EXCHANGE RATE VOLATILITY AND EXPORTS: THE CASE OF EMERGING EAST ASIAN ECONOMIES

Submitted by: Myint Moe Chit

Director of Study: Doctor Amrit Judge

Second Supervisor: Doctor Marian Rizov

Time of Submission: November 2008

This dissertation is submitted to the Middlesex University Business School in partial fulfilment of the Degree of Doctor of Philosophy

Acknowledgements

I would like to express my sincere gratitude to the following people who have given me great support and guided me to accomplish this study.

First of all, I am deeply grateful to my Director of Study, Dr Amrit Judge, and supervisor Dr Marian Rizov for their valuable guidance and advices. Without their knowledge and intellectual guidance, I could not imagine how I can complete this thesis.

I would also like to express my appreciation to my former Director of Study, Dr Dirk Willenbockel, and Professor Shujie Yao, for their supports, constructive comments and suggestions, which have led me to finish this thesis.

I am also grateful to the Middlesex University Business School for awarding me a four-year full PhD studentship, without which, I would not be able to complete this thesis. I would also like to express my sincere gratitude to Ms Frida Attrams and other staff from MUBS Research Office for providing administrative support.

Finally, I would like to thank my parents and my family for their love, encouragement, understanding and supports while I was doing my PhD research.

Declaration

- A version of Chapter 6 has been published in the following journal.
  - 'Exchange Rate Volatility and Exports: Evidence from the ASEAN-China Free Trade Area', *Journal of Chinese Economics and Business Studies*, 6 (3), pp.261-277.
- A version of Chapter 7 is submitted to the *International Review of Applied Economics* and currently under revision.

Abstract

This thesis provides an empirical analysis of the impact of exchange rate volatility on the exports of five emerging East and South East Asian economies; China, Indonesia, Malaysia, the Philippines and Thailand. The countries under consideration are the main members of the impending ASEAN-China Free Trade Area (ACFTA), and the options for a closer monetary integration including proposals for the eventual formation of a currency union within the region are currently an active area of research and policy debate. Therefore, an understanding of the degree to which exchange rate volatility affects their export activity is important for setting the optimal exchange rate policy in emerging East Asian countries.

Recognizing the specificity of the exports of the sample countries which is different from those of industrialised countries this study employs an augmented generalised gravity model instead of a pure gravity model. A GMM-IV approach is used to overcome the potential econometric problems of endogeneity and heteroskedasticity. In addition, this study is the first to conduct the recently developed panel unit-root and cointegration tests to verify the existence of a long-run stationary relationship between real exports and exchange-rate volatility. The benchmark measure of the exchange rate volatility which represents uncertainty is the standard deviation of the first difference of the logarithmic exchange rate. In order to check the robustness of the results two additional measures of exchange rate volatility – the moving average standard deviation of the logarithmic

exchange rate (MASD) and the conditional exchange rate volatility which follows a Generalised Autoregressive Conditional Heteroscedascity process (GARCH) – are also used to estimate the model.

The results provide a strong evidence that exchange rate volatility has an economically and statistically significant negative impact not only on the overall exports to the world market but also on the intra-regional exports of emerging East Asian countries. In addition, the results indicate that the adverse effect of exchange rate volatility on exports is not a linear and is conditional on the financial sector development of the exporting country: the more financially developed an economy is, the less its exports are adversely affected by exchange rate volatility. These results are robust across different estimation techniques and do not depend on the variable chosen to proxy exchange rate uncertainty.

In conclusion, the results of the thesis suggest that whilst exchange rate flexibility has desirable properties as a 'shock absorber' to dampen the impact of real shocks, on average it still has an adverse effect on the exports of the emerging East Asian countries, and the impact is more severe on a financially less developed economy.

EXCHANGE RATE VOLATILITY AND EXPORTS: THE CASE OF EMERGING EAST ASIAN ECONOMIES

TABLE OF CONTENTS

LISTS OF TABLES

LIST OF FIGURES

ACRONYMS AND ABBREVIATION

ACFTA	ASEAN-China Free Trade Area
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
ARDL	Auto-Regressive Distributed Lag
ECM	Error Correction Model
EU	European Union
FIML	Fully Identified Maximum Likelihood
FSDI	Financial Sector Development Index
(G)ARCH	(Generalized) Auto-Regressive Conditional Heteroscedascity
GMM	Generalised Method of Moments
IMF	International Monetary Funds
IV	Instrumental Variables
OLS	Ordinary Least Square
VAR	Vector Auto-Regression
WTO	World Trade Organization

Chapter I

Introduction

The single market must not be endangered by real exchange-rate misalignments, or by excessive nominal exchange-rate fluctuations between the euro and the other EU currencies, which would disrupt trade flows between member states.
(Resolution of the European Council; 16 June 1997)

Since the breakdown of the Bretton-Woods system of fixed exchange rates, the volatility of exchange rates among countries has increased.[1] Conventional wisdom views that excessive exchange rate volatility could have a negative impact on international trade directly by increasing the riskiness of trading activity and indirectly through its impact on the optimal allocation of resources (Côte, 1994). The presumption of a negative nexus between exchange rate volatility and trade is an argument routinely used by proponents of managed or fixed exchange rates. This argument has also been reflected in the establishment of the European Monetary Union, as one of the stated purposes of EMU is to reduce exchange rate uncertainty in order to promote intra-EU trade and investment (EEC Commission, 1990).

[1] Flood and Rose (1999) and Frömmel and Menkhoff (2003) empirically examine the volatility of major floating exchange rates for the period from 1973 to 1998 and find evidence of increasing volatility for most currencies.

Given the fact that understanding the impact of exchange rate volatility on international trade is important for a country's exchange rate and trade policies, this issue has attracted a large number of theoretical and empirical studies. However, extant theoretical propositions and empirical evidence regarding the impact of exchange rate volatility on trade are far from conclusive. A comprehensive survey of the literature by McKenzie (1999) concludes that exchange rate volatility may impact differently on different markets and calls for further tests using export market specific data. According to a recent survey by Bahmani-Oskooee and Hegerty (2007), this conclusion is still pertinent. This implies that exchange rate volatility may have different impact on different country groups, different development stages and different types of exports.

This thesis empirically examines the impact of exchange rate volatility on the exports of five emerging East and South East Asian economies; China, Indonesia, Malaysia, the Philippines and Thailand.[2] Despite the fact that there have been a large number of empirical studies which examine the impact of exchange rate volatility on exports, no single paper focuses on emerging East Asian economies. Therefore, this study intends to fill this gap in the literature.

The main objective of the thesis is to understand the impact of real exchange rate volatility on the exports of the five emerging East Asian countries. There are three important issues why the impact of exchange rate volatility on exports is important for this group of countries. First of all, these countries rely

[2] Indonesia, Malaysia, the Philippines and Thailand are members of the Association of Southeast Asian Nations (ASEAN). Throughout the thesis, these sample countries plus China will be referred to as emerging East Asia economies.

heavily on exports for their economic growth. Recently, Asian Development Bank remarked that trade will play a prominent role in East Asia's medium-term outlook and longer-term development prospects (Asia Development Bank, 2006). Therefore, an understanding of the degree to which exchange rate volatility affects their export activity is important for setting the optimal exchange rate policy in emerging East Asian countries.

Secondly, the countries under consideration are the main members of the impending ASEAN-China Free Trade Area (ACFTA), and the options for a closer monetary integration including proposals for the eventual formation of a currency union within the region are currently an active area of research and policy debate.[3] Since these countries are at the early stage of the process of regional integration, understanding the direction and extent of the impact of exchange rate volatility on their bilateral trade becomes an important issue. If the bilateral-exchange rate volatility among these countries has a negative impact on their bilateral trade, attempting to promote the regional trade without considering the stabilization of their bilateral exchange rates will be fruitless. The results of this thesis should in particular inform this ongoing debate by providing a vital piece of missing evidence for the evaluation of their regional integration and exchange rate policy options.

Finally, the recent trend of globalisation has led to financial sector reform in the emerging East Asian economies (for example, China's domestic banking sector reform after the accession to the World Trade Organization). As a result of

[3] See e.g. Kwack (2005), Eichengreen (2006), Huang and Guo (2006), Kim (2007).

the reform process, the financial sector of emerging East Asian economies emerged to be generally more developed and mature than before. There are theoretical propositions which suggest that a high degree of financial sector development may dampen the adverse impact of exchange rate volatility by facilitating the trading, hedging, diversifying and pooling risk. Under such circumstances, the understanding of the role of financial sector development on the relationship between exchange rate volatility and exports has been an important research agenda for these economies.

In terms of scope and methodology, this thesis extends the previous literature in several important aspects. First and foremost, this study is the first to investigate the relationship between exchange rate volatility and bilateral trade flows of emerging East Asia countries by utilizing a panel data set comprising 25 years of quarterly data. There are previous empirical studies that focus on the impact of exchange rate volatility on the exports of developing countries (for example, Caballero and Corbo, 1989; Arize *et al.*, 2000: Dognalar, 2002), but not specifically on the emerging East Asian countries nor in the bilateral context.

Secondly, recognizing the specificity of the exports of the sample countries which is different from those of industrialised countries this study employs an augmented generalised gravity model instead of a pure gravity model. The use of the generalised gravity model helps to overcome potential misspecification problems which may arise as a result of employing a pure gravity model to analyse the trade patterns of emerging economies.

Thirdly, this study is the first to utilise the recently developed panel unit-root and cointegration tests to verify the existence of a long-run stationary relationship between real exports and exchange-rate volatility. None of the previous panel data studies on the current issue have conducted panel unit-root and cointegration tests. Therefore, the previous panel data studies are subject to the problem of spurious regression and the existence of the long-run relationship between bilateral exchange rate volatility and exports in these studies is questionable.

Finally, this is the first study that examines the role of financial sector development on the trade effects of exchange rate volatility. So far the majority of empirical studies which investigate the impact of exchange rate volatility on exports explicitly or implicitly assume that the relationship between exchange rate volatility and exports is linear. In contrast, this study also examines the presence of a nonlinear effect of exchange rate volatility on exports; that is the impact of exchange rate volatility is more negative for a country with low level of financial sector development. This is particularly important for an emerging economy like China, which is currently receiving intense international criticism for its inflexible exchange rate system. If the impact of exchange rate volatility is more intense for a country with a low level of financial development, China should first speed up its financial sector reform before adapting a more flexible exchange rate, which will effectively lead to an increase in exchange rate volatility.

The rest of the chapter is organized as follows. The importance of exports as a driving force of the economic growth in the emerging East Asia economies is presented in Section 1.1. Section 1.2 discusses the recent trend and developments related to the emerging East Asian economies and the issues related to their regional integration. The structure of exports and exchange rate arrangements of the sample countries are presented in Section 1.3. The role of financial sector development in the relationship between exchange rate volatility and exports is discussed in section 1.4. Finally, Section 1.5 presents the structure and organization of the thesis.

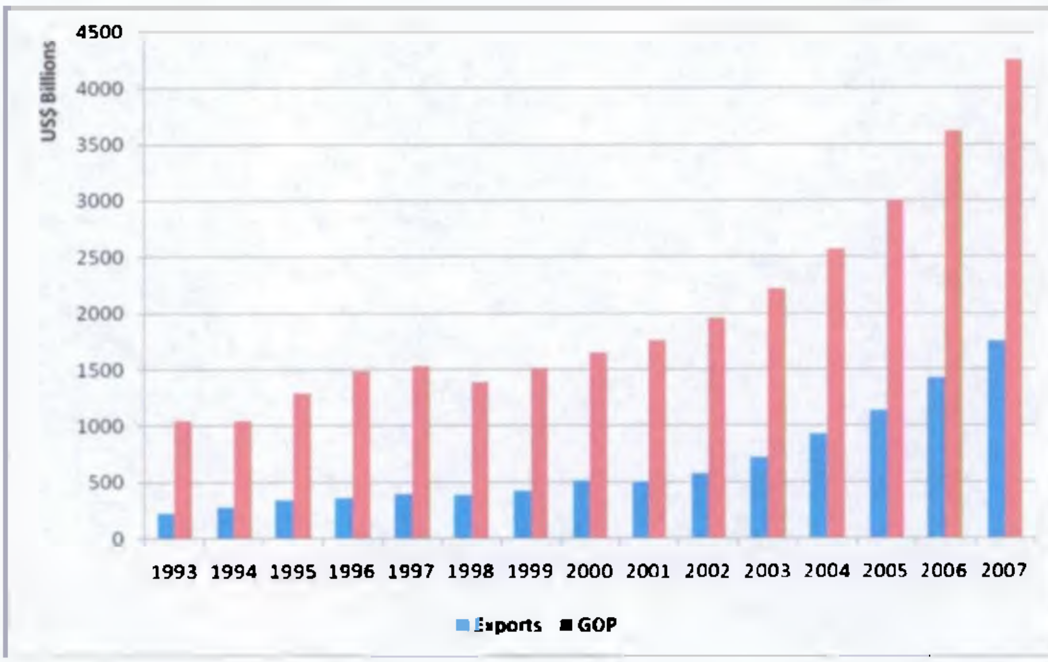
1.1 The importance of exports as a driving force of economic growth

Following the success stories of Japan and South Korea, emerging East Asian economies adopted export-oriented policies in the mid-1980s and early 1990s in order to pursue the path of trade-led industrial growth. By the mid-1980s, Malaysia, the Philippines and Thailand started exporting electrical and non-electrical machineries and other more sophisticated products. Then, China and Indonesia emerged as fast-growing exporters of labour-intensive manufactured goods in the late 1980s and early 1990s. Figure 1.1 illustrates the evolutions of exports and GDP of emerging East Asia economies. The importance of export promotion as a catalyst for economic growth of emerging East Asia economies is reflected in the following remark of the Asia Development Bank.

"International trade provided an environment conducive to rapid industrial growth and transformation of the predominantly agricultural economies of East and Southeast Asia into modern industrial economies in a

remarkably short period of time by historical standards." (Asian Development Bank, 2007b, pp. 83)

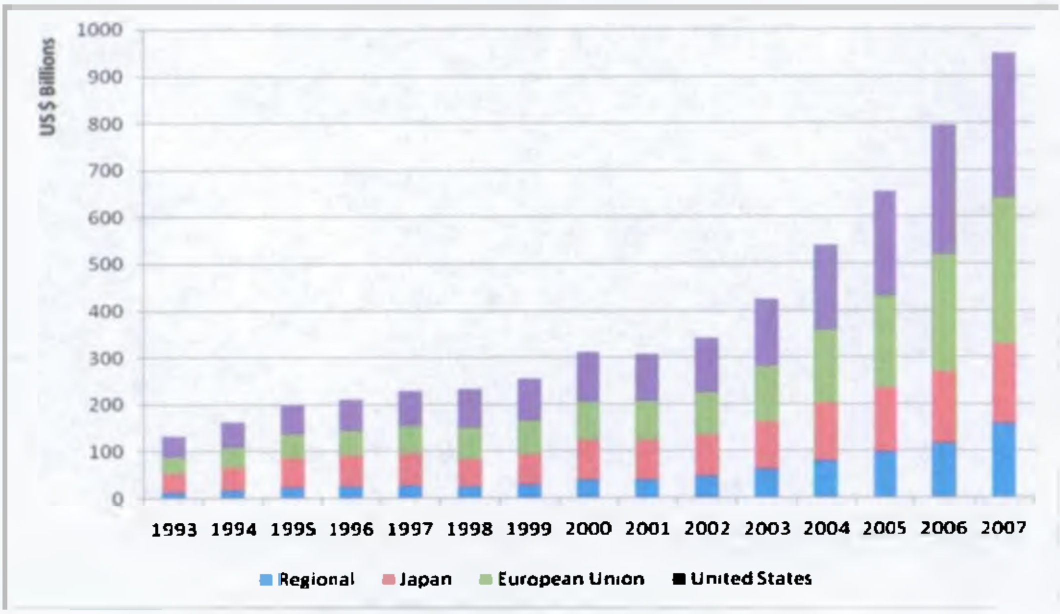
Figure 1.1: The evolution of exports and GDP of emerging East Asia



Source: The Direction of Trade Statistics and International Financial Statistics

As a result of the policies aimed at export promotion and regional integration, emerging East Asia has seen a phenomenal upsurge in their exports. Figure 1.1 shows that the value of the exports of emerging East Asian economies has increased almost nine fold in the past 15 years; from 200 billion US dollars in 1993 to almost 1.8 trillion in 2007. One remarkable feature is that these countries do not rely on a particular major export market. Exports to three major destinations; the United States, the EU and Japan, as well as bilateral exports among them have a similar upward trend (See figure 1.2).

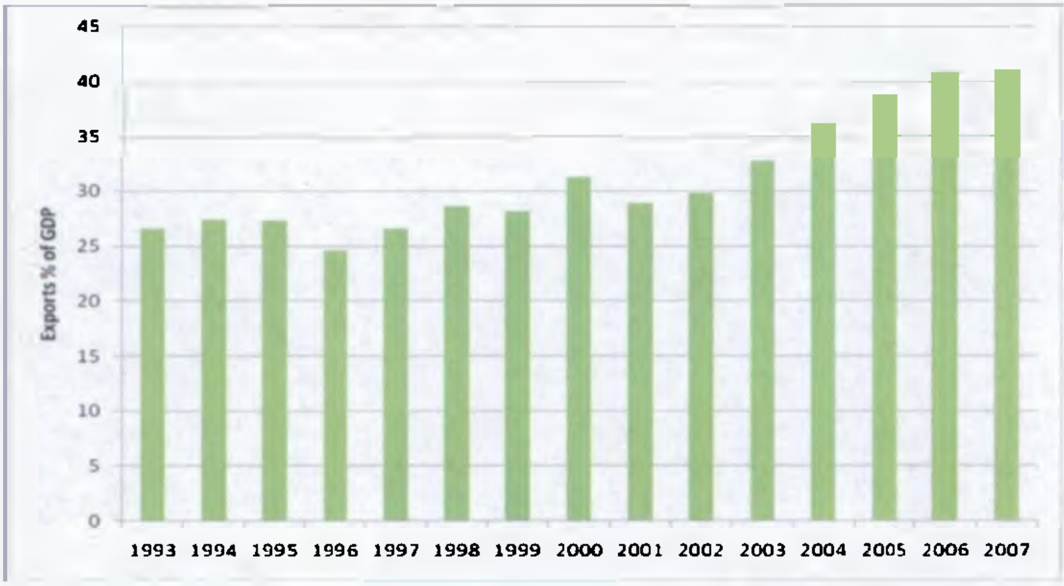
Figure 1.2: Exports of emerging East Asia to major markets



Source: The Direction of Trade Statistics

It would be difficult to conclude that export promotion alone can initiate and grant a sustainable economic growth, but evidence presented in figure 1.3 suggests that trade liberalization has been an important element among the factors that has helped boost productivity and growth in emerging East Asia. A high ratio of exports to the GDP demonstrates a key message that emerging East Asia has a strong interest in promoting their exports as they have been relying on trade openness for their road to prosperity. In 2006, net exports contributed 16% of GDP growth of the sample countries. Since exports are major driving force for their economic growth and development, the knowledge of the degree to which exchange rate volatility affects the export flows has become an important issue for the design of exchange rate and trade policies.

Figure 1.3: Ratio of exports to GDP of the five emerging East Asian economies



Source: World Development Indicators

1.2 Recent trend of globalisation and regionalisation of emerging East Asia

1.2.1 Globalisation and emerging East Asia

As the process of globalisation has intensified the world has seen a gradual removing of tariff and non-tariff barriers among the countries. One of the examples is China's accession to the World Trade Organization (WTO) in

November 2001 which can be seen as one of the outcomes of globalisation. Against this background, the World Bank estimates that East Asia would benefit more than any other region from global liberalisation because of the potential shown by its dynamic exporters. The World Bank estimates the potential gains to the region from global liberalisation could reach to hundreds of billions of U.S. dollars by 2015 (Krumm and Kharas, 2003).

As pointed out by Clark *et al.* (2004), globalisation has also led to not only the liberalisation of trade but also the liberalisation of capital flows among the countries and the associated rise in movements of cross-border financial transactions. Clark *et al.* (2004) warned that the extent and diversity of cross-border financial transactions have clearly intensified the magnitude of exchange rate volatility in those countries with underdeveloped capital markets and where there is lack of stable economic policies. The extreme volatility of the currencies of emerging East Asia countries during the Asian financial crisis in 1997 was a notable evidence of this phenomenon.

In addition, the current and potential transition of exchange rate arrangements in emerging East Asia, especially in China, has led to the adoption of a more flexible exchange rate arrangement. On July 21 2005, China revalued its currency by 2.1 percent, changing the current exchange rate from 8.28 to 8.11 per U.S. dollar. The Yuan's dollar peg was abandoned in favour of a managed float against a basket of currencies. This flexibility of Chinese currency is predicted to lead to an increase in fluctuations over time (Bénassy-Quéré and

Lahrèche-Révil, 2003). Under such circumstances, the currencies of emerging East Asian currencies are likely to be more volatile in the future.

On the other hand, the globalisation process has led to financial sector reform in the emerging East Asian economies. Clark *et al.* (2004) notes that the proliferation of direct and indirect hedging instruments associated with financial sector liberalisation could reduce firms' vulnerability to the risks arising from exchange rate volatility. On balance, it is not clear whether the changes in economic condition and financial structure brought about by the current globalisation process have led to reduce or intensify the impact of exchange rate volatility on the exports of emerging East Asian countries.

1.2.2 Regional integration: ASEAN-China Free Trade Area

Along with globalisation, today's world is witnessing the emergence of a new form of regionalism. In the age of new regionalism, China's importance in East Asian region is growing with its strong economic growth. The increasing significance of the role of China in the global economy has signalled two emerging and polarized attitudes for the other emerging East Asian countries. The first view is the attitude of the 'China's threat'. In their preliminary study, Zhang and Zhang (2005) found that the expansion of China's share in the world manufacturing goods market led to a slow-down in the growth of some ASEAN countries. In contrast, second point of view is that China's rapid growth is an 'opportunity' for the East Asian countries. As China has become a regional manufacturing base for consumer's goods, it imports more and more intermediate goods from the Asian trading partners (Story, 2005).

All of five emerging East Asia countries except China experienced the damaging effects of 1997 financial crisis. The crisis highlighted the economic interdependence of the region and prompted policy makers from East Asia to explore options for regional cooperation in trade and investment, monetary cooperation and macroeconomic policy coordination (Pangestu and Gooptu, 2003). In order to circumvent the attitude of 'China's threat' and to enhance mutual interests and interdependence, ASEAN-China Free Trade Area (ACFTA) was formed in November 2004. ACFTA aims at forging closer economic relations between China and ASEAN through lowering of trade and investment barriers and through joint technical and economic cooperation projects.

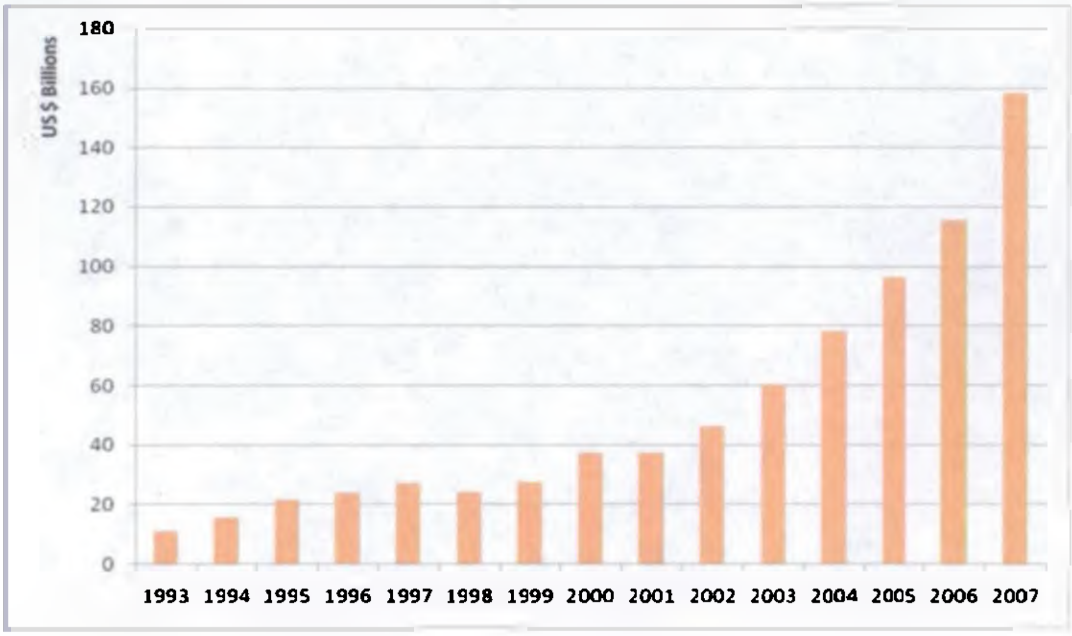
According to the agreement, tariffs will be reduced to zero for the most products by 2010 to enhance economic cooperation and to promote trade in goods, services and investment.[4] ACFTA will create an economic region with 1.7 billion consumers, a regional Gross Domestic Product (GDP) of about US$ 4 trillion and total trade estimated at US$1.23 trillion. This makes it the biggest free tare area in the world in terms of population size. A simulations study conducted by the ASEAN Secretariat suggests that ACFTA will increase ASEAN's exports to China by 48 per cent and China's exports to ASEAN by 55.1 percent. The FTA will increase ASEAN's GDP by 0.9 percent or by US$5.4 billion while China's

[4] ACFTA will be effective for newer ASEAN member states (Cambodia, Lao, Myanmar, and Vietnam) by 2015.

real GDP expands by 0.3 percent or by US 2.2 billion in absolute terms (Cordenillo, 2005).

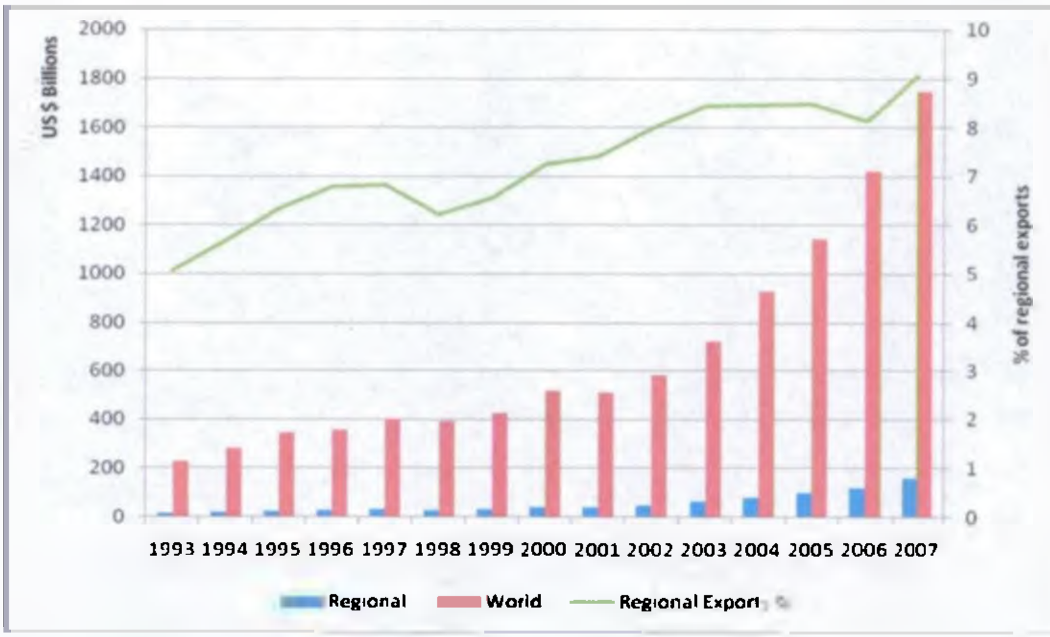
As shown in figure 1.4, bilateral exports among five emerging East Asian economies have grown faster than their exports to other major export markets. Bilateral trade among the sample emerging East Asian economies now makes up 9 percent of their total exports (See Figure 1.5). Against this background, analysts from the World Bank estimate that East Asia could achieve much of the benefits of the global liberalisation through regional integration because of the complementarity of production and exports among very diverse economies (World Bank, 2002).

Figure 1.4: Intra-regional exports



Source: World Development Indicators

Figure 1.5: Intra-regional exports versus total exports

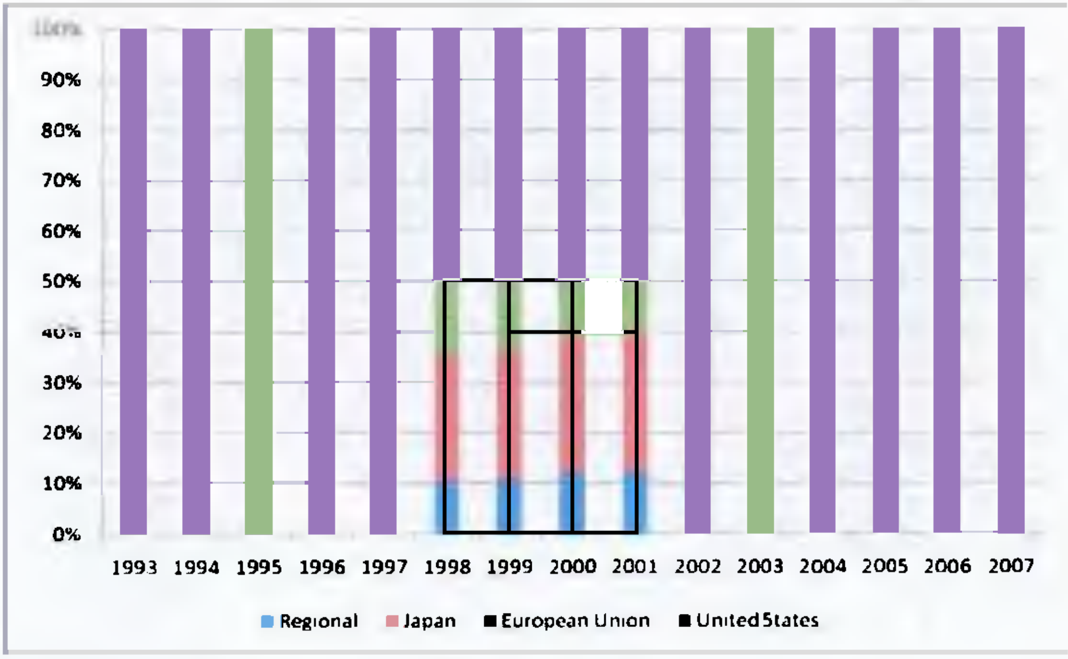


Source: Direction of Trade Statistics

Since July 2005, fewer tariff and non-tariff barriers for selected products have been in effect under the 'Early Harvest Programme'.[5] As a result, bilateral trade among the sample countries increased 19 percent from 49 billion dollars in the first half of 2005 to 58.47 billion dollars in the second half of 2005. Amid ongoing reductions in tariffs and increasing complementarity among the East Asian economies, bilateral trade among these countries has reached 158.1 billion dollars in 2007. It was a staggering increase of almost 47 percent compared with the 107.5 billion dollars in 2005. Figure 1.6 shows that intraregional trade among the emerging East Asia has grown faster than trade with any other market.

[5] Early Harvest Programme products are livestock, dairy, fish and agricultural produces that fall under the Chapters 01 to 08 of the Harmonised System Codes (HS Codes) of commodity classification.

Figure 1.6: Exports to major markets



Source: Direction of Trade Statistics

However, removing tariff and non-tariff barriers alone cannot guarantee to achieve their attempted trade promotion and regional integration. There are other issues that can hinder the trade promotion and regional integration process. One of these issues is the impact of exchange rate volatility on trade. Under such circumstances, the understanding of the degree to which exchange rate volatility affects regional trade flows and overall exports of emerging East Asia economies becomes an important issue not only for the design of exchange rate and trade policies, but also for their attempts of regional integration.

1.3 Current exchange rate arrangements and the pattern of exports

According to the classification of the IMF (as of July 31, 2006), the exchange rate arrangements of the sample countries range from a fixed peg arrangement of China to an independent floating regime of Indonesia and the Philippines (IMF, 2006).[6] During 1982 to 2006, the exchange rate arrangement of each country also varied from time to time. However, it is important to note that managed or pegged exchange rate regimes do not necessarily reduce the volatility of exchange rate. As pointed out by Clark *et al.* (2004), pegging to one currency still leaves an economy exposed to fluctuations in the anchor currency against other currencies. In addition, a pegged or managed exchange rate arrangement could also lead to large discrete changes in currency value, when the arrangement becomes misaligned (Engel and Hakkio, 1993).

Emerging East Asian countries, especially members of ASEAN, have long seen the value of cooperation in order to promote stability and economic growth within the region. Since the 1997 financial crisis, East Asian economies have accelerated their cooperation in the financial sector and macroeconomic management. As economies expand and become integrated, these nations have changed their focus towards implementing the measures that would limit the susceptibility of their economies to another financial crisis while strengthening the region's economic solidarity. The policymakers from these countries are

[6] On July 21, 2005, China shifted its exchange rate arrangement from a fixed peg to allow the value of the Yuan to fluctuate based on market supply and demand with reference to an undisclosed basket of currencies. However, the fluctuation in the Yuan-U.S dollar exchange rate was less than the 2% range (for a three-month period) used in the IMF's de facto exchange rate classification system as an indicator for a conventional fixed peg exchange rate arrangement.

considering the policy options for closer monetary integration including proposals for the eventual formation of a currency union within the region (Kawai and Akiyama, 2000; Ngiam and Yuen, 2001).

Although it seems unlikely that, at least in the foreseeable future, the EU style monetary integration will be materialised, East Asia regional integration has reached, for the moment, the phase of free trade area with some form of monetary arrangements for exchange rate stability. As Pangestu and Gooptu (2003) stated, the focus of the policymakers of emerging East Asia economies is now on stabilizing their currencies. Therefore, in order to justify their efforts of monetary and exchange rate policy coordination to stabilize their exchange rates, the assessment of the degree to which exchange rate volatility affects the bilateral trade flows of ACFTA countries has also become an important issue.

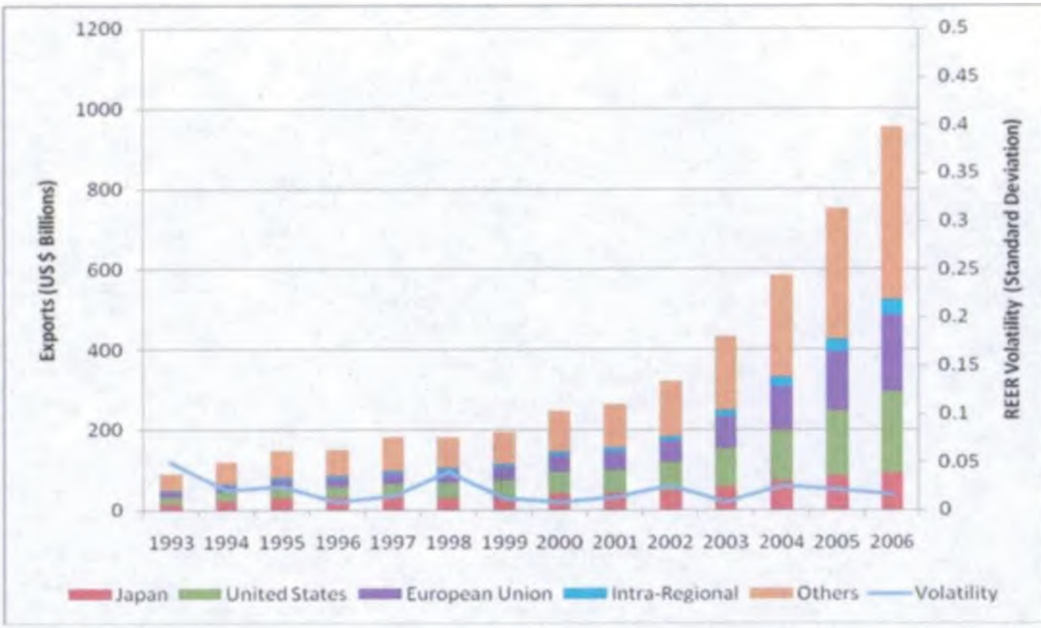
1.3.1 China's exchange rate arrangement and the patterns of exports

China appears to be an exception amongst emerging East Asia economies, which have been hit by the 1997 financial crisis. China pegged its currency, Yuan, to the US dollar until recently. However, the entry of China into the WTO and the accumulation of foreign exchange reserves have created intense international pressure on the Chinese government to revalue its currency. As a result, China revalued its currency by 2.1 percent, changing the current exchange rate from 8.28 to 8.11 per U.S. dollar on July 21, 2005. The Yuan's dollar peg was abandoned in favour of a managed float against a basket of currencies and Chinese currency would now be allowed to fluctuate up to 0.3% plus or minus the central rate against the US dollar each day. This reform is intended for a more flexible exchange rate which based on market condition with reference to a basket of currencies in the medium and long-term. However, Figure 1.7 demonstrates that even a managed exchange rate like that of China is not immune to the fluctuations to a certain extent. Moreover, it is very likely that the shift of the exchange rate arrangement from a fixed peg to a managed float regime will effectively lead to an increase in exchange rate volatility over time.[7]

China's economy has changed from a closed centrally planned system to a more market-oriented economy since the 1970s. China has rapidly expanded its exports, which has increased 18.5 percent per annum on average since the 1990s. The accession of China to the World Trade Organization (WTO) in November 2001 has been one of the major factors behind this phenomenal increase in exports. It is obvious that China's WTO accession has had an enormous impact on both China and the world trading system. In 2007, China's exports have reached a milestone of 1.2 trillion US dollars in nominal terms. It is a staggering increase compared with only 267 billion dollars in 2001. The importance of international trade for China's economic growth is demonstrated by continued contribution of net exports to the Chinese economic growth. In 2006, China's GDP grew by 10.7 percent, a 10-year high and a fourth year of double-digit growth; net exports contributed 2.25 percentage points, or 23% of total GDP growth.

[7] Aghion *et al.* (2008) notes that switching from fixed to flexible exchange rate regime could lead to 50% increase in exchange rate volatility.

Figure 1.7: Exchange rate volatility and exports of China



Sources: International Financial Statistics; Direction of Trade Statistics

Martin *et al.* (2003) point out that this phenomenal upsurge in China's exports associated with its WTO accession and deeper integration into the world economy has created important opportunities for other emerging East Asian economies to benefit, both as suppliers of exports to this rapidly-growing market, and as importers of lower-priced and higher quality products. For these reasons, economists from the World Bank labelled China as an important driver of change in East Asia (Ianchovichina, *et al.*, 2003). Even if China still exports most of its products to the United States and the EU (21 percent and 19.6 percent respectively in 2006), the share of exports to emerging East Asia is increasing. In 2003, China's exports to Indonesia, Malaysia, the Philippines and Thailand were only 2.6 percent of total exports. In 2006, it reached 4 percent (see Figure 1.7).

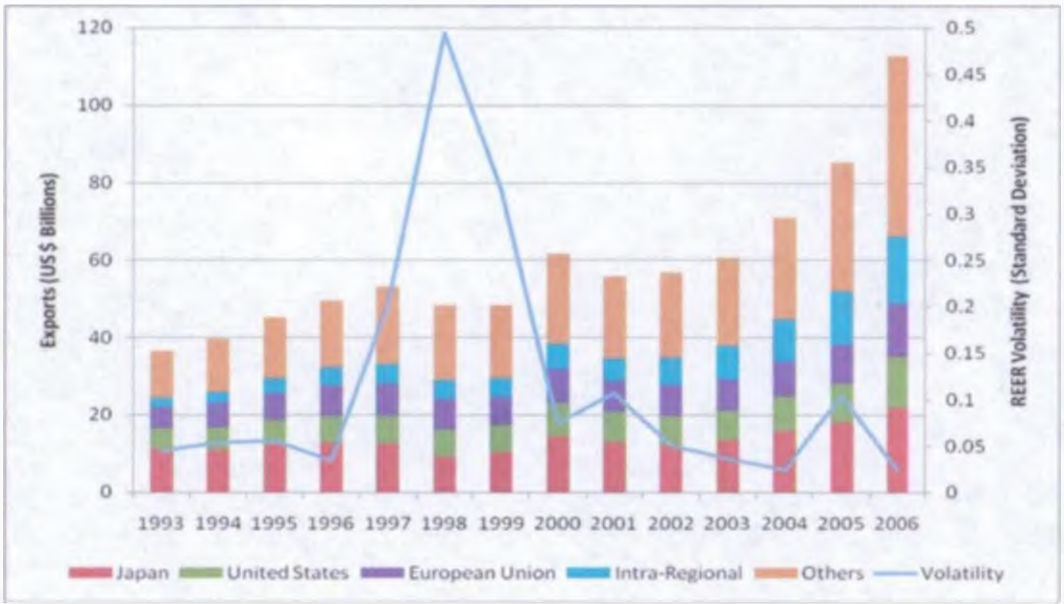
1.3.2 Indonesia's exchange rate arrangement and the patterns of exports

According to the de facto classification of the IMF, Indonesia is supposed to be pursuing an independently floating exchange rate regime with monetary policy anchored by a monetary aggregate target (IMF, 2006). However, in terms of actual implementation of the monetary cum-exchange rate policy, Park and Yang (2006) point out that the behaviour of both the nominal and real effective exchange rates of Indonesia indicate its currency is linked to a basket of major currencies. As shown in figure 1.9, pegging to a basket of major currencies still leaves Indonesian currency exposed to fluctuations in the anchor currency against other currencies. During the 1997 crisis period, Indonesia experienced a very volatile exchange rate. Between June 1997 and September 1998, Indonesia's currency depreciated 77.7 percent in nominal terms and 56.3 percent in real terms.

Indonesia has been undergoing significant economic reforms since 2004. In 2006, Indonesian economy grew by 5.5 percent. Net exports also made a contribution of 5.5 percent to overall economic growth. In 2006, export values surged by 16% and export earnings accounted for 30% of the GDP, supported by buoyant world trade and high global prices for Indonesia's commodities such as crude oil, natural gas, minerals, and palm oil. Although the US and Japan has been its major trading partner, a high proportion of Indonesian exports are now redestined to emerging East Asian countries. Since 2004, Indonesia's exports to emarging East Asian markets has surpassed its exports to the US and EU markets (Figure 1.8). As a member of the ASEAN-China free trade area, Indonesian exports benefit significantly from the lower tariff and non-tariff barriers of the

"Early Harvest" programme which have been in effect since 1 July 2005.[8] In addition, China's high demand for commodities such as rubber and palm oil leads to a boom in Indonesian exports to China.

Figure 1.8: Exchange rate volatility and exports of Indonesia



Sources: International Financial Statistics; Direction of Trade Statistics

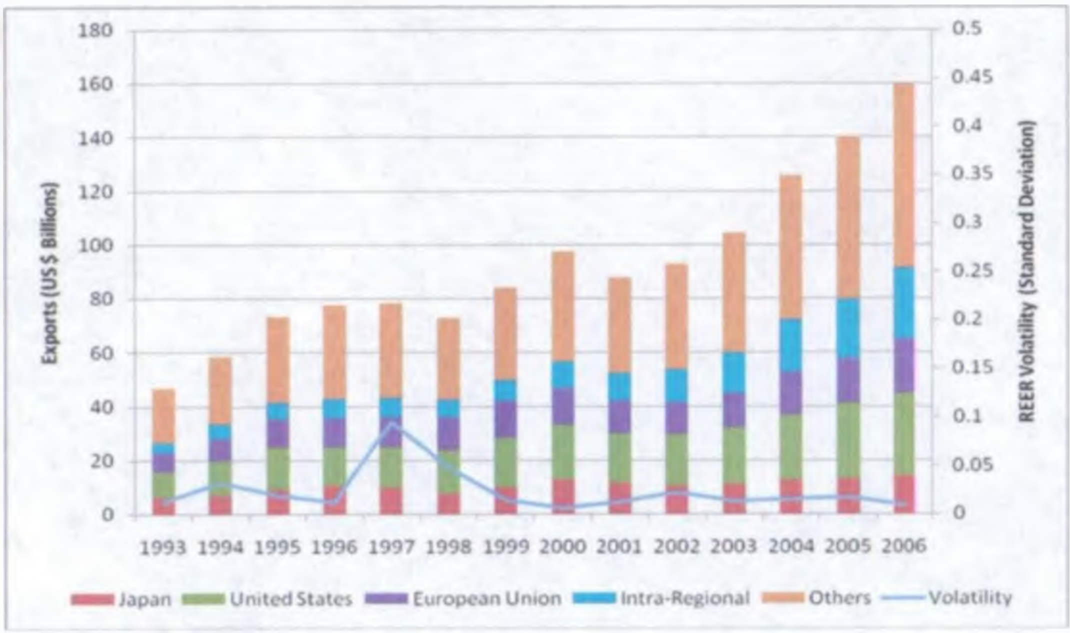
1.3.3 Malaysia's exchange rate arrangement and the patterns of exports

Malaysia adopted a flexible exchange rate regime before the 1997 financial crisis. During the crisis, the Malaysian Ringgit depreciated 34 percent against the US dollar. This decrease in the value has led the Ringgit to be pegged to the US dollar after the crisis. And then, in 2005 the exchange rate arrangement of Malaysia has shifted to a managed floating with no pre-determined path for the exchange rate

[8] See footnote 5.

again. Since then, the Malaysian Ringgit appreciated 6 percent per year against the dollar in 2006-07. Asian Development Bank (2007a) commented that the credibility of the Malaysian monetary authorities has improved because of the smooth shift to a managed floating regime and the steady appreciation of Ringgit against the US dollar. It reduced the possibility of sudden currency realignments, which might lead to high exchange rate volatility. This is evident in figure 1.9 as the real effective exchange rate was relatively less volatile after the crisis.

Figure 1.9: Exchange rate volatility and exports of Malaysia



Sources: International Financial Statistics; Direction of Trade Statistics

Malaysia has transformed itself since the 1970s from an economy which relied on production of raw materials and commodities into an emerging multi-sector economy. In 2006, Malaysia's economy grew by 5.9 percent. Total exports, supported by strong growth in electronic and electrical goods and rising prices for oil, gas, and some agricultural products, still exceeded imports. The total export value of Malaysia is 110% of its GDP in 2006. As a member of ACFTA, Malaysia's exports have also been positively affected by China's WTO accession. As shown in figure 1.9, Malaysia has become an important trading partner for other emerging East Asian economies. In 2007, Malaysia's exports to emerging East Asia reached US$ 32 billion. In comparison, the value of exports to the US and the EU were US$ 22 billion and US$ 27 billion, respectively.

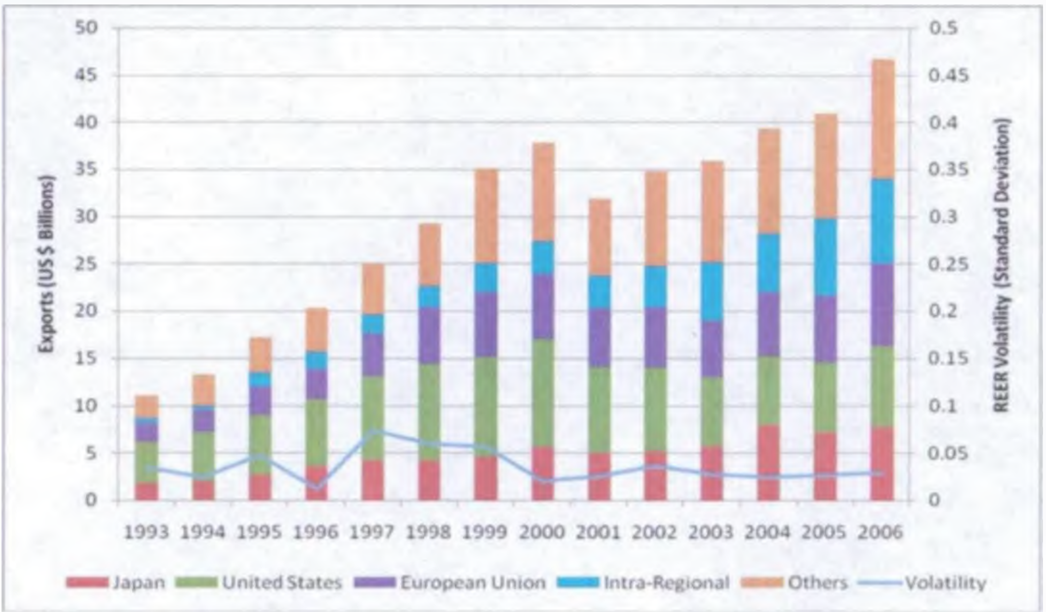
1.3.4 Philippines's exchange rate arrangement and the patterns of exports

During the 1997 financial crisis period, the Philippines experienced a rapid fall in its currency value against the US dollar. Between June 1997 and September 1998, the Philippines Peso depreciated 38.3 percent in nominal terms and 26.3 percent in real terms. Figure 1.10 demonstrates the increase in exchange rate volatility during that period. According to the IMF's classification, the Philippines has been implementing an independently floating exchange rate regime with monetary policy anchored by an inflation target (IMF, 2006). However, Park and Yang (2006) suggest that, according to the behaviour of both the nominal and real effective exchange rates of the Philippines, the Philippines Peso appears to be linked to a basket of major currencies.

The Philippines economy grew by 5.4% in 2006; personal consumption expenditures and net exports were the main contributors. Large remittances from the millions of Filipinos who work abroad – $12.8 billion (11.0 percent of GDP) –

have played an important role in the growth of personal consumption expenditure. Net exports contributed 18 percent to GDP growth. The exports of the Philippines continued to perform well as a result of robust demand from extemal markets. Almost a fifth of the Philippines' exports are now oriented to emerging East Asian market (Figure 1.10). This proportion is expected to grow along with China's WTO accession and the reduction of tariffs and non-tariff barriers resulting from the ACFTA. lanchovichina *et al.* (2003) point out that the Philippines is well positioned to increase production of food and feed grains, cottons, sugar, vegetables, and fruits in response to growing demand from China after WTO accession.

Figure 1.10: Exchange rate volatility and exports of the Philippines

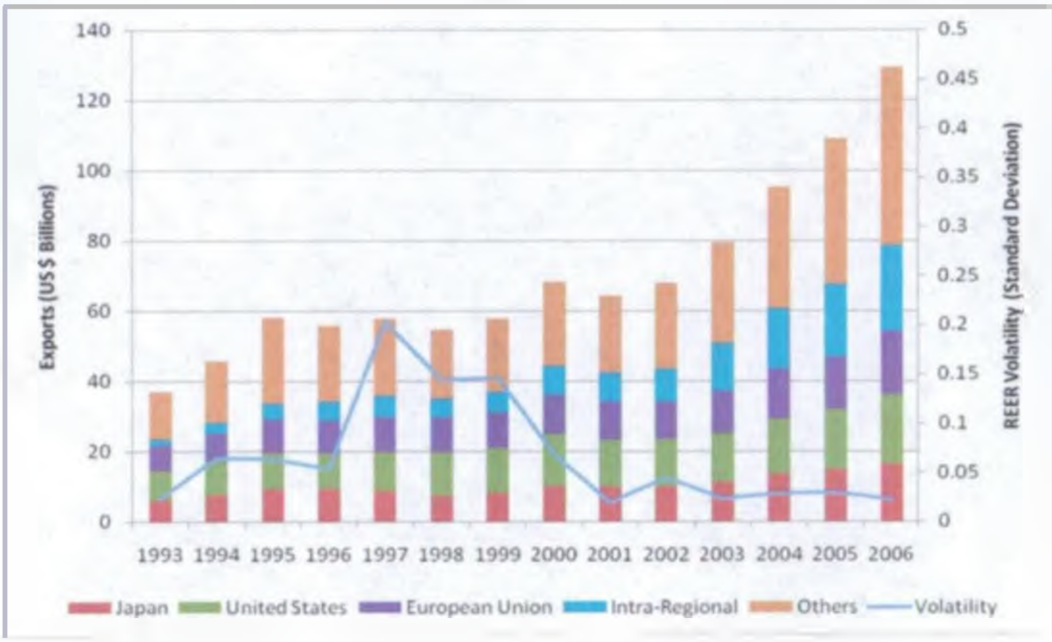


Sources: International Financial Statistics; Direction of Trade Statistics

1.3.5 Thailand's exchange rate arrangement and the patterns of exports

Before the 1997 Asian financial crisis, Thailand's exchange rate regime was a pegged system that allowed a small movement of the exchange rate within a band. In July 1997 Thailand devalued its currency and this devaluation ignited the Asian currency crisis which spread rapidly to other countries. Between June 1997 and September 1998, Thailand's currency depreciated 36 percent in nominal terms and 19 percent in real terms. The high volatility of the real effective exchange rate between 1997 and 1999 is evident in figure 1.11. However, after the year 2000, the volatility of real effective exchange rate has decreased. Since July 1997, Thailand has adopted a managed floating exchange rate regime with monetary policy anchored by an inflation target (IMF, 2006).

Figure 1.11: Exchange rate volatility and exports of Thailand



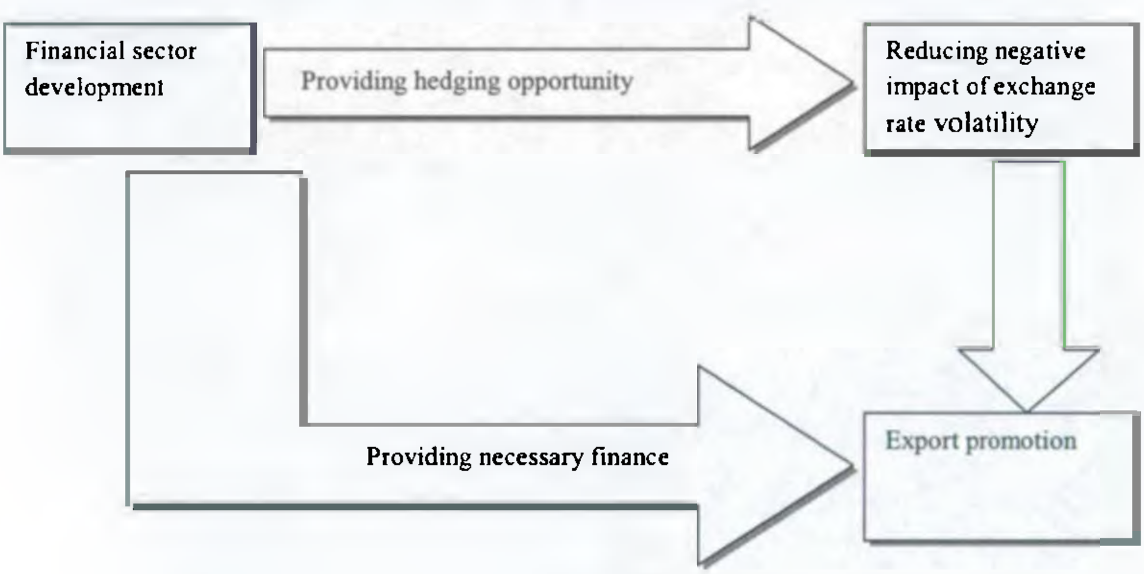
Sources: International Financial Statistics; Direction of Trade Statistics

Driven by a strong export growth, Thailand's economy grew 5% in 2006. Net exports of goods and services contributed 26% of the overall GDP expansion. Thailand has pursued preferential trade agreements with a variety of partners in an effort to boost its exports. As a result of strong demand from foreign markets and high prices for commodity exports, including natural rubber and rice, exports grew by a nominal 18.5 percent. Thailand's exports to emerging East Asia region will continue growing. It increased from 11 percent in 2000 to over 18 percent in 2006 as a result of the ASEAN-China free trade agreements by which quantitative restrictions has been lifted. Since 2004, intra-regional exports have overtaken the exports to the US market and the EU market.

1.4 The role of financial sector development and exports

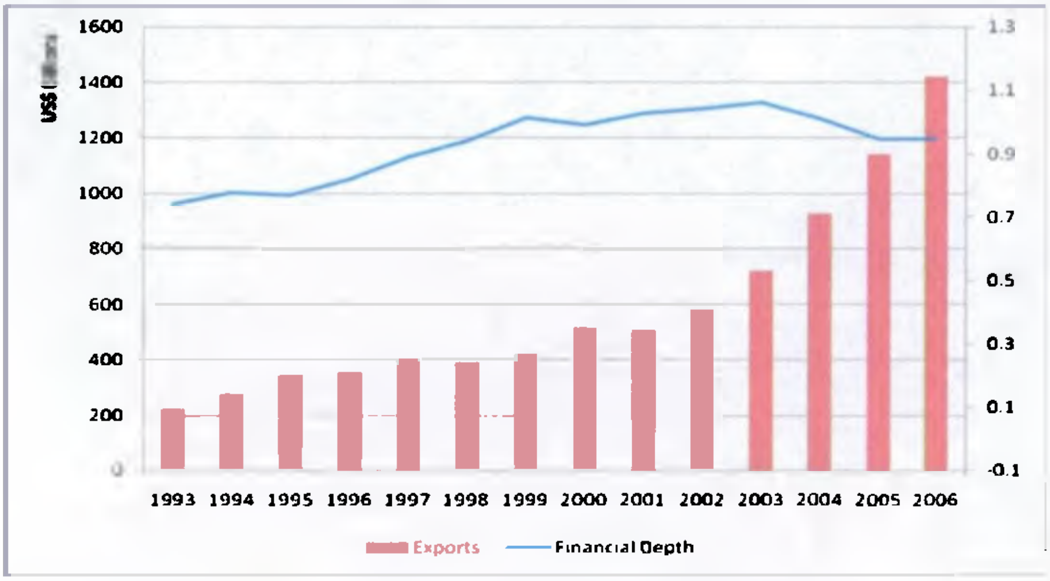
As discussed in the section 1.2, the globalisation process has led to financial sector reform in the emerging East Asian economy. As a result of the reform process, the financial sector of emerging East Asian economies has become generally more developed and mature than before (IMF, 2008). A developed financial sector could help to mitigate the effect of exchange rate volatility on exports via two main mechanisms. The first mechanism in which a developed financial sector could mitigate the effect of exchange rate uncertainty is that a greater degree of financial sector development could provide more effective ways of transferring risks arising from exchange rate volatility. Merton and Bodie (1995) emphasize that one of the main functions of a financial system is to facilitate the trading, hedging, diversifying and pooling of risk. Secondly, a higher level of financial sector development can provide better access to finance for exporting firms so that they can withstand the adverse impact of exchange rate volatility. The direct and indirect impacts of financial sector development are expressed in Figure 1.12. Financial sector development can promote exports both indirectly by providing more effective ways of transferring risks to reduce the adverse impact of exchange rate volatility, and directly by providing better access to finance.

Figure 1.12: The direct and indirect impact of financial sector development



Although, there are numerous studies investigating the impact of exchange rate volatility on exports, there has been no attempt to examine the role of financial sector development in mitigating the risk of exchange rate uncertainty in emerging economies. Figure 1.13 demonstrates the relationship between financial sector development and exports of emerging East Asian economies.[9] The figure clearly demonstrates a positive relationship between exports and financial sector development although the correlation has gone the opposite way during the last three years. Clark *et al.* (2004) notes that the proliferation of direct and indirect hedging instruments, which progress in association with the reform of the financial sector, could reduce firms' vulnerability to the risks arising from volatile foreign exchange rate movements, but the authors do not empirically investigate the issue. Hence, there is an obvious gap in empirical literature and this study is the first to look at the role of financial sector development on the impact of exchange rate volatility on exports.

Figure 1.13: Exports and financial sector development of Emerging East Asia



Source: International Financial Statistics and Direction of Trade Statistics

[9] The level of financial sector development is measured by 'financial depth' – the ratio of liquid liabilities to GDP – which represents the overall size of the financial intermediary sector.

1.5 Structure of the thesis

This thesis empirically examines the impact of exchange rate volatility on the exports of five emerging East and South East Asian economies; China, Indonesia, Malaysia, the Philippines and Thailand. The remaining chapters of the thesis are organised as follows.

Chapter 2 surveys theoretical contributions to the literature on the relationship between exchange rate volatility and international trade flows. In general the theoretical proposition can be divided into two categories; partial equilibrium models and general equilibrium models. Earlier theoretical studies adopted a partial equilibrium framework which assumes exchange rate uncertainty as the only variable that changes and all other factors that might influence the level of trade remained constant. This framework focuses on the theory of risk and the sign of the impact of exchange rate uncertainty depends upon the underlying assumptions of a model. In contrast, recent literature follows the general equilibrium framework that takes into account the interaction of all major macroeconomic variables to provide a more complete picture of the relationship between exchange rate volatility and trade. However, it is obvious from the review that the effect of exchange rate volatility on trade is theoretically far from conclusive.

Chapter 3 reviews empirical studies on the relationship between exchange rate volatility and trade. Since the theoretical literature analysing the effect of exchange rate volatility on trade is far from conclusive, the nature and magnitude of the relationship between exchange rate volatility and trade becomes an empirical issue. However, although numerous studies have attempted to understand and quantify the effect of exchange rate volatility on trade, the survey of the empirical literature in Chapter 3 suggests that empirical findings are also sensitive to the choice of the proxy for exchange rate volatility, the underlying exchange rates, the type of trade flows, the choice of trade model and the estimation techniques.

By reviewing the extant empirical literature, it is possible to identify a suitable methodology to examine the impact of exchange rate volatility on the exports of emerging East Asian economies. Chapter 4 outlines the research methodology to be used in the empirical chapters. An empirical specification based on the generalised gravity model, the definition of variables and data source, and the methods of estimation of the thesis are presented in the chapter.

Chapter 5 empirically examines the effect of exchange rate volatility on the bilateral export flows of five emerging East Asian countries by using an augmented generalised gravity model. The impact of exchange rate volatility on the exports among the five East Asian countries as well as on export flows to 13 other industrialized countries is examined by using a panel data set of 85 cross-sectional observations for the period from 1982:Q1 to 2006:Q4. The principal contribution of this chapter is to provide new insights into the relationship between real exchange rate volatility and the exports of emerging East Asian economies which has not been examined in the extant empirical literature. The empirical estimations detect a statistically and economically significant negative impact of bilateral real exchange rate volatility on export volume of the five countries under study. These results are robust across different estimation techniques and seemingly do not depend on the variable chosen to proxy exchange rate uncertainty. Chapter 5 also investigates the impact of the level of competitiveness among the sample countries on the exports of emerging East Asia countries. The findings confirm that, for the sample countries, an increase in competitiveness relative to other countries has a positive impact on their exports. On the other hand, the 1997 Asian financial crisis led to a substantial decrease in the exports of the sample countries.

Chapter 6 examines the impact of exchange rate volatility on the bilateral exports among the sample five emerging East Asian economies. In this chapter the focus of the study shifts from the total exports to the intra-regional exports among the emerging East Asia countries. Since the sample countries are the main members of the newly formed ASEAN-China Free Trade Area (ACFTA), which aims at forging closer economic relations between China and ASEAN, understanding of the degree to which the bilateral exchange rate volatility affects their intra-regional exports is particularly important for their future exchange rate policies and regional integration process. The findings of the chapter provide evidence that exchange-rate volatility in emerging East Asia economies has a significant negative impact on their regional exports flows suggesting ACFTA countries should prioritise their exchange rate stabilisation policies along with trade liberalisation policies. Thus, the results of this chapter provide a valuable piece of evidence informing the ongoing debate and the evaluation of exchange rate and trade policy options for ACFTA countries.

Chapter 5 and 6 analyse the impact of exchange rate volatility on exports of the emerging East Asian economies assuming that the relationship is linear. In contrast, Chapter 7 investigates the possible nonlinearity of the impact of exchange rate volatility on exports. The aim of this chapter is to investigate the role of financial sector development on the relationship between exchange rate volatility and the exports of emerging East Asian countries. The findings of Chapter 7 suggest that the effect of exchange rate volatility on exports is conditional on the level of financial sector development: the more financially developed an economy, the less its exports are adversely affected by exchange rate volatility. The estimation results are consistent with the notion that financial sector development provides the mechanism for firms to mitigate the effects of exchange rate volatility and in so doing stimulates export growth.

Finally, Chapter 8 concludes the thesis by providing a summary of the findings. The contributions of the thesis to existing literature on the relationship between exchange rate volatility and exports are also presented. Then, the limitations of the study and some thoughts for future research are discussed in the chapter.

Chapter 2

Theoretical Aspects of the Relationship between Exchange Rate Volatility and Trade: Review of the Literature

2.1 Introduction

With the collapse of the fixed exchange rate system established at Bretton Woods, both real and nominal exchange rates have fluctuated widely. This volatility has often been cited by the proponents of managed or fixed exchange rates as detrimental to international trade. The argument is based on the fact that exchange rate uncertainty will depress the volume of international trade directly through uncertainty and adjustments costs, and indirectly through its effect on the allocation of resources and government policies (Côte, 1994). Exchange risk in this sense can be defined as future uncertainty arising from current volatility or variability of exchange rate. [10]

The negative hypothesis is based on the view that an increase in risk arising from exchange rate volatility will lead risk averse individuals to shift from risky activities to less risky ones. In addition, there could be an indirect impact of exchange rate volatility on trade through the effect of exchange rate volatility on the structure of output and on government policy. In line with this view, De Grauwe (1988) states that exchange rate movements not driven by fundamentals

[10] Exchange rate volatility and exchange rate uncertainty are used interchangeably in this review.

lead to misalignment problems which in turn lead to losses of employment and output in the countries with overvalued currencies. As a result of or to prevent these losses, affected countries will impose protectionist barriers that lead to decline in output and international trade.[11]

As in other areas of economics, there is an opposite view supporting the positive hypothesis that exchange rate volatility may lead to a greater volume of international trade. This view stems from the fact that an increase in exchange rate volatility creates profit opportunity for firms when they can protect themselves from negative effects by some form of hedging opportunities. Moreover, in the political economic point of view, exchange rate movements facilitate the adjustment of the balance of payments in an event of external shocks, and thus, reduce the use of trade restrictions and capital movement controls to achieve equilibrium, and this in turn encourages international trade (Brada and Méndez, 1988).

This chapter surveys theoretical contributions to the literature on the relationship between exchange rate volatility and international trade flows. The earlier studies adopt a partial equilibrium framework which focuses on the theory of risk and option. This framework assumes the exchange rate as the only variable that changes and all other factors that might influence the level or trade to remain constant. In contrast, recent literature uses the general equilibrium framework that takes into account the interaction of all major macroeconomic variables to provide a more complete picture of the relationship between exchange rate volatility and

[11] De Grauwe (1988) called this stream of literature 'political economy of exchange rate variability'.

trade. The remainder of the chapter proceeds as follows. Section 2.2 reviews the theoretical models of the impact of exchange rate volatility on trade flows in a partial equilibrium framework. Section 2.3 surveys the literature that utilizes general equilibrium models, and section 2.4 concludes.

2.2 Relationship between exchange rate volatility and trade: Partial equilibrium models

Since the collapse of the Bretton-Woods system of fixed-exchange rate, the relationship between exchange rate volatility and international trade has been a growing area of study. Earlier theoretical models are in the partial equilibrium framework which takes the exchange rate as the only variable that changes. All other factors that might influence the level of trade are assumed to remain constant. In this framework, the relationship between exchange rate volatility and level of trade depends on the attitudes toward risk, type of trader, market environment, existence of adjustment costs, availability of domestic market, and hedging opportunities.

Several models have shown that exchange rate volatility have adverse effect on international trade flows. In the simplest trade model, higher exchange rate volatility is expected to increase the uncertainty of profits from export sales in foreign currency. In this situation, risk-averse exporters will reduce their supply of exports. The adverse impact of exchange rate uncertainty increases with the degree of risk aversion.

Contrarily, some theoretical models have shown that an increase in exchange rate volatility may have a positive impact on the volume of international trade. These models focus on the profit opportunities created by greater exchange rate uncertainty. In these models, exporting can be seen as an 'option' that is exercised in favourable conditions. According to the option pricing theory, the value of an option increases when the variability of the underlying asset increases. In the same way, as exchange rate variability increases the probability of making a large profit increases. Therefore, an increase in exchange rate volatility may have a positive impact on the volume of international trade.

However, it is obvious that these unambiguous propositions are the results of restrictive assumptions on which different theoretical models are based. A summary of the selected partial equilibrium theoretical models are provided in table 2.1.

Table 2.1: Summary of selected partial equilibrium models

Study	Agent's risk attitudes	Type of trader	Market structure	Capital market	Adjustment costs	Domestic market	Impact on trade	Remarks
Clark (1973)	Risk averse	Exporter/ producer	Perfect competition	With limited maturity	No	No	negative	the production decision is made in advance of the realization of exchange rate
Ethier (1973)	Risk averse	Producer who import foreign input	Perfect competition	Yes	No	Yes	negative	The reduction of trade depends on the willingness to assume risk
Hooper and Kohlhagen (1978)	Risk averse	Importer and exporter	Perfect competition	Partly hedge	No	Yes	Negative if risk averse	The relative risk preference of agents, the currency denomination of contracts, and the proportion of forward hedging determine the impacts.

Table 2.1: Summary of selected partial equilibrium models (Contd.)

Study	Agent's risk attitudes	Type of trader	Market structure	Capital market	Adjustment costs	Domestic market	Impact on trade	Remarks
Kawai and Zilcha (1986)	Risk averse	Exporter/ producer	competitive	Forward and future	No	No	No impact with complete hedge. Negative when the hedge market is not complete.	No costs to hedge
Caballero and Corbo (1988)	Risk neutral	Producer/ exporter	Perfect competition	No	No	No	Positive with symmetric costs of capital adjustment.	When risk aversion and sunk costs are introduced, uncertainty has negative impact on exports.
De Grauwe (1988)	Risk averse	Producer	Perfect competition	No	No	Yes	Depend on degree of risk aversion	Positive impact if very risk averse. Negative if slightly risk averse

Table 2.1: Summary of selected partial equilibrium models (Contd.)

Study	Agent's risk attitudes	Type of trader	Market structure	Capital market	Adjustment costs	Domestic market	Impact on trade	Remarks
Dixit (1989)	Not depend on agent's risk attitude	Exporter	Perfect competition	No	Entry-exit	No	Positive	Extend the range of exchange rate within which exporting (non-exporting) firm stays in (out of) export market.
Franke (1991)	Risk neutral	Exporting firm	Monopolistic competition	No	Entry-exit	Yes	Positive	Real exchange is mean-reverting
Sercu (1992)	Risk neutral	Exports oriented and imports substitution	Perfect competition and monopoly	Yes	Tariffs	Yes	Positive in both market condition but not clear for intermediate market scenario	risk aversion does not affect the result

Table 2.1: Summary of selected partial equilibrium models (Contd.)

Study	Agent's risk attitudes	Type of trader	Market structure	Capital market	Adjustment costs	Domestic market	Impact on trade	Remarks
Sercu and Vanhulle (1992)	Risk averse	Exporting firm	Monopolist and price taking	Perfect hedge	Transaction and maintenance	No	positive	Real exchange rate follows random walk dumping activity
Viaene and de Vries (1992)	Risk averse	Importer and exporter	Perfect competition	Yes	No	Yes	Negative or positive (opposite effect on exporter and importer)	Depend on net currency exposure and the aggregate measure of risk aversion.
Gagnon (1993)	Risk averse	International trader	Perfect competition	No	Yes	No	Negative	With transaction costs both uncertainty and variability of exchange rate reduce the trade flows.

Table 2.1: Summary of selected partial equilibrium models (Contd.)

Study	Agent's risk attitudes	Type of trader	Market structure	Capital market	Adjustment costs	Domestic market	Impact on trade	Remarks
Broll (1994)	Risk averse	Multination -al firm	Monopoly	Yes	No	No	No impact	Negative impact if no forward market
De Grauwe (1994)	Risk averse	Producer	Price taking	No	No	No	positive	Firm has production flexibility.
Wolf (1995)	Risk averse	Importing firm	Competitive	Optimal hedge	No	No	Negative (backwardation) Indeterminate (contango)	depend on the futures-expected spot price relationship

Table 2.1: Summary of selected partial equilibrium models (Contd.)

Study	Agent's risk attitudes	Type of trader	Market structure	Capital market	Adjustment costs	Domestic market	Impact on trade	Remarks
Broll and Eckwert (1999)	Risk averse	Internation-al firm	Price taking	No	No	Yes	Positive	Decision on the choice of sales location depends on realization of exchange rate.
Barkolus, Baum, and Caglayan (2002)	Risk averse	Importers and exporters	Perfect competition	No	No	No	Negative if exchange rate uncertainty arise from microstructure shock	Exchange rate uncertainty emanate from microstructure shocks, fundamental shocks, and noisy policy intervention
Campa (2004)	Not depend on agent's risk attitude	Exporter	Perfect competition	No	Entry-exit	No	No impact on current period export volume	Exchange rate uncertainty affects the probability that the firm will enter the export market at this period.

2.2.1 Attitudes toward risk and uncertainty

The traditional theoretical models focus on the effects of the uncertainty of profit from trade arising from exchange rate volatility. In these models, the exchange rate volatility increases the risk of international trade activities and then will have a negative impact on trade due to the risk aversion of the individuals. It has been argued that unanticipated movements in the exchange rate affect realized profits and hence the volume of trade since most trade contracts are not for immediate delivery of goods, and they are denominated in the currency of the exporter or the importer.

Clark (1973) developed a simple model of a firm that produces and exports a homogeneous commodity under a perfectly competitive environment. It is assumed that the firm has no domestic market and uses no foreign inputs. The firm receives foreign currency for its exports and converts the export earnings in a forward exchange market which is limited for one maturity. The firm cannot change its output over horizon in response to movements in exchange rate because the production decision is made in advance of the realization of exchange rate. In this situation, the firm must decide the level of output (exports) by taking into account the uncertainty of future profit, which arises solely from the exchange rate movement. The firm maximizes its expected utility which is assumed to be a quadratic function of profits denominated in home currency. If the firm is risk averse, Clark (1973) demonstrates that the firm's marginal revenue exceeds the marginal cost. In perfectly competitive situation, the price of output (exports) is equal to marginal cost. In this situation, greater marginal revenue than marginal cost means that the firm must be compensated for the exchange risk it bears. The risk-averse exporter must receive a higher price than one who is indifferent to risk in order to produce the same output. Thus, Clark (1973) concludes that the supply curve of the risk-averse exporters will shift leftward and the output (exports) and trade will be reduced.

Soon after the breakdown of Bretton-Woods agreement, Ethier (1973) investigated the relationship between goods market and forward exchange market and the impact of exchange rate uncertainty on a risk-averse producer who imports foreign input. Ethier (1973) models the risk-averse firm which make decision on the volume of imports and on the amount of forward cover in an environment of exchange rate uncertainty. If it is assumed that the firm has perfect foresight on how exchange rate changes affect its profit, the uncertainty about the future spot rate would reduce the volume of imports. In this case, the reduction in the volume of import depends upon the degree to which the forward rate exceeds the expected future spot rate (forward premium) independently of attitudes toward risk, volatility of spot rate, etc. However, this situation is very unlikely and if the firm has uncertainty about future profit which is subject to the future spot rate, the volume of import will drop and the reduction will depend on the willingness of the firm to take risk.

In a bilateral framework, Hooper and Kohlhagen (1978) analyze the impact of exchange rate risk on both equilibrium prices and volume of traded goods by modelling different risk-bearing of the market. Unlike the studies of Clark (1973) and Ethier (1973) which considered only the export supply or import demand side of the market, Hooper and Kohlhagen (1978) focus on both sides of the market. As a result, their study allows for differences in risk preferences between importers and exporters, and hence it is able to analyses the effect of exchange risk on both prices and quantities of trade. They assume that some proportion of the contract is denominated in the foreign currency and a fraction of foreign currency is hedged in the forward market. Hence, the only source of uncertainty arises from unhedged foreign currency. In their analytical model, the relative risk preference of agents, the currency denomination of contracts, and the proportion of forward hedging are vital parameters in determining the impact of exchange rate uncertainty on the prices and volume of trade. With the assumption that importers and exporters maximize their utility, which is increasing function of expected profits and decreasing function of the standard deviation of the profits, Hooper and Kohlhagen (1978) demonstrate that an increase in exchange rate uncertainty, *ceteris paribus*, will reduce the volume of trade.

So far, in the above mentioned models the negative impact of exchange rate volatility on trade is the result of the risk aversion of the agents. If agents are risk neutral, uncertainty in exchange rate has no impact on the firm's decision. However, De Grauwe (1988) showed that even with the assumption of risk aversion, the relationship between exchange rate uncertainty and trade can be negative or positive depending on the impact of the mean-preserving spread in the exchange rate (increase in exchange risk) on expected marginal utility of export revenue. With the assumption of a perfectly competitive environment and access to both domestic and foreign markets, De Grauwe shows that if exporters are sufficiently risk averse, an increase in exchange risk will raise the expected marginal utility of export revenue and leads to higher export activity. De Grauwe (1988) demonstrated that if the exporters are very risk averse, they will worry about the worst possible outcome. Therefore, when exchange risk increases very risk averse exporters will increase their export activity to avoid a drastic decline in their export revenues. In contrast, if producers are slightly risk averse, higher exchange rate risk will negatively affect on expected marginal utility of export revenues and induces them to produce less for exports as they are less concerned with extreme outcomes.

De Grauwe (1988) stresses that increase in foreign exchange risk has both a substitution and an income effect. The substitution effect is a decrease in exports activities when increase in exchange risk lowers the attractiveness of risky activities and agents substitute export (risky) activities with domestic (less risky) activities. The income effect, on the other hand, is the increase of resources in the export sector when expected utility of export revenue declines as a result of increase in exchange risk. Hence, the negative impact of exchange risk on export activity requires the substitution effect to dominate the income effect. De Grauwe (1988) argues that the elimination of the income effect of exchange risk will always lead to negative relationship between exchange risk and export activities. Thus, the negative relationship in the models proposed by Hooper and Kholhagen (1978) is the result of the restriction imposed on the utility function that assumed absolute risk aversion (De Grauwe, 1988).

In contrast, Caballero and Corbo (1989) argue that increase in exchange rate volatility will increase exports with the assumption of risk neutrality. They show that under perfect competition, convexity of profit functions to the real exchange rate, and predetermined capital, exports is an increasing function of exchange rate uncertainty. Their justification is as follows: when the real exchange rate changes are unfavourable, the firm will produce less and has more capital than optimal. When movements in real exchange rate are favourable, firm will produce more and the firm will need more capital. Since the profit function is convex to the real exchange rate by assumption, the potential profits forgone due to insufficient capital when exchange rate is favourable are higher than the losses due to underutilized capital in the case of unfavourable exchange rate. So profit maximizing firms will tend to invest more, and thus increase exports in the face of uncertainty. However, with the assumption of risk aversion, they argue that the convexity of the profit functions to relative prices is offset by concavity of the utility function, investment, and thus, export activity is decreasing with the uncertainty of exchange rate.

Dellas and Zilberfarb (1993) also derive a theoretical model to demonstrate a positive impact of exchange rate variability on trade. By using a conventional asset portfolio model, they propose a model with incomplete asset markets and *ex-ante* trading decisions, in which the choice of exports is made before the resolution of uncertainty in prices. Their model contains two assets: safe asset (a completely hedged trade contract) and a risky asset (nominal unhedged trade contract). By using a model of a small open economy in which the single domestic agent lives in two periods but consumes and trades both available goods in second period, Dellas and Zilberfarb (1993) show that an increase in the riskiness of the return on risky assets – that is an increase in volatility of the exchange rate – increases or decreases trade (investment) depending on the nature of the risk aversion parameter of the model. If the coefficient of relative risk aversion is assumed to be less than unity – that is the profit function is convex – then an increase in risk decreases total exports. However, if the profit function is assumed to be a concave (large value of relative risk aversion), the possibility that exchange rate uncertainty will be associated with increase in trade cannot be rule out. The intuition is that higher riskiness makes high risk aversion individuals to commit more resources in exports to protect themselves against very low consumption of imported goods in the next period.

Recently, Barkolus, *et al.* (2002) analyse the effects of exchange rate uncertainty on the volume and variability of trade flows by employing a signal extraction framework. In their model exchange rate uncertainty originates from three relevant sources: general microstructure shocks, the fundamentals driving the exchange rate process, or a noisy signal of policy innovations. They show that the direction and magnitude of risk averse agents' optimal trading activities depend upon the source of the uncertainty. Their rationale is that agents have no perfect information about the behaviour of future exchange rate in a flexible exchange rate regime since exchange rates are subject to a number of shocks. However, agents use all available past information and a noisy signal about future policies for optimal prediction of future spot rates. As the information content of the signal improves, Barkolus *et al.* (2002) asserts that the predictability of exchange rates is expected to affect the volume of trade flows. They show that an increase in the variance of the general microstructure shock in the exchange rate process arising from the effects of excess speculation, bubbles and rumors, bandwagon effects, or the effects of technical trading by chartists and "noise traders" reduces the volumes of imports and exports. However, the effects of an increase in the variance of the stochastic elements in the fundamentals driving the exchange rate process and the variance of the noise of the signal regarding future policies on trade flows are ambiguous in their model.

2.2.2 Availability of hedging opportunity

It has been argued that the availability of capital market to hedge the foreign exchange risk can reduce the effect of exchange rate volatility. The earlier theoretical models (for example, Clark, 1973 and Ethier, 1973;) conclude that with perfect hedging opportunities the exchange rate uncertainty alone has no impact on the volume of trade. Kawai and Zilcha (1986) investigate the implications of the existence of forward market and commodity future markets on the trade decision of a risk averse firm. They derive a model of competitive, risk averse firm which produces and exports a commodity and faces two types of uncertainty; foreign currency price of the product and the future spot exchange rate. It is assumed that the firm is a price-taker and maximizes its expected utility of local currency profit which is strictly concave, increasing and differentiable. In addition, by assumption, there are no costs to hedge uncertainty in the forward and commodity future markets. With complete market (both forward and commodity future markets exists), the firm's optimum production is given by a point where marginal costs equals fully hedged price in local currency (that is the product of forward exchange rate and future commodity price). In this case, optimum production is independent of the utility function or the probability distribution of the random variables. With incomplete market where the forward exchange market and/or future commodity market does not exist, Kawai and Zilcha (1986) demonstrate that the firm's optimal production depends upon the relative risk aversion of the firm, such that more risk-averse firm will always produces less.

De Grauwe (1988), however, notes that the inclusion of capital market would not change the basic ambiguity of the impact of exchange rate volatility without formally testing this notion. Viaene and de Vries (1992) and Dellas and Zilberfarb (1993) explicitly tested this hypothesis. Dellas and Zilberfarb (1993) introduce a forward market in their model but it requires the payment of a fee (commission) in order to participate in forward market. With nonzero transaction costs, exporters will choose to only partly hedge exchange risk through forward market. So, increased exchange risk will have an impact on volume of trade, but the sign of this impact is ambiguous depending on the risk aversion parameter. They conclude that the inclusion of forward market with risk premium do not change the basic results, and their finding supports De Grauwe's hypothesis.

In contrast, Viaene and de Vries (1992) find striking results when a forward market is incorporated into their model. They develop a model which combines the behaviour of risk loving speculators, risk averse exporters and importers with a forward market in foreign currency invoicing. They show that, in the absence of forward markets, an increase in the exchange rate volatility reduces both exports and imports. But when they include a forward market in the model, the volatility of spot exchange rate can only affect trade volumes via a channel through its effect on the forward exchange rate. An increase in exchange rate volatility causes benefit or detriment to trade flows depending on the net foreign currency exposure and the aggregate measure of risk aversion. Viaene and de Vries (1992) demonstrate that, without forward market intervention by central banks, exporters lose (benefit) and importers benefit (lose) whenever the forward exchange risk premium is positive (negative). Their conclusion is that since the exporters and importers are on the opposite sides of forward market, by definition, the effects of exchange rate volatility on the exports and imports are opposite to each other.

Broll (1994) also considers the economic behaviour of risk averse multinational firms who engage in the global trading environment by producing in a foreign country and selling abroad. Without a forward market, exchange rate uncertainty causes a decline of the production in foreign country. When a matured forward market is incorporated, Broll (1994) demonstrates that the production decision of the firm is independent of the utility function or the uncertainty of spot exchange rate. The salient result of the model that incorporates the forward market in the analysis of the relationship between exchange rate volatility and volume of trade is, however, relevant only for the currencies of developed countries with matured financial markets, and for trade contract with specific short term maturity.

However, most of the previous theoretical studies propose that with a forward exchange market, the 'separation property' holds, i.e., the optimal output level is independent of both the distribution of exchange rate and the agent's attitude towards risk. In contrast, Wolf (1995) proves that in the presence multiplicative form of uncertainty arising from exchange rate uncertainty and imported input price uncertainty, the 'separation property' does not hold so that the production decision is not independent of the hedging decision and the risk parameters. Wolf (1995) presented a model of risk averse importer who maximizes expected utility under competitive environment. The agent faces a multiplicative form of risk arising from uncertainties of exchange rates and imported commodity prices. In this case, Wolf (1995) demonstrates that the impact of exchange rate volatility and risk aversion on imports depends on the relationship between futures and expected foreign exchange rate. The impact is negative, when the expected foreign exchange spot price exceed future exchange rate (backwardation). When the expected spot exchange rate is less than future exchange rate (contango), the impact is indeterminate.

Nonetheless, Côte (1994) points out that there might be a number of reasons why firms cannot, or choose not, to completely hedge foreign exchange risk in forward market. For example, the forward market for most of the currencies of developing countries and long-term trade contract may simply not exist. If existed, the cost of hedging would come with higher costs. In such circumstances, possibilities of hedging in forward market will depend on the currencies denominated and nature of a firm.

2.2.3 Production and sales flexibility

The conclusion of a negative impact of exchange rate volatility from most of the theoretical models mentioned in the previous sub-sections rests on the assumption that the firm cannot change its factor inputs and production level in order to respond optimally to exchange rate movements. These models still ignore the firm's option to adjust its production volume and sales destination in response to exchange rate movements. When firms have flexibility in production volume and destination market, Sercu (1992), De Grauwe (1994), and Broll and Eckwert (1999) demonstrate a positive impact of exchange rate volatility on exports.

Sercu (1992) develops a model of a risk neutral firm which produce in the current period for sales in the next period. It is assumed that future sales prices are dependent on the next period realized exchange rate. Hence, the decision to import or export is made at the end of next period when the end of period exchange rate is realized. Under these assumptions, Sercu (1992) develops a model of an exporting firm operating under perfect competition or monopoly framework. According to the model, an increase in exchange rate volatility, which is measured by an increase in conditional standard deviation, leads to a decrease in domestic production as well as lower average price in the import substitution sector. A decrease in price will reinforce the rise in expected demand because of an assumed convex demand curve. In this case, exchange risk leads to a decline in production of the import substitution sector and normally raises the expected demand for import. As a result expected imports increase. On the other hand, an increase in exchange rate volatility leads to higher expected prices and production level in the export sector. The increase in the export prices leads to a decline in domestic demand of exportable product. Hence, the combined effect of higher production and lower domestic demand increases exports. Sercu (1992) concludes that the exchange rate volatility has positive impact on trade whether the trader-producer is in perfect-competition or monopoly framework. However the effect of uncertainty is not known with certainty for intermediate market structure such as oligopoly or monopolistic competition.

Similarly, De Grauwe (1994) shows that increase in exchange rate volatility can in fact increase the output and thus volume of trade. An increase in exchange rate volatility raises price fluctuation for the firm's product. If the firm can adjust its output according to the realized price level, higher price induces higher output so as to profit from the higher revenue per unit of output. When the price is low due to the unfavourable exchange rate movement, the firm will reduce its output to limit the decline in its total profit. In this scenario with production flexibility, the negative impact of unfavourable exchange rate movements has been limited, and thus, exchange rate volatility has a positive impact on trade. Therefore, exchange rate volatility represents not only risk; it can also create a profit opportunity. The more variable the exchange rate, the greater the opportunity to make large profits. De Grauwe (1994) argues that exporting can be seen as an option. With favourable exchange rate movement, the firm exercises its option to export and earns large profits. When exchange rate is not favourable, the option is not exercised. Therefore, exchange rate volatility could have a positive impact since the more variable the exchange rate the greater the benefit for the firm with an option to export (De Grauwe, 1994 p. 65).

In addition to the production flexibility, one aspect of flexibility is in sales destination. Broll and Eckwert (1999) show that an international firm with a huge domestic market base has the ability to benefit from the exchange rate movements by reallocating its sales between domestic and foreign market. Broll and Eckwert (1999) propose a model of a price taking, risk averse international firm which produces a product for sale in both domestic and foreign market. The only source of uncertainty is the exchange rate and the firm makes a production decision before this uncertainty is resolved. It is assumed that, however, the firm's decision on the choice of sales location – domestic or foreign market – is flexible and contingent on the realization of the exchange rate. The objective of the firm is to maximize the expected utility of its local currency profits which is strictly concave, increasing and twice differentiable. Under these assumptions, Broll and Eckwert (1999) prove that the firm's exporting strategy is like having an option contract. The domestic price can be seen as the 'strike price' of the real export option since the return from domestic market is certain and not dependent on exchange rate. The firm will export when exchange rate is favourable. As in the standard option pricing theory, the value of the option (option to export) will increase with the greater volatility of profit from underlying asset (benefits from international trade). Thus, higher exchange rate volatility increases the potential benefits from international trade and make production more profitable. At the same time, the firm will face a higher risk exposure when the exchange rate is more volatile and tends to decrease production and the volume of trade. Broll and Eckwert (1999) demonstrate that if the degree of relative risk aversion is less than unity, the average export volume of the firm is increasing in exchange rate volatility. One of the main assumptions in the model to derive this conclusion is the violation of law of one price which means that domestic and foreign market are segmented in the sense that arbitrage is either impossible or unprofitable.

2.2.4 Nature and environment of the firm

The impact of exchange rate volatility on trade volumes also depends upon the type of the firm. The impact on a manufacturing firm is not necessarily the same as on a trading firm. Hence, when faced with exchange rate uncertainty, the decision making of a trading agent is not likely to be the same as a manufacturing firm. The impact is also different between a multinational firm engaging in the global trading environment and a exporting firm focusing on a single export market. For a multinational firm, Clark *et al.* (2004) notes that the effect of exchange rate volatility is likely to be offset with the different movements among different currencies.

In addition, degree of competitiveness in the market environment also determines the degree and sign of the impact of exchange rate volatility on trade.

The impact of exchange rate volatility on exports of a firm in perfect competitive environment is likely to be different from that of one which operates in the monopolistic environment. A monopolist is able to set price with a certain amount of mark up over marginal costs (provided that exchange rate shock is not so large to raise marginal cost above price). This mark up pricing may reduce the impact of exchange rate volatility. In contrast, in perfect competition environment, the impact is likely to be more intense because of its competitive pricing nature. The uncertainty in price arising from competitive pricing is likely to augment the exchange rate uncertainty. For this reason, some theoretical studies explicitly incorporate price uncertainty in their models. For instance, see Kawai and Zilcha (1986) and Wolf (1995).

Broll (1994) considers the economic behaviour of a risk averse multinational firm which engages in the global trading environment by producing in a foreign country and selling abroad. It is assumed that multinational firm has monopoly power in the foreign market and faces exchange rate uncertainty. The firm maximizes its expected utility of income which is strictly concave. Under these circumstances, Broll (1994) proves that the firm produces more when the expected exchange rate is fixed. Thus, exchange rate uncertainty causes decline in production in the foreign country. However, when a matured forward market is incorporated, Broll (1994) demonstrates that the decision of the firm on foreign investment and foreign labour demand is independent of the utility function or the probability distribution of the stochastic spot exchange rate.

2.2.5 Presence of adjustment costs

Another aspect of the relationship between exchange rate volatility and trade is the role of hysteresis in trade caused by large exchange rate shocks[12]. In order to penetrate a foreign market, exporters have to make significant investment to set up marketing and distributing frameworks, and production facilities for differentiated products. For non-exporters, they need to make these investments if they wish to enter a foreign market. These costs are irreversible. For an existing exporter, to exit from foreign market also incurs sunk costs such as losses arising from liquidating existing physical investment. The existence of these costs can also affect the exchange rate volatility-trade relationship.

Gagnon (1993) develops a dynamic optimising model of a risk averse international trader who purchases goods at one country and exports to another country to maximise the discounted future utility which is concave function of the level of profit. Because of the adjustment costs such as contracting and marketing costs, the trader faces a convex cost structure which is modelled as quadratic in the change in trade flow. Gagnon (1993) shows that if there were no adjustment costs in trade, only exchange rate uncertainty (conditional variance) would affect trader's decision and reduce the trade flows. With adjustment costs both uncertainty and variability of exchange rate (unconditional variance) reduce the trade flows.

[12] Dixit (1989) defines hysteresis as failure of an effect to reverse itself when the underlying cause has been reversed.

2.2.6 The entry and exit costs and the role of hysteresis in trade

In order to emphasize the importance of the sunk costs to the relationship between exchange rate volatility and trade, Caballero and Corbo (1989) present a two period partial equilibrium model of an exporting firm. Caballero and Corbo (1989) replace the assumption of predetermined capital by assuming the irreversibility of capital (sunk costs) with opportunity to adjust the capital stock in the second period at a higher cost. Their argument is that when capital is irreversible but not predetermined, the firms have the opportunity to invest in the second period. It limits the losses of investing too low in the previous period with the possibility of higher costs to invest more in the second period. Meanwhile, the firms face the potential losses of over investing in the first period when the exchange rate turns out to be unfavourable in the second period. Caballero and Corbo (1989) argue that when exporting firms have the availability to adjust their capital stock (at a higher cost), they would not commit to much investment in the first period when the exchange rate is volatile, and thus the uncertainty reduces exports.

In contrast, Dixit (1989) shows that these sunk costs would make a firm to become less responsive to exchange rate movements, and hence an increase in exchange rate volatility will widen the hysteresis band. As long as the expected gross profits from participating in (abandoning of) the export market is greater than the entry (exit) sunk costs, the firms will enter (exit) the export market (Dixit, 1989). Otherwise, they will adopt a "wait-and-see" approach. The opportunity of the exporting (non exporting) firm to exit (enter) the foreign market in the future is analogous to owning a call option on a common stock. For a non-exporting firm, it gives the right (not obligation) to make an investment expenditure (the exercise price of the option) and receive an export project (a share of stock) the value of which fluctuates stochastically depending on the volatility of exchange rate. The greater the volatility of the exchange rate, the greater the value of owning the option which implies that increased exchange rate volatility will extend the range of exchange rate within which exporting (non exporting) firm stays in (out of) the export market.

Franke (1991) also provides the support for positive hypothesis by using the option framework. He proposes a model of a risk neutral firm operating in monopolistic competition for an intertemporal infinite time horizon. The firm maximizes the net present value of cash flow from exports which is an increasing and strictly convex in the exchange rate. Because of the arbitrage opportunity, the exchange rate in the model is mean-reverting. The higher the arbitrage opportunity, the speedier the mean-reverting will be. The potential price differences caused by an increase in exchange rate volatility generate more opportunity for profitable commodity arbitrage through international trade. A firm that enters (exits) a foreign market incurs entry (exit) costs. The presence of these sunk costs leads the firm to weight the entry (exit) costs associated with entering (abandoning) a foreign market against the profits (losses) created by exports. Because of assumption that the cash flow function is convex in the exchange rate, the present value of cash flows grows faster than that of transaction costs and the firm benefits from increased exchange rate volatility. In this situation, Franke

(1991) shows that the firm will enter sooner and exit later when exchange rate volatility increases, and that the number of trading firms will also increase, which in turn, leads to increase international trade.

Sercu and Vanhulle (1992) point out three limitations in Franke's (1991) analysis, the assumption of risk neutrality, the convexity of cash flows in the exchange rate and mean-reverting exchange rate. In contrast, Sercu and Vanhulle (1992) base their model on the assumption of risk aversion, perfect hedging and a random process of exchange rate. In addition, the cash flow function depends on the market structure and it is piecewise linear-quadratic in the exchange rate. The entry and exit costs are replaced by other type of transaction costs. Unlike Franke's (1991) model which assume the same entry cost no matter how many times a firm exits and re-enters, Sercu and Vanhulle (1992) consider that the re-entry cost is generally lower than first entry investment. And there might be a situation of suspending exports but continues to maintain its investment as an option to earn future export profit. These maintenance costs are similar to the role of re-entry and exit costs. Under these assumptions, Sercu and Vanhulle (1992) provide theoretical and numerical evidence for monopoly and price taking firms. In both market structures, an increase in exchange rate risk raises the value of the exporting firm and lowers the threshold of the level of exchange rate that leads the firms to exit from the foreign market. Even if the exporting is not profitable due to unfavourable exchange rate, the firm will be willing to sustain losses, and engage in dumping, before abandoning the foreign market. Hence, an increase in exchange rate volatility raises the level of international trade.

Campa (2004) extends the role of hysteresis in trade by examining the micro decision of the export participation of a firm by developing a model that captures the presence of entry and exit sunk costs and the existence of exchange rate uncertainty. The model incorporates two decisions: the firm's entry and exit decision and export supply decision. Campa (2004) argues that the decision to enter and exit depends on the current value of the exchange rate and its conditional distribution. The current value of exchange rate affects the expected profit from exporting at the current period, whilst the conditional distribution of exchange rate affects the expected value of being an exporter in the future or not. However, the export supply decision depends only on the current period's exchange rate. Based on these arguments, Campa (2004) has shown that an exchange rate change can affect the expected exports of a firm in two different channels. The first one is by changing the optimal export level at which an exporting firm will decide to export and the second channel is by affecting the probability that the firm will choose to be an exporter at a given period.

2.3 The relationship between exchange rate volatility and trade: General equilibrium analysis

Up to this point, theoretical modelling of exchange rate volatility and trade has been derived from partial-equilibrium framework that assumes volatility of exchange rate as the only variable that changes. Clark *et al.* (2004) points out that these theoretical models suffer a weakness because of the assumption that all other factors that might influence the level or trade remain constant as a nature of partial-equilibrium framework. In addition, most of the partial equilibrium literature assumes that demand function or cash flow function as given, and therefore ignores how these functions are affected by changes in an economy that are caused by an increase in exchange risk. Partial equilibrium models assume that exchange rate volatility is purely determined by exogenous shocks and ignore the dynamic process of relationship between trade volume and exchange rate volatility which are likely to affect the exchange rate through other macroeconomic channels.

Recently, the theoretical modelling of the relationship between exchange rate volatility and trade employs a general equilibrium framework, which is based on the "new open-economy macroeconomics" that synthesizes nominal rigidities, micro-foundation of decision making process, intertemporal approaches, and the effects of market structure on international trade. In the general-equilibrium framework the fundamentals that cause changes in exchange rate can lead to changes in other macroeconomic variables. For example, a depreciation in a home country's currency as a result of monetary expansion leads to higher import price and reduces imports, but higher demand generated by monetary expansion could offset part or all of the effect of exchange rate depreciation (Clark *et al.*, 2004). This could be a reason why the relationship between exchange rate volatility and trade is ambiguous in partial equilibrium framework which ignores the impact of other related macroeconomic variables.

Another feature of general equilibrium framework is that it can be utilized to model the endogeneity of exchange rate volatility. To this extent, general equilibrium models can shed more light on the relationship between exchange rate volatility and trade by taking into account the response of other macroeconomic variables. It highlights a more complete picture of the relationship between exchange rate volatility and trade whether exchange rate volatility has an impact on trade or trade has an impact on exchange rate volatility.

2.3.1 Impact of exchange rate volatility on trade

Following recent development in open-economy macroeconomics, Bacchetta and Van Wincoop (1998) develop a simple, two-country general equilibrium model to analyze the effect of different exchange rate system on trade. They argue that analyzing the effect of different exchange rate systems on international trade is more appropriate than studying the impact of exchange rate uncertainty in isolation although they acknowledge that exchange rates are more volatile in floating than fixed regime. First, they consider a two-country general-equilibrium model where uncertainty arises only from monetary shocks. They conclude that level of trade depends on the preference of consumers regarding the trade-off between consumption and leisure. They demonstrate that trade is higher (lower) under fixed rate regime when consumption and leisure are substitutes (complements). In contrast, under flexible exchange rate system trade is higher when consumption and leisure are complements; it is lower when consumption and leisure are substitutes.

Bacchetta and Van Wincoop (2000) extend the benchmark monetary model by including other sources of shocks, such as, fiscal and technology shocks. In this case, the relationship between trade and exchange rate arrangements depends crucially on the correlation between the money supply and other shocks. Under a floating rate regime, monetary policy can be used to respond to fiscal and productivity shocks in order to stabilise the business cycle. Bacchetta and Van Wincoop (2000) prove that monetary policy under a floating regime stabilizes domestic labour demand and makes labour costs lower when selling goods in a domestic market. Hence, it would be more attractive to sell goods in the domestic market and trade volume will be decline. When this is the case, Bacchetta and Van Wincoop (2000) provide evidence that trade is higher under a fixed rate regime.

Ostfeld and Rogoff (2001) also provide an analysis of the impact of exchange risk on expected output and trade by extending the "new open-economy macroeconomic framework". They propose a two-country model of stochastic environment where the exchange risk has an impact on the price setting decisions of individual producers, and thus, on expected output and international trade flows. By modelling nominal price setting by monopolistic producers under uncertainty, Ostfeld and Rogoff (2001) show that higher exchange rate variability will reduce expected output and consumption in both countries and hence the volume of trade will decline. The degree of such impact depends on the relative sizes of countries, variability of consumption, productivity shock, covariance between level of consumption and domestic currency, covariance between the exchange rate and a domestic (foreign) productivity shock, and covariance between level of consumption and domestic (foreign) productivity shock. One striking feature of their analysis is that fluctuations in the risk premium may be a very significant source of exchange rate volatility. However, this model assumes the securities markets are redundant and, as a result, current accounts are always in equilibrium which can be seen as unrealistic in a real world situation.

Sercu and Uppal (2003) develop a general equilibrium stochastic endowments economy in which exchange rate and the prices of financial securities are determined endogenously. They assume that commodity markets are segmented so that there are deviations from purchasing power parity. The segmentation of commodity markets is represented by transportation costs for goods across countries. In contrast, financial markets are assumed to be complete and perfectly integrated. Thus, this model allows cross-border financial investment and hedging. They find that, in this general equilibrium setting, impact of exchange rate volatility on international trade may be positive or negative, depending on the source underlying the increase in exchange rate volatility. If the exchange rate volatility is caused by increase in the volatility of endowments, the expected volume of trade will increase. On the one hand, if higher costs to international trade boost the volatility of the exchange rate, it will decrease trade.

2.3.2 Impact of trade on exchange rate volatility

Another feature of general equilibrium framework is it can be utilized to model the endogeneity of exchange rate volatility. To this extent, general equilibrium models highlight the role of trade in determining real exchange rate volatility by taking into account the response of other macroeconomic variables. Broda and Romalis (2004) develop a model to identify the relationship between trade and exchange rate volatility. They argue that most of the existing studies are based on the assumption of an exogenously driven exchange rate process and ignore the effect of trade on volatility. This ignorance leads to the overestimation of the true impact of exchange rate volatility on trade. They develop a general equilibrium model of bilateral trade which has four countries and two sectors; manufacturing and commodities. Their model focuses on the impact of trade on exchange rate volatilities (the source of reverse causality), and differences in the impact of exchange rate volatility on trade in two different sectors. Because commodity trade is determined by an organized exchange, they claim that the volatility of exchange rate has no significant impact on this kind of trade. In contrast, exchange rate volatility has an impact on the trade in manufactured products. They show that manufacturing trade depends on transport and market entry costs (sunk costs) which will depend on the distribution of the exchange rate and attitudes toward risk. In their model, the movement of real exchange rate depends on the difference in the importance of exporting country's goods for importing country and in the consumption baskets between two countries. The less trade there is between the countries, the more different their consumption baskets will look, and the greater the volatility of their real exchange rate.

Recently, Bravo-Ortega and di Giovanni (2005) examine the impact of trade costs on real exchange rate volatility by using a two-country model based on "open-economy macroeconomic framework". In equilibrium, the range of goods that a country produces or imports depends on productivity differentials and trade costs. These trade costs lead to a range of domestic and foreign goods to be non-tradable. Thus, the law of one price is violated because the prices of traded goods are not equal as a result of trade costs. Then Bravo-Ortega and di Giovanni (2005) derive a model of the real exchange rate where the relative prices not only depend on the prices of non-tradable goods, but also on the international specialization pattern that arises from existence of trade costs. From this model, they show that real exchange rate volatility is increasing in trade costs. This theoretical proposition leads to the fact that there could be an inverse relationship between exchange rate volatility and trade volume.

2.4 Conclusion

This chapter has reviewed the theoretical literature on the relationship between exchange rate volatility and trade in two approaches; partial equilibrium and general equilibrium framework. In partial equilibrium analysis, the sign of the impact depends upon the assumptions of a model. The theoretical models which show a negative impact are based on the assumptions that the agent is risk averse, the exchange rate risk is the main source of the exporter's profit risk, a hedging opportunity is not available or is costly, and export volume is independent of the level of exchange rate. In this case, an increase in exchange rate volatility increases risk faced by the agent. Since the agent is risk averse and exchange risk cannot be hedged, the increase in risk results in an added cost to cover the risk associated with exchange rate volatility or to shift to less risky endeavours. Both activities decrease the volume of international trade. When these assumptions are relaxed, some theoretical models show that exchange rate uncertainty has positive impact on international trade. In addition, if firms operate in the global trading environment, the effect of exchange rate volatility can be mitigated to some extent because of the offsetting movements across difference currencies.

The existence of adjustment costs, such as marketing and product differentiation costs that are required in order to penetrate a foreign market, make firms less responsive to short term exchange rate movements. Thus, international trade can be affected as existing exporters delay their exit and non-exporters delay their entry when faced with exchange rate uncertainty. Firms adopt a "wait and see" policy and the impact of exchange rate uncertainty on trade depends on the future profitability from exporting.

Based on the theoretical propositions of partial equilibrium models, if agents are risk averse, the export volume of emerging economies is likely to be negatively affected by exchange rate volatility since hedging tools, such as financial derivatives, are rather primitive or nonexistent for their currencies. Moreover, the exporting firms in these countries are normally small and medium size and export their products to one or two major markets. So, the portfolio effect arising from operating in several foreign markets is likely to be small, and different movements in exchange rates among different currencies may not offset the effect of exchange rate volatility. In addition, the majority of the exports of emerging countries are likely to be raw materials and commodities.[13] A feature of commodity exports from emerging countries is that there is very little flexibility in terms of production capacity and sales destination. Most of these conditions indicate that if exchange rate volatility has any impact on trade, it is likely to be negative for emerging countries.

Some theoretical models suggest that the exchange rate uncertainty does not affect the commodity trade since the prices of commodities are generally determined by organized international commodity exchanges (Broda and Romalis, 2004). But this is not likely to be the case for commodity product like agricultural produce in which production costs are incurred mostly in domestic currency and revenue is determined by the level of the exchange rate. When the future exchange rate is uncertain due to high volatility, the domestic producer has the alternative to shift from producing export crop to the crop that has a domestic market base since agricultural production has short production cycle, and hence, exports will decline. The decline in exports is followed by a reduction in imports since emerging countries depend on export income for imports and trade will eventually decline.

Compared with partial equilibrium analysis, theoretical models based on general equilibrium analysis improve the understanding of the relationship

[13] Bayoumi and Mauro (1999) point out that some manufactured goods of emerging economies – for example computer chips – have some of the characteristics of commodities. These commodities have world prices and lack the degree of product differentiation and price stickiness generally associated with manufacturing goods.

between exchange rate volatility and trade to a certain extent. General equilibrium models have the advantage of considering the other aspects of economic environment affected by developments in fundamentals that generate the exchange rate movements and interaction among them. In a general equilibrium framework, there is no clear relationship between exchange rate volatility and trade. It depends on the interaction of consumers' preferences and the correlation between the money supply and other sources of shocks, such as fiscal and technology shocks (Bacchetta and Van Wincoop, 1998; 2000). So the utilization of monetary policy for stabilizing an economy is crucial in determining the relationship. This proposition means that credibility of monetary policy is important for emerging economies. For countries with a history of high inflation the impact of exchange rate volatility is likely to be more pronounced.

Another proposition that arises from a general equilibrium model is that the relationship between exchange rate volatility and trade is determined by the underlying source of exchange rate volatility. If the source of increased volatility in the exchange rate is an increase in the degree of segmentation of commodity market between two countries, international trade will decrease along with exchange rate volatility (Sercu and Uppal, 2003). If this is the case, protectionism, which is usually associated with emerging economy countries to protect their infant industries or to control balance of payments problems, increases the costs to international trade, and thus, boosts the volatility of exchange rate which in turn reduces the trade. This proposition highlights the endogeneity of exchange rate volatility which suggests the relationship between exchange rate volatility and trade could run in both directions.

In summary, this chapter shows that the effects of exchange rate volatility on exports are ambiguous. Even though general equilibrium modelling helps to clarify some ambiguity in the relationship between exchange rate volatility and trade, there is no real consensus on either the direction or the nature of the relationship. As noted by Caballero and Corbo (1989) '... unless very specific assumptions are made, theory alone cannot determine the sign of the relation between exchange rate uncertainty and exports'. This implies that the nature and magnitude of the relationship between exchange rate volatility and trade becomes an empirical issue and next chapter reviews the empirical literature on the trade-exchange rate volatility relationship.

Chapter 3

Empirical Studies of the Relationship between Exchange Rate Volatility and International Trade: Review of Literature

3.1 Introduction

Having reviewed the theoretical analysis of the relationship between exchange rate volatility and trade, it is obvious that the effect of exchange rate volatility on trade is theoretically far from conclusive. This implies that the nature and magnitude of the relationship between exchange rate volatility and trade becomes an empirical issue. In fact, numerous studies have attempted to understand and quantify the effects of exchange rate volatility on trade. The empirical evidence on this relationship is, however, as ambiguous as the theoretical propositions. Sauer and Bohara (2001, p. 133) conclude that '...clear consensus about the nature and importance of the relationship is yet to emerge'.

This chapter surveys the empirical literature on the relationship between exchange rate volatility and trade. The lack of a clear and consistent pattern of results make a number of issues apparent as the literature of empirical investigation evolved. The most important issues are concerned with the measure for exchange rate volatility (commonly used as a proxy for exchange rate risk), type of the trade flows, the empirical model specifications and the estimation techniques. An overview of how extant empirical studies have attempted to deal with these issues and a summary of their findings are presented in Table 3.1. Among these studies, 23 papers focus on developed and advanced economies whilst 13 studies test the impact of exchange rate volatility on exports of developing and emerging economies. It reveals that 43% of the studies which focus the developed economies find negative impact. In contrast 54% of studies examine the developing and emerging economies prove that exchange rate volatility has a significant negative impact on exports.

The rest of the chapter is organised as follows. Section 3.2 focuses on the issues concerned with the choice of the proxy for exchange rate volatility. Section 3.3 provides a review of the literature on the issues arising from using different types of trade flows in the empirical studies. Section 3.4 discusses the issues related to the choice of trade models. Section 3.5 focuses on the econometric techniques and the final section concludes.

Table 3.1: Summary of main features and results for the empirical studies

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Hooper and Kohlhagen (1978)	US and German 1965-1975 quarterly	multilateral and bilateral imports and exports with Japan, France and UK	Average absolute difference between current spot rate and previous forward rate	nominal	$X = f(UC, UC^*, P, Y, CU, S, V)$ OLS	No significant effect on trade volume
Abrams (1980)	19 developed countries 1973-76	Bilateral exports	Standard deviation of bilateral exchange rate and standard deviation of percentage change in bilateral exchange rate	nominal	Gravity model Pooled OLS	Significant negative impact

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	**Country and the sample period**	**Trade flows (Dependent variable)**	**Measure of exchange rate Volatility**	**Type of exchang e rate**	**Model specification and estimation technique**	**General Results**
Akhtar and Spence-Hilton (1984)	U.S and Germany 1974-1981 Quarterly	Aggregate exports and imports of manufactured products	Standard deviation	Nominal effective	$M_t = f(Y_t, RP_t, CU_t, V_t)$ $X_t = f(Y_t^*, RP_t, CU_t^*, V_t)$ OLS	Significant negative impact on exports and imports volume of Germany
Gotour (1985)	US, France, Germany, Japan, UK	Exports and imports	Moving average standard deviation	Nominal effective	$X = f(P, Y^*, PC, S, V)$ OLS	Not significant and mixed results
Cushman (1986)	US 1965-83 quarterly	Bilateral exports	Moving Average Standard Deviation	Real	$X = f(P, Y^*, PC, S, V)$ OLS	negative effect and existence of third country effect

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Kenen and Rodrik (1986)	11 industrialized countries 1975-84 quarterly	Aggregate exports	Standard Deviation of monthly change	Real	$X_t = f(Y_t^*, E_t, V_t)$ OLS	Significant negative impact in US, Canada, Germany and UK
Thursby and Thursby (1987)	17 countries Industrialized, Europe, and South Africa 1974-1982 Annual	Bilateral exports	The variance of the spot exchange rate around its predicted trend	Nominal and real	Gravity model OLS	Significant negative effect for 10 countries

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and sample period	Trade flows (dependent variable)	Measure of exchange rate Volatility	Type of exchang e rate	Model specification and estimation technique	General Results
Bailey and Tavlas (1988)	U.S. 1975-86 Annual	Aggregate exports	1.absolute value of quarterly percentage change in real effective exchange rate 2. deviation between REER and FEER	Real effective	$X_t = f\left(Y_t^*, RP_t, V_t, OIL_t\right)$ OLS	not significant
Brada and Méndez (1988)	30 developed and developing countries 1973-77 (Annual)	Bilateral trade value	Trade regime dummy variables	N/A	$X_{ij} = f\begin{pmatrix} Y_i, Y_j, N_i, N_j, DI_{ij}, \\ FT_{ij}, FIX_i, FIX_j, FL_{ij} \end{pmatrix}$ cross-sectional OLS	Negative impact of exchange risk on trade volume

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and sample period	Trade flows (dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
De Grauwe (1988)	10 industrialized countries 1960-69/1973-84 Annual	Bilateral trade	Standard deviation of the percentage change of bilateral exchange rate around the mean observed during a sub period	Real and nominal	$\Delta X_{ij} = f(\Delta Y_j, E_{ij}, V_{ij}, FT_{ij})$ SURE	Significant negative effect on the growth rate of bilateral trade flows
Caballero and Corbo (1989)	Chile, Colombia, Peru, Philippines, Thailand, Turkey quarterly	Aggregate Exports	Annual standard deviation by averaging the standard deviation of four quarters of each year	Real	$X_t = f([E_t + Y_t^*], V_t, X_{t-1})$ OLS and IV	Significant negative relationship for Peru, Thailand, and Turkey

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchang e rate	Model specification and estimation technique	General Results
Koray and Lastrapes (1989)	UK, France, Germany, Japan, Canada 1959-1985 Monthly	Bilateral imports with the US	Moving Average Standard Deviation	Real	$\mathbf{x}_t = \mathbf{m} + \mathbf{A}\mathbf{x}_{t-k} + \boldsymbol{\varepsilon}_t$, where $\mathbf{x} = \begin{bmatrix} MS, MS^*, I, I^*, P, \\ P^*, Y, Y^*, V, S, M \end{bmatrix}'$	Weak impact on imports
Bini-Smaghi (1991)	Intra-EMS (Germany, France, Italy) 1976-1984 Quarterly	Sectoral manufactured products export volume and price	Standard deviation	Nominal	$X_t = f(Y_t^*, RP_t, V_t, PC_t)$ OLS	negative impact on volume of all countries, negative impact on price for Germany, Positive for France and Italy

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Kumar and Dhawan (1991)	Pakistan 1974-85 Quarterly	bilateral exports	Moving Average Standard Deviation	Real and nominal	$X_t = f(P_t^*, Y_t^*, V_t, E_t)$ OLS	Significant negative impact
Pozo (1992)	U.K 1900-1940 Annual	Aggregate Exports to the U.S.	1.Moving Average Standard Deviation 2.GARCH	Real	$X_t = f(Y_t^*, E_t, V_t, D)$ OLS	Significant negative relationship
Chowdhury (1993)	G-7 countries 1976-1990 Quarterly	Aggregate Exports	Moving Average Standard Deviation	Real	$X_t = f(RP_t, Y_t^*, V_t)$ Johasen's cointegration ECM	Significant negative relationship

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Holly (1995)	UK 1974-92 quarterly	Manufacture exports	GARCH	Real effective	$\Delta X_t = f(RP_t, \Delta W_t, V_t, ST)$ ECM with IV	Not significant
McKenzie and Brooks (1997)	US-German	Bilateral exports	ARCH	Nominal	$X = f(P, Y^*, S, V)$ OLS	Significant positive relationship
Dell'ariccia (1999)	15 EU countries 1975-1994	Bilateral trade volume	1.Standard deviation 2.The sum of squares of forward error 3.Percentage difference between the maximum and minimum spot rate	Nominal and real	Gravity model $(X+Y)_{ijt} = f\begin{pmatrix} Y_{it}Y_{jt}, N_{it}N_{jt}, \\ DI_{ij}, V_t, BOR_{ij}, \\ FT_{ij}, LG_{ij} \end{pmatrix}$ Pooled and panel OLS	Significant negative effect on bilateral trade

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Doroodian (1999)	India, Malaysia, South Korea 1973-96 quarterly	Aggregate Exports	GARCH ARMA	Real	$X_t = f\left(PX_t, P_t^{*}, Y_t^{*}, V_t\right)$ OLS	Significant negative impact
Arize *et al.* (2000)	13 LDC 1973-1996	Aggregate exports	Moving sample standard deviation	Real effective	$X_t = f\left(D_t^{*}, RP_t, V_t\right)$ Johasen's cointegration, ECM	Significant negative long-run relationship
Chou (2000)	China 1981-1996 Annual	Aggregate and sectoral exports	ARCH	Real effective	$X_t = f\left(RP_t, Y_t^{*}, V_t\right)$ Johasen's cointegration, ECM	Negative impact on total exports, manufacture and mineral & fuels, not significant on the exports of foodstuff

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Rose (2000)	186 countries 1970-90 Annual	Bilateral exports	Standard Deviation of monthly change	Nominal	The gravity model Panel	Significant negative relationship
Anderton and Skudelny (2001)	Euro area members 1989-99 Quarterly	Imports from the US, Japan, Denmark, Sweden, UK, Switzerland	Moving average Standard deviation of weekly exchange rate return	Nominal	The gravity model Panel OLS	Significant negative impact

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Aristotelous (2001)	UK 1889-1999	UK aggregate exports to the US	MASD	real	Gravity model without distance variable	No impact
Doyle (2001)	Ireland 1979-1992 monthly	Aggregate and sectoral exports to the UK	GARCH Average absolute difference between current spot rate and previous forward rate	Real and nominal	$X_t = f(IP_t, E_t, V_t)$ Cointegration and ECM	Significant positive impact on the exports
Sauer and Bohara (2001)	22 developed and 69 developing countries 1975-1993	Aggregate exports	1.ARCH(1) 2.Moving standard error of trend estimate	Real effective	$X_t = f(Y_t^*, E_t, V_t, TOT)$ Fixed and random effect panel data analysis	Significant negative impact on Latin America and Africa countries

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Bahmani-Obkooee (2002)	Iran 1959-1989 Annual	Aggregate Imports and Exports Non-oil Exports	Standard Deviation of the percentage change in exchange rate	Black market exchange rate	$M_t = f(Y_t, E_t, V_t, T)$ $X_t = f(Y_t^*, E_t, V_t, T)$ Johasen's cointegration	Significant negative relationship on imports and non-oil exports
Cho *et al.* (2002)	10 developed countries 1974-1995 annual	Bilateral sectoral trade	1.Moving Average Standard Deviation 2. Long-run exchange rate uncertainty	Real	Gravity model Fixed-effect panel	Significant negative relationship on overall trade and agricultural trade

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Doğnalar (2002)	Turkey, S. Korea, Malaysia, Indonesia, Pakistan 1980-1996 Quarterly	Aggregate exports	Moving average standard deviation of the growth rate of exchange rate	Real	$X_t = f(RP_t, Y_t^*, V_t)$ Engle-Granger Cointegration, ECM	Significant negative impact
Arize *et al.* (2003)	10 Developing 1973-1998 Quarterly	Aggregate exports	Moving Average Standard Deviation	Real effective	$X_t = f(Y_t^*, RP_t, V_t)$ Johasen's cointegration, ECM	Significant negative impact except South Africa

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Bénassy-Quéré and Lahrèche-Révil (2003)	10 East Asian 1984-2001 quarterly	Bilateral exports to 23 countries	Standard deviation	Real	Gravity model Fixed effects Panel OLS	Negative impact
Bredin *et al.* (2003)	Ireland 1978-1998	Sectoral exports to the EU countries	MASD	Real effective	$X_t = f(Y_t^*, RP_t, V_t)$ Johansen error correction model	Positive impact in the long-run but no impact in the short-run
Grube and Samanta (2003)	Mexico 1980-2000 Quarterly	Aggregate Exports Aggregate Imports	Standard Deviation	Real	$X_t = f(Y_t^*, E_t, V_t)$ $M_t = f(Y_t, E_t, V_t)$ OLS	Significant negative relationship on import volume

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Baum *et al.* (2004)	13 Industrialized countries 1990-1998 monthly	Bilateral exports	AR(2) forecast based on past monthly volatilities generated from daily data	Real	$X_t = f\begin{pmatrix} Y_t^*, E_t, V_t, Y^*V_t, \\ [V_t \times Y^*V_t], ERM_t \end{pmatrix}$ nonlinear least square	On average positive impact
Clark *et al.* (2004)	176 countries 1975-2000	Aggregate, Bilateral, Disaggregated	Standard Deviation of monthly difference GARCH	Nominal and real effective Bilateral	Gravity model Fixed and random effect Panel estimation	No significant impact

Table 3.1: Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
De Vita and Abbot (2004a)	UK 1993-2001 Monthly	Aggregate and sectoral exports volume to 14 EU countries	1. Moving average standard deviation 2. ARCH	Real and nominal	$X_t = f(RP_t, Y_t^*, V_t)$ ARDL bound ECM	Short-run volatility has no impact on trade but Long-run volatility has significant negative impact
De Vita and Abbot (2004b)	US 1987-2001 quarterly	Aggregate exports to Mexico, Germany, Canada, Japan, and the UK	Moving average standard deviation of the level of exchange rate	Real	$X_t = f(RP_t, Y_t^*, V_t)$ ARDL bound ECM	Negative impact on the exports to Mexico, Japan, and the UK but Significant positive impact on the exports to Japan

Table 3.1; Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Klaassen (2004)	US 1978-96 monthly	Bilateral exports to G-7	AR(2) forecast based monthly volatilities	Real	$X_t = f(Y_t^*, E_t, V_t)$ Maximum likelihood	No clear effect of exchange risk on trade
Poon *et al.* (2005)	Five East Asian countries 1973-2002	Aggregate exports	MASD	Real effective	$X_t = f(Y_t^*, E_t, V_t, TOT)$ VAR-ECM	Significant negative impact except Singapore
Tenreyro (2007)	104 countries 1970-1997 Annual	Bilateral exports	1.Standard deviation of monthly exchange rate 2. Probability to peg common anchor	Nominal	$X_{ijt} = f\begin{pmatrix} Y_{it}Y_{jt}, N_{it}N_{jt}, DI_{ij}, \\ V_t, BOR_{ij}, FT_{ij}, LG_{ij} \\ COL_{ij}, AR_i, AR_j, LL_{ij} \end{pmatrix}$ PMLwith IV	No significant relationship with instrumental variable

Table 3.1; Summary of main features and results for the empirical studies (contd.)

Author(s) (year)	';Country and the sample period	Trade flows (Dependent variable)	Measure of exchange rate Volatility	Type of exchange rate	Model specification and estimation technique	General Results
Wang and Barrett (2007)	Taiwan exports to US (1989-1998)	sectoral exports	GARCH	Real	$X_t = f(RP_t, Y_t^*, V_t)$ FIML	Insignificant in most sectors except agricultural exports
Arize *et al.* (2008)	Eight Latin America countries 1973-2004	Aggregate exports	ARCH	Real effective	$X_t = f(Y_t^*, RP_t, V_t)$ Johasen's cointegration, ECM	Negative short-run and long-run impact

Notes: X =export volume, M = import volume, Y= income, Y^*= foreign income, E^e=expected real exchange rate, E= real exchange rate, RP =relative price, V=exchange rate volatility, Y^*V = foreign income volatility, IP = industrial production, CU=capacity utilization, CU^*= capacity utilization abroad, PC = production costs, PX = export prices, TOT = terms of trade, N = population, DI = distance, SD = seasonal dummy, FT= free trade dummy, LG= common language dummy, ERM=exchange rate mechanism dummy, BOR = common border dummy. COL=colonial tie dummy, AR = geographical area, LL= land lock dummy, MS=money supply, I=interest rate, UC=unit costs, S=nominal exchange rate, W=world export index, ST=strike dummy, OIL=oil revenue

OLS refers to ordinary least square; IV refers to instrumental variable; ECM refers to error correction model; VAR refers to vector autoregression; (G)ARCH refers to (generalized) autoregressive conditional heteroscedascity; FIML refers to Fully Identified Maximum Likelihood; ARDL refers to Auto-Regressive Distributed Lag

3.2 Measuring the exchange rate volatility

One of the important issues in the empirical study is how to measure the exchange risk arising from exchange rate uncertainty. Akhtar and Spence Hilton (1984) define exchange rate uncertainty as:

Exchange rate uncertainty refers to a state of doubt about future rates at which various currencies will be exchanged against each other. Of particular interest are the timing and size of exchange rate fluctuations that cannot be systematically explained by economic factors. Specifically exchange rate uncertainty reflects the extent to which exchange rate changes, in term of their timing and size, are unpredictable on the basic of past experience and existing economic models. (Akhtar and Spence Hilton; 1984, p.7)

The impossibility to precisely measure the above notion of exchange rate uncertainty has led empirical studies to use a measurable exchange rate volatility as proxy of exchange rate uncertainty. However, in the numerous empirical studies on exchange rate volatility and trade, it is obvious that there is no consensus on the appropriate method of measuring such exchange rate volatility. McKenzie (1999) states that '...economists generally agree that it is uncertainty in the exchange rate which constitutes exchange rate volatility, no generally accepted technique exists by which one may quantify such risk'(McKenzie, 1999; p. 76). This lack of consensus on the proxy for exchange rate volatility that appropriately represents exchange rate risk led to a wide variety of measures that have been used in the literature. Table 3.2 provides a summary of the measures of exchange rate volatility which have been employed in the empirical literature.

Table 3.2: Summary of measures used as proxy for exchange rate volatility

Measure of Exchange Rate Volatility	Derivation
1. Absolute percentage change of the exchange rate (Thursby and Thursby, 1987)	$V_t = \|(e_t - e_{t-1})\|/e_{t-1}$, where e is the spot exchange rate.
2. Average absolute difference between the expected (previous forward) and realized (current spot) exchange rate (Ethier, 1973; Hooper and Kohlhagen, 1987)	$V_t = \sum_{t=1}^{n} \|f_{t-1} - e_t\| / n$, where f is the forward rate.
3. Variance of spot exchange rate around its trend (Thursby and Thursby, 1987)	$\ln e_t = \phi_0 + \phi_1 t + \phi_2 t^2 + \varepsilon_t$
4. Standard deviation of the level of exchange rate (Hooper and Kohlhagen, 1978; Akhtar and Spence-Hilton, 1984)	$V_t = \sqrt{\sum_{t=1}^{n} (e_i - \bar{e})^2 / (n-2)}$, where e is the logarithm of exchange rate.
5. Standard deviation of the growth rate or change of exchange rate (Kenen and Rodrik, 1986; and Bini-Smaghi, 1991; Rose, 2000; Dell'ariccia, 1999)	$V_t = \sqrt{\sum_{t=1}^{n} (\Delta e_i - \Delta\bar{e})^2 / (n-2)}$, where e is the logarithm of exchange rate.
6. Moving average of the standard deviation of the exchange rate (Cushman, 1983; Kennen and Rodrick, 1986; Koray and Lastrape, 1989; Chowdhury, 1993)	$V_t = \left[(1/m) \sum_{i=1}^{m} (e_{t+i-1} - e_{t+i-2})^2 \right]^{1/2}$, where e is the logarithm of exchange rate and m is order of moving average.

Table 3.2: Summary of measures used as proxy for exchange rate volatility (Contd.)

Measure of Exchange Rate Volatility	Derivation
7. Medium-run exchange rate uncertainty (Perée and Steinherr, 1989)	$V_t = \frac{\max e_{t-k}^t - \min e_{t-k}^t}{\min e_{t-k}^t} + \left[1 + \frac{\lvert e_t - e_t^p \rvert}{e^p}\right]$ where e_{t-k}^t is the value of exchange rate over a given time interval of size k up to time t, and e_t^p is equilibrium exchange rate.
8. ARCH and GARCH models (Holly, 1995; Arize, 1995; Doroodian, 1999; Doyle, 2001; De Vita and Abbot, 2004a)	$x_t = \alpha_0 + \alpha_1 x_{t-1} + u_t$, u_t is white noise error with constant variance. Its conditional variance h_t^2 could be time varying which follows; $V(u_t \lvert I_{t-1}) = h_t^2 = \beta_0 + \beta_1 u_{t-1}^2 + \phi_1 h_{t-1}^2$
9. The sum of the squares of forward errors (Dell'ariccia, 1999)	$V_t = \sum_{t=1}^{n} (f_t - e_t)^2$
10. AR(2) forecast based on past monthly volatilities generated from daily data (Baum *et al.*, 2004; Klaassen, 2004)	$V_{t-1}[s_t] = \mu + \sum_{p=1}^{2} \alpha_p \left(\sqrt{\sum_{d=1}^{D_{t-p}} \{100(s_d - s_{d-1})} \right.$

In addition to the appropriate measure for exchange rate volatility, the nature of exchange rate itself such as real or nominal also becomes an important factor for the empirical analysis.[14] However, several studies have proved that nominal exchange rates move very closely to real exchange rates. Dell'ariccia (1999) also proves that there is strong correlation between nominal and real exchange rate volatility. In their recent paper, Clark *et al.* (2004) provided evidence that there is no major difference between these two measures and conclude that even though the nominal and real exchange rates are conceptually distinct, they do not differ much in reality especially for the short and medium terms when prices of goods tend to be sticky.[15] Hence, the use of nominal or real exchange rate makes little difference in practice; nominal and real exchange rate series generate nearly identical empirical results (Thursby and Thursby, 1987; McKenzie and Brooks 1997; Dell'ariccia, 1999; Tenreyro, 2007). Nonetheless, for a study that focuses on the countries which adopt fixed peg exchange rate arrangements (for example, China, Malaysia), real exchange rate volatility is the only available measure of exchange rate fluctuation.

In earlier literature, the standard deviation of the level of the nominal exchange rate is employed as a measure for exchange rate volatility (for example, Hooper and Kohlhagen, 1978; and Akhtar and Spence-Hilton, 1984; among others). Akhtar and Spence-Hilton (1984) examined the bilateral trade flows between the United States and Germany for the period of 1974-1981. In their empirical model, export volume is a function of capital utilization, income, relative prices, nominal exchange rate, and exchange rate uncertainty which is

[14] For developing countries with parallel exchange rate, this issue is more complex. Bahmani-Obkooee (2002) investigates the impact of black market exchange rate volatility on export of Iran.
[15] There is evidence that the deviation from PPP has estimated half life of adjustment in the order of about three to five years (Rogoff, 1996), so during this time horizon prices and costs tend to be sticky and real and nominal exchange rates move very closely.

measured as standard deviation of the nominal effective exchange rate. Their results indicate that exchange rate variability has a negative impact on the US export volume and German bilateral trade flows. However, Bini-Smaghi (1991) argues that the use of the standard deviation of the level of exchange rate as a measure for exchange rate uncertainty is suitable when the exchange rate moves around a constant level in the absence of any permanent changes. In the presence of a trend this index would probably overestimate exchange rate uncertainty (Bini-Smaghi, 1991).

Hooper and Kohlhagen (1978) tested several alternative measures for future foreign exchange risk. Their measures include the variance of spot rate and future rate, and absolute difference between previous forward rate and current spot rate. They find that the estimation that uses absolute difference between previous forward rate and current spot rate yields more significant coefficients and better overall equation fits than other measures. Their explanation for the finding is that the difference between previous forward rate and current spot rate might capture the effect of parity change under a pegged but adjustable regime and represent the market's assessment of exchange risk better than the other two measures (Hooper and Kohlhagen, 1978, p. 500).

Another measure of the exchange risk employed in the empirical work is the standard deviation of the percentage change of the exchange rate (for example, Kenen and Rodrik, 1986; Bini-Smaghi, 1991; Rose, 2000; and Tenreyo, 2007). Bini-Smaghi (1991) employed the standard deviation of weekly rates of changes of the intra EMS effective exchange rates to examine the impact of exchange rate volatility on manufacturing trade of three EMS countries, and provided evidence of the negative impact of exchange rate volatility on manufactured exports of Germany, France, and Italy for the period of 1976-84. As pointed out by Dell'ariccia (1999), this measure of exchange rate volatility is consistent with the standard representation of risk-averse firms. The justification is that this measure will equal zero when the exchange rate follows a constant trend, which could be perfectly anticipated and would not be a source of uncertainty. In contrast, when there are extreme movements, it gives a larger weight to the volatility.

In order to account for period of high and low exchange rate uncertainty, a number of empirical studies use the moving sample standard deviation of exchange rate as a proxy for exchange rate risk (Cushman, 1983; Kennen and Rodrick, 1986; Koray and Lastrape, 1989; Chowdhury, 1993; De Vita and Abbott, 2004a; 2004b). Koray and Lastrape (1989) assert that this measure captures the temporal movements in the exchange rates changes, and thus, exchange risk over time. However, Bini-Smaghi (1991) argues that the moving average transformation smoothes out the series and distorts the measurement of volatility. In addition, the arbitrary nature of choosing the order of moving average is also questionable.

So far, above mentioned studies focus on the impact of short-run volatility (typically less than one year) on trade. De Grauwe (1988) extended the time horizon to concentrate on the effect of long-run exchange rate variability to understand the impact of protectionist pressure arising from the exchange rate misalignment (long-run exchange rate variability). In his study, exchange rate variability is measured by the yearly percentage changes of the bi-lateral exchange rates around the means observed during the sub-periods of 1960-69 (the fixed exchange rate period) and 1973-84 (the flexible exchange rate period). By comparing the impact of exchange rate variability between the fixed rate and flexible rate periods, De Grauwe (1988) concludes that the variability of exchange rate is higher in the flexible rate period than fixed rate period and the growth rate of bilateral trade flows among the ten major industrial countries is negatively affected by exchange rate variability.

De Vita and Abbott (2004a) also investigated the impacts exchange rate volatility on the UK exports to the European Union (EU) countries by using short-run and long-run volatility. Their argument is that it is important to distinguish between the impact of short-run and long-run volatility since exporters can hedge against short-term risk through forward market transactions, but it is much more difficult and expensive to hedge against long-term risk (De Vita and Abbot, 2004a). So, the impact of exchange risk arising from long-run exchange rate volatility is likely to be more pronounced than the impact of short-run volatility. By using a newly developed ARDL bounds testing procedure and export volume disaggregated by markets of destination and sectors for the period 1993 to 2001, De Vita and Abbot (2004a) find evidence that the UK's exports to the EU14, at both aggregate and sectoral level, are generally unaffected by short-term exchange rate volatility. Re-estimation of the model using a long-term measure of volatility, however, provides evidence supporting the hypothesis that exchange rate uncertainty has a negative and significant influence on the UK exports to the EU countries.

However, the use of unconditional measures of volatility is subject to criticism since they lack parametric models for the time-varying variance of exchange rates. It has been recognized that financial assets and foreign exchange markets have the characteristic of time varying volatility such that large changes tend to be followed by large changes of either sign and small changes tend to be followed by small changes (Engel and Bollerslev, 1986). As noted by Doyle (2001), the time-varying variance may be attributed to factors such as rumours, political changes, and changes in government monetary and fiscal policies. Hence, Doyle (2001) suggests that the variance of the forecast errors of the exchange rate tends to be nonconstant and autocorrelated, and time-varying volatility measure is more suitable to proxy for the exchange uncertainty.

The time dependent conditional variance model measured by GARCH (Generalized Auto-Regressive Conditional Heteroscadascity) process has been used as a measure of exchange rate volatility in a number of studies (for example, Arize, 1995; Holly, 1995; Doyle, 2001; among others). In a GARCH (or simple form ARCH) model, exchange rate uncertainty is proxied by specifying the variance of exchange rate as a linear function of the expected squares of the lagged value of the error term from an auxiliary regression determining the mean of the exchange rate. Since exchange rate risk is associated with unexpected movements, a GARCH model that captures unexpected volatility is considered as an appropriate to measure the exchange rate risk.

However, the use of GARCH model as a measure for exchange rate uncertainty is also not without criticism. The problem of the GARCH measure is low correlation in volatility which implies low or zero persistence of shocks in monthly exchange risk (Baum *et al.* 2004; Klaassen, 2004). Klaassen (2004) provided evidence of the high persistence of real exchange shocks in moving standard deviation measure and low persistence of shocks in the GARCH measures by using real exchange rate between the US and its two most important trading partners. To solve this contradiction, Klaassen (2004) proposed the autoregressive model of order two (AR-2) forecast based on past monthly volatilities generated from daily data as an alternative measure for exchange rate risk.

It is obvious from the review of the literature that one of the major methodological issues in estimating the effect of exchange rate volatility on trade is choosing an appropriate measure of exchange rate volatility. A variety of measures have been employed to represent exchange rate volatility and there is no consensus on the appropriate measure. Consequently, in order to overcome this shortcoming, a number of studies use different proxies for exchange rate volatility to check the robustness of the results (for example, Kumar and Dhawan, 1999; Dell'arricia, 1999; Clark *et al.*, 2004).

3.3 Underlying trade flows

3.3.1 Aggregate trade flows

Another important aspect is the type of trade flows under study. Most of the earlier studies examine the impact of exchange rate volatility on aggregate multilateral trade flows (for example, Caballero and Corbo, 1989; Choudhury, 1993; Baily and Tavlas, 1988; Doroodian, 1999). Caballero and Corbo (1989) examine the impact of exchange rate volatility on aggregate exports of five developing economies. The empirical results of their study show a strong negative effect of exchange rate uncertainty on exports: an increase of 5 percent of real exchange rate volatility leads to a decline of exports ranged from 10 to 30 percent. Choudhury (1993) also finds a significant negative impact of exchange rate volatility on aggregate multilateral exports of G-7 countries. On the other hand, Baily and Tavlas (1988) find no evidence of the significant impact of exchange rate volatility on the US aggregate exports.

McKenzie (1999) points out that using aggregated national trade data implicitly assumes identical impact of exchange rate volatility across countries of destination and commodities. In reality, the impact is likely to be different depending on type of commodities and market destinations. If a country's bilateral trade flows with different trading partners produce positive and negative effects, these effects are likely to be cancelled each other out at the aggregate level. Therefore, using aggregate trade data may weaken the empirical findings since different impacts of exchange rate volatility on different commodities and/or different countries offset each others.

3.3.2 Bilateral trade flows

According to Clark *et al.* (2004) and Klaassen (2004), one of the reasons of mixed empirical results might be due to the well-known "aggregation bias" arising from using aggregate trade flows. In addition, empirical studies that investigate the impact of exchange rate volatility on aggregate exports employ the volatility of multilateral trade-weighted exchange rate. Klaassen (2004) points out that this kind of trade-weighted exchange rate is difficult to construct. Recognizing the limitations of analysing the aggregate data, more and more paper shifted their focus on the impact of exchange rate volatility on exports across different country pairs and over time (for example, Hooper and Kohlhagen, 1978; Cushman, 1986; Thursby and Thursby, 1987; De Grauwe, 1988; Koray and Lastrape, 1989; Dell'ariccia, 1999; Baum *et al.*, 2004; Clark *et al.*, 2004; Klaassen, 2004; among other). Clark *et al.* (2004) claims that shifting the focus to bilateral exports and volatility can improve the chance to detect an effect of exchange rate volatility on exports since bilateral study allows to control not only exchange rate volatility but also a variety of other factors – such as distance between two countries, level of exchange rate and cultural and geographical relationships – that could affect bilateral trade. In addition, since bilateral studies evaluate the volatility of bilateral exchange rate – which is the rate that is actually used by exporters and importers – they may provide a more accurate analysis.

Nonetheless, the results provided by the studies using bilateral data do not help to solve the basic ambiguity of the studies that use aggregate trade flows. Koray and Lastrape (1989) employed vector auto-regression (VAR) models to investigate the impact of real exchange rate volatility on the US bilateral imports from Canada, France, Germany, Japan, and the United Kingdom. Their study finds the evidence of a weak relationship between exchange rate volatility and bilateral imports. McKenzie and Brooks (1997) analyses the impact of exchange rate volatility on the German-US bilateral trade flows and find a statistically significant positive impact. On the other hand, Cushman (1986) also examines the US bilateral exports and the results indicate that exchange rate volatility has a significant negative impact.

Cushman (1986) asserts that the utilization of bilateral trade flow may have a specification problem because of omitting the "third country effect". For example, if the bilateral exchange rate volatility between Malaysia and the US is greater than that of Malaysia-Japan, the study of the impact of volatility on the Malaysia-Japan trade flows may give a positive relationship as a result of diverted trade flows from the US to Japan. Kumar and Dhawan (1991) tested the third country effect in their study of the impact of exchange rate uncertainty on Pakistan's exports to the developed world for 1974–85, and discovered strong evidence to suggest the presence of third-country effects.

Dell'ariccia (1999) investigated the effects of exchange rate volatility on bilateral trade flows of 15 EU countries plus Switzerland for the sample period from 1975 to 1994. He used three different variables as proxies for exchange rate uncertainty and instrumental variables to control the possible simultaneity problem. By using a gravity model and panel data analysis, all proxies give consistent results which suggest that the impact of exchange rate volatility on trade is negatively significant but the magnitude is small. Dell'ariccia (1999) also examined the third country effect by including the variable representing the exchange rate volatility of the two currencies with respect to rest of the countries. However, the coefficient is not significant and has the wrong sign suggesting that third country effect may not be significant for the EU countries.

3.3.3 Sectoral trade flows

It is worth noting that the whole economy bilateral analysis might still suffer a certain level of aggregation bias. According to Bini-Smaghi (1991), the contradictory results arising from empirical studies may be consequence of a series of methodological problems. One of the methodological issues is the sectoral aggregation. Bini-Smaghi (1991) argues that given the different nature of the market in which trade occurs, exchange rate volatility may have different impacts on different export sector. Goldstein and Khan (1985) suggest that the aggregation of trade data is likely to constrain the income, price and exchange rate volatility elasticities to be equal across sectors, and thus may imply the loss of important information. For this reason, a number of studies investigate the impact of exchange rate volatility on disaggregated sectoral trade flows (Bini-Smaghi , 1991; Holly, 1995; Doyle, 2001, Cho *et al.*, 2002; De Vitta and Abbott, 2004; Clark *et al.*, 2004a; for example).

To compare the effect of exchange rate volatility on aggregate and sectoral trade, Doyle (2001) examined the impact of exchange-rate volatility on Ireland' s exports to its most important trading partner, the United Kingdom, from 1979 to 1992 in both aggregate and 2-digit SITC Division levels. By using cointegration and error correction techniques, Doyle's finding suggests that both nominal and real exchange rate volatility have positive impact on the Irish aggregate exports to the UK. For STIC two digits sectoral level, however, some sectors are negatively affected by exchange rate volatility and some are positively affected. It is obvious that sectoral disaggregation can capture a more complete picture of the effect of exchange rate volatility on exports.

Cho *et al.* (2002) examine the effect of exchange rate uncertainty on the bilateral sectoral trade flows of ten developed countries between 1974 and 1995 by using a gravity model. Bilateral trade flows across ten developed countries are disaggregated into four categories: machinery, chemicals, other manufacturing, and agriculture. Exchange rate uncertainty is derived by using a moving standard deviation of the first differences in the exchange rate over the prior ten years in order to capture the medium to long-run variability of exchange rate. Their findings suggest that the sign and degree of the impact of exchange rate uncertainty vary across the different sectors. Exchange rate variability has significant negative impact on total trade as well as agricultural trade. However, the impact is more pronounce on agricultural trade which is around ten times higher than the impact on total trade. Alternative measure of long-run exchange rate uncertainty suggested by Perée and Steinherr (1989) also gives the consistent results. The results are still robust to the inclusion of the exchange rate volatility with other countries to control the third country effect.

Chou (2000) estimates the impact of exchange rate variability on aggregate exports of China by SITC category. By using ARCH conditional volatility of real exchange rate, Chou (2000) finds that that exchange rate variability has a long-run negative effect on total exports, exports of manufactured goods and exports of mineral and fuels. However, it should be noted that Chou (2000)'s study focuses on aggregated sectoral exports, not on bilateral sectoral exports. It is obvious that by investigating the impact of bilateral exchange rate volatility on bilateral sectoral exports can avoid aggregating bias. So far, only empirical studies which focus on advanced and developed economies are able to examine the impact of exchange rate volatility on bilateral sectoral exports. In order to examine the impact of bilateral exchange rate volatility on bilateral sectoral exports of emerging and developing countries is, however, constrained by the limited availability of bilateral export data at sectoral level.

3.4 Trade models specification

In addition to the choice of the measure for exchange rate uncertainty and trade flows, another important aspect in the empirical study on the relationship between exchange rate volatility and trade flows is the choice of trade model specification. It is obvious that empirical findings are sensitive to the choice of trade model.

From the literature, trade models used in empirical studies can be generally classified into two categories; the long-run export demand model and gravity type model.

3.4.1 Long-run export demand model

In a long-run export demand model exports is specified as a function of foreign income, relative price of exports, exchange rate and exchange rate volatility. This model assumes that export supply is infinitely inelastic and the exporter has little or no market power so that equilibrium export quantity is demand determined (see for example, Bini-smaghi, 1991; Chowdhury, 1991; Doordian, 1999; Chou, 2000; Sauer and Bohara, 2001). Alternatively, if the exporter is assumed to have some market power, equilibrium export quantity is determined by supply and demand simultaneously. In this situation, the trade model includes supply side factors such as production costs, capacity utilization and the competitors' price into the long-run export equation (see for example, Akhtar and Spence-Hilton, 1984; Hooper and Kohlhagen, 1987).

Most of the studies that focus on the multilateral exports use long-run export demand models. For example, Bredin *et al.* (2003) investigate the short-run and long-run impact of real exchange rate volatility on aggregate and sectoral exports of Ireland to the EU market by using a long-run export demand model in which exports is a function of foreign income, relative prices and exchange rate volatility. They find that exchange rate volatility has no impact in the short-run, but a significant positive impact in the long-run on both aggregate and sectoral exports. Based on their finding, the decline in intra-EU exchange rate volatility associated with the single currency would lead to a long-run fall in Irish exports to the EU. In contrast, by using a similar trade model but for the aggregate exports of eight Latin American countries, Arize *et al.* (2008) finds that exchange rate volatility measured by ARCH conditional volatility has a significant negative impact in both long-run and short-run in each of the sample countries.

3.4.2 Gravity models

Another trade model employed in the literature is the gravity model of trade which has been widely used in international economics (for example, Abrams, 1980; Thursby and Thursby, 1987; Krugman, 1991; Dell'ariccia, 1999; Rose, 2000; Clark *et al*, 2004; and Tenreyro, 2007). Unlike long-run export demand models which focus on a number of purely economic variables, gravity models contemplate a more geographic approach. Gravity models relate bilateral trade between two countries to the size of their markets, their proximity to each other, existence of a common borders and common language between them. It has been argued that the gravity model is one of the most empirically successful and widely used relationships in international economics (Deardorff, 1998; Clark *et al.*, 2004; Klein and Shambaugh, 2006).

Abrams (1980) uses a gravity model to examine the impact of exchange rate volatility on the value (rather than the volume) of the bilateral exports of 19 developed countries by using a pooled OLS estimation method. Although Abrams (1980) does not mention the gravity model in his study, he formulates the value of bilateral exports as a function of the importing and exporting countries' GDPs, the distance between each pair of countries, the percentage difference in each pair's real per capita incomes and dummies for membership in the European Economic Community. By using annual data over the period 1973-1976 of 19 developed countries, Abrams (1980) finds that exchange rate uncertainty, which is measured by the standard deviations of both the levels and the rate of change of monthly exchange-rate, has a significantly negative effect on the export value. However, the use of OLS technique to estimate a pooled data set is later criticised as this will lead to violation of the assumption of the homoskedascity of error term.

In a similar vein, Thursby and Thursby (1987) assess the impact of exchange rate uncertainty on bilateral export values of 17 countries for the period 1974-1982 by using an empirical model of the bilateral trade flows which is similar to the gravity model. In their model bilateral trade flows are a function of both countries' CPIs and GDPs, relative export and import prices, transport costs, tariff rates (proxied by dummies for membership in trade blocs), the nominal exchange rate and a proxy for exchange rate uncertainty which is measured by the standard deviation of the spot rate around a predicted trend. By incorporating per capital income of trading countries and a measure for exchange rate uncertainty into their model, Thursby and Thursby (1987) find a negative impact of exchange rate volatility on bi-lateral trade flows. However, unlike the study of Abrams (1980), Thursby and Thursby (1987) address the issue of heteroskedascity and use an estimation procedure suggested by MacKinnon and White (1985) to correct the estimated *t*-statistics.

In a cross-sectional context, Brada and Mendez (1988) test the impact of exchange rate volatility on the export values of 30 developed and less-developed countries by using a gravity model in which bilateral exports are modelled as a function of foreign income, population, distance, and the existence of preferential trade agreements between each pair of nations. Instead of using a particular measure of exchange rate volatility, Brada and Mendez (1988) employ dummy variables to represent fixed and floating exchange-rate regimes between each pair of countries. Using OLS method to estimate the model for each year from 1973 to 1978, their results confirm that although exchange rate volatility reduces bilateral trade, level of trade is significantly higher in floating rate regime. Recently, Klein and Shambaugh (2006) re-examine the same issue by using a larger data set (181 countries) and a different classification method to reflect the de facto exchange regime. They find different results suggesting that fixed exchange rate regime encourages bilateral trade whilst the impact of exchange rate volatility has a small negative impact.

In contrast, Dell'Ariccia (1999) applies fixed-effects and random-effects panel estimation approach to analyse the impact of exchange rate volatility on bilateral exports of 15 countries of the European Union, plus Switzerland, over the period from 1975-1994 by using a gravity model. Dell'arriccia (1999) employs four different measures of exchange rate volatility and for every measure of volatility employed the effect of exchange rate uncertainty is consistently significantly negative in both fixed-effects and random-effects estimations.

Rose (2000) also employed the gravity approach to measure the effect of currency unions on members' trade. By combining a very large data set involving 186 countries for five years 1970, 1975, 1980, 1985, and 1990, the author finds a small but significant negative effect of exchange rate volatility on bilateral trade. Exchange rate volatility in this study is measured as the standard deviation of the first difference of the monthly logarithm of the bilateral nominal exchange rate, which is computed over the five years preceding the year of estimation. So, in essence it is long-run exchange rate volatility. This result is robust when using three alternative measures of volatility.

Baum *et al.* (2004) introduced foreign income uncertainty as a variable to investigate the magnitude of the impact of exchange rate uncertainty when uncertainty in foreign income level varies. The underlying rationale is higher volatility in foreign income could be a signal of greater profit opportunity for exporters according to the theoretical literature which considers the "real options" of exporting activities. Their empirical model includes a proxy for income volatility, as well as the interaction term of foreign income and foreign exchange volatility in addition to the foreign income, relative price, and exchange rate volatility. In their analysis of the impact of exchange rate volatility on real international trade flows of 13 industrialized countries over the period between 1980 and 1998, they find that exchange rate volatility has a significant impact on real exports in all sample countries except Germany and on average the impact is positive.

Recently, Tenreyro (2007) addresses a number of the problems associated with the gravity model of bilateral trade, including heteroskedasticity of the error term, the existence of observations with zero values of bilateral exports, and potential endogeneity. She uses a pseudo-maximum likelihood procedure and instrumental variable method to correct for the relevant biases. By using a gravity model in which exports is a function of distance, per capita GDP, population, area, and dummies for free-trade agreements, contiguity, common language and colonial heritage, Tenreyro (2007) finds that nominal exchange-rate volatility has no effect on trade.

3.5 Estimation methods and econometric issues

Most of the papers that focus on the impact of exchange rate volatility on aggregate exports employ time-series data. Along with the advancement of time-series econometrics, these studies utilize the developments of estimation methods. However, recent work on this topic focuses on the impact of exchange rate volatility on exports across different country pairs and over time by utilizing the advancement in the econometrics of panel data analysis.

3.5.1 Time-series estimation methods

One of the contentious issues in the empirical analysis of the relationship between exchange rate volatility and trade flow is the choice of estimation method. Most of the earlier studies utilized the Ordinary Least Square (OLS) method to estimate time-series data (for example, Hooper and Kohlhagen, 1978; Akhtar and Spence-Hamilton, 1984, Bailey and Tavlas, 1988; Caballero and Corbo, 1989; Bini-Smaghi, 1991; and Pozo, 1992) but failed to provide conclusive results. De Vitta and Abbott (2004a; 2004b) pointed out that most of the early studies employed standard OLS regressions by implicitly assuming the stationarity of all the series and ignored the need for investigating the order of integration of relevant variables.

Since the trade variables are likely to be non-stationary, the regression analysis employed may give spurious results. This could be a reason that leads to incorrect inferences regarding the impact of exchange rate volatility on exports in the previous studies. This methodological problem has led the empirical studies to employ cointegration and error correction models in which the stationarity and cointegration of trade variables are taken into account (for example, Chowdhury, 1993; Holly, 1995; Arize *et al.*, 2000; 2003; Chou, 2000; Doyle, 2001; Doganlar, 2002; and Bahmani-Obkooee, 2002; Bredin *et al.*, 2003 among others). The methodology is based on a cointegration technique which attempts to establish whether there is a long-run relationship among a set of variables.

Apart from OLS and cointegration estimation methods, VAR (Vector autoregression) models have been used in the empirical studies which employ time-series data. Poon *et al.* (2003) employed the VAR model to examine the impact of exchange rate volatility on exports of five East Asian countries; Indonesia, Japan, South Korea, Singapore and Thailand. They employ a long-run export demand model augmented with exchange rate volatility which is measured by moving average standard deviation of real effective exchange rate. Their results provide evidence that exchange rate volatility has significant negative impact on exports of the sample countries except Singapore.

As noted by McKenzie (1999), if the measure of exchange rate volatility is stationary, it cannot be included in cointegration analysis as a determinant of trade. Holly (1995), Doyle (2001), and De Vitta and Abbott (2004a; 2004b) provided evidence that the exchange rate volatility measure is stationary, that is $I(0)$. This implies that it cannot enter into long-run cointegrating relationships with other variables such as trade flows, real exchange rate and incomes which are first-difference stationary $I(1)$. In his empirical study, which focused on the demand and supply of UK manufacturing exports, Holly (1995) did not include the measure of exchange rate volatility in the Johansen's cointegration test because it is stationary. Instead cointegration test is conducted in order to confirm the existence of long-run relationship between other non-stationary variables.

To overcome the problem of potential stationarity of exchange rate volatility measure, De Vita and Abbott (2004a; 2004b) employ an autoregressive distributed lag (ARDL) framework. They suggest that ARDL bound test is suitable whether the order of integration of volatility measure is $I(1)$ or $I(0)$. De Vita and Abbott (2004b) estimated the US exports to its five main trading partners and rest of the world over the period 1985-2001. Their long-run estimated coefficients suggest that long-run exchange rate volatility has a negative impact on the US exports to Mexico, Germany, and the UK, and a positive impact on the exports to Japan.

3.5.2 Panel data analysis

By contrast to the studies employed time-series data, a number of studies have used panel data estimation techniques which combine the cross-sectional and time-series dimensions of data (For example, Dell'ariccia, 1999; Rose, 2000; Anderton and Skudelny, 2001; Sauer and Bohara, 2001; Clark *et al.*, 2004; and Tenreyo, 2007). Dell'ariccia (1999) suggests that the availability of panel data allows a different approach to solve the simultaneous causality problem arise from the simultaneity bias when central banks try to stabilize the bilateral exchange rate against their countries' main trade partners. Dell'ariccia (1999) demonstrated that when the relative importance of trading partners remain the same overtime, the central bank effect would be captured by the country-pair dummy, and the fixed effects estimation of panel data approach would give unbiased estimates.

Sauer and Bohara (2001) also investigate the link between exchange rate volatility and exports by using a large panel of developed and developing countries. They pointed out that the use of panel data can overcome omitted variable problem as fixed and random effect models of panel estimation approach can capture the unobservable structural and policy differences across the countries. Using annual data for the 1966-93 period, Sauer and Bohara (2001) estimated the effects of exchange rate volatility on the real exports of 22 developed and 69 developing countries. Their results indicate that exports from developing countries are negatively affected by exchange rate volatility whereas most of the developed countries' exports are not.

In their recent study, Clark *et al.* (2004) analyse the role of exchange rate volatility in aggregate and sectoral trade by using a panel data set which covers 178 IMF member countries from 1975 to 2000. Their benchmark model which uses both time and country fixed effects provides evidence of a statistically significant negative impact of exchange rate volatility on trade. However, there is no evidence of the negative effect of exchange rate volatility on trade when they employ a panel model which controls for time-varying country specific factors.

Although panel data analysis has particular advantages in examining the impact of exchange rate volatility on trade, the longer time dimension of panel data (for example; Dell'ariccia, 1999; Baak, 2004) may lead to the problem of non-stationarity and spurious regression. Baltagi (2001) notes that for a macro-panel with large N (numbers of countries) and longer T (length of time series) nonstationarity deserves more attention. None of the above mentioned panel data studies conducted a panel cointegration test to verify the long-run relationship among the variables. So these studies might be subject to the problem of spurious regression.

Moreover, the fixed effect specification of panel data approach assumes homoskedasticity of error terms. However, there is the possibility that individual effects may vary over time as a result of omitted macroeconomic shocks. That is, individual countries may respond to the effects of time-varying unobservable shocks differently. This could lead to the problem of heteroskedasticity. In order to overcome this potential problem, later studies utilize Generalised Method of Moments (GMM) approach which is more efficient than OLS in the presence of heteroskedasticity. For example, Tenreyro (2007) uses a pseudo- maximum likelihood (PML) technique which is a variant of GMM approach.

3.5.3 Endogeneity of exchange rate volatility

For the studies that focus on bilateral exports, it has been argued that there is a potential problem of endogeneity, that is, an increase in the level of trade between two countries may lead to a more stable bilateral exchange rate. One situation is, as pointed out by Dell'Ariccia (1999), monetary authority may try to stabilize the bilateral exchange rate with the most important trading partner. In this situation exchange rate volatility could become an endogenous variable and the results of OLS estimation would be biased.

Hau (2002) and Bravo-Ortega and Giovanni (2005) demonstrate that a high degree of economic integration between two countries might lead to a more stable real exchange rates. Tenreyro (2007) points out that the potential endogeneity is one of the main problems that cast doubt on the findings of previous empirical studies which utilise OLS regression. In order to control this problem, some studies apply instrumental variables (IV) approach by using an appropriate instrument for exchange rate volatility (See for example, Frankel and Wei, 1993; Dell'ariccia, 1999; Rose, 2000; Tenreyro, 2007).

Frankel and Wei (1993) use the standard deviation of relative money supplies as an instrument for the exchange rate volatility and find a negative and significant effect of exchange rate volatility on trade, but the size of this effect is smaller when using an IV approach than when using OLS. Their justification for using the standard deviation of the relative money supply as an instrument for the exchange rate volatility is that although relative money supplies are highly correlated with bilateral exchange rate, the monetary policies are less affected by export considerations than exchange rate policies (Frankel and Wei, 1993). Rose (2000) also uses inflation and monetary quantity variables as instruments and obtains results consistent with those from OLS.

Dell'ariccia (1999) argues that the use of country-pair fixed effects could control for the possibility of endegoneuity. Nonetheless, he employs the sum of the squares of the three-month logarithmic forward error as an instrument for the standard deviation of the first differences of the logarithmic spot rate. The author claims that the forward error is not controlled by central banks, but it is positively correlated with his measure of exchange rate volatility. Dell'ariccia (1999) finds that the results obtained with instrumental variable estimation are more or less the same as those of the panel OLS estimation.

Tenreyro (2007) argues that the instrumental variable approach used by Frankel and Wei (1993) and Rose (2000) are driven by factors that are also likely to affect trade flows directly. Therefore, she uses a dummy variable that indicates whether two countries share a common anchor currency or the propensity of that two countries share a common anchor currency as an instrument for the exchange rate volatility. In contrast, Clark *et al.* (2004) control for the potential endogeneity by using two instrumental variable approaches. The estimation results using Frankel-Wei instrumental approach show that the negative impact of exchange rate volatility is statistically significant only in two out of six specifications. In these two cases, they find the negative impact is substantially larger than the results obtained with OLS estimation. When they use instrumental variable approach similar to Tenreyro (2007), the coefficients of the exchange rate volatility measure becomes insignificant across all specification.

3.6 Conclusion

This chapter has reviewed the contributions of the empirical studies on the relationship between exchange rate volatility and exports. The synopsis of the review is that the findings are sensitive to the choice of the proxy for exchange rate volatility, the underlying exchange rate, the type of trade flows and the choice of trade model and estimation techniques. Nonetheless, a growing number of studies, which utilize the gravity model and panel estimation techniques, have proved to be more robust and successful in the bilateral context.

It is obvious that one of the most important issues in the empirical literature is to choose an appropriate exchange rate volatility measure. In the empirical literature, there is no generally accepted exchange rate volatility measure, which can quantify foreign exchange risk arising from the exchange rate uncertainty. So far, the common practice in the recent literature is to use different types of measure and check the robustness of the results.

Another notable and important point of view in the literature on the relationship between exchange rate volatility and international trade is the direction of causality. The traditional view is that exchange rate volatility increases exchange rate uncertainty and thus reduces incentives to international trade. However, a number of studies have demonstrated that a high degree of economic integration might lead to more stable real exchange rates. Hence, endogeneity of exchange rate volatility is also an important issue in considering the research methodology.

By reviewing the extant literature on the impact of exchange rate volatility on trade, it is possible to identify a suitable methodology to be employed in the current study. Specifically, following methodological issues are considered to be important to enhance the validity of the current study in order to provide new evidence of the impact of exchange rate volatility on the exports of emerging East Asia economies.

- To use bilateral exports and bilateral exchange rate to avoid aggregating bias
- To use a gravity model suitable for the characteristics of emerging economies in order to avoid the potential problem of mis-specification

- To employ different exchange rate volatility measures in order to check the robustness of the results
- To use panel data in order to increase the efficiency and to control unobservable country-pair specific effects and third country effects
- To check the stationarity of the panel data in order to avoid the problem of spurious regression
- To employ instrumental variable approach in order to avoid the potential problem of endogeneity
- To utilize the GMM approach in order to overcome the potential problem of heteroskedascity

Next chapter will present the research methodology in which above mentioned issues are dealt with in order to provide fresh insights into the relationship between real exchange rate volatility and exports of five emerging East Asian countries.

Chapter 4

Research Methodology

4.1 Introduction

According to theoretical propositions presented in the literature review section the impact of exchange rate volatility on exports is not unambiguous. Partial equilibrium models demonstrate that the impact of exchange rate volatility depends on the relative risk aversion of the exporter. On the other hand, general equilibrium models posit that the effect of exchange rate volatility on trade is determined by the sources of exchange rate volatility. Given the fact that the relationship between exchange rate volatility and international trade is theoretically indeterminate, this issue has attracted a large numbers of empirical studies. However, having reviewed the empirical literature in Chapter 3, a clear consensus about this relationship is yet to emerge.

This chapter outlines the research methodology to be used in the following empirical chapters. It has been argued that the use of conventional cross-section or time-series estimations are misspecified since it is not able to deal with bilateral (exporter and/or importer) heterogeneity, which is extremely likely to be present in bilateral trade flows. In contrast, recent studies which employed panel based approach are more desirable because heterogeneity issues can be modelled by including country-pair "individual" effects, and thus tends to find more robust results (for example, Dell'ariccia, 1999; Clark *et al.*, 2004). There are apparent advantages of analysing the impact of exchange rate volatility on bilateral exports in panel data context. By combining cross-sectional and time-series dimensions, a panel data analysis can control not only for temporal effects but also heterogeneity across the countries. For these reasons, this study utilizes a panel-data set that pool time-series data and cross-sectional bilateral trade flows of five emerging East Asian countries.

As obvious from the review on empirical literature, there are several methodological problems that cast doubt on the previous findings on the relationship between exchange rate volatility and exports. First of all, although panel data analysis has particular advantages in examining the impact of exchange rate volatility on trade, the longer time dimension of panel data may lead to the problem of non-stationarity, and spurious regression. Baltagi (2001) notes that for a macro-panel with large N (numbers of cross-sectional units) and longer T (length of time series) nonstationarity deserves more attention. Hence, in order to avoid the problem of spurious regression, it is necessary to conduct panel unit-root and cointegration tests to verify the long-run relationship among the variables.

Secondly, with a few exceptions, previous empirical studies explicitly or implicitly assume that bilateral exchange rate volatility is exogenous to the trade flows between two respective countries. However, there is a possible inverse relationship between bilateral exchange rate volatility and trade, that is, an increase in the level of trade between two countries may lead to more stable bilateral exchange rate. If the sample countries implement policies aimed at lowering bilateral exchange rate volatility in order to increase their exports, the model considered would suffer an endogeneity bias. Under such circumstance, exchange rate volatility cannot be treated as an exogenous variable, and the estimates of Ordinary Least Square (OLS) regression would tend to produce a bias. In order to control for this possibility, the instrumental variable (IV) approach is employed in the current study.

Third issue is related to the problem of aggregating bias; that is putting countries which are in different structural, institutional and development stages together in the sample. It is very unlikely that the impact of exchange rate volatility on trade is uniform across countries which are at different stages of development. As noted by Bayoumi and Eichengreen (1995), the relationship between trade and other economic characteristics might be different between industrial and developing countries because of the differences in the structure and nature of trade. Therefore using a sample of countries consists of both advanced and developing countries (for example, Rose, 2000; Tenreyro, 2007) might lead to an aggregating bias. In contrast, this study focuses on the impact of exchange rate volatility on exports of five emerging East Asian economies. These countries are relatively homogeneous in terms of technology, development level, per capita income and the pattern of exports. By focusing on the countries with relatively similar characteristics, it can overcome the problem of aggregating bias.

Finally, majority of previous panel data studies use fixed-effect estimation approach. The estimates of fixed-effects panel model would be unbiased only if the error terms were homoskedastic. However, if the sample countries respond differently to time-varying unobservable macroeconomic shocks, it is very likely that individual effects may vary over time as a result of omitted macroeconomic shocks. In this case, the fixed-effect panel data estimation may be subject to the problem of heteroskedasticity. When residuals are heteroskedastic, the estimated coefficients will be biased. In order to control for this possibility, the Generalised Method of Moments (GMM) estimation technique is employed in this study.

The outline of the chapter is as follows. Section 4.2 discusses the issues related to the choice of empirical model. The definitions of the variables and data sources are presented in section 4.3. Section 4.4 discusses the panel data estimation methods and their benefits and limitations. Finally, the last section gives conclusions.

4.2 Model specification

To investigate the effect of exchange rate volatility on exports, there are several factors other than exchange rate volatility that affect bilateral exports and it is important to account for them in a way that is consistent with economic theory. As obvious from the existing empirical studies, the gravity model has been widely used in the studies that examine the relationship between exchange rate volatility and bi-lateral trade. In terms of its ability to explain a large part of variations in the observed trade patterns, Anderson and van Wincoop (2003) claim that '(T)he gravity equation is one of the most empirically successful in economics.'(Anderson and van Wincoop, 2003; pp. 1)

4.2.1 Gravity model

Gravity model of international trade utilizes gravitational force concept as an analogy to explain the volume of trade between two countries. According to the Newton's Law for the gravitational force, the gravitational force (GF_{ij}) between two objects i and j is directly proportional to the masses of the objects (M_i and M_j) and indirectly proportional to the distance between them (D_{ij}) which can be expressed as:

$$GF_{ij} = M_i M_j / D_{ij}. \qquad (4.1)$$

In the gravity model of international trade the volume of trade between two countries increases with the product of GDPs (economic mass) of these countries and decreases with their geographical distance. In log-linear form, the gravity model of bilateral trade between two countries can be expressed as;

$$\ln X_{ij} = \ln GDP_i + \ln GDP_j - \ln D_{ij}. \qquad (4.2)$$

The basic concept is that country with a larger economy tends to trade more in absolute terms. A high level of income in the exporting country suggests a high level of production, which increase the availability of goods to exports. A high level of income in the importing country leads to higher demand for imports. On the other hand, distance between two countries represents a proxy for transportation costs and it depresses bilateral trade.

Theoretical foundations of the gravity model can be linked to different structural models such as Armington structure of demand (e.g., Anderson, 1979, Bergstrand, 1985), Ricardian models (e.g., Davis, 1995, Eaton and Kortum, 1997), Heckscher–Olin (HO) models of factor endowment differences (e.g., Deardorff, 1998) and increasing returns to scale (IRS) models of the New Trade Theory (e.g., Helpman and Krugman, 1985; Helpman, 1987, Bergstrand, 1989).[16]

The standard formulation of the gravity model is commonly extended to include other factors generally perceived to influence bilateral trade between two countries. In its theoretical specification, the gravity model can be expressed as follows:

$$X = f(Y, Y^{*}, Dist, Z) \tag{4.3}$$

where real exports (X) between two countries depend on the income level of exporting country (Y) and host country (Y^{*}), the distance between two countries ($Dist$) and the vector of bilateral variables (Z) which frequently includes exchange rate variables in its level and volatility forms and dummy variables representing the use of a common language, membership of a free trade area and sharing a common border.

[16] See Anderson (1979), Helpman(1999) and Evenett and Keller (2002) for the review of theoretical explanations for the gravity model.

Recently, Feenstra *et al.* (2001) have shown how a gravity equation can be derived even with *homogeneous* goods produced in all countries by modelling the market structure of the homogeneous good as Cournot-Nash competition, and using the "reciprocal dumping" model of trade. They showed that the gravity equation is quite general, so it can be used to model the trade flows for both *differentiated* and *homogeneous* goods. According to Feenstra *et al.* (2001, p.440) bilateral exports of homogenous goods between two countries can be explained by a gravity model in which the real exports is a function of exporter's GDP, importer's GDP, the distance between two countries and a number of auxiliary variables relevant for the bilateral trade flows. Since the current study focuses on the bilateral exports of emerging countries which can be generally classified as inter-industry trade of homogenous products, the gravity model derived by Feenstra *et al.* (2001) seems appropriate for this study. [17]

However, Bergstrand (1985) demonstrates that price terms derived from underlying utility and production functions have a significant impact on bilateral trade flows. Bergstrand (1989) developed a general equilibrium model of world trade with two differentiated product industries and two factors. The author specified the supply side of economies and argued that prices in the form of GDP deflators might be important additional variables to added into the gravity equation. Bergstrand (1989) argue that typical gravity equation omitting price

[17] Cordenillo (2005) noted that most of the bilateral trade flows among the sample countries comprises of electrical equipment, computer/machinery, lubricants/fuels/oil, organic chemicals, plastics, fats & oils and rubber which are classified as inter-industry trade.

variables could be misspecified.[18] Therefore, trade model used in this study is the gravity model of Feenstra *et al.* (2001) augmented with relative prices variable in the spirit of Bergstrand (1989) and the variable of main interest exchange rate volatility. The augmented generalised gravity model can be expressed as follows:

$$X = f(Y, Y^{*}, RP, VOL, Dist, CB, FTA) \tag{4.4}$$

where the real exports (X) is a function of home country's GDP (Y), importing country's GDP (Y^{*}), relative prices (RP), exchange rate volatility (VOL), and a set of gravity variables – the distance between two countries ($Dist$), sharing of a common border (CB) and membership of Free Trade Area (FTA).[19]

The export volume between two countries is expected to be positively related to income of the exporting and importing country. The higher price level in importing country relative to exporting country will induce more exports from the exporting country, so the real exports is expected to be negatively related to the relative price levels of exporting country to importing country. In addition, sharing a common border and the membership of free trade agreement are expected to increase the bilateral trade flows between two countries whilst the

[18] Bergstrand (1989) also added income per capita of exporting and importing country along with price variables into the standard gravity model and labels as generalised gravity model. In general, a per capita income variable is included to represent specialization; richer countries tend to be more specialized, and thus they tend to have a larger volume of international trade for any given per capita GDP level. Since current study focuses on the bilateral exports of emerging countries which can be generally classified as inter-industry trade, per capita income of exporting and importing country are excluded from the model.

[19] Given the fact that the sample countries are major recipients of foreign direct investment, FDI inflows are likely to have significant impact on their exports (See for instance Blattner; 2005). However, theoretically, it is not clear whether FDI is a substitute for or a complement to trade, so that the direction of the impact is undetermined (see Markusen and Venables, 1998, and Egger and Pfaffermayr, 2004). In addition, FDI inflows may simply imply a change in the ownership of an existing firm without having any impact on international trade. More importantly, bilateral FDI data are not readily available for the sample countries. For these reasons, FDI flows variable is excluded from the model.

distance between two countries is negatively related to the bilateral export flows. As discussed in the literature review section, the relationship between exchange rate volatility and export volume is yet to be determined.

4.3 The definition of the variables and data sources

This study restricts itself to examining the effect of exchange rate variability on exports, notwithstanding the fact that an examination of overall trade would permit an analysis of the welfare effects of variability. Real exports is defined as the export values deflated by export price indices. However, export price indices are available only for total exports of a country but not available for bilateral exports. In order to transform the export values which are expressed in current US dollars in the IMF's Direction of Trade Statistics (*DOTS*), into real exports (export volume) there are two possible ways to proceed. The first method is to convert the US dollar denominated export values into exporters' currencies and then deflate with each country's GDP deflator. Then, real exports in local currency can be converted into a common currency. Alternatively, the US dollar denominated bilateral export values can be expressed in constant prices by using the US GDP deflator. Each method of transformation has its own advantages and disadvantages. Because of the limitation in data availability this study employs the second procedure. Eichengreen and Irwin (1996), Yao and Zhang (2003) Clark *et al.* (2004) and Klaassen (2004) also use the same procedure to deflate the export values denominated in the current U.S. dollar into constant prices by using the US GDP deflator. Following their transformation procedure, the real exports from country i to country j (X_{ijt}) is defined as follows:

$$X_{ijt} = \left(\frac{Export_{ijt}}{USGDPD_t} \right) \tag{4.5}$$

where export values ($Export_{ijt}$) is obtained from IMF's *DOTS* database.

The real GDP of the home country and importing country are constructed as follows. The quarterly GDP in current prices are transformed into constant prices by using each country's GDP deflator and then converted into a common currency (US dollar).

Real exchange rate is defined as nominal bilateral exchange rate deflated by relative price level (CPI) of respective countries. In this study, real exchange rate is constructed by using the end of period nominal exchange rate adjusted by the respective price levels of two countries. Quarterly nominal exchange rates and prices levels are obtained from the IMF's International financial statistics. For China, the data for quarterly CPI is not readily available for the whole sample period, and the missing data are constructed by using Otani-Riechel method to transform the annual data obtained from the World Bank's World Development Indicators database and various Chinese Statistical Yearbooks into quarterly data.

Relative price (*RP*) is constructed as the ratio of the wholesale price index of the exporting country to the consumer price index of the destination country expressed in the currency of exporting country. In fact, a more suitable relative price should be the ratio of the export price index of the exporting country to the consumer price index of the importing country. This type of relative price can represent the substitution effect more realistically as the importer compares the price of imports with the domestic price level. However, the export price index data are not readily available for the sample countries for the sample period.

Among the sample countries, Indonesia, Malaysia, the Philippines, Thailand are members of the Association of South East Asian Nations (ASEAN). These countries established the ASEAN Free Trade Area (AFTA) in January 1992 to eliminate tariff barriers among them. Therefore, a dummy variable which equals to one is included to represent the membership of AFTA from 1993:Q1 onwards. In addition a dummy represents the presence of a common border is added into the model in order to control for the effect of sharing a common border on the bilateral exports. Another gravity variable, distance, is represented by the shipping distance between two countries available from the www.portworld.com.

4.3.1 Measures of exchange rate volatility

Before discussing the measure of exchange rate volatility, it is useful to note two important issues that are particularly relevant for developing countries. The first issue is concerned with the volatility of exchange rate under managed or pegged exchange rate regimes. According to the classification of the IMF (as of July 31, 2006), the exchange rate arrangements of the sample countries range from a fixed peg arrangement of China to independent floating regime of Indonesia and the Philippines (IMF, 2006). During the period of estimation (from 1982 to 2006), the exchange rate arrangement of each country also varied from time to time. For example, Malaysia adopted a flexible exchange rate regime before the 1997 financial crisis. After the crisis, Malaysia ringgit was pegged to the US dollar. And then, in 2005 the exchange rate arrangement of Malaysia has shifted to a managed floating regime. However, as pointed out by Clark *et al.* (2004), it is important to note that managed or pegged exchange rate regimes do not necessarily reduce the volatility of exchange rate.

The second issue is the role of currency invoicing in the exports between a pair of developing countries. Most of the trade between two developing countries are invoiced in a major currency instead of the either currency of these countries. Therefore, it might seem that volatility of bilateral exchange rate of two trading partners is not relevant volatility to be considered. But this is not the case. Clark *et al.* (2004) demonstrates that any fluctuations of the bilateral exchange rate between the trading partners must reflect the fluctuations in the invoicing currency and the currency of each trading country.

It is obvious from the review of the literature that one of the major issues in estimating the effect of exchange rate volatility on trade is choosing an appropriate proxy to represent the exchange rate volatility. The first concern is the choice between real and nominal exchange rate. This study focuses on real exchange rates: that is, the nominal exchange rate adjusted by relative prices of the two countries. Therefore, real exchange rate volatility depends upon not only the variability in the nominal foreign exchange rate but also on the volatility of the prices. Clark *et al.* (2004) emphasise that this measure is particularly appropriate for analysing the decision problem of an exporter for a longer term period of time during which production costs, export prices and import prices will vary. Nonetheless, as pointed out by Dell'Ariccia (1999) and Tenreyro (2007), the nominal and real exchange rate tends to move closely together as a result of the stickiness of domestic prices.

A variety of measures have been employed to represent exchange rate volatility in the previous empirical studies and there is no consensus on the appropriate measure. Consequently, some studies employ different proxies for exchange rate volatility to test the model (for example, Kumar and Dhawan, 1999; Dell'arricia, 1999; Clark *et al.*, 2004). Following their practice, this study employs three measures of exchange rate volatility: the standard deviation of the first difference of the logarithm of real exchange rate, the moving average standard deviation of the logarithm of quarterly bilateral real exchange rate, and the conditional volatilities of real exchange rates estimated using a Generalised Autoregressive Conditional Heteroscedascity (GARCH) model.

The first measure is the standard deviation of the first difference of the logarithm of real exchange rate. The characteristic of this measure is it gives large weight to extreme volatility. Since the countries being considered have to focus on the export promotion policies and their domestic markets cannot absorb the entire production of exportable products, their exports might not be affected by relatively small volatility. In addition, this measure will equal zero when the exchange rate follows a constant trend. If the exchange rate follows a constant trend it could be perfectly anticipated and therefore would not be a source of exchange risk. For these reasons, the standard deviation of the first difference of the logarithm of real exchange rate is employed as a benchmark proxy for the exchange rate volatility in this study. Specifically, the standard deviation of the first difference of quarterly bilateral real exchange rate is derived as:

$$V_{ijt} = \sqrt{\sum_{t=1}^{m}\left(\Delta e_{ijt} - \Delta\overline{e}_{ijt}\right)^2 / m-1} \tag{4.6}$$

where e_{ij} is the logarithm of bilateral exchange rate change, and m is number of quarters which equals eight.

In order to check the robustness of the results, two other measures of exchange rate volatility will also be employed. The second measure of exchange rate volatility is the moving average standard deviation of the logarithm of bilateral real exchange rate. This measure can capture the movements of exchange rate uncertainty overtime. The characteristic of this measure is its ability to capture the higher persistence of real exchange rate movements in the exchange rate (Klassen, 2004). The moving average standard deviation measure of exchange rate volatility is defined as follows:

$$V_{ijt} = \left[(1/m)\sum_{i=1}^{m}\left(e_{ijt+i-1} - e_{ijt+i-2}\right)^2\right]^{1/2}, \tag{4.7}$$

where e_{ij} is the logarithm of bilateral exchange rate, and m is the order of moving average which equals eight in order to be consistent with the benchmark measure.

In both standard deviation based exchange rate volatility measures, the temporal window is set to eight quarters in order to stress the importance of medium-run uncertainty. The current volatility is calculated on the exchange rate movements during previous eight quarters in order to reflect the backward-looking nature of risk, that is, it is assumed that firms use past volatility to predict present risk. In order to test the robustness, the standard deviation of the first difference of quarterly bilateral real exchange rate using four-quarter window is also employed in this study.

As noted earlier, however, there is no 'ideal' measure of exchange rate volatility. Accordingly, as part of robustness analysis the conditional volatilities of the exchange rates estimated using a GARCH model is also used in this study as a third measure of exchange rate volatility. The GARCH exchange rate volatility allows volatility clustering, which means large variances in the past generate large variances in the future. The underlying idea is that part of the exchange rate volatility is conditional upon historical information from previous period. Hence, the volatility can be predicted based on the past movements of exchange rates. In a GARCH model the log difference of monthly exchange rates is assumed to follow a process of a random walk with drift as follows:

$$e_{i,t} = \alpha_0 + \alpha_1 e_{i,t-1} + \mu_{i,t}, \tag{4.8}$$

where $\mu_{it} \sim N(0, h_{it})$ and the conditional variance is:

$$h_{i,t} = \beta_0 + \beta_1 \mu_{i,t-1}^2 + \beta_2 h_{i,t-1} \tag{4.9}$$

The conditional variance equation (4.9) represents three terms: (i) the mean, β_0; (ii) the one-period lag of the squared residual from exchange rate equation, which represents news about the volatility from previous period, $\mu^2_{i,t-1}$ (the ARCH term); and the last period's forecast error variance, $h_{i,t-1}$ (the GARCH term). The advantage of this measure is that it relies on a parametric model for time varying variance.

A GARCH (1, 1) model is estimated and the estimated conditional volatility of the first month of the quarter will be used as the approximation of the conditional volatility of that quarter. For example, the conditional volatility of the first quarter of a year is assumed to equal the estimated conditional volatility for January of that year in the GARCH regression.[20] The construction and derivation of the variables and data sources are presented in Table 4.1.

[20] However, it is argued that the GARCH-based volatility measure is more suitable to measure the volatility of high frequency data such as daily exchange rate movements (see Baum *et al.*, 2004; Klaassen, 2004). But for the sample countries during sample period, daily exchange rates are not readily available. So, GARCH volatility is only employed as a measure to check the robustness of the results.

Table 4.1: Construction of the variables and data sources

Variable	Definition and Construction	Source
Real Exports (X_{ijt})	$X_{ijt} = \left(\frac{Export_{ijt}}{USGDPD_t} \right)$	Author's construction using bilateral exports value from the *Direction of Trade Statistics* and the US GDP deflator obtained from the *International Financial Statistics.*
Real GDP of Home Country (Y_{it})	$Y_{it} = \frac{GDP_{it}}{GDPD_{it}} \times \frac{1}{E_{i,US,t}}$	Author's construction using GDP in current price, GDP deflators and end of the period nominal exchange rates obtained from the *International Financial Statistics*
Real GDP of Importing Country (Y_{jt})	$Y_{jt} = \frac{GDP_{jt}}{GDPD_{jt}} \times \frac{1}{E_{j,US,t}}$	Author's construction using GDP in current price, GDP deflator and end of the period nominal exchange rate obtained from the *International Financial Statistics*

Table 4.1 Construction of the variables and data sources (Contd.)

Variable	Definition and Construction	Source
Relative prices (RP_{ijt})	$RP_{ijt} = \frac{WPI_{it}}{CPI_{jt}} \times \frac{1}{E_{ijt}}$	Author's construction using the whole sales price index of exporting country, consumer price index of the destination country and nominal exchange rate obtained from the *International Financial Statistics*.
Volatility of real bilateral exchange rate (V_{ijt})	1. $V_{ijt} = \sqrt{\sum_{t=1}^{m} \left(\Delta e_{ijt} - \Delta \bar{e}_{ijt}\right)^2 / m-1}$ 2. $V_{ijt} = \left[(1/m)\sum_{i=1}^{m} \left(e_{ijt+i-1} - e_{ijt+i-2}\right)^2\right]^{1/2}$ 3. GARCH conditional Volatility	Author's construction using nominal exchange rate and CPI from the *International Financial Statistics* and Chinese Statistical Yearbooks.
Distance ($Dist_{ij}$)	The logarithm of shipping distance between two countries	Obtain from the www.portworld.com.

Table 4.1 Construction of the variables and data sources (Contd.)

Variable	Definition and Construction	Source
The presence of a common border ($D1_{ij}$)	Dummy variable taking the value of 1 if both countries are sharing a common border	
Membership of the ASEAN Free Trade Area ($D2_{ijt}$)	Dummy variable taking the value of 1 if both countries are members of the AFTA at a time	

4.4 Methods of estimation

Most of the earlier papers employed only cross-sectional or time-series data and the empirical evidence of these earlier studies is, nonetheless not unambiguous. For example, Hooper and Kohlhagen (1978), Bailey and Tavlas (1988), and Holy (1995) used time-series data to examine the impact of exchange rate volatility on exports of industrialised countries and found essentially no evidence of any negative effect. In contrast, Cushman (1986), De-Grauwe (1988) and Bini-Smaghi (1991) examined the sample of industrialised countries by using time-series data and found evidence of a significant negative effect. However, time series analysis cannot control for country-pair specific effects such as distance between two countries.

Cross-sectional studies, such as Brada and Mendez (1988) and Frankel and Wei (1993) found a negative impact of exchange risk on trade volume, but the effect is, in most cases, relatively small. However, the major drawback of cross sectional analysis is that it cannot control the impact of changes in time variant variables (income, relative price, exchange rate volatility) of countries on changes in the pattern of bilateral trade over time.

Unlike time-series or cross-sectional data, panel data allows to control for unobserved individual heterogeneity. If such unobservable effects are omitted and are correlated with the independent variables, OLS estimates would be biased. For example, although the sample countries are similar in the level of development and pattern of exports, these countries have cultural, political and institutional differences. Time-series and cross-sectional studies cannot control for this heterogeneity and have the potential of obtaining biased results. The use of panel data can eliminate the effects of omitted variables that are specific to individual cross-sectional units and specific time period (Hsiao, 1999). This advantage is important for the current study since cross-country structural and policy differences may have impacts on their trade flows.

Another advantage of using a panel data is that panel data analysis can provide more informative data, more variability, less collinearity among the variables, more degree of freedom and more efficiency (Baltagi, 2001). In contrast, time-series studies of individual country are more likely to exhibit multicollineariry. For instance, it is very likely that there is high collinearity between the relative price and income variables in a time-series for an individual country-pair. However, a panel study that combines cross-sectional dimensions adds a great deal of variability and can provide more informative data that improve the efficiency of econometric estimates.

Moreover, a panel data can control the effects that are simply not detectable in pure cross-sectional or time-series analysis. For example, some countries may try to stabilize the bilateral exchange rate with their most important trading partner. In conventional cross-sectional or time-series analysis, the effect of stabilisation is unobservable. In contrast, stabilization effort could be captured by controlling the country-pair specific effect in a panel data model. There are two different techniques – fixed-effects estimation and random-effects estimation – to control the unobservable individual specific factors.

4.4.1 The fixed effect estimation

As specified in the Model specification section, the pooled panel data model can be expressed as:

$$\begin{aligned} \ln X_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} + \beta_5 D1_{ij} \\ &+ \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \eta_{ijt} \end{aligned} \tag{4.10}$$

However, in the pooled OLS estimator obtained from (4.10) unobservable heterogeneity is captured by the disturbance term η_{ijt}, which consists of two components: unobservable individual specific effect and remainder disturbance term.

$$\eta_{ijt} = \alpha_{ij} + \varepsilon_{ijt}$$

where α_{ij} denotes unobservable country-pair specific effect and ε_{ijt} represents the remainder disturbance. The country-pair specific effects, such as cultural, economical, and institutional factors that are constant over time are not explicitly represented in the model. Since α_{ij} are likely to be correlated with the independent variables, OLS estimates would be biased. Baltagi (2001) demonstrates how these unobservable cross-sectional specific effects can be accounted for via following 'one-way error component model'.

$$\begin{aligned} \ln X_{ijt} &= \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt} \end{aligned} \qquad (4.11)$$

where α_{ij} represents the unobservable country-pair specific effect.

In general, the transformation process can be expressed as follows.

$$\begin{aligned} x_{ijt} &= \alpha_{ij} + \beta_1 y_{it} + \beta_2 y_{jt} + \beta_3 rp_{ijt} + \beta_4 v_{ijt} + \beta_5 D1_{ij} \\ &+ \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt} \end{aligned} \qquad (4.12)$$

where all small letters represent the logarithm of the variables. For each country-pair observation *ij*, averaging the above equation over time gives;

$$\begin{aligned} \bar{x}_{ij} &= \alpha_{ij} + \beta_1 \bar{y}_i + \beta_2 \bar{y}_j + \beta_3 r\bar{p}_{ij} + \beta_4 \bar{v}_{ij} + \beta_5 D1_{ij} \\ &+ \beta_6 D\bar{2}_{ij} + \beta_7 Dist_{ij} + \bar{\varepsilon}_{ij} \end{aligned} \qquad (4.13)$$

Then subtracting (4.13) from (4.12);

$$
\begin{aligned}
x_{ijt} - \bar{x}_{ij} &= (\alpha_{ij} - \alpha_{ij}) + \beta_1(y_{it} - \bar{y}_i) + \beta_2(y_{jt} - \bar{y}_j) + \beta_3(rp_{ijt} - r\bar{p}_{ij}) \\
&+ \beta_4(v_{ijt} - \bar{v}_{ij}) + \beta_5(D1_{ij} - D1_{ij}) + \beta_6(D2_{ijt} - D\bar{2}_{ij}) \\
&+ \beta_7(Dist_{ij} - Dist_{ij}) + (\varepsilon_{ijt} - \bar{\varepsilon}_{ij})
\end{aligned} \tag{4.14}
$$

Note that unobserved cross-sectional fixed effects, α_{ij}, and time invariant variables, *D1* and *Dist* has now disappeared. The transformation process expressed in (4.14), is called the 'within transformation' as the coefficients are estimated based on variation *within* each cross-sectional unit.

Above mentioned 'one-way error component model' can be extended to a 'two-way error component model' in which a variable that control for unobservable time specific effect is added into the model. In this model the disturbance term of (4.10) consists of two error components:

$$\eta_{ijt} = \alpha_{ij} + \lambda_t + \varepsilon_{ijt}$$

For a two-way error component model, regression model (4.11) can be extended as follows:

$$
\begin{aligned}
x_{ijt} &= \alpha_{ij} + \lambda_t + \beta_1 y_{it} + \beta_2 y_{jt} + \beta_3 rp_{ijt} + \beta_4 v_{ijt} + \beta_5 D1_{ij} \\
&+ \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt}
\end{aligned} \tag{4.15}
$$

where λ_t denotes unobservable time effect which accounts for any individual-invariant time-specific effect that is not included in the regression (4.11). For example, it could account for the effects of the temporal effects of technological changes or oil price shocks that are specific to each time period but are the same for all sample country-pairs.

However, a major limitation of 'within transformation' process in the fixed-effect estimation is it wipes out all time-invariant explanatory variables. Cheng and Wall (2005) suggested estimating an OLS regression by adding country-pair specific dummies and time-specific dummies to the right hand side of the model to control for possible unobservable country-pair and time specific effects. This type of estimation is called 'the least square dummy variable' (LSDV) estimation. However, this approach ignore the potential correlation between explanatory variables and unobserved individual and time specific effects, therefore, resulting estimates are likely to be biased. In addition LSDV estimation technique may be numerically unattractive for a panel data model with large number of cross-sectional units because of the large number of dummy variables which will lead to the loss of degree of freedom to a certain extent.

4.4.2 The random effect estimation

Another variant of panel data model is random effects estimation method in which country-pair specific effects are captured as a random variable. Random-effects estimation method offers different ways of allowing for different intercepts to overcome the drawbacks of fixed-effects error component model and LSDV model. Random-effects estimation method is similar to the fixed-effect model in that it proposes that different intercepts for each individual. But this method considers the different country-pair specific term as an random element and deviations from the random element are treated as a part of the error term. Therefore, in a random-effects model the error term has two components: the traditional error unique to each observation and an error term representing the extent to which the intercept of the individual country-pair differs from the overall intercept.

The basic concept of random effect model can be expressed as follows. First, start with fixed-effect model.

$$\begin{aligned}\ln X_{ijt} &= \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt}\end{aligned} \tag{4.16}$$

Instead of treating α_{ij} as a fixed variable, it is assumed as a random variable with mean value of $\overline{\alpha}$. In this case, the country-pair specific intercept can be expressed as

$$\alpha_{ij} = \overline{\alpha} + e_{ij} \tag{4.17}$$

where e_{ij} is a i.i.d error term with mean value zero and constant variance of σ_e^2. By substituting (4.17) into (4.16),

$$\begin{aligned}\ln X_{ijt} &= \overline{\alpha} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist + \omega_{ijt}\end{aligned} \tag{4.18}$$

where $\omega_{ijt} = e_{ij} + \varepsilon_{ijt}$.

The composite error term ω_{ijt} consists of two error components, ε_{ijt}, which is a panel error components, and e_{ij}, which is a country-pair specific error component. In a random effect model, it is assumed that country-pair specific error components are not correlated with each other and are not autocorrelated across both cross-section and time series units. However, it can be shown that the composite error term ω_{ijt} and ω_{ijs} $(t \neq s)$ are correlated with the correlation coefficient of

$$\operatorname{corr}(\omega_{ijt}, \omega_{ijs}) = \frac{\sigma_e^2}{\sigma_e^2 + \sigma_\varepsilon^2}. \tag{4.19}$$

Because of this correlation structure, generalised least square (GLS) method is used to estimate the equation (4.18) instead of using ordinary least square (OLS) method. As in a two-way error component model, the time specific effect, λ_t, can also be expressed as a random with mean value $\overline{\lambda}$ and a disturbance term, φ_t. In this model the composite error term ω_{ijt} consists of three components; panel error components, ε_{ijt}, the country-pair specific error component, e_{ij}, and time specific error component, φ_t. Random effect model has advantage over fixed-effect model as the effect of any time invariant variables can be estimated. However, random effect estimator is unbiased only if the country-pair and time specific error components are not correlated with each other and are not autocorrelated across both cross-section and time series units. By saving on degrees of freedom, the random effects model produce more efficient estimator of the coefficient than the fixed effects model whenever it is unbiased.

4.4.3 The importance of country-pair and time specific effects

By using a panel data, unobservable cross-sectional specific effects can be accounted for either via fixed effects or random effects specification. The country-pair specific effect, such as cultural, economical, and institutional country-pair-specific factors that are not explicitly represented in the model are controlled by the fixed-effects specification (Dell'arricia; 1999). This advantage is important for the current study since cross-country structural and policy differences may have apparent impact on their bilateral trade flows. In terms of methodology, ignoring the heterogeneity across countries can lead to highly distorted estimates. In this context, Mátyás (1998) proposed to include two sets of country dummies (for exporting and importing countries). However, Egger and Pfaffermayr (2003) showed that instead of having one dummy variable per country, individual country-pair dummies (fixed effects) and time dummies to control for common shocks should be used to get efficient estimators.

The use of panel data to estimate the effect of exchange rate volatility on exports allows overcoming a number of methodological problems. The first one is so called simultaneity problems. The exchange rate volatility and exports may be negatively correlated but the direction of causality is uncertain in some circumstances. One situation is, as pointed out by Dell'Ariccia (1999), monetary authority may try to stabilize the bilateral exchange rate with the most important trading partner. Hence, exchange rate volatility could become an endogenous variable and the results of OLS estimation would be biased. In this situation, Dell'arricia (1999) demonstrates that if the relative size of the trade partners of the sample countries remains the same over time; the simultaneity bias will be captured by the country pair specific effect which is treated as a fixed effect. (Dell'arricia (1999) p.321).

In addition, the inclusion of country-pair specific effect is particularly important for the gravity model as theoretical foundation of the gravity model emphasizes on "remoteness" or "multilateral resistance" (Anderson and van Wincoop, 2003; Feenstra *et al.*, 2001). Clark *et al.* (2004) points out that the multilateral resistance indices can be captured by fixed-effects in empirical estimations.

Another important issue is the inclusion of variable to control for time specific effects. In order to account for the effects of omitted variables that are specific to each time period but are the same for all country-pairs, time-fixed effects variable can be included in the model. For example, the temporal effects of any change in world income, technological change, oil price shocks or liquidity shocks will be captured by the time-fixed effects variable. This is particularly important as time-fixed effect can control for so called 'third country effect', that is, any temporal changes in the income of the rest of the world with respect to two trading partners (Clark *et al.*, 2004). For instance, any changes in the world income affect the share of income of a country, as well as bilateral trade flows. Even though an importing country's income decreases compared to the prior period, if the world income decreases faster than that of an importing country, the share of importer's income to the world income increase and resulting in more imports.

4.4.4 Tests in panel data models

It is obvious that if the true model is fixed effects model as in (4.12), pooled OLS in (4.11) will yield bias estimates due to the fact that OLS omits the relevant individual effect dummies. The joint significance of these dummy variables can be tested by performing a *F*-test. This is a simple Chow test for the presence of individual effects, i.e.

H_0: $\alpha_{ij}=0$, $ij=1,\ldots,N-1$.

In this case

$$F_{1-way}=\frac{(RRSS-URSS)/(N-1)}{URSS/(NT-N-K)}\ . \tag{4.20}$$

Here *RRSS* denotes the restricted residuals sum of square of OLS on the pooled model (4.11) and *URSS* represents the unrestricted residuals sum of square of the LSDV regression (4.12). Under the H_0, the statistic $F_{1\text{-}way}$ is distributed as F with N-1, $N(T$-$1)$-K degrees of freedom. For a two-way error component model, the test of the joint significance of the dummy variables becomes:

H_0: $\alpha_{ij}=0$, $ij=1,\ldots,N-1$ and $\lambda_t=0$, $t=1,\ldots,T-1$.

The restricted residuals sum of square is that of pooled OLS model (4.10) and the unrestricted residuals sum of square is that from (4.15). Then F statistic for two-way error component model can be calculated as:

$$F_{2-way}=\frac{(RRSS-URSS)/(N+T-2)}{URSS/((N-1)(T-1)-K)}, \tag{4.21}$$

where $F_{2\text{-}way}$ statistic is distributed as F with $N+T-2$, $(N-1)(T-1)-K$.

When estimating a multi-country panel model, the hypothesis of homogenous coefficient should also be tested. Baltagi (2001) suggested a poolability test that requires the estimation of the model under the restriction of common slopes across countries, as well as allowing heterogeneous slopes. The test, which is also known as *RZB* test, is a generalization of the Chow test for the N linear regression case, under the general assumption of heteroskedastic variances. The F statistic for *RZB* test can be calculated as

$$F_{RZB} = \frac{(ess_c - (ess_1 + ess_2 + \ldots + ess_N)/(N-1)(K+1)}{(ess_1 + ess_2 + \ldots + ess_N)/N(T-K+1)} , \tag{4.22}$$

where ess_c is the error sum of squares from the pooled (constrained) regression and $ess_1, ess_2, \ldots, ess_N$ are the error sum of squares from the N separate time-series regressions. Since the variances of the disturbance of the original regressions model are heteroskedastic, all regressions are transformed to have homoskedastic variances. However, it has been argued that the use of *RZB* test limits the question of whether 'to pool or not to pool' to a test of the validity of the null hypothesis of homogenous coefficients for all countries (Baltagi, 2001).

Baltagi (2001) asserts that the pooled model will reduce the variance of the estimators and yield more efficient estimates but may produce bias. In this situation, Baltagi (2001) suggested a testing procedure based on mean square errors (MSE) criteria developed by Wallace (1972) and McElroy (1977). In fact, these MSE criteria do not test the null hypothesis of the poolability, but allow choosing between the constrained (homogenous estimators) and unconstrained estimators on the basis of the trade-off between bias and efficiency of estimators. Wallace (1972; p. 697) provides a summary table of MSE criteria and McElroy (1977) extends these criteria under the general assumption of heteroskedastic variances. According to these MSE criteria, the pool estimator is preferable to the unconstrained estimator if non-centrality parameter, λ, is less than or equal its critical value. Note that in a normal *RZB* test, which uses central *F* statistics, λ equals to zero. These criteria are presented in Table 4.2.

Table 4.2 Criteria and tests for restrictions in linear regression

Criterion	**Critical value of λ**	**Test: Compute F_{RZB} and calculate non centrality parameter λ of:**
Strong MSE criterion	$\lambda \leq 1/2$	noncentral $F(1/2)$ tabulated in Wallace and Toro-Vizcarrondo (1969).
First Weak MSE criterion	$\lambda \leq \theta$ [21]	noncentral $F(\theta)$ tabulated in Goodnight and Wallace (1972).
Second Weak MSE criterion	$\lambda \leq (m/2)$ where m is the numerator degree of freedom	noncentral $F(m/2)$ tabulated in Goodnight and Wallace (1972).

Source: Wallace (1972)

[21] See Wallace (1972) for the computation of θ.

4.4.5 GMM-IV estimation

However, the proposed panel data regression may not be completely reliable as a result of two econometric problems. The first one is the potential problem of endogeneity, that is, an increase in the level of trade between two countries may lead to a more stable bilateral real exchange rate. If the sample countries implement policies aimed at lowering exchange rate volatility in order to increase their bilateral exports, the model considered would suffer endogeneity bias. As demonstrated by Dell'arricia (1999), the inclusion of country-pair fixed-effects dummy variables could control for the potential endogeneity if the relative size of the trading partners of the sample countries remains the same over the period considered. If this is not the case, the assumption that exchange rate volatility is exogenous to exports may not be warranted.

Suppose, for simplicity, exchange rate volatility is the only explanatory variable that determines the bilateral exports. Then, ordinary least squares estimator ($\widehat{\beta}_{OLS}$) is used to estimate the mean structure of a model of the form

$$x_{ijt} = \beta v_{ijt} + \varepsilon_{ijt}, \tag{4.23}$$

and $\widehat{\beta}_{OLS}$ can be estimated as follows:

$$\widehat{\beta}_{OLS} = \frac{\sum_{ij=1}^{N}\sum_{t=1}^{T} v_{ijt} x_{ijt}}{\sum_{ij=1}^{N}\sum_{t=1}^{T} v_{ijt}^2} = \frac{\sum_{ij=1}^{N}\sum_{t=1}^{T} v_{ijt}\left(v_{ijt}\beta + \varepsilon_{ijt}\right)}{\sum_{ij=1}^{N}\sum_{t=1}^{T} v_{ijt}^2} = \beta + \frac{\sum_{ij=1}^{N}\sum_{t=1}^{T} v_{ijt}\varepsilon_{ijt}}{\sum_{ij=1}^{N}\sum_{t=1}^{T} v_{ijt}^2}. \tag{4.24}$$

When exchange rate volatility (v) and error term (ϵ) are uncorrelated, the final term goes to zero in the limit and the estimator is unbiased with decreasing variance as the number of observations increase and thus also consistent. When v and ε are correlated, however, the estimator is biased and inconsistent. In order to control this problem, instrumental variables (IV) approach can be employed by using an appropriate instrument for exchange rate volatility.

An instrumental variable is one that is correlated with the independent variable but not with the error term. Suppose, an observable variable z satisfies these two assumptions:

(1) z is uncorrelated with ϵ, that is, $\text{Cov}(z,\epsilon) = 0$;

(2) z is correlated with v, that is, $\text{Cov}(z, v) \neq 0$.

Then, z can be treated as an instrumental variable for v and $\hat{\beta}_{IV}$ can be estimated as;

$$\hat{\beta}_{IV} = \frac{\sum_{ij=1}^{N}\sum_{t=1}^{T} z_{ijt}x_{ijt}}{\sum_{ij=1}^{N}\sum_{t=1}^{T} z_{ijt}v_{ijt}} = \frac{\sum_{ij=1}^{N}\sum_{t=1}^{T} z_{ijt}\left(v_{ijt}\beta + \varepsilon_{ijt}\right)}{\sum_{ij=1}^{N}\sum_{t=1}^{T} z_{ijt}v_{ijt}} = \beta + \frac{\sum_{ij=1}^{N}\sum_{t=1}^{T} z_{ijt}\varepsilon_{ijt}}{\sum_{ij=1}^{N}\sum_{t=1}^{T} z_{ijt}v_{ijt}} \tag{4.25}$$

Since z and ε are uncorrelated, the final term approaches zero in the limit, and the IV estimation will provide a consistent estimator. One computational method often used for implementing the IV estimation technique is two-stage least-squares (2SLS). Under the 2SLS approach, exchange rate volatility variable is regressed on all valid instruments including the full set of exogenous variables in the main regression in the first stage. Since the instruments are exogenous, these approximations of the endogenous variable (exchange rate volatility) will not be correlated with the error term. Therefore, the instrumental variables provide a suitable way to analyze the relationship between the exports and the possible endogenous variable, exchange rate volatility. In the second stage, the regression of interest is estimated as usual, except that in this stage exchange rate volatility is replaced with its approximation estimated in the first stage regression.

Another potential problem is that although the IV estimator obtained under 2SLS approach is consistent, it is inefficient in the presence of heteroskedasticity. There is the possibility that individual effects may vary over time as a result of omitted macroeconomic shocks. That is, individual countries may respond to the effects of time-varying unobservable shocks differently. Specifically, if time-varying individual shocks are unobservable, the panel data specification can be rewritten as follows;

$$\begin{aligned}\ln X_{ijt} &= \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} + \beta_5 D1_{ij} \\ &+ \beta_6 D2_{ijt} + \beta_7 Dist + \xi_{ijt}\end{aligned} \tag{4.26}$$

where $\xi_{ijt} = \theta_t \alpha_{ij} + \varepsilon_{ijt}$.

In this situation, variance of the composite error term becomes $\theta_t^2 \sigma_{\alpha_{ij}}^2 + \sigma_{\varepsilon_{ijt}}^2$, which is not a constant. This could lead to the problem of heteroskedasticity; that is the variance of the error is not a constant. Although this problem can be partially addressed by using heteroskedasticity consistent or "robust" standard errors and statistics, the conventional 2SLS-IV estimator is inefficient in the presence of heteroskedasticity.

In order to control for the presence of heteroskedasticity of unknown form the Generalized Method of Moments (GMM) approach can be applied. The GMM approach, introduced by Hansen (1982), does not require restrictive distributional assumption of OLS approach, such as normality, and can allow for heteroskedasticity of unknown form. GMM estimators are constructed from exploiting the sample moment counterparts of population moment conditions of the data generating model. Therefore, GMM does not require complete knowledge of the distribution of the data. Only specified moments derived from an underlying model are needed for GMM estimation. If there are more moment equations than parameters, then GMM proceeds similar to instrumental variable estimation. It estimates the parameter vector by minimizing the sum of squares of the differences between the population moments and the sample moments, using the variance of the moments as a metric. The adjustment to the covariance matrix accounts not only the moving average aspect of disturbances but also for heteroskedasticity aspect of the disturbance conditional on the explanatory variables. In this essence, GMM utilise the orthogonality conditions to ensure efficient estimation in the presence of heteroskedasticity of unknown form. According to Baum, *et al.* (2003), the GMM estimator is more efficient than the simple IV estimator in the presence of heteroskedasticity, but if heteroskedasticity is not present, the GMM estimator is still no worse asymptotically than the IV estimator.

4.4.6 Panel unit roots and cointegration test

Although the panel data analysis has particular advantages in examining the impact of exchange rate volatility on trade, the longer time dimension of panel data may lead to the problem of non-stationarity, and spurious regression. Baltagi (2001) notes that for a macro-panel with large N (numbers of countries) and a longer T (length of time series) nonstationarity deserves more attention. Therefore, in order to verify the existence of long-run stable relationship between exchange rate volatility and exports, both testing for unit roots within the panel and assessing cointegration are necessary before estimating the model. In recent years, a variety of procedures for testing the unit roots and cointegration in panel data context have been developed and gaining increased acceptance in empirical research.[22]

The first step is testing for staitionarity in a panel data, that is, to investigate the integrating property of each variable. Im, Pesaran, and Shin (2003) propose a panel unit root testing procedure based on averaging individual unit root test statistics of the series across the panel. The *IPS* t-bar statistics can be expressed as:

$$t_b = \frac{\sqrt{N}\left(t_{NT} - E(t_T)\right)}{\sqrt{Var(t_T)}} \qquad (4.27)$$

where $t_{NT} = N^{-1}\sum_{i=1}^{N} t_{i,T}$ is an average of the individual t-statistics of augmented Dicky-Fuller (ADF) test. $E(t_T)$ and $Var(t_T)$ are the mean and variance of t

[22] See Banerjee (1999) and Baltagi and Kao (2000) for the survey of the developments in nonstationary panels, panel unit roots and cointegration tests.

statistics, respectively. Im *et al.* (2003) shows that, under the null hypothesis that each series in the panel are integrated of order one against the alternative hypothesis of at least one of the individual series in the panel is stationary, the t-bar statistic converges to the standard normal distribution as N and T tend to infinity. However, the rejection of the null of non-stationary by *IPS* test does not imply that all series in the panel are stationary process. If one series of the panel is stationary, *IPS* test will reject the null of non-stationary in all series.

In contrast, Hadri (2000) proposed a residual-based Lagrange multiplier test for the null hypothesis that all series in the panel are stationary around a deterministic trend against the alternative hypothesis of a unit root in panel data. In fact, the Hadri's LM test generalizes the univariate KPSS unit root test to the panel data context. The null hypothesis of the Hadri LM panel unit root test is that all series in the panel are stationary against the alternative hypothesis of a unit root in panel data. Hadri develops LM statistics for following panel model:

$$y_{it} = z'_{i,t}\gamma + r_{i,t} + \varepsilon_{i,t} \tag{4.28}$$

where $z'_{i,t}$ is the deterministic component, $r_{i,t}$ is a random walk

$$r_{i,t} = r_{i,t-1} + u_{i,t} \tag{4.29}$$

$u_{i,t}$ and $\varepsilon_{i,t}$ are mutually independent normals and IID. Then, the model can be written as

$$y_{i,t} = z'_{i,t}\gamma + e_{i,t} \tag{4.30}$$

where $e_{i,t} = \sum_{j=1}^{t} u_{i,j} + \varepsilon_{i,t}$. Let $\hat{e}_{i,t}$ be the estimated residuals from the regression in (4.30) and $\hat{\sigma}_{\varepsilon}^{2}$ be the estimate of the error variance, then the LM statistics is

$$LM = \frac{\frac{1}{N}\sum_{i=1}^{N}\frac{1}{T^2}\sum_{t=1}^{T} S_{i,t}^{2}}{\hat{\sigma}_{\varepsilon}^{2}} \tag{4.31}$$

where $S_{i,t}$ is the partial sum of residuals, $S_{i,t} = \sum_{j=1}^{t} \hat{e}_{i,j}$. Hadri (2000) then, provides the test statistic, Z_{μ}, for the null of level stationary, which has the following limiting distribution.

$$Z_{\mu} = \frac{\sqrt{N}\left(LM - E_{\mu}(LM)\right)}{\sqrt{Var_{\mu}(LM)}} \tag{4.32}$$

where $E_{\mu}(LM)$ and $Var_{\mu}(LM)$ are consistent estimators of the mean and variance of the test statistic. Z_{μ} statistic converges to the standard normal distribution as T tends to infinity followed by N tends to infinity.

In order to establish the cointegrated combination among the variables in a panel model, the residuals of the panel estimation need to be stationary. Pedroni (1999) developed a method for testing the null of no cointegration in panels with multiple regressors. This test allows testing for the presence of long-run equilibria in multivariate panels while permitting long-run cointegrating vectors to be heterogeneous across individual series. Pedroni (1999) introduced seven test statistics for panel cointegration test and derived the approximate critical values for these statistics. Of these seven statistics, four are based on the within-dimension statistics which are constructed by summing both the numerator and the denominator terms over the N dimension separately, and three are based on between-dimension statistics are constructed by first dividing the numerator by the denominator prior to summing over the N dimension.

Thus, within-dimension statistics are based on estimators that effectively pool the autoregressive coefficient across different cross-sectional units for the unit root tests on the estimated residuals. For the within-dimension statistics the test for the null of no cointegration is implemented as a residual-based test of the null hypothesis $H_0 : \gamma_i = 1$ for all i, versus the alternative hypothesis $H_1 : \gamma_i = \gamma < 1$ for all i, so that it presumes a common value for $\gamma_i = \gamma$.

In contrast, between-dimension statistics are based on estimators that simply average the individually estimated coefficients for each cross-sectional unit. The null of no cointegration for between-dimension statistics is implemented as a residual-based test of the null hypothesis $H_0 : \gamma_i = 1$ for all i, versus the alternative hypothesis $H_1 : \gamma_i < 1$ for all i, so that it does not presume a common value for $\gamma_i = \gamma$ under the alternative hypothesis.

Pedroni (1999) refers to the within dimension-based statistics as panel cointegration statistics, and the between dimension-based statistics as group mean panel cointegration statistics. In the current study six statistics – three panel cointegration statistics and three group mean panel cointegration statistics – are applied to test for the long-run relationship among the variables. The first is a panel version of a non-parametric statistic that is analogous to the familiar Phillips-Perron rho-statistic. The second statistic is also non-parametric and is analogous to the Phillips-Perron t-statistic. The third of the within dimension-based statistics is a parametric statistic which is analogous to the augmented Dickey & Fuller t-statistic. The other three panel cointegration statistics are based on a group mean approach. The first of these is analogous to the Phillips and Perron rho-statistic, and the last two are analogous to the Phillips and Perron t-statistic and the augmented Dickey & Fuller t-statistic respectively.

Following Pedroni (1999), consider a multivariate panel model:[23]

$$y_{i,t} = \alpha_i + \beta_{1i}x_{1i,t} + \beta_{2i}x_{2i,t} + \dots + \beta_{Mi}x_{Mi,t} + e_{i,t} \tag{4.33}$$

for $t = 1,\dots, T$; $i = 1,\dots, N$; $m = 1,\dots,M$, where T is the number of observations over time, N number of cross-sectional units in the panel, and M number of regressors. In this set up, α_i represents the member specific intercept or fixed effects parameter which varies across individual cross-sectional units.

To construct Panel ADF-statistics, the first step is to estimate the residual $\hat{\eta}_{i,t}$ of the following first differenced regression.

$$\Delta y_{i,t} = b_{1i}\Delta x_{1i,t} + b_{2i}\Delta x_{2i,t} + \dots + b_{Mi}x_{Mi,t} + \eta_{i,t} \tag{4.34}$$

Then compute the long-run variance of $\hat{\eta}_{i,t}$ as follow:

$$\hat{L}^2_{11i} = \frac{1}{T}\sum_{t=1}^{T}\hat{\eta}^2_{i,t} + \frac{2}{T}\sum_{s=1}^{k_i}\left(1 - \frac{s}{k_i + 1}\right)\sum_{t=s+1}^{T}\hat{\eta}_{i,t}\eta_{i,t-s} \tag{4.35}$$

[23] The following section which demonstrates the derivation of test statistics relies heavily from Pedroni (1999).

Pedroni (1999) interpret $\hat{L}_{11i}^{2}$ as a conditional asymptotic variance based on the projection of $\Delta y_{i,t}$ onto $\Delta x_{i,t}$. By using above statistics and the simple contemporaneous panel variance estimator $\tilde{s}_{N,T}^{2} = \frac{1}{N}\sum_{i=1}^{N}\hat{s}_i^2$, Panel ADF-statistics is can be constructed as:

$$\text{Panel ADF-statistics} = \left(\tilde{s}_{N,T}^{2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1/2}\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} \qquad (4.36)$$

To construct the Pedroni's Group-ADF statistic, the first step is to estimate the residuals $\hat{e}_{i,t}$ of the panel regression. Then, estimate the ADF equation of $\hat{e}_{i,t} = \hat{\gamma}_t\hat{e}_{i,t-1} + \sum_{k=1}^{K_i}\hat{\gamma}_{i,k}\Delta\hat{e}_{i,t-k} + \hat{u}_{i,t}$ and use the estimated residuals $\hat{u}_{i,t}$ to compute its simple variance as $\hat{s}_i = T^{-1}\sum_{t=1}^{T}\hat{u}_{i,t}^2$. Using these statistics, Pedroni's Group-ADF statistic can be constructed as:

$$\text{Group ADF-statistics} = N^{-1/2}\sum_{i=1}^{N}\left(\sum_{t=1}^{T}\hat{s}_i^2\hat{e}_{i,t-1}^2\right)^{-1/2}\sum_{t=1}^{T}\hat{e}_{i,t-1}\Delta\hat{e}_{i,t}. \qquad (4.37)$$

For the non-parametric statistics estimate $\hat{e}_{i,t} = \hat{\gamma}_i e_{i,t-1} + \hat{u}_{i,t}$ and use the residuals to compute the long-run variance of $\hat{u}_{i,t}$ denoted $\hat{\sigma}_i^2$. The term $\hat{\lambda}_i$ can then be computed as $\hat{\lambda}_i = \frac{1}{2}\left(\hat{\sigma}_i^2 - \hat{s}_i^2\right)$ where $\hat{s}_i^2$ is just the simple variance of $\hat{u}_{i,t}$.

$$\text{Panel } \rho\text{-Statistic} = T\sqrt{N}\left(\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\hat{e}_{i,t-1}^{2}\right)^{-1}.\sum_{i=1}^{N}\sum_{t=1}^{T}\hat{L}_{11i}^{-2}\left(\hat{e}_{i,t-1}\Delta\hat{e}_{i,t} - \hat{\lambda}_i\right)$$

$$\text{Panel } t\text{-Statistic} = \left(\tilde{\sigma}^2_{N,T} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}^{-2}_{11i} \hat{e}^2_{i,t-1} \right)^{-\frac{1}{2}} \sum_{i=1}^{N} \sum_{t=1}^{T} \hat{L}^{-2}_{11i} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right).$$

$$\text{Group } \rho\text{-Statistic} = TN^{-\frac{1}{2}} \sum_{i=1}^{N} \left(\sum_{t=1}^{T} \hat{e}^2_{i,t-1} \right)^{-1} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right)$$

$$\text{Group } t\text{-Statistic} = N^{-\frac{1}{2}} \sum_{i=1}^{N} \left(\hat{\sigma}^2_i \sum_{t=1}^{T} \hat{e}^2_{i,t-1} \right)^{-\frac{1}{2}} \sum_{t=1}^{T} \left(\hat{e}_{i,t-1} \Delta \hat{e}_{i,t} - \hat{\lambda}_i \right),$$

where $\tilde{\sigma}^2_{N,T} \equiv \frac{1}{N} \sum_{i=1}^{N} \hat{L}^{-2}_{11i} \hat{\sigma}^2_i$.

Pedroni (1999) has shown that the asymptotic distribution of this statistic can be expressed as:

$$t_b = \frac{\chi_{NT} - \mu\sqrt{N}}{\sqrt{v}} \rightarrow N(0,1)$$

where N and T are sample parameter values and, μ and v are mean and variance adjustment terms reported in Table 2 (pp. 666) of Pedroni (1999).

4.5 Conclusion

This chapter outlines the research methodology to be used in the following empirical chapters to analyse the impact of exchange rate volatility on exports of emerging East Asian economies. Specifically, the methodology chapter focuses on the several methodological issues that cast doubt on the previous finding on the impact of exchange rate volatility on exports, and presents the potential solutions to overcome these methodological problems.

An empirical specification based on the generalised gravity model is presented. Based on trade models that support the augmented generalised gravity model, it is a most appropriate empirical model to analyse the trade pattern of homogenous products. Then advantages of using panel data to deal with bilateral (exporter and/or importer) heterogeneity, which is extremely likely to be present in analysing the impact of exchange rate volatility on bilateral exports, are also discussed. The importance of country-pair and time specific fixed effects and econometric issues regarding to controlling these effects are also presented in the chapter. Then, this chapter presents a brief technical note of GMM-IV estimation approach and justification for using this approach to control for the potential endogeneity and heteroskedasticity problems that cast doubt on the previous findings.

Chapter 5

Exchange Rate Volatility and Exports: New Empirical Evidence from Emerging East Asia countries

5.1 Introduction

This chapter empirically examines the effects of exchange rate volatility on the bilateral export flows of five emerging East Asian countries. Given the fact that emerging economies depend on exports as a driving force for their economic growth, an understanding of the degree to which bilateral exchange rate volatility affects their export activity is important for setting optimal exchange rate and trade policies for their development.

The impact of bilateral exchange rate volatility on exports among the five East Asian countries as well as on export flows to 13 other industrialized countries is examined by using a panel data set of 85 cross-sectional observations for the period 1982:Q1 through 2006:Q4. List of the importing countries and the share of exports destined to these countries to the total exports of sample countries are presented in Table 5.1.

Table 5.1 Exports of emerging East Asian (% of 2006 total exports)

Importers	Exporters				
	China	Indonesia	Malaysia	Philippines	Thailand
Australia	1.41	2.84	2.83	1.02	3.35
Austria	0.11	0.08	0.18	0.11	0.23
Belgium	1.02	0.94	0.38	1.56	1.11
Canada	1.60	0.74	0.64	0.61	0.95
China	-	7.70	7.25	9.83	9.05
Denmark	0.38	0.16	0.23	0.05	0.27
France	1.44	0.87	1.36	0.45	1.10
Germany	4.16	2.32	2.17	3.78	1.79
Indonesia	0.98	-	2.54	0.77	2.56
Italy	1.65	1.43	0.62	0.42	1.15
Japan	9.47	19.37	8.86	16.48	12.63
Malaysia	1.40	3.96	-	5.57	5.10
Netherlands	3.18	2.10	3.64	10.12	2.50
Philippines	0.59	0.79	1.35	-	1.98
Spain	1.19	1.53	0.58	0.20	0.83
Thailand	1.01	2.79	5.29	2.82	-
United Kingdom	2.49	1.50	1.82	1.03	2.62
United States	21.04	11.47	18.79	18.32	15.03
Exports to major partners	**53.10**	**60.58**	**58.54**	**73.14**	**62.25**
Total exports (in million US$)	969284	113645	160664	46976	130555

Source: Direction of Trade Statistics.

The main objective of this chapter is to provide new evidence on the relationship between real bilateral exchange rate volatility and exports of emerging East Asian countries. The major advantage of analysing bilateral rather than aggregate multilateral trade flows is the ability to control not only for exchange rate volatility but also for a variety of other factors such as distance between each pair of countries, level of exchange rate, and cultural and geographical relationships that can affect the trade between countries. Klaassen (2004) points out that the use of bilateral instead of multilateral data can overcome the difficulties in constructing multi-country explanatory variables.

Although there are studies which focus on either emerging and developing countries or East Asian economies, not any single studies pay attention on emerging East Asian economies. In addition, there are two apparent issues that cast doubt on the findings of previous studies. The first issue concerns with the stationarity of data. None of the panel based studies on the relationship between exchange rate volatility and exports conducted a panel unit-root and cointegration test to verify the long-run relationship among the variables. So these studies might be subject to the problem of spurious regression. In order to verify the long-run relationship between exchange rate volatility and trade, this study is the first to apply panel unit roots and cointegration tests.

The second issue relates to the use of the same model for estimation of different trade flows. The majority of the empirical studies that focus on the relationship between exchange rate volatility and bilateral trade employ the standard gravity model (see for example, Dell'ariccia, 1999; Rose, 2000;

Anderton and Skudelny, 2001; Clark *et al.*, 2004; Baak, 2004; Tenereyro, 2007). However, Dell'ariccia (1999) argued that the standard gravity model is more suitable to estimate intra-industry trade flows between two developed countries since the theoretical foundations of the model assume identical and homothetic preferences across countries and rely heavily on the concept of intra-industry trade. Therefore, the use of gravity model in which sample countries are a grouping of developed and developing countries is questionable since the developed and developing countries might have different structural circumstances and trade patterns. Recognizing the nature of the exports of the countries being studied, an augmented generalized gravity model is employed. The use of the generalised gravity model helps to overcome potential misspecification problems which may arise as a result of employing a pure gravity model to analyse the trade patterns of emerging economies.

The outline of the chapter is as follows. Section 5.2 presents the descriptive statistics and correlation analysis of two main variables: real exports and exchange rate volatility. Section 5.3 presents the empirical research findings, and final section gives conclusion.

5.2 Descriptive statistics and correlations: Main variables

This section presents the summary statistics of two main variables: Real exports and exchange rate volatility of the sample emerging East Asian countries. Means, standard deviation, minimum and maximum of aggregate real exports of the sample five emerging East Asian countries to 17 countries over the period 1982-2006 are presented in the Table 5.2.

Table 5.2: Descriptive statistics of Real Exports

Exporting Country	Log of Real Exports			
	Mean	**Standard Deviation**	**Min**	**Max**
China	19.7410	1.6978	14.7062	24.6001
Indonesia	18.6642	1.8715	4.6363	22.4048
Malaysia	19.0864	1.5385	13.8552	22.6719
Philippines	17.8807	1.6948	13.4289	21.8714
Thailand	18.9541	1.4702	14.1361	22.2581
All countries	18.8653	1.7671	4.6363	24.6001

There are four different measures of exchange rate volatility used to analyse the impact of exchange rate volatility on the bilateral exports of emerging East Asia countries. Table 5.3 presents the mean and standard deviation of four different measures of exchange rate volatility. Among the five sample countries, the real exchange rate of Indonesia exhibited relatively more volatile during the sample periods. In contrast Malaysian Ringgit was relatively more stable. It is interesting to note that China has had the third most volatile real bilateral exchange rate among the sample countries although its nominal exchange rate was pegged to the US dollar until July 2005. It seems that pegging to one currency still leaves an economy exposed to fluctuations in the other macroeconomic variables especially the price which lead to the volatility of real exchange rate. Compared with other volatilities, GARCH volatility is relatively lower as a result of using a low frequency data (monthly exchange rate).

Table 5.3: Descriptive statistics of real exchange rate volatility

Exporting Country	Real Exchange Rate Volatility							
	SD(4-quarter)		SD(8-quarter)		MASD		GARCH	
	means	SD	means	SD	means	SD	means	SD
China	0.0638	0.051	0.0689	0.044	0.0877	0.055	0.0028	0.006
Indonesia	0.0881	0.087	0.0971	0.079	0.1283	0.108	0.0067	0.018
Malaysia	0.0509	0.038	0.0545	0.033	0.0728	0.048	0.0013	0.002
Philippines	0.0700	0.045	0.0731	0.036	0.0997	0.056	0.0026	0.008
Thailand	0.0559	0.048	0.0614	0.042	0.0825	0.065	0.0017	0.008
All countries	0.0657	0.058	0.0710	0.052	0.0942	0.072	0.0030	0.010

Table 5.4 reports the correlation between real exports and four different exchange rate volatility measures. The correlation between exchange rate

volatility and exports is negative except two exchange rate volatility measures for Indonesia. However, the statics should be interpreted with caution as the correlation coefficients reveal only correlation between the variables not the causation.

Table 5.4: Correlation between exports and exchange rate volatility

Exporting Country	Correlation between Exports and Exchange Rate Volatility			
	SD(4-quarter)	SD(8-quarter)	MASD	GARCH
China	**-0.0995**	**-0.1223**	**-0.0649**	**-0.0915**
Indonesia	**-0.0120**	0.0023	0.0025	**-0.0203**
Malaysia	**-0.0480**	**-0.0470**	**-0.0529**	**-0.0229**
Philippines	**-0.1579**	**-0.1992**	**-0.1748**	**-0.0720**
Thailand	**-0.0455**	**-0.0689**	**-0.0626**	**-0.0337**
All countries	**-0.0842**	**-0.0904**	**-0.0871**	**-0.0471**

5.3 Empirical results

This chapter examines the impact of real exchange rate volatility on the exports of the sample five emerging East Asian economies for the period 1982 to 2006 by using a panel data approach. As explained in the methodology chapter, the use of panel data to estimate the effect of exchange rate volatility allows overcoming a number of methodological problems. The first one is so called simultaneity problems. The exchange rate volatility and exports may be negatively correlated but the direction of causality is uncertain in some circumstances. One situation is, as pointed out by Dell'ariccia (1999), monetary authority may try to stabilize the bilateral exchange rate with the most important trading partner. In this situation exchange rate volatility could become an endogenous variable and the results of OLS estimation would be biased.

The benchmark measure of the exchange rate volatility which represents the uncertainty is the standard deviation of the first difference of the logarithmic exchange rate (denotes as SD). In order to check the robustness of the results two additional measures of exchange rate volatility – the moving average standard deviation of the logarithmic exchange rate (MASD) and the conditional exchange rate volatility which follows a Generalised Autoregressive Conditional Heteroscedascity process (GARCH) – are also used to estimate the model. The definitions and construction of variables and sources of the data are already presented in the methodology chapter.

5.3.1 Panel unit root and conintegration tests

This study utilizes the panel-data that pool time-series data and cross-sectional bilateral trade flows of five emerging East Asian countries. Although panel data analysis has particular advantages in examining the impact of exchange rate volatility on trade, the longer time dimension of panel data may lead to the problem of non-stationary, and spurious regression. In order to verify the existence of a long-run stable relationship between exchange rate volatility and exports, both testing for unit roots within the panel and assessing cointegration is necessary before estimating the model.

The first step is testing for stationarity in a panel data, that is, to investigate the integrating property of each variable. In this chapter, the *IPS* test (Im *et al.*, 2003) and the Hadri LM test (Hadri, 2000) are employed to test the panel unit roots. Im *et al.* (2003) propose a panel unit root testing procedure based on averaging individual unit root test statistics of the series across the panel. In fact, the *IPS* t-bar statistics is an average of the individual t-statistics of augmented Dicky-Fuller (ADF) test. Im *et al.* (2003) show that, under the null hypothesis, each series in the panel is integrated of order one against the alternative hypothesis that at least one of the individual series in the panel is stationary.

The results of the *IPS* panel unit roots test in Table 5.5 indicate that the null of non-stationarity is rejected except for foreign income (Y_{jt}) and relative price (RP_{ijt}). However, the null hypothesis of the *IPS* test is that all series in the panel are non-stationary process against the alternative hypothesis of a fraction of the series in the panel being stationary. If one series of the panel is stationary, the *IPS* test will reject the null of non-stationarity in all series. Karlsson and Löthgren (2000) has demonstrated that, for a panel data set with longer time dimension (100 quarters in this study), the *IPS* test has high power and there is a potential risk of concluding that the whole panel is stationary even when there is only a small proportion of stationary series in the panel. Therefore the rejection of the null of non-stationary suggested by the *IPS* test should be interpreted with care since it does not imply that all series in the panel are stationary.

Table 5.5: *IPS* Panel unit roots test

Variables	***IPS* test (t-statistics)**	
	Level	**First Difference**
Real Exports (X_{ijt})	-1.948[1] (0.000)	-9.785[1] (0.000)
Home Income (Y_{it})	1.897[1] (0.000)	9.317[1] (0.000)
Foreign Income (Y_{jt})	-1.391 (0.931)	-8.571[1] (0.000)
Relative Price (RP_{ijt})	-0.938 (1.000)	-7.256[1] (0.000)
Volatility (SD-8q)	-2.555[1] (0.000)	-6.080[1] (0.000)
Volatility (MASD)	-2.798[1] (0.000)	-7.995[1] (0.000)
Volatility (GARCH)	-4.950[1] (0.000)	-9.413[1] (0.000)
Volatility (SD-4q)	-3.947[1] (0.000)	-7.302[1] (0.000)

Notes: [1] indicates significant at 1 percent level. Values in the parentheses are P-value. Null hypothesis of the *IPS* test is that each series in the panel is integrated of order one. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

In contrast, Hadri (2000) proposed a residual-based Lagrange multiplier test, which generalizes the univariate KPSS unit root test to the panel data context.

The null hypothesis of the Hadri LM test is that all series in the panel are stationary around a deterministic trend against the alternative hypothesis of a unit root in panel data. The test statistic is distributed as standard normal under the null hypothesis. The results are presented in Table 5.6.

Table 5.6: Hadri LM Panel unit roots test

Variables	Hadri LM test (Z_μ statistics)	
	Level	First Difference
Real Exports (X_{ijt})	484.116[1] (0.000)	-6.289 (1.000)
Home Income (Y_{it})	563.317[1] (0.000)	-1.745 (0.959)
Foreign Income (Y_{jt})	575.029[1] (0.000)	-6.273 (1.000)
Relative Price (RP_{ijt})	362.871[1] (0.000)	-4.269 (1.000)
Volatility (SD-8q)	50.360[1] (0.000)	-5.262 (1.000)
Volatility (MASD)	49.403[1] (0.000)	-5.489 (1.000)
Volatility (GARCH)	23.885[1] (0.000)	-9.542 (1.000)
Volatility (SD-4q)	26.165[1] (0.000)	-8.478 (1.000)

Notes: [1] indicates significant at 1 % level. Values in the parentheses are P-value. Null hypothesis of Hadri LM test is each series is level stationary with heteroskedastic disturbances across units. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

Unlike the *IPS* test, the Hadri LM test reject the null of stationary in all series of the panel. However, as pointed out by Caner and Kilian (2001), the Hadri LM test is a generalization of the uni-variate KPSS unit root test, and it may cause size distortion if the model under the null hypothesis is highly persistent. Hence, these results should also be interpreted with care since the test tends to over-reject the true null hypothesis. When testing the stationarity of the first differences, the *IPS* test rejects the null of nonstationarity in all variables and the Hadri LM test suggests that all series of the panel are stationary. Therefore, both tests approve that variables of the sample follow an $I(1)$ process.

Since all the variables are integrated of order one, the residuals of the panel estimation need to be stationary in order to establish a cointegrated combination among the variables in the panel model. In this chapter six panel cointegration test statistics – three panel cointegration statistics and three group mean panel cointegration statistics – developed by Pedroni (1999) are applied to test for a long-run relationship among the variables. [24]

The results are presented in Table 5.7. All of the calculated statistics suggest that the null of no cointegration is rejected for all estimations. Therefore, there is a strong evidence that support the existence of a long-run relationship among the variables of the study.

[24] Detail derivations of these statistics are presented in Chapter 4.

Table 5.7: Pedroni (1999)'s Panel cointegration Tests

Statistics	Estimation with the SD (8-quarters)	Estimation with the MASD	Estimation with the GARCH	Estimation with the SD (4-quarters)
Panel-ρ	-8.6849	-8.5965	-8.5468	-8.8478
Panel-t	-10.6120	-10.5924	-10.6392	-10.8538
Panel-ADF	-10.8899	-10.9292	-9.8098	-5.5691
Group-ρ	-9.6941	-9.7874	-9.8789	-9.8147
Group-t	-12.3395	-12.4156	-12.6647	-12.5063
Group-ADF	-12.1753	-12.2504	-11.9082	-6.2356

Notes: The critical value at 1% significant level is -2.0. Null hypothesis is no cointegration. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

5.3.2 The impact of exchange rate volatility on exports

A panel data set of 85 country-pairs for the period from 1982:Q1 to 2006:Q4 is estimated. The specification of the trade model can be described as follows:

$$\begin{aligned}\ln X_{ijt} &= \beta_0 + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt}\end{aligned} \qquad (5.1)$$

which is a pooled model similar to equation (4.10).

The results of the pooled OLS estimation are presented in Table 5.8. All the estimated coefficients show expected sign and significant at one percent level. However, the results of the pooled OLS estimation ignore the unobservable individual specific effects such as cultural, economical, and institutional factors that are constant over time. Since unobservable individual specific effects, which are not explicitly represented in the model, are likely to be correlated with the independent variables, pooled OLS estimates would be inconsistent even when $T \rightarrow \infty$, as shown by Pesaran and Smith (1995).

Table 5.8: Estimation results of pooled OLS regression

Variables	SD (8-q)	MASD	GARCH	SD (4-q)
Home Income (*Y*)	0.7509***	0.7472***	0.7478***	0.7487***
	(0.0195)	(0.0197)	(0.0192)	(0.0196)
Foreign income (*Y)**	0.9131***	0.9170***	0.9162***	0.9145***
	(0.0050)	(0.0049)	(0.0046)	(0.0049)
Relative price (*RP*)	-0.0118***	-0.0121***	-0.0081*	-0.0095***
	(0.0031)	(0.0031)	(0.0030)	(0.0030)
Volatility (*V*)	-2.8164***	-1.8482***	-8.5309***	-2.2131***
	(0.1463)	(0.2547)	(1.1296)	(0.2987)
Common border	0.6773***	0.6835***	0.6909***	0.6846***
	(0.0239)	(0.0242)	(0.0263)	(0.0238)
FTA	0.9158***	0.9092***	0.9398***	0.9211***
	(0.0625)	(0.0598)	(0.0636)	(0.0618)
Distance	-0.7062***	-0.6838***	-0.7070***	-0.7017**
	(0.0196)	(0.0199)	(0.0191)	(0.0195)
R-square	0.6553	0.6541	0.6512	0.6539
Number of Observations	8500	8500	8500	8500

Notes: The figures in parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

5.3.4 One way error component model with country-pair fixed effects

In order to control for the unobserved individual heterogeneity, one-way error component model is applied. The model to be estimated becomes;

$$\begin{aligned}\ln X_{ijt} &= \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \alpha_{ij} + \varepsilon_{ijt}\end{aligned} \quad , \qquad (5.2)$$

where α_{ij} represents the unobservable country-pair specific effect. This fixed effect model can capture the time invariant country-pair specific effects that are constant over time and are not explicitly represented in the model. If the true model is a fixed effect as in (5.2), pooled OLS in (5.1) will yield bias estimates due to the fact that it omits the relevant country-pair specific effects. The joint significance of the unobservable country-pair specific effects are tested by performing an F-test. The Chow test yields the F-statistics of $F_{(1,\ 8410)} = 19.09$, which suggesting the joint significance of the country-pair specific effects.

The estimation results of one-way error component model are presented in Table 5.9. In order to estimate the effects of time-invariant explanatory variables - distance and common border - which have been wiped out by 'within transformation' process of fixed effects estimation, the results of random-effects estimation are also reported in the table. The estimated coefficients are similar to those of the pooled OLS estimation except the coefficients of exchange rate volatility variables which is two times to five times smaller than those in pooled OLS estimation. This comparison clearly demonstrates that omitting the country-pair specific effects overestimates the impact of exchange rate volatility.

Table 5.9: Estimation results of country-pair fixed-effect estimation

Variables	SD (8q)		MASD		GARCH		SD (4q)	
	FE	RE	FE	RE	FE	RE	FE	RE
Home Income	1.0019***	1.0092***	1.0017***	1.0090***	1.0054***	1.0118***	1.0038***	1.0109***
(*Y*)	(0.0198)	(0.0185)	(0.0198)	(0.0185)	(0.0197)	(0.0185)	(0.0197)	(0.0185)
Foreign	1.1125***	1.0833***	1.1129***	1.0836***	1.1063***	1.0798***	1.1104***	1.0812***
income (*Y)**	(0.0335)	(0.0302)	(0.0335)	(0.0302)	(0.0335)	(0.0304)	(0.0335)	(0.0302)
Relative price	-0.0151***	-0.0157***	-.0161***	-0.0166***	-0.0141***	-0.0146***	-0.0143***	-0.0149***
(*RP*)	(0.0051)	(0.0050)	(0.0052)	(0.0050)	(0.0051)	(0.0050)	(0.0051)	(0.0050)
Volatility (*V*)	-0.6135***	-0.6234***	-0.2978***	-0.3042***	-3.7685***	-3.7956***	-0.5094***	-0.5174***
	(0.1176)	(0.1178)	(0.0859)	(0.0860)	(0.5564)	(0.5572)	(0.1027)	(0.1029)
Common	-	0.8544**	-	0.8567**		0.8504**	-	0.8542**
border		(0.4229)		(0.4224)		(0.4382)		(0.4189)

Table 5.9: Estimation results of Country-pair fixed-effect estimation (Contd.)

Variables	SD (8q)		MASD		GARCH		SD (4q)	
	FE	RE	FE	RE	FE	RE	FE	RE
FTA	0.1754***	0.1971***	0.1726***	0.1943***	0.1763***	0.1962***	0.17548***	0.1973***
	(0.0353)	(0.0347)	(0.0353)	(0.0347)	(0.0352)	(0.0347)	(0.0353)	(0.0347)
Distance	-	-0.9454***	-	-0.9430***		-0.9461***	-	-0.9428***
		(0.1377)		(0.1375)		(0.1426)		(0.1364)
R-square	0.7112		0.7107		0.7118		0.7111	
Number of Observations	8500		8500		8500		8500	
Country-pairs	85		85		85		85	

Notes: The figures in parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively. FE and RE refer to Fixed-effects and Random-effects, respectively.

5.3.5 Two-way error component model with country-pair and time fixed effects

In order to control for the effects of omitted variables that are specific to each time period and country-pair, a two-way error components model is applied to the basic model as follows.

$$\begin{aligned} \ln X_{ijt} &= \beta_1 \ln Y_{jt} + \beta_2 \ln RP_{ijt} + \beta_3 \ln E_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \lambda_t + \alpha_{ij} + \varepsilon_{ijt} \end{aligned} \tag{5.3}$$

Note that variable λ_t is allowed to change over time in order to account for the effects of omitted variables that are specific to each time period but are the same for all country-pairs. By allowing the intercept to change over time, the current gravity model can control for the omitted variables that are specific to each time period but are the same for all country-pairs. (For example, changes in the world income or technological changes which have the similar impact on all of the sample countries).

The results of the two-way error components fixed-effects and random effect estimation are presented in Table 5.10. All estimation results confirm that the impact of bilateral exchange rate volatility on bilateral exports is negative and statistically significant in both fixed-effects and random-effects estimations. The result is also robust across the different measures of exchange rate volatility. The joint significance of the unobservable time specific effects is also confirmed by the Chow test which yields the *F*-statistics of $F_{(1,\,8311)} = 9.95$.

Table 5.10: The impact of exchange rate volatility on exports (two-way error components model): Main results

Variables	SD (8q)		MASD		GARCH		SD (4q)	
	FE	RE	FE	RE	FE	RE	FE	RE
Home Income	0.8177***	0.8012***	0.8203***	0.8035***	0.8244***	0.8087***	0.8221***	0.8051***
(*Y*)	(0.0327)	(0.0314)	(0.0327)	(0.0314)	(0.0326)	(0.0314)	(0.0326)	(0.0313)
Foreign income	0.9710***	0.9459***	0.9727***	0.9474***	0.9671***	0.9443***	0.9717***	0.9461***
(*Y)**	(0.0400)	(0.0351)	(0.0400)	(0.0351)	(0.0399)	(0.0354)	(0.0400)	(0.0351)
Relative price	-0.0018	-0.0012	-0.0027	-0.0021	-0.0021	-0.0016	-0.0021	-0.0015
(*RP*)	(0.0057)	(0.0055)	(0.0057)	(0.0056)	(0.0057)	(0.0055)	(0.0057)	(0.0055)
Volatility (*V*)	-0.6800***	-0.6977***	-0.3064***	-0.3183***	-3.4765***	-3.5012***	-0.5069***	-0.5183***
	(0.1462)	(0.1464)	(0.1064)	(0.1065)	(0.6166)	(0.6168)	(0.1246)	(0.1247)
Common border	-	0.7703*	-	0.7739*		0.7682*	-	0.7719*
		(0.4227)		(0.4221)		(0.4379)		(0.4187)

Table 5.10: The impact of exchange rate volatility on exports (two-way error components model): Main results (Contd.)

Variables	SD (8q)		MASD		GARCH		SD (4q)	
	FE	RE	FE	RE	FE	RE	FE	RE
FTA	0.1426***	0.1532***	0.1407***	0.1513***	0.1469***	0.1567***	0.1445***	0.1554***
	(0.0358)	(0.0352)	(0.0359)	(0.0353)	(0.0358)	(0.0352)	(0.0359)	(0.0352)
Distance	-	-0.8390***	-	-0.8369***		-0.8418***	-	-0.8390***
		(0.1383)		(0.1382)		(0.1432)		(0.1371)
R-square	0.7188		0.7183		0.7191		0.7186	
AIC (BIC)	13129.01 (13869.04)		13142.77 (13882.79)		13118.69 (13858.71)		13134.23 (13874.25)	
Numbers of Observations	8500		8500		8500		8500	
Country-pairs	85		85		85		85	

Notes: The figures in parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively. FE and RE refer to Fixed-effects and Random-effects, respectively.

Sauer and Bohara (2001) noted that the random-effects model is more appropriate for a sample which is randomly drawn from a large population and the inference is to be made about the underlying population. On the other hand, the fixed-effects model is an appropriate specification if the focus is on a specific set of sample countries and the inference is restricted to the behaviours of these countries (Baltagi, 2001). For this analysis the sample countries are 'one of a kind', not a random draw from some underlying population and the prediction to be made is for these particular countries. In this respect, fixed-effects estimation approach is considered to be more appropriate for the current study. Nonetheless, in order to ensure the robustness of the results and to estimate the effects of time-invariant explanatory variables – sharing a common border and distance between two countries – the random-effects models are also estimated.

The estimation results confirm that the impact of bilateral exchange rate volatility on the exports of emerging East Asian countries is negative and statistically significant in both estimation methods although the magnitudes are different across the volatility measures. The results are more or less similar to those of one-way error component model presented in the previous sub-section. The only difference is that the coefficient of relative prices variable is now insignificant although it shows a correct sign. The finding of a negative impact of bilateral exchange rate volatility on exports is consistent with previous studies which analyse different samples of Asian countries (for example, Bénassy-Quéré and Lahrèche-Révil, 2003; Baak, 2004).

5.3.6 The choice of optimal exchange rate volatility

As discussed in the methodology section, there is no theoretically obvious optimal measure of exchange rate volatility. A common if questionable approach in the literature has been to choose the measure of volatility which provides the most significant results of the appropriate sign based on econometric model selection criteria.[25] Based on model selection criteria- such as R-square, AIC (Akaike Information Criterion) and BIC (Schwarz Bayesian Information Criterion), the model based on the GARCH measure seems to be the "optimal" model of estimation. However, there are two potential problems with the GARCH volatility measure. First, it has been argued that the ARCH-based volatility measure is more suitable for the high frequency data such as daily exchange rate. It is not very precise to measure the volatility of low frequency data as the exchange rate may move around a lot during the month, and yet end up close to its value the same as the previous month.[26] Secondly, as mentioned by McKenzie (1999), the exchange rate volatility generated prior to the end of a sample period incorporates information about the future, since ARCH models are estimated over the entire sample period. For these reasons, exchange rate volatility measure based on standard deviation of the first difference of the logarithm of real exchange rate over 8 quarters is considered as a suitable measure and will be employed as the benchmark measure of volatility.

[25] For example Kumar and Dhawan (1991) tested over 15 different measures of exchange rate volatility and selected the optimal measure based on the standard criteria of 'Goodness of fit'- such as R-square (within), *t*-statistics, etc.

[26] In order to overcome the problem Baum *et al.* (2004) and Klaassen (2004) use daily exchange rate to construct the volatility of monthly exchange rate. But for the sample countries during the sample period, daily exchange rates are not readily available.

5.3.7 Poolability test

One of the assumptions of a multi-country panel data analysis is the homogeneity of coefficients; that is, the analysis assumes that estimated coefficients are the same for all sample countries of the panel. Some argue that this is a rather strong assumption. In order to examine the homogeneity of coefficients in the current panel based estimation, *RZB* poolability test suggested by Baltagi (2001) is conducted. The first column of Table 5.11 shows the test statistics for the *RZB* test. The null hypothesis of poolability is rejected suggesting a certain degree of parameter heterogeneity.

Nonetheless, the estimations of individual time-series model as a part of *RZB* test ignore the important time invariant variables such as sharing a common border and distance. This limitation can be eliminated by calculating an alternative poolability test introducing interaction between the regressors and the country-pair specific dummies and testing for the joint significance of the coefficients of interaction variables. The second column of Table 5.11 presents the test statistic of the alternative poolability test. The null hypothesis of poolability is again rejected although the *F*-statistics is much smaller than that of the *RZB* test. However, it is important to note that for a multi-country panel data analysis like the current one with 85 cross-sectional trade flows, it is extremely difficult to verify the homogeneity of the coefficients. Among the 85 coefficients, if only one coefficient is statistically different from that of panel data estimate, the null of homogeneity will be rejected.

Table 5.11: Poolability test

	***RZB* test**	**Interaction test**
Statistics	$F_{(420,8075)} = 148.85$	$F_{(524,7975)} = 12.13$
P-value	(0.00)	(0.00)

However, Baltagi *et al.* (2000) claim that although a panel data model may create some bias, the efficiency gained from the pooling more than offset the bias. This view is also supported by Attanasio, Picci and Scorcu (2000). In this sense, the panel model can yield more efficient estimates at the expenses of bias. McElroy (1977) suggested three tests based on mean square errors (MSE) criteria that do not test the falsity of the poolability hypothesis, but allow a choice between the constrained and unconstrained estimator on the basis of the trade-off between bias and efficiency. This study employs two tests; strong MSE test and second weak MSE test.[27] Table 5.12 presents the results of MSE criteria tests. According to the tests, the pooled model is preferable to the unconstrained model under the second Weak MSE criteria. In other words, estimating the pooled data of emerging East Asia countries as a panel data model in the current study

[27] Another test called First Weak MSE criterion is not carried out in this study due to the limitation of the Econometric software used in the analysis.

provides more efficient estimates than estimating the individual country regressions.

Table 5.12: MSE criteria Tests

	"Strong MSE Test"	**"Second Weak MSE Test"**
Statistics	λ_{WT}=127.64	λ_{WT}=127.64
Null Hypothesis	$\lambda_{WT} \leq 0.5$	$\lambda_{WT} \leq (N-1)K'/2$=252
Pooling is better	**no**	**yes**

5.3.8 Controlling for potential endogeneity of exchange rate volatility

The previous section utilizes the fixed-effects panel data estimation. However, as explained in the methodology section, the results of the fixed-effects estimation may not be reliable because of two methodological problems. The first one is the potential problem of endogeneity. If the sample countries implement policies aimed at lowering bilateral exchange rate volatility with their trading partners in order to increase their exports, the model considered would suffer an endogeneity bias. In this situation exchange rate volatility could become an endogenous variable and the results of OLS estimation would be biased.

Tenreyro (2007) points out that the potential endogeneity is one of the main problems that cast doubt on the findings of previous empirical studies. In order to control for this possibility, the instrumental variable (IV) approach is employed. Following Frankel and Wei (1993) and Clark *et al.* (2004), the volatility in the relative money supply is used as an instrumental variable. The rationale of using the standard deviation of the relative money supply as an instrument for the exchange rate volatility is that although relative money supplies are highly correlated with bilateral exchange rate, the monetary policies are less likely to be affected by export considerations than exchange rate policies (Frankel and Wei, 1993).

The second potential problem may arise from the fact that individual effects may vary over time as a result of omitted macroeconomic shocks. If the sample countries respond to the time-varying unobservable macroeconomic shocks, such as oil price shocks, differently, the fixed-effects panel data estimation approach may be subject to the problem of heteroskedasticity. Although including time-specific error components in the two-way error components model can control the effects of time-varying unobservable macroeconomic shocks, the fixed effect specification assumes the homoskedasticity of the residual. If the residuals are not homoskedastic, the estimates will still be consistent but inefficient. A groupwise likelihood ratio heteroskedasticity test is conducted on the residuals of the baseline two-way error components fixed-effects model, and the result of the test (χ^2 (85) = 33820.33) rejects the null hypothesis of residual homoskedasticity across groups.[28] Given the result of this test, the results presented in Table 5.10 might be inefficient as a result of the residuals heteroskedasticity.

In order to control for potential endogeneity and to correct for the heteroskedasticity across country-pairs as well as residual serial correlation, GMM-IV fixed effect estimation approach, in which estimators are efficient for arbitrary heteroskedasticity and autocorrelation is used.[29] The results of the GMM-IV estimation are presented in Table 5.13. In order to estimate the coefficients of time invariant variables, the results of Generalised Two Stages Least Square (G2SLS) estimation are also reported.[30] The results of the GMM-IV estimation confirm that all coefficients still have the expected sign and are statistically and economically significant except the relative price variable.[31]

Various diagnostic tests confirm that the volatility of relative money supply is a valid instrument for the exchange rate volatility. In order to identify the problem of weak instruments, a weak ID test suggested by Stock and Yogo (2005) is conducted. Stock and Yogo (2005) suggest two definitions of weak instruments and provide a table of critical values to test whether instruments are

[28] The test is chi-squared distributed with $N-1$ degrees of freedom, where N is the number of groups in the sample, 85 country-pairs in this study.
[29] Baum *et al.* (2003) point out that in the presence of heteroskedasticity the GMM estimator is more efficient than the simple IV estimator.
[30] System GMM approach suggested by Arellano and Bover (1995) and Blundell and Bond (1998) can estimate the impact of time-invariant variables. But this approach is suitable only for a panel with small T and large N as the number of instruments is increasing with time dimension T (Roodman, 2006). Since the time dimension of the panel data set of the current study is larger than the cross-sectional dimension, the System GMM is not applicable.
[31] In order to test whether the instrument is uncorrelated with error term, that is to conduct Hansen-J test, the number of instruments excluded from the regression need to exceed the number of included endogenous variables (Baum *et al.*, 2003). Therefore, variables representing the relative volatility of money and a lagged value of exchange rate volatility are used as instrumental variables in the two stages least square estimation technique.

weak by using the Cragg-Donald F-statistic (first-stage F-statistics). The null hypothesis is that a given group of instruments is weak against the alternative that it is strong. If the instruments were weak, the IV estimators would be biased. Since the Cragg-Donald F-statistic is greater than the critical value provided by Stock and Yogo (2005), the null hypothesis of weak instruments can be rejected. The Sargan-Hansen test for verifying overidentification is also conducted. The joint null hypothesis of the Sargan-Hansen test is that the instruments are valid, i.e., uncorrelated with the error term, and that the instruments are correctly excluded from the estimated equation. The test result suggests the joint null hypothesis of Sargan-Hansen test cannot be rejected.

From the estimation results using the bench mark volatility measure the impact of bilateral exchange rate volatility on exports can be computed. It shows that the effect of an increase in exchange rate volatility by one standard deviation (5.2 percent) around its mean would lead to 3.1 percent reduction of bilateral exports of emerging East Asian countries. For other measure of exchange rate volatility, reduction in exports range from 2.0% (MASD measure) to 7.3% (GARCH measure).[32] This finding can be compared to those of other studies using similar methodology but different sample data set to examine the trade effect of exchange rate volatility; for example, by using over 100 countries of sample data set Tenreyro (2007) estimates a reduction ranging from 4 – 8 percent. Rose (2003) estimates a 13 percent reduction, and Clark *et al.*(2004) estimate 7 percent of reduction.

[32] This impact is computed as the estimated coefficient of volatility measure in the benchmark equation multiply by one standard deviation of volatility measure, then multiplied by 100 to convert into percent.

Table 5.13: Controlling for endogeneity of exchange rate volatility: GMM-IV

Variables	SD (8q)		MASD		GARCH		SD (4q)	
	GMM-IV	G2SLS	GMM-IV	G2SLS	GMM-IV	G2SLS	GMM-IV	G2SLS
Home Income	0.8261***	0.8105***	0.8285***	0.8123***	0.8311***	0.8087***	0.8311***	0.8149***
(*Y*)	(0.0329)	(0.0319)	(0.0329)	(0.0320)	(0.0327)	(0.0314)	(0.0329)	(0.0319)
Foreign	0.9781***	0.9497***	0.9797***	0.9513***	0.9702***	0.9447***	0.9785***	0.9497***
income (*Y)**	(0.0491)	(0.0355)	(0.0492)	(0.0356)	(0.0491)	(0.0359)	(0.0492)	(0.0355)
Relative price	-0.0009 (0.0049)	-0.0004	-0.0017	-0.0013	-0.0021	-0.0017	-0.0009	-0.0004
(*RP*)		(0.0055)	(0.0048)	(0.0056)	(0.0051)	(0.0055)	(0.0049)	(0.0055)
Volatility (*V*)	-0.5953***	-0.6226***	-0.2685**	-0.3143***	-6.9682^	-7.2198***	-0.2678	-0.3200**
	(0.1792)	(0.1585)	(0.1294)	(0.1318)	(3.9450)	(1.6546)	(0.2393)	(0.1661)
Common	-	0.7720*	-	0.7751*		0.7573*		0.7753*
border		(0.4216)		(0.4210)		(0.4372)		(0.4174)
FTA	0.1477***	0.1595***	0.1459***	0.1576***	0.1558***	0.1669***	0.1486***	0.1609***
	(0.0375)	(0.0352)	(0.0374)	(0.0353)	(0.0389)	(0.0354)	(0.0376)	(0.0353)

Table 5.13: Controlling for endogeneity of exchange rate volatility: GMM-IV (Contd.)

	SD (8q)		MASD		GARCH		SD (4q)	
	GMM-IV	G2SLS	GMM-IV	G2SLS	GMM-IV	G2SLS	GMM-IV	G2SLS
Distance	-	-0.8374***	-	-0.8355***		-0.8428***	-	-0.8371***
		(0.1381)		(0.1378)		(0.1430)		(0.1367)
R-square within	0.7178		0.7174		0.7170		0.7176	
Number of Observations	8415		8415		8415		8415	
Country-pairs	85		85		85		85	
Cragg-Donald (*F*)	9530.380		804.057		13.810		1088.211	
Sargen-Hansen *J* statistic	0.337		0.404		0.552		0.474	
	χ^2 (1) p =0.539		χ^2 (1) p =0.525		χ^2 (1) p =0.457		χ^2 (1) p =0.4913	

Notes: ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively. FE and RE refer to Fixed-effects and Random-effects, respectively. Estimates are efficient for arbitrary heteroskedasticity and autocorrelation. Statistics are robust to heteroskedasticity and autocorrelation. Cragg-Donald F-statistics tests for weak identification. 10% and 15% critical value of Stock-Yogo weak ID test is 19.93 and 11.59 respectively.

The estimated coefficients of the remaining variables are very similar across the different estimation methods and volatility measures. All dummy variables are significant and show the expected sign. However, the coefficient of the relative price variable, which represents the competitiveness of the exporting countries relative to the importing countries, is insignificant in all estimations. A potential explanation for this finding might be that for the importing countries the imports from the sample East Asian countries consist, to a large extent, of non-competing imports of necessity goods such as raw material and intermediate inputs, which are price-insensitive.

There are two important points supporting the use of an augmented generalised gravity model with presumption that exports from the sample countries are predominantly inter-industry trade comprising raw materials and intermediate goods. First and foremost, the results confirm that estimated coefficient of the home country's income is less than that of importing country's income. This finding is consistent with the theoretical prediction and empirical findings of Feenstra *et al.* (2001) which demonstrate and prove that a country's exports of homogenous product are more sensitive to importing country's income than to its own income.[33]

The second point is that the coefficient of the importing country's income variable is significant and positive but less than unity. It indicates that income

[33] Feenstra *et al.* (2001) empirically examines the three categories of exports: differentiated goods, referenced priced goods and homogenous goods by using a gravity model similar to this study but without the relative price variable. Their results confirm that the estimated coefficient of home country GDP is less than that of the GDP of partner country.

elasticity of demand for the exports of emerging East Asia countries is positive but less than one suggesting that the exports of emerging East Asian countries are normal goods but necessities. This finding is also in line with the presumption underlying model specification choice that exports from these countries are predominantly inter-industry trade flows comprising raw materials and intermediate goods. This finding can be compared to the study of Hondroyiannis *et al.* (2006) which found income elasticities of exports in the range of 1.6-1.7 for the exports of G-7 countries. Bénassy-Quéré and Lahrèche-Révil (2003) who estimate the relationship between exports and exchange rate in Asia found that the income elasticity of exports is around 1.1, yet the sample of their study is the combination of emerging and developed Asian economies.

5.3.9 Competitiveness of East Asian countries on third markets

One characteristic of the emerging East Asian economies is that although they are increasingly interdependent and attempt to promote their regional cooperation, they compete against each other for exports to the world markets. The study of Roland-Holst and Weiss (2004) provides strong evidence that the main ASEAN countries have been exposed to increasing competition from China. Eichengreen *et al.* (2007) also find that the growth of Chinese exports led to a decrease in the exports of other Asian countries, especially for exports in consumer goods. In their preliminary study, Zhang and Zhang (2005) found that expansion of China's share in the world manufacturing goods market led to slow-down in the growth of some ASEAN countries.

In this section the competitiveness of an emerging East Asia exporting country against other sample countries is employed to estimate the extent of competition in third markets. The level of competitiveness of an exporting country relative to other sample countries is computed as the ratio of the bilateral real exchange rate between exporting country and importing country, E_{ijt}, to the real effective exchange rate of the sample countries, RE_{sjt}, which is weighted by the export share of sample countries to the importing country.[34] Thus, an increase in the level of competitiveness of the exporting country i relative to the rest of the sample East Asia countries to the destination country j is expected to have positive impact on the exports of i to j. The benchmark model becomes:

$$\ln X_{ijt} = \gamma_t + \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 Comp_{ijt} + \beta_4 V_{ijt} + \beta_5 D1_{ij} \\ + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt} \qquad (5.4)$$

where $Comp_{ijt}$ represents the level of competitiveness of the exporting country against the rest of the sample countries to a destination market. The estimation results are shown in Table 5.14.

[34] Bénassy-Quéré, and Lahrèche-Révil (2003) construct the same variable to estimate the level of competitiveness of East Asian countries competing in the world market.

Table 5.14: Competitiveness of East Asian countries on tbird markets

Variable	GMM-IV	G2SLS-IV
Home income	0.8262***	0.8107***
	(0.0328)	(0.0319)
Foreign income	0.9739***	0.9474***
	(0.0481)	(0.0351)
Competitiveness	0.0061**	0.0058***
	(0.0026)	(0.0018)
Volatility	-0.6081***	-0.6337***
	(0.1815)	(0.1584)
Common border	-	0.7702*
		(0.4236)
FTA	0.1469***	0.1587***
	(0.0375)	(0.0350)
Distance	-	-0.8366***
		(0.1383)
R-square (within)	0.7182	
Number of Observations	8415	
Number of Country-pairs	85	
Cragg-Donald (F-statistics)	9512.730	
Hansen *J* statistics	0.344; χ^2 (1) p =0.557	

Notes: ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Estimates are efficient for arbitrary heteroskedasticity and autocorrelation. Statistics are robust to heteroskedasticity and autocorrelation. Cragg-Donald F-statistics tests for weak identification. 10% and 15% critical value of Stock-Yogo weak ID test is 19.93 and 11.59 respectively.

The results confirm that an increase in the competitiveness of an emerging East Asian country against the other sample countries has a positive impact on its exports to a destination market, but the magnitude of the impact is very small relative to the negative impact of exchange rate volatility. The estimation results suggest that the impact of a favourable exchange rate, relative to other regional competitors, on exports is inconsequential. This reinforces the views of Adams *et al.* (2006) and Roland-Holst and Weiss (2004) who find that there is no monocausal explanation for the export performance of East Asia and the favourable exchange rate is only one factor of the recent upsurge in their exports. It also depends on other factors such as specialization, technology sophistication and consumer preferences.

5.3.10 The impact of 1997 financial crisis

All of the sample East Asian emerging countries except China experienced the 1997 Asian Financial Crisis. The underlying sources of the 1997 financial crisis are still a debatable issue, but the Asian Crisis has caused severe economic turbulence in Indonesia, Malaysia, the Philippines and Thailand (Karunatilleka, 1999). During the crisis period, these countries experienced a rapid fall in their currencies value against the US dollar. For example, between June 1997 and September 1998, Indonesia's currency depreciated 77.7 percent in nominal terms and 56.3 percent in real terms. Malaysian Ringgit and the Philippines Peso depreciated 34% and Thailand's Bath depreciated 46% against the US dollar. It has been evident that the extent of the changes in macroeconomic indicators –

such as interest rate and stock market index – was too large such that level of macroeconomic uncertainty was very high in these countries during the crisis period. The movements of macroeconomic indicators during the 1997 financial crisis period are presented in Table 5.15.

Table 5.15: Exchange and Interest Rates during the Asian Crisis

Country	3-month interest rates		Change in dollar Exchange rate	Change in real dollar Exchange rate	Stock market movement 1997
	Average in 1996	1997 peak			
Indonesia	13.8%	27.7%	-77.7%	-56.3%	-37.0%
Malaysia	7.3%	8.8%	-39.8%	-27.2%	-52.2%
Philippines	11.7%	85.0%	-38.3%	-26.0%	-40.3%
Thailand	13.0%	26.0%	-36.7%	-19.1%	-55.2%

Sources: Karunatilleka (1999)

Following the results from previous section, which suggest that the uncertainty arising from exchange rate volatility has a significant negative impact on exports, the other macroeconomic uncertainty during the Asian financial crisis should have also had a negative impact on the exports of the affected countries. On the other hand, as these countries experienced a rapid fall in their currencies value against the US dollar during the crisis period, theoretically it should have led to an increase in exports of these countries.

Table 5.16: The effect of 1997 financial crisis

Variable	GMM-IV	G2SLS-IV
Home income	0.8214***	0.8049***
	(0.0329)	(0.0316)
Foreign income	0.9680***	0.9440***
	(0.0400)	(0.0352)
Relative price	-0.0009	-0.0013
	(0.0056)	(0.0055)
Volatility	-0.7232***	-0.7401***
	(0.1515)	(0.1516)
Effect of Financial Crisis	0.0616	0.0610
	(0.0545)	(0.0546)
Common border	-	0.7698^
		(0.4254)
FTA	0.1387***	0.1491***
	(0.0359)	(0.0352)
Distance	-	-0.8350***
		(0.1392)
R-square (within)	0.7188	
Number of Observations	8415	
Number of Country-pairs	85	

Notes: ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively.

In this section, the bench mark model is used to estimate the effect of the 1997 financial crisis on the exports of the emerging East Asian countries. A dummy variable is constructed equal to 1 for the period of 1997:Q3 to 1999:Q2 for country-pairs in which the exporting country was affected by the 1997 financial crisis in order to control the effect of uncertainty other than exchange rate volatility during the crisis.[35] The estimation results are presented in Table 5.16. All the usual coefficients are still significant and have the right sign. However, the effect of the financial crisis is insignificant. It seems possible competitive devaluation has led to no significant increase in exports. The estimation result seems suggesting that during the financial crisis, the exports of the sample countries are not adversely affected by the uncertainty arising from macroeconomic volatility but uncertainty arising solely from the exchange rate fluctuations.

5.4 Conclusion

This chapter examines the impact of real exchange rate volatility on real exports of five emerging East Asian countries by using an augmented generalised gravity model as a framework of analysis. Unlike other studies on this topic, panel unit-root and cointegration test have been used to verify the long-run relationship among the variables. The results provide evidence that exchange rate volatility has

[35] The duration to recover from the financial crisis was different for the each country. But it is assumed that the major effect of the crisis lasted for two years. See, Karunatilleka, (1999) for the chronology of events.

a statistically and economically significant negative impact on the exports of emerging East Asian countries. These results are robust across different estimation techniques and seemingly do not depend on the variable chosen to proxy the exchange rate uncertainty.

The effects of the level of competitiveness among the sample countries and the 1997 financial crisis are also examined in this chapter. The findings confirm that, for sample countries, an increase in competitiveness relative to other has a positive impact on exports, but the magnitude is relatively inconsequential. On the other hand, the 1997 Asian financial crisis led to no significant impact on the exports of the sample countries.

The estimation results demonstrate that, as expected, home country's income and importing country's income affect exports positively. But the net exports are more sensitive to the importing country's income than to exporting country's own income. Moreover, the results show that the income elasticity of demand for the exports of the sample countries is less than one, suggesting that their exports are mostly comprised of basic commodities. From a methodological point of view, this justified the use of the augmented generalised gravity model instead of a pure gravity model.

The problems of possible simultaneity bias and heteroskedasticity are addressed by employing a GMM-IV estimation approach. The result of GMM-IV estimation, in which the volatility of relative money supply is used as an instrumental variable, also confirms the negative impact of exchange rate volatility on exports. These findings suggest that negative relationship between exchange rate volatility and exports of emerging East Asian economies is not solely determined by the simultaneous causality bias. The empirical results derived in this chapter are consistent with recent research done for larger samples of developed and less developed countries.

One interesting issue is that although the sample countries are competing each other for exports to third markets, these countries are members of the newly formed ASEAN-China Free Trade Area (ACFTA), which aims at forging closer economic relations between China and ASEAN through lowering of trade and investment barriers and through joint technical and economic cooperation projects. Therefore, understanding of degree to which the bilateral exchange rate volatility affects their intra-regional exports is also important for their future exchange rate policies and regional integration process. The next chapter will examine this issue, in particular, the impact of bilateral exchange rate volatility on the intra-regional exports of emerging East Asia countries.

Chapter 6

The Impact of Exchange Rate Volatility on the Intra-Regional Export Flows of Emerging East Asia Countries

6.1 Introduction

This chapter examines the impact of exchange rate volatility on the bilateral exports among the five emerging East Asian economies – namely, China, Indonesia, Malaysia, the Philippines, and Thailand. These countries are the main members of the newly formed ASEAN-China Free Trade Area (ACFTA) which aims at forging closer economic relations between China and ASEAN through lowering of trade and investment barriers and through joint technical and economic cooperation projects. According to the free trade agreement, tariffs will be reduced to zero for the most products by 2010. Cordenillo (2005) predicted that ACFTA will increase ASEAN's exports to China by 48 per cent and China's exports to ASEAN by 55.1 percent.

However, removing tariff and non-tariff barriers alone cannot guarantee to achieve their attempted trade promotion and regional integration. There are other issues that can hinder the trade promotion and regional integration process. One of these issues is the impact of exchange rate volatility on trade. If exchange rate volatility had an adverse impact on their bilateral trade, their attempted regional integration would be fruitless without implementing necessary policies to stabilize their bilateral exchange rates. In such circumstances, understanding of the degree to which exchange rate volatility affects the bilateral trade flows of ACFTA countries become an important issue.

The contribution of this chapter is to provide fresh insights into the relationship between real exchange rate volatility and bilateral trade flows among the major ACFTA countries. In fact, this study is the first to investigate the relationship between exchange rate volatility and bilateral trade flows of ACFTA countries utilizing a panel data set comprising 25 years of quarterly data. Since these countries are major members ACFTA, the finding of this study should provide a vital piece of missing evidence for the evaluation of their trade, regional integration and exchange rate policy options.

The outline of the chapter is as follows. Section 6.2 presents the descriptive statistics and correlations between the main variables. Then the research findings are presented in section 6.3. The final section draws conclusions.

6.2 Descriptive statistics and correlations: Main variables

This section presents the descriptive statistics of two main variables: Real exports and exchange rate volatility. To grasp the consequence of structural changes after the Asian financial crisis, time period is divided into pre-crisis period (1982:Q1-

1997:Q2) and post-crisis period (1997:Q3-2006:Q4). Table 6.1 shows the mean, standard deviation and the coefficient of variation of the dependent variable, real exports. During the pre-crisis period, the variations of bilateral export volume among the sample countries were more or less the same except for the exports from Indonesia to China which was relatively more volatile. In contrast, during the post-crisis period, the volatility of exports has decreased whilst real exports (export volume) among the sample countries have increased. The increased in the volume and decreased in the volatility of bilateral exports among the sample countries seem to be consequences of their attempted regional integration after the 1997 financial crisis.

Table 6.1: Descriptive statistics of Real Exports

Before the Asian financial Crisis (1982:Q1-1997:Q2)			
Country-pairs	**Log of Real Exports**		
	Mean	**Standard Deviation**	**Coefficient of Variation**
China-Indonesia	18.3087	1.0435	0.0569
China-Malaysia	18.6975	0.6483	0.0346
China-Philippines	18.3586	0.5924	0.0322
China-Thailand	18.8334	0.7830	0.0415
Indonesia-China	18.4253	1.7391	0.0943

Table 6.1: Descriptive statistics of Real Exports (Contd.)

Before the Asian financial Crisis (1982:Q1-1997:Q2)			
Country-pairs	**Log of Real Exports**		
	Mean	**Standard Deviation**	**Coefficient of Variation**
Indonesia -Malaysia	18.1119	0.9374	0.0517
Indonesia -Philippines	17.9849	0.6807	0.0378
Indonesia -Thailand	17.8722	0.9189	0.0514
Malaysia-China	18.8350	0.8887	0.0471
Malaysia-Indonesia	18.1723	1.0479	0.0576
Malaysia -Philippines	18.5684	0.4665	0.0251
Malaysia-Thailand	19.4821	0.6745	0.0346
Philippines-China	17.2063	0.7257	0.0421
Philippines-Indonesia	16.4520	0.7278	0.0442
Philippines-Malaysia	17.8003	0.5116	0.0287
Philippines-Thailand	17.4068	1.2120	0.0696
Thailand-China	18.7116	0.7177	0.0383
Thailand-Indonesia	17.7670	0.9449	0.0531
Thailand- Malaysia	19.1350	0.5552	0.0290
Thailand-Philippines	17.2951	0.9384	0.0542
All countries	18.1712	1.1277	0.0620

Table 6.1: Descriptive statistics of Real Exports (Contd.)

Post-financial Crisis period (1997:Q3-2006:Q4)			
Country-pairs	Log of Real Exports		
	Mean	Standard Deviation	Coefficient of Variation
China-Indonesia	20.5639	0.6677	0.0324
China-Malaysia	20.7468	0.6745	0.03251
China-Philippines	20.1608	0.5910	0.02931
China-Thailand	20.4397	0.5642	0.02761
Indonesia-China	20.5029	0.4688	0.0228
Indonesia -Malaysia	20.0733	0.5415	0.0269
Indonesia -Philippines	19.1659	0.3866	0.0201
Indonesia -Thailand	19.5972	0.8114	0.0414
Malaysia-China	20.8514	0.6804	0.0326
Malaysia-Indonesia	19.9577	0.3398	0.0170
Malaysia -Philippines	19.7161	0.5922	0.0300
Malaysia-Thailand	20.7316	0.9360	0.0451
Philippines-China	19.4827	1.1211	0.0575
Philippines-Indonesia	17.7776	1.0921	0.0614
Philippines-Malaysia	19.7845	0.3755	0.0189
Philippines-Thailand	19.3408	0.8181	0.0423

Table 6.1: Descriptive statistics of Real Exports (Contd.)

Post-financial Crisis period (1997:Q3-2006:Q4)			
Country-pairs	**Log of Real Exports**		
	Mean	**Standard Deviation**	**Coefficient of Variation**
Thailand-China	20.6785	0.6806	0.0329
Thailand-Indonesia	19.8846	0.5343	0.0268
Thailand- Malaysia	20.5048	0.5982	0.0291
Thailand-Philippines	19.5705	0.3615	0.0542
All countries	19.9765	0.8656	0.0433

Following the previous chapter, three different measures of exchange rate volatility are used in this chapter to analyse the impact of exchange rate volatility on intra-regional trade of emerging East Asia countries. Table 6.2 presents the mean and standard deviation of the three measures of the main independent variable, exchange rate volatility. Before the financial crisis, the mean values of the bilateral exchange rate volatility among the sample countries were similar apart from the bilateral exchange rate between Malaysia and Thailand which was relatively more stable. This could be a result of the East Asia's de facto pegged exchange rate against the US dollar before the crisis. McKinnon (1998) refers this informal dollar peg as a pseudo exchange rate union. However, this aspect has changed in the post-crisis period. The volatility of exchange rate among the sample countries has increased 40 percent for the standard deviation measures and almost 94 percent for the conditional volatility measure. Nonetheless, the increase in the region's post-crisis exchange rate volatility is mainly contributed by the remarkable increase in the volatility of Indonesian exchange rate.

Table 6.2: Descriptive statistics of exchange rate volatility

Country-pairs	Before the Asian financial Crisis (1982:Q1-1997:Q2)					
	SD(8-quarter)		MASD		GARCH	
	Means	SD	Means	SD	Means	SD
China-Indonesia	0.0784	0.0426	0.0776	0.0382	0.0046	0.0119
China-Malaysia	0.0661	0.0425	0.0682	0.0371	0.0016	0.0038
China-Philippines	0.0844	0.0449	0.0829	0.0419	0.0035	0.0067
China-Thailand	0.0655	0.0416	0.0653	0.0380	0.0020	0.0039
Indonesia -Malaysia	0.0483	0.0439	0.0471	0.0427	0.0028	0.0104
Indonesia-Philippines	0.0687	0.0462	0.0664	0.0432	0.0063	0.0152
Indonesia -Thailand	0.0505	0.0485	0.0489	0.0475	0.0064	0.0369
Malaysia -Philippines	0.0536	0.0336	0.0533	0.0321	0.0017	0.0026
Malaysia-Thailand	0.0283	0.0151	0.0278	0.0132	0.0005	0.0005
Philippines-Thailand	0.0581	0.0366	0.0567	0.0347	0.0016	0.0022
All countries pair	0.0602	0.0431	0.0594	0.0407	0.0031	0.0149

Table 6.2: Descriptive statistics of the main variables: exchange rate volatility (Contd.)

Country-pairs	Post-financial Crisis period (1997:Q3-2006:Q4)					
	SD(8-quarter)		MASD		GARCH	
	Means	SD	Means	SD	Means	SD
China-Indonesia	0.1467	0.1015	0.1460	0.0983	0.0103	0.0184
China-Malaysia	0.0544	0.0411	0.0530	0.0415	0.0014	0.0019
China-Philippines	0.0665	0.0341	0.0647	0.0332	0.0027	0.0041
China-Thailand	0.0780	0.0541	0.0756	0.0523	0.0025	0.0041
Indonesia -Malaysia	0.1288	0.0961	0.1262	0.0908	0.0061	0.0104
Indonesia -Philippines	0.1238	0.1025	0.1231	0.0965	0.0225	0.0508
Indonesia -Thailand	0.1279	0.1062	0.1244	0.1012	0.0107	0.031
Malaysia -Philippines	0.0351	0.0201	0.0356	0.0185	0.0014	0.0022
Malaysia-Thailand	0.0430	0.0181	0.0420	0.0168	0.0013	0.0026
Philippines-Thailand	0.0459	0.0168	0.0449	0.0147	0.0011	0.0014
All countries pair	0.0850	0.0794	0.0835	0.0765	0.0060	0.0209

Notes: Author's calculation. See the methodology chapter for the sources of data.

Table 6.3 reports the correlation between the real exports and three exchange rate volatility measures. Before the financial crisis, the relationship between exchange rate volatility and exports is negative for most of the country-pairs of sample countries (shown in bold type face) but for some country-pairs the relationship was positive. In contrast, the post-crisis relationship between the exchange rate volatility and the exports is negative for all country-pairs of the sample. In addition, the magnitude of correlation has intensified in the post-crisis period. However, these statistics should be interpreted with caution as the correlation coefficients reveal only correlation between the variables not the causation.

Table 6.3: Correlation between exports and exchange rate volatility

Before the Asian financial Crisis (1982:Q1-1997:Q2)			
Country-pairs	**Correlation between Exports and Volatility**		
	SD(8-quarter)	**MASD**	**GARCH**
China-Indonesia	**-0.0145**	**-0.0216**	**-0.0382**
China-Malaysia	0.4303	0.3992	0.0130
China-Philippines	0.1339	0.1164	**-0.2010**
China-Thailand	0.2681	0.3028	0.0189
Indonesia-China	**-0.2013**	**-0.1935**	**-0.0519**
Indonesia -Malaysia	**-0.5301**	**-0.5263**	**-0.1591**

Table 6.3: Correlation between exports and exchange rate volatility (Contd.)

Before the Asian financial Crisis (1982:Q1-1997:Q2)			
Country-pairs	**Correlation between Exports and Volatility**		
	SD(8-quarter)	**MASD**	**GARCH**
Indonesia -Philippines	**-0.4331**	**-0.4432**	**-0.1816**
Indonesia -Thailand	**-0.6435**	**-0.6274**	**-0.1495**
Malaysia-China	0.4932	0.4682	0.0391
Malaysia-Indonesia	**-0.4314**	**-0.4202**	**-0.1517**
Malaysia -Philippines	0.0851	0.0563	**-0.0175**
Malaysia-Thailand	**-0.4616**	**-0.5099**	**-0.1218**
Philippines-China	**-0.0230**	**-0.0253**	**-0.0571**
Philippines-Indonesia	**-0.6177**	**-0.6122**	**-0.2553**
Philippines-Malaysia	0.0458	0.0237	**-0.0006**
Philippines-Thailand	**-0.5321**	**-0.5345**	**-0.5036**
Thailand-China	0.2710	0.2696	**-0.1071**
Thailand-Indonesia	**-0.6724**	**-0.6732**	**-0.1299**
Thailand- Malaysia	**-0.4612**	**-0.5290**	**-0.2207**
Thailand-Philippines	**-0.5141**	**-0.5092**	**-0.4387**
All countries pair	**-0.2292**	**-0.2295**	**-0.1175**

Table 6.3: Correlation between exports and exchange rate volatility (Contd.)

Post-financial Crisis period (1997:Q3-2006:Q4)			
Country-pairs	Correlation between Exports and Volatility		
	SD(8-quarter)	MASD	GARCH
China-Indonesia	-0.7222	-0.7792	-0.6523
China-Malaysia	-0.7445	-0.7441	-0.3904
China-Philippines	-0.6537	-0.6474	-0.3342
China-Thailand	-0.7901	-0.7951	-0.4291
Indonesia-China	-0.6716	-0.6994	-0.4760
Indonesia -Malaysia	-0.6667	-0.6837	-0.4703
Indonesia -Philippines	-0.4670	-0.4798	-0.3652
Indonesia -Thailand	-0.5749	-0.5836	-0.2753
Malaysia-China	-0.7508	-0.7569	-0.4098
Malaysia-Indonesia	-0.6482	-0.6803	-0.4767
Malaysia -Philippines	-0.0605	-0.0749	-0.4754
Malaysia-Thailand	-0.7464	-0.7586	-0.3525
Philippines-China	-0.7726	-0.7790	-0.3981
Philippines-Indonesia	-0.7286	-0.7430	-0.5135
Philippines-Malaysia	-0.1402	-0.1717	-0.4099
Philippines-Thailand	-0.5344	-0.5709	-0.6041

Table 6.3: Correlation between exports and exchange rate volatility (Contd.)

Country-pairs	Correlation between Exports and Volatility		
	SD(8-quarter)	MASD	GARCH
Post-financial Crisis period (1997:Q3-2006:Q4)			
Thailand-China	**-0.7465**	**-0.7524**	**-0.3409**
Thailand-Indonesia	**-0.7337**	**-0.7425**	**-0.4492**
Thailand- Malaysia	**-0.7630**	**-0.7707**	**-0.3692**
Thailand-Philippines	**-0.4768**	**-0.4977**	**-0.5254**
All countries pair	**-0.3473**	**-0.3584**	**-0.2882**
The whole sample period (1982:Q1-2006:Q4)			
All countries pair	**-0.0658**	**-0.0671**	**-0.0829**

Notes: Author's calculation. See the methodology chapter for the sources of data.

6.3 Empirical results

The impact of exchange rate volatility on the bilateral exports among five emerging East Asian economies is estimated by using a panel data approach. As discussed in the chapter 4, the trade model used in this chapter is the gravity model of Feenstra *et al.* (2001) augmented with a relative prices variable in the spirit of Bergstrand (1989) and the variables of main interest exchange rate volatility, which can be expressed as:

$$X = f(Y, Y^{*}, RP, VOL, Dist, CB, FTA) \tag{6.1}$$

where the real exports (X) is a function of home country's GDP (Y), importing country's GDP (Y^*), relative prices (RP), exchange rate volatility (VOL) and a set of auxiliary variables – the distance between two countries ($Dist$), sharing of a common border (CB) and membership of Free Trade Area (FTA). The definitions of the variables and data sources are presented in Chapter 4.

As discussed in the literature review section, a variety of measures have been employed to represent exchange rate volatility and there is no consensus on the appropriate measure. This chapter employs three measures of exchange rate volatility: the standard deviation of the first difference of the logarithm of real exchange rate, the moving average standard deviation of the quarterly logarithm of bilateral real exchange rate, and the conditional volatilities of the exchange rates estimated using a General Autoregressive Conditional Heteroscedascity (GARCH) model.

6.3.1 Panel unit-root and cointegration tests

Despite the fact that a panel data analysis has particular advantages in examining the impact of exchange rate volatility on trade, the longer time dimension of the panel data in this study may lead to the problem of non-stationarity and spurious regression as explained in the methodology chapter. Therefore, in order to verify the existence of a long-run stable relationship between bilateral exchange rate volatility and the bilateral exports among the ACFTA countries, it is necessary to test the stationarity of the variables and cointegration within the panel before estimating the model. Table 6.4 reports the results from the *IPS* panel unit root test suggested by Im *et al.* (2003). The results of the *IPS* test indicate that the null of non-stationarity are rejected for all variables.

Table 6.4: *IPS* Panel unit roots test

Variables	*IPS* test (*t*-statistics)
	Level
Real Exports	-3.411[1] (0.000)
Home Income	-2.401[10] (0.101)
Foreign Income	-2.401[10] (0.101)
Relative Prices	-2.970[1] (0.000)
Volatility (SD-8q)	-2.853[1] (0.000)
Volatility (MASD)	-2.795[1] (0.000)
Volatility (GARCH)	-4.850[1] (0.000)

Notes: [1] and [10] indicate significant at 1 percent amd 10 percent level). Values in the parentheses are P-value. Null hypothesis of IPS test is that each series in the panel is integrated of order one. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

However, as discussed in the previous chapter, the rejection of the null of non-stationary suggested by the *IPS* test does not imply that all series in the panel are stationary. Therefore, the results of the Lagrange multiplier test of Hadri (2000) are also reported in Table 6.5. The results of the Hadri LM test reject the null of stationary in all series of the panel. However, these results also should be interpreted with care since high autocorrelation of the data may lead to serious size distortion in KPSS test; and as a result it might lead to over-rejection of the true null hypothesis when monthly or quarterly data is used (Kuo and Mikkola, 2001). When testing the stationarity of the first differences of the variables, both *IPS* test and Hadri LM test indicate that variables of the sample follow the $I(1)$ process.

Since the variables are integrated of order one $I(1)$, the residuals of the panel estimation need to be stationary in order to establish a meaningful long-run relationship among the variables of the model. In order to verify the existence of long-run stable relationship among the variables, Pedroni (1999)'s panel cointegration test which allows testing for the presence of long-run equilibria in multivariate panels is conducted. Out of seven statistics derived by Pedroni (1999), this chapter apply six statistics to test for the long-run relationship among the variables: three panel cointegration statistics, which are based on the within-dimension of the panel, and three group mean panel cointegration statistics, which are based on the between dimension of the panel.

Table 6.5: Hadri LM Panel unit roots test

Variables	Hadri LM test (Z_τ statistics)	
	Level	First-Difference
Real Exports	12.623[1] (0.000)	-0.094 (0.519)
Home Income	21.326[1] (0.000)	0.134 (0.446)
Foreign Income	21.326[1] (0.000)	0.134 (0.4466)
Relative Prices	12.756[1] (0.000)	-0.399 (0.625)
Volatility (SD-8q)	2.972[1] (0.001)	-2.453 (0.993)
Volatility (MASD)	3.099[1] (0.001)	-2.369 (0.991)
Volatility (GARCH)	8.622[1] (0.000)	-2.441 (0.992)

Notes: [1] indicates significant at 1 percent level. Values in the parentheses are P-value. Null hypothesis of Hadri LM test is each series is level stationary with heteroskedastic disturbances across units. The test statistics of Hadri LM test are controlled for serial dependence in errors. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

Table 6.6 reports the results of Pedroni (1999)'s panel cointegration tests. The calculated statistics are less than 99 percent critical value of -2.00. Therefore, the null of no cointegration is rejected suggesting the existence of a long-run relationship among the variables of the models.

Table 6.6: Pedroni (1999)'s panel cointegration tests

Statistics	Estimation with the SD (8-quarters)	Estimation with the MASD volatility	Estimation with the GARCH volatility
Panel-ρ	-10.125	-10.093	-10.028
Panel-t	-12.506	-12.466	-12.157
Panel-ADF	-4.805	-4.807	-4.779
Group-ρ	-12.313	-12.274	-12.385
Group-t	14.690	-14.691	-13.911
Group-ADF	-6.524	-6.521	-6.573

Notes: The critical value at 1% significant level is -2.0. Null hypothesis is no cointegration. All statistics are estimated from a model with heterogeneous intercept.

6.3.2 The impact of exchange rate volatility on the intra-regional exports

This study utilizes the panel-data approach that pool time-series and cross-sectional dimensions of the bilateral trade flows of five emerging East Asian countries. The estimation results of pooled OLS are presented in Table 6.7. All estimated coefficients except that of the '*Distance*' variable are significant at 1 percent level and have expected signs. One notable point is that the coefficient of '*Home Income*' is larger than that of importing country's income. Given the fact that bilateral trade among the sample countries can be classified as inter-industry trade of homogenous product (see Cordenillo, 2005), this finding is contrary to the theoretical prediction of Feenstra *et al.* (2001), which proposes that the coefficient of exporter's income should be smaller than that of importer's income for the estimation of the bilateral trade flows of homogenous products.

Table 6.7: The impact of exchange rate volatility (pooled OLS)

Variables	SD (8-q)	MASD	GARCH
Home Income (*Y*)	0.7189***	0.7195***	0.7016***
	(0.0227)	(0.0226)	(0.0232)
Foreign income (*Y)**	0.6024***	0.6029***	0.5851***
	(0.0283)	(0.0282)	(0.0290)
Relative price (*RP*)	-0.0118***	-0.0118***	-0.0118***
	(0.0016)	(0.0016)	(0.0017)
Volatility (*V*)	-2.8065***	-2.9935***	-5.8367***
	(0.4814)	(0.5036)	(1.4644)
Distance	0.0670	0.0711	0.0817
	(0.0452)	(0.0451)	(0.0446)
FTA	0.7962***	0.7949***	0.8164***
	(0.0265)	(0.0266)	(0.0282)
Common border	0.9477***	0.9471***	0.9644***
	(0.0549)	(0.0549)	(0.0524)
R-square	0.6186	0.6193	0.6085
Number of Observations	2000	2000	2000

Notes: The figures in parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively.

However, as explained in the previous chapter, the pooled OLS estimation ignores the unobservable individual specific effects such as cultural, economical, and institutional factors that are constant over time are not explicitly represented in the model. If such unobservable effects are omitted and are correlated with the independent variables, the pooled OLS estimates would be biased. In order to control for unobserved country-pairs heterogeneity and time-specific effects, two-way error component model is applied for the analysis.

There are apparent advantages of using a two-way error component model for the current study as this model allows controlling for the unobserved heterogeneity. This advantage is particularly important for the current analysis since unobservable cross-country structural and policy differences may have a significant impact on their bilateral trade. By using panel data and a two-way error component model, unobservable cross-sectional specific effects and time-specific can be accounted for either via a fixed effects or random effects specification. Then, the model to be estimated becomes;

$$\begin{aligned} \ln X_{ijt} &= \lambda_t + \alpha_{ij} + \beta_1 \ln Y_{it} + \beta_2 \ln Y_{jt} + \beta_3 \ln RP_{ijt} + \beta_4 V_{ijt} \\ &+ \beta_5 D1_{ij} + \beta_6 D2_{ijt} + \beta_7 Dist_{ij} + \varepsilon_{ijt} \end{aligned} , \qquad (6.2)$$

where α_{ij} is the unobservable country-pair specific effect and these effects are allowed to differ according to the direction of trade (i.e., $\alpha_{ij} \neq \alpha_{ji}$). The unobservable time fixed-effects are controlled by λ_t, which is allowed to change over time.

In order to justify the use of two-way error components model, the joint significance of the unobservable country-pair specific effect and temporal effects are tested by performing a Chow *F*-test. Table 6.8 presents the results of Chow-test which suggesting the two-way error components model is the correct one and omitting these effects could lead to biased results.

Table 6.8: Chow-Test results

Chow test	***F-statistics***
Joint significance of country-pair specific effects	$F(18, 1974) = 169.63$ Prob > F = 0.0000
Joint significance of temporal effects	$F(99, 1893) = 9.27$ Prob > F = 0.0000
Joint significance of country-pair specific and temporal effects	$F(116, 1876) = 35.85$ Prob > F = 0.0000

The results of both fixed-effects and random-effects two-way error components panel estimations using different measures of exchange rate volatility are presented in Table 6.9. The estimation results confirm that bilateral exchange rate volatility has statistically and economically significant negative impact on the bilateral exports of ACFTA countries. The finding of negative impact of exchange rate volatility is evident across the different estimation methods and volatility measures except in the fixed-effects estimation which uses GARCH measure of exchange rate volatility. Apart from that, the estimated coefficients of both fixed-effects and random-effects estimations are almost identical.

According to the model selection criteria of Sauer and Bohara (2001), the fixed-effects model seems an appropriate specification since this study focuses on the specific set of East Asian countries and the inference is restricted to the behaviours of these countries. Hsiao (1999) also notes that if the time period (100 quarters in the current study) is sufficiently larger than the number of cross-sectional unit (20 country-pairs), then the fixed-effects coefficients are consistent and asymptotically efficient. As explained in the Chapter 4, however, the fixed-effects estimation wipes out the effects of time-invariant variables – distance and sharing a common border. In contrast, the random-effect estimation has an obvious advantage of controlling the effect of these two time-invariant explanatory variables. But the drawback of the random effects estimation is that the estimates are unbiased only if the composite error is uncorrelated with the explanatory variables. In order to test the independence between the error term and the explanatory variables, the Hausman test is conducted. The test statistics of the Hausman test cannot reject the null hypothesis suggesting that the random effects estimators are also unbiased.

Table 6.9: The impact of exchange rate volatility on the intra-regional exports; (2 ways error components model)

Variables	SD (8-q)		MASD		GARCH	
	F.E	R.E	F.E	R.E	F.E	R.E
Home income	0.3463***	0.3342***	0.3456***	0.3337***	0.3381***	0.3274***
	(0.0695)	(0.0647)	(0.0695)	(0.0647)	(0.0695)	(0.0831)
Foreign income	0.6584***	0.5820***	0.6575***	0.5822***	0.6527***	0.5756***
	(0.0692)	(0.0646)	(0.0692)	(0.0646)	(0.0691)	(0.0722)
Relative Prices	-0.0055	-0.0042	-0.0053	-0.0042	-0.0122	-0.0058
	(0.0592)	(0.0271)	(0.0592)	(0.0272)	(0.0591)	(0.0236)
Volatility	-0.6703***	-0.7058**	-0.6827**	-0.7212**	-0.9564	-0.9778**
	(0.2715)	(0.2714)	(0.2826)	(0.2823)	(0.7380)	(0.5100)
Distance	-	-0.0606	-	-0.0583	-	-0.0539
		(0.3713)		(0.3737)		(0.3727)
Common border	-	0.7949***	-	0.7953***	-	0.8021***
		(0.3046)		(0.3077)		(0.2773)

Table 6.9: The impact of exchange rate volatility on the intra-regional exports (2 ways error components model) (Contd.)

Variables	SD (8-q)		MASD		GARCH	
	F.E	R.E	F.E	R.E	F.E	R.E
FTA	-0.0848*	-0.0970*	-0.0828*	-0.0947*	-0.0835*	-0.0949*
	(0.0495)	(0.0495)	(0.0495)	(0.0494)	(0.0493)	(0.0519)
R-square within	0.8404		0.8404		0.8396	
No. of observations	2000		2000		2000	
Country-pairs	20		20		20	
Hausman Test	χ^2 (103) =8.09 (p=1.000)		χ^2 (103) =8.77 (p=1.000)		χ^2 (103) =3.06 (p=1.000)	
AIC (BIC)	2840.872 (3428.967)		2841.145 (3429.24)		2848.679 (3431.173)	

Notes: The figures in parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively. The null hypothesis of the Hausman test is that fixed and random effects estimators are insignificantly different from one another, that is, random effect estimators are efficient and consistent. R-square within describes the goodness of fit for the observations that have been adjusted for their individual means. F.E and R.E refer to the fixed-effects and random-effects estimations.

The potential benefit of fixing the bilateral exchange rate of ACFTA countries – that is reducing exchange rate volatility to zero – can be computed. According to the results, total elimination of exchange rate volatility in 2006 (mean of the exchange rate volatility was 0.0506 in 2006) would have increase the intra-regional exports of ACFTA countries by around 4.5 percent. In contrast, by using a similar methodology but a pure gravity model, Dell'ariccia (1999) finds that reducing volatility to zero in 1994 results in an increase in intra-EU trade by 13 percent.

Among the three gravity type variables considered in the model, only the variable representing '*Common Border*' is significant and has a expected sign. The coefficient of the '*Distance*' variable has a negative sign but is not statistically significant. It is interesting to compare these findings with the results of the previous chapter, in which '*Distance*' variable is negative and significant but '*Common Border*' dummy variable is insignificant. It seems, unlike the exports to the world market, the distance between two countries is not important as a determinant of exports for the intra-regional trade of the sample countries. Since these countries are situated closely, the sharing of a common border seems more important for their regional trade. Higher proportion of border trade to total trade of the sample countries might have led to this finding.[36] In addition, the coefficient of the dummy representing the membership of ASEAN Free Trade

[36] According to country-level data, cross-border component trade accounts for more than a half of total imports and exports in Malaysia and the Philippines, and more than a third in Thailand (Athukorala and Yamashita, 2006).

Area is negative.[37] This could be a consequence of the high proportion of components and raw material exports, which are bulky and already have lower tariff rates, in the bilateral exports among these countries. According to the UN Trade Database, intra-regional exports of parts and components are about 50 percent of the region's total exports of parts and components. In comparison, Intra-regional exports are only 10 percent of the region's exports to the world market.

However, unlike pooled OLS estimation, the coefficient of the relative price variable, which represents the competitiveness of the exporting countries relative to the importing countries, is insignificant in all estimation although the sign of the coefficient is negative as expected. A potential explanation for this finding might be that intra-regional trade of emerging East Asian countries mainly consist of price-insensitive commodities and raw materials.

6.3.3 Poolability test

As discussed in the previous chapter, multi-country panel data analysis assumes the homogeneity of coefficients. In order to test this assumption of homogeneity of coefficients, the *RZB* poolability test is conducted. The first column of Table 6.10 shows the test statistics for the *RZB* test. The null hypothesis of poolability is rejected suggesting a certain degree of parameter heterogeneity. However, the *RZB* test ignore the important time invariant variables such as sharing a common

[37] This is not an unusual result. For example, Frankel (1997) finds that the European Community has had a significant negative effect on bilateral trade flows of its members for the period 1965-75 (see Table 6.4a, p.141).

border and distance. In order to overcome this limitation, the results of an alternative poolability test which employs interaction between the regressors and the country-pair specific dummies and testing for the joint significance of these interaction variables are also reported in the second column of Table 6.10. The null hypothesis of poolability is again rejected.

Table 6.10: Poolability test

	RZB test	Interaction test
Statistics	$F_{(114,1880)} = 3.826$	$F_{(96,1879)} = 18.63$
P-value	(0.00)	(0.00)

However, as noted by Baltagi (2001) panel data analysis can provide more informative data, more variability, less collinearity among the variables, more degree of freedom and more efficiency. In order to provide the justification of choosing a panel model rather than estimating the impact of exchange rate volatility on exports of individual country by using time-series models, two mean square error (MSE) criteria tests suggested by McElroy (1977) is conducted. Table 6.11 reports the non-centrality parameter, λ, calculated for the model. Weaker MSE test suggests that the panel estimator is preferable to the unconstrained estimator on the basis of the trade-off between consistency and efficiency. Hence, it can be concluded that the panel model used in this chapter yields more efficient estimates than the individual country time-series regressions.

Table 6.11: MSE criteria Tests

	"Strong MSE Test"	"Second Weak MSE Test"
Statistics	λ_{WT}=3.0624	λ_{WT}=3.0624
Null Hypothesis	$\lambda_{WT} \leq 0.5$	$\lambda_{WT} \leq (N-1)K'/2$=57
Pooling is better	no	yes

6.3.4 Controlling for the potential econometric problems

So far it is assumed that exchange rate volatility is exogenous to bilateral exports. As discussed in the chapter 5, there is a possible inverse relationship between real exchange rate volatility and trade, that is, an increase in the level of trade between two countries may lead to more stable bilateral real exchange rate. Hau (2002) and Bravo-Ortega and Giovanni (2005) demonstrate that a high degree of economic integration might lead to more stable real exchange rates. In this case exchange rate volatility cannot be treated as an exogenous variable; the results presented in the previous section would suffer an endogeneity bias. In order to control for the potential endogeneity, the Instrumental Variables (IV) estimation approach is used. In line with the Chapter 5, the standard deviation of the relative money supply is employed as an instrument for the real bilateral exchange rate volatility.

As explained in the section 4.5, another potential econometric problem is the heteroskedasticity of the error terms. A general assumption of fixed-effects specification is that the variance of error terms is a constant (homoskedasticity). If the assumption is not met, the estimates of fixed-effects specification will be consistent but inefficient. The presence of groupwise heteroskedasticity in the OLS residuals is tested for the model and the modified Wald statistic rejects the null hypothesis of homoskedasticity. Following the methodology applied in the previous chapter, the Generalised Method of Moments estimation technique with instrumental variables (GMM-IV) is employed in this chapter in order to control for the residual heteroskedasticity arising from time-varying omitted variables and potential endogeneity of exchange rate volatility.

GMM-IV fixed effect estimation approach, in which estimators are efficient for arbitrary heteroskedasticity and autocorrelation, correct for heteroskedasticity across countries as well as residual serial correlation. Table 6.12 presents the results of GMM-IV estimation which uses the benchmark volatility measure, the standard deviation of the difference of exchange rate. The results of Generalised Two Stages Least Square (G2SLS-IV) estimation are also reported for the estimates of time-invariant variables.

The estimation results are quantitatively more or less the same as the fixed-effects OLS estimation. This impact of exchange rate volatility can be computed as the effect of increasing volatility by one standard deviation (0.0608 for SD-8quarters) around its mean, which implies a reduction of trade flow of 5.4 percent.[38]

[38] This impact is computed as the estimated coefficient of the benchmark equation multiply by one standard deviation of volatility measure, then multiplied by 100 to convert to percent.

Table 6.12: Controlling for endogeneity of exchange rate volatility: GMM-IV

Variable	GMM-IV	G2SLS-IV
Home income	0.3104**	0.2999**
	(0.0948)	(0.0661)
Foreign income	0.6319**	0.5632**
	(0.0814)	(0.0652)
Relative price	0.0029	-0.0051
	(0.0632)	(0.0292)
Volatility	-0.8858**	-0.9262**
	(0.2438)	(0.2930)
Distance	-	-0.0472
		(0.3914)
Common border	-	0.8035***
		(0.3088)
FTA	-0.0945	-0.1071*
	(0.0493)	(0.0491)
R-square (within)	0.8435	0.7921
Number of Observations	1980	1980
Number of Country-pairs	20	20
Cragg-Donald F-statistic	3341.387	
Hansen J statistic	0.412 ($p = 0.5212$)	

Notes: ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of Stock-Yogo weak ID test is 19.93.

The validity of using the volatility of relative money supply as an instrument for the exchange rate volatility is confirmed by post-estimation diagnostic tests. The null hypothesis of weak instruments is rejected since the Cragg-Donald F-statistic (first stage F-statistic) is greater than the critical value provided by Stock and Yogo (2005). In addition, the Sargan-Hansen test of overidentification cannot reject the joint null hypothesis that the instruments are valid and that the instruments are correctly excluded from the estimation. All two diagnostic tests suggest that the instruments are uncorrelated with the error term, and that they are correctly excluded from the estimated equation.

The results confirm that estimated coefficient of the home country's income is less than that of the importing country's income. This finding is consistent with the theoretical prediction of Feenstra *et al.* (2001) which proposes that for homogenous product a country's exports are more sensitive to importing country's income than to own income. In addition, the coefficient of the importing country's income variable is significant and positive but markedly less than unity. This finding is in line with the fact that bilateral exports among the emerging East Asian countries are predominantly inter-industry trade flows comprising raw materials and intermediate goods.

6.3.5 The effect of 1997 financial crisis

In this section, the bench mark model is used to estimate the impact of the macroeconomic uncertainty during the 1997 financial crisis on the intra-regional exports of emerging East Asian countries. A dummy variable is constructed equal to 1 for the period of 1997:Q3 to 1999:Q2 for country-pairs in which exporting country was affected by the crisis in order to control the effect of uncertainty other than exchange rate volatility during the crisis.

The estimation results are presented in Table 6.13. All the usual coefficients are still significant and have the right sign and the impact of exchange rate volatility on exports is almost unchanged. However, the result shows that the effect of the financial crisis is positive on the exports. This result seems surprising and conflicts with the previous findings. Possible explanation is that, as De Grauwe (1988) demonstrated, income effect seems to dominate substitution effect; that is, a fall in export income had led to a rise in the intra-regional exports of emerging East Asian countries during the crisis period. In this sense, the finding is consistent with the study of Duttagupta and Spilimbergo (2004) which also finds that decline in dollar dominated export income during the crisis has led to an increase in intra-regional exports of the East Asian countries.

Table 6.13: The effect of 1997 financial crisis

Variables	GMM-IV	G2SLS-IV
Home income	0.3234**	0.3110**
	(0.0947)	(0.0655)
Foreign income	0. 6185**	0.5587*
	(0.0812)	(0.0654)
Relative Prices	-0.0299	-0.0039
	(0.0640)	(0.0282)
Volatility	-0.8742**	-0.9056**
	(0.2429)	(0.2925)
Financial Crisis	0.2404**	0.2355*
	(0.0661)	(0.0999)
Distance	-	-0.0110
		(0.4400)
Common border	–	0.5925*
		(0.3091)
FTA	-	1.0201**
		(0.4142)
R-square	0.8440	
Number of Observations	1980	
Number of Country-pairs	20	
Cragg-Donald F-statistic	3348.743	
Hansen J statistic	0.388 (p=0.5332)	

Notes: ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of Stock-Yogo weak ID test is 19.93.

6.3.6 Comparing the impact of exchange rate volatility before and after the 1997 financial crisis

Considering the finding of Frankel and Wei (1994) which shows the impact of exchange rate volatility is time-dependent, the whole sample period is divided into two sub-period; pre-crisis (1982:Q1 to 1997:Q2) and post-crisis (1997:Q3 to 2006:Q1) in this sub-section. Table 6.13 presents the estimation results for the two sub-periods. It is interesting to point out that the impact of exchange rate volatility on bilateral exports has significantly declined after the 1997 crisis.

There are two possible explanations. It has been recognized that, before the 1997 crisis, the sample countries implicitly or explicitly pegged their exchange rates against the US dollar. McKinnon (1998) once noted this informal dollar peg across the region as a pseudo exchange rate union. However, if a fixed peg exchange rate arrangement was not credible, there would be an expectation of relatively large exchange rate re-alignment. Clark *et al.* (2004) notes that a pegged or managed exchange rate arrangement could lead to a large discrete changes in currency value when the arrangement becomes misaligned. This might be the case of the sample East Asian economies before the financial crisis.[39] In this situation, as Dell'arricia (1999) noted, exporters might find the system of discrete changes, which are large over a short-term, are more risky than similar but more gradual changes. Therefore, the exporters from sample countries may have found more

[39] Before the crisis, the sample East Asian countries' currencies were overvalued about 30 to 40 percent against Japanese Yen and this currency misalignment was one of causes of the Asian financial crisis (Min, 1998).

uncertainty during the fixed peg regime and react particularly negatively resulting in a disincentive to trade.

Second explanation is based on the political economic point of view suggested by Brada and Mendez (1988). According to this view, countries with fixed or managed exchange rate regimes are more likely to use trade restrictions to defend their trade balance in an event of external shock. In order to maintain their de facto fixed exchange rate regime, these countries might have used trade barriers in an event of external shocks, which effectively led to a reduction in their bilateral trade. After the crisis, these countries shifted toward more flexible exchange rate regime (see Kuroda, 2006; Park and yang, 2006). As a result, there might be a fewer use of trade restrictions to maintain their fixed peg regimes. The combine effect of these two situations may have led to decrease in the impact of exchange rate volatility on their bilateral exports after the crisis.

Another interesting result, is that, the coefficient of the relative price variable becomes significant in the post-crisis period, particularly in the fixed effects estimation. Since the relative price variable is, by definition, analogous to the real exchange rate, this implies that a depreciation (decrease in relative prices) of the real exchange rate of exporting country promotes its exports to a partner country. It seems that before the financial crisis, the relative price variable which represents the price sensitiveness is not significant since the exchange rates of the sample countries did not reflect their true values.

Table 6.14: Estimation results for the before and after the crisis period

Variables	Before the crisis period (1982:Q1-1997:Q2)		After the crisis period (1997:Q3-2006:Q4)	
	GMM-IV	G2SLS-IV	GMM-IV	G2SLS-IV
Home income	0.6929**	0.5054**	0.7340**	0.8107**
	(0.1426)	(0.0889)	(0.1365)	(0.1243)
Foreign income	0.6793**	0.4977**	1.0257**	0.8745**
	(0.1112)	(0.0888)	(0.1669)	(0.1244)
Relative Prices	-0.1018	-0.0015	-0.3641**	-0.0769**
	(0.1115)	(0.0247)	(0.0591)	(0.0272)
Volatility	-1.7183**	-1.8479**	-0.4275*	-0.5703**
	(0.5354)	(0.6238)	(0.2320)	(0.2393)
Distance	-	-0.0456	-	0.0682
		(0.3181)		(0.4409)
Common border	–	0.8971**	–	0.5712*
		(0.2520)		(0.3137)
FTA	-0.0408	-0.0752	-	1.1455**
	(0.0636)	(0.0766)		(0.3963)
R-square	0.6535		0.7784	
No. of Observations	1220		740	
Country-pairs	20		20	
Cragg-Donald F-statistic	1196.104		1058.214	
Hansen J statistic	1.327 (p=0.2493)		0.011 (p=0.9157)	
Hausman Test	χ^2 (65) =10.03 (p=1.000)		N.A	

Notes: ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of Stock-Yogo weak ID test is 19.93.

It could be interpret that before the financial crisis the impact of exchange rate volatility was more pronounce whilst the coefficient of the relative price variable is insignificant because the real exchange rates of the sample countries did not represent their true value. After the crisis, these countries abandoned their managed and protected exchange rate (except Malaysia), and then the coefficient of the relative price variable becomes significant and the impact of exchange rate volatility has significantly decreased.

6.3.7 Comparing the impacts of exchange rate volatility

Table 6.15 presents the comparison of the impacts of exchange rate volatility on the bilateral exports among emerging East Asian countries and on the exports outside the region. The coefficients of exchange rate volatility are almost identical. The results suggest that one percent increase in bilateral exchange rate volatility would lead to about 0.9 percent reduction in the bilateral exports regardless of whether the importing country is within the region or outside the region.

Another interesting result is that the coefficients of both foreign and home country income for the intra-regional exports are much less than those for the extra-regional exports. These results suggest that intra-regional trade is income inelastic whilst the exports to outside the region are relatively income elastic. This might be a confirmation that intra-regional trade of emerging East Asia countries is comprised mainly of raw materials and intermediate goods.[40] This finding is further supported by the significance of the coefficient of relative price variable suggesting that exports of the sample countries to the countries outside the region are price sensitive unlike intra-regional exports.

Table 6.15: The comparison of the effects of exchange rate volatility

Variables	Intra-regional exports		overall exports	
	GMM-IV	G2SLS-IV	GMM-IV	G2SLS-IV
Home income	0.3104***	0.2999***	0.9187***	0.9012***
	(0.0948)	(0.0661)	(0.0332)	(0.0366)
Foreign Income	0.6319***	0.5632***	1.2922***	1.1457***
	(0.0814)	(0.0652)	(0.0943)	(0.0707)
Relative Prices	0.0029	-0.0051	-0.0211***	-0.0201***
	(0.0632)	(0.0292)	(0.0050)	(0.0059)
Volatility	-0.8858***	-0.9262***	-0.8293***	-0.8699***
	(0.2438)	(0.2930)	(0.2480)	(0.1433)
Distance	-	-0.0472		-0.4047
		(0.3914)		(0.2742)
Common border		0.8351**	–	
		(0.3088)		

[40] Intra-regional exports of parts and components are about 50 percent of total regional exports of parts and components. In comparison, Intra-regional exports are only 10 percent of the region's export to the world market.

Table 6.15: The comparison of the effect of exchange rate volatility (Contd.)

Variables	Intra-regional exports		overall exports	
	GMM-IV	G2SLS-IV	GMM-IV	G2SLS-IV
FTA	-0.0945	-0.1071**	-	-
	(0.0493)	(0.0491)		
R-square	0.8435		0.6754	
Number of Observations	1980		6435	
Country-pairs	20		65	
Cragg-Donald F-statistic	3341.387		6581.111	
Hansen J statistic	0.412 (p = 0.5212)		1.143 (p=0.2849)	

Notes: The figures in parentheses are standard errors. *** and ** in the table denote statistical significant coefficients in 1% and 5% respectively. SD, MASD and GARCH are different measures of exchange rate volatility which are standard deviation, moving average standard deviation and Generalised Auto-Regressive Conditional Heteroskedasticity respectively.

6.4 Conclusion

This chapter examines the impact of real exchange rate volatility on the real bilateral exports among five emerging East Asian countries. The panel cointegration test confirms the long-run relationship among the variables. The problems of possible simultaneity bias and heteroskedascity are addressed by the GMM-IV estimation method. The results provide evidence that exchange rate volatility has a negative impact on bilateral exports among the sample countries. These results are robust across different estimation techniques and measures of exchange rate volatility.

Another interesting finding is the effect of the Asian Financial crisis on intra-regional exports. Unlike the results of previous chapter which suggest that the financial crisis had no significant impact on exports to the world market, the crisis had a positive and economically and statistically significant effect on the intra-regional exports of the emerging East Asia. This finding suggests that during the crisis period, income effect dominated substitution effect; that is, a fall in export income had led to a rise in exports among the sample countries.

In order to compare the impacts of exchange rate volatility on the intra-regional exports, the sample period is divided into two sub-period; pre-crisis (1982:Q1 to 1997:Q2) and post-crisis (1997:Q3 to 2006:Q1). The results show that the impact of exchange rate volatility on bilateral exports has significantly declined after thc 1997 crisis. It seems the combine effect of adapting more flexible exchange rate policies, which led to lower possibility of exchange rate misalignment, and reduction in trade barriers across the region would have led to a decrease in the impact of exchange rate volatility on exports after the crisis.

The empirical results derived in this chapter are consistent with findings of previous studies on both developed and less developed countries suggesting that exchange-rate volatility in emerging East Asia economies has a significant negative impact on their export flows. The results of this chapter suggest that sample East Asian countries may not achieve their attempted regional integration by removing trade barriers vis-a-vis the main trading partners without pursuing regional monetary and exchange rate policy cooperation in order to stabilize their bilateral exchange rates.

Chapter 7

The Role of Financial Sector Development on the Impact of Exchange Rate Volatility and Exports: Evidence from the Emerging East Asian Economies

7.1 Introduction

The findings of previous two empirical chapters suggest that exchange rate volatility has a negative impact on exports of the emerging East Asian economies. In these chapters it is assumed that the relationship between exchange rate volatility and exports is a linear. In contrast, this chapter investigates the possible nonlinearity of the impact of exchange rate volatility.

According to theoretical literature reviewed in the Chapter 3, the earlier theoretical models (for example, Clark, 1973; Ethier, 1973; Kawai and Zilcha, 1986) concluded that, with perfect hedging opportunities, the uncertainty of exchange rate alone would have no impact on the volume of trade. Even with the lack of matured financial market with perfect hedging opportunities, Broll *et al.* (1999) asserts that exporting firm can reduce the foreign exchange risk exposure via hedging activities of other currencies or financial assets which are highly correlated to the exchange rate. According to Clark *et al.* (2004), the development of financial hedging instruments could dampen firms' vulnerability to the risk arising from exchange rate volatility.

Bartov and Bodnar (1994) point out that exporting firms can use numerous ways to hedge currency risk. However, the main difficulty in testing theoretical propositions of the role of foreign exchange hedging behaviour in mitigating the adverse impact of exchange rate volatility is the unavailability of comprehensive hedging data. Most of the exporting firms from emerging countries have to rely on other indirect hedging methods to protect from the foreign exchange risk. For instance, an exporter from the country with a developed financial market can borrow foreign currency to finance their exporting activity with intent to avoid the foreign exchange risk.

For developing and emerging countries, data on foreign currency borrowing and other operational indirect hedging activities are difficult to obtain. However, it can be argued that a well-developed financial market may reduce the effect of exchange rate volatility on exports. According to Merton and Bodie (1995), one of the main functions of a financial system is to facilitate the trading, hedging, diversifying and pooling of risk. In line with this view, the existence of a developed financial sector can be considered as a way by which a firm can protect itself against the risk arising from exchange rate uncertainty.

Moreover, Dekel and Ryoo (2006) argued that a high degree of financial sector development may dampen the real economic costs of exchange rate volatility. Suppose that a firm's borrowing capacity (financing constraint) is proportional to the degree of financial sector development of its economy. So, the higher the degree of financial sector development, the higher the firm's ability to borrow, and, *ceteris paribus*, the more likely to survive adverse foreign exchange shocks that affect the firm's production and exports. Dekle and Ryoo (2006) suggest considering financing constraints and potentially other non-linearities, when modelling the relationship between exchange rates and export volumes.

Although, there are numerous studies investigating the impact of exchange rate volatility on exports, it seems there has been no attempt to analyse the role of the development of financial intermediaries in managing the risk of exchange rate uncertainty in emerging economies. One exception is the study of Aghion *et al.* (2006) which examines the role of financial sector development in the linkage between exchange rate volatility and productivity growth but not on exports. The aim of this chapter is to investigate the role of financial sector development on the relationship between exchange rate volatility and the exports of emerging East Asia countries. This is particularly important for an emerging economy like China, which is currently receiving intense international criticism for its inflexible exchange rate system. If the impact of exchange rate volatility is more intense for a country with a low level of financial development, China should first speed up the financial sector reform before adapting a more flexible exchange rate, which will effectively lead to an increase in exchange rate volatility.[41]

Instead of focusing on the trade impact of exchange rate volatility in isolation, this chapter focuses on the interaction between exchange rate volatility and the level of financial development. So far majority of empirical studies investigating the impact of exchange rate volatility on exports explicitly or implicitly assume that the relationship between exchange rate volatility and

[41] Aghion *et al.* (2006) notes that switching from fixed to flexible exchange rate regime could lead to 50% increase in exchange rate volatility.

exports is a linear. In contrast, this chapter focuses on the presence of a nonlinear effect of exchange rate volatility on exports. More specifically, this chapter examines whether the impact of exchange rate volatility is more negative at lower levels of financial development. The contribution of this chapter to the extant empirical literature is that it is first to provide new insights into the role of financial sector development on the relationship between exchange rate volatility and exports of the emerging East Asian economies.

The outline of the chapter is organized as follows. Section 7.2 reviews the related literature which establishes the relationship between financial sector development and a firm's exporting activities. Section 7.3 discusses the research methodology including model specification, construction of the Financial Sector Development Index (*FSDI*) and data sources. Section 7.4 presents and discusses the estimation results, and the final section draws conclusions.

7.2 Financial sector development and exports

A high degree of financial sector development could dampen the real economic costs of exchange rate volatility via two mechanisms. The first mechanism in which a developed financial sector could mitigate the effect of exchange rate uncertainty is that a greater degree of financial sector development could provide more effective ways of transferring risks arising from exchange rate volatility. Clark *et al.* (2004) notes that the availability of direct and indirect hedging instruments provided by a developed financial sector could help mitigating the risks of exchange rate volatility.

Secondly, a higher level of financial sector development can provide better access to finance for exporting firms so that they can withstand the adverse impact of exchange rate volatility. Recently, Chaney (2005) and Dekle and Ryoo (2006) demonstrated that financing constraint plays a vital role in determining the level of exports. That is, the higher the degree of financial sector development, the higher the firm's ability to borrow and the more likely it can survive the adverse impacts of foreign exchange risk on exports.

An important issue to note is the role of Soft Budget Constraints (SBC), which is considered as a common phenomenon in emerging and transition economies, in the development of financial sector.[42] SBC has many interrelated consequences. One of the main consequences directly related to current study is that softness of budget constraint may reduce an exporting firm's sensitivity towards exchange rate changes and price signals (Kornai *et al.*, 2003). In this sense, it might be difficult to distinguish between the role of financial sector development and the consequence of SBC in dampening the impact of exchange rate volatility on exports. Nevertheless, several studies suggest that the development of financial sector and institutions might help to eradicate the SBC syndrome. For example, Qian and Roland (1998) report that the impact of SBC

---

[42] Kornai (1998) argues that soft budget constraints come with government ownership and government's subsidy, taxation, credit and administrative pricing systems are all subject to soft budget constraints. On the other hand Dewatripont and Maskin (1995) identify soft budget constraints with a dynamic commitment problem. See Maskin and Xu (2001) for theories regarding the origin of SBC and Rizov (2008) for the role of SBC in transition and emerging economies.

has decreased in China because of the devolution of the supervision power of state-owned enterprises from the central to local governments and increase competition among regional governments to attract foreign capital. Huang and Xu (1999) also demonstrate how decentralization of credit may serve to harden firms' budget constraints.

7.2.1 The role of financial sector development in mitigating the adverse impact of exchange rate volatility

According to the earlier theoretical models (for example, Clark, 1973 and Ethier, 1973), the uncertainty of exchange rate alone have no impact on volume of trade if firms have perfect hedging opportunity.[43] Kawai and Zilcha (1986) derive a model of competitive, risk averse firm which produces and exports a commodity and faces two types of uncertainty; foreign currency price of the product and the future spot exchange rate. It is assumed that the firm is a price-taker and maximizes its expected utility of local currency profit which is strictly concave, increasing and differentiable. By assumption, there are no costs to hedge uncertainty in the forward and commodity future markets. With a complete market (both forward and commodity future markets exists), the firm's optimum production is given by a point where marginal cost equals fully hedged price in local currency (that is the product of forward exchange rate and future commodity price). In this case, optimum production is independent of the utility function or

[43] See section 2.2.2 of Chapter 2 for the theoretical propositions regarding the role of hedging opportunity in mitigating the adverse impact of exchange rate volatility.

the probability distribution of the random variables such as exchange rate movements.

Merton and Bodie (1995) emphasize that one of the main functions of a financial system is to facilitate the trading, hedging, diversifying and pooling of risk. For instance, an exporter from a country with developed financial markets can borrow foreign currency to finance their exporting activity with intent to avoid the foreign exchange risk.[44] As a result, a well-developed financial market may reduce the effect of exchange rate volatility on exports.

7.2.2 The role of financial sector development in providing better access to finance for exporter

There is a vast literature on the importance of the availability of finance on a firm's export activities. Brander and Spencer (1985) argue that, under a certain market structure, providing export subsidies can improve the relative position of a domestic firm with foreign firms, enabling it to expand its market share, i.e., encourage the exports. Banerjee and Newman (2004) incorporate credit market imperfections into a model of international trade and argue that providing capital subsidies to exporting sectors can enhance export growth since the subsidy might help some relatively unproductive exporting firms to survive or even expand.

[44] One possible argument is that an exporter from a financially underdeveloped country can borrow foreign exchange from a financially developed country to avoid the foreign exchange risk. But, it has been well documented that borrowing from home country would be relatively cheaper because of the home country preference and lower costs of information and monitoring. In addition, foreign lender would charge higher risk premium as they are likely to have limited experience of local firms and laws, presumably because of a short history in lending to local firms (Iacoviello and Minetti; 2005). Therefore, borrowing from a foreign financial intermediary would be more costly and would not be an effective way of overcoming the foreign exchange risk.

At firm level, Dekel and Ryoo (2006) developed a microeconomic model to demonstrate that less financially constrained firms tend to have lower sensitivity of exports to exchange rate fluctuations. Their study examines whether exchange rate fluctuations are strongly related to the export quantities of firms by using Japanese firm level data. They find that financing constraints play an important role in affecting the sensitivity of exports to exchange rate fluctuations. Their study confirms that financially less constrained firms, for example, *keiretsu* firms, tend to have lower exchange rate elasticities.

Recently, Aghion *et al.* (2006) examine the role of financial sector development in the linkage between exchange rate volatility and productivity growth. They developed a model of an open monetary economy with wage stickiness to demonstrate that high level of financial sector development can assist a firm's ability to innovate which can lead to output and export growth. Since the level of hedging activities in the sample countries is difficult to measure, Aghion *et al.* (2006) employ Financial Sector Development Indicator as a measure of the firm's ability to protect against adverse exchange rate movements and to overcome liquidity problems. Their empirical analysis, which based on a panel data set of 83 countries spanning the years 1960-2000, finds that real exchange rate volatility can have a significant impact on the productivity growth, but the effect depends on the country's level of financial development.

Another related stream of literature is the relationship between financial sector development and liquidity constraints and their roles in international trade. In general, better access to finance provided by a more developed financial sector can help reduce the level of liquidity constraints for exporting firms.[45] On the other hand, liquidity constraints are consequences of an imperfect financial market and both are simultaneously determined by the same factors, such as asymmetric information and mis-allocation of financial resources. Chaney (2005) analyses the role of liquidity constraints on international trade. His basic argument is as follows. Firms that want to export need to have either enough liquidity on their own or access to a developed financial sector in order to cover the fixed costs of entering foreign markets. The lack of the ability to access a developed financial market to finance the entry costs may hinder the potential exporters from exporting activities. Moreover, there are reasons to believe that exporting activities may not be easy to finance because of the risk associated with foreign markets and the existence of information asymmetry between potential investor and would be exporter. Under such circumstances, Chaney (2005) develops a model that predicts a deepening (firms get easier access to external finance) or a widening (more firms get access to cheap external finance) of financial markets will ease liquidity constraints and increase total exports.

7.3 Methodology and data

The role of financial sector development in the impact of the bilateral exchange rate volatility on the bilateral export flows of five emerging East Asian countries

[45] See Kelly and Mavrotas (2003) for evidence of the influence of financial sector development on liquidity constraints in developing economies.

amongst themselves, as well as to 13 industrialized countries, is examined by using a panel data set of 85 cross-sectional observations for the period from 1990:Q1 to 2006:Q4. Unlike previous empirical chapters, sample period starts from 1990 due to availability of data to construct financial sector development indicators.

7.3.1 Model specification

Following the model specification of previous chapters, trade model used in this chapter is the gravity model of Feenstra *et al.* (2001) augmented with relative prices variable in the spirit of Bergstrand (1989) as explained in the Chapter 4. Then, the generalised gravity model is augmented with variables of main interest exchange rate volatility and financial sector development.

$$X = f(Y, Y^{*}, RP, VOL, FSD, Dist, CB, FTA) \qquad (7.1)$$

where the real exports (*X*) is a function of home country's GDP (*Y*), importing country's GDP (Y^{*}), relative prices (*RP*), exchange rate volatility (*VOL*), financial sector development of exporting country (FSD) and a set of auxiliary variables – the distance between two countries (*Dist*), sharing of a common border (*CB*) and membership of Free Trade Area (*FTA*).[46]

[46] See Table 4.1 for the construction of the variables and data sources.

7.3.2 Measures for financial sector development

The definitions and sources of the explanatory variables apart from financial sector development have been presented in the Chapter 4. Following the previous empirical chapters, this chapter uses the standard deviation of the first difference of the logarithm of real exchange rate as a benchmark measure of exchange rate volatility in order to compare the results and for consistency. This section focuses on the definition and construction of financial sector development index.

According to the DFID (2004), the development of a financial sector can be expressed in the following different ways.

- Improvements in the efficiency and competitiveness of the financial sector
- Expansion in the range of available financial services
- Increase in the diversity of financial institutions
- Increase in the amount of money that is intermediated through the financial sector
- Increase in the extent to which capital is allocated by private sector financial institutions, to private sector enterprises, by responding to market signals (rather than government directed lending by state owned banks)
- Improvements in the regulation and stability of the financial sector

Hence it is obvious that there is no single definition of financial sector development, and the theoretical and empirical studies focus on different aspects. As asserted by Mavrotas and Son (2006), the term 'financial development' has not yet received a concrete definition due to the fact that the financial structure is not only quite complicated in an economy, but also has evolved differently in the development process of different countries. Since the sample countries in this study can be classified as emerging economies, their finical market is at the early stage of development compared to those in the advanced economy. Most of the exporting firms from these countries are not listed in financial markets and the major source of finance for these firms is from banks rather than from financial markets (Ang and McKibbin; 2007). Therefore, their financial system can be described as a bank-based system rather than a market-based system. Beck *et al.* (2000) develops a comprehensive set of indicators for financial intermediary development to quantify the development, structure and performance of bank-based financial sectors. This study employs three measures of financial sector development indicators by using the methodology suggested by Beck *et al.* (2000) but in the context of quarterly data.

The first and commonly use indicator is the ratio of liquid liabilities to GDP. Liquid Liabilities has been used as a typical measure of 'financial depth', which represents the overall size of the financial intermediary sector. Liquid Liabilities, denoted by *LQ*, equals currency plus demand and interest-bearing liabilities of banks and other financial intermediaries divided by GDP.

$$LQ_{i,t} = [0.5 \text{ X } \{M_{i,t} / CPI_{i,t} + M_{i,t-1} / CPI_{i,t-1}\}] / [GDP_{i,t} / CPI_{i,t}] \qquad (7.2)$$

where *M* is money (IFS line 34) plus quasi-money (IFS line 35), *GDP* (IFS line 99b), *CPI* is quarterly CPI (IFS line 64).

The second indicator is bank credit to the private sector which measures the activity of financial intermediaries. This indicator, denoted by *PCR*, is the ratio of private credit by commercial banks and other financial institutions to GDP.[47] Levine *et al.* (2000) interprets that a higher level of credit to the private sector indicates the higher level of financial services and therefore greater financial intermediary development. This indicator isolates credit issued to the private sector as opposed to credit issued to governments and public enterprises. Hence, it focuses on the mobilized savings that are directed to private firms. Underlying rationale is that the private sector is able to utilize funds more efficiently compared to the public sector, and thus, the exclusion of credit to the public sector better reflects the extent of efficient resource allocation (Beck *et al.*, 2000). The measure of the activity of financial intermediaries, *PCR*, is the ratio of private credit by deposit money banks and other financial institutions to GDP.

$$PCR_{i,t} = [0.5 \text{ X } \{ F_{i,t} / CPI_{i,t} + F_{i,t-1} / CPI_{i,t-1} \}] / [GDP_{i,t} / CPI_{i,t}] \quad (7.3)$$

where, *F* stands for credit by deposit money banks and other financial institutions to the private sector (IFS lines 22d +42d: where available), *GDP* is from IFS (line 99b), *CPI* is quarterly CPI (IFS line 64).

In order to measure the size of financial intermediaries Beck *et al.* (2000) propose the ratio of commercial bank assets divided by commercial bank plus central bank assets. This indicator, denoted by *CMB*, measures the relative importance of the degree to which the commercial banks versus the central bank to allocate the economy's savings, hence the relative importance of the commercial banks in the financial system. The basic idea underlying this indicator

[47] Kelly and Mavrotas (2003) define this indicator as an approximate measure of the liquidity constraint.

is that commercial banks are more likely to identify profitable investments, monitor managers, facilitate risk management, and mobilize savings than central banks (Levine *et al*, 2000). The measure of the size of financial intermediaries, *CMB*, is the ratio of commercial bank domestic assets to commercial bank domestic assets plus central bank domestic assets.

$$CMB_{i,t} = DB_{i,t} \,/\, [\, DB_{i,t} + CB_{i,t} \,] \qquad (7.4)$$

where *DB* is assets of deposit money banks (IFS lines 22a-d) and *CB* is central bank assets (IFS lines 12a-d).

Beck *et al.* (2000) argue that these financial sector development indicators can capture different aspects of the financial sector development process. However, there is no single indicator appeared to be the most appropriate measure for financial sector development. For example, whilst the ratio of commercial bank assets divided by commercial bank plus central bank assets captures the structure of the financial system, the ratio of liquid liabilities to GDP indicates the size of financial sector. Since these variables are highly correlated, including all variables in the model will lead to the problems of multicollinearity and over-parameterization. In order to overcome these problems, Mavrotas and Son (2006) and Ang and McKibbin (2007) suggest constructing an eclectic indicator by using Principal Component Analysis technique.

Principal component analysis provides methods for simplification by combining correlated variables into a smaller number of underlying dimensions. Principal component analysis has traditionally been used to reduce a large set of correlated variables into a smaller set of uncorrelated variables, known as principal components. The method of principal components involves transforming the sub-variables into a new set of variables which will be pair-wise uncorrelated and of which the first will have the maximum possible variance.

By using Principal Component Analysis technique, Financial Sector Development Index (*FSDI*) is constructed as a linear combination of three financial sector development indicators; bank credit to the private sector (*PCR*), ratio of commercial bank assets (*CMB*), and Liquid Liabilities (*LQ*), as follows;

$$FSDI_{i,t} = Z_{i,t} = a_{1i}PCR_{i,t} + a_{2i}CMB_{i,t} + a_{3i}LQ_{i,t} \tag{7.5}$$

where $Z_{i,t}$ is the first principal component and coefficient vectors (a_{1i}, a_{2i}, a_{3i}) are calculated from the time-series data of each country. Theoretically, *FSDI* is not only able to capture most of the information from the original three financial development measures but also sufficiently deals with the problems of multicollinearity and over-parameterization.[48] Hence, Financial Sector Development Index (*FSDI*) represents as an overall indicator of the level of financial development.

Summary statistics of the main variables are presented in Table 7.1. Among the sample countries, the real exchange rate of Indonesia exhibits relatively more volatility during the sample periods. It is interesting to point out

[48] The first principal component of a set of variables is a weighted average of the variables in which the weights are chosen to make the composite variable reflect the maximum possible proportion of the total variation in the set. For example, the financial sector development for China is estimated as:
$FSDI_{China,t} = 0.5754\ PCR_{China,t} + 0.5612\ CMB_{China,t} + 0.5908 LQ_{China,t}$ and this linear combination reflect the 93.5% of the total variation.

that China has the third most volatile real exchange rate among the sample countries although its nominal exchange rate was pegged to the US dollar until July 2005. It seems that pegging to one currency still leaves the economy exposed to fluctuations in the other macroeconomic variables especially the price level which lead to the volatility of the real exchange rate. Another interesting point is that the *FSDI* of China is the highest among the countries due to its high level of liquid liabilities (*LQ*).

Table 7.1: Summary statistics

		Log of Exports	Volatility	PCR	LQ	CMB	FSDI
China	**Mean**	20.3501	0.0729	1.0277	1.2264	0.9640	1.8607
	Std. Dev	1.4939	0.0503	0.2296	0.3686	0.0229	0.3601
	Max	24.6000	0.3592	1.4410	1.8177	0.9886	2.4468
	Min	16.1628	0.0170	0.5754	0.5145	0.9260	1.1569
Indonesia	**Mean**	19.1381	0.1005	0.3519	0.4415	0.8521	0.8381
	Std. Dev	1.63711	0.0916	0.1488	0.0652	0.1263	0.1916
	Max	22.3099	0.3993	0.6953	0.6120	0.9974	1.1734
	Min	4.6363	0.0038	0.1625	0.3087	0.6156	0.5811

Table 7.1: Summary statistics (Contd.)

		Exports	Volatility	PCR	LQ	CMB	FSDI
Malaysia	**Mean**	19.5032	0.0574	1.1356	1.1056	0.9755	0.9267
	Std. Dev	1.3859	0.0366	0.2448	0.2151	0.0181	0.2794
	Max	22.6719	0.3292	1.5828	1.3760	0.9963	1.3073
	Min	15.7134	0.0017	0.5827	0.5798	0.9390	0.2554
Philippines	**Mean**	18.2261	0.0701	0.3566	0.4812	0.8653	0.9128
	Std. Dev	1.6410	0.0365	0.1110	0.0980	0.0729	0.1389
	Max	21.8714	0.3349	0.6025	0.6075	0.9620	1.1333
	Min	14.5025	0.0041	0.1908	0.2950	0.6330	0.6759
Thailand	**Mean**	19.4463	0.0630	1.0828	0.9364	0.9825	1.5773
	Std. Dev	1.2321	0.0482	0.2746	0.1767	0.0081	0.2466
	Max	22.2580	0.3478	1.7076	1.1442	0.9961	2.1358
	Min	16.6582	0.0074	0.5847	0.5810	0.9627	1.0853
All Countries	**Mean**	19.3327	0.0728	0.7909	0.8382	0.9279	1.2231
	Std. Dev	1.6356	0.0583	0.4149	0.3848	0.0872	0.4867
	Max	24.6000	0.3993	1.7076	1.8177	0.9974	2.4468
	Min	4.6363	0.0017	0.1625	0.2950	0.6156	0.2554

The correlations among the variables are presented in Table 7.2. Correlation statistics reveals that the relationship between exchange rate volatility and exports is negative whilst the correlation between financial sector development and exports is positive.

Table 7.2: Pearson correlation coefficients

	Exports	*Volatility*	*PCR*	*CMB*	*LQ*
Exports	1				
Volatility	-0.1099	1			
PCR	0.3303	-0.1157	1		
CMB	0.4370	-0.1271	0.8649	1	
LQ	0.2024	-0.2962	0.6769	0.5489	1
FSDI	0.3605	-0.0683	0.7026	0.7296	0.5214

7.3.3 Method of Estimation

A panel-data set of five emerging East Asian countries for the period from 1990 to 2006 is used to analyse the role of financial sector development in the impact of exchange rate volatility on exports. As discussed before, the use of panel data can eliminate the effects of omitted variables that are specific to individual cross-sectional units but stay constant over time (Hsiao, 1999).

In order to examine the direct and nonlinear effect of financial sector development, Financial Sector Development Index variable and an interaction term of Financial Sector Development Index and exchange rate volatility are included in the augmented generalised gravity model. Specifically, the regression equation to be estimated is:

$$X_{ijt} = \lambda_t + \alpha_{ij} + \beta_1 Y_{it} + \beta_2 Y_{jt} + \beta_3 RP_{ijt} + \beta_4 V_{ijt} + \beta_5 FSDI_{jt} +$$

$$\beta_6 V_{ijt} * FSDI_{it} + \beta' Z_{ijt} + \epsilon_{ijt} \qquad (7.6)$$

where X_{ijt} denotes the real value of aggregate exports from country i to j at time t; Y_{it} and Y_{jt} is the real GDP of exporting country i and importing country j at time t respectively; RP_{ijt} is the relative price of the exporting country i and importing country j at time t; $FSDI_{it}$ is the index of financial sector development of exporting country i at time t; V_{ijt} is the volatility of real bilateral exchange rate between i and j at time t; Z_{ijt} represents a set of gravity variables and ϵ_{ijt} is a random error term. β_1, β_2 and β_5 are expected to be positive and, β_3 and β_4 are expected to be negative. The coefficient of the interaction term, β_6, is expected to be positive so that the overall impact of exchange rate volatility $\beta_4 + \beta_6 * FSDI_{it}$ is more negative at low levels of financial sector development.

In line with previous empirical chapters, GMM-IV estimation approach, which employs the standard deviation of the relative money supply as an instrument for the real bilateral exchange rate volatility, is employed to control for the potential problems of endogeneity of exchange rate volatility and heteroskedascity.

7.4 Empirical results

The previous empirical chapters have shown that real exchange rate volatility has a negative impact on the exports of the sample emerging East Asian countries. An interesting question is whether the level of financial development plays any significant role on the impact of exchange rate volatility on exports.

Table 7.3: ***IPS*** **panel-unit root test**

Variables	*t-bar Statistics*	*P-value*
Real Exports (*X*)	-3.7324[1]	0.0001
Home Income (*Y*)	-3.389[1]	0.0002
Foreign Income (*Y)**	-10.8120[1]	0.0000
Relative Prices (*RP*)	-1.3089[10]	0.0953
Exchange rate volatility (*V*)	-4.5749[1]	0.0000
FSDI	-3.4948[1]	0.0002
Volatility*FSDI	-3.7744[1]	0.0001

Notes: [1] and [10] indicates significant at 1 percent level and 10% level respectively. Null hypothesis of *IPS* test is that each series in the panel is integrated of order one.

As discussed before, although panel data analysis has particular advantages in examining the impact of exchange rate volatility, the longer time dimension of the panel data in this study may lead to the problem of non-stationarity, and spurious regression. As the panel data set of the current study can be classified as a macro-panels with large N (85 cross-sectional observations) and large T (68 quarters) nonstationarity deserves more attention. Therefore, the first stage is to conduct a panel unit-root test. Table 7.3 reports the results of *IPS* panel unit-root test suggested by Im *et al.* (2003). The results of the test reject the null of non-stationarity in all series of the panel. Since all variables are level stationary, it can be concluded that a long-run relationship among the variables exists and the estimation results are not spurious.

Table 7.4: *Hadri-LM* panel-unit root test (Hadri, 2000)

Variables	Level		Difference	
	$Z\mu$ Statistics	*P*-value	$Z\mu$ Statistics	*P*-value
Real Exports (*X*)	260.494	0.0000	6.962	1.0000
Home Income (*Y*)	352.037	0.0000	-6.883	1.0000
Foreign Income (*Y)**	375.319	0.0000	-7.564	1.0000
Relative Prices (*RP*)	211.521	0.0000	-5.172	1.0000
Exchange rate volatility (*V*)	68.851	0.0000	-2.092	0.9818
FSDI	228.599	0.0000	27.664	0.0000
Volatility*FSDI	48.275	0.0000	-1.840	0.9671

Notes: Null hypothesis of Hadri LM test is each series is level stationary with heteroskedastic disturbances across units.

However, Karlsson and Löthgren (2000) has demonstrated that, for a panel data set with larger *T*, the *IPS* test has high power and there is a potential risk of concluding that the whole panel is stationary even when there is only a small proportion of series in the panel is stationary. Therefore, another panel unit-roots test suggested by Hadri (2000) is also conducted. According to Hadri's LM test, all variables are integrated of order 1 (Table 7.4). However, further test of panel cointegration suggested by Pedroni (1999) confirms that all variables are cointegrated, which support the existence of a long-run relationship among the variables. The results are presented in Table 7.5.

Table 7.5: Pedroni (1999)'s Panel cointegration Tests

	Panel-PP	**Panel ADF**	**Group-PP**	**Group-ADF**
Standard model	-34.181	-20.732	-24.722	-10.602
Model with heterogeneous intercept	-7.4275	-3.1791	-69.6199	-73.2757

Notes: The critical value at 1% significant level is -2.0. Null hypothesis is no cointegration.

7.4.1 The impact of Exchange rate volatility on exports

Table 7.6 presents the estimation results of the impact of bilateral exchange rate volatility on the exports of the sample countries. The first column reports the results of the random-effects panel data estimation. However, because of the potential problem of endogeneity, the relative money supply volatility between the two countries is used as an instrument for exchange rate volatility. The second column reports the results of GMM-IV estimation techniques. In order to estimate the effects of time invariant gravity variables (distance between two countries and membership of free trade area), which have been wiped out by the fixed effects GMM-IV estimation, the Generalised Two Stage Least Square Instrumental Variable (G2SLS-IV) method is also employed and the results are presented in the third column. The results provide evidence that exchange rate volatility has a significant negative impact on the exports of emerging East Asian economies. This result is consistent with most of the previous studies which find a negative impact of exchange rate volatility on bilateral exports of emerging and developing economies (for example, Arize, *et al.*, 2000; 2008; Chou, 2000; Sauer and Bohara, 2001; Doğnalar, 2002).

Various diagnostic tests confirm that the volatility of relative money supply is a valid instrument for the exchange rate volatility. This study conducts a weak ID test suggested by Stock and Yogo (2005) to identify the problem of weak instruments. If the instruments were weak, the IV estimators would be biased. It is found that the Cragg-Donald F-statistic is greater than the critical value provided by Stock and Yogo (2005). Therefore, the null hypothesis of weak instruments can be rejected. The Sargan-Hansen test is for verifying overidentification. The joint null hypothesis is that the instruments are valid, i.e., uncorrelated with the error term, and that the instruments are correctly excluded from the estimated equation. Applying the test we were not able to reject the joint null hypothesis.

Table 7.6: The impact of exchange rate volatility on exports

Variables	GLS-panel	GMM-IV	G2SLS-IV
Home country income (*Y*)	1.2771***	1.2790***	1.1352***
	(0.0539)	(0.1376)	(0.0704)
Importing country income (*Y)**	1.1440***	1.4216***	1.1329***
	(0.0526)	(0.0628)	(0.0538)
Relative Price (*RP*)	0.0179***	0.0174***	0.0186***
	(0.0059)	(0.0054)	(0.0060)
Exchange rate volatility (*V*)	-0.5685***	-2.4442**	-2.2634***
	(0.1562)	(1.1851)	(0.5879)
Distance	-0. 8449***	-	-0. 8132***
	(0.1378)		(0.1387)
Sharing a common border	0.7400*	-	0.7305*
	(0.4156)		(0.4171)
Membership of AFTA	0. 4776***	0.5026***	0.5333***
	(0.0494)	(0.0524)	(0.0530)
***R*-square**	0.6478	0.5072	0.5085
Number of Observations	5780	5695	5695
Number of Country-pairs	85	85	85
Cragg-Donald F-statistic	-	117.390	-
Hansen J statistic (*P*-value)	-	0.784(0.37)	-

Notes: Numbers in the parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of Stock-Yogo weak ID test is 19.93.

7.4.2 The role of financial sector development

Table 7.7 presents the role of financial sector development on the trade effect of exchange rate volatility. As explained in the methodology section, an exporting country's financial development is measured by a Financial Sector Development Index. The first and second columns show the results of the impact of exchange rate volatility along with financial development and a set of control variables by using G2SLS-IV and GMM-IV estimation techniques. When including a variable representing the level of financial sector development of an exporting country, the results provide evidence that the level of financial sector development has a significant positive impact on the volume of real exports. This finding is consistent with the theoretical proposition of Chaney (2005).

The third and fourth regressions add a variable interacting the exchange rate volatility and the measure of financial sector development in order to test the main prediction of the chapter: the non-linear effects of exchange rate volatility on exports, that is, the effect of exchange rate volatility on exports is conditional on the level of financial sector development. The results of the regressions show that the interaction term of exchange rate volatility and financial sector development is positive and significant. This indicates that the negative impact of exchange rate volatility on exports is more intense in a less financially developed economy. All other control variables are statistically significant and show expected sign except the relative price variable, which is positive suggesting that exports of the sample East Asian countries consist, to a large extent, of price-insensitive non-competing necessity goods.

Table 7.7: Exchange rate volatility and exports: The role of financial sector development

Variables	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
Home country income (*Y*)	0.8578***	0.9609***	1.1735***	1.2388***
	(0.0688)	(0.0847)	(0.0907)	(0.1172)
Importing country income (*Y**)	1.1312***	1.4181***	1.2539***	1.4317***
	(0.0539)	(0.0614)	(0.0635)	(0.0623)
Relative Price (*RP*)	0.0179***	0.0168***	0.0164***	0.0170***
	(0.0060)	(0.0053)	(0.0061)	(0.0057)
Exchange rate volatility (*V*)	-2.6074***	-2.6801**	-4.6133***	-3.2580*
	(0.5523)	(1.1197)	(1.2522)	(1.8399)
FSDI	0.2771***	0.2588***	0.0019	0.0783
	(0.0483)	(0.0676)	(0.1168)	(0.1883)
Exchange rate volatility * *FSDI*	-	-	2.7683***	2.0673*
			(0.8767)	(1.2441)
Distance	-0. 8074***	-	-0.8911***	
	(0.1391)		(0.2023)	
Sharing a common border	0.7048**	-	0.7730	
	(0.4185)		(0.6165)	

Table 7.7: Exchange rate volatility and exports: The role of financial sector development (Contd.)

Variables	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
Membership of AFTA	0.5418***	0.5006***	0.5320***	0.4711***
	(0.0529)	(0.0528)	(0.0543)	(0.0489)
***R*-square**	0.5073	0.5069	0.5045	0.5137
Cragg-Donald F-statistic	-	138.077	-	94.088
Hansen J statistic	-	0.219	-	2.349
Chi-sq(1) *P*-value		0.6400		0.1254
Number of Observations	5695		5695	
Number of Country-pairs	85		85	

Notes: Numbers in the parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of weak ID test is 19.93.

The role of financial sector development in dampening the impact of exchange rate volatility can be estimated from the results. For example, China's Financial Sector Development Index is around 1.16 in 1990. At that level of financial sector development, 1 percent increase in exchange rate volatility would reduce its exports by about 0.9 percent. In 2006, the Financial Sector Development Index reached around 2, and the negative impact of exchange rate volatility has vanished. For the least financially developed country of the sample, Indonesia, whose Financial Sector Development Index is around 0.68 for 2006, 1% increase in exchange rate volatility would lead to 1.9% reduction of its exports.[49]

It should be noted that one of the assumptions of multi-country panel data analysis is the homogeneity of coefficients. For the current study, the poolability test suggested by Baltagi (2001) yields $F_{(420,\ 5205)}=30.05$ which rejects the null hypothesis of the homogeneity of coefficients. However, for a multi-country panel data analysis with 85 cross-sectional trade flows, if only one coefficient is statistically different from that of panel data estimate, the null of homogeneity is very likely to be rejected. In line with previous empirical chapters, McElroy's (1977) MSE criterion test, which based on mean square errors (MSE) criteria on the basis of the trade-off between bias and efficiency, is conducted in order to check the efficiency of the panel model. Table 7.8 reports the MSE criterion test results. According to the tests, the pooled model is preferable to the unconstrained model under the second Weak MSE criteria.

Table7.8: MSE criteria Tests

	Strong MSE Test	Second Weak MSE Test
Statistics	$\lambda_{WT}=25.86$	$\lambda_{WT}=25.86$
Null Hypothesis	$\lambda_{WT}\leq 0.5$	$\lambda_{WT}\leq (N-1)K'/2=336$
Pooling is better	no	yes

[49] The overall impact of exchange rate volatility is computed as $\beta_4+\beta_6*FSDI_{it}$.

7.4.3 Robustness tests

The results presented in Table 7.7 provide evidence that the level of financial development plays an important role in mitigating the adverse impact of exchange rate volatility on exports in Emerging East Asian economies. As a robustness check, the trade model is estimated by using two alternative measures of exchange rate volatility – moving average standard deviation (MASD) and Generalised Auto-Regressive Conditional Heteroskedasticity (GARCH) conditional volatility. The results presented in Table 7.9 confirm that the nonlinear effect of exchange rate volatility on exports and the impact is conditional on the level of financial sector development. So, the non-linear effect of exchange rate volatility does not depend on the choice of the measure of exchange rate volatility.

As another robustness test, three alternative financial sector development indicators, these being the ratio of private credit by deposit banks and other financial institutions to GDP (*PCR*), liquid liabilities divided by GDP (*LQ*), and the ratio of deposit bank domestic assets to deposit bank domestic assets plus central bank domestic assets (*CMB*) are also employed as proxies for financial sector development of the exporting country. The results are presented in Table 7.10 and they confirm that the nonlinear effects of exchange rate volatility still hold. Only in the GMM-IV regressions which use *PCR* and *CMB* as measures of financial sector development the interaction term are not significant at conventional levels.

Table 7.9: Robustness Check: Alternative measures of exchange rate volatility

Variables	MASD		GARCH	
	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
Home country income (*Y*)	1.0543***	1.2960***	1.1096***	1.3116***
	(0.0763)	(0.1120)	(0.0797)	(0.1239)
Importing country income (*Y)**	1.1492***	1.4581***	1.2221***	1.4517***
	(0.0536)	(0.0641)	(0.0619)	(0.0642)
Relative Price (*RP*)	0.0149***	0.0126**	0.0123**	0.0099
	(0.0060)	(0.0064)	(0.0063)	(0.0076)
Exchange rate volatility (*V*)	-2.7788***	-3.0297***	-66.2410***	-92.9592**
	(0.7607)	(1.3322)	(21.5982)	(46.4487)
FSDI	0.0868	-0.0008	0.1889**	0.0794
	(0.0974)	(0.1836)	(0.0772)	(0.1670)
Exchange rate volatility * *FSDI*	1.7139***	1.9616**	48.0388***	69.2867*
	(0.5195)	(0.8872)	(16.6732)	(36.3099)
Distance	-0.8252***		-0.8961***	
	(0.1378)		(0.1828)	

Table 7.9: Robustness Check: Alternative measures of exchange rate volatility (Contd.)

Variables	MASD		GARCH	
	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
Sharing a common border	0.7201*		0.7399	
	(0.4151)		(0.5553)	
Membership of AFTA	0.5179***	0.4738***	0.5106***	0.4886***
	(0.0524)	(0.0485)	(0.0537)	(0.0522)
***R*-square**	0.5064	0.5055	0.4865	0.4395
Number of Observations	5695		5695	
Number of Country-pairs	85		65	
Cragg-Donald F-statistic	126.008		9.547	
Hansen J statistic	0.016		0.537	
Chi-sq(1) *P*-value	(0.9008)		(0.4638)	

Notes: Numbers in the parentheses are standard errors. ***, ** and * in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of Stock-Yogo weak ID test is 19.93.

Table 7.10: Robustness Check: Alternative measures of financial sector development

Variables	*PCR*		*LQ*		*CMB*	
	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
Home country income (*Y*)	1.1229***	1.4482***	1.1297***	1.4854***	1.1312***	1.4338***
	(0.0515)	(0.0628)	(0.0518)	(0.0682)	(0.0522)	(0.0635)
Importing country income (*Y)**	1.1187***	1.3755***	0.6519***	0:7179***	1.2294***	1.4294***
	(0.0636)	(0.0752)	(0.0676)	(0.0733)	(0.0650)	(0.0681)
Relative Price (*RP*)	0.0167***	0.0146**	0.0146**	0.0156**	0.0176***	0.0221***
	(0.0060)	(0.0062)	(0.0062)	(0.0061)	(0.0060)	(0.0050)
Exchange rate volatility (*V*)	-3.6479***	-3.3073**	-9.2954***	-8.6861***	-7.3927	-2.3833
	(0.8983)	(1.5339)	(1.9779)	(3.3501)	(5.0997)	(5.6027)

Table 7.10: Robustness Check: Alternative measures of financial sector development (Contd.)

Variables	*PCR*		*LQ*		*CMB*	
	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
FSDI	-0.0500	-0.1369	0.3578**	0.3659	-0.3986	0.3368
	(0.1287)	(0.2267)	(0.1549)	(0.2716)	(0.6335)	(0.7216)
Exchange rate	2.6804***	2.7067**	9.5721***	9.0479**	7.6317	2.8176
volatility * *FSDI*	(0.8435)	(1.3752)	(2.1725)	(3.6236)	(5.6880)	(9.859)
Distance	-0.8112***		-0.7795***		-0.8324***	-
	(0.1279)		(0.1252)		(0.1306)	
Sharing a common	0.6896*		0.5663		0.7350*	-
border	(0.3843)		(0.3751)		(0.3528)	
Membership of	0.5430***	0.4774***	0.6423***	0.5578***	0.4927	0.4351***
AFTA	(0.0533)	(0.0494)	(0.0578)	(0.0580)	(0.0523)	(0.0534)
***R*-square**	0.5037	0.5092	0.4809	0.5083	0.5083	0.5165

Table 7.10: Robustness Check: Alternative measures of financial sector development (Contd.)

Variables	*PCR*		*LQ*		*CMB*	
	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV	G2SLS-IV	GMM-IV
Number of Observations	5695		5695		5695	
Number of Country-pairs	85		85		85	
Cragg-Donald F-statistic		89.995		37.437		41.006
Hansen J statistic		0.564		0.536		4.814
Chi-sq(1) *P*-value		(0.4529)		(0.4639)		(0.0282)

Notes: Numbers in the parentheses are standard errors. ***, **, * and ^ in the table denote statistical significant coefficients in 1%, 5% and 10% respectively. Cragg-Donald F-statistics tests for weak identification. 10% critical value of Stock-Yogo weak ID test is 19.93.

7.5 Conclusion

This chapter examines the role financial sector development plays in determining the impact real exchange rate volatility has on the exports of five emerging East Asian countries. The findings suggest that the effect of exchange rate volatility on exports is conditional on the level of financial sector development: the more financially developed an economy, the less its exports are adversely affected by exchange rate volatility. The nonlinear effect of exchange rate volatility still holds when alternative measures of exchange rate volatility and financial sector development are used. The estimation results are consistent with the notion that financial sector development provides the mechanism for firms to mitigate the effects of exchange rate volatility and in so doing stimulates export growth. These findings should act as a spur to those countries lagging behind in the level of financial sector development to speed up this process.

The results of the chapter also provide important implications for the choice of exchange rate regime for the sample countries which have been implementing export promotion policies for their economic growth and development, and regional integration. Whilst exchange rate flexibility has desirable properties as a 'shock absorber' to dampen the impact of real shocks, on average it still has an adverse effect on the exports of the financially less developed economies. Therefore, emerging East Asian economies should adapt managed exchange rate regimes, instead of a fully flexible regime, while they are attempting to reform their financial sector.

Chapter 8

Summary and Conclusions

This thesis has provided a comprehensive empirical analysis of the impact of exchange rate volatility on the exports of five emerging East Asian economies; China, Indonesia, Malaysia, the Philippines and Thailand. Despite a large number of empirical studies that have examined the relationship between exchange rate volatility and exports, there has been no specific study on emerging East Asian economies. In order to fill this gap in existing empirical literature, this thesis has examined the impact of bilateral real exchange rate volatility on the real exports of five emerging East Asian countries to the world market as well as among themselves. Moreover, unlike previous studies, which assume a linear relationship between exchange rate volatility and trade, this thesis is the first to verify the role of financial sector development in the trade impact of exchange rate volatility.

Given the fact these emerging economies depend on their exports as a driving force for economic growth, an understanding of the degree to which bilateral exchange rate volatility affects their export activity is important for setting up optimal exchange rate and trade policies. Furthermore, the countries under consideration are the main members of the impending ASEAN-China Free Trade Area, and the options for closer monetary integration including proposals for the eventual formation of a currency union within the region are currently an active area of research and policy debate. Since these countries are at the beginning stage of regional integration process, understanding the direction and extent of the impact of exchange rate volatility on their bilateral trade also becomes an important issue.

The results of the thesis provide evidence that exchange rate volatility has a significant negative impact on both intra-regional and overall exports of emerging East Asian countries. These results are robust across different estimation techniques and variables chosen to proxy exchange rate uncertainty. Unlike previous panel based studies, the long-run relationship among the variables is verified by conducting panel unit-root and cointegration tests in order to avoid the problem of spurious regression. In addition, the results indicate that the effect of exchange rate volatility on exports is conditional on the level of financial sector development, that is, the less financially developed an economy is, the more its exports are adversely affected by exchange rate volatility.

8.1 Summary of the thesis

Before conducting an empirical analysis, it is imperative to review the theoretical background and the extant empirical literature on the topic. Chapter 2 surveyed the theoretical contributions to the literature on the relationship between exchange rate volatility and international trade flows. The earlier studies applied a partial equilibrium framework which focuses on the theory of risk and real option. In this framework, exchange rate volatility is the only source of risk to a firm and all other factors that might influence the level of trade are assumed to remain constant. According to these models, exchange rate volatility increases the variance of profit. If firms are risk averse, this will lead to a decline in volume of exports, as firms wish to reduce their exposure to risk.

On the other hand, there are other theoretical propositions supporting the positive hypothesis that an increase in exchange rate volatility may lead to a greater volume of international trade. These propositions focus on the profit opportunities created by greater exchange rate uncertainty. According to this stream of literature, exporting can be seen as an 'option' that can be exercised in favourable conditions. Hence, along with the more variable exchange rate, the probability of making a larger profit from international trade increases. The higher probability of making a larger profit from international trade will lead to a greater volume of trade.

In contrast, another stream of theoretical literature employed a general equilibrium framework which takes into account the interaction of all relevant macroeconomic variables to provide a more complete picture of the relationship between exchange rate volatility and trade. According to the propositions derived from general equilibrium models, the effect of exchange rate volatility on trade is determined by the sources of exchange rate volatility. Therefore, it can be concluded that theory alone cannot provide an unambiguous answer to the effect of exchange rate volatility on trade. In summary, the review of theoretical literature reveals that the impact of exchange rate volatility on exports is analytically far from conclusive. Even though general equilibrium modelling helps to explain some ambiguity in the relationship between exchange rate volatility and trade, there is no real consensus on either the direction or the nature of the relationship.

Since the impact of exchange rate volatility on exports is theoretically indeterminate, this issue has attracted a large volume of empirical studies. Chapter 3 reviewed the extant empirical literature on the relationship between exchange rate volatility and trade. The empirical evidence on this relationship is, however, as ambiguous as the theoretical propositions. The lack of a clear and consistent pattern in existing empirical findings makes a number of issues apparent as the literature of empirical investigation has evolved. It is obvious that previous findings are sensitive to the choice of the proxy for exchange rate volatility, the underlying exchange rate, the type of trade flows, the choice of trade model and estimation techniques. From the review of the extant empirical literature, it is possible to identify the following methodological problems that cast doubt on the findings of previous empirical studies.

- Aggregating bias as a result of using aggregate multilateral exports
- Potential mis-specification problem arising from using the same trade model to analyse the trade flows of both developed and developing countries
- Potential problems of endogeneity and heteroskedascity
- The spurious regression problem as a result of paying no attention to test the staionarity and cointegration of panel data

After identifying the weaknesses of existing empirical studies, Chapter 4 outlined the research methodology used in the empirical analysis of this study. Chapter 4 also provided a brief background of gravity model and the justification of using a generalised gravity model of Feenstra *et al.* (2001) augmented with relative prices variable in the spirit of Bergstrand (1989). Then, the chapter identified the appropriate methods of estimating the impact of exchange rate volatility on exports of emerging East Asian economies. The construction of the variables and data sources are also reported in this Chapter. In addition, the advantages of using panel data in analysing the impact of exchange rate volatility on bilateral exports are also discussed. Finally, Chapter 4 presented the importance of country-pair and time specific fixed effects for a gravity model and the related econometric issues.

Chapter 5 empirically examines the effects of exchange rate volatility on the export flows of five emerging East Asian countries by using an augmented generalised gravity model. The impact of bilateral exchange rate volatility on exports among the five East Asian countries as well as on export flows to 13 other industrialized countries is examined by using a panel data set of 85 cross-sectional observations for the period from 1982:Q1 to 2006:Q4. Unlike other studies on this topic, the long-run relationship of the model was verified by panel unit-root and cointegration test. The results of Chapter 5 provide evidence that exchange rate volatility has a negative impact on the exports of emerging East Asian countries. These results are robust across different estimation techniques and seemingly do not depend on the variable chosen to proxy exchange rate uncertainty.

The estimation results of Chapter 5 demonstrated that home country's income and importing country's income affect exports positively: but the net exports are more sensitive to importing country's income than to its own income. Moreover, the results show that the income elasticity of demand for the exports of the sample countries is less than one, suggesting that their exports are mostly comprised of basic commodities. From a methodological point of view, this justified the use of a generalised gravity model instead of a standad gravity model.

The problems of a possible simultaneity bias and heteroskedasticity are addressed by employing GMM-IV estimation approach in Chapter 5. The result of GMM-IV estimation, in which the volatility of relative money supply is used as an instrumental variable, also confirms the negative impact of exchange rate volatility on exports. Various diagnostic tests verify the validity of the instrumental variable. The results of GMM-IV estimation suggest that the empirical results derived in this chapter are consistent with recent research carried out on larger samples of developed and less developed countries, which suggests that exchange-rate volatility of emerging East Asia economies has a significant negative impact on their export flows to the world market.

The estimation results using the bench mark volatility measure demonstrated that the effect of an increase in exchange rate volatility by one standard deviation (5.2 percent) around its mean would lead to 3.1 percent reduction in the bilateral exports of emerging East Asian countries. For the alternative measures of exchange rate volatility, the reduction in exports as a result of one standard deviation increase in the exchange rate volatility range from

2.0% (MASD measure) to 7.3% (GARCH measure). These results are more or less in line with other studies, which use similar methodology but different sample data set to examine the trade effect of exchange rate volatility; for example, by using a sample consisting of over 100 countries, Clark *et al.*(2004) estimated a 7-percent of reduction.

Chapter 5 also examined the impact of the level of competitiveness among the sample countries and the effect of the 1997 financial crisis on their exports. The findings have confirmed that, for the sample countries, an increase in the level of competitiveness of a country relative to others has positive impact on its exports but the magnitude is relatively inconsequential. This finding reinforces the point of view that the favourable exchange rate is just one of the factors which determine the export performance of East Asian economies. It also depends on other factors such as specialization, technology sophistication and consumer preferences (Adams *et al.*, 2006; Roland-Holst and Weiss, 2004). However, it has been found out that the effect of the financial crisis on the exports is insignificant. The result suggests that during the financial crisis, the exports of the sample countries are not adversely affected by the uncertainty arising from macroeconomic volatility.

One interesting issue is that although the sample countries are competing with each other for the exports to third markets, these countries are members of the newly formed ASEAN-China Free Trade Area (ACFTA), which aims at forging closer economic relations between China and ASEAN through lowering of trade and investment barriers. Therefore, understanding of degree to which the bilateral exchange rate volatility affects their intra-regional exports is particularly important for their future exchange rate policies and regional integration process. Chapter 6 examines the impact of exchange rate volatility on the bilateral exports among the sample emerging East Asian economies by using a panel data set of 20 bilateral observations for the period from 1982:Q1 to 2006:Q4. The panel cointegration test confirms the long-run relationship among the variables. The results of Chapter 6 provide evidence that exchange rate volatility has a significant negative impact on bilateral exports among the sample countries. These results are robust across different estimation techniques and measures of exchange rate volatility. From the results of chapter 6, the potential benefit of fixing the bilateral exchange rate of ACFTA countries – that is reducing exchange rate volatility to zero – can be computed. According to the results, total elimination of exchange rate volatility in 2006 (mean of the exchange rate volatility was 0.0506 in 2006) would have increased bilateral exports of ACFTA countries by around 4.5 percent. As a comparison, by using a pure gravity model, Dell'ariccia (1999) estimates that reducing bilateral exchange rate volatility to zero in 1994 results in an increase in intra-EU trade by 13 percent.

Chapter 6 also examined the effect of the Asian Financial crisis on intra-regional exports of emerging East Asian economies. Unlike the results of Chapter 5 which found that the financial crisis had no significant impact on exports to the world market, the crisis had positive and economically and statistically significant effect on the intra-regional exports. This finding suggests that during the crisis period, income effect dominated substitution effect; that is, a fall in export income had led to a rise in bilateral exports of the sample countries. Chapter 6 also compared the effect of exchange rate volatility on the intra-regional exports between two periods; pre-crisis (1982:Q1 to 1997:Q2) and post-crisis (1997:Q3 to 2006:Q1). The results showed that the impact of exchange rate volatility on bilateral exports has significantly declined after the 1997 crisis.

Previous two chapters has analysed the impact of exchange rate volatility on exports of the emerging East Asian economies. In those chapters, the relationship between exchange rate volatility and exports is assumed to be a linear. In contrast, chapter 7 empirically investigates the possible nonlinearity of the impact of exchange rate volatility by focusing on the role of financial sector development in the relationship between exchange rate volatility and the exports of emerging East Asian countries. None of the previous studies have investigated this issue. This is the first study that examines the role of financial sector development on the trade effects of exchange rate volatility. The findings of chapter 7 suggest that the effect of exchange rate volatility on exports is conditional on the level of financial sector development: the more financially developed an economy, the less its exports are adversely affected by exchange rate volatility. The nonlinear effect of exchange rate volatility still holds when alternative measures of exchange rate volatility and financial sector development are used. The estimation results are consistent with the notion that financial sector development provides the mechanism for firms to mitigate the effects of exchange rate volatility and in so doing stimulates export growth.

8.2 Contributions of the thesis

The overall contribution of this study to the existing empirical literature is to provide new evidence on the relationship between real exchange rate volatility and exports of the emerging East Asian economies. This thesis has extended the existing empirical literature in several important dimensions, both in terms of scope and methodology. This study is the first to investigate the relationship between exchange rate volatility and bilateral trade flows of emerging East Asia countries. Understanding the degree to which exchange rate volatility has impacted on the exports of emerging East Asia economies is an important issue for regional integration and export promotion policies. The empirical evidence provided by this research enhances this understanding, and therefore, fills an important gap in the existing literature.

Recognizing that the nature of the exports of emerging East Asia countries is different from that of industrialised countries, a generalised gravity model is employed instead of a pure gravity model. The use of a generalised gravity model enables the current study to overcome potential mis-specification problems which may arise as a result of employing pure gravity model to analyse the trade pattern of developing economies.

In addition this study conducted the recently developed panel unit-root and cointegration test to verify the existence of a long-run stationary relationship between real exports and exchange-rate volatility. Since, none of the previous studies which utilized panel data to examine the impact of exchange rate volatility on trade conducted panel unit-root and cointegration tests, the existence of the long-run relationship between bilateral exchange rate volatility and exports is questionable in the previous panel data studies and they are subject to the problem of spurious regression.

Finally, this is the first study that examines the role of financial sector development on the trade effects of exchange rate volatility. So far the majority of empirical studies investigating the impact of exchange rate volatility on exports explicitly or implicitly assume that the relationship between exchange rate volatility and exports is linear. In contrast, this study investigated the presence of a nonlinear effect of exchange rate volatility on exports. The empirical results suggest that the impact of exchange rate volatility is nonlinear indicating a more negative impact of exchange rate volatility at low levels of financial development.

8.3 Limitations of the thesis

This study examines the impact of bilateral exchange rate volatility on aggregate bilateral exports in order to avoid the aggregate bias arising from analysing the impact of real effective exchange rate volatility on aggregate multilateral exports. By focusing on the impact of bilateral exchange rate volatility on aggregate bilateral exports, the study has assumed that the impact is uniform across different types of products. In fact exchange rate volatility might have different effect on exports of different type of products. For example, the impact of exchange rate volatility on differentiated products may not be the same as the impact on homogeneous products. By assuming a uniform impact on different product categories, this study still encounters aggregation bias to a certain extent. However, for the sample countries data on disaggregated exports are only available for exports to the world market, not in bilateral context.

It is important to note that in the extant empirical literature, there is no consensus on the appropriate method for measuring exchange rate volatility. As an attempt to alleviate this methodological issue, this study followed the approach employed in much of the empirical literature on the topic by using three different measures of exchange rate volatility including a GARCH based conditional volatility. The GARCH measure allows volatility clustering, which means large variances in the past generate large variances in the future. Hence, the volatility can be predicted based on the historical information from previous period. However, it has been argued that the GARCH-based volatility measure is more suitable for high frequency data such as daily exchange rates. This study employs monthly exchange rate data to estimate the GARCH-based volatility measure, since daily bilateral exchange rates and price indexes to construct real exchange rate at daily frequency are not available for the sample countries.

In addition, the discussion in Chapter 2 recognizes that the availability of hedging opportunities can mitigate the adverse impact of exchange rate volatility. However, data on hedging activity of the sample countries are not readily available. Hence, this study employed the level of financial sector development of the exporting country as an indicator for the availability of direct and indirect hedging opportunities. The level of financial sector development is measured by financial sector development index which is a linear combination of three financial sector development measures.

Despites these limitations, which arise largely from the lack of data, the overall findings of this study that real exchange rate volatility has statistically and economically significant negative impact on exports of emerging East Asian economies seem to be robust. In addition, by using level of financial sector development as an indicator of indirect and direct hedging opportunities, the evidence of the nonlinear effect of exchange rate volatility on exports seems to support the theoretical literature.

8.4 Suggestions for future research

The limitations of the study pointed out in the previous section suggest useful areas for future research. First of all, it would be interesting to examine the impact of exchange rate volatility on exports of different product categories in bilateral context when the data becomes available. By doing so, this will eliminate aggregation bias completely.

This study is the first to employ the level of financial sector development of the exporting country as an indicator of direct and indirect hedging opportunities. Since the study has focused on emerging East Asian economies, an area of future research would be to investigate the role of financial sector development in mitigating the adverse impact of exchange rate volatility of different regions and countries with different development stages in order to find out whether the non-linear impact is the characteristic of emerging East Asia or this effect prevails in different regions. This type of research would help to shed more light on the nonlinearity of the impact of exchange volatility on exports.

One of the propositions put forward by the theoretical literature is that the degree and sign of the impact of exchange rate volatility on exports may also depend on the level of competitiveness of the market structure in which an exporting firm operates. According to this proposition, the effect of exchange rate volatility on exports of a perfectly competitive firm is different from that of a monopolistic firm. It would be interesting to analyse the relationship between market structure and the impact of exchange rate volatility by using firm level data.

8.5 Conclusions

In conclusion, the results of the thesis provide important implications for the choice of exchange rate regime for the sample countries which have been implementing the export promotion and regional integration policies for their economic growth. The results suggest that whilst exchange rate flexibility has desirable properties as a 'shock absorber' to dampen the impact of real shocks, on average it still has an adverse effect on the exports of the emerging East Asian countries. In addition, this study demonstrated that the effect of exchange rate volatility on exports is conditional on the level of financial sector development. These findings should act as a spur to those countries lagging behind in the level of financial sector development to speed up this process. Since the impact of exchange rate volatility is more intense for a country with a low level of financial development, emerging East Asia countries should first speed up the financial sector reform before adopting a more flexible exchange rate, which will effectively lead to an increase in exchange rate volatility. The results of this study provide a valuable piece of evidence informing the ongoing debate and the evaluation of policy options for emerging East Asian economies.

References

Abrams, R.K. 1980. 'International trade flows under flexible exchange rates', *Economic Review: Federal Reserve Bank of Kansas City*, 65, pp. 3-10.

Adams, F., Gangnes, B., and Shachmurove, Y. (2006) 'Why is China so competitive? Measuring and explaining China's competitiveness', *The World Economy*, 29 (2), pp. 95-122.

Aghion, P., Bacchetta, P., Ranciere, R., and Rogoff, K. (2006) 'Exchange rate volatility and productivity growth: the role of financial development', *National Bureau of Economic Research Working Paper*, No. 12117.

Akhtar, M. A. and Spence-Hilton, R. (1984) 'Effects of exchange rate uncertainty on German and US trade', *Quarterly Review: Federal Reserve Bank of New York*, Spring, pp. 7-16.

Anderson, J.E. (1979) 'A theoretical foundation for the Gravity equation', *American Economic Review,* 69(1), pp.106-116.

Anderson, J. and Van Wincoop, E. (2003) 'Gravity and Gravitas: A solution to the border puzzle', *American Economic Review*, 93, pp. 170-192.

Anderton, R. and Skudelny, F. (2001) 'Exchange rate volatility and euro area imports', *ECB Working Paper*, No 64.

Ang J.B., McKibbin W. (2007) 'Financial liberalization, financial sector development and growth: Evidence from Malaysia', *Journal of Development Economics*, 84, pp. 215 – 233.

Arellano, M., and Bover, O. (1995) 'Another look at the instrumental variables estimation of errorcomponents models, *Journal of Econometrics*, 68, pp. 29–51.

Aristotelous, K. (2001) 'Exchange-rate volatility, exchange-rate regime, and trade volume: evidence from the UK-US export function (1889-1999)', *Economic Letters*, 72, pp. 87-94.

Arize, C. (1995) 'The effects of exchange-rate volatility on U.S. exports: An empirical investigation', *Southern Economic Journal*, 62, pp. 34-43.

Arize, A., Osang, T., and Slottje, D. (2000) 'Exchange-rate volatility and foreign trade: evidence from thirteen LDCs', *Journal of Business and Economic Statistics*, 18 (1), pp. 10-17.

Arize, A., Osang, T. and Slottje, D. (2003) 'Does exchange-rate volatility depress export flows: The case of LDCs', *International Advances in Economic Research*, 9, pp. 7-20.

Arize, A., Osang, T. and Slottje, D. (2008) 'Exchange-rate volatility in Latin America and its impact on foreign trade', *International Review of Economics and Finance*, 17, pp. 33–44.

Asian Development Bank (2006) 'Routes for Asia's trade', *Asian Development Outlook*, Manila.

Asian Development Bank (2007a) 'Economic trends and prospects in developing Asia', *Asian Development Outlook*, Manila.

Asian Development Bank (2007b) 'Growth amid change', *Asian Development Outlook*, Manila.

Athukorala, P. and Yamashita, N. (2006) 'Production fragmentation and trade integration: East Asia in a global context,' *The North American Journal of Economics and Finance*, 17(3), pp. 233-256.

Attanasio, O., Picci, L., and Scorcu, A. (2000) 'Saving, growth, and investment: A Macroeconomic analysis using a panel of countries,' *The Review of Economics and Statistics*, 82(2), pp. 182-211.

Baak, S.J. (2004) Exchange Rate Volatility and Trade among the Asia Pacific Countries, *Journal of International Economic Studies*, 8 (1) pp.93-116.

Bacchetta, P., and van Wincoop E. (1998) 'Does exchange-rate stability increase trade and capital flows?', *National Bureau of Economic Research*, Working Paper 6704.

Bacchetta, P., and van Wincoop, E. (2000) 'Does exchange-rate stability increase trade and welfare?', *American Economic Review*, 90, pp. 1093-1109.

Bahmani–Oskooee, M. (2002) 'Does black market exchange rate volatility deter the trade flows? Iranian experience', *Applied Economics*, 34, pp. 2249-2255.

Bahmani-Oskooee, M. and Hegerty, S. (2007) 'Exchange rate volatility and trade flows: A review article', *Journal of Economic Studies*, 34(3), pp. 211-255.

Bailey, M., and Tavlas, G. (1988) 'Trading and investment under floating rates: The US experience', *Cato Journal*, 8(2), pp. 421-49.

Baltagi, B., Griffin, J., and Xiong, W. (2000) 'To pool or not to pool: Homogeneous versus heterogeneous estimations applied to cigarette demand', *The Review of Economics and Statistics*, 82 (1), pp. 117-126.

Baltagi, B., and Kao, C. (2000) 'Nonstationary panels, cointegration in panels, and dynamic panels: A survey', *Advances in Econometrics*, 15, pp. 7-51.

Baltagi, B.H. (2001). *Econometric analysis of panel data*, (2nd Ed.). Chichester: Wiley.

Banerjee, A. (1999) 'Panel data unit roots and cointegration: An overview', *Oxford Bulletin of Economics and Statistics*, 61(4), pp. 607-629.

Banerjee, A., and Newman, A. (2004) 'Inequality, growth and trade policy,' Mimeo, MIT.

Barkoulas, J., Baum, C., and Caglayan, M. (2002) 'Exchange rate effects on the volume and variability of trade flows', *Journal of International Money and Finance*, 21(4), pp. 481-496.

Bartov, E., and Bodnar, G. (1994) 'Firm Valuation, Earnings Expectations, and the Exchange-Rate Exposure Effect', *The Journal of Finance*, 5, pp. 1755-1785.

Baum, C., Schaffer, M., and Stillman, S. (2003) 'Instrumental variables and GMM: Estimation and testing', *Stata Journal*, 3(1): p. 1-31.

Baum, C., Caglayan, M., and Ozkan, N. (2004) 'Nonlinear effects of exchange rate volatility on the volume of bilateral exports', *Journal of Applied Econometrics*, 19, pp. 1-22.

Bayoumi, T., and Eichengreen, B. (1995) 'Is regionalism simply a diversion? Evidence from the evolution of the EC and EFTA', *CEPR Discussion Papers*, No. 1294.

Bayoumi, T., and Eichengreen, B. (2001) 'Exchange rate volatility and intervention: Implication of the theory of optimum currency areas', *Journal of International Economics*, 45 (2), p. 191–209.

Bayoumi, T., and Mauro, P. (1999) 'The Suitability of ASEAN for a Common Currency arrangement', *The World Economy*, 24 (7), pp. 933-954.

Beck, T., Demirguc-Kunt, A., and Levine, R. (2000) 'A new database on the financial development and structure', *Financial Sector Discussion Paper No. 2*, The World Bank.

Bénassy-Quéré, A., and Lahrèche-Révil, A. (2003) 'Trade linkages and exchange rates in Asia: The role of China', *CEPII, Working Paper No 2003 – 21.*

Bergstrand, J.H. (1985) 'The Gravity equation in international trade: some Microeconomic foundations and empirical evidence', *Review of Economics and Statistics,* 67, pp. 474-481.

Bergstrand, J.H. (1989) 'The generalized Gravity equation, monopolistic competition, and the Factor-Proportions theory in international trade', *Review of Economics and Statistics,* 71, pp. 143-153.

Bini-Smaghi, L. (1991) 'Exchange rate variability and trade: Why is it so difficult to find any empirical relationship?' *Applied Economics,* 23(5), pp. 927-35.

Blattner, T.S. (2005) 'What drives foreign direct investment in Southeast Asia? A dynamic panel approach'. Mimeo, European Central Bank.

Blundell, R., and Bond, S. (1998) 'Initial conditions and moment restrictions in dynamic panel data models', *Journal of Econometrics*, 87, pp. 115–144.

Bowen, H., Hollander, A., and Viaene, J. (1998) *Applied International Trade Analysis*, Basingstoke: Macmillan.

Brada, J., and Méndez. J. (1988) 'Exchange rate risk, exchange rate regime and the volume of international trade', *KYKLOS*, 41, pp. 263-80.

Brander, J., and Spencer, B. (1984) 'Export subsidies and international market rivalry,' *Journal of International Economics*, 18, pp. 83-100.

Bravo-Ortega, C., and Giovanni, J. (2005) 'Remoteness and real exchange rate volatility', *Working Paper, WP/05/1*, International Monetary Fund.

Bredin, D., Fountas, S., Murphy, E. (2003) 'An empirical analysis of short-run and long-run Irish export functions: does exchange rate volatility matter?, *International Review of Applied Economics, 17*(2), pp. 193-208.

Broda, C., and Romalis, J. (2004) 'Identifying the effect of exchange rate volatility on the composition and volume of trade', unpublished mimeo; Federal Reserve Bank of New York and Chicago Graduate School of Business).

Broll, U. (1994) 'Foreign production and forward markets' *Australian Economic Papers*, 62, pp. 1-6.

Broll, U., and Eckwert, B. (1999) 'Exchange rate volatility and international trade', *Southern Economic Journal*, 66, pp. 178-185.

Broll, U., Wong, K.P., and Zilcha, I. (1999) 'Multiple currencies and hedging', *Economica*, 66, pp. 421-432.

Caballero, R., and Corbo, V. (1989) 'The effect of real exchange rate uncertainty on exports: empirical evidence', *The World Bank Economic Review*, 3, pp. 263-278.

Campa, J.M. (2004) 'Exchange rate and trade: how important is hysteresis in trade?', *European Economic Review*, 48, pp. 527-48.

Caner, M., and Kilian, L. (2001) 'Size distortions of tests of the null hypothesis of stationarity: Evidence and implications for the PPP debate', *Journal of International Money and Finance*, 20, (5) pp. 639-657.

Chaney, T. (2005) 'Liquidity constrained exporters' *University of Chicago Working Paper*.

Cheng, I., and Wall, H. (2005). 'Controlling for heterogeneity in gravity models of trade and integration,' *Federal Reserve Bank of St. Louis Review*, pp. 49-63

Cho, G., Sheldon, I., and McCorriston, S. (2002) 'Exchange rate uncertainty and agricultural trade', *American Journal of Agricultural Economics*, 84, pp. 931-942.

Chou, W.L. (2000) 'Exchange rate variability and china's exports', *Journal of Comparative Economics*, 28, pp. 61-79.

Chowdhury, A.R. (1993) 'Does exchange rate depress trade flows? Evidence from error-correction models', *The Review of Economics and Statistics*, 76, pp. 700-06.

Clark, P.B. (1973) 'Uncertainty, exchange Risk, and the level of international trade', *Western Economic Journal*, 11 (3), pp. 302-13.

Clark, P., Tamirisa, N., and Wei, S. (2004), 'A new look at exchange rate volatility and trade flows', *IMF Occasional Paper* No. 235.

Cordenillo, R.L. (2005) 'The economic benefits to ASEAN of the ASEAN-China Free Trade Area (ACFTA)', *Bureau for Economic Integration*, ASEAN Secretariat. Available at: http://www.aseansec.org/17310.htm

Côte, A. (1994) 'Exchange rate volatility and trade', *Bank of Canada Working Paper*, No. 94-5.

Cushman, D.O. (1986) 'Has exchange risk depressed international trade? The impact of third-country exchange risk', *Journal of International Money and Finance*, 5(3), pp. 361-79.

Davis, D.R. (1995) 'Intra-industry trade: a Hecksher-Ohlin-Ricardo approach,' *Journal of International Economics*, 39, pp. 201-226.

Deardorff, A.V. (1998) 'Determinants of bilateral trade: does gravity work in a neoclassical world?' in *The Regionalization of the World Economy* (ed.: Jeffrey A. Frankel), Chicago: University Press, pp.7-22.

De Grauwe, P. (1988) 'Exchange rate variability and the slowdown in growth of international trade', *IMF Staff Papers*, 35, pp. 63-84.

De Grauwe, P. (1994) *The Economics of Monetary Integration*, New York: Oxford University Press.

Dekle R, Ryoo H.H. (2007) 'Exchange rate fluctuations, financing constraints, hedging, and exports: evidence from firm level data', *Journal of International Financial Markets, Institutions and Money*, 17, pp. 437-451.

Dell'Ariccia, G. (1999) 'Exchange rate fluctuations and trade flows: evidence from the European Union', *IMF Staff Papers* 46(3), pp. 315-334.

Dellas, H., and Zilberfarb, B. (1993) 'Real exchange rate volatility and international trade: a re-examination of the theory', *Southern Economic Journal*, 59, pp. 641-47.

De Vita, G., and Abbott, A. (2004a) 'The impact of exchange rate volatility on UK exports to EU countries', *Scottish Journal of Political Economy*, 51, pp. 62-81.

De Vita, G., and Abbott, A. (2004b) 'Real exchange rate volatility and US exports: An ARDL bound testing approach', *Economic* Issues, 9, pp. 69-78.

Dewatripont, M., and Maskin, E. (1995) 'Credit and efficiency in centralized and decentralized economies', *Review of Economic Studies*, 62, pp. 541-555.

DFID (2004) 'The Importance of Financial Sector Development for Growth and Poverty Reduction', *Department for International Development Policy Division Working Paper.*

Dixit, A. (1989) 'Entry and Exit Decisions under Uncertainty', *Journal of Political Economy*, 97, pp. 627-38.

Doğnalar, M. (2002) 'Estimating the impact of exchange rate volatility on exports: Evidence from Asian countries', *Applied Economics Letters*, 9, (13), pp. 859-863.

Doroodian, K. (1999) 'Does exchange rate volatility deter international trade in developing countries?', *Journal of Asian Economics*, 10, (3), pp. 465-474.

Doyle, E. (2001). 'Exchange rate volatility and Irish-UK trade', *Applied Economics*, 33, (2), pp. 249-265.

Duttagupta, R., and Spilimbergo, A. (2004) 'What happened to Asian exports during the crisis?', *IMF Staff Papers*, 51 (1), pp. 72-95.

Eaton, J., and Kortum, S. (1997) 'Technology and bilateral trade', *NBER working paper*: No. 6253.

EEC Commission (1990) 'One market, one money: an evaluation of the potential benefits and costs of forming an economic and monetary union', *European Economy*, No.44, October.

Egger, P., and Pfaffermayr, M. (2003). 'The proper panel econometric specification of the gravity equation: A three-way model with bilateral interaction effects', *Empirical Economics*, 28, pp. 571-580.

Egger, P., and Pfaffermayr, M. (2004). 'Distance, trade and FDI: a Hausman-Taylor SUR approach', *Journal of Applied Econometrics*, 19 (2), pp. 227-246.

Eichengreen, B. (2006) 'The parallel currency approach to Asian monetary integration', *American Economic Review*, 96 (2), pp. 432-436.

Eichengreen, B., and Irwin, D. (1996) 'The role of history in bilateral trade flows', *NBER Working Paper*: No. 5565.

Eichengreen, B., Rhee, Y., and Tong, H. (2007) 'China and the exports of other Asian countries', *Review of World Economics*, 143 (2) pp., 201-226.

Engel, C. and Hakkio, S. (1993) 'Exchange rate regimes and volatility', *Economic Review: Federal Reserve Bank of Kansas City*, 3, pp. 43-58.

Engle, R., and Bollerslev, T. (1986) 'Modelling the persistence of conditional variance', *Economic Reviews*, 5, pp. 1-50.

Ethier, W. (1973) 'International trade and the forward exchange market', *American Economic Review*, 63 (3), pp. 494-503.

Evenett, S. J. and Keller, W. (2002) 'On theories explaining the success of the Gravity equation', *Journal of Political Economy,* 110(2), pp. 281-316.

Feenstra, R., Markusen, J., and Rose, A. (2001) 'Using the gravity equation to differentiate among alternative theories of trade,' *Canadian Journal of Economics*, 34, pp. 430–47

Flood, R., and Rose, A. (1999), 'Understanding exchange rate volatility without the contrivance of macroeconomics', *Economic Journal*, 109, pp. 660-672.

Franke, G. (1991) 'Exchange rate volatility and international trading strategy', *Journal of International Money and Finance*, 10, pp. 292-307.

Frankel. J. (1997) *Regional trading blocs in the world economic system.* Washington, DC: Institute for International Economics.

Frankel, J. and Wei, S. (1993) 'Trade blocs and currency blocs', *NBER Working Papers*, No. 4335.

Frömmel, M. and Menkhoff, L. (2003) 'Increasing exchange rate volatility during the recent float', *Applied Financial Economics*, 13 (12), pp. 877–883.

Gagnon, J.E. (1993) 'Exchange rate variability and the level of international trade' *Journal of International Economics*, 34, pp. 269-87.

Goodnight, J., and Wallace, T. (1972) 'Operational techniques and tables for making weak MSE tests for restrictions in regressions,' *Econometrica*, 40 (4), pp. 699-709.

Goldstein, M., and Khan, M. (1985) 'Income and price effects in foreign trade', in *Handbook of International Economics*; Volume (2) (ed.) Grossman, G., and K. Rogoff: Elsevier Science, Amsterdam. pp. 1041-1099

Gotur, P. (1985) 'Effects of exchange rate volatility on trade: Some further evidence' *IMF Staff Papers*, 32 (3), pp. 475-512.

Grube, B., and Samanta, S. (2003) 'Effects of exchange rate uncertainty on Mexican foreign trade', *The Multinational Business Review*, 11 (2), pp. 3-15.

Hadri, K. (2000) 'Testing for stationarity in heterogeneous panel data', *Econometrics Journal*, 3(2), pp. 148-161.

Hansen, L. (1982) 'Large sample properties of generalized method of moments estimators' *Econometrica* 50(3), pp. 1029-1054.

Hau, H. (2002) 'Real exchange rate volatility and economy openness: Theory and evidence', *Journal of Money, Credit, and Banking*, 34(3), pp.611-630.

Helpman, E. (1987) 'Imperfect competition and international trade: evidence from 14 countries,' *Journal of the Japanese and International Economies*, 1, pp. 62–81.

Helpman, E. (1999) 'The structure of foreign trade', *Journal of Economic Perspectives*, 13(2), pp. 121–144.

Helpman, E., and Krugman, P. (1985) *Market structure and foreign trade.* MIT Press; Cambridge, MA.

Holly, S. (1995) Exchange rate uncertainty and export performance: Supply and demand effects, *Scottish Journal of Political Economy*, 42 (4), pp. 381-391.

Hondroyiannis, G., Swamy, P., Tavlas, G. and Ulan, M. (2006) 'Some further evidence on exchange rate volatility and export', *Bank of Greece Working Paper*, No. 28.

Hooper, P., and Kohlhagen, S. (1978) 'The effect of exchange rate uncertainty on the prices and volume of international trade', *Journal of International Economics*, 8(4), pp. 483-511.

Hsiao, C. (1999). *Analysis of panel data*, Cambridge: Cambridge University Press.

Huang, C., and Xu, C. (1999) 'Boundary of the Firm, Commitment and R&D Financing', *WDI Working Paper*, No. 316. Available to download from: http://econ.lse.ac.uk/staff/cxu/papers/FirmRD.pdf

Huang, Y and Guo, F. (2006) 'Is currency union a feasible option in East Asia? A multivariate structural VAR approach'. *Research in International Business and Finance*, 20 (1), pp. 77-94.

Iacoviello, M., and Minetti, R. (2006) 'International business cycles with domestic and foreign lenders, *Journal of Monetary Economics*, 53. pp. 2267–2282.

Im, K. S., Pesaran M., and Shin, Y. (2003) Testing for unit roots in heterogeneous panels, *Journal of Econometrics*, 115, pp. 53-74.

Ianchovichina, E., Suthiwart-Narueput, S., and Zhao, M. (2003) 'Regional impact of China's WTO Accession', in *East Asia integrates: A trade policy agenda for shared growth*, K. Krumm and H. Kharas (eds.), The World Bank; Washington D. C.

IMF (2006) *De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework*, International Monetary Fund; Washington, D.C. Available at: http://www.imf.org/external/np/mfd/er/2006/eng/0706.htm

IMF (2008) *Regional economic outlook: Asia and Pacific*, International Monetary Fund; Washington, D.C.

Karlsson, S. and Löthgren, M. (2000) 'On the power and interpretation of panel unit root tests, *Economics Letters*, 66, pp. 249-255.

Karunatilleka, E. (1999), 'The Asian economic crisis', *House of Commons Research Paper* No. 99/14.

Kawai, M., and Akiyama, S. (2000) 'Implications of the currency crisis for exchange rate arrangements in Emerging Asia'. *The World Bank Policy Research Working Papers Series.* No. 2502.

Kawai, M. and Zilcha, I. (1986) 'International trade with forward-futures markets under exchange rate and price uncertainty', *Journal of International Economics*, 20, (1), pp. 83-98.

Kelly, R. and Mavrotas, G. (2003) 'Financial Sector Development – Futile or Fruitful? An Examination of the Determinants of Savings in Sri Lanka', World Institute for Development Economics Research (WIDER) Discussion Paper No. 2003/14.

Kenen, P., and Rodrik, D. (1986) 'Measuring and analysing the effects of short-term volatility on real exchange rates,' *Review of economics and Statistics*, (Notes), pp.311-15.

Kim, D. (2007) 'An East Asian currency union? The empirical nature of macroeconomic shocks in East Asia', *Journal of Asian Economics*, 18 (6), pp. 847-66.

Klaassen, F. (2004). 'Why it is so difficult to find an effect of exchange rate risk on trade?' *Journal of International Money and Finance*, 23 (5), pp. 817-839.

Klein, M., and Shambaugh, J. (2006) 'Fixed exchange rates and trade,' *Journal of International Economics*, 70(2), pp. 359-383.

Koray, F. and Lastrapes, W. (1989) 'Real exchange rate volatility and U.S bilateral trade: A VAR approach', *The Review of Economics and Statistics*, 71, pp. 708-12.

Kornai, J. (1998) 'The concept of the soft budget constraint syndrome in economic theory', *Journal of Comparative Economics*, 26(1), pp. 11–17.

Kornai, J., Maskin, E. and Roland, G. (2003) Understanding the soft budget constraint, *Journal of Economic Literature*, 41, pp. 1095-1136.

Krugman, P. (1991) 'The Move Toward Free Trade Zones' *Economic Review-Federal Reserve Bank of Kansas City*, 76(6), pp. 5-25

Krumm, K., and Kharas, H. (2003) *East Asia Integrates: A Trade Policy Agenda for Shared Growth*, Washington, D.C: The World Bank.

Kumar, R., and Dhawan, R. (1991) 'Exchange rate volatility and Pakistan exports to the developed world: 1974-85' *World Development*, 19, pp. 1225-40

Kuo, B., and Mikkola, A. (2001) 'How sure are we about Purchasing Power Parity? Panel evidence with the null of stationary real exchange rates' *Journal of Money, Credit and Banking*, 33 (3), pp. 767-789.

Kuroda, H. (2006) Towards deeper Asian economic integration: Progress and prospects, Keynote speech at the Asia Business Conference 2006. (Harvard University Business School, USA; 11 February 2006) available at: http://www.adb.org/Documents/Speeches/2006/ms2006006.asp

Kwack, S.Y. (2005), 'Exchange rate and monetary regime options for regional cooperation in East Asia', *Journal of Asian Economics,* 16 (1), pp. 57-75.

Levine, R., Loayza, N., and Beck, B. (2000) 'Financial intermediation and growth: causality and causes', *Journal of Monetary Economics*, 46(1), pp. 31-77.

MacKinnon, J., and White, H. (1985) Some heteroscedasticity consistent covariance matrix estimators with improved finite sample properties, *Journal of Econometrics*, 29, pp. 305–325.

Markusen, J., and Venables, A. (1998) 'Multinational firms and the new trade theory', *Journal of International Economics*, 46 (2), pp. 183-203.

Martin, W., Bhattasali, D., and Li, S. (2003) 'China's Accession to the WTO: Impacts on China', In *East Asia integrates: A trade policy agenda for shared growth*, K. Krumm and H. Kharas (eds.), The World Bank; Washington D. C.

Maskin, E., and Xu, C. (2001) Soft budget constraint theories: from centralization to the market. *Economics of transition*, 9 (1). pp. 1-27.

Mátyás, L. (1998). 'The gravity model: Some econometric considerations', *The World Economy*, 21 (3), pp. 397-401.

Mavrotas, G., and Son, S. (2006) 'Financial sector development and growth: re examining the nexus', in *Transparency, Governance and Markets*, M. Bagella, L. Becchetti and I. Hasan (eds.): Elsevier Publishers

McElroy, M.B. (1977) 'Weaker MSE criteria and tests for linear restrictions in regression models with non-spherical disturbances', *Journal of Econometrics*, 6, pp. 389-394.

McKenzie, M.D. (1999) 'The impact of exchange rate volatility on international trade flows', *Journal of Economic Surveys*, 13(1), pp. 71–106.

McKenzie, M., and Brooks, R. (1997). 'The impact of exchange rate volatility on German-US trade flows', *Journal of International Financial Markets, Institutions, and Money*', 7 (1), pp. 73-87.

McKinnon, R. (1998). 'Exchange-rate coordination for surmounting the East Asian currency crisis', *Asian Economic Journal*, 12 (4), pp. 317-329.

Merton, R., and Bodie, Z. (1995) 'A conceptual framework for analysing the financial environment', in *The Global financial System: A functional Perspective*, D. Crane *et al.* (eds), Harvard Business School Press, Boston: MA

Min, H.G. (1998) 'Dynamic capital mobility, capital market risk, and exchange rate misalignment: evidence from seven Asian countries' *World Bank Policy Research Working Paper*: No. 2025.

Ngiam, K., and Yuen, H. (2001). 'Monetary cooperation in East Asia: a way forward', *The Singapore Economic Review*, 46 (2), pp. 211-246.

Obstfeld, M., and Rogoff, K. (2001) 'Risk and exchange rates', In *Contemporary Economic Policy: Essays in Honour of Assaf Razin*, E. Helpman and E. Sadka (eds.),Cambridge: Cambridge University Press.

Pangestu, M., and Gooptu, S. (2003) 'New Regionalism: Options for China and East Asia', In *East Asia integrates: A trade policy agenda for shared growth*, K. Krumm and H. Kharas (eds.), The World Bank; Washington.

Park, Y.C. and Yang, D.Y. (2006) 'Prospects for regional financial and monetary integration in East Asia', *Korea Institute for International Economic Policy*, Policy Reference 06-06.

Pedroni, P. (1999) 'Critical values for cointegration tests in heterogeneous panels with multiple regressors', *Oxford Bulletin of Economics and Statistics*, 61(4), pp. 653-670.

Perée, E., and Steinherr, A. (1989) 'Exchange rate uncertainty and foreign trade', *European Economic Review*, 33, pp. 1241–1264.

Pesaran, H., and Smith, R. (1995) 'Estimating long-run relationships from dynamic heterogeneous panels', *Journal of Econometrics*, 109, pp. 79–113.

Poon, W.C., Choong, C.K., and Habibullah, M. (2005) 'Exchange rate volatility and exports for selected East Asian countries: evidence from error correction model', *ASEAN Economic Bulletin*, 22 (2), pp. 144–159.

Pozo, S. (1992) 'Conditional exchange rates volatility and volume of international trade: Evidence from the early 1900s,' *The Review of Economics and Statistics*, (Notes), pp. 335-329.

Qian, Y. and Roland, G. (1998) 'Federalism and the Soft Budget Constraint', *American Economic Review*, 88(5), pp. 1143-1162.

Rizov, M. (2008) 'Corporate capital structure and how soft budget constraints may affect it', *Journal of Economic Surveys*, 22(4), pp. 648-684.

Rogoff, K. (1996) 'The purchasing power parity puzzle', *Journal of Economic Literature*, 34, pp. 647-668.

Roland-Holst, D., and Weiss, J. (2004), 'ASEAN and China: export rivals or partners in regional growth?' *The World Economy*, 27 (8), pp. 1255-1274.

Roodman, D. (2006) 'How to do xtabond2: An introduction to "Difference" and "System" GMM in Stata' The Centre for Global Development Working Paper Number 103.

Rose, A.K. (2000). 'One money, one market: the effect of common currencies on trade,' *Economic Policy*, 30, pp. 9-45.

Sauer, C., and Bohara, A. (2001). 'Exchange rate volatility and exports: Regional differences between developing and industrialized countries', *Review of International Economics*, 9 (1), pp. 133-152.

Sercu, P. (1992) 'Exchange risk, exposure, and the option to trade', *Journal of International Money and Finance*, 11, pp. 579-593.

Sercu, P., and Vanhulle, C. (1992) 'Exchange rate volatility, international trade, and the value of exporting firms', *Journal of Banking and Finance*, 16, pp. 155-182.

Sercu, P., and Uppal, R. (2003) 'Exchange rate volatility and international trade: a general-equilibrium analysis', *European Economic Review*, 47, pp. 429-441.

Stock, J. and Yogo, M. (2005) 'Testing for weak instruments in linear IV regression', in *Identification and Inference for Econometric Models: A Festschrift in Honour of Thomas Rothenberg*, J. Stock and D. Andrews (eds.), Cambridge University Press: Cambridge, pp.80–108.

Story, J. (2005) China: Workshop of the world? *Journal of Chinese Economic and Business Studies*, 3(2), pp. 95-109.

Tenreyro S. (2007) 'On the trade impact of nominal exchange rate volatility', *Journal of Development Economics*, 82, pp. 485-508.

Thursby, J., and Thursby, M. (1987) 'Bilateral trade flows, the Linder hypothesis, and exchange risk', *The Review of Economics and Statistics*, 69, pp. 488-95.

Viaene, J., and de Vries, C. (1992) 'International trade and exchange rate volatility', *European Economic Review*, 36, pp. 1311-21.

Wallace, T.D. (1972) 'Weaker criteria and tests for linear restrictions in regression', *Econometrica*, 40(4), pp. 689-698.

Wallace, T. and Toro-Vizcarrondo, C. (1969) 'Tables for the mean square error test for exact linear restrictions in regression', *Journal of the American Statistical Association*, 64, pp. 1649-1663.

Wang, K.L., and Barrett, C. (2007) 'Estimating the effects of exchange rate volatility on export volumes', *Journal of Agricultural and Resource Economics*, 32(2), pp. 225-255.

Wolf, A. (1995) 'Import and hedging uncertainty in international trade', *Journal of Future Markets*, 15, pp. 101-110.

World Bank (2002) *Global Economic Prospects, and Developing Countries: Making Trade Work for Poor.* Washington, D.C.: World Bank.

Yao, S., and Zhang, Z. (2003) Openness and economic performance: A comparative study of China and the Asia NIEs, *Journal of Chinese Economic and Business Studies*, 1(1), pp. 71-95.

Zhang, W., and Zhang, T. (2005) Competitiveness of China's manufacturing Industry and its impacts on the neighbouring countries, *Journal of Chinese Economic and Business Studies*, 3(3), pp. 205-229.