huge increase in the stock market capitalization and thus a significant decrease in the equity home bias. The total number of listed companies has increased from 14 by the end of year 1991 to 1,530 with a total market value of 32.71 trillion Chinese Yuan. This rapid growth was characterized by rapid gains in the share prices of listed banks, particularly after the listing of Industrial and Commercial Bank of China (ICBC) in year 2006.

On the other hand, the pattern of equity home bias in Brazil, Canada, Spain and US is not very apparent. To be more specific, the figure shows a clear trend towards more international diversification during the period of 1990s in Brazil, Canada, Spain and US, but a upward trend in equity home bias after the beginning of the 2000s, which was mainly due to the decrease of domestic market capitalization in the world market. In the case of Japan, the figure shows a dramatic increase in equity home bias for the period 1992-1997, which was primarily caused by the crash of Japan's stock prices in the early 1990s, bringing Japan's market capitalization from 47 percent of the world market capitalization in year 1988 back to 11 percent at the end of year 1997.Overall, it is clear that although a general trend towards more international diversification, home bias in equity holdings still remains strong worldwide.

4.3 Review of the Related Literature

This study is related to one large strand of the literature that tries to explain home bias in portfolio choice by the presence of non-traded goods in household's consumption basket. This strand of the literature is inspired by the work of Lucas

(1982). Lucas (1982) analyses portfolio choice by using a two-country endowment economy model within a GE framework. In his model, all consumption goods are assumed to be non-storable traded goods, and household's preferences are identical across countries. His model suggests that all households hold identical equity portfolios in equilibrium, which permits full risk sharing. However, Lucas' work cannot generate cross-country differences in portfolios. In order to overcome this problem, a big strand of literature in international portfolio choice tries to extend Lucas' analysis and study the equity home bias in models with consumption home bias by introducing non-traded goods, for examples, Stockman and Dellas (1989), Tesar (1993), Stockman and Tesar (1995), Baxter, Jermann and King (1998), Serrat (2001), Pesenti and van Wincoop (2002), Kollmann (2006a), Matsumoto (2007), Collard, Dellas, Diba and Stockman (2008) and Coeurdacier (2009).

Tesar (1993) and Pesenti and van Wincoop's (2002) study home bias in portfolio within a partial equilibrium framework. Tesar (1993) argues that if the share of non-traded goods in total output is large in an economy, household's preferences over consumption of traded and non-traded goods and over the intertemporal allocation of consumption can result in an optimal portfolio biased toward claims on domestic output. Furthermore, Tesar (1993) and Stockman and Tesar (1995) show theoretically and empirically that the presence of non-traded goods can help explain the relatively low correlations between consumption growth rates across countries. Pesenti and van Wincoop (2002) derive a similar result in a partial equilibrium framework and confirm it empirically using a sample of 14 OECD countries. However, since both studies are carried out within a partial equilibrium framework, their results may not necessarily hold in GE models.

Apart from the partial equilibrium analysis of portfolio home bias discussed above, there are a lot of papers that study the role of non-traded goods in explaining home bias in equity holdings within a GE framework. Stockman and Dellas (1989) made an earlier contribution to solve for the optimal portfolio with non-traded goods within a GE framework. They develop a two-country endowment economy model in which household's preferences are separable in traded and non-traded goods, and no home bias is assumed for traded goods. Their model predicts that, in equilibrium, it is optimal for domestic investors to hold 100 percent of the domestic non-traded goods equity and fully internationally diversified traded good equity, which are equally split between home and foreign traded equities.

However, Baxter, Jermann and King (1998) argue that Stockman and Dellas' (1989) results are sensitive to the assumption that utility is separable between traded and non-traded goods. They study portfolio choice by using a multi-country endowment model with complete security markets. In their model, household's preferences are non-separable in traded and non-traded goods, and there is perfect substitutability in home and foreign traded goods. They find that the presence of non-traded goods cannot explain equity home bias as long as investors have access to free international trade in financial assets. Moreover, they claim that, depending on the elasticity of substitution between traded and non-traded goods, domestic investors may want to hold less than 100 percent of domestic non-traded good equity or even want to short it.

Serrat (2001) also employs a non-separable utility function to study portfolio choice in an endowment GE model with both traded and non-traded goods. His model predicts that, in a dynamic setup, frictions in goods market that are captured by the existence of non-traded goods can lead to home bias in domestic investors' portfolios. In his framework, domestic investors fully hold the domestic non-traded good equity, and the home bias in the traded goods equity arises under conditions similar to those in Tesar (1993).

Kollmann (2006a) disputes the assertions made by Serrat (2001). He argues that since the assumed preferences, dividends and equity prices are collinear in Serrat's economy the non-traded portfolio split becomes indeterminate. Therefore, Serrat's model fails to explain the home bias in traded goods equity. Kollmann's statement is quite similar to the claim made by Baxter, Jermann and King (1998) who also argue that home bias in traded goods equity cannot arise in a static economy with complete markets and international trade in claims to traded and non-traded goods.

Matsumoto (2007) uses a two-country, two sector production economy model to study the role of non-traded goods and non-separable utility in portfolio choice. His paper concludes that the presence of non-traded goods with non-separable utility can be a potential solution to the equity home bias puzzle. However, he finds that the traded goods equity is no longer fully diversified internationally if the utility is non-separable between traded and non-traded goods. His claim overrules the findings of Stockman and Dellas (1989) and Baxter, Jermann and King (1998). Another important finding in his paper is that the optimal traded goods equity portfolios are very sensitive to the elasticity of substitution between home and foreign traded goods.

Collard, Dellas, Diba and Stockman (2008) extend the work of Stockman and Dellas (1989) by allowing for differentiated home and foreign traded goods and non-separable utility in a dynamic GE model. Their model suggests that the degree of international trade in goods is the main determinant of international equity portfolios. In their framework, investors can achieve full international risk diversification if the share of wealth invested in foreign equity matches their country's degree of openness, which is measured as a country's imports of GDP share. Unlike other previous studies, their results are robust in the presence of plausible and large variation in the key parameters values of the model. Their study once again confirms the role of consumption home bias in explaining the home bias in equity portfolios.

Coeurdacier (2009) solves for international equity portfolios in a static two-country two-sector GE model. His model departs from the previous studies by assuming a different financial asset structure. To be more specific, investors are assumed to hold claims over the aggregate stock market of a country, but they cannot trade separate claims on traded and non-traded goods in each country. In this setup, he finds that the presence of trade costs in goods markets and non-traded goods cannot explain the consumption and the portfolio home biases simultaneously. However, since his claims are made within a static model, it is questionable if the results can still hold in a dynamic GE model.

While all the above studies (except Coeurdacier, 2009) consider the extreme of zero trade costs for traded goods and very high trade costs for other goods, making them non-traded, there are several studies explicitly introduce trade costs for traded goods in their studies. Examples are Uppal (1993), Obstfeld and Rogoff (2000a), Kollmann (2006b), Obstfeld (2007) and Heathcote and Perri (2007). Obstfeld and Rogoff (2000a) argue that the presence of trade costs for traded goods in international markets can lead to home bias in consumption, which can help to explain the equity home bias puzzle. However, Coeurdacier (2009) finds that this conclusion no longer holds when adopting a more realistic assumption about the elasticity of substitution between goods. On the other hand, Obstfeld (2007) argues that one can make the model even more realistic by introducing both non-traded goods and trade costs for traded goods. He finds that this can lead to realistic home bias for both claims on traded and non-traded goods equity.

It is obvious that depending on details of the model setup and assumptions of the key parameter values, different studies can draw different conclusions. Some of these papers argue that non-traded goods and trade costs can explain most of the home bias in portfolios, while some papers conclude that they cannot account for observed portfolio home bias.

4.4 The Baseline Model

The baseline model presented in this chapter is a three-country endowment model, which is developed based on the two-country framework used in Collard *et al.* (2008). In the baseline model, the world consists of three countries, which are labelled as U (for United States), E (for Europe), and A (for Asia). These three countries are perfectly symmetric and their sizes can be flexibly calibrated. In each period, each region receives an exogenous endowment of a traded good, $Y_{it}>0$ and a non-traded good, $Z_{it}>0$. All the goods are perishable. By assuming the endowments of both non-traded and traded goods are given exogenously, the model implicitly assumes that capital and labour are not mobile between sectors in the short run. The model distinguishes between home and foreign produced traded goods, and also between traded and non-traded goods. Households in three countries have the same preferences in consumption. Moreover, I have assumed complete asset markets and perfectly flexible nominal prices in the model. While these assumptions may be relaxed in the future, without understanding complete market settings, it is difficult to judge which form of incompleteness is more appropriate.

4.4.1 Specification of the endowments

The endowment process for the traded goods takes the form

$$\begin{aligned} y_{Ut}-\bar{y}_U &= \rho^y_{UU}\left(y_{Ut-1}-\bar{y}_U\right)+\rho^y_{UE}\left(y_{Et-1}-\bar{y}_E\right)+\rho^y_{UA}\left(y_{At-1}-\bar{y}_A\right)+\varepsilon^y_{Ut} \\ y_{Et}-\bar{y}_E &= \rho^y_{EU}\left(y_{Ut-1}-\bar{y}_U\right)+\rho^y_{EE}\left(y_{Et-1}-\bar{y}_E\right)+\rho^y_{EA}\left(y_{At-1}-\bar{y}_A\right)+\varepsilon^y_{Et} \\ y_{At}-\bar{y}_A &= \rho^y_{AU}\left(y_{Ut-1}-\bar{y}_U\right)+\rho^y_{AE}\left(y_{Et-1}-\bar{y}_E\right)+\rho^y_{AA}\left(y_{At-1}-\bar{y}_A\right)+\varepsilon^y_{At} \end{aligned} \quad (4.1)$$

where y_{it} = $\log(Y_{it})$, i = U, E, A. The eigenvalues of the matrix $A_y = \begin{pmatrix} \rho^y_{UU} & \rho^y_{UE} & \rho^y_{UA} \\ \rho^y_{EU} & \rho^y_{EE} & \rho^y_{EA} \\ \rho^y_{AU} & \rho^y_{AE} & \rho^y_{AA} \end{pmatrix}$ all lie inside the unit circle and $\left(\varepsilon^y_{Ut},\varepsilon^y_{Et},\varepsilon^y_{At}\right) \sim N\left(0,\Sigma_y\right)$.

Similarly for the non-traded goods

$$\begin{aligned} z_{Ut}-\bar{z}_U &= \rho^z_{UU}\left(z_{Ut-1}-\bar{z}_U\right)+\rho^z_{UE}\left(z_{Et-1}-\bar{z}_E\right)+\rho^z_{UA}\left(z_{At-1}-\bar{z}_A\right)+\varepsilon^z_{Ut} \\ z_{Et}-\bar{z}_E &= \rho^z_{EU}\left(z_{Ut-1}-\bar{z}_U\right)+\rho^z_{EE}\left(z_{Et-1}-\bar{z}_E\right)+\rho^y_{EA}\left(z_{At-1}-\bar{z}_A\right)+\varepsilon^z_{Et} \\ z_{At}-\bar{z}_A &= \rho^z_{AU}\left(z_{Ut-1}-\bar{z}_U\right)+\rho^z_{AE}\left(z_{Et-1}-\bar{z}_E\right)+\rho^z_{AA}\left(z_{At-1}-\bar{z}_A\right)+\varepsilon^z_{At} \end{aligned} \quad (4.2)$$

where z_{it} = $\log(Z_{it})$, i = U, E, A. The eigen-values of the matrix

$$A_z = \begin{pmatrix} \rho_{UU}^Z & \rho_{UE}^Z & \rho_{UA}^Z \\ \rho_{EU}^Z & \rho_{EE}^Z & \rho_{EA}^Z \\ \rho_{AU}^Z & \rho_{AE}^Z & \rho_{AA}^Z \end{pmatrix}$$ all lie inside the unit circle and $\left(\varepsilon_{Ut}^Z, \varepsilon_{Et}^Z, \varepsilon_{At}^Z\right) \sim N\left(0, \Sigma_Z\right)$.

4.4.2 Household's Problem

Country i (i = U, E, A) is inhabited by a representative agent whose preferences can be described by

$$E_t \sum_{t=0}^{\infty} \beta^t \frac{C_{it}^{1-\sigma} - 1}{1-\sigma} \quad \text{with } \sigma > 0 \tag{4.3}$$

C_{it} denotes the total consumption of the household in country i. It consists of both traded and non-traded goods that are based on the specification

$$C_{it} = \left(\omega_i^{\frac{1}{\rho}} C_{it}^{y\,\frac{\rho-1}{\rho}} + \left(1-\omega_i\right)^{\frac{1}{\rho}} C_{it}^{z\,\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}} \quad \omega_i \in (0,1) \text{ and } \rho > 0 \tag{4.4}$$

where C_{it}^{y} and C_{it}^{z} denotes the consumption of traded and non-traded goods in country i at period t.

The aggregate of each country's traded goods combines one domestic and two foreign traded goods

$$C_{Ut}^{y} = \left(\alpha^{\frac{1}{\eta}} \left(C_{UUt}^{y}\right)^{\frac{\eta-1}{\eta}} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} \left(C_{UEt}^{y}\right)^{\frac{\eta-1}{\eta}} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} \left(C_{UAt}^{y}\right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

$$C_{Et}^{y} = \left(\alpha^{\frac{1}{\eta}} \left(C_{EEt}^{y}\right)^{\frac{\eta-1}{\eta}} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} \left(C_{EUt}^{y}\right)^{\frac{\eta-1}{\eta}} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} \left(C_{EAt}^{y}\right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

$$C_{At}^{y} = \left(\alpha^{\frac{1}{\eta}} \left(C_{AAt}^{y}\right)^{\frac{\eta-1}{\eta}} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} \left(C_{AEt}^{y}\right)^{\frac{\eta-1}{\eta}} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} \left(C_{AUt}^{y}\right)^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{4.5}$$

where C_{ijt}^{y} denotes the consumption of the traded good j in country i at period t.

Households in all three countries have access to an equity market where the shares of the firms that own the endowments of the six goods can be traded. The budget constraint of the representative household in country i takes the form

$$\sum_{j=U,E,A}\left(Q^{y}_{jt}S^{y}_{ijt+1}+Q^{z}_{jt}S^{z}_{ijt+1}+P^{y}_{jt}C^{y}_{ijt}\right)+P^{z}_{it}C^{z}_{it}=\sum_{j=U,E,A}\left[\left(Q^{y}_{jt}+P^{y}_{jt}Y_{jt}\right)S^{y}_{ijt}+\left(Q^{z}_{jt}+P^{z}_{jt}Z_{jt}\right)S^{z}_{ijt}\right] \tag{4.6}$$

where P^{y}_{jt} and P^{z}_{jt} are the prices of the traded and non–traded good j respectively. S^{y}_{ijt} denotes the number of shares of traded goods j owned by the households in country i at the beginning of period t, while S^{z}_{ijt} is the number of shares of the non–traded goods. The price of traded goods shares is Q^{y}_{jt} and that of non–traded goods is Q^{z}_{jt}. The traded goods shares yield a dividend of $P^{y}_{jt}Y_{jt}$ and the non–traded ones $P^{z}_{jt}Z_{jt}$. Note that there are six equities in this model and six independent sources of uncertainty. This implies that the equity markets in this model can support the complete asset markets allocation of resources up to a linear approximation. As in Kollmann (2006b) and Collard *et al.* (2008), I will use this equivalence to determine asset holdings.

The household's consumption and portfolio choices are determined by maximizing (4.3) subject to (4.4) – (4.6). The evolution of asset prices is given by the standard Euler equations

$$Q^{y}_{jt}\lambda^{i}_{t}=\beta E_{t}\lambda^{i}_{t+1}\left(Q^{y}_{jt+1}+P^{y}_{jt+1}Y_{jt+1}\right) \tag{4.7}$$

$$Q^{z}_{jt}\lambda^{i}_{t}=\beta E_{t}\lambda^{i}_{t+1}\left(Q^{z}_{jt+1}+P^{z}_{jt+1}Z_{jt+1}\right) \tag{4.8}$$

where i, j = U, E, A. Since asset markets are complete and the three countries are perfectly symmetric, then $\lambda^{U}_{t}=\lambda^{E}_{t}=\lambda^{A}_{t}$.

4.4.3 Market Clearing Conditions

The required market clearing conditions are

$$Z_{Ut} = C^{z}_{Ut} \quad (4.8)$$

$$Z_{Et} = C^{z}_{Et} \quad (4.9)$$

$$Z_{At} = C^{z}_{At} \quad (4.10)$$

$$Y_{Ut} = C^{y}_{UUt} + C^{y}_{EUt} + C^{y}_{AUt} \quad (4.11)$$

$$Y_{Et} = C^{y}_{EEt} + C^{y}_{UEt} + C^{y}_{AEt} \quad (4.12)$$

$$Y_{At} = C^{y}_{AAt} + C^{y}_{UAt} + C^{y}_{EAt} \quad (4.13)$$

Since asset markets are assumed to be complete in the baseline model, the solution of the model can be determined without knowing the equity shares. To solve the model, the equilibrium need to satisfy both the first order conditions of the representative agent's optimization problems in all three countries and the market clearing conditions.

4.4.4 Solution to Asset Holdings

To solve the asset holdings, I follow the steps that Collard *et al.* (2008) did in their work. In this section, I solve for the asset holdings in United States (i = U) as an example to demonstrate the asset holdings solutions.

First of all, define the US household's wealth in utility terms

$$\Omega^{U}_{t} \equiv \lambda^{U}_{t} \left(Q^{y}_{Ut} S^{y}_{UUt+1} + Q^{y}_{Et} S^{y}_{UEt+1} + Q^{y}_{At} S^{y}_{UAt+1} + Q^{z}_{Ut} S^{z}_{UUt+1} + Q^{z}_{Et} S^{z}_{UEt+1} + Q^{z}_{At} S^{z}_{UAt+1} \right) \quad (4.14)$$

where λ^{U}_{t} is the Lagrange multiplier that associated with the household's budget constraint (4.6).

Applying the above definition of wealth, the US household's budget constraint (4.6) can be rewritten as

$$\Omega_t^U + \lambda_t^U \left(P_{Ut}^y C_{UUt}^y + P_{Et}^y C_{UEt}^y + P_{At}^y C_{UAt}^y + P_{Ut}^z C_{Ut}^z\right)$$

$$= \lambda_t^U \frac{Q_{Ut}^y + P_{Ut}^y Y_{Ut}}{Q_{Ut-1}^y} Q_{Ut-1}^y S_{UUt}^y + \lambda_t^U \frac{Q_{Et}^y + P_{Et}^y Y_{Et}}{Q_{Et-1}^y} Q_{Et-1}^y S_{UEt}^y$$

$$+ \lambda_t^U \frac{Q_{At}^y + P_{At}^y Y_{At}}{Q_{At-1}^y} Q_{At-1}^y S_{UAt}^y + \lambda_t^U \frac{Q_{Ut}^z + P_{Ut}^z Z_{Ut}}{Q_{Ut-1}^z} Q_{Ut-1}^z S_{UUt}^z$$

$$+ \lambda_t^U \frac{Q_{Et}^z + P_{Et}^z Z_{Et}}{Q_{Et-1}^z} Q_{Et-1}^z S_{UEt}^z + \lambda_t^U \frac{Q_{At}^z + P_{At}^z Z_{At}}{Q_{At-1}^z} Q_{At-1}^z S_{UAt}^z \quad (4.15)$$

After putting equation (4.15) one period forward and using the previous household's Euler equations (4.7) and (4.8) for asset decisions, I find similar result as Collard, Dellas, Diba and Stockman (2008) found in their framework, which is that if six shares are predetermined, then it leads to a stochastic difference equation in wealth

$$\Omega_t^U \equiv \beta E_t\left[\Omega_{t+1}^U + \lambda_{t+1}^U \left(P_{Ut+1}^y C_{UUt+1}^y + P_{Et+1}^y C_{UEt+1}^y + P_{At+1}^y C_{UAt+1}^y + P_{Ut+1}^z C_{Ut+1}^z\right)\right] \quad (4.16)$$

Equation (4.16) determines the household's wealth in US, Ω_t^U.

Define the gross asset returns

in US as:

$$R_{Ut}^y = \frac{Q_{Ut}^y + Y_{Ut}}{Q_{Ut-1}^y}, \qquad R_{Ut}^z = \frac{Q_{Ut}^z + P_{Ut}^z Z_{Ut}}{Q_{Ut-1}^z},$$

in Europe as:

$$R_{Et}^y = \frac{Q_{Et}^y + P_{Et}^y Y_{Ut}}{Q_{Et-1}^y}, \qquad R_{Et}^z = \frac{Q_{Et}^z + P_{Et}^z Z_{Et}}{Q_{Et-1}^z},$$

and in Asia as:

$$R_{At}^y = \frac{Q_{At}^y + P_{At}^y Y_{At}}{Q_{At-1}^y}, \qquad R_{At}^z = \frac{Q_{At}^z + P_{At}^z Z_{At}}{Q_{At-1}^z}.$$

Let us also define the shares of economy '*i*' total wealth that are accounted by each asset as:

$$\alpha^{y}_{iUt+1} = \frac{\lambda^{U}_{t} Q^{y}_{Ut} S^{y}_{UUt+1}}{\Omega^{U}_{t}}, \quad \alpha^{y}_{iEt+1} = \frac{\lambda^{U}_{t} Q^{y}_{Et} S^{y}_{UEt+1}}{\Omega^{U}_{t}}, \quad \alpha^{y}_{iAt+1} = \frac{\lambda^{U}_{t} Q^{y}_{At} S^{y}_{UAt+1}}{\Omega^{U}_{t}}$$

$$\alpha^{z}_{iUt+1} = \frac{\lambda^{U}_{t} Q^{z}_{Ut} S^{z}_{UUt+1}}{\Omega^{U}_{t}}, \quad \alpha^{z}_{iEt+1} = \frac{\lambda^{U}_{t} Q^{z}_{Et} S^{z}_{UEt+1}}{\Omega^{U}_{t}},$$

$$\alpha^{z}_{iAt+1} = 1 - \alpha^{y}_{iUt+1} - \alpha^{y}_{iEt+1} - \alpha^{y}_{iAt+1} - \alpha^{z}_{iUt+1} - \alpha^{z}_{iEt+1}.$$

Using these definitions in the domestic budget constraint gives

$$\frac{\Omega^{U}_{t}}{\lambda^{U}_{t}} + C^{y}_{UUt} + P^{y}_{Et} C^{y}_{UEt} + P^{y}_{At} C^{y}_{UAt} + P^{z}_{Ut} C^{z}_{Ut}$$

$$= \frac{\Omega^{U}_{t-1}}{\lambda^{U}_{t-1}} \left[\begin{array}{c} \left(R^{y}_{Ut} - R^{z}_{At}\right)\alpha^{y}_{UUt} + \left(R^{y}_{Et} - R^{z}_{At}\right)\alpha^{y}_{UEt} + \left(R^{y}_{At} - R^{z}_{At}\right)\alpha^{y}_{UAt} \\ + \left(R^{z}_{Ut} - R^{z}_{At}\right)\alpha^{z}_{UUt} + \left(R^{z}_{Et} - R^{z}_{At}\right)\alpha^{z}_{UEt} \end{array} \right] + R^{z}_{At} \frac{\Omega^{U}_{t-1}}{\lambda^{U}_{t-1}}$$

or, equivalently

$$\left(R^{y}_{Ut} - R^{z}_{At}\right)\alpha^{y}_{UUt} + \left(R^{y}_{Et} - R^{z}_{At}\right)\alpha^{y}_{UEt} + \left(R^{y}_{At} - R^{z}_{At}\right)\alpha^{y}_{UAt} + \left(R^{z}_{Ut} - R^{z}_{At}\right)\alpha^{z}_{UUt} + \left(R^{z}_{Et} - R^{z}_{At}\right)\alpha^{z}_{UEt}$$

$$= \frac{\lambda^{U}_{t-1}}{\Omega^{U}_{t-1}} \left(\frac{\Omega^{U}_{t}}{\lambda^{U}_{t}} + C^{y}_{UUt} + P^{y}_{Et} C^{y}_{UEt} + P^{y}_{At} C^{y}_{UAt} + P^{z}_{Ut} C^{z}_{Ut} \right) - R^{z}_{At}$$

4.5 Baseline Model Parameterization

Before exploring the model's predictions for both the wealth and equity shares, it is necessary to first discuss the parameterization issues in the baseline model. In the benchmark parameterization, I assume there is no consumption bias in traded goods. This baseline parameterization corresponds to the model of Collard *et al.* (2008).

Table 4.2: Baseline Model Parameterization: No Consumption Bias

Parameter		Separable	Non-Separable
Preferences			
Discount Factor	β	0.99	0.99
Risk Aversion	σ	2.00	2.00
Share of Traded Goods in Total Consumption	ω	0.21	0.21
Substitution between Traded and Non-traded Goods	ρ	0.50	0.25 (Complements)
			0.75 (Substitutes)
Share of Domestic Traded Good in Total Traded Goods	α	1/3	1/3
Substitution between Domestic and Foreign Traded Goods	η	1.50	1.50
Endowments of Traded and Non-traded Goods			
Persistence	$\rho_{UU}^{y} = \rho_{EE}^{y} = \rho_{AA}^{y} = \rho_{UU}^{z} = \rho_{EE}^{z} = \rho_{AA}^{z}$	0.85	
Spillover	$\rho_{UE}^{y} = \rho_{UA}^{y} = \rho_{EU}^{y} = \rho_{EA}^{y} = \rho_{AU}^{y} = \rho_{AE}^{y}$	0.05	
	$\rho_{UE}^{z} = \rho_{UA}^{z} = \rho_{EU}^{z} = \rho_{EA}^{z} = \rho_{AU}^{z} = \rho_{AE}^{z}$	0.05	
Volatility	$\sigma_{U}^{y} = \sigma_{E}^{y} = \sigma_{A}^{y} = \sigma_{U}^{z} = \sigma_{E}^{z} = \sigma_{A}^{z}$	0.01	
Correlation	$Corr(\varepsilon_{U}^{y}, \varepsilon_{E}^{y}), Corr(\varepsilon_{U}^{y}, \varepsilon_{A}^{y}), Corr(\varepsilon_{E}^{y}, \varepsilon_{A}^{y})$	0.00	
	$Corr(\varepsilon_{U}^{z}, \varepsilon_{E}^{z}), Corr(\varepsilon_{U}^{z}, \varepsilon_{A}^{z}), Corr(\varepsilon_{E}^{z}, \varepsilon_{A}^{z})$	0.00	

Table 4.2 above reports the calibration of the parameters. First, let us look at the parameter values if utility is separable in traded and non-traded goods. Previous studies find that the elasticity of substitution in consumption between traded and non-traded goods, ρ, and the elasticity of substitution in consumption between the traded goods produced by the three countries, η are the two critical parameters in determining the value of equity shares. For ρ, the benchmark case is based on a value of $\rho = 0.5$, which is suggested by Lane and Milesi-Ferretti (2004). Compare with other estimates suggested in the literature, this is a fair number to choose. For

examples, Mendoza (1991) chooses a value of 0.74 for ρ, Ostry and Reinhart (1992) suggest the value of ρ should lie between 0.66 to 1.3 for some sample developing countries, and Stockman and Tesar (1995) set the value of ρ to 0.44. Once the value of ρ is fixed to 0.5, the risk aversion parameter in the household's utility function, σ, is set to 2, since the assumed separable utility here requests $\sigma\rho = 1$.

Studies in the literature suggest a wide range of values for η. Estimates based micro trade data normally find much higher values for η, ranging from 4 to 15, for examples, Feenstra (1994), Hummels (2001) and Broda and Weinstein (2004). On the other hand, studies using time series macro data usually suggest much lower values for η, ranging from 1 to 3, for examples, Backus *et al.* (1994). As suggested by Obstfeld and Rogoff (2005), the value of η is chosen from the lower bound of estimates from the trade literature and is set to 1, which is the same value as used in the Collard *et al.*'s (2008) paper.

By assuming no bias in the consumption of traded goods, the share of domestic traded goods in the traded goods bundle, α, is therefore set to 1/3. Households in each country consume the traded goods that produced by the firms in US, Europe and Asia equally. Since the imports share can be calculated as $\omega(1-\alpha)$, where ω is the share of traded goods in the household's total consumption, once the imports share is known, the value of ω can be determined with already fixed value of α. Here, I use the imports share in US as a proxy to calculate ω since Europe and Asia are assumed to be identical to US in the baseline model. Refer back to table 4.1, the average imports share in US over the period 1992-2007 is approximately 14%.

Therefore, ω is thus equal to 0.21 when $\alpha = 1/3$. Moreover, the discount factor, β, is set to a common value 0.99.

The parameters in the traded and non-traded endowment processes are set to the same values as in the Collard *et al.*'s (2008) work. I assume that all the endowment processes are identical. Since all diversified risk can be perfectly shared in the baseline model, the form of the endowment processes does not matter for the results of the wealth and equity shares. However, the average level of the endowment process does actually matter. In the baseline model, traded and non-traded endowments are such that the relative price of non-traded goods is equal to unity.

Next, if utility function is non-separable between non-traded and traded goods, $\sigma\rho \neq 1$, the calibration of the parameters are shown in the last column of table 4.2. The value of ρ is set to 0.25 when non-traded and traded goods are complements, whereas everything else remains the same as in the separable case. On the other hand, if non-traded and traded are assumed to be substitutes, the value of ρ is set to 0.75.

I also report the results with an alternative parameterization, which involves a consumption bias in either home traded goods or foreign traded goods. If households have a home consumption bias, leaving everything else the same, the value of α is set above 1/3 ($\alpha = 0.6$), and the value of α is below 1/3 ($\alpha = 0.1$) if there is a foreign consumption bias.

4.6 Baseline Model Results and Discussions

4.6.1 Separable Utility Cases: $\sigma\rho = 1$

When $\sigma\rho = 1$, the household's utility function is separable, traded and non-traded goods are neither substitutes nor complements. To be more specific, the changes in the consumption of non-traded goods cannot affect the household's utility from the consumption of traded goods, *vice versa*. Or to put it in other words, the household's marginal utility of traded goods consumption is independent of the consumption of non-traded goods.

4.6.1.1 No consumption bias: $\alpha = 1/3$

Observation 1: Investors choose to hold 100 percent and 0 percent of the domestic and foreign non-traded good equities respectively and a 1/3 share in each of the three traded goods equities.

Table 4.3: Wealth and Equity Shares: Separable Utility, No Consumption Bias

	Wealth Shares						Equity Shares					
$\sigma\rho = 1$	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
$\alpha = 1/3$	0.0767	0.7700	0.0767	0.0000	0.0767	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000

Table 4.3 reports the share of total wealth of a domestic agent that is held in the form of one of the six available assets ('wealth shares'), and the share of the value of equity in a particular industry that is owned by domestic agents ('equity shares') when there is no bias in the consumption of traded goods. In this case, the model predicts that it is optimal for investors to hold 100 percent of the domestic non-traded goods equity and 0 percent of the foreign non-traded goods equities in order to prevent any future risks when there is a shock to the non-traded goods endowment. This finding is identical to the finding of Collard *et al.* (2008), where

their two-country model with separable utility also predicts that domestic investors should hold 100 percent and 0 percent domestic and foreign non-traded goods equity respectively when there is no consumption bias. The intuition behind this finding is that since variation in the endowment of the domestic non-traded goods can only affect the value of the stream of dividends in proportion to the number of shares held and the expenditure needed to finance the consumption of non-traded goods due to the price change, the gain or loss as an investor can exactly offsets the loss or gain as a consumer by holding 100 percent of the domestic non-traded goods equity and consuming 100 percent of the domestic non-traded goods (Collard *et al.*, 2008).

Another finding from the table is that, without consumption bias, investors choose to have a fully diversified portfolio of traded goods equities by holding the three traded good equities equally. This result confirms the finding of Collard *et al.* (2008) in a two-country model, which says that it is optimal for investors hold domestic and foreign traded goods equities in equal shares when there is no consumption bias.

4.6.1.2 Foreign bias in traded goods consumption: $\alpha < 1/3$

<u>*Observation 2*</u>*: Foreign consumption bias in traded goods induces home bias in traded goods equities.*

Table 4.4: Wealth and Equity Shares: Separable Utility, Foreign Bias in Consumption

	Wealth Shares						Equity Shares					
$\sigma\rho=1$	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
$\alpha<1/3$	0.1477	0.7700	0.0411	0.0000	0.0411	0.0000	0.6424	1.0000	0.1788	0.0000	0.1788	0.0000

*Note: when $\alpha<1/3$, α=0.1.

Table 4.4 reports the values of the wealth share and the equity share when there is a foreign bias in traded goods consumption. First, investors still hold 100 percent and 0 percent of the domestic and foreign non-traded goods equities when there is foreign consumption bias in traded goods, which is the same as the result in the no consumption bias case. It is because that with separable utility function, non-traded goods sector is independent of traded goods sector, therefore variation in the value of α does not affect the holdings of non-traded goods equities.

Second, the existence of foreign consumption bias in traded goods increases the holdings of the domestic traded goods equity, but decreases the holdings of the foreign ones. In this case, the portfolio of traded goods equity is no longer fully diversified and is home biased. Investors choose to hold more domestic traded goods equity and hold the other two foreign traded goods equities in equal shares. This result can be explained in the following way.

First, let us assume the US is the home country and there is a positive shock to the US domestic traded good endowment. Next, suppose the consumption of the US traded goods increases by the same proportion in the three countries, but the consumptions of the other two foreign traded goods (i.e. the European and Asian traded goods) remain unchanged. Based on the baseline model setup, when there is a foreign bias in traded goods consumption (α=0.1), the US households only consume 10 percent of their own produced traded goods, while the households in Europe and Asia both consume 45 percent of the US traded goods. Therefore, both the European and Asian consumptions of the US traded goods increase by more than the US consumption of its own traded goods (i.e. $\Delta C^{Y}_{UUt} < \Delta C^{Y}_{EUt} = \Delta C^{Y}_{AUt}$). Accordingly, both the European and Asian consumptions of all the traded goods increase by more than the US consumption of all the traded goods (i.e. $\Delta C^{Y}_{Ut} < \Delta C^{Y}_{Et} = \Delta C^{Y}_{At}$). In addition, the marginal utility of the US traded goods in each of the three countries is given by

(in US) $$\frac{\partial U_{Ut}}{\partial C^{Y}_{UUt}} = \omega^{\frac{1}{\rho}} \alpha^{\frac{1}{\eta}} C^{Y}_{UUt}{}^{-\frac{1}{\eta}} C^{Y}_{Ut}{}^{\frac{1}{\eta}-\frac{1}{\rho}} C_{Ut}{}^{\frac{1}{\rho}-\sigma}$$

(in EU) $$\frac{\partial U_{Et}}{\partial C^{Y}_{EUt}} = \omega^{\frac{1}{\rho}} \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y}_{EUt}{}^{-\frac{1}{\eta}} C^{Y}_{Et}{}^{\frac{1}{\eta}-\frac{1}{\rho}} C_{Et}{}^{\frac{1}{\rho}-\sigma}$$

(in Asia) $$\frac{\partial U_{At}}{\partial C^{Y}_{AUt}} = \omega^{\frac{1}{\rho}} \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y}_{AUt}{}^{-\frac{1}{\eta}} C^{Y}_{At}{}^{\frac{1}{\eta}-\frac{1}{\rho}} C_{At}{}^{\frac{1}{\rho}-\sigma}$$

Since the elasticity of substitution between domestic and foreign traded goods (η) is greater than the elasticity of substitution between traded and non-traded goods (ρ) in my baseline model calibration, the marginal utility of the US traded goods is decreasing in each country's total traded goods consumption. Also, given that $\Delta C^{Y}_{Ut} < \Delta C^{Y}_{Et} = \Delta C^{Y}_{At}$, the marginal utility of the US traded goods has decreased more in the EU and Asia than in the US. Similarly, the marginal utility of the European and Asian traded goods has also decreased more in the EU and Asia than in the US. However, this violates the international consumption risk sharing principle, which states that marginal utility of consumption should be equalized across countries (Canova and Ravn, 1996). In order to satisfy the international consumption risk sharing principle, the US consumption of its own traded goods must increase by a larger proportion than the European and Asian consumptions. Therefore, investors in the US should increase the ratio of domestic to foreign expenditures of traded goods. In an efficient equilibrium, this requests that dividend income at home (i.e. US) increases by more than dividend income abroad (i.e. EU and Asia) when there is a positive shock to the endowment of the US traded goods. As a result, the supporting portfolio of traded goods equities must have a home bias. Moreover, since $\Delta C^{Y}_{Et} = \Delta C^{Y}_{At}$, thus the marginal utility of all the three traded goods in both the EU and Asia decreases by the same amount. Consequently, investors in the US should choose to hold the European and Asian traded goods equities in equal shares.

In this scenario, the overall portfolio home bias is increased due to the home bias in the traded goods equity sub-portfolio. The changes in the holdings of the domestic and foreign traded goods equities are relatively large, which are nearly half of the original equity shares. On the other hand, Collard *et al.* (2008) find a rather small change in their numerical solutions of the equity shares, which is about 15 percent.

4.6.1.3 Home bias in traded goods consumption: $\alpha > 1/3$

Observation 3: Home consumption bias in traded goods induces foreign bias in traded goods equities.

Table 4.5: Wealth and Equity Shares: Separable Utility, Home Bias in Consumption

	Wealth Shares						Equity Shares					
$\sigma\rho = 1$	α^y_{UU}	α^z_{UU}	α^y_{UE}	α^z_{UE}	α^y_{UA}	α^z_{UA}	S^y_{UU}	S^z_{UU}	S^y_{UE}	S^z_{UE}	S^y_{UA}	S^z_{UA}
$\alpha > 1/3$	0.0329	0.7700	0.0985	0.0000	0.0985	0.0000	0.1429	1.0000	0.4286	0.0000	0.4286	0.0000

*Note: when α>1/3, α=0.6.

Table 4.5 reports the values of the wealth share and the equity share when there is a home bias in the traded goods consumption. First, the holdings of the domestic and foreign non-traded goods equities remain the same due to the separable utility function. Second, investors tend to hold more foreign traded goods equities but less domestic one in the presence of a home consumption bias in traded goods. This can be explained using the same logic that I have used under the foreign consumption bias scenario.

Again, let us assume the US is the home country and still suppose the consumption of the domestic traded goods (i.e. the US traded goods) increases by the same proportion in the three countries, but hold the consumptions of the European and Asian traded goods constant. Since the US investors have a home bias in their traded goods consumption this time, therefore, the US consumption of its own produced traded goods would increase by more than the European and Asian consumptions of the US produced traded goods. Given $\eta > \rho$, the marginal utility of all the three traded goods is still decreasing in each country's total traded goods consumption. As a result, the marginal utility of all the three traded goods would decrease more in the US than in the EU and Asia when the households in the US have a home consumption bias in the traded goods. This, again, violates the international consumption risk sharing principle. For the marginal utilities to be equalized across the three countries, the US consumption of its own traded goods has to increase by a smaller proportion than the European and Asian consumptions. Accordingly, the supporting portfolio of traded goods equities must have a foreign bias. Since the marginal utility of all the three traded goods in both the EU and Asia decreases by the same amount, investors in the US should hold the European and Asian traded goods equities in equal shares.

In this case, overall portfolio home bias may still be obtained. For example, if the share of non-traded goods in the household's consumption basket is about 50 percent, then the home bias will be remained in the overall consumption bundle and portfolio despite the value of α.

4.6.2 Non-separable Utility Cases: $\sigma\rho \neq 1$

In this section, the household's utility function is assumed to be non-separable in non-traded and traded goods by allowing $\sigma\rho$ to depart from unity. Following the work of Collard *et al.* (2008) and other standard calibrations in the literature, I assume that $\rho<1$ and $\eta>1$ for all the non-separable utility cases discussed in this section. By imposing these restrictions on the values of ρ and η, I assume that the domestic and foreign traded goods are substitutes and the traded goods are more substitutable among themselves than they are with the non-traded goods.

4.6.2.1 Non-traded and traded goods are complements: $\sigma\rho<1$

<u>Observation 4</u>: *When non-traded and traded goods are complements, investors hold less than 100 percent of the domestic non-traded goods equity in order to claim a larger proportion of the traded goods bundle.*

Table 4.6: Wealth and Equity Shares: Non-separable Utility,
Non-traded and Traded Goods are Complements

	Wealth Shares						**Equity Shares**					
$\sigma\rho<1$	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
$\alpha<1/3$	0.1921	0.7687	0.0188	0.0008	0.0188	0.0008	0.8363	0.9979	0.0819	0.0011	0.0819	0.0011
$\alpha=1/3$	0.0766	0.7687	0.0766	0.0008	0.0766	0.0008	0.3333	0.9979	0.3333	0.0011	0.3333	0.0011
$\alpha>1/3$	0.0087	0.7687	0.1105	0.0008	0.1105	0.0008	0.0378	0.9979	0.4811	0.0011	0.4811	0.0011

*Note: ρ=0.25, σ=2; when $\alpha<1/3$, α=0.1; when α>1/3, α=0.6.

Given that non-traded and traded goods are complements (i.e. $\sigma\rho<1$), table 4.6 reports the baseline model calibration results of both the wealth and equity shares in three different scenarios: a foreign consumption bias in traded goods ($\alpha<1/3$), no consumption bias ($\alpha=1/3$) and a home consumption bias in traded goods ($\alpha>1/3$).

There are two important findings here. First, when there is no consumption bias in traded goods, the portfolio of traded goods equities is fully diversified for all the three countries. On the other hand, when there is a home bias in the consumption of traded goods, domestic investors are willing to hold more foreign traded goods equity in order to hedge risks from any unexpected endowment shocks in the domestic traded good sector, *vice versa*. This finding is consistent with the finding of the baseline model under the same scenarios.

Second, the calibration results suggest that when non-traded and traded goods are complements, the optimal portfolio involves holding a large equity share in the domestic non-traded goods sector and very small equities shares in the two foreign non-traded goods sectors. This finding can be explained as follow.

Suppose the US is the home country and there is a positive endowment shock in its non-traded good sector. Since non-traded and traded goods are complements, in an efficient equilibrium, the households in the US want to consume more traded goods, because the increase in the consumption of non-traded goods increases the marginal utility of traded goods consumption. However, since the world supply of the three traded goods is fixed, an increase in the US consumption of all the traded goods requires a reallocation of the world traded goods across the three countries. This result can be achieved if some of the shares of firms producing the US non-traded goods are held by investors in the EU and Asia. If so, the US households consume 100 percent of the non-traded goods but hold less than 100 percent of its equity. As a result, the gain to the US households as consumers of the non-traded goods would exceed their loss as investors in those goods. Meanwhile, both the European and Asian investors would suffer an investment loss without obtaining any consumption benefit from the US non-traded goods. Consequently, this creates a redistribution of income across the three countries and hence allows the US households to claim a larger proportion of the world traded goods bundle.

Further, given that the three countries have the same preferences over non-traded and traded goods and the same value of the elasticity of substitution between traded and non-traded goods (ρ) in the baseline model calibration, the households in the EU and Asia will behave exactly the same way as the US households when there is a positive endowment shock in their domestic non-traded sector. As a result, the US households would hold equal shares in the other two foreign non-traded goods equities in an efficient equilibrium.

4.6.2.2 Non-traded and traded goods are substitutes: $\sigma\rho > 1$

Observation 5: When non-traded and traded goods are substitutes, investors hold more than 100 percent of the domestic non-traded goods equity and short the foreign non-traded goods equities in order to invest in a larger proportion of the non-traded goods bundle.

Table 4.7: Wealth and Equity Shares: Non-separable Utility,
Non-traded and Traded Goods are Substitutes

	Wealth Shares						Equity Shares					
$\sigma\rho > 1$	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
$\alpha < 1/3$	0.1123	0.8120	0.0588	-0.0210	0.0588	-0.0210	0.4884	1.0546	0.2558	-0.0273	0.2558	-0.0273
$\alpha = 1/3$	0.0767	0.8120	0.0767	-0.0210	0.0767	-0.0210	0.3333	1.0546	0.3333	-0.0273	0.3333	-0.0273
$\alpha > 1/3$	0.0538	0.8120	0.0881	-0.0210	0.0881	-0.0210	0.2339	1.0546	0.3831	-0.0273	0.3831	-0.0273

*Note: ρ=0.75, σ=2; when $\alpha < 1/3$, α=0.1; when $\alpha > 1/3$, α=0.6.

Table 4.7 shows the calibration results of both the wealth and equity shares in three different consumption bias scenarios when the non-traded and traded goods are assumed to be substitutes (i.e. $\sigma\rho > 1$).

The first finding here is that the household's preferences in traded goods are important factors in determining the optimal holdings of the domestic and foreign traded goods equities. In the absence of consumption bias in traded goods, the portfolio of traded goods equities is always fully diversified. On the other hand, a foreign bias in the consumption of traded goods tends to create a home bias in the sub-portfolio of traded goods equities while a home consumption bias always induces a foreign bias in the sub-portfolio of traded goods. This finding is, again, consistent with the findings from the previous sections.

The second finding here is that investors choose to hold more than 100 percent of the domestic non-traded goods equity and short foreign non-traded goods equities when non-traded and traded goods are considered as substitutes despite the household's preferences in traded goods. This result can be explained using the same type of reasoning that I have used to explain the optimal holdings of non-traded goods equities when non-traded and traded goods are complements.

To be more specific, when non-traded and traded goods are substitutes, a positive endowment shock in a country's non-traded sector will make the households in that country want to consume less traded goods, because the increase in the consumption of non-traded goods lowers the marginal utility of the traded goods consumption. Again, this implies a reallocation of the world traded goods across the three countries as long as the three traded goods sectors remain unchanged. This reallocation can be achieved if the shock-affected households hold more than 100 percent of the domestic non-traded good equity but short the foreign non-traded goods equities. In this case, the gain to the shock-affected households as consumers of the domestic non-traded good would be less than their loss as investors in that good, because while they consume 100 percent of it they hold more than 100 percent of its equity. On the other hand, the foreign households would gain from the sale of the non-traded good equity issued by the shock-affected country. Hence, the resulting redistribution of income across the three countries allows the shock-affected households to claim a smaller proportion of the world traded goods bundle. Meanwhile, since the three countries are perfectly symmetric in the baseline model calibration, the shock-affected households would choose to sell the same amount of shares of the other two foreign non-traded goods equities.

4.6.3 Baseline Model Summary

In summary, based on the numerical solutions of the baseline model, two general findings are found in this section. First, the optimal holdings of non-traded goods equities only depend on the separability between traded and non-traded goods. They are not affected by the household's preferences over the domestic and foreign traded goods. If utility function is separable between traded and non-traded goods, investors always choose to hold 100 percent and 0 percent of domestic and foreign non-traded goods equities. This result implies that if the non-traded goods weigh about 50 percent in a country's total output so that the non-traded goods equity represents about half of the domestic equity, then the existence of non-traded goods can explain up to 50 percent of the overall portfolio home bias in a country. On the other hand, if utility function is non-separable and traded and non-traded goods are complements, the optimal portfolio involves holding a large share in the domestic non-traded goods sector and very small shares in the two foreign non-traded goods sectors. If traded and non-traded goods are substitutes, it is optimal for investors to hold more than 100 percent of the domestic non-traded goods equity and short foreign non-traded goods equities. Further, since the three countries are perfectly symmetric in the baseline model, therefore, domestic households will always hold or sell the two foreign non-traded goods equities in equal shares.

Second, the baseline model suggests that the household's preferences over the domestic and foreign traded goods are important factors in determining the optimal holdings of the domestic and foreign traded goods equities. This finding holds in both separable and non-separable utility cases. To be more specific, when there is no consumption bias in traded goods, the portfolio of traded goods equities is fully internationally diversified. However, when there is a home (foreign) bias in the consumption of traded goods, investors are willing to hold more foreign (home) traded goods equities in order to hedge risks from any unexpected endowment shocks in the domestic traded good sector. Again, since the three countries are perfectly symmetric in the baseline model, therefore, domestic households will always hold the two foreign traded goods equities in equal shares.

Overall, these two general findings are consistent with the findings in Stockman and Dellas (1989) and Collard *et al.* (2008).

4.7 A Model with Asymmetric Preferences in Traded Goods

4.7.1 Specification of Asymmetric Preferences in Traded Goods

In this section, I extend the baseline model by assuming asymmetric household's preferences over domestic and foreign traded goods. To be more specific, I assume that the US and Europe are 'mirror symmetric' in their preferences for each other's traded goods, but attach the same weight to Asian traded goods. Meanwhile, Asia weighs the US and European traded imports equally. The previous Equation (4.6) is therefore modified to equation (4.17) below. When there is no bias in the consumption of traded goods (i.e. $\alpha = \delta = 1/3$ and γ=2/3), equation (4.17) is identical to equation (4.6) and the extended model coincides with the previous baseline model. Therefore, I exclude the no consumption bias scenario from the following analysis of the extended model.

$$C^y_{Ut} = \left(\alpha^{\frac{1}{\eta}} C^y_{UUt}{}^{\frac{\eta-1}{\eta}} + (\gamma - \alpha)^{\frac{1}{\eta}} C^y_{UEt}{}^{\frac{\eta-1}{\eta}} + (1-\gamma)^{\frac{1}{\eta}} C^y_{UAt}{}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

$$C^y_{Et} = \left(\alpha^{\frac{1}{\eta}} C^y_{EEt}{}^{\frac{\eta-1}{\eta}} + (\gamma - \alpha)^{\frac{1}{\eta}} C^y_{EUt}{}^{\frac{\eta-1}{\eta}} + (1-\gamma)^{\frac{1}{\eta}} C^y_{EAt}{}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}}$$

$$C^y_{At} = \left(\delta^{\frac{1}{\eta}} C^y_{AAt}{}^{\frac{\eta-1}{\eta}} + \left(\frac{1-\delta}{2}\right)^{\frac{1}{\eta}} C^y_{AUt}{}^{\frac{\eta-1}{\eta}} + \left(\frac{1-\delta}{2}\right)^{\frac{1}{\eta}} C^y_{AEt}{}^{\frac{\eta-1}{\eta}} \right)^{\frac{\eta}{\eta-1}} \tag{4.17}$$

Regarding the calibration of the extended model, as suggested by Obstfeld and Rogoff (2000b, 2005), I set both α and δ, the consumption weights of US/Europe and Asia on domestic traded goods within the traded goods bundle, equal to 0.7 when there is a home consumption bias in the traded goods. In this case, $\gamma = 0.8$, which implies that US and Europe would like to place weights of 0.1 (i.e. $\gamma - \alpha = 0.8 - 0.7 = 0.1$) on each other's traded goods, and twice that weight ($1-\gamma = 1-0.8 = 0.2$) on Asian traded goods. On the other hand, Asia consumes the US and European traded goods evenly and with a weight of 0.15 (i.e. $(1-\delta)/2 = (1-0.7)/2 = 0.15$) on each imported good. In another case, if there is a foreign consumption bias, both α and δ are set to 0.1 and $\gamma = 0.4$. In both cases, I assume US and Europe both trade more with Asia than with each other as suggested by Obstfeld and Rogoff (2005).

4.7.2 Separable Utility Cases: $\sigma\rho = 1$

In the following analysis, I only report the wealth and equity shares for the US since US and Europe are assumed to be 'mirror symmetric' in the extended model. Table 4.8 on the next page reports the calibration results of the wealth and equity shares in two consumption scenarios when the household's utility function is separable between traded and non-traded goods.

The first general finding here is that, in all the three scenarios, investors in all the three countries choose to hold 100 percent of the domestic non-traded goods equity and 0 percent of the foreign non-traded goods equities. This finding is identical with the prior finding of the baseline model under the same scenarios. This is because, when non-traded goods are separable from traded goods in utility, variation in the consumption of traded goods does not affect the household's utility from the consumption of non-traded goods. Therefore, even though households across the three countries are assumed to have asymmetric preferences over the domestic and foreign traded goods in this extended model, this asymmetry cannot affect the optimal holdings of non-traded goods equities as long as the utility function is separable.

The second finding is that, for all the three countries, the portfolio of traded goods equities becomes biased in the presence of either a foreign bias or a home bias in the consumption of traded goods. In particular, a foreign consumption bias in traded goods tend to induce a home bias in the sub-portfolio of traded goods equities, while a home consumption bias can induce a foreign bias in the sub-portfolio of traded goods equities. Again, this general finding is consistent with the finding of

Table 4.8: Wealth and Equity Shares: Asymmetric Case with Separable Utility

Panel A: US Case (EU is 'mirror symmetric')

With Separable Utility		Wealth Shares						Equity Shares					
	$\sigma\rho=1$	α^y_{UU}	α^z_{UU}	α^y_{UE}	α^z_{UE}	α^y_{UA}	α^z_{UA}	S^y_{UU}	S^z_{UU}	S^y_{UE}	S^z_{UE}	S^y_{UA}	S^z_{UA}
Foreign Consumption Bias	$\alpha,\delta<1/3$	0.1439	0.7709	0.0562	0.0000	0.0290	0.0000	0.6308	1.0000	0.2436	0.0000	0.1256	0.0000
Home Consumption Bias	$\alpha,\delta>1/3$	0.0231	0.7709	0.1374	0.0000	0.0686	0.0000	0.1009	1.0000	0.5993	0.0000	0.2997	0.0000

*Note: ρ=0.5, σ=2; when α,δ<1/3, $\alpha,\delta=0.1$, γ=0.4; when $\alpha,\delta>1/3$, $\alpha,\delta=0.7$, γ=0.8.

Panel B: Asian Case

With Separable Utility		Wealth Shares						Equity Shares					
	$\sigma\rho=1$	α^y_{AA}	α^z_{AA}	α^y_{AE}	α^z_{AE}	α^y_{AU}	α^z_{AU}	S^y_{AA}	S^z_{AA}	S^y_{AE}	S^z_{AE}	S^y_{AU}	S^z_{AU}
Foreign Consumption Bias	$\alpha,\delta<1/3$	0.1393	0.7709	0.0449	0.0000	0.0449	0.0000	0.6078	1.0000	0.1961	0.0000	0.1961	0.0000
Home Consumption Bias	$\alpha,\delta>1/3$	0.0141	0.7709	0.1075	0.0000	0.1075	0.0000	0.0602	1.0000	0.4699	0.0000	0.4699	0.0000

*Note: ρ=0.5, σ=2; when α,δ<1/3, $\alpha,\delta=0.1$, γ=0.4; when $\alpha,\delta>1/3$, $\alpha,\delta=0.7$, γ=0.8.

the baseline model and the intuitions behind these results have been fully explained earlier on in the baseline model sections.

However, based on the calibration results reported in table 4.8, I have noticed that although households in all the three countries decide to hold more domestic traded goods equity when there is a foreign consumption bias and less domestic traded goods equity when there is a home consumption bias, investors in the US and EU choose to hold different amount of the two foreign traded goods equities while the Asian investors tend to hold the two foreign traded goods equities in equal shares. This finding can be explained in the following way.

Let us first look at the US case. Assume the US is the domestic country and the US households have a foreign consumption bias in traded goods. Now, consider a positive shock to the US traded goods endowment. Suppose the consumption of the US traded goods increases by the same proportion in the three countries, but the consumptions of the European and Asian traded goods remain unchanged. Recall that, when there is a foreign consumption bias, α=0.1 (i.e. α is the share of domestic traded good in total traded goods) and γ=0.4 (i.e. γ is the share of the US and European traded good in total traded goods) in the extended model calibration. Since the US and EU are assumed to be 'mirror symmetric', therefore, in the presence of a foreign consumption bias, the US households only consume 10 percent of their own produced traded goods, while the households in the EU and Asia consume 30 percent (i.e. γ-α=0.3) and 60 percent (i.e. 1-γ=0.6) of the US traded goods respectively. As a result, the Asian consumption of the US traded goods would increase by more than the European consumption of the US traded goods (i.e. $\Delta C_{EUt}^{Y} < \Delta C_{AUt}^{Y}$). Accordingly, the Asian consumption of all the traded goods increase by more than the European consumption of all the traded goods (i.e.

$\Delta C^{Y}_{Et} < \Delta C^{Y}_{At}$).

In addition, the marginal utility of the US traded goods in the EU and Asia in the extended model is given by

(in EU) $$\frac{\partial U_{Et}}{\partial C^{Y}_{EUt}} = \omega^{\frac{1}{\rho}} (\gamma-\alpha)^{\frac{1}{\eta}} C^{Y\,-\frac{1}{\eta}}_{EUt} C^{Y\,\frac{1}{\eta}-\frac{1}{\rho}}_{Et} C_{Et}^{\frac{1}{\rho}-\sigma}$$

(in Asia) $$\frac{\partial U_{At}}{\partial C^{Y}_{AUt}} = \omega^{\frac{1}{\rho}} \left(\frac{1-\delta}{2}\right)^{\frac{1}{\eta}} C^{Y\,-\frac{1}{\eta}}_{AUt} C^{Y\,\frac{1}{\eta}-\frac{1}{\rho}}_{At} C_{At}^{\frac{1}{\rho}-\sigma}$$

Since the elasticity of substitution between domestic and foreign traded goods (η) is greater than the elasticity of substitution between traded and non-traded goods (ρ) in the model calibration, the marginal utility of the US traded goods is decreasing in each country's total traded goods consumption. Thus, given $\Delta C^{Y}_{Et} < \Delta C^{Y}_{At}$, the marginal utility of the US traded goods has decreased more in Asia than in the EU. Similarly, the marginal utility of the European and Asian traded goods has also decreased more in Asia than in the EU. However, this violates the international consumption risk sharing principle. In order to satisfy the risk sharing principle, the European consumption of the US traded goods must increase by a larger proportion than the Asian consumption. In an efficient equilibrium, this requests that dividend income in the EU increases by more than dividend income in Asia when there is a positive shock to the endowment of the US traded goods. As a result, the US investors should hold more the European traded goods equity but less the Asian one.

Next, suppose the home country is still the US but there is a home consumption bias in traded goods this time. Again, consider a positive shock to the US traded goods endowment. Still suppose the consumption of the US traded goods increases by the same proportion in the three countries, but the consumptions of the European and

Asian traded goods remain the same. Recall that, when there is a home consumption bias, α=0.7 and γ=0.8, and the US and EU are assumed to be 'mirror symmetric'. Therefore, in the presence of a home consumption bias, the US households consume 70 percent of their own produced traded goods, while the households in the EU and Asia consume 10 percent (i.e. γ-α=0.1) and 20 percent (i.e. 1-γ=0.2) of the US traded goods respectively. Therefore, the Asian consumption of all the traded goods still increases by more than the European consumption of all the traded goods (i.e. $\Delta C_{Et}^{Y} < \Delta C_{At}^{Y}$). Consequently, given $\eta>\rho$, the marginal utility of all the traded goods would still decreased more in Asia than in the EU, which once again violates the international consumption risk sharing principle. As a result, investors in the US should still hold more the European traded goods equity but less the Asian one.

Now, let us consider the Asian case. Consider a positive shock to the Asian traded goods endowment. Suppose the consumption of the Asian traded goods increases by the same proportion in the three countries, but the consumptions of the US and European traded goods remain fixed. Since the US and EU attach the same weight to the Asian traded goods in the extended model, the US and European consumptions of the Asian traded goods would increase by the same amount (i.e. $\Delta C_{UAt}^{Y} = \Delta C_{EAt}^{Y}$). And this result would lead to $\Delta C_{Ut}^{Y} = \Delta C_{Et}^{Y}$. Consequently, given $\eta>\rho$, to satisfy the international consumption risk sharing principle in an efficient equilibrium, the Asian investors need to hold the US and European traded goods equities in equal shares because the marginal utility of all the three traded goods in both the US and EU decreases by the same amount when there is a positive endowment shock in the Asian traded goods sector. Moreover, when there is a consumption bias, in an efficient equilibrium, the Asian investors will always choose to hold the US and European traded goods equities in equal shares despite the type of consumption bias (i.e. either a foreign consumption bias or a home consumption bias) as long as the US and EU attach the same weight to the Asian traded goods in their total traded goods consumptions.

4.7.3 Non-separable Utility Cases: $\sigma\rho \neq 1$

4.7.3.1 Non-traded and traded goods are complements: $\sigma\rho < 1$

Table 4.9 on the next page shows the calibration results of the wealth and equity shares for all the three countries when non-traded and traded goods are complements. There are two general findings in this section.

First, when non-traded and traded goods are complements, the optimal portfolio in every country involves holding a large share in the domestic non-traded goods sector and a very small share in the two foreign non-traded goods sectors. Further, given that the three countries have the same preferences over non-traded and traded goods and the same value of the elasticity of substitution between traded and non-traded goods (ρ) in the extended model calibration, therefore, households in every country will hold the two foreign non-traded goods equities in equal shares. This finding is consistent with the finding of the baseline model under the same scenarios. The intuition behind this result has already been well discussed in the baseline model sections.

Second, households in all the three countries tend to hold more domestic traded goods equity when there is a foreign consumption bias and less domestic traded goods equity when there is a home consumption bias. Moreover, investors in the US

Table 4.9: Wealth and Equity Shares: Asymmetric Case with Non-separable Utility, Non-traded and Traded Goods are ***Complements***

Panel A: US Case (EU is 'mirror symmetric')

Non-Separable Utility		Wealth Shares						Equity Shares					
	$\sigma\rho<1$	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
Foreign Consumption Bias	$\alpha,\delta<1/3$	0.1475	0.7687	0.0551	0.0008	0.0271	0.0008	0.6422	0.9979	0.2396	0.0011	0.1182	0.0011
Home Consumption Bias	$\alpha,\delta>1/3$	0.0144	0.7687	0.1415	0.0008	0.0738	0.0008	0.0627	0.9979	0.6248	0.0011	0.3125	0.0011

*Note: ρ=0.25, σ=2; when α,δ<1/3, $\alpha,\delta=0.1$, γ=0.4; when $\alpha,\delta>1/3$, $\alpha,\delta=0.7$, γ=0.8.

Panel B: Asian Case

Non-Separable Utility		Wealth Shares						Equity Shares					
	$\sigma\rho<1$	α_{AA}^{y}	α_{AA}^{z}	α_{AE}^{y}	α_{AE}^{z}	α_{AU}^{y}	α_{AU}^{z}	S_{AA}^{y}	S_{AA}^{z}	S_{AE}^{y}	S_{AE}^{z}	S_{AU}^{y}	S_{AU}^{z}
Foreign Consumption Bias	$\alpha,\delta<1/3$	0.1561	0.7687	0.0368	0.0008	0.0368	0.0008	0.6792	0.9979	0.1604	0.0011	0.1604	0.0011
Home Consumption Bias	$\alpha,\delta>1/3$	0.0109	0.7687	0.1094	0.0008	0.1094	0.0008	0.0462	0.9979	0.4769	0.0011	0.4769	0.0011

*Note: ρ=0.25, σ=2; when α,δ<1/3, $\alpha,\delta=0.1$, γ=0.4; when $\alpha,\delta>1/3$, $\alpha,\delta=0.7$, γ=0.8.

and EU choose to hold different amount of the two foreign traded goods equities, while the Asian investors tend to hold the two foreign traded goods equities in equal shares, which is caused by the asymmetric preferences over the traded goods across the three countries. This finding is identical with the finding that I have just found in the extended model under the scenario when traded and non-traded goods are separable in the household's utility.

4.7.3.2 Non-traded and traded goods are substitutes: $\sigma\rho > 1$

Table 4.10 on the next page reports the calibration results of the wealth and equity shares for all the three countries when non-traded and traded goods are substitutes. There are two general findings under this scenario.

First, when non-traded and traded goods are substitutes, households in all the three countries tend to hold more than 100 percent of the domestic non-traded goods equity and short foreign non-traded goods equities. In addition, since the three countries have the identical preferences over non-traded and traded goods, therefore, households in every country will sell the same amount of shares of the two foreign non-traded goods equities. This finding is consistent with the finding of the baseline model under the same scenarios and the intuition behind this finding has already been fully discussed in the baseline model sections.

Second, households in all the three countries tend to hold more domestic traded goods equity when there is a foreign consumption bias and less domestic traded goods equity when there is a home consumption bias. Moreover, investors in the US and EU choose to hold different amount of the two foreign traded goods equities, while the Asian investors tend to hold the two foreign traded goods equities in equal shares. This finding is identical with the finding that I have just found in the extended model under the previous two scenarios.

Table 4.10: Wealth and Equity Shares: Asymmetric Case with Non-separable Utility, Non-traded and Traded Goods are ***Substitutes***

Panel A: US Case (EU is 'mirror symmetric')

Non-Separable Utility		Wealth Shares						Equity Shares					
	$\sigma\rho>1$	α^y_{UU}	α^z_{UU}	α^y_{UE}	α^z_{UE}	α^y_{UA}	α^z_{UA}	S^y_{UU}	S^z_{UU}	S^y_{UE}	S^z_{UE}	S^y_{UA}	S^z_{UA}
Foreign Consumption Bias	$\alpha,\delta<1/3$	0.1402	0.8142	0.0789	-0.0364	0.0395	-0.0364	0.5422	1.0616	0.3052	-0.0275	0.1526	-0.0275
Home Consumption Bias	$\alpha,\delta>1/3$	0.0551	0.8142	0.1354	-0.0364	0.0681	-0.0364	0.2134	1.0616	0.5244	-0.0275	0.2622	-0.0275

*Note: ρ=0.75, σ=2; when α,δ<1/3, $\alpha,\delta=0.1$, γ=0.4; when $\alpha,\delta>1/3$, $\alpha,\delta=0.7$, γ=0.8.

Panel B: Asian Case

Non-Separable Utility		Wealth Shares						Equity Shares					
	$\sigma\rho>1$	α^y_{UU}	α^z_{UU}	α^y_{UE}	α^z_{UE}	α^y_{UA}	α^z_{UA}	S^y_{UU}	S^z_{UU}	S^y_{UE}	S^z_{UE}	S^y_{UA}	S^z_{UA}
Foreign Consumption Bias	$\alpha,\delta<1/3$	0.1242	0.8142	0.0672	-0.0364	0.0672	-0.0364	0.5174	1.0616	0.2413	-0.0275	0.2413	-0.0275
Home Consumption Bias	$\alpha,\delta>1/3$	0.0456	0.8142	0.1065	-0.0364	0.1065	-0.0364	0.1930	1.0616	0.4035	-0.0275	0.4035	-0.0275

*Note: ρ=0.75, σ=2; when α,δ<1/3, $\alpha,\delta=0.1$, γ=0.4; when $\alpha,\delta>1/3$, $\alpha,\delta=0.7$, γ=0.8.

4.7.4 Asymmetric Model Summary

In summary, based on the calibration results of the extended model, there are two general findings are found in this section, which are quite similar to the general findings of the baseline model. First, the optimal holdings of non-traded goods equities only depend on the separability between traded and non-traded goods. As a result, the asymmetric preferences over the domestic and foreign traded goods across the three countries introduced in the extended model do not have an impact on the optimal holdings of non-traded goods equities. Therefore, the extended model provides the same solutions to the optimal holdings of non-traded goods equities as the baseline model. To be more specific, both models suggest that, investors always choose to hold 100 percent and 0 percent of domestic and foreign non-traded goods equities if traded and non-traded goods are separable in utility. Further, if utility function is non-separable and traded and non-traded goods are complements, investors choose to hold a large share in the domestic non-traded goods sector and a small share in the foreign non-traded goods sectors. If traded and non-traded goods are substitutes, the optimal portfolio involves holding more than 100 percent of the domestic non-traded goods equity and selling the foreign non-traded goods equities.

Second, the extended model suggests that the asymmetric preferences over the domestic and foreign traded goods do affect the optimal holdings of the traded goods equities. In general, a home consumption bias in the traded goods makes domestic investors want to hold more foreign traded goods equities in an efficient equilibrium, *vice versa*. Further, in the extended model, the optimal holdings of the two foreign traded goods equities depend on the amount of domestic traded goods each foreign country consumes. If both foreign countries consume the same amount of domestic traded goods, in order to satisfy the international consumption risk sharing principle in an efficient equilibrium, the extended model suggests that domestic investors to hold the two foreign traded goods equities in equal shares. However, if foreign country A consumes more domestic traded goods than foreign country B does, then, it is optimal for domestic investors to hold a smaller share in the foreign country A's traded sector but a larger share in the foreign country B's traded sector, *vice versa*. This general finding holds in both separable and non-separable utility cases.

4.8 Sensitivity Analysis

In this section, a sensitivity analysis is carried out for both the baseline and extended models in order to investigate how variation in the key parameters of the model affects the holdings of the equity shares. Appendix table 4.1 and 4.2 provide information on the sensitivity analysis of the results around the two baseline parameterizations. One is the separable utility with no consumption bias case, and the other one is the separable utility with foreign consumption bias case. The results are quite robust except that the results in appendix table 4.1 suggest that there are two cases where the baseline model fails to generate home bias in portfolio. One case is when the elasticity of substitution between traded and non-traded goods is very high (i.e. ρ=5), the other case is when the consumption share of traded goods is very high (i.e. ω=0.75). Collard *et al.* (2008) find the same problems associated with very high values of ρ and ω in their two-country model. However, they claim that $\rho = 5$ and ω=0.75 are empirical unlikely.

Appendix table 4.3 provides the sensitivity analysis results for the extended model. The benchmark parameterization used in this sensitivity analysis is the separable utility with foreign consumption bias case. Since US and EU are 'mirror symmetric' but different from Asia, therefore, the sensitivity analysis is carried out for both US/EU and Asia. Panel A reports the results of the US/EU case, while panel B presents the results of the Asian case. The results are even more robust in the extended model except that the results in panel B suggbst that when the elasticity of substitution between traded and non-traded goods is very high (i.e. ρ=5) the extended model fails to generate home bias in portfolio for Asia.

Overall, the three-country model survives from large variation in most key parameters values. Importantly, unlike the models proposed by Baxter, Jermann and King (1998) and Matsumoto (2007), this three-country model can successfully generate equity home bias with high values of the elasticity of substitution between home and foreign traded goods, η.

4.9 Discussion

In general, the 3-country model studied in this chapter not only confirms the robustness of the Collard *et al.* (2008) 2-coutry model's theoretical results, but also offers the same implication as found in the Collard *et al.'s* (2008) paper, which states that investors can achieve full international risk diversification if the share of wealth invested in foreign equity is equal to the share of imports in GDP.[15] Although we have learned at the beginning of this chapter that this model implication is relatively strongly supported by the developed country data (also claimed by Collard *et al.* (2008) in their paper), I would like to further examine the robustness of the empirical evidence by examining the match of the two shares in some developing and emerging economies in this section.

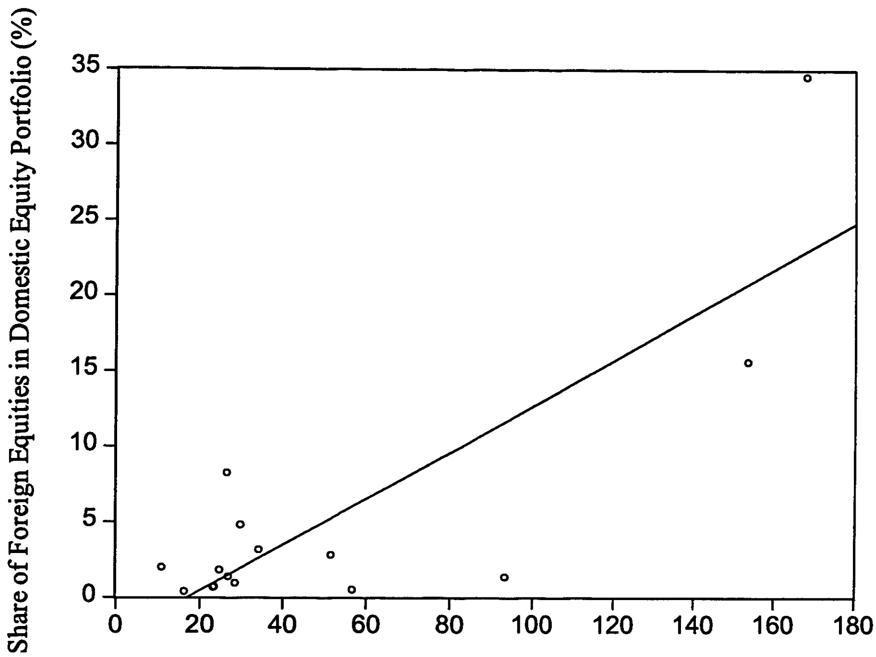
Again, I run a linear regression between the two shares, where using the share of foreign portfolio equity holdings as the dependent variable and the imports to GDP share as the independent variable for 15 selected developing and emerging countries.[16] The estimation results are reported in figure 4.3.

As in figure 4.3 the match between the two shares in the selected developing and new emerging countries are very low (i.e. the match between the two shares in the selected developed countries in figure 4.1 is 0.868 whereas here the match is only 0.152). A similarly low match also obtains in individual years, in sub-periods and so on. This robust estimation result suggests that both the 3-country model studied in this chapter and the Collard et al. (2008) 2-coutry model do not apply to developing countries and emerging economies. However, given the widespread use of capital controls and the presence of severe official and unofficial financial impediments in those developing and new emerging countries, this finding is not surprising. Nevertheless, what we could imagine here is that, once all these

[15] See Technical Appendix section 3 for the full mathematical derivation.

[16] Sample countries used in this regression include Brazil, China, Hong Kong, India, Indonesia, Korea, Malaysia, Mexico, Philippines, Russia, Saudi Arabia, Singapore, South Africa, Thailand and Turkey.

Figure 4.3: Foreign Equity Assets and Imports to GDP Shares
(average 1992-2007, 15 developing and emerging countries)



Note: The regression line is $FEA_i = \underset{(2.029)}{-2.598} + \underset{(0.029)}{0.152} IM_i$, where FEA_i represents a country's share of foreign equities in the domestic equity portfolio and is calculated as $\text{Foreign Assets}/(\text{Stock Market Capitalization - Foreign Liabilities + Foreign Assets})$.[17] Moreover, IM_i is a country's import to GDP share. This regression has R^2=0.68. Standard errors are in the parenthesis.

developing and new emerging countries finish their economy transformation (i.e. become developed countries), the model implication would fit quite well with these countries' data.

Overall, compared with the Collard *et al.* (2008) 2-coutry model, the 3-country model studied in this chapter cannot improve the match between the real world data and the model's predication any further. Moreover, the empirical evidence suggests that the theoretical implication offered by both models is supported by the developed country data only.

[17] I have used the same set of data sources as used in figure 4.1.

4.10 Conclusion

Financial theory suggests that, in order to reduce portfolio risk, investors should hold nationally and internationally well diversified portfolios. However, investors still hold too little of their wealth in foreign assets relative to the predictions of standard financial and macroeconomic theory. Many researchers have tried to seek resolutions to this 'equity home bias' puzzle. Potential explanations range from barriers to international capital movements to frictions that justify the observed portfolios as optimal risk management decisions. However, no fully convincing explanation has been found yet.

The main objective of this chapter is to investigate the role of consumption bias in generating equity portfolio bias based on the numerical solutions provided by a three-country GE model, which is developed based on the Collard *et al.*'s (2008) two-country framework. Also, this chapter implicitly tests the validity and robustness of the results found by Collard *et al.* (2008). The focus in this study is on articulating the new insights that can be gained by going from two countries to three, particularly in understanding different scenarios of optimal equity portfolio holdings across countries when households in every country have asymmetric preferences in the consumption of traded goods.

The analysis is first carried out in a symmetric three-country model with both separable and non-separable utilities in traded and non-traded goods and then in an extended model by simply assuming that households have asymmetric preferences over the domestic and foreign traded goods across the three countries. Then, a sensitivity analysis is performed to investigate the robustness of the results predicted by both models.

The main findings of this study can be summarized as follows. First, in both the baseline and extended models, the optimal holdings of non-traded goods equities only depend on the separability between traded and non-traded goods. They are not affected by the household's preferences in traded goods. Second, household's preferences in traded goods play an important role in determining the optimal holdings of the domestic and foreign traded goods equities. In general, the optimal portfolio of traded goods equities is fully diversified across countries in the absence of consumption bias in traded goods. However, in the presence of a consumption bias in traded goods, the optimal portfolio of traded goods equities becomes biased. In particular, a foreign consumption bias can induce a home bias in the sub-portfolio of traded goods equities while a home consumption bias tends to introduce a foreign bias in the sub-portfolio of traded goods equities. This conclusion holds in both separable and non-separable utility cases. Third, the extended model suggests that, in a three-country framework, the optimal holdings of the two foreign traded goods equities depend on the amount of domestic traded goods each foreign country consumes. If both foreign countries consume the same amount of domestic traded goods, it is optimal for domestic investors to hold the two foreign traded goods equities in equal shares. On the other hand, if foreign country A consumes more domestic traded goods than foreign country B does, then, it is optimal for domestic investors to hold a smaller share in the foreign country A's traded sector but a larger share in the foreign country B's traded sector, *vice versa.* This general finding holds in both separable and non-separable utility cases. Finally, the sensitivity analysis suggests that the results of both the baseline and extended models are very robust in the presence of plausible and large variation in the parameters values.

Last but not least, although the Collard et al.'s (2008) results are found to be very robust in a three-country framework, the empirical evidence suggests that the theoretical implication offered by both models is supported by the developed country data only. Moreover, the setup of the three-country model presented in this chapter is rather simple. Therefore, an interesting avenue for future research is to add some new features to the existing three-country model, for examples, assuming markets are incomplete, introducing bond into the financial markets, adding in price rigidity, and then see whether the conclusions made by Collard *et al.*(2008) can still be robust in a more complicated GE model.

Chapter 4 Appendix

Appendix Table 4.1: Sensitivity Analysis of the Baseline Model

Benchmark: Separable Utility, No Consumption Bias

	Wealth Shares						Equity Shares					
	α^y_{UU}	α^z_{UU}	α^y_{UE}	α^z_{UE}	α^y_{UA}	α^z_{UA}	S^y_{UU}	S^z_{UU}	S^y_{UE}	S^z_{UE}	S^y_{UA}	S^z_{UA}
enchmark	0.0766	0.7701	0.0766	0.0000	0.0766	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000
isk aversion: σ												
50	0.0766	0.8262	0.0766	-0.0281	0.0766	-0.0281	0.3333	1.0732	0.3333	-0.0366	0.3333	-0.0366
00	0.0766	0.7814	0.0766	-0.0057	0.0766	-0.0057	0.3333	1.0150	0.3333	-0.0075	0.3333	-0.0075
asticity of Substitution between Traded and Non-traded Goods: ρ												
25	0.0766	0.7687	0.0766	0.0006	0.0766	0.0006	0.3333	0.9983	0.3333	0.0008	0.3333	0.0008
75	0.0766	0.8104	0.0766	-0.0202	0.0766	-0.0202	0.3333	1.0525	0.3333	-0.0262	0.3333	-0.0262
00	0.0766	0.0801	0.0766	0.3449	0.0766	0.3449	0.3333	0.1040	0.3333	0.4480	0.3333	0.4480
asticity of Substitution between Traded Goods: η												
60	0.0766	0.7701	0.0766	0.0000	0.0766	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000
00	0.0766	0.7701	0.0766	0.0000	0.0766	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000
00	0.0766	0.7701	0.0766	0.0000	0.0766	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000
onsumption Share of Domestic Traded Goods in Consumption of Traded: α												
05	0.1787	0.7701	0.0256	0.0000	0.0256	0.0000	0.7769	1.0000	0.1116	0.0000	0.1116	0.0000
90	0.2759	0.7701	-0.0230	0.0000	-0.0230	0.0000	1.2004	1.0000	-0.1002	0.0000	-0.1002	0.0000
onsumption Share of Traded Goods: ω												
10	0.0292	0.9124	0.0292	0.0000	0.0292	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000
50	0.2377	0.2869	0.2377	0.0000	0.2377	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000
75	0.3152	0.0544	0.3152	0.0000	0.3152	0.0000	0.3333	1.0000	0.3333	0.0000	0.3333	0.0000

Appendix Table 4.2: Symmetric Baseline Model Sensitivity Analysis

Benchmark: Separable Utility, Foreign Consumption Bias

	Wealth Shares						**Equity Shares**					
	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
enchmark	0.1477	0.7701	0.0411	0.0000	0.0411	0.0000	0.6424	1.0000	0.1788	0.0000	0.1788	0.0000
sk aversion: σ												
50	0.1569	0.8371	0.0364	-0.0334	0.0364	-0.0334	0.6825	1.0867	0.1587	-0.0433	0.1587	-0.0433
00	0.1495	0.7837	0.0401	-0.0067	0.0401	-0.0067	0.6505	1.0175	0.1748	-0.0087	0.1748	-0.0087
asticity of Substitution between Traded and Non-traded Goods: ρ												
25	0.1922	0.7686	0.0188	0.0008	0.0188	0.0008	0.8363	0.9979	0.0819	0.0010	0.0819	0.0010
75	0.1121	0.8139	0.0588	-0.0218	0.0588	-0.0218	0.4884	1.0568	0.2558	-0.0284	0.2558	-0.0284
00	0.3498	-0.3502	-0.0599	0.5601	-0.0599	0.5601	1.5215	-0.4549	-0.2607	0.7274	-0.2607	0.7274
asticity of Substitution between Traded Goods: η												
50	0.0115	0.7701	0.1092	0.0000	0.1092	0.0000	0.0503	1.0000	0.4748	0.0000	0.4748	0.0000
00	0.1095	0.7701	0.0602	0.0000	0.0602	0.0000	0.4763	1.0000	0.2619	0.0000	0.2619	0.0000
00	0.0843	0.7701	0.0728	0.0000	0.0728	0.0000	0.3672	1.0000	0.3164	0.0000	0.3164	0.0000
nsumption Share of Domestic Traded Goods in Consumption of Traded: α												
05	0.1787	0.7701	0.0256	0.0000	0.0256	0.0000	0.7769	1.0000	0.1116	0.0000	0.1116	0.0000
00	0.2759	0.7701	-0.0230	0.0000	-0.0230	0.0000	1.2004	1.0000	-0.1002	0.0000	-0.1002	0.0000
nsumption Share of Traded Goods: ω												
10	0.0688	0.8928	0.0192	0.0000	0.0192	0.0000	0.6424	1.0000	0.1788	0.0000	0.1788	0.0000
50	0.5609	0.1269	0.1561	0.0000	0.1561	0.0000	0.6424	1.0000	0.1788	0.0000	0.1788	0.0000
75	0.6189	0.0365	0.1723	0.0000	0.1723	0.0000	0.6424	1.0000	0.1788	0.0000	0.1788	0.0000

Appendix Table 4.3: Asymmetric Model Sensitivity Analysis

Benchmark: Separable Utility, Foreign Consumption Bias

nel A: US Case (EU is 'mirror symmetric')

	Wealth Shares						Equity Shares					
	α_{UU}^{y}	α_{UU}^{z}	α_{UE}^{y}	α_{UE}^{z}	α_{UA}^{y}	α_{UA}^{z}	S_{UU}^{y}	S_{UU}^{z}	S_{UE}^{y}	S_{UE}^{z}	S_{UA}^{y}	S_{UA}^{z}
enchmark	0.1439	0.7709	0.0562	0.0000	0.0290	0.0000	0.6308	1.0000	0.2436	0.0000	0.1256	0.0000
sk aversion: σ												
50	0.1531	0.8386	0.0501	-0.0334	0.0250	-0.0334	0.6711	1.0866	0.2193	-0.0433	0.1096	-0.0433
00	0.1459	0.7853	0.0548	-0.0067	0.0274	0.0067	0.6395	1.0174	0.2404	-0.0087	0.1201	-0.0087
asticity of Substitution between Traded and Non-traded Goods: ρ												
25	0.1475	0.7687	0.0618	0.0008	0.0204	0.0008	0.6422	0.9979	0.2694	0.0011	0.0884	0.0011
75	0.1402	0.8142	0.0789	-0.0364	0.0395	-0.0364	0.5422	1.0616	0.3052	-0.0275	0.1526	-0.0275
00	0.4246	-0.0541	-0.0654	0.4129	-0.1309	0.4129	1.8605	-0.0701	-0.2868	0.5350	-0.5737	0.5350
asticity of Substitution between Traded Goods: η												
50	0.0162	0.7709	0.1411	0.0000	0.0718	0.0000	0.0711	1.0000	0.6193	0.0000	0.3096	0.0000
00	0.1119	0.7709	0.0780	0.0000	0.0392	0.0000	0.4684	1.0000	0.3268	0.0000	0.1634	0.0000
00	0.0836	0.7709	0.0968	0.0000	0.0487	0.0000	0.3652	1.0000	0.4232	0.0000	0.2116	0.0000
S/European Consumption Share of Domestic Traded Goods in Consumption of Traded: α												
05	0.1767	0.7709	0.0192	0.0000	0.0332	0.0000	0.7715	1.0000	0.0842	0.0000	0.1443	0.0000
35	0.0183	0.7709	0.2008	0.0000	0.0100	0.0000	0.0799	1.0000	0.8771	0.0000	0.0430	0.0000
S/European Consumption Share of Both US and European Traded Goods in Consumption of Traded: γ												
15	0.2418	0.7709	0.2745	0.0000	-0.2872	0.0000	1.0596	1.0000	1.2026	0.0000	-1.2622	0.0000
95	0.2418	0.7709	-0.2872	0.0000	0.2745	0.0000	1.0596	1.0000	-1.2622	0.0000	1.2026	0.0000
nsumption Share of Traded Goods: ω												
10	0.0354	0.9438	0.0137	0.0000	0.0071	0.0000	0.6308	1.0000	0.2436	0.0000	0.1256	0.0000
50	0.5266	0.1654	0.2032	0.0000	0.1048	0.0000	0.6308	1.0000	0.2436	0.0000	0.1256	0.0000
75	0.5934	0.0592	0.2292	0.0000	0.1182	0.0000	0.6308	1.0000	0.2436	0.0000	0.1256	0.0000

Appendix Table 4.3 (continued): Asymmetric Model Sensitivity Analysis

<u>*Benchmark*: Separable Utility, Foreign Consumption Bias</u>

el B: Asia Case

	Wealth Shares						Equity Shares					
	α^y_{UU}	α^z_{UU}	α^y_{UE}	α^z_{UE}	α^y_{UA}	α^z_{UA}	S^y_{UU}	S^z_{UU}	S^y_{UE}	S^z_{UE}	S^y_{UA}	S^z_{UA}
chmark	0.1393	0.7709	0.0449	0.0000	0.0449	0.0000	0.6078	1.0000	0.1961	0.0000	0.1961	0.0000
aversion: σ												
	0.1429	0.8152	0.0514	-0.0304	0.0514	-0.0304	0.5814	1.0809	0.2093	-0.0404	0.2093	-0.0404
	0.1281	0.7506	0.0664	-0.0057	0.0664	-0.0057	0.5614	1.0614	0.2193	-0.0082	0.2193	-0.0082
ticity of Substitution between Traded and Non-traded Goods: ρ												
	0.1640	0.7570	0.0387	0.0008	0.0387	0.0008	0.6792	0.9981	0.1604	0.0010	0.1604	0.0010
	0.1163	0.7822	0.0711	-0.0203	0.0711	-0.0203	0.4496	1.0547	0.2752	-0.0275	0.2752	-0.0275
	0.2964	-0.0498	-0.0041	0.3808	-0.0041	0.3808	1.2251	-0.0701	-0.0171	0.5350	-0.0171	0.5350
ticity of Substitution between Traded Goods: η												
	0.0223	0.7709	0.1034	0.0000	0.1034	0.0000	0.0959	1.0000	0.4520	0.0000	0.4520	0.0000
	0.1013	0.7709	0.0639	0.0000	0.0639	0.0000	0.4418	1.0000	0.2791	0.0000	0.2791	0.0000
	0.0825	0.7709	0.0733	0.0000	0.0733	0.0000	0.3602	1.0000	0.3199	0.0000	0.3199	0.0000
n Consumption Share of Domestic Traded Goods in Consumption of Traded: δ												
	0.1537	0.7709	0.0377	0.0000	0.0377	0.0000	0.6706	1.0000	0.1647	0.0000	0.1647	0.0000
	0.3373	0.7709	-0.0541	0.0000	-0.0541	0.0000	1.4726	1.0000	-0.2363	0.0000	-0.2363	0.0000
sumption Share of Traded Goods: ω												
	0.0342	0.9438	0.0110	0.0000	0.0110	0.0000	0.6078	1.0000	0.1961	0.0000	0.1961	0.0000
	0.5072	0.1654	0.1637	0.0000	0.1637	0.0000	0.6078	1.0000	0.1961	0.0000	0.1961	0.0000
	0.5718	0.0592	0.1845	0.0000	0.1845	0.0000	0.6078	1.0000	0.1961	0.0000	0.1961	0.0000

Technical Appendix

First order conditions and the log-linearized system

1. Efficient Allocation

The following set of conditions are needed for solving the efficient allocation problem in equilibrium, and I assume $P^{y}_{Ut} = 1$

$$C_{Ut} = \left(\omega^{\frac{1}{\rho}} C^{Y\,\frac{\rho-1}{\rho}}_{Ut} + (1-\omega)^{\frac{1}{\rho}} C^{Z\,\frac{\rho-1}{\rho}}_{Ut} \right)^{\frac{\rho}{\rho-1}}; \tag{E1}$$

$$C_{Et} = \left(\omega^{\frac{1}{\rho}} C^{Y\,\frac{\rho-1}{\rho}}_{Et} + (1-\omega)^{\frac{1}{\rho}} C^{Z\,\frac{\rho-1}{\rho}}_{Et} \right)^{\frac{\rho}{\rho-1}}; \tag{E2}$$

$$C_{At} = \left(\omega^{\frac{1}{\rho}} C^{Y\,\frac{\rho-1}{\rho}}_{At} + (1-\omega)^{\frac{1}{\rho}} C^{Z\,\frac{\rho-1}{\rho}}_{At} \right)^{\frac{\rho}{\rho-1}}; \tag{E3}$$

$$C^{Y}_{Ut} = \left(\alpha^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{UUt} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{UEt} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{UAt} \right)^{\frac{\eta}{\eta-1}}; \tag{E4}$$

$$C^{Y}_{Et} = \left(\alpha^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{EEt} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{EUt} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{EAt} \right)^{\frac{\eta}{\eta-1}}; \tag{E5}$$

$$C^{Y}_{At} = \left(\alpha^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{AAt} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{AUt} + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,\frac{\eta-1}{\eta}}_{AEt} \right)^{\frac{\eta}{\eta-1}}; \tag{E6}$$

$$\Lambda_{Ut} P^{Z}_{Ut} = (1-\omega)^{\frac{1}{\rho}} C^{Z\,-\frac{1}{\rho}}_{Ut} C_{Ut}^{\frac{1}{\rho}-\sigma}; \tag{E7}$$

$$\Lambda_{Ut} = \omega^{\frac{1}{\rho}} \alpha^{\frac{1}{\eta}} C^{Y\,-\frac{1}{\eta}}_{UUt} C^{Y\,\frac{1}{\eta}-\frac{1}{\rho}}_{Ut} C_{Ut}^{\frac{1}{\rho}-\sigma}; \tag{E8}$$

$$\Lambda_{Ut} P^{Y}_{Et} = \omega^{\frac{1}{\rho}} \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C^{Y\,-\frac{1}{\eta}}_{UEt} C^{Y\,\frac{1}{\eta}-\frac{1}{\rho}}_{Ut} C_{Ut}^{\frac{1}{\rho}-\sigma}; \tag{E9}$$

$$\Lambda_{Ut}P_{At}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{UAt}^{Y}{}^{-\frac{1}{\eta}}C_{Ut}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{Ut}^{\frac{1}{\rho}-\sigma}; \tag{E10}$$

$$\Lambda_{Et}P_{Et}^{Z}=(1-\omega)^{\frac{1}{\rho}}C_{Et}^{Z}{}^{-\frac{1}{\rho}}C_{Et}^{\frac{1}{\rho}-\sigma}; \tag{E11}$$

$$\Lambda_{Et}P_{Et}^{Y}=\omega^{\frac{1}{\rho}}\alpha^{\frac{1}{\eta}}C_{EEt}^{Y}{}^{-\frac{1}{\eta}}C_{Et}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{Et}^{\frac{1}{\rho}-\sigma}; \tag{E12}$$

$$\Lambda_{Et}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{EUt}^{Y}{}^{-\frac{1}{\eta}}C_{Et}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{Et}^{\frac{1}{\rho}-\sigma}; \tag{E13}$$

$$\Lambda_{Et}P_{At}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{EAt}^{Y}{}^{-\frac{1}{\eta}}C_{Et}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{Et}^{\frac{1}{\rho}-\sigma}; \tag{E14}$$

$$\Lambda_{At}P_{At}^{Z}=(1-\omega)^{\frac{1}{\rho}}C_{At}^{Z}{}^{-\frac{1}{\rho}}C_{At}^{\frac{1}{\rho}-\sigma}; \tag{E15}$$

$$\Lambda_{At}P_{At}^{Y}=\omega^{\frac{1}{\rho}}\alpha^{\frac{1}{\eta}}C_{AAt}^{Y}{}^{-\frac{1}{\eta}}C_{At}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{At}^{\frac{1}{\rho}-\sigma}; \tag{E16}$$

$$\Lambda_{At}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{AUt}^{Y}{}^{-\frac{1}{\eta}}C_{At}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{At}^{\frac{1}{\rho}-\sigma}; \tag{E17}$$

$$\Lambda_{At}P_{Et}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{AEt}^{Y}{}^{-\frac{1}{\eta}}C_{At}^{Y}{}^{\frac{1}{\eta}-\frac{1}{\rho}}C_{At}^{\frac{1}{\rho}-\sigma}; \tag{E18}$$

$$Y_{Ut}=C_{UUt}^{Y}+C_{EUt}^{Y}+C_{AUt}^{Y}; \tag{E19}$$

$$Y_{Et}=C_{EEt}^{Y}+C_{UEt}^{Y}+C_{AEt}^{Y}; \tag{E20}$$

$$Y_{At}=C_{AAt}^{Y}+C_{UAt}^{Y}+C_{EAt}^{Y}; \tag{E21}$$

$$Z_{Ut}=C_{UUt}^{Z}; \tag{E22}$$

$$Z_{Et}=C_{EEt}^{Z}; \tag{E23}$$

$$Z_{At}=C_{AAt}^{Z}; \tag{E24}$$

$$Q_{Ut}^{Y}\Lambda_{Ut} = \beta E_t[\Lambda_{Ut+1}(Q_{Ut+1}^{Y} + Y_{Ut+1})]; \quad \text{(E25)}$$

$$Q_{Et}^{Y}\Lambda_{Et} = \beta E_t[\Lambda_{Et+1}(Q_{Et+1}^{Y} + P_{Et+1}^{Y}Y_{Et+1})]; \quad \text{(E26)}$$

$$Q_{At}^{Y}\Lambda_{At} = \beta E_t[\Lambda_{At+1}(Q_{At+1}^{Y} + P_{At+1}^{Y}Y_{At+1})]; \quad \text{(E27)}$$

$$Q_{Ut}^{Z}\Lambda_{Ut} = \beta E_t[\Lambda_{Ut+1}(Q_{Ut+1}^{Z} + P_{Ut+1}^{Z}Y_{Ut+1})]; \quad \text{(E28)}$$

$$Q_{Et}^{Z}\Lambda_{Et} = \beta E_t[\Lambda_{Et+1}(Q_{Et+1}^{Z} + P_{Et+1}^{Z}Y_{Et+1})]; \quad \text{(E29)}$$

$$Q_{At}^{Z}\Lambda_{At} = \beta E_t[\Lambda_{Ut+1}(Q_{At+1}^{Z} + P_{At+1}^{Z}Y_{At+1})]; \quad \text{(E30)}$$

2. Equilibrium

The equilibrium comprises a set of quantities:

$$\{C_t^U, C_{Ut}^Y, C_{UUt}^Y, C_{UEt}^Y, C_{UAt}^Y, C_{Ut}^Z, C_t^E, C_{Et}^Y, C_{EEt}^Y, C_{EUt}^Y, C_{EAt}^Y, C_{Et}^Z . C_t^A, C_{At}^Y, C_{AAt}^Y, C_{AUt}^Y, C_{AEt}^Y, C_{At}^Z\},$$

$$\{Y_{Ut}, Y_{Et}, Y_{At}, Z_{Ut}, Z_{Et}, Z_{At}\},$$

and a set of prices:

$$\{\Lambda_{Ut}, \Lambda_{Et}, \Lambda_{At}, P_{Ut}^Z, P_{Et}^Z, P_{At}^Z, P_{Et}^Y, P_{At}^Y, Q_{Ut}^Z, Q_{Et}^Z, Q_{At}^Z, Q_{Ut}^Y, Q_{Et}^Y, Q_{At}^Y\},$$

which satisfy all the first order conditions, market clearing conditions and pre-assumed endowment processes.

3. Some Steady State Results

The following set of conditions are required to solve the steady state of problem in equilibrium

$$C_U = \left(\omega^{\frac{1}{\rho}} C_U^{Y\frac{\rho-1}{\rho}} + (1-\omega)^{\frac{1}{\rho}} C_U^{Z\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}; \quad \text{(S1)}$$

$$C^E = \left(\omega^{\frac{1}{\rho}} C_E^{Y\frac{\rho-1}{\rho}} + (1-\omega)^{\frac{1}{\rho}} C_E^{Z\frac{\rho-1}{\rho}} \right)^{\frac{\rho}{\rho-1}}; \quad \text{(S2)}$$

$$C^{A}=\left(\omega^{\frac{1}{\rho}}C_{A}^{Y\frac{\rho-1}{\rho}}+(1-\omega)^{\frac{1}{\rho}}C_{A}^{Z\frac{\rho-1}{\rho}}\right)^{\frac{\rho}{\rho-1}}; \tag{S3}$$

$$C_{U}^{Y}=\left(\alpha^{\frac{1}{\eta}}C_{UU}^{Y\frac{\eta-1}{\eta}}+\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{UE}^{Y\frac{\eta-1}{\eta}}+\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{UA}^{Y\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}; \tag{S4}$$

$$C_{E}^{Y}=\left(\alpha^{\frac{1}{\eta}}C_{EE}^{Y\frac{\eta-1}{\eta}}+\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{EU}^{Y\frac{\eta-1}{\eta}}+\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{EA}^{Y\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}; \tag{S5}$$

$$C_{A}^{Y}=\left(\alpha^{\frac{1}{\eta}}C_{AA}^{Y\frac{\eta-1}{\eta}}+\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{AU}^{Y\frac{\eta-1}{\eta}}+\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{AE}^{Y\frac{\eta-1}{\eta}}\right)^{\frac{\eta}{\eta-1}}; \tag{S6}$$

$$\Lambda_{U}P_{U}^{Z}=(1-\omega)^{\frac{1}{\rho}}C_{U}^{Z\,-\frac{1}{\rho}}C_{U}^{\frac{1}{\rho}-\sigma}; \tag{S7}$$

$$\Lambda_{U}=\omega^{\frac{1}{\rho}}\alpha^{\frac{1}{\eta}}C_{UU}^{Y\,-\frac{1}{\eta}}C_{U}^{Y\frac{1}{\eta}-\frac{1}{\rho}}C_{U}^{\frac{1}{\rho}-\sigma}; \tag{S8}$$

$$\Lambda_{U}P_{E}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{UE}^{Y\,-\frac{1}{\eta}}C_{U}^{Y\frac{1}{\eta}-\frac{1}{\rho}}C_{U}^{\frac{1}{\rho}-\sigma}; \tag{S9}$$

$$\Lambda_{U}P_{A}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{UA}^{Y\,-\frac{1}{\eta}}C_{U}^{Y\frac{1}{\eta}-\frac{1}{\rho}}C_{U}^{\frac{1}{\rho}-\sigma}; \tag{S10}$$

$$\Lambda_{E}P_{E}^{Z}=(1-\omega)^{\frac{1}{\rho}}C_{E}^{Z\,-\frac{1}{\rho}}C_{E}^{\frac{1}{\rho}-\sigma}; \tag{S11}$$

$$\Lambda_{E}P_{E}^{Y}=\omega^{\frac{1}{\rho}}\alpha^{\frac{1}{\eta}}C_{EE}^{Y\,-\frac{1}{\eta}}C_{E}^{Y\frac{1}{\eta}-\frac{1}{\rho}}C_{E}^{\frac{1}{\rho}-\sigma}; \tag{S12}$$

$$\Lambda_{E}P_{U}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{EU}^{Y\,-\frac{1}{\eta}}C_{E}^{Y\frac{1}{\eta}-\frac{1}{\rho}}C_{E}^{\frac{1}{\rho}-\sigma}; \tag{S13}$$

$$\Lambda_{E}P_{A}^{Y}=\omega^{\frac{1}{\rho}}\left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}}C_{EA}^{Y\,-\frac{1}{\eta}}C_{E}^{Y\frac{1}{\eta}-\frac{1}{\rho}}C_{E}^{\frac{1}{\rho}-\sigma}; \tag{S14}$$

$$\Lambda_A P_A^Z = (1-\omega)^{\frac{1}{\rho}} C_A^{Z\,-\frac{1}{\rho}} C_A^{\frac{1}{\rho}-\sigma}; \quad \text{(S15)}$$

$$\Lambda_A P_A^Y = \omega^{\frac{1}{\rho}} \alpha^{\frac{1}{\eta}} C_{AA}^{Y\,-\frac{1}{\eta}} C_A^{Y\,\frac{1}{\eta}-\frac{1}{\rho}} C_A^{\frac{1}{\rho}-\sigma}; \quad \text{(S16)}$$

$$\Lambda_A P_U^Y = \omega^{\frac{1}{\rho}} \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{AU}^{Y\,-\frac{1}{\eta}} C_A^{Y\,\frac{1}{\eta}-\frac{1}{\rho}} C_A^{\frac{1}{\rho}-\sigma}; \quad \text{(S17)}$$

$$\Lambda_A P_E^Y = \omega^{\frac{1}{\rho}} \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{AE}^{Y\,-\frac{1}{\eta}} C_A^{Y\,\frac{1}{\eta}-\frac{1}{\rho}} C_A^{\frac{1}{\rho}-\sigma}; \quad \text{(S18)}$$

$$Y_U = C_{UU}^Y + C_{EU}^Y + C_{AU}^Y; \quad \text{(S19)}$$

$$Y_E = C_{EE}^Y + C_{UE}^Y + C_{AE}^Y; \quad \text{(S20)}$$

$$Y_A = C_{AA}^Y + C_{UA}^Y + C_{EA}^Y; \quad \text{(S21)}$$

$$Z_U = C_{UU}^Z; \quad \text{(S22)}$$

$$Z_E = C_{EE}^Z; \quad \text{(S23)}$$

$$Z_A = C_{AA}^Z; \quad \text{(S24)}$$

$$Q_U^Y = \beta(Q_U^Y + Y_U); \quad \text{(S25)}$$

$$Q_E^Y = \beta(Q_E^Y + P_E^Y Y_E); \quad \text{(S26)}$$

$$Q_A^Y = \beta(Q_A^Y + P_A^Y Y_A); \quad \text{(S27)}$$

$$Q_U^Z = \beta(Q_U^Z + P_U^Z Z_U); \quad \text{(S28)}$$

$$Q_E^Z = \beta(Q_E^Z + P_E^Z Z_E); \quad \text{(S29)}$$

$$Q_A^Z = \beta(Q_A^Z + P_A^Z Z_A); \quad \text{(S30)}$$

Define

$$\overline{P}_U^Y = \left(\alpha P_U^{Y1-\eta} + \left(\frac{1-\alpha}{2}\right) P_E^{Y1-\eta} + \left(\frac{1-\alpha}{2}\right) P_A^{Y1-\eta} \right)^{\frac{1}{1-\eta}}$$

$$\overline{P}_E^Y = \left(\alpha P_E^{Y1-\eta} + \left(\frac{1-\alpha}{2}\right) P_U^{Y1-\eta} + \left(\frac{1-\alpha}{2}\right) P_A^{Y1-\eta} \right)^{\frac{1}{1-\eta}}$$

$$\overline{P}_A^Y = \left(\alpha P_A^{Y1-\eta} + \left(\frac{1-\alpha}{2}\right) P_U^{Y1-\eta} + \left(\frac{1-\alpha}{2}\right) P_E^{Y1-\eta} \right)^{\frac{1}{1-\eta}};$$

Equation (S8)-(S10), (S12)-(S14) and (S16)-(S18) reduce to

$$\Lambda^U \overline{P}_U^Y = \omega^{\frac{1}{\rho}} C_U^{Y-\frac{1}{\rho}} C^{U\frac{1}{\rho}-\sigma}; \tag{S31}$$

$$\Lambda^U \overline{P}_E^Y = \omega^{\frac{1}{\rho}} C_E^{Y-\frac{1}{\rho}} C^{E\frac{1}{\rho}-\sigma}; \tag{S32}$$

$$\Lambda^U \overline{P}_A^Y = \omega^{\frac{1}{\rho}} C_A^{Y-\frac{1}{\rho}} C^{A\frac{1}{\rho}-\sigma}; \tag{S33}$$

Let's focus on the case of a symmetric equilibrium: $Y_U = Y_E = Y_A$, $Z_U = Z_E = Z_A$, $C_U^Z = C_E^Z = C_A^Z$, $C^U = C^E = C^A$, $C_{UU}^Y = C_{EE}^Y = C_{AA}^Y$, $C_{UE}^Y = C_{EU}^Y$, $C_{UA}^Y = C_{AU}^Y$ and $C_{EA}^Y = C_{AE}^Y$. Since here I only consider the symmetric case, taking US as the representative economy and use (S7) and (S31):

$$1 = \frac{P_U^Z}{\overline{P}_U^Y} = \left(\frac{1-\omega}{\omega}\right)^{\frac{1}{\rho}} \left(\frac{C_U^Z}{C_U^Y}\right)^{-\frac{1}{\rho}} \Leftrightarrow \frac{C_U^Z}{C_U^Y} = \frac{1-\omega}{\omega}; \tag{S34}$$

Note that since I have assumed all the relative prices are equal to 1, it follows that:

$$Z_U = C_U^Z; \tag{S35}$$

$$C_U^Y = P_U^Y C_{UU}^Y + P_E^Y C_{UE}^Y + P_A^Y C_{UA}^Y = C_{UU}^Y + C_{UE}^Y + C_{UA}^Y = C_{UU}^Y + C_{EU}^Y + C_{AU}^Y \tag{S36}$$

Combine with (S19) we get:

$$C_U^Y = Y_U; \qquad \text{(S37)}$$

Combine (S37) with (S34) and (S35) we get:

$$\frac{Z_U}{Y_U} = \frac{Z_E}{Y_E} = \frac{Z_A}{Y_A} = \frac{1-\omega}{\omega}; \qquad \text{(S38)}$$

At the same time, with the relative prices equal to 1, equations (S8)-(S10), (S12)-(S14) and (S16)-(S18) imply

$$\frac{\alpha}{C_{UU}^Y} = \frac{1-\alpha}{2C_{UE}^Y} = \frac{1-\alpha}{2C_{UA}^Y} = \frac{\alpha}{C_{EE}^Y} = \frac{1-\alpha}{2C_{EU}^Y} = \frac{1-\alpha}{2C_{EA}^Y} = \frac{\alpha}{C_{AA}^Y} = \frac{1-\alpha}{2C_{AU}^Y} = \frac{1-\alpha}{2C_{AE}^Y} \qquad \text{(S39)}$$

which produces

$$\frac{\alpha}{C_{UU}^Y} = \frac{1}{C_{UU}^Y + C_{EU}^Y + C_{EA}^Y} = \frac{1}{Y_U} \Leftrightarrow \frac{C_{UU}^Y}{Y_U} = \alpha; \qquad \text{(S40)}$$

and similarly,

$$\frac{C_{UU}^Y}{Y_U} = \frac{C_{EE}^Y}{Y_E} = \frac{C_{AA}^Y}{Y_A} = \alpha;$$

and $$\frac{C_{UE}^Y}{Y_U} = \frac{C_{UA}^Y}{Y_U} = \frac{C_{EU}^Y}{Y_E} = \frac{C_{EA}^Y}{Y_E} = \frac{C_{AU}^Y}{Y_A} = \frac{C_{AE}^Y}{Y_A} = 1-\alpha; \qquad \text{(S41)}$$

Therefore, asset prices in the deterministic steady state can be easily determined. With relative prices equal to unity, we have

$$Q_i^x = \frac{\beta}{1-\beta} x_i;$$

where $i = \{U, E, A\}$ and $x = \{Y, Z\}$. A direct consequence is that $Q^Z / Q^Y = Z / Y$.

4. Log-linear Representation

The log-linear version of the system is given by

$$C^{U\frac{\rho-1}{\rho}}\hat{c}_t^U = \omega^{\frac{1}{\rho}} C_U^{Y\frac{\rho-1}{\rho}}\hat{c}_{Ut}^Y + (1-\omega)^{\frac{1}{\rho}} C_U^{Z\frac{\rho-1}{\rho}}\hat{c}_{Ut}^Z; \tag{L1}$$

$$C^{E\frac{\rho-1}{\rho}}\hat{c}_t^E = \omega^{\frac{1}{\rho}} C_E^{Y\frac{\rho-1}{\rho}}\hat{c}_{Et}^Y + (1-\omega)^{\frac{1}{\rho}} C_E^{Z\frac{\rho-1}{\rho}}\hat{c}_{Et}^Z; \tag{L2}$$

$$C^{U\frac{\rho-1}{\rho}}\hat{c}_t^A = \omega^{\frac{1}{\rho}} C_A^{Y\frac{\rho-1}{\rho}}\hat{c}_{At}^Y + (1-\omega)^{\frac{1}{\rho}} C_A^{Z\frac{\rho-1}{\rho}}\hat{c}_{At}^Z; \tag{L3}$$

$$C_U^{Y\frac{\eta-1}{\eta}}\hat{c}_{Ut}^Y = \alpha^{\frac{1}{\rho}} C_{UU}^{Y\frac{\eta-1}{\eta}}\hat{c}_{UUt}^Y + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{UE}^{Y\frac{\eta-1}{\eta}}\hat{c}_{UEt}^Y + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{UA}^{Y\frac{\eta-1}{\eta}}\hat{c}_{UAt}^Y; \tag{L4}$$

$$C_E^{Y\frac{\eta-1}{\eta}}\hat{c}_{Et}^Y = \alpha^{\frac{1}{\rho}} C_{EE}^{Y\frac{\eta-1}{\eta}}\hat{c}_{EEt}^Y + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{EU}^{Y\frac{\eta-1}{\eta}}\hat{c}_{EUt}^Y + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{EA}^{Y\frac{\eta-1}{\eta}}\hat{c}_{EAt}^Y; \tag{L5}$$

$$C_A^{Y\frac{\eta-1}{\eta}}\hat{c}_{At}^Y = \alpha^{\frac{1}{\rho}} C_{AA}^{Y\frac{\eta-1}{\eta}}\hat{c}_{AAt}^Y + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{AU}^{Y\frac{\eta-1}{\eta}}\hat{c}_{AUt}^Y + \left(\frac{1-\alpha}{2}\right)^{\frac{1}{\eta}} C_{AE}^{Y\frac{\eta-1}{\eta}}\hat{c}_{AEt}^Y; \tag{L6}$$

$$\hat{\lambda}_t^U + \hat{p}_{Ut}^Z = -\frac{1}{\rho}\hat{c}_{Ut}^Z + \left(\frac{1}{\rho}-\sigma\right)\hat{c}_t^U; \tag{L7}$$

$$\hat{\lambda}_t^U + \hat{p}_{Ut}^Y = -\frac{1}{\eta}\hat{c}_{UUt}^Y + \left(\frac{1}{\eta}-\frac{1}{\rho}\right)\hat{c}_{Ut}^Y + \left(\frac{1}{\rho}-\sigma\right)\hat{c}_t^U; \tag{L8}$$

$$\hat{\lambda}_t^U + \hat{p}_{Et}^Y = -\frac{1}{\eta}\hat{c}_{UEt}^Y + \left(\frac{1}{\eta}-\frac{1}{\rho}\right)\hat{c}_{Ut}^Y + \left(\frac{1}{\rho}-\sigma\right)\hat{c}_t^U; \tag{L9}$$

$$\hat{\lambda}_t^U + \hat{p}_{At}^Y = -\frac{1}{\eta}\hat{c}_{UAt}^Y + \left(\frac{1}{\eta}-\frac{1}{\rho}\right)\hat{c}_{Ut}^Y + \left(\frac{1}{\rho}-\sigma\right)\hat{c}_t^U; \tag{L10}$$

$$\hat{\lambda}_t^E + \hat{p}_{Et}^Z = -\frac{1}{\rho}\hat{c}_{Et}^Z + \left(\frac{1}{\rho}-\sigma\right)\hat{c}_t^E; \tag{L11}$$

$$\hat{\lambda}_t^E + \hat{p}_{Et}^Y = -\frac{1}{\eta}\hat{c}_{EEt}^Y + (\frac{1}{\eta} - \frac{1}{\rho})\hat{c}_{Et}^Y + (\frac{1}{\rho} - \sigma)\hat{c}_t^E; \tag{L12}$$

$$\hat{\lambda}_t^E + \hat{p}_{Ut}^Y = -\frac{1}{\eta}\hat{c}_{EUt}^Y + (\frac{1}{\eta} - \frac{1}{\rho})\hat{c}_{Et}^Y + (\frac{1}{\rho} - \sigma)\hat{c}_t^E; \tag{L13}$$

$$\hat{\lambda}_t^E + \hat{p}_{At}^Y = -\frac{1}{\eta}\hat{c}_{EAt}^Y + (\frac{1}{\eta} - \frac{1}{\rho})\hat{c}_{Et}^Y + (\frac{1}{\rho} - \sigma)\hat{c}_t^E; \tag{L14}$$

$$\hat{\lambda}_t^A + \hat{p}_{At}^Z = -\frac{1}{\rho}\hat{c}_{At}^Z + (\frac{1}{\rho} - \sigma)\hat{c}_t^A; \tag{L15}$$

$$\hat{\lambda}_t^A + \hat{p}_{At}^Y = -\frac{1}{\eta}\hat{c}_{AAt}^Y + (\frac{1}{\eta} - \frac{1}{\rho})\hat{c}_{At}^Y + (\frac{1}{\rho} - \sigma)\hat{c}_t^A; \tag{L16}$$

$$\hat{\lambda}_t^A + \hat{p}_{Ut}^Y = -\frac{1}{\eta}\hat{c}_{AUt}^Y + (\frac{1}{\eta} - \frac{1}{\rho})\hat{c}_{At}^Y + (\frac{1}{\rho} - \sigma)\hat{c}_t^A; \tag{L17}$$

$$\hat{\lambda}_t^A + \hat{p}_{Et}^Y = -\frac{1}{\eta}\hat{c}_{AEt}^Y + (\frac{1}{\eta} - \frac{1}{\rho})\hat{c}_{At}^Y + (\frac{1}{\rho} - \sigma)\hat{c}_t^A; \tag{L18}$$

$$Y_U \hat{y}_{Ut} = C_{UU}^Y \hat{c}_{UUt}^Y + C_{EU}^Y \hat{c}_{EUt}^Y + C_{AU}^Y \hat{c}_{AUt}^Y; \tag{L19}$$

$$Y_E \hat{y}_{Et} = C_{EE}^Y \hat{c}_{EEt}^Y + C_{UE}^Y \hat{c}_{UEt}^Y + C_{AE}^Y \hat{c}_{AEt}^Y; \tag{L20}$$

$$Y_A \hat{y}_{At} = C_{AA}^Y \hat{c}_{AAt}^Y + C_{UA}^Y \hat{c}_{UAt}^Y + C_{EA}^Y \hat{c}_{EAt}^Y; \tag{L21}$$

Chapter 5

Conclusion

This thesis addresses three issues in international macroeconomics. In particular, chapter 2 and chapter 3 provide empirical investigations of the determinants and the sustainability of current account positions in eight largest emerging Asian economies respectively. Furthermore, chapter 4 provides a theoretical investigation of the linkages between equity portfolio home bias and consumption home bias in a three-country GE framework. The findings are as follows.

In chapter 2, I have empirically examined both the long-run determinants of current account and also the short-run dynamics of current account adjustment for eight largest emerging Asian economies. Given the non-stationary nature of the data, a cointegrated VAR approach is adopted in this study. In this chapter, I find that current account behaviours in emerging Asian economies are heterogeneous. This heterogeneity is an indication of structural differences among the emerging Asian economies toward business cycle heterogeneity. The empirical results suggest that, compared with the real effective exchange rate and domestic relative income, the initial stock of net foreign assets and the degree of openness to international trade are more important factors in explaining the long-run behaviour of current account in most of the sample economies. Moreover, current accounts of all sample economies have a self-adjusting mechanism, the only exception being China. On average, the short-run current account adjustment toward long-run equilibrium path is gradual, with the disequilibrium term being the main determinant of the short-run current account variations. In addition, I find that China's current account is not driven by any of the macroeconomic factors considered in this study in the long-run, while it only reacts to changes in the real effective exchange rate in the short-run. Moreover, the empirical results suggest that China's current account can be used as a policy instrument in to control its initial stock of net foreign assets, but not the other way around. Since current account adjustment process could be non-linear. Therefore, an interesting avenue for future research is to use non-linear econometric approaches to analyze the short-run dynamics of a country's current account.

Chapter 3 analyzes current account sustainability for each of the eight selected emerging Asian economies in the context of the intertemporal budget constraint approach. In particular, I have employed the theoretical background developed by Husted (1992) and applied various unit root and cointegration techniques to analyze the form of current account sustainability for each sample economy. Both strong and weak form tests of current account sustainability are performed in the chapter. In this chapter, I show that whether or not one can find sustainability depends not only on the definition, but also on the econometric techniques applied. The key findings in this chapter can be summarized as follows. Based on more generalized sustainability conditions, all the sample economies are found to be on a sustainable current account path. Moreover, multiple structural breaks are found for all the selected economies. Most of these endogenously identified structural breaks are linked to either some crucial global economic events or some important domestic policy changes. In addition, I find that accounting for endogenously identified structural breaks increases the instances of cointegration between an economy's exports and imports, which are more in favour of current account sustainability.

Finally, in chapter 4, I use a three-country general equilibrium model, which is developed based on the two-country model proposed by Collard *et al.* (2008), to investigate the importance of consumption bias in generating equity portfolio bias. . The analysis is firstly carried out in a three-country baseline model where households across the three countries have symmetric preferences in their consumptions of traded goods. Later on, the analysis is carried out in an extended model where households have asymmetric preferences over the domestic and foreign traded goods across the three countries. In this study, both models suggest that the optimal holdings of non-traded goods equities are only affected by the separability between traded and non-traded goods, while the optimal holdings of traded goods equities are determined by the household's preferences over domestic and foreign traded goods. In addition, the calibration results suggest that, within a three-country framework, the optimal holdings of the two foreign traded goods equities depend on the amount of the domestic traded goods each foreign country consumes. The sensitivity analysis suggests that the results of the three-country model are very robust in the presence of plausible and large variation in the parameters values. Last but not least, the Collard *et al.*'s (2008) results are found to be very robust in a three-country framework. In future research, it will be interesting to relax several constraints on the model such as the perfect markets and the perfectly flexible prices and then re-examine the robustness of the Collard *et al.*'s (2008) results using a more complicated model.

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