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FOREIGN EXCHANGE RISK: THE MALAYSIAN EXPERIENCE

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A thesis presented in fulfilment of the requirement for the degree of Doctor of Philosophy

2006

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ACKNOWLEDGEMENTS

The completion of this thesis is not possible without the kind assistance and guidance of some individuals. I am extremely grateful to my supervisor, Professor Ronald MacDonald for providing overall guidance and insightful comments throughout the period of my study. Very special thanks go to Professor Jacques Melitz, Keith Ingham, Robin Alpine, Dr. Joe Byrne, Julia Darby, Dr. Eddie McKenzie, my fellow-postgraduate PhD students, staff in the Department of Economics especially Fiona, Joyce, Kathleen, Kirsty, Moira and Morag, and all my friends in the UK and Malaysia for their advice, encouragement and support.

My sincere appreciation to Fabrizio Casalin and Sandy Kyaw for helping me with the econometrics and use of the software, Nur Anisah Abdullah, Dennis Khong and Shaopeng Huang with their help on the computing front, Zainal Abidin Abu Bakar at the Department of Statistics, Malaysia, Nuur Ashikin Mohd Salleh at MIDA and Nirwan Noh at EPU for providing me the Malaysian trade and FDI data, Martin Kemmit, Dr Omar Samat and Arizza Sapuan for helping me to extract the market shares prices from the Datastream and Adele McPherson for editing this thesis. I am also grateful to Universiti Teknologi MARA for providing the scholarship to enable me to pursue my PhD.

My gratitude is extended to my parents, *abah* and *mak*, my sisters and brothers-in-law, brother and sister-in-law, nephews and nieces for the source of love, encouragement and aspiration. To *Faiz* and *Acik*, thank you so much for taking care of our "properties" and "doing the errands" while we were away. To my nephews and nieces, follow my footsteps and excel in your studies.

Finally, my heartiest gratitude and appreciation of love to my husband, *Dzyful*, for all his sacrifices, patience, understanding, untiring support, continuous care and love. From the bottom of my heart, thank you so much *Abang*....

To my family and beloved husband.

ABSTRACT

Foreign exchange rate risk has certain implications on the economic growth of a country. Such risk, measured by the volatility of exchange rates, is said to deter companies from engaging in international trade, reduce the profitability of firms (directly or indirectly) and discourage foreign direct investment inflows.

The overall aim of this research is to analyse the impact of exchange rate risk or volatility on the Malaysian economy. The implications of exchange risk are substantiated by empirical studies on the impact of exchange rate volatility on Malaysia's trade balance and main categories of exports (primary trading partners only), on its market shares and on inward foreign direct investment from its main suppliers. Different forms of estimations have been conducted to establish these relationships including cointegration, Granger causality effects, impulse response, variance decomposition, vector error correction models and panel fixed effects. Two measures of exchange rate volatility have been used: the moving average standard deviations and the GARCH model.

The overall results reveal that exchange rate volatility has inconsistent impacts on Malaysian economic factors. Exchange rate volatility is found to have a significant impact only on Malaysia's trade balance with the United States and Singapore. The major export categories are found to have a positive significant relationship with exchange rate volatility during the floating exchange rate period and a negative significant relationship during the fixed exchange rate period. The empirical results conclude that Malaysian stock prices lead exchange rate volatility. Aggregate inward foreign direct investment into Malaysia has a positive significant relationship, while disaggregate inward foreign direct investment has an insignificant positive relationship with exchange rate volatility.

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CHAPTER ONE

INTRODUCTION

1 Research Issue

The south-eastern Asian country of Malaysia achieved independence from Great Britain in 1957. Prior to this it was known as Malaya. Malaysia was created in 1963, through a merging of the former British colonies of Malaya and Singapore, including the East Malaysian states of Sabah and Sarawak on the northern coast of Borneo. However, in 1965 Singapore opted out of this union, leaving a Malaysia comprised of the peninsula and the northern one-third of the island of Borneo. A middle-income country, by the late 1990s Malaysia had transformed itself from a producer of raw materials in the 1970s into an emerging multi-sector economy.

When the Bretton Woods exchange rate (or fixed exchange rate) system ended in spring 1973, Malaysia, like most countries, adopted a floating (or flexible) exchange rate system. However, rather than choosing the free-float system, Malaysia chose the managed-float system instead. On September 2, 1998 as a result of the 1997 Asian financial crisis, Dr Mahathir Mohamed (the then Prime Minister and Finance Minister of Malaysia), announced that ringgit Malaysia would be pegged to the US dollar at RM3.8000 from that point of time. This was one of his financial packages aimed restoring an economy badly hit by the 1997 crisis. On July 21, 2005, the pegging was lifted and ringgit was back to a managed float against a basket of currencies.

Since the abandonment of the fixed exchange rate system in 1973, foreign exchange rates have been highly volatile. The volatility[1] of exchange rate is the source of exchange rate risk[2] and this has certain implications on the economic growth of a country. This is because a rise in exchange rate volatility is said to deter companies from engaging in international trade, thus affecting the trade balances of countries, the profitability of firms in a country and a reduction in foreign direct investment.

Theoretical and empirical studies often yield conflicting results on the relationship between foreign exchange rate uncertainty and international trade. A number of models (e.g. Ethier (1973), Cushman (1986) and Peree and Steinherr (1989)) support the theory that exchange rate uncertainty will inevitably depress the volume of international trade by increasing the riskiness of trading activities, while other models (e.g. Franke (1991), Sercu and Vanhulle (1992) and Viaene and de Vries (1992)) support the positive hypothesis that exchange rate volatility may lead to greater levels of international trade. These conflicting theoretical models conclude that the impact of foreign exchange rate volatility on international trade may be positive or negative depending on the assumptions employed (e.g. traders' attitude towards risk, presence or absence of hedging facilities, profit opportunities and diversifiable risk).

The results of the empirical studies are no less confusing, where in general the results have been insignificant or inconclusive. In considering a number of issues which could affect the outcome (e.g. the proxy for exchange rate volatility, the use of nominal or real exchange rate uncertainty, the use of a bilateral or a multilateral exchange rate risk, the use of aggregate or disaggregate data and trade model specification), some of these studies showed significant results, e.g. Cushman (1983),

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[1] Volatility is the most basic statistical risk measure. The terms volatility, uncertainty, variability and fluctuation are used interchangeably throughout this thesis.

[2] The terms exchange rate risk and foreign exchange risk are used interchangeably throughout this thesis.

Thursby and Thursby (1987), McKenzie and Brooks (1997) and Dell'ariccia (1999). Meanwhile, Hooper and Kohlhagen (1978), Belanger, Gutierrez, Racette and Raynauld (1992), Vergil (2002) and de Vita and Abbott (2004), were amongst those whose studies indicated insignificant results.

The dynamic interrelationship between the stock market and the foreign exchange market has prompted researchers and policy makers (as well as analysts) to carry out further detailed study of this. This is because both markets have tremendous policy implications in which any policy changes are quickly reflected. There is a lack of theoretical consensus on the relationship between exchange rate uncertainty and stock prices. While traditional views are that exchange rate volatility affects stock prices, e.g. Dornbusch and Fisher (1980), Jorian (1990) and Bodnar and Gentry (1993), others suggest the opposite e.g. Branson (1983), Solnik (1984) and Bahmani-Oskooee and Sohrabian (1992).

Among the empirical studies, in general these have indicated feedback interaction e.g. Ajayi, Friedman and Mehdian (1998), Ibrahim (2000) and Doong, Yang and Wang (2005), as well as unidirectional causality from stock prices to exchange rate uncertainty - and vice versa e.g. Abdalla and Murinde (1997), Ibrahim (2000), Smyth and Nandha (2003) and Hatemi-J and Roca (2005). Besides examining the interactions between exchange rate volatility and stock prices, previous studies have also examined the impact of exchange rate variability on stock prices. These findings are also inconsistent across the various studies. Some studies showed positive effects of exchange rate fluctuation on the stock market, e.g. Aggarwal (1981) and Fang and Miller (2002), while others found negative effects, e.g. Soenen and Hennigar (1988) and Chiang, Yang and Wang (2000). Yet other studies concluded that exchange rate volatility has no significant impact what so ever on the stock market, e.g. Solnik (1984).

The relationship between exchange rates and foreign direct investment (FDI) is very important for the formulation of FDI policies because FDI brings a range of benefits to both investing countries (or home countries) and recipient countries (or host countries). Thus, the impact of exchange rate volatility on FDI is essential especially with regard to a company's FDI decisions. Theoretical and empirical studies on FDI

and exchange rates show that the level and volatility of exchange rates can have significant effects on FDI. Their evidence, however, is ambiguous. The impact of exchange rate risk on FDI depends on many assumptions, e.g. the types of investment, aggregate or disaggregates data used, time period, and the countries used in the studies. The theoretical work on the impact of exchange rate volatility on FDI is largely focused on risk aversion and production flexibility. In the risk aversion concept (Cushman (1985) and Goldberg and Kolstad (1995)), the models show that exchange rate uncertainty stimulates FDI, while in the latter, the models state a negative correlation between exchange rate volatility and FDI levels (Aizenman (1992) and Sung and Lapan (2000)).

Generally, empirical works in this area tend to imply a negative impact (Darby, Hughes-Hallett, Ireland and Piscitelli (1999), Chakrabarti and Scholnick (2001), Serven (2003) and Kiyota and Urata (2004)), regardless of the different perceptions and assumptions of the studies. However, there are some which report a positive impact (Cushman (1985), Byrne and Davis (2003) and Pain and Van Welsum (2003)), as well as some studies which found exchange rate uncertainty had no impact on FDI (Gorg and Wakelin (2001) and Foad (2005)).

1.1 Overview of Malaysian economy

In the past two decades, Malaysia has taken major steps to liberalise its trade and financial sectors. Using the ratio of the average exports and imports as a measure of openness, Malaysia's ratio in the 1990s was in the range of 75-94%. This shows that Malaysia is fast becoming an open economy. Malaysia's trade balance was in surplus, and increasing in value, during the late 1970s. It was at US$3159.78 million in 1979, an increase from just US$240.50 million in 1974. However, in the early 1980s, the trade balance was in deficit at US$115.01 million and US$731.36 millions in 1981 and 1982, respectively, before picking up in the next few years. During the period 1986 through to mid-1990, the trade balance was still at a surplus but in a declining trend. The trade balance was US$3214.48 million in 1986 and only US$1577.21 million in 1994, with a recorded deficit of US$103.42 million in 1995

(International Financial Statistics, various series). These scenarios were mainly due to the slow movement of exports compared to the increase in imports, (particularly capital and intermediate goods), resulting from of the rapid economic growth that took place during those periods.

It is said that the opening-up of Malaysia's economy has led to strong growth performance, especially evident during the 1990s. Despite a declining trade balance during this period, Malaysia was able to maintain an average of 8% growth per year. Growth is almost exclusively driven by exports, particularly manufactured exports, have expanded significantly during the last three decades. The contribution of manufactured exports to Malaysia's total exports increased from an average of 12% in the 1970s to around 70% by the late 1990s, with electrical and electronic products and apparel being the main contributors. The manufacturing sectors accounted for more than 32% of Malaysia's GDP. As for the non-manufactured exports, (i.e. palm oil, timber and timber products and rubber and rubber-based products) their combined total contributed around 8-15% to total GDP during the 1990s and early 2000 period (Bank Negara Malaysia, various reports). Malaysia's trading partners have always been dominated by a few traditional partners, namely, the United States, Japan and Singapore. Besides these, Malaysia's other main trading partners are the Southeast Asian countries, China, Republic of Korea, Taiwan and the EU.

The Malaysian stock market was bullish in the early 1980s before slowing in the mid-80s, due to the world economic recession happening during those periods. With the Malaysian government actively promoting Kuala Lumpur as a newly emerging world stock market during the late 1980s, this brought an influx of capital inflows into Malaysia in the early 1990s. The Kuala Lumpur Stock Exchange (KLSE)[3] was booming in 1993 and 1996, occurring amidst investment frenzies on East Asian emerging markets. The KLSE Composite Index, the main market barometer of Malaysia's securities industry, shot up to 1015.42 points in December 1993 - the first time it had ever crossed the 1000 points mark! In 1996, it was reaching more than

[3] The KLSE was renamed Bursa Malaysia, effective from May 1, 2004.

1000 points every month, ending the year at 1220.18 points. When the Asian financial crisis struck in 1997, confidence in the ringgit shattered, and investors began a mass selling of stocks on the KLSE. The Composite Index fell from 1237.96 points at the end of January 1997 to 528.45 points at the end of the year, a drop of 138%! In August 1998, immediately before the imposition of capital controls on September 2, 1998, the Composite Index stood at 386.27 points (Datastream International).

Foreign direct investment inflows to Malaysia grew remarkably over two decades from the mid-1970s to the mid-1990s, increasing more than ten-fold between 1987 and 1997. The volume of inward FDI jumped from US$933.9 million in 1980 to US$2332.46 million by 1990, peaking between 1990 and 1997, when inflows were reported at US$5005.64 million and US$5136.51 million in 1993 and 1997, respectively (International Financial Statistics). However, in 1998, the FDI inflows dropped to US$2163.4 million, as a result of the financial crisis. About two thirds of the inward investments to Malaysia came from within the region itself. The main suppliers were Japan, the Republic of Korea, Taiwan, Singapore, Hong Kong, the United States and the European countries. In terms of FDI inflows by sector, this was dominated by the manufacturing sector, especially electrical and electronic products.

The ringgit Malaysia was quite stable and appreciated in value during the period 1970 through to 1984. Exchange rates during those periods were around RM2.8300 per US dollar, with an average fluctuation rate of about 2.5%. However, during 1985 and 1986, ringgit depreciated against the US dollar by 12.18% and 19.10%, respectively. This was primarily due to the world economic crisis which occurred in 1985. From 1987 until just before the 1997 Asian financial crisis, ringgit was very strong and valued at the range of RM2.4300 to RM 2.7800 per US dollar, with a range of volatility rates also. Ringgit fluctuated as high as 7.39% in 1992 and as low as 0.08% in 1990. The appreciation of ringgit, despite the trade balance's deficits, indicates overvaluation of ringgit when the crisis began in 1997. Thus, as a result, ringgit depreciated during the crisis by more than 50% against some major currencies. In June 1997, just before the crisis happened, ringgit was trading at RM 2.5248 against the US dollar, RM4.1995 against the British pound and RM2.2070

against the Japanese yen. One year into the crisis, on July 1998, ringgit depreciated by 64% to RM4.1365 against the US dollar, by 61% to RM6.7748 against the British pound and by 30% to RM2.8786 against the Japanese yen (International Financial Statistics series). Figure 1.1 shows the monthly ringgit exchange rates as quoted against some major currencies for the period from 1990 through to 2002.

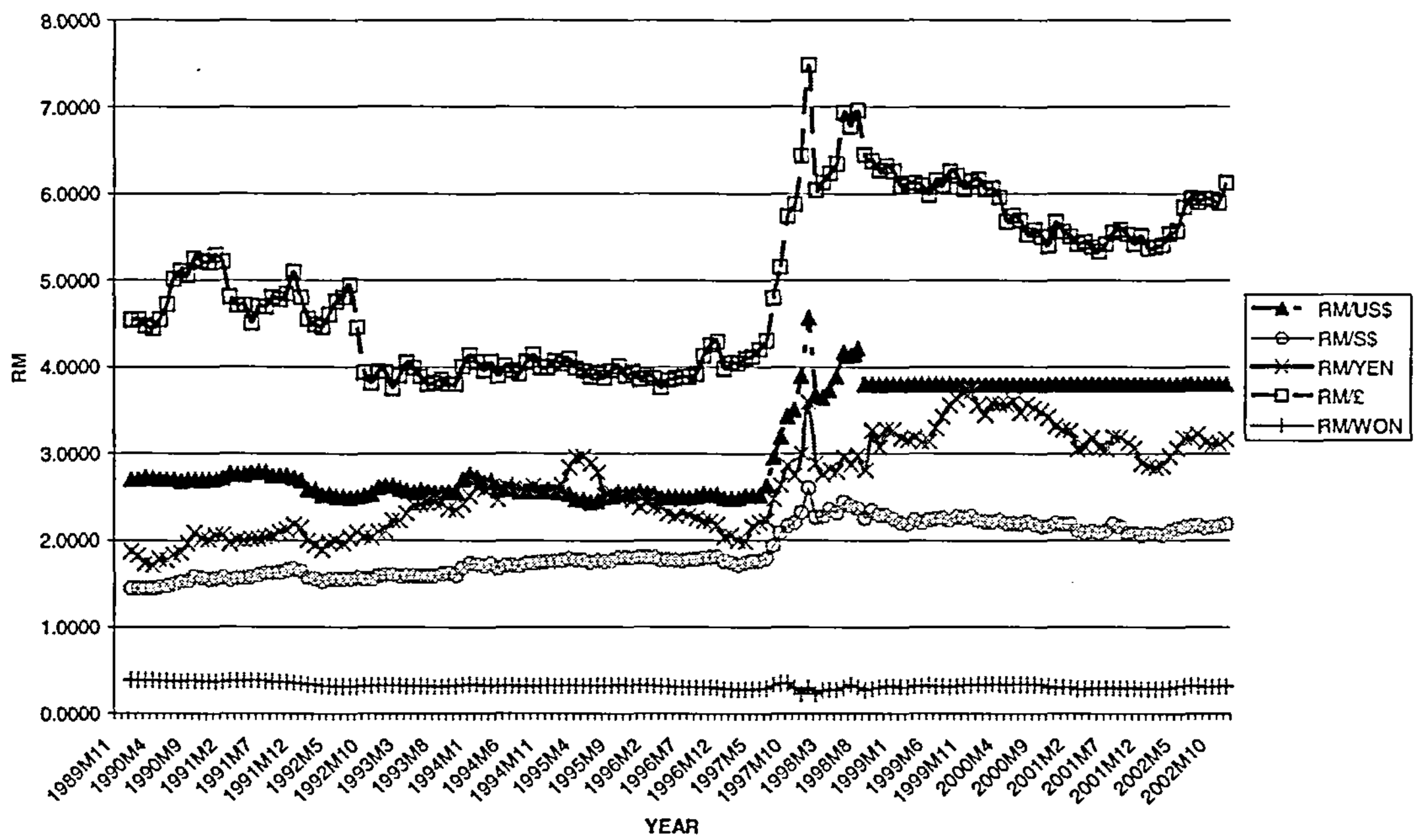

Figure 1.1. Ringgit exchange rates against some major currencies

Surprisingly, after ringgit was pegged to the US dollar in September 1998, the trade balance recorded a huge surplus every year from 1998 onwards. The trade balance in 1998 was US$17505.00 million, an increase of almost 400% from US$3509.54 million in 1997. In 1999, the trade balance shot up even further to US$22647.60 million, before declining slightly between 2000-2002 and then improving in 2003 with an amount of US$ 25711.00 million. The KLSE Composite Index improved every year from just 262.70 points in September 1999 (a year after the capital controls imposition), to 752.91 points a year later, reaching 800 points by the end of 2003. The FDI inflows also improved from 1999 onwards, to more than US$3000

million every year, except in 2001 due to poor economic performance in Japan during that time.

Therefore, it is the ambiguous implications of exchange rate risk on the Malaysian economy, particularly relating to its trade balance, major exports, market shares and foreign direct investment inflows, which have prompted this researcher to undertake this study. The key research questions are:

1. does exchange rate volatility have a significant impact on Malaysia's trade balance?

2. are there any significant impacts on Malaysian major exports categories due to the volatility in the exchange rates?

3. is there any possibility that exchange rate uncertainty leads the stock market in Malaysia?

4. are there any implications that exchange rate volatility discourages inward FDI into Malaysia?

2 Research Objectives

The overall aim of this research is to examine the effects of exchange rate volatility on the Malaysian economy by establishing a conceptual link between exchange rate uncertainty and the economic factors. The main objectives are:

1. to analyse the economic implications of exchange rate volatility and evaluate its relationship on Malaysian trade balance with its major trading partners;

2. to ascertain the impacts of exchange rate uncertainty on Malaysia's major exports categories with its major trading partners;

3. to identify the direction of any causal relationship between exchange rate movements and Malaysian share markets; and

4. to determine whether exchange rate variability discourages FDI inflows into Malaysia.

3 Research Contributions

The main contributions of this research are:

1. to add to existing empirical studies on the relationship between exchange rate volatility and international trade, market share and FDI inflows;

2. to enrich studies of exchange rate variability on international trade, market share and FDI inflows of developing countries;

3. to provide an alternative view on the impact of exchange rate changes on the Malaysian economy; and

4. to offer the Malaysian government the option of applying either a float or fixed exchange rate regime in order to boost the economy.

4 Methodology

The theoretical expositions of the standard theories of exchange rate volatility and international trade, market share and FDI inflows are the analytical platform with which this research evaluated the impact of exchange rate volatility on the Malaysian economy. A contextual analysis on Malaysia's economy and exchange rate

uncertainty is also carried out. To complement the exchange rate volatility inferences and deductions, a qualitative analysis of the economic implications of exchange rate volatility is carried out, with reference to related issues such as trade balance, major exports categories, market share and FDI inflows. Secondary data were sourced from publications of the Bank Negara Malaysia (BNM), Statistics Department of Malaysia, Ministry of Trade and Industry (MITI) of Malaysia, Malaysian Industrial Development Authority (MIDA) as well as reports of commissioned studies and publications on the Malaysian economy by various authors, national and international agencies such as the World Bank, International Monetary Fund (IMF), United Nations Conference on Trade And Development (UNCTAD) and Asian Development Bank (ASB).

Figure 1.2 is a schematic diagram illustrating the design for this research.

Figure 1.2. Research Design

Overall aim	Research Objectives	Econometrics Methods	Findings	Conclusion
To examine the effect of exchange rate volatility on the Malaysian economy	To analyse the implications of exchange rate volatility on Malaysian trade balance with its major trading partners	Johansen cointegration analysis and vector error correction model (VECM) and Granger causality tests	Significant long-run relationship on Malaysian trade balance with US and Singapore and no significant causality effect running from the exchange rate to trade balance	Final Conclusions
	To ascertain the impacts of exchange rate uncertainty on Malaysian major exports categories with its major trading partners	Panel individual fixed effects estimation	Significant positive relationship in most categories during floating exchange rate period and significant negative relationship during fixed exchange rate period	
	To identify the direction of causal relationship between exchange rate movements and Malaysian share markets	Gregory and Hansen's cointegration analysis, Granger causality effects, impulse response and variance decomposition tests	Significant negative relationships between exchange rate volatility and stock markets and stock price seems to lead exchange rate volatility	
	To determine whether exchange rate variability discourages foreign direct investment inflows into Malaysia	Ordinary least squares (OLS) estimations for aggregate study and Pedroni's panel cointegration and panel individual fixed effects for disaggregate study	Significant positive relationship in aggregate study and positive insignificant relationship in disaggregate study	

4.1 Chapter outline

The findings of this research are presented in the remaining six chapters, as follows:

- *Chapter Two* is a literature survey discussing the definitions of exchange rates and their volatility, as well as the different measures of exchange rate volatility. This is extended to include discussions on the theoretical and empirical literature, which has examined the relationship that exchange rate volatility has with international trades, market share and foreign direct investment.

- *Chapter Three* dwells on the long-run impact of bilateral real exchange rate volatility on Malaysia's bilateral trade balance with its major trading partners, comprising the United States, Singapore, Japan, the United Kingdom and the Republic of Korea, over the monthly period 1990:1 through to 2002:12. The cointegration analysis and the vector error correction model (VECM) framework, as well as the Granger causality tests within the VECM, are used to establish the long-run relationships.

- *Chapter Four* delves into the impact of exchange rate volatility on Malaysian major exports categories, namely, electrical and electronic products, palm oil, timber, apparel and rubber. Using disaggregated data for the period 1990 through to 2002, the fixed effect panel data estimation is deployed to study these relationships. The study looks at both a float and fixed exchange rate regime and, in order to capture the third country's effects, comparative bilateral exchange rate volatility as well as bilateral exchange rate volatility is applied in both studies.

- *Chapter Five* examines the interactions between the stock market and the foreign exchange market in Malaysia using a bivariate and multivariate framework. The focus of the study is on the overall performance as well as the sectoral performance, of the Malaysian stock market covering the period January 1990 through to December 2002.

- *Chapter Six* is a study on the impact of ringgit volatility on foreign direct investments to Malaysia, focusing on the aggregate and disaggregate inward FDI for the period 1981 through to 2002. The aggregate study is used to determine the factors which attract foreign investors to Malaysia, while the disaggregate study is aimed at determining the factors which attract its major suppliers, namely, Japan, Singapore, the Republic of Korea and the United States, from investing in Malaysia.

- *Chapter Seven* comprises a diagnosis of the impact of exchange rate volatility on the Malaysian economy, as well as the summary and conclusion. The summary reflects on what the research has done from chapter one through to chapter seven, while the conclusion prescribes what, in the face of exchange rate risk, the Malaysian government needs to do in order to boost its economy.

References

Abdalla, Issam S.A., and Victor Murinde, 1997, Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan and the Philippines, *Applied Financial Economics* 7, 25-35.

Aggarwal, R., 1981, Exchange rates and stock prices: A study of the US capital markets under floating exchange rates, *Akron Business and Economic Review* 12, 7-12.

Aizenman, Joshua, 1992, Exchange rate flexibility, volatility and the patterns of domestic and foreign direct investment, NBER Working Papers Series (Cambridge).

Ajayi, Richard A., Joseph Friedman, and Seyed M. Mehdian, 1998, On the relationship between stock returns and exchange rates: Tests of Granger causality, *Global Finance Journal* 9, 241-251.

Bahmani-Oskooee, Mohsen, and A. Sohrabian, 1992, Stock prices and the effective exchange rate of the dollar, *Applied Economics* 24, 459-64.

Belanger, Denis, Sylvia Gutierrez, Daniel Racette, and Jacques Raynauld, 1992, The impact of exchange rate variability on trade flows: Further results on sectoral US imports from Canada, *North American Journal of Economics and Finance* 3, 61-82.

Bodnar, Gordon M., and William M. Gentry, 1993, Exchange rate exposure and industry characteristics: Evidence from Canada, Japan and the USA, *Journal of International Money and Finance* 12, 29-45.

Branson, W.H., 1983, Macroeconomic determinants of real exchange rate risk, in R.J. Herring, ed.: *Managing Foreign Exchange Rate Risk* (Cambridge University Press, Cambridge, MA).

Byrne, Joseph P., and E. Philip Davis, 2003, Panel estimation of the impact of exchange rate uncertainty on investment in the major industrial countries, Department of Economics and Finance Discussion Papers, University of Brunel (Uxbridge).

Chakrabarti, Rajesh, and Barry Scholnick, 2001, Exchange rate expectations and FDI flows, Working Paper Series, Georgia Tech Center for International Business Education and Research (Atlanta, Georgia).

Chiang, Thomas C., Sheng-Yung Yang, and Tse S. Wang, 2000, Stock return and exchange rate risk: Evidence from Asian stock markets based on a bivariate GARCH model, *International Journal of Business* 5, 97-117.

Cushman, David O., 1983, The effects of real exchange rate risk on international trade, *Journal of International Economics* 15, 45-63.

Cushman, David O., 1985, Real exchange rate risk, expectations and the level of direct investment, *The Review of Economics and Statistics* 67, 297-308.

Cushman, David O., 1986, Has exchange risk depressed international trade? The impact of third-country exchange risk, *Journal of International Money and Finance* 5, 361-379.

Darby, Julia, Andrew Hughes-Hallett, Jonathan Ireland, and Laura Piscitelli, 1999, The impact of exchange rate uncertainty on the level of investment, *Economic Journal* 109, C55-C67.

de Vita, Glauco , and Andrew Abbott, 2004, The impact of exchange rate volatility on UK export to EU countries, *Scottish Journal of Political Economy* 51, 62-81.

Dell'ariccia, Giovanni, 1999, Exchange rate fluctuations and trade flows: evidence from the European Union, International Monetary Fund.

Doong, Shuh-Chyi, Sheng-Yung Yang, and Alan T. Wang, 2005, The dynamic relationship and pricing of stocks and exchange rates: Empirical evidence from Asian emerging markets, *Journal of American Academy of Business* 7, 118-123.

Dornbusch, R., and S. Fisher, 1980, Exchange rate and the current account, *American Economic Review* 70, 960-971.

Ethier, W, 1973, International trade and the forward exchange market, *American Economic Review* 63, 494-503.

Fang, WenShwo, and Stephen M. Miller, 2002, Currency depreciation and Korean stock market performance during the Asian financial crisis, Working Paper 2002, University of Connecticut (Storrs, Connecticut).

Foad, Hisham S., 2005, Exchange rate volatility and export oriented FDI, Department of Economics, Emory University (Atlanta, GA).

Franke, Gunter, 1991, Exchange rate volatility and international trading strategy, *Journal of International Money and Finance* 10, 292-307.

Goldberg, Linda S., and Charles D. Kolstad, 1995, Foreign direct investment, exchange rate variability and demand uncertainty, *International Economic Review* 36, 855-873.

Gorg, Holger, and Katharine Wakelin, 2001, The impact of exchange rate variability on US direct investment, GEP Research Papers Series, School of Economics, University of Nottingham (Nottingham).

Hatemi-J, Abdulnasser, and Eduardo Roca, 2005, Exchange rates and stock prices interaction during good and bad times: Evidence from the ASEAN4 countries, *Applied Financial Economics* 15, 539-546.

Hooper, Peter, and Steven W. Kohlhagen, 1978, The effect of exchange rate uncertainty on the prices and volume of the international trade, *Journal of International Economics* 8, 483-511.

Ibrahim, M.H., 2000, Cointegration and Granger causality tests of stock price and exchange rate interactions in Malaysia, *ASEAN Economic Bulletin* 17, 36-47.

Jorian, Philippe, 1990, The exchange rate exposure of US multinationals, *Journal of Business* 63, 331-345.

Kiyota, Kozo, and Shujiro Urata, 2004, Exchange rate, exchange rate volatility and foreign direct investment, *The World Economy* 27, 1501-1536.

McKenzie, Michael D. , and Robert D. Brooks, 1997, The impact of exchange rate volatility on German-US trade flows, *Journal of International Financial Markets, Institutions and Money* 7, 73-87.

Pain, Nigel, and Desiree Van Welsum, 2003, Untying the Gordian Knot: The multiple links between exchange rates and foreign direct investment, *Journal of Common Market Studies* 41, 823-846.

Peree, Eric, and Alfred Steinherr, 1989, Exchange rate uncertainty and foreign trade, *European Economic Review* 33, 1241-1264.

Sercu, Piet, and Cynthia Vanhulle, 1992, Exchange rate volatility, international trade, and the value of exporting firms, *Journal of Banking and Finance* 16, 155-182.

Serven, Luis, 2003, Real exchange rate uncertainty and private investment in LDCs, *Review of Economics and Statistics* 85, 201-234.

Smyth, R., and M. Nandha, 2003, Bivariate causality between exchange rates and stock prices in South Asia, *Applied Economics Letters* 10, 699-704.

Soenen, Luc A., and Elizabeth S. Hennigar, 1988, An analysis of exchange rates and stock prices-The US experience between 1980 and 1986, *Akron Business and Economic Review* Winter 19, 7-16.

Solnik, B. H., 1984, Stock and money variables: The international evidence, *Financial Analyst Journal* 69-73.

Sung, Hongmo, and Harvey E. Lapan, 2000, Strategic foreign direct investment and exchange rate uncertainty, *International Economic Review* 41, 411-423.

Thursby, Jerry G., and Marie C. Thursby, 1987, Bilateral trade flows, the Linder hypothesis, and exchange risk, *The Review of Economics and Statistics* 69, 488-495.

Vergil, Hasan, 2002, Exchange rate volatility in Turkey and its effect on trade flows, *Journal of Economic and Social Research* 4, 83-99.

Viaene, Jean-Marie , and Casper G. de Vries, 1992, International trade and exchange rate volatility, *European Economic Review* 36, 1311-1321.

CHAPTER TWO

LITERATURE SURVEY

1 Introduction

With the breakdown of the Bretton Woods exchange rate system in the spring of 1973, the international exchange rate system was replaced with the floating exchange rate system. Since the advent of the floating regime, exchange rates have been subject to excessive volatility, and deviations from equilibrium values have persisted over sustained periods of time. More recently, high exchange rate fluctuations in the sphere of growing trade and financial liberalization have attracted a great deal of interest from both economists and policy makers. This is because the rise in exchange rate volatility is said to deter companies from engaging in international trade, thus affecting the trade balances of countries, the profitability or value of firms in a country and a reduction in foreign direct investment (FDI).

In this chapter, we will first discuss the definitions of *exchange rate* and *exchange rate volatility*, followed with a discussion on the different measurements of exchange rate volatility. Then, we will discuss the literature pertaining to the relationship between exchange rate volatility and international trade and trade balance, stock market and foreign direct investment.

2 Exchange Rate and Exchange Rate Volatility

2.1 Exchange rate

Exchange rate is the price of one currency in terms of another currency. It is, however, important to distinguish between nominal exchange rates and real exchange rates. The *nominal exchange rate* is the rate at which a person can trade the currency of one country for the currency of another. It is normally established on currency financial markets called FOREX market (similar to the stock exchange market), and the rates are usually established in continuous daily quotation in newspapers. For example, if the exchange rate of one US dollar is quoted at 3.8000 ringgit Malaysia (RM), then every one US dollar could be exchanged for RM3.8 and RM3.80 would give back one US dollar.

The *real exchange rate* is the nominal exchange rate corrected somehow by inflationary measures. Thus, it is an indicator of how much a country's international competitiveness is changing, because the real exchange rate is basically the relative price of goods of two countries. For example, if country A has a higher inflation rate than country B, then its products will lose price competitiveness, unless there is an offsetting depreciation of its nominal exchange rate. This relationship is true because the real exchange rate depends on the nominal exchange rate and on the prices of goods in the two countries measured in the local currencies.

$$\text{Real exchange rate} = \frac{\text{Nominal exchange rate} \times \text{Foreign price}}{\text{Domestic price}} \qquad (1)$$

Since studying an economy as a whole we focus on overall prices rather than on the prices of individual items, then to measure the real exchange rate, we must use price indexes such as a consumer price index, which measures the price of a basket of goods and services. Therefore, the overall real exchange rate can be calculated as:

$$R = E\,(P^*/P) \qquad (2)$$

where

R = real exchange rate

E = nominal exchange rate (domestic price of one unit of foreign currency)

P* = price index for the foreign basket

P = price index for a domestic basket

An exchange rate can always be expressed in two ways: direct basis and indirect basis. *Direct basis* is when the exchange rate is expressed in terms of domestic currencies per one unit of foreign currency, e.g. RM3.8000 per US dollar. *Indirect basis* is when the exchange rate is expressed in terms of foreign currencies per one unit of domestic currency, e.g. US$0.2632 per ringgit Malaysia. Thus, direct basis and indirect basis is just a reciprocal to one another[1].

Why does the real exchange rate matter so much? As we know, the real exchange rate is a key determinant of a country's net export of goods and services and is a measure of it's international competitiveness. When R *falls*, it means an *appreciation* of the real exchange rate and therefore the country loses its international competitiveness. Domestic goods and services become expensive, relative to foreign goods and services, and this encourages consumers both at home and abroad to buy more of the foreign goods and more goods from other countries. As a result, the country's exports fall and its imports rise and both of these changes drop the country's net exports.

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[1] Throughout this thesis, we will express the nominal exchange rate in the direct basis quotation i.e. domestic currencies per one unit of foreign currency and ringgit Malaysia will be the domestic currency.

Conversely, when R *rises*, it indicates a *depreciation* of the real exchange rate and the country would then gain international competitiveness. Domestic goods and services become cheaper, relative to foreign goods and services, and this would make consumers both at home and abroad buy less foreign goods and more domestic goods. Eventually, the country's exports rise and its imports fall leading to a rise in the country's net exports.

Basically there are two types of exchange rate regime: fixed and floating. A fixed exchange rate regime, such as the Bretton Woods, is where governments are committed to maintaining target exchange rates, while in the floating or flexible exchange rate regime the exchange rates are determined by the interaction of currency supplies and demands. The supplies and demands of currencies are influenced by fundamental factors such as price level changes, interest differentials and economic growth.

2.2 Exchange rate volatility

Exchange rates fluctuate all the time, but when they are fixed the fluctuation or volatility simply disappears and does not show up elsewhere in the macro economy. On the other hand, when exchange rates are flexible they tend to be very volatile. Exchange rate volatility may be defined as the risk associated with unexpected movements in the exchange rate. Though the exchange rate volatility or risk is not directly observable, it may be calculated and the measurements used as a proxy for the risk in empirical estimations involving exchange rate volatility. Since empirical results are influenced by the way exchange rate volatility may be measured, selection of the measures is crucial for any study in these regards.

3 Exchange Rate Volatility Measurements

The establishment of the appropriate technique by which one may generate estimates of exchange rate volatility is not founded. This is because whilst economists generally agree that it is uncertainty in the exchange rate that constitutes exchange rate volatility, no generally accepted technique exists by which one may quantify such risk. However, this issue is very important because the measurement of exchange rate volatility may impact on the outcome of an investigation that involves such a variable. According to international economic theory, exchange rates are determined by the exchange rate fundamentals. This relationship may be expressed as:

$$e_t = \alpha + \beta X_t + \varepsilon_t \tag{3}$$

where e_t is the spot exchange rate, X_t are explanatory variables representing the exchange rate fundamentals, α is a scalar, β a vector of regressor coefficients and ε_t is a stochastic error term. Volatility may be defined in a number of ways including the conditional and unconditional variance or standard deviation of e_t, ε_t and $\varepsilon_t - \varepsilon_{t-1}$, or unanticipated changes in the exchange rate (McKenzie (1999)). In the past a wide variety of statistical measures of exchange rate variability have been used in empirical studies, encompassing each of the different possibilities alluded to above. Some of the common types of exchange rate volatility measures will be discussed below.

3.1 Absolute change of the exchange rate

This is the simplest measurement of exchange rate volatility. The volatility could be measured based on the absolute percentage change of the exchange rate or by the absolute difference between the forward rate and the spot rate. When the absolute percentage change of the exchange rate is used, the volatility is calculated as:

$$V_t = \left|(e_t - e_{t-1})\right| / e_{t-1} \tag{4}$$

where e is the spot exchange rate and t refers to time. This method was used by Bailey, Tavlas and Ulan (1986). Another method of using absolute value was used by Hooper and Kohlhagen (1978) where they took the average absolute difference between the previous forward and the current spot rate, i.e.

$$V_t = \sum_{i=1}^{n} \left|f_{t-1} - e_t\right| / n \tag{5}$$

where f is the forward rate.

3.2 Variance or standard deviation

Thursby and Thursby (1987) use the variance of the spot exchange rate around its predicted trend, where the trend is estimated as:

$$\ln e_t = \phi_0 + \phi_1 t + \phi_2 t^2 + \varepsilon_t \tag{6}$$

Apart from the variance of the exchange rate approach, the moving average standard deviation of the exchange rate technique is also one of the measurements used as a proxy for volatility. In fact this technique is the most popular technique used, especially during the earliest studies relating to this area, and is still a favourite in recent studies. Different varieties of moving average standard deviation approach are used, depending on the type of exchange rate and also on the order of the moving average. For example, the exchange rates could be nominal or real bilateral rate; nominal or real effective rate and the moving average order could be in numbers of months or quarters. The basic equation of the moving average standard deviation is expressed as:

$$V_t = \left[(1/m)\sum_{i=1}^{m}(R_{t+i-1} - R_{t+i-2})^2\right]^{1/2} \tag{7}$$

where R is the natural logarithm of the exchange rate (depending on the type of exchange rate used) and m is the order of the moving average. Amongst the studies that have used this approach are Cushman (1983), Akhtar and Hilton (1984), Kenen and Rodrik (1986), Klein (1990), Arize (1996), Aristotelous (2001), Das (2003) and Agolli (2004).

3.3 ARCH Models

All the approaches discussed so far have the problem of potentially ignoring information on the stochastic process by which exchange rates are generated. Financial time series (e.g. exchange rates and share prices) are typically heteroskedastic and leptokurtic, and exhibit volatility clustering which violates the assumptions underlying standard regression analysis (Bollerslev, Chou and Kroner (1992)). To overcome these problems, Engle (1982) introduced the Autoregressive Conditional Heteroskedasticity (ARCH) model to capture the time varying conditional variance of the exchange rates. The standard deviation obtained from the conditional variance was then used as a proxy for exchange rate volatility. Since exchange rates are generally characterized by the clustering of large shocks to conditional variance, the Generalized ARCH (GARCH) model is often the underlying model in this technique. The GARCH model takes the following form:

$$R_t = \alpha_0 + \alpha_1 R_{t-1} + \varepsilon_t, \qquad \varepsilon_t \big| I_{t-1} \sim N(0, h_t^2) \tag{8}$$

$$h_t^2 = \beta_0 + \beta_1 \varepsilon_{t-1}^2 + \beta_2 h_{t-1}^2 \tag{9}$$

First, as stated in Equation (8), exchange rate uncertainty is assumed as a first-order ARCH model where R refers to the difference in the log of the exchange rate; ε_t is the disturbance term; I_{t-1} is all relevant and available information at time $t-1$ and h_t^2 is the conditional variance. Then, assuming that the disturbances in Equation (8) are not autocorrelated, the GARCH model in Equation (9) is formulated to measure exchange rate volatility, where ε_{t-1}^2 is the ARCH term that measures the information

about volatility in the previous period and h_{t-1}^2 is the GARCH term representing last period's forecast variance. Thus, the predicted values of h_t^2 from Equation (9) will provide a measure of exchange rate volatility.

Since its introduction by Engle (1982), the ARCH model has emerged as one of the most appropriate measures of exchange rate volatility. Some studies which have employed this model are Kroner and Lastrapes (1993), Caporale and Doroodian (1994), McKenzie and Brooks (1997), Law and Tan (2000), Bah and Amusa (2002), Agolli (2004), Cheong (2004) and Pattichis, Cheong, Mehari and Williams (2004).

4 Exchange Rate Volatility and International Trade

4.1 Introduction

The effect of foreign exchange rate volatility on international trade is often discussed in the literature. While most economists believe that exchange rate volatility has a negative effect on international trade, others suggest the opposite. Indeed, theoretical and empirical studies often yield conflicting results on foreign exchange rate volatility and international trade relationships. A number of models find support for the negative hypothesis, that volatility acts to depress the international trade, while in true economic style, other models have been derived which support the positive hypothesis that exchange rate volatility may lead to greater levels of international trade. The results of the empirical studies are no less confusing, where in general the results have been insignificant or where significant, conflicting.

4.2 Theoretical models of the impact of exchange rate volatility on international trade

Theoretical models on this subject generally predict a negative relationship between exchange rate volatility and the level of international trade. Amongst others, Ethier (1973), Hooper and Kohlhagen (1978), Cushman (1986) and Peree and Steinherr (1989) argued that exchange rate volatility may reduce trade flows. Franke (1991), Sercu and Vanhulle (1992) and Viaene and de Vries (1992) however, contend that exchange rate uncertainty positively affects international trade. These conflicting theoretical models, aimed at examining the effect of foreign exchange rate variability on international trade levels, conclude that the postulated impact may be positive or negative depending on the assumptions employed. These assumptions could be related to factors such as traders' attitude towards risk, presence or absence of hedging facilities, profit opportunities, diversifiable risk, and nature of the trader and model specification.

4.2.1 Traders' attitude towards risk

The early traditional theoretical models on this subject generally predict a negative relationship between exchange rate volatility and the level of international trade. This is because in the earlier literature models are based on the assumption that firms are risk-averse, and exchange rate risk is assumed to be the main source of profit risk for a risk-averse firm. Since exchange rate volatility would increase the risks of foreign traders due to the increase of the profit risk, the risk-averse traders will tend to reduce their trade levels, especially if the forward market facilities do not exist or the hedging facilities are costly. As a result, the volume of international trade of that country would decrease.

Clark (1973) developed a model of an exporting firm producing a homogeneous commodity under perfect competition and sold entirely in the foreign market. The export price is denominated in foreign currency and hedging facilities are limited. This would result in uncertainty on future export receipts in domestic currency due to

the variability of the future exchange rates, so the firm must decide on a level of exports that takes this uncertainty into account. The firm's expected value of utility is assumed to be a quadratic function of profits expressed in the home currency ($U(\pi) = a\pi + b\pi^2$) and would require marginal revenue to exceed marginal cost in order to maximize utility value. In this scenario, a risk-averse firm that wants to reduce its risk exposure would reduce its exports volume when exchange rate volatility increases. By doing this, both the expected profits and the variance of profits decline, but expected utility increases. This illustrates how the level of trade responds adversely to exchange rate uncertainty.

Baron (1976) developed a model of an exporting firm that relaxes the assumption of perfect competition in order to analyse the effect of exchange rate volatility on prices (thus highlighting the role of invoicing currency). Baron argues that when an exporter issues invoices for his exports in foreign currency, he faces price risk because his future revenues and profits are uncertain. In this case, the risk-averse firm that wants to reduce its risk exposure would increase the price of the exports when there is an increase in the exchange rate risk. The higher price reduces expected profits (due to the decrease in demand by the importer), but increases expected utility. In this case, the trade level responds negatively to exchange rate risk.

Hooper and Kohlhagen (1978) specified a model of differential risk bearing by import demand and export supply sides of the market for traded goods. This approach enabled them to analyse the impact on price as well as volume, while allowing for differences in risk bearing between importers and exporters whenever exchange rate risk occurs. The key parameters in determining the impact of exchange rate risk in their model are the currency denomination of contracts, the proportion of forward hedging and the relative degrees of exporters' and importers' risk aversion. A fraction of the contracts is assumed to be priced in foreign currency and a fraction of transactions is hedged in the forward market.

Hooper and Kohlhagen first derive demand and supply function for individual firms and then aggregate them to obtain a reduced-form equation for the market

equilibrium price and quantity. Their reduced-form equation for the market equilibrium price is as follows:

$$P^* = \frac{UC^*}{2(EH^* - \gamma^*\delta^*\sigma_{1/R_1})} - \frac{aUC + bPD + cY + dCU}{2ai(EH + \gamma\delta\sigma_{R_1})} \qquad (10)$$

and the reduced-form equation for the market equilibrium quantity is:

$$q^* = \frac{ni}{4}(aUC + bPD + cY + dCU) + \frac{nai^2}{4}\frac{UC^*(EH + \gamma\delta\sigma_{R_1}}{(EH^* - \gamma^*\delta^*\sigma_{1/R_1})} \qquad (11)$$

where UC^* and UC is the exporter's and importer's domestic unit cost of production respectively; EH^* and EH is the expected value of a weighted average of the cost of foreign currency to the exporter and importer respectively; PD is the price of other goods in importer's country; Y is the income of importer's country; CU is the non-price rationing in importer's country; γ^* and γ is the relative measure of risk preference of exporter and importer respectively; σ_{1/R_1} is the standard deviation of exchange rate $1/R_1$, where R_1 is the spot exchange rate prevailing on the (future) date of payment; σ_{R_1} is the standard deviation of exchange rate R_1; $\delta^* = (1-\beta)(1-\alpha^*)F$ and $\delta = \beta(1-\alpha)$ where β is some of the proportion of export or import, F is forward exchange rate, α^* is exporter constant proportion of foreign exchange risk, α is importer constant proportion of foreign exchange risk; i is the fixed ratio of imports to total quantity and n is the number of identical competitive importers. Equations (10) and (11) reflect the fact that the equilibrium price and quantity are affected by the degree of exchange rate risk faced by exporters and importers.

Using the reduced-form equations, Hooper and Kohlhagen then analysed the effects of increases in the variance of the exchange rate and changes in tastes for risk-bearing traders. They used Taylor-series expansion to approximate σ_{1/R_1} by $\sigma_{R_1}R_1^{-2}$, differentiating Equation (10) and (11) with respect to σ_{R_1}, and assuming risk aversion yields:

$$\frac{\partial P^*}{\partial \sigma_{R_1}} = \frac{(UC^*\gamma^*\delta^* R_1^{-2})}{2(EH^* - \gamma^*\delta^*\sigma_{R_1} R_1^{-2})^2} + \frac{\gamma\delta(aUC + bPD + cY + dCU)}{2ai(EH + \gamma\delta\sigma_{R_1})^2} \lessgtr 0, \tag{12}$$

$$\frac{\partial P^*}{\partial \sigma_{R_1}} = \left(\frac{nai^2 UC^*}{4(EH^* - \gamma^*\delta^* R_1^{-2}\sigma_{R_1})}\right)\left(\gamma\delta + \frac{(EH + \gamma\delta\sigma_{R_1})\gamma^*\delta^* R_1^{-2}}{EH^* - \gamma^*\delta^* R_1^{-2}\sigma_{R_1}}\right) < 0 \tag{13}$$

Thus, if exporters and importers are risk-averse ($\gamma, \gamma^* > 0$), an increase in exchange rate risk will reduce the volume of trade and have an ambiguous effect on price. If they are risk-neutral, ($\gamma, \gamma^* = 0$), there will be no effect on either q^* or P^* and, for risk-lovers, ($\partial q^* / \partial \sigma_{R_1} > 0$).

Hooper and Kohlhagen argue that differentiating Equation (10) and (11), with respect to the importers' and exporters' risk preferences, reinforces the following results:

$$\frac{\partial P^*}{\partial \gamma} = \left(\frac{(aUC + bPD + cY + dCU)}{2ai(EH + \gamma\delta\sigma_{R_1})^2}\right)\sigma_{R_1} < 0, \tag{14}$$

$$\frac{\partial q^*}{\partial \gamma} = \frac{nai^2 UC^*\delta\sigma_{R_1}}{4(EH^* - \gamma^*\delta^*\sigma_{1/R_1})} < 0, \tag{15}$$

$$\frac{\partial P^*}{\partial \gamma^*} = \frac{UC^*\delta^*\sigma_{1/R_1}}{2(EH^* - \gamma^*\delta^*\sigma_{1/R_1})^2} > 0, \tag{16}$$

$$\frac{\partial q^*}{\partial \gamma^*} = \frac{nai^2 UC^*(EH + \gamma\delta\sigma_{R_1})}{4(EH^* - \gamma^*\delta^*\sigma_{1/R_1})^2}(\delta^*\sigma_{1/R_1}) < 0. \tag{17}$$

Increased risk aversion places two distinct and opposing forces on the price. The more risk averse the importers are the less the foreign currency price will be, because buyers will decrease their demand. Similarly, an increase in risk aversion among exporters would result in higher prices because exporters would reduce supply and increase prices as a risk premium. As a result, we see that higher risk aversion on the part of either importers or exporters would reduce the volume of international trade.

De Grauwe (1988) derived a model of a competitive producer able to allocate its production between domestic and foreign markets. Both domestic and foreign prices are fixed and the only source of risk to the producer is the local currency price of exports. Given these assumptions, the effect of an increase in exchange rate risk will depend on the convexity properties of the expected marginal utility of export income function of the exchange rate. The effect also depends on the degree of risk aversion, for example if the producer demonstrates only a slight degree of risk aversion, the increase in the exchange rate risk would reduce the export activity in view of the fact that such an increase would reduce the expected marginal utility of exports revenues. In this scenario, exchange rate risk has a negative relationship with international trade. However, if the producer is very risk-averse and worried about the worst possible outcomes, any increase in exchange rate volatility will increase exports thus avoiding a drastic decline in the revenue incomes. So, in this situation exchange rate risk reflects a positive relationship with international trade.

Not all firms are risk-averse. Some are risk-taker or risk neutral. Franke (1991) analysed a risk neutral firm and was able to provide support for the positive relationship between exchange rate risk and international trade level. Franke analysed the exporting strategy of a risk neutral firm, operating in a monopolistic competition framework. The export strategy was determined by transaction costs incurred whereby the firm weighs the entry (exit) costs associated with entering (existing) a foreign market against the profits (losses) created by the exports. Firm will enter (exit) a foreign market if the present value of the cash flow of the export exceeds the present value of the entry (exit) costs. Franke also regards exporting as an option that is exercised if profitable and argued that the value of the exports depends on exchange rate volatility. He hypothesized that the higher the volatility, the higher will be the value of the exports and, assuming mean-reverting real exchange rates, linearity of log cash flows in exchange rates and risk neutrality, when exchange rate volatility increases, export value increases. He concludes, therefore, that firms on average enter a foreign market sooner and exit later when exchange rate volatility increases. As a result, the number of trading firms will increase due to the benefits that firm enjoys when exchange rate volatility occurs.

4.2.2 *Hedging facilities*

The effect of foreign exchange rate volatility faced by firms could be reduced, if not totally eliminated, by the use of hedging facilities of which there are several to choose from. They could choose from the physical or synthetic products categories. The *physical products* categories include spot, forwards, forward-forwards and short- and long-term physical swaps. The *synthetic* or *derivative products* include futures, options, swaps and option products.[2] The most popular hedging facility used is forward exchange contracts, and several models have incorporated the effects of this into the link between exchange rate volatility and trade flows.

Ethier (1973) developed a decision making model for a risk-averse firm considering the volume of goods to be imported and the amount of forward exchange coverage that it would enter in a scenario of exchange rate volatility. Assuming the imports are denominated in foreign currency, at any given value of the exchange rate in the future, the firm would know in advance its profit level. In this case, exchange rate volatility would not influence the trade level, but does determine the degree of forward cover to be taken. The model concludes that, with the availability of perfect forward market, and assuming no other sources of risk but the exchange rate, the volume of trade is unaffected by exchange rate volatility. However, since it is unlikely that the future exchange rate will be known, Ethier extends the model to integrate uncertainty regarding the firm's position. In this scenario, the level of trade responds negatively to exchange rate uncertainty, though the significance of this response declines the more the firm hedges its exchange rate risk.

Viaene and de Vries (1992) provided a theoretical explanation on the presence of forward market opportunities in determining the relationship between exchange rate uncertainty and international trade flows. They began by discussing the behaviour of

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[2] See Batten, Jonathan, and Robert Mellor, 1993, Foreign exchange risk management practices and products used by Australian firms, *Journal of International Business Studies* 24, 557-573. to know which hedging facilities are mostly used by firms.

the importers and exporters in connection with the forward market. First, they assumed that all transactions are invoiced in the foreign currency and there is a one period trade credit given to all parties. The traders are also assumed to be risk-averse and they would hedge their foreign exchange risk by entering the forward foreign market. Assuming these scenarios, the importer's profit function is as follows

$$\tilde{P} = aY - \tilde{w}Y + (\tilde{w} - f)L - \tfrac{1}{2}Y^2 \tag{18}$$

where a is the spot foreign exchange rate, Y is the import quantity, w is the one period ahead spot foreign exchange rate, f is the forward rate, L is the forward foreign currency contract and $\sim$ is the random nature of the foreign exchange rate.

If forward market does not exist, then the straightforward optimisation of the importer is:

$$Y = (a - \varepsilon)/(1 + \alpha\sigma^2) \tag{19}$$

where $\mathrm{E}\,\tilde{w} = \varepsilon$ and var $\tilde{w} = \sigma^2$ and presumably $a > \varepsilon$

If forward market does exist, the optimizing choices of the importer are:

$$Y = a - f \tag{20}$$

and

$$L = (\varepsilon - f)/\alpha\sigma^2 + Y \tag{21}$$

and presumably $a > f$. The separation theorem shows that import Y only depends on the forward rate f but the hedge L is also influenced by the degree of risk aversion α and the exchange rate volatility σ^2.

Viaene and de Vries (1992) postulated the exporters profit function as:

$$\tilde{P} = \tilde{w}X + (\tilde{w} - f)K - dX - \tfrac{1}{2}X^2 \tag{22}$$

where X is the quantity exported, K is the hedging contract and d is the spot foreign exchange rate. If hedging facility is not available, the optimal export volume is:

$$X = (\varepsilon - d)/(1 + \alpha\sigma^2) \tag{23}$$

and presumably $d < \varepsilon$. If forward market is available, the optimising export and hedging levels are:

$$X = f - d \tag{24}$$

and

$$K = (\varepsilon - f)/\alpha\sigma^2 - X \tag{25}$$

and presumably $d < f$.

When Equations (21) and (25) are compared, one sees that the speculative parts of the hedges, that is $(\varepsilon - f)/\alpha\sigma^2$ are similar, but the hedge parts, that is Y and X enter with opposite signs. The difference in the signs is simply because exporters expect to **receive** some foreign currency while importers have to **pay** in foreign currency. The difference on the signs in the forward rate f in Equations (20) and (24) can be explained analogously. Significantly, Viaene and de Vries (1992) concluded that exporters and importers take opposite hedge positions on the forward market, but both traders have the same attitudes towards risk.

After discussing the relationship between exporters and importers and the forward market, Viaene and de Vries (1992) investigate the connection between trade and exchange rate volatility using the trade balance approach. They define trade balance TB as the difference between exports and imports:

$$TB = \sum_{i=1}^{m} X_i - \sum_{i=1}^{n} Y_i \tag{26}$$

where m is the number of exporters and n is the number of importers. First, they consider the case when there is no developed forward market. From Equation (19), (23) and (26) they propose the following Proposition 1:

$$-\frac{\partial Y}{\partial \varepsilon}=\frac{\partial X}{\partial \varepsilon}=\frac{1}{m+n}\frac{\partial TB}{\partial \varepsilon}=1+\frac{1}{1+\alpha\sigma^2}>0, \tag{27}$$

and

$$\frac{\partial Y}{\partial \sigma^2}=-\frac{\alpha Y}{1+\alpha\sigma^2}<0,\ \frac{\partial X}{\partial \sigma^2}=-\frac{\alpha X}{1+\alpha\sigma^2}<0,$$

$$\frac{\partial TB}{\partial \sigma^2}=-\frac{\alpha TB}{1+\alpha\sigma^2}. \tag{28}$$

In the absence of forward markets, a change in the mean exchange rate affects trade flows and the trade balance as predicted by the conventional terms of trade analysis. An increase in exchange rate volatility reduces both imports and exports, and the surplus or deficit of the trade balance is reduced as well.

In the presence of forward markets, Proposition 1, given above, has to be modified. From Equations (20), (24) and (26) the following lemma is derived:

$$\frac{\partial Y_i}{\partial f}=-1, \qquad \frac{\partial X_i}{\partial f}=1, \qquad \frac{\partial TB}{\partial f}=m+n \tag{29}$$

Here, the only means by which changes in the volatility of the exchange rate can affect trade volumes is through the forward rate. With a forward market, one trade flow benefits while the other trade flow inevitably loses from changes in either the expected rate or the volatility. The effects of exchange rate uncertainty on importers and exporters are opposite to each other because they themselves are on opposite sides of the forward market.

4.2.3 *Profit opportunities*

In the basic trade models, exchange rate does not affect the real opportunities facing the firm. The firm is constrained to make production and export decisions before the exchange rate is known. If these assumptions are relaxed, uncertainty in exchange rate does not only represent risk but it could create opportunities to make profit. This is a case of price uncertainty phenomenon faced by a firm. If a firm were a price taker, then, when exchange rate uncertainty increased, the price of the output would also increase. In this scenario, the firm's production output must rise and, therefore, its exports, in order to compensate from losses due to the exchange rate change. This will result in a higher revenue per unit basis.

Franke (1991) used the "option" framework to analyse the direct effects of exchange rate volatility on the export strategy of a firm. He regarded exporting as an option that is exercised if profitable and argued that the value of the exports will depend on exchange rate volatility. The higher the volatility, the higher will be the value of the exports. Since firms enjoy the benefits when exchange rate volatility occurs, firms will take this opportunity to increase their exports volume. This shows that trade benefits from exchange rate risk

4.2.4 *Diversifiable risk*

Most theoretical models focus on the decisions of a single trading firm, but the increase in the importance of multinational trading firms in the global trading environment has made economists look into this area.[3].The multinational firm is assumed to produce in a foreign country and sells that output abroad. It is also assumed that the multinational firm has monopoly power in the foreign market and thus faces exchange rate uncertainty. If hedging facilities were not available, exchange rate uncertainty would reduce the production in the foreign country.

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[3] See Broll, U., 1994, Foreign production and forward markets, *Australian Economic Papers* 62, 1-6.

However, where hedging facilities are accessible, then the exchange rate volatility bears no impact on the decision of the firm regarding foreign investment and foreign labour demand.

The multinational firm has always been characterized as a diversified firm due to its ability to diversify its risks by operating in many countries. In finance literature, the general focus on the behaviour of the diversified firm is on the effects of exchange rate volatility on the risk and return of the firm's overall set of activities.[4] The diversified firm holds a portfolio of assets and liabilities denominated in a variety of currencies, and exports and imports affect both accounts receivables and account payables. Even if the variability of the exchange rate is high, the exports and imports can still be attractive if it is able to diversify trading as a whole.

4.2.5 Nature of the trader

Theoretical models of the relationship between exchange rate volatility and trade also depend on assumptions regarding the nature of traders. Many models assume that traders are either exporters or importers and predict that exchange rate volatility has a negative impact on international trade flows (see Ethier (1973) and Hooper and Kohlhagen (1978)) and could also have a positive relationship (Franke (1991) and Viaene and de Vries (1992)). Wolf (1995) considered a utility maximizing model of a risk-averse manufacturing firm that imports inputs from a foreign country. The manufacturer is assumed not only to face exchange rate volatility, but also uncertainty on the inputs price. Wolf explicitly proves that exchange rate volatility has a negative effect on the level of imports.

In his theoretical study of the relationship of exchange rate volatility and international trade, Gagnon (1993) modelled the impact on an international

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[4] See Makin, John H., 1978, Portfolio theory and the problem of foreign exchange risk, *Journal of Finance* 33, 517-34.

arbitrageur who buys goods from producers in one country and sells these goods in another. The arbitrageur's objective is to maximize the infinite sum of discounted expected future utility and is assumed to be risk-averse with a concave utility function, as well as a convex cost of adjusting the trade level, because of contracting and marketing costs. Gagnon extends the theoretical dynamic optimising model of a risk-averse firm, popularised by Lucas and Prescott (1971) and Hansen and Sargent (1980). In this model, exchange rate uncertainty is shown to depress volume of trade.

4.2.6 Model specification

Most of the theoretical studies in this area have taken the partial equilibrium model by focusing on the decision of the firm. Kumar (1992), however, employed a two-country general equilibrium model with scale economies and product differentiation and then added to this exchange rate risk. Each country produces two goods, manufactured and agricultural, with a single input, labour. The home country has a comparative advantage in manufacturing (and is a net exporter), while the foreign country has a comparative advantage in agricultural production (being the sole exporter). Further, Kumar assumed for these two countries purchasing power parity holds, incomplete hedging facilities, risk aversion and foreign currency invoicing. Kumar claims that an increase in exchange rate risk is equivalent to a negative technological change. In the home country, resources flow from the manufactured goods sector to the agricultural sector since the latter is not exposed to exchange rate risk. In the foreign country, both sectors are exposed, but since the manufacturing sector is assumed to have some market power, it can raise its mark-up and its relative productivity will increase. As a result, resources flow to the manufacturing sector. Kumar found that an increase in exchange rate risk reduces the inter-country differences in relative productivity and inhibits the level of international trade, whilst escalating the level of intra-industry trade.

4.2.7 Conclusion

In general, a number of theoretical models of the relationship between exchange rate volatility and trade have emerged in the literature. However, the theories do not allow one to draw any firm conclusion on the effects of exchange rate volatility on international trade. To establish that exchange rate volatility may have either a positive or negative impact on the level of international trade, one has to rely on a set of stringent assumptions.

4.3 Empirical estimation of the impact of exchange rate volatility on international trade

Theoretical economists try to model the hypothetical response of firms to exchange rate volatility. Empirical researchers, however, examine actual data when trying to establish a systematic relationship between exchange rate risk and international trade. In doing so there are a number of issues that must be considered, as these may affect the outcome. Some of these important issues are discussed below.

4.3.1 Proxies for exchange rate volatility

What is the best proxy for exchange rate volatility? There is no definite answer to this question. Different types of volatility will be important for different kind of firms or for economies as a whole. A wide variety of measures have been discussed above. The volatility measures could be based on the absolute percentage change of the exchange rate; the absolute difference between the forward rate and the spot rate; the variance of the spot exchange rate around its predicted trend; the moving average standard deviation of the exchange rate; or the ARCH model. In deciding which approach to use as a measure of the volatility, the researcher must also decide which exchange rate to apply.

4.3.2 *Nominal or real exchange rate*

There have been conflicting arguments as to whether exchange rate variability is better measured by nominal or real exchange rate uncertainty. Some studies that have used the nominal rate, with significant results, are Akhtar and Hilton (1984) and Cheong (2004), while Cushman (1983), Kenen and Rodrik (1986) and Arize (1998), amongst others, have shown significant results using the real exchange rate. One determining factor when choosing which exchange rate to use is the time dimension of the study. If a long-run relationship is to be determined, the real exchange rate will normally be used and for a short-run relationship, the nominal rate will be applied (see Akhtar and Hilton (1984) and IMF (1984)). This phenomenon is based on the purchasing power parity theory which implies a currency must have the same purchasing power in every country to be valid over the long-run period but not in the short-run period.[5]

It has been said that nominal exchange rates are guilty of overestimating the existing uncertainty in the exchange rate and are thus, more volatile than the real exchange rate. This is because the exchange rate volatility could be due to the actions of the prices and the price actions could offset the real effects of the variations in the exchange rates. These offsetting movements are considered in the real exchange rates. This was the reasoning Gotur (1985) believed in when he criticised Akhtar and Hilton's use of nominal exchange rate volatility measures in their 1984 work. Cushman (1983) also believed real exchange rate volatility to be the appropriate measure of the risk. He re-tested the nominal nature of Hooper and Kohlhagen's

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[5] Some studies on the purchasing power parity that agree on the long-run validity of purchasing power parity include Frenkel, Jacob A., 1978, Purchasing power parity: Doctrinal perspectives and evidence from the 1920's, *Journal of International Economics* 8, 169-91. Krugman, Paul R., 1978, Purchasing power parity and exchange rates, *Journal of International Economics* 8, 397-408. and MacDonald, Ronald, 1993, Long-run purchasing power parity: Is it for real?, *Review of Economics and Statistics* 75. 690-5.

(1978) work using the real exchange rate version. His empirical results were an improvement over the original Hooper and Kohlhagen results.

Some studies, however, have shown that, under the flexible exchange rate regime, fluctuations in nominal and real exchange rates are highly correlated (see Thursby and Thursby (1987), Mark (1990) and McKenzie and Brooks (1997)). Thursby and Thursby (1987) used both nominal and real measures of exchange rate volatility and found that their results for nominal exchange rate volatility were indistinguishable from those based on real volatility. Mark (1990) found the variability of real exchange rate changes to be approximately equal to the variability of nominal exchange rate changes and these changes are highly correlated in the long-run as well as in the short-run. McKenzie and Brooks (1997) used an ARCH model to quantify the volatility in their study of US-German bilateral trade flows over the period 1973 to 1993 and found that the parameters estimated in the ARCH model fitted to the real exchange rate did not significantly differ from the model fitted to the nominal exchange rate. Therefore, the use of nominal or real exchange rate volatility does not matter so much, since the distinction between them makes no difference to the results derived. Moreover, both types of exchange rates have shown significant results when investigating the relationships between exchange rate uncertainty and trade flows.

4.3.3 Bilateral or multilateral exchange rate

Another important issue is the decision whether to use a bilateral exchange rate risk (see Hooper and Kohlhagen (1978) and Cushman (1983)) or a multilateral exchange rate risk (see Peree and Steinherr (1989) and Kroner and Lastrapes (1993)) in the estimations. Bilateral exchange rate is an exchange rate that involves the currencies of two countries. Multilateral exchange rate (also called the effective exchange rate or trade-weighted exchange rate) is an exchange rate that measures an overall value of one currency against a basket of currencies. Both exchange rates could be in the form of nominal or real exchange rate quotation.

Hooper and Kohlhagen (1978) used the bilateral nominal exchange rate to investigate the impact of exchange rate uncertainty on bilateral and multilateral trade flows among the United States, Germany and several other industrial countries during the period 1965 through 1975. They estimated the relationship using the linear reduced-form quantity equation and assumed foreign exchange rate uncertainty to be the only source of risk faced by the importers or exporters. They also assumed the normal contract leads and payment lags in their model, so that variations in the exchange rate in the future would induce fluctuations in the unhedged profit streams of international traders. They apply several proxies for the exchange rate risk but found the average absolute difference between this period's spot exchange rate and last period's forward rate to be the best indicator for risk. In line with earlier studies, they too fail to find any statistically significant impact on the volume of trade, despite considerable effort and experimentation with alternative risk proxies and alternative functional forms of the quantity equation. They argue that the absence of a significant impact on volume might be attributable to relatively inelastic export supply in the short-run and the hedging opportunities that importers and exporters have applied.

Cushman (1983) empirically analysed the effects of exchange risk on the volume of trade using an extension and modification of Hooper and Kohlhagen's (1978) framework. He covers the same bilateral trade flows included in the Hooper and Kohlhagen study but extended the period up to 1977. Cushman however, applies real bilateral exchange rates instead of the nominal exchange rates used by Hooper and Kohlhagen. Cushman's linear reduced-form quantity equation is similar to Hooper and Kohlhagen's but he also included the importer's domestic price level (since it is an explicit variable used to measure the real exchange rate) as well as a dock strike dummy variable. His linear reduced-form quantity equation is as follows:

$$Q = a_0 + a_1 Y + a_2 CU + a_3 UC + a_4 UC^* + a_5 EH + a_6 EH^* + a_7 \sigma_{R_1} + a_8 D \qquad (30)$$

where Y is money income in importing country; CU is importer's non-price rationing; UC and UC^* is importer's and exporter's unit cost, respectively; EH and EH^* expected cost of foreign exchange rate for the importer and exporter,

respectively; σ_{R_1} is the standard deviation of the future real spot exchange rate and D is the dock strike dummy.

Cushman's empirical results show that exchange rate risk and trade volume is statistically negatively significant at 5% level. These significantly negative results are believed to be the first study ever to have found such results when considering industrialised countries during that time period. Cushman claims that his results were significant due to several factors, such as the use of real exchange rate, the proxy for exchange rate risk and the longer time period. Surprisingly, Cushman still found significantly negative results with the period reset to 1965 to 1972, which essentially avoids the floating period.

Even though using the bilateral exchange rate allows different exchange rate regimes to be taken into the estimations, it does not consider the dependency of the result on third countries. Cushman (1986) provides a good example to explain the third country effect. A third country effect arises when developments in a third country have significant impacts on any two countries under consideration. Such effects are very important and need to be considered when determining the trade flows between any two countries because the existence of the third country will have certain impact on the trade flows between these two countries. In Cushman (1986), a rise in the US dollar/Pound risk leads to an expected reduction of US exports to the UK, while a simultaneous rise in the US Dollar/Mark risk causes an increase in US exports to the UK. Accordingly, the result for the aggregate volume of exports is ambiguous and it is not possible to predict the effects of the bilateral exchange rate developments. Even though the use of multilateral exchange rate risk could overcome the problem of the third country effects, this approach sacrifices potentially useful bilateral information of using the bilateral exchange rate. Also, it is not free from omitted variable bias.

Peree and Steinherr (1989) empirically investigated the medium term period of exchange rate volatility and trade flows of industrialised countries for the period 1960 through to1985. Unlike other studies during that period which apply variance of exchange rates as a proxy for exchange rate risk, Peree and Steinherr come up with

two alternative measures more suitable for the long-run nature of their study. Their rejection of the variance of exchange rate as a proxy of exchange rate risk is because they believe that variances over past periods are of very limited relevance for appreciating uncertainty over periods of several years in the future. They believe that the two measures are able to capture uncertainty on the basis of historical experience. Their empirical work uses annual data and they apply nominal multilateral or effective foreign exchange rate.

The first measure of exchange rate risk they proposed is:

$$V_t = V_t^1 + V_t^2 = \frac{\max X_{t-k}^t - \min X_{t-k}^t}{\min X_{t-k}^t} + \left[1 + \frac{\left|X_t - X_t^p\right|}{X^p}\right]^2 \tag{31}$$

where X_t is the nominal effective exchange rate at time t, $\max X_{t-k}^t$ and $\min X_{t-k}^t$ refer to maximum and minimum values of the nominal effective exchange rate over a given time interval of size k up to time t, and X_t^p is the equilibrium exchange rate.

V^1 is believed to capture accumulated experience and V^2 adds more recent information to the historical component V^1. A drawback of measure V is that it does not incorporate the duration of misalignment. Therefore, they proposed a second measure of uncertainty designed to capture this effect using the integral of misalignment over a relevant past period.

$$U_t = \left[\sum_{i=t-10}^{t} \frac{\left|X_i - X_i^*\right|}{X_i^*}\right] . \left[1 + \sum_{i=t-k}^{t} \frac{\left|X_i - X_i^*\right|}{X_i^*}\right] \tag{32}$$

where X^* is the equilibrium exchange rate. The first term is the sum of the absolute values of exchange rate disparities over the ten years preceding t. To give more weight to recent periods, the first bracket is multiplied with the second bracket that contains the same integral over a shorter period of time. Peree and Steinherr have used $k = 5$ in their study. The measure V takes only current misalignment into account, whilst measure U focuses on past and present misalignment.

Their export equation is modelled as:

$$E_t = \alpha_0 + \alpha_1 Y_t^* + \alpha_2 R_t + \alpha_3 W_t + \alpha_4 T_t + \xi_t \tag{33}$$

where Y_t is a proxy for world demand; R_t is the real exchange rate; W_t is the proxy for exchange rate risk, measured either by V_t or U_t; T_t is the proxy for supply effects and ξ_t is the error term with the usual Gaussian properties assumed.

Their empirical results showed that when exchange rate uncertainty is defined over a medium term period, it negatively affects the volume of trade of the industrialised countries under review (United States, United Kingdom, Belgium, Germany and Japan) with notable exception of the United States.

Kroner and Lastrapes (1993) try to find the reduced-form impact of exchange rate volatility on international trade quantities and prices using a joint estimation technique in the context of a parameterized model of conditional variance. Their empirical model allows joint estimation of the relationship between volatility and trade and how past information is related to perceived volatility. In effect, their model imposes rationality on the variance forecasts of market participants by estimating a multivariate GARCH model, in which the variance of the exchange rate appears in the conditional mean specification-GARCH-in-mean. Their tests are performed for five industrialized countries (US, UK, Germany, Japan and France) using monthly data for the period 1973 through to 1990, and effective exchange rates are used in the measurement proxy for exchange rate volatility.

Their estimates of the impact of exchange rate volatility on international trade are based upon the following model.

$$\Delta x_t = a_0 + a_1 \Delta s_t + a_2 \Delta p_t^* + a_3 \Delta c_t + a_4 \Delta y_t^* + d_x f(h_{t+1})$$

$$+ a_5 \Delta x_{t-1} + a_6 \Delta x_{t-2} + a_7 \Delta x_{t-3} + a_8 \varepsilon_{xt-1} + \varepsilon_{xt}, \tag{34}$$

$$\Delta q_t = b_0 + b_1 \Delta s_t + b_2 \Delta p_t^* + b_3 \Delta c_t + b_4 \Delta y_t^* + d_q f(h_{t+1})$$

$$+ b_5 \Delta q_{t-1} + b_6 \Delta q_{t-2} + b_7 \Delta q_{t-3} + b_8 \varepsilon_{qt-1} + \varepsilon_{qt}, \tag{35}$$

$$\Delta s_t = c_0 + \varepsilon_{st} \tag{36}$$

where x_t denotes real exports from the domestic country to the rest of the world during time period t; q_t is the corresponding price of exports denominated in foreign currency and s_t is the foreign currency price of domestic currency. The right-hand side variables include the ratio of foreign to domestic prices (p_t^*), domestic real unit labour costs (c_t), real foreign income (Y_t^*) and a function of the time-varying conditional variance of the future exchange rate (h_{t+1}). Δ is the first difference operator. The ε s are assumed to be white noise stochastic processes.

Kroner and Lastrapes imposed a GARCH structure on the covariance matrix of the residuals in Equations (34), (35) and (36). Define $\varepsilon_t = \left[\varepsilon_{xt} \varepsilon_{qt} \varepsilon_{st} \right]'$. Then,

$$\varepsilon_t \left| \varepsilon_{t-1,\ldots} \right. \sim N(0, H_t),$$

$$H_t = \begin{pmatrix} \sigma_{xt}^2 & \sigma_{xqt} & 0 \\ \sigma_{xqt} & \sigma_{qt}^2 & 0 \\ 0 & 0 & h_t \end{pmatrix}, \tag{37}$$

$$\sigma_{xt}^2 = \alpha_0 + \alpha_1 \varepsilon_{xt-1}^2 + \alpha_2 \sigma_{xt-1}^2,$$

$$\sigma_{qt}^2 = \beta_0 + \beta_1 \varepsilon_{qt-1}^2 + \beta_2 \sigma_{qt-1}^2,$$

$$h_t = \gamma_0 + \gamma_1 \varepsilon_{st-1}^2 + \gamma_2 h_{t-1},$$

$$\sigma_{xqt} = \delta_0 + \delta_1 \varepsilon_{xt-1} \varepsilon_{qt-1} + \delta_2 \sigma_{xqt-1}.$$

In general, the GARCH model assumes stochastic dependence between the current realization of $\varepsilon_t \varepsilon_t'$ and its past realizations. Thus, conditional variances and covariances are time-varying. The presence of h_{t+1} in the conditional mean equations implies that Equations (34) through (37) are a multivariate GARCH-in-mean model

Kroner and Lastrapes's empirical results show that the impact of nominal effective exchange rate volatility on exports and price is statistically significant for all the industrialized countries under review. However, even though the relationship is statistically significant, the direction of the effects differs across countries. Only for the US and UK is the impact of exchange rate volatility on trade negative.

4.3.4 Aggregate, bilateral or sectoral trade data

In the past, many of the empirical studies conducted were based on aggregate data. However, the use of aggregate data may contribute to the range of conflicting results derived. This is because using aggregate data would implicitly assume that the impact of exchange rate uncertainty is uniform between countries and commodities, both in terms of direction and magnitude. If this assumption is incorrect, then the investigation of aggregate trade data is likely to weaken the true nature of the relationship and lessen the probability of deriving a significant result. Recognising this possibility, many researchers have recently adopted disaggregate or sectoral trade data when examining the relationship between exchange rate uncertainty and international trade flows.

4.3.4.1 Aggregate, bilateral trade study

Hooper and Kohlhagen (1978) provided one of the first empirical studies relating to this topic. Since then, many empirical studies have been conducted to investigate the relationship of exchange rate risk and international trade flows. Most of these look at the aggregate bilateral trade and exchange rate risk relationship. Amongst the studies

are (Cushman (1988), McKenzie and Brooks (1997) and Baum, Caglayan and Ozkan (2001)).

Cushman (1988) investigated the US bilateral trade flows with its six largest trading partners[6] for possible exchange rate risk effects on volume. Unlike his earlier studies, this study restricts the estimation to the floating rate period only. In this study, Cushman applies five different measures of exchange rate risk. Each measure assumes that traders use recent variability as a risk proxy and recent 'surprises'(in standard deviation form) as their estimate of the relevant future standard deviation.

Cushman's original risk measure, S_0 (S refers to the risk proxy) is a four-quarter moving standard deviation of recent changes in the real exchange rate, R. The next measure, S_1, is constructed from a twelve month moving standard deviation of recent monthly R changes and the next three use information contained in the forward exchange rate concerning exchange rate expectation. S_2 assumed that forward rate equals the expected future spot rate, whilst S_3 assumed the opposite. Finally, S_4 assumes a more general relationship for the varying risk premium.

The empirical results of this study show that significant negative risk effects appear in five of six US import flows, with the robust cases being the Netherlands, the UK and Japan. Risk effects on US exports are less conclusive. Exports to the UK and Canada show significant negative effects while those to Japan remain positive. Overall, these results are consistent with several previously published results for aggregate trade flows. Cushman also claims that the risk measures, derived from forward exchange rates and the assumption of a time varying risk premium, provide marginally more significant results than other measures.

McKenzie and Brooks (1997) study the effect of exchange rate volatility on Germany-US bilateral trade flows for the period 1973:4 through to 1992:9 using the

[6] The trading partners are the same countries as in his 1986 studies.

monthly data. They tested the relationship of exchange rate risk against Germany's exports to, and imports from, the US and apply the ARCH models to generate the measure of exchange rate volatility using the nominal bilateral exchange rate. The model that they used in their study is the international trade theory model which states trade as a function of income, prices, level of the exchange rate and exchange rate volatility, i.e.

$$X_t^G = f\left[Y_t^{US}, Y_t^G, P_t^{US}, P_t^G, R_t, V_t\right] \tag{38}$$

$$M_t^G = f\left[Y_t^{US}, Y_t^G, P_t^{US}, P_t^G, R_t, V_t\right] \tag{39}$$

where X_t^G represents Germany's exports to the US in period t and M_t^G is Germany's imports from the US; Y is the level of GDP in Germany and the US in period t; P represents Germany and US price levels in period t; R is the nominal level of the US-Germany exchange rate in period t and V is the proxy for exchange rate uncertainty.

Their empirical results show that an increase in exchange rate volatility increases both the level of Germany's exports to, and imports from, the US. Volatility is found to impact positively and be statistically significant on trade as a whole at a level of 5%. The results differ from many papers previously published, as the effects are found to be positive and statistically significant for the period under review.

Given the lack of a clear resolution of the impact of uncertainty on trade flows in earlier studies, Baum, Caglayan and Ozkan (2001) attempted to address this issue by investigating the relationship for a broader set of data. Most of the previous research utilizes aggregate United States or G7 export data. In this study, Baum, Caglayan and Ozkan (2001) applied a 13-country data set which includes US, Canada, Germany, UK, France, Italy, Japan, Finland, Netherlands, Norway, Spain, Sweden and Switzerland, and consists of bilateral real export for the period 1980 through to 1998 on a monthly basis in each direction. As proxy to capture exchange rate volatility,

they utilized daily spot exchange rates to compute the one-month a-head exchange rate volatility from the intra-monthly variations in the exchange rate.[7] This approach to measuring exchange rate risk is believed to provide a more representative measure of the perceived volatility, avoiding potential problems.

Baum, Caglayan and Ozkan (2001) reported the estimated effect of exchange rate volatility when taking into account the entire set of 149 bilateral models. They found this to be generally positive with a mean value of 0.157, a 95% confidence interval (0.079, 0.235) and a median value of 0.014. However, these summary statistics mask the variation in these effects across the 13 exporting countries. Focusing on the degree to which these effects are distinguishable from zero, of the 149 models considered, 29 have positive values and 8 have negative values at the 95% level of significance. The greatest number of significant effects is reported by Switzerland and Japan, each having four positive and two negative estimates of risk. Overall, Baum, Caglayan and Ozkan (2001) have demonstrated that exchange rate volatility has a significant impact on real exports in all 13 developed countries between 1980-1998, except for Germany, and on average the total effects are found to be positive.

4.3.4.2 Sectoral trade study

Bini-Smaghi (1991) argued that the use of disaggregate trade data may have greater potential since they do not constrain income, price and exchange rate risk elasticities to be equal across sectors as in aggregate data. However, most of the empirical studies on this subject are based on aggregate data. Only a relatively small number of recent papers that empirically test the impact of exchange rate variability on trade use sectoral disaggregate data. The sectoral studies that have been conducted show conflicting results as to the effects of foreign exchange rate risk on international trade flows. The only general conclusion from these studies is that differences do exist

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[7] A method based on Merton, Robert, 1980, On estimating the expected return to the market: An exploratory investigation., *Journal of Financial Economics* 8, 323-361.

across sectors. Some sectoral studies of exchange rate variability and international trade include Klein (1990), Belanger, Gutierrez, Racette and Raynauld (1992), Cheong, Mehari, Pattichis and Williams (2002), Pattichis, Cheong, Mehari and Williams (2004) and de Vita and Abbott (2004).

Klein (1990) analysed the effects of real exchange rate volatility on the proportions of monthly bilateral sectoral exports of nine categories of goods from the US to seven major industrial countries during the period of February 1978 to June 1986. He uses a fixed effect framework to test the effects for individual sectors and export value instead of export volume or export price for the study since it is suggested that appropriate sectoral-bilateral price deflators are not available. Klein's regression equation, which captures the impact of exchange rate volatility on the value of bilateral exports of a particular category of good to a particular country, is:

$$\ln(P_{it}Q_{it}) = \beta_0 + \sum_{k=0}^{j} \beta_{1k} \ln Y_{it-k} + \sum_{k=0}^{m} \beta_{2k} \ln RER_{it-k} + \beta_3 V_{it} + \beta_4 T + \varepsilon_t \qquad (40)$$

where P_{it} is the domestic currency price and Q_{it} is the volume of exports to country i in period t, Y_{it} is a measure of economic activity in the importing country, RER_{it} represents the real exchange rate between the exporting country and country i, V_{it} is a measure of the volatility of the real bilateral exchange rate between the exporter and country i, T represents a time trend, ε_t is an error term and ln represents the natural logarithm of variables. Contemporaneous and lagged values of the economic activity and real exchange rate variables enter the regression. Standard assumptions apply for the error term.

In this study, Klein considers the volatility as a function of comparative bilateral volatility because he argues that the volatility of a bilateral exchange rate only affects the value of trade between two countries when it differs from the volatility of other bilateral exchange rates between either of these trading partners and other countries. The comparative volatility term represents the volatility of the bilateral exchange rate between the United States and the importing country, relative to a weighted average of the volatility of the bilateral dollar exchange rates of all the importing countries in

the sample. The empirical results show that bilateral exchange rate uncertainty has a positive effect on trade. Out of the nine categories, six categories show that real exchange rate volatility significantly affects the value of US exports, with five categories having a positive relationship.

Belanger, Gutierrez, Racette and Raynauld (1992) focused on the impact of nominal exchange rate risk on real sectoral imports to the US from Canada using quarterly data over the period 1974 through to 1987. They considered five sectors, which jointly addressed the potential biases raised by the use of proxies for exchange rate risk using the non-parametric approach suggested by Pagan and Ullah (1988). This should allow unbiased estimates of the size of the effect of exchange rate risk on trade volumes. Their risk measures were based on three-month forecast errors on the forward market and their overall results indicated that exchange rate volatility does not significantly depress the imports volume US from Canada.

McKenzie (1998) analysed not only the impact of exchange rate variability on Australian aggregate exports and imports, but also disaggregate sectoral trade data using quarterly data over the period 1969 through to 1995. He concludes that testing using sectoral trade data allows him to detect whether aggregate trade data distorts the true nature of the relationship between exchange rate volatility and trade flows. He applies the ARCH model to generate a proxy for exchange rate volatility. The results obtained suggest that the impact of exchange rate variability differs between exports and imports flows rather than between aggregate and disaggregate data. The Australian exports flows have a positive effect in both aggregate and disaggregate data while the imports flows show a negative impact in both types of data. It seems quite difficult to firmly establish the nature of the relationship.

Cheong, Mehari, Pattichis and Williams (2002) investigated the impacts of exchange rate volatility on the monthly-disaggregated exports of the UK manufacturing data, covering the period January 1976 through to January 2000. They applied vector autoregressive (VAR) models to analyze the relationship for each of the four major manufacturing export sectors of the UK. The overall results show that exchange rate variability affects exports in a negative way and contradict the conclusions of the previous studies of Klein (1990) and McKenzie (1998). Since the results show that

exchange rate volatility has a tendency to depress major manufacturing UK exports, this result would support the proposition that by adopting the euro the UK would enhance its exports performance.

While Cheong, Mehari, Pattichis and Williams (2002) studied the impact of exchange rate volatility on the disaggregated exports of the UK's four major manufacturing categories, Pattichis, Cheong, Mehari and Williams (2004) studied the disaggregated imports of the UK's 15 major manufacturing categories. They too employ the monthly data, but cover the period January 1974 through to July 2000. They measure exchange rate volatility using the GARCH model based on the UK's nominal effective exchange rate index. Their results show that exchange rate volatility has a negative relationship with the UK's imports manufacturing categories, even though in most cases this relationship is statistically insignificant. The findings clearly show that exchange rate variability and trade have a negative association suggesting that by adopting the euro, the UK will gain from increased international trade, since exchange rate volatility will be eliminated when trading with the European Union (EU) (the UK's main trading partner).

de Vita and Abbott (2004) examined the impact of exchange rate risk on UK exports to EU countries using monthly data disaggregated by market of destination and sectors for the period covering January 1993 through to June 2001. Two exports volumes were studied: 1. Aggregate bilateral exports of UK to each market of destination of the EU14 individually; 2. Multilateral exports to the EU14 for five sectors of the aggregate data: total manufactured goods; food, beverages and tobacco; basic materials; fuels; and services. The newly developed autoregressive distributed lag (ARDL) bounds testing approach was employed to test for the existence of a cointegrating relationship between variables[8]. The advantage of the ARDL bounds testing approach is that it allows testing for the existence of a cointegrating relationship between variables in levels, irrespective of whether the

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[8] See Pesaran, M. Hashem, Yongcheol Shin, and R.J. Smith, 2001, Bounds testing approaches to the analysis of level relationships, *Journal of Applied Econometrics* 16, 289-326.

underlying regressors are I(0), I(1) or mutually cointegrated. Their results reveal that short-term volatility appears to have a statistically insignificant impact on the exports of UK to the EU14 at both the aggregate and sectoral level. The long term variability shows that there is a statistically negative impact on the exports volumes.

4.3.5 Data sample segmentation

One problem faced by any study on the volatility and trade flows issue has been to gather a sufficiently large sample of observations drawn from a freely floating period. This particular issue is especially relevant to many of the early studies. For those studies that contain data samples prior to 1973, one possible way to account for the regime changes is to split the data into a pre and post regime change sample. Examples of such studies are Cushman (1986) and Bailey, Tavlas and Ulan (1987).

Cushman (1986) empirically analysed the effect of exchange rate risk on US bilateral export flows to its six largest trading partners, the UK, the Netherlands, France, Germany, Canada and Japan, by including the impact of third country exchange rate risk factors. He uses two estimation periods; the first covers the period of 1965 through to 1977 and the second period from 1973 through to 1983. The equation estimated for each US bilateral export flows is

$$Q = f(Y, CU, UC, UC_{US}, R_1, M_1, \sigma\theta_1, D, R_2, M_2, \sigma\theta_2, \mathrm{cov}(\theta_1, \theta_2)) \qquad (41)$$

where Q is the real exports; Y and CU is the real GNP and capacity utilization in the importing country; UC and UC_{US} is importer and exporter real unit costs; R_1, M_1 and $\sigma\theta_1$ is the real dollar price of importer's currency, a moving, four quarter mean of $\theta_1 = R_{1,t} / R_{1,t-1}$ and a moving, four quarter standard deviation of θ_1. Third country exchange rate variables are given by R_2 (the real dollar price of the third country's currency), M_2, $\sigma\theta_2$ and $\mathrm{cov}(\theta_1, \theta_2)$. A dock strike dummy is given by D.

In both estimation periods, Cushman tested the export equation with and without the third country variable factors. In the 1965-1977 periods, he found the exchange rate

risk to have significant negative signs both with and without the third country variable factors. When examining the third country variables, the exchange rate risk of the third country has significant positive sign effect in four out of the six cases under study. This is consistent with the expectation under the positive covariance assumption. The other two cases, which have negative signs, could be due to those countries favouring the riskless home market.

Between 1973-1983, the results of the export equation without the third country variables show that the exchange rate risk effect is also negative on balance, but not as significant as in the first period. When third country variables are included, the original bilateral exchange rate effect is now twice as significant at the 0.05 level. Unlike in the first period, the exchange rate risk of the third country never exhibits a significant positive effect between 1973-1983. On the contrary, four of these coefficients are significantly negative at least at the 10% levels.

Bailey, Tavlas and Ulan (1987) examined the effects of exchange rate volatility for 11 Organisation for Economic Co-operation and Development (OECD) countries using the quarterly data over the period 1962 through to 1985. The authors split the data into two time periods, 1962:2 through to 1974:4 and 1975:1 through to 1985:3 and tested for the impact of volatility using an absolute percentage change and a log of the standard deviation measure of exchange rate volatility expressed in both real and nominal terms. The choice of 1975:1 as the first observation of the second time period is to allow for a clean break between sub-periods, since some of the variables in the regression are lagged. The estimated regressions are of the form:

$$\log(X_i) = \log a_1 + a_2 \log Y_i + a_3 \log RP_i + a_4 \log OP + a_5 V_i + \log \varepsilon_i \qquad (42)$$

where X_i is the volume of exports of country i, Y_i is real GDP/GNP of industrial trading partner countries, RP_i is a measure of relative prices of export of country i to those of its trading partners, OP represents real export earnings of oil producing

countries, V is the exchange rate variability and ε is residual error term with the Gauss-Markov properties.

In general, their results failed to provide any real substantive evidence as to a damaging effect of volatility on real exports. Of the seven equations tested for the pre-1973 floating period, none shows negatively significant impact. However, six did produce a positive impact, three of which are significant. Over the floating period, 35 regression equations were tested. In several instances, a positive and significant association between exchange rate volatility and real exports was found. In only three instances did the results show a significant and negative relationship between exchange rate volatility and real trade flows. These three regressions were based on a real volatility measure and no nominal volatility coefficients were significant.

4.3.6 Trade model specified

The vast majority of studies in this area have specified models in which trade is a function of some sort of income proxy, relative prices, the exchange rate and exchange rate volatility. A number of studies, however, have chosen to extend the scope of their international trade model in an attempt to enhance their analysis.

Bailey, Tavlas and Ulan (1986) derived a model which included real export earnings of oil-producing countries as a dependent variable. They justified the inclusion of this variable by stating that oil producers' export earnings and their importance as export markets for industrial countries have increased greatly since 1973. The authors study the real exports of the "Big Seven" OECD countries for the period 1973 to 1984 and apply the absolute percentage change in the nominal effective exchange rate as their measure of variability. Of a total of 28 equations tested, none were able to provide statistically significant evidence of a trade-reducing effect of volatility.

Cushman (1986) extends the Cushman (1983) study by introducing the possibility of third country effects to the model. Using the same standard deviation based measure of uncertainty and modifying the export quantity equation in his 1983 study to test

for the third country's effects, Cushman tested the US bilateral exports flows to its six largest trading partners. The empirical results show that volatility depressed trade flows and third country effects influenced the magnitude of that impact.

Thursby and Thursby (1987) constructed a bilateral trade flows model which focuses on the gravity model and the Linder hypothesis. The gravity model specifies the value of trade between two countries as a positive function of incomes of the countries and a negative function of the distance between them. The Linder hypothesis states that trade of manufactured goods between two countries will be inversely related to the difference in their per capita incomes. Thursby and Thursby's empirical model extended the standard set of determinant variables to also include tariff levels, transport costs, consumer tastes and hedging variable. This model was tested for 17 countries over the period 1974 through to 1982 using the mean annual variance of the spot exchange rate around its predicted trend (based on a 12 month lag) as a measure of variability. They estimate the exchange rate variability using both the real and nominal exchange rate. Their empirical results show that 15 of the countries tested have a negative relationship between exchange rate variability and bilateral trade flows, while 10 of those countries have a statistically significant effect.

Dell'ariccia (1999) used a gravity model and panel data from Western Europe to analyze the effects of exchange rate volatility on bilateral trade flows from 1975 through to 1994. Dell'ariccia restricts this to include only Western Europe countries, since the theoretical foundation of the gravity model assume identical and homothetic preferences across countries and relies heavily on the concept of intra-industry trade. Western Europe countries are relatively homogeneous in terms of technology, factor endowments and per capita income. Thus, the model seems particularly appropriate for this case. In his actual estimation, Dell'ariccia applied three different forms of exchange rate uncertainty proxy: the standard deviation of the first differences of the logarithmic exchange rate, the sum of the squares of the forward errors and the percentage differences between the maximum and minimum of the nominal spot rate. The regressions results seem to be robust and most coefficients are similar for the different regressions, suggesting that the different

measures of exchange rate uncertainty are in some way equivalent. There was evidence of a small but significant negative effect of bilateral volatility on trade.

Overall, the alternative models of trade that include additional variables are interesting. These models are interesting because they consider factors other than the one included in the standard trade model such as the real export earnings of oil-producing countries, third country effects, Linder hypothesis and gravity model in determining the relationships between exchange rate volatility and trade flows. Having these additional factors in the trade models would extend the scope of the international trade models and enhance the analysis. However, the results obtained do not differ substantially to those of the standard trade model. As such it would appear that the standard model that specifies trade as a function of income, prices, the exchange rate and exchange rate volatility is adequate in the current context.

4.3.7 Non-stationarity, cointegration and long-run exchange rate volatility

Econometric theory tells us that a group of non-stationary time series are cointegrated if there is some linear combination of them that does not have a stochastic trend. In this case, a long-run relationship exists between these variables. This is an important implication for the trade flow literature, as the trade variables are likely to be non-stationary. If the measures of volatility are stationary, then they cannot appear in a long-run relationship as a determinant of trade. Based on this, the stationarity of the volatility series is clearly important in determining the likelihood of deriving any form of long-run systematic relationship between volatility and trade flows.

Most of the research in this area focuses on the short-run volatility but some papers have extended their time horizon and derived medium and long-run measures of exchange rate risk. This distinction may be important because international trading contracts are typically long term in nature, and firms generally do not know either the magnitude or the timing of their foreign exchange transactions with any degree of

certainty. As medium to long-run hedging instruments are infrequently available, importers and exporters are exposed to higher, and possibly unhedgable, exchange rate risk.

Peree and Steinherr (1989), as summarized in Section 4.2.3, found that the costs of medium term exchange rate uncertainty exceed those of the short term. Also the results of the medium term uncertainty for all countries tested, except the United States, show that exchange rate volatility has exerted a negative influence on trade. Asseery and Peel (1991) emphasised the importance of integrated non-stationarity of the variables employed in estimation by examining the impact of exchange rate volatility on exports, allowing formally for the potential non-stationarity of the variables for five countries, namely, Australia, Japan, United Kingdom, United States and West Germany over the period 1972 through to 1987. Various real exchange rate volatility measures were employed in this study. They specify a standard long-run relationship model between real exports, the level of real activity, competitiveness and exchange rate volatility as:

$$\ln X_t = \beta_0 + \beta_1 \ln W_t + \beta_2 \ln P_t + \beta_3 V_t \tag{43}$$

They carried out the standard unit root test to determine whether the variables were non-stationary and the results show that all variables for all countries, except for exchange rate volatility, were non-stationary, I(1). The measures of exchange rate volatility were found to be stationary. They then tested for cointegration between the non-stationary I(1) integrated variables and found that the variables are cointegrated at the normal levels of significance. Their empirical findings reported that the measures of exchange rate volatility have a significant impact on exports in all countries at either 10 or 5 % level of significance and for all countries, except the United Kingdom, they have a significant positive impact.

Asafu-Adjaye (1999) conducted an empirical investigation of the effects of an increase in real exchange rate variability on the exports growth in Fiji for the period 1981:1 through to 1997:6 using error correction and cointegration modelling techniques. The long-run equilibrium export demand function is specified as follows:

$$x_t = a_0 + a_1 y_t^f + a_2 P_t + a_3 e_t^* + a_4 S_t + v_t \quad (44)$$

where x_t is the logarithm of real exports; y_t^f is the logarithm of real foreign income; P_t is the logarithm of Fiji export prices relative to trade weighted foreign prices; e_t^* is the logarithm of the real effective exchange rate; S_t is a measure of exchange rate variability and v_t is an error term. The exchange rate volatility is proxied by the sample standard deviation of the growth rate of the real exchange rate.

Since the author employs the error correction and cointegration modelling techniques to test the long-run relationship between exchange rate variability and exports flows of Fiji, the author must conduct the test for non-stationarity of the variables used in the estimation. Once the variables are established to be integrated of the same order, the test for cointegration will be carried out. In this study, the author applied Augmented Dickey-Fuller (ADF) unit root test for stationary testing and Johansen's cointegration testing for cointegration relationships. The error correction model results, which represent the short-run effects, show that exchange rate volatility has a significantly negative impact on Fiji's exports flows. While the long-run effects of real exchange rate volatility has adverse impacts on Fiji's exports, the magnitude of the effect is not as significant as expected.

Vergil (2002) also employed the error correction and cointegration modelling techniques to investigate the impact of real exchange rate volatility on the exports flows of Turkey to the United States and its three major trading partners in the European Union (Germany, France and Italy) for the period 1990:1 through to 2000:12. Applying the traditional export demand function with an additional measure of exchange rate volatility, and using two measures of exchange rate uncertainty proxies, Vergil found that the long-run relationship between Turkey's real exports and its exchange rate volatility is negative and statistically significant for Germany, France and the United States. In addition, the exchange rate uncertainty has negative short-run effects on real exports to Germany. For the rest of the countries, the short-run impact of the exchange rate risk is statistically insignificant.

4.3.8 Estimation technique used

In considering the exchange rate volatility and trade flows relationship, there exists a variety of approaches that are well suited to the task at hand. One possibility is to examine data gathered over time or doing time series analysis (some studies are Hooper and Kohlhagen (1978), Cushman (1983), McKenzie and Brooks (1997) and Cheong (2004)). Another approach is to take a cross-sectional study and compare the level or rate of trade across countries at a given point of time (some examples are Bailey, Tavlas and Ulan (1987), Thursby and Thursby (1987), Peree and Steinherr (1989) and Baum, Caglayan and Ozkan (2001)). Finally, one could also examine the data using the pooled or panel data approach and some examples of work done in this manner are Klein (1990) and Dell'ariccia (1999).

By far the most popular estimation technique that has been employed by researchers both past and present, is the **Ordinary Least Squares (OLS)** regression analysis. OLS is frequently used due to its simple and straightforward estimation technique. Some studies which apply OLS regression analysis are Hooper and Kohlhagen (1978), Kenen and Rodrik (1986), Bini-Smaghi (1991), McKenzie and Brooks (1997), Dell'ariccia (1999) and Cheong (2004).

There is an econometric difficulty in investigating the systematic link between risks in exchange rates and international trade flows, because the data series of volatility in exchange rates are not directly observed and are thus measured in an indirect way. As discussed in Section 3, empirical researchers have applied many methods of measuring this volatility. Recently, use of the ARCH type models to generate the volatility has become a favourite amongst the researchers.[9] Estimating the structural equation by replacing the unobserved volatility with the measures proxy is called two-step procedure estimation. Even though applying the OLS method in this two

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[9] The popularity of ARCH models in measuring volatility stems from the models' usefulness in capturing non-constant, clustered time varying variance in higher moments which represents stochastic processes by which risk terms are generated.

step-procedure leads to consistent estimators, these do not have consistent covariance matrix and, as a result, are inefficient (Pagan (1984)). It means the standard errors of the OLS estimators are larger than those of conventional OLS estimators due to the composite error term involving noise in the auxiliary equation. This implies that the application of the test statistics based on conventional OLS estimation may be misleading, even in a large sample. Thus, to have statistically reliable inferences, the non-spherical covariance matrix of the OLS estimates in the second stage should be adjusted by taking account of time dependence and heteroskedasticity in error term. This is what was done by Cheong, Lu and Podivinsky (2004).

Cheong, Lu and Podivinsky (2004) investigated the effect of exchange rate risk on United States bilateral imports from the United Kingdom using monthly data that covers the period 1974:1 through to 2003:4 and employed the ARCH type models to generate exchange rate volatility. For their empirical estimation, instead of using the conventional OLS method, they applied the **OLS-based Generalized Method of Moments (GMM)** estimations of Newey and West (1987) method. This adjusts the non-scalar covariance matrix of OLS estimators in the second stage, mainly due to the generated regressor. By applying this approach, their empirical results indicated that volatility in the real US/UK exchange rate had a statistically significant negative impact on US imports from the UK.

Other estimation techniques commonly being used are the **ARCH and its subsequent generalisations type models**. These models, introduced by Engle (1982), pick up on the often observed characteristic that large shocks to the unpredictable component of returns tend to occur in clusters, and there seems to be an autoregressive nature to the shocks. So, Engle's ARCH process allows the conditional variance to vary over time driven by past shocks. This specification, together with its generalisations, has proved to be very popular amongst empirical researchers in recent years. A recent development in the ARCH literature has been the extension of the GARCH-in-mean model to a **multivariate (M-GARCH-in-mean)** framework. One possible application of this new class of ARCH model has been to determine the reduced form impact of exchange rate volatility on international trade. As mentioned in Section 4.2.3, Kroner and Lastrapes (1993)

apply the M-GARCH-in-mean estimation to study the relationship between exchange rate volatility and multilateral export volume and value for Germany, Japan, France, United States and United Kingdom over the period 1973 through to 1990 using monthly data. The results of this procedure indicate that the impact of exchange rate volatility seems largely confined to the price of exports rather than on the volume of trade, and that the direction of the impact differs across countries.

Caporale and Doroodian (1994) used a bivariate version of the M-GARCH-in-mean model to test if real exchange rate variability had an adverse effect on the value of United States imports from Canada over the period 1974:1 through to 1992:10. They used a GARCH (1,1) model to capture the time-varying conditional variance of the real exchange rate as proxy for exchange rate volatility. Their findings indicate that exchange rate volatility reduces the volume of trade and that the coefficients are statistically significant at the 1% level.

Vector Autoregression (VAR) estimation is frequently used by empirical researchers for modelling multivariate relationships in time series analysis. Two main advantages can be attributed to VAR. Firstly, VAR estimation can accommodate general dynamic relationships between variables that are considered an important factor in obtaining significant results. Secondly, VAR imposes no explicit theoretical restrictions between variables specified within the system. However, one disadvantage of the VAR technique is that, being a reduced form model, it cannot distinguish between structural hypotheses in general. Some studies that apply this estimation technique have been Koray and Lastrapes (1989), Lastrapes and Koray (1990), Chowdhury (1993), Law and Tan (2000), and Cheong, Mehari, Pattichis and Williams (2002).

Koray and Lastrapes (1989) tested United States bilateral trade flows to five industrialized countries over the period 1959 through to 1985 using a moving standard deviation measure to proxy volatility. Their empirical results suggested only a weak relationship between trade and volatility. Lastrapes and Koray (1990) again tested the trade flows of United States to five industrialized countries but this time used US multilateral trade flows and excluded the fixed exchange rate period from their analysis. Their results provide some evidence of a statistically significant

relationship, although quantitatively the effect is small compared to other variables included in the system.

VAR estimation requires that all variables in the equation are stationary. Even though one possible response to non-stationary data is to formulate the VAR in the first differences of the variables, such formulation provides no information on the relationship between the levels of the variables in the VAR. A satisfactory alternative would be when the variables in the equation are cointegrated. This means that if the variables in the equation are found to be non-stationary but cointegrated, then models that capture the short-run responses and the long-run relationships among the levels of the variables could be formulated using the **error correction model (ECM).** Apart from the studies discussed in Section 4.2.7, some studies that have applied ECM estimation are Arize (1996), Arize (1998), Bah and Amusa (2002, Das (2003) and Agolli (2004).

Another estimation that could be applied to investigate the long-run relationship between the variables when they are non-stationary and cointegrating, is the **autoregressive distributed lag (ARDL) critical bound** testing procedure generated by Pesaran, Shin and Smith (2001). Pesaran, Shin and Smith's (2001) ARDL critical bound approach allows testing for the existence of a long-run relationship which incorporates both I(1) and I(0) variables. The testing procedure is based on the F test and the adjusted critical values accommodate both I(1) and I(0) variables. Some studies that have applied this approach are Abbot, Darnell and Evans (2001) and de Vita and Abbott (2004).

Abbot, Darnell and Evans (2001) examined the impact of exchange rate variability on United Kingdom exports between 1973Q2 and 1990Q3 using quarterly data, and the standard deviation of the log percentage change in a UK nominal effective exchange rate index as the proxy for exchange rate volatility. They apply the ECM critical bounds testing and estimate the actual long-run elasticities using the ARDL equation, in which the lag structure is determined by the Akaike Information Criterion (AIC) or Schwarz Bayesian Criterion (SBC) (following Pesaran, Shin and Smith (2001). The results suggest that exchange rate variability had no significant

long-run influence on the demand for UK exports volumes over the sample period considered.

4.3.9 Countries specified

Since the early 1970s, most of the empirical studies investigating the impact of exchange rate volatility on international trade flows have centred on the experiences of developed countries in Western Europe and North America. This is due to the nature of economic developments and levels of economic openness of these developed countries, which immediately had to face the risks associated with higher exchange rate volatilities of a floating exchange rate regime during the early part of the post-Bretton Woods system. Moreover, the bulk of international trade is between developed countries, so it is appropriate for the focus to be on the impact of exchange rate volatility on international trade flows between these. However, even though many empirical studies have been conducted on the developed countries, there is no real consensus as to whether exchange rate volatility benefits or adversely affects trade flows.

Recently, several researchers have taken an interest in the impact of exchange rate volatility on international trade flows for the less developed countries. Studies of these developing countries are of potential importance because much of their real exchange rate uncertainty stems from macroeconomic policies. In addition, it is assumed that exchange rate uncertainty is more important in developing countries trade flows since financial markets for hedging currency risk are not well developed. However, the results from such studies do not unanimously agree with the negative relationship between exchange rate volatility and trade flows. Some studies on the developing countries are Arize (1996), Law and Tan (2000), Bah and Amusa (2002), Rahmatsyah, Rajaguru and Siregar (2002) and Das (2003).

Arize (1996) investigated the dynamic relationship between real exchange rate uncertainty and exports of South Korea using the multivariate cointegration and error correction techniques for the period 1973:1 through to 1991:4. Arize proxied

exchange rate volatility by constructing a moving sample standard deviation of the growth rate of the real effective exchange rate. His findings show that the effect of real exchange rate uncertainty on Korea's real exports is negative and statistically significant in the short-run as well as the long-run equilibrium.

Law and Tan (2000) analysed the impact of real exchange rate volatility of Malaysia's ringgit on Malaysian exports to its major trading partners, namely Singapore, United States and Japan from the period 1985 through to 1997. They employ the Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration approach to examine the long-run export demand function on the linkages among real exports, trade partner's income, relative export prices and exchange rate volatility. Besides this, they also investigated the short-run causality relationships within the vector error correction modelling framework. As for the measurement of exchange rate volatility, they applied the Engle (1982) ARCH model. Their findings indicate that all the four variables in the export demand function have a tendency to move together in the long-run. The short-run causality tests on the two sub-periods (1985-1990 and 1991-1997) reveal that there is no significant causality running from exchange rate volatility to the real exports during the first sub-period of low volatility. However, in the second sub-period of high volatility, it is found that exchange rate volatility causes the real exports in the case of the US and Japan with weak 10% significant level but no effects detected for the case of Singapore. For the impact of exchange rate volatility on the real exports, the results indicate that real exchange rate volatility has an adverse impact on the exports, except for the case of United States.

Bah and Amusa (2002) examined the impact of real exchange rate volatility on South Africa's export flows to its largest, single-nation trading partner, the United States, over the quarterly period 1990:1 through to 2001:4. In measuring exchange rate volatility of the South African rand against the US dollar, the authors employed the Engle (1982) ARCH model and estimated the export demand model using Johansen's multivariate cointegration procedure. The empirical results show that there exists a long-run relationship among the variables of the export function. The

findings of the exchange rate volatility exert significant and negative effects on South African's exports to the United States in both the long and short-run.

Rahmatsyah, Rajaguru and Siregar (2002) tested the impact of the exchange rate volatilities of Thailand's baht against the Japanese yen and the US dollar on the performance of the country's bilateral trades with two key partners: Japan and the United States. The study covers the period from the 1970s until the second quarter of 1997, using quarterly data. The authors generate both the nominal and real exchange rate series of exchange rate volatilities using moving average standard deviation of the growth rate of the exchange rate and the ARCH models. In order to test the relationship between exchange rate volatility and trade flows, the authors use ARDL estimation models. The empirical findings show several interesting results. Based on the four estimated coefficients of the exchange rate volatility index, exchange rate volatility has significantly and adversely affected Thailand's trades (exports and imports) with the Japanese market at both the 10 and 5 % significance levels. As for Thailand's trade to the US, the authors find no overall conclusive results from its exports to the US market though they find significantly negative impacts on Thailand's imports from the US.

Das (2003) studied the empirical relationship between exchange rate volatility and international trade flows of four developing economies of East Asian region, namely Indonesia, Malaysia, Thailand and Korea, all four of which were affected by the East Asian 1997 economic crisis. Das used quarterly data from the period 1980 through to 2001 and applied both the nominal and real exchange rate series of exchange rate volatilities using moving average standard deviation of the growth rate of the exchange rates. For his estimation, he applied the error correction model and cointegration techniques as well as pool regression techniques to achieve results on a group basis. Das also employed the standard long-run relationship model used by Gotur (1985), Asseery and Peel (1991) and Chowdhury (1993), as follows:

$$\ln X_t = \beta_0 + \beta_1 \ln Y_t + \beta_2 \ln P_t + \beta_3 V_t \tag{45}$$

where X_t is the real export volume, Y_t is a measure of real foreign activity, P_t represents the competitiveness measured by the relative export prices and V_t is a measure of exchange rate volatility. The empirical results show interesting findings. His test results indicate that there is a long-run relationship among all variables of the export function in all countries. As for the exchange rate volatility impact on the real exports volume, Das finds that real effective exchange rate volatility exert a significant negative effect on export demand in both the short and long-run period in all four countries under study. Finally, the panel data results of these four countries show a significant reduction in the exports volume when exchange rate volatility increases.

4.3.10 Conclusion

Reviewing the empirical studies lead us to conclude that the evidence on the effect of exchange rate volatility is mixed. Results of the different studies are difficult to compare since the framework of the studies vary widely in terms of the measurement of exchange rate volatility, types of exchange rates used, types of data gathered, countries included under study, model specification and estimation procedures. Overall, a larger number of studies appear to favour the conventional assumption that exchange rate volatility depresses the level of trade. However, there are also some evidences of a positive effect of volatility on international trade flows.

5 Exchange Rate Volatility and Equity Market

5.1 Introduction

Traditionally, the stock market and foreign exchange market have been regarded as sectors of the financial market where any policy changes are quickly reflected. Since

both markets have tremendous policy implications, a break in either or both markets tends to raise concern amongst policy makers. In view of this, the dynamic interrelationship between both markets has prompted researchers and policy makers (as well as analysts) to carry out detailed study of this relationship. Even though there is a lack of theoretical consensus on the relationship between foreign exchange rate volatility and stock prices, the interaction between stock prices and foreign exchange rates is often discussed in the literature. While traditional views are that exchange rate volatility affects stock prices, others suggest the opposite. On the empirical studies, the results are no less confusing. In general the results have shown feedback interaction as well as unidirectional causality from stock prices to exchange rate changes, and vice versa.

5.2 Theoretical models on the interaction between exchange rate volatility and stock prices

As mentioned earlier, there is no theoretical consensus on the interaction between exchange rates changes and stock prices. Classical economic theory, however, suggests that intermediate variables such as wealth, demand for money and interest rates play a vital role in establishing the relationship between exchange rate behaviour and stock market performance. The suggestion is derived from the theory about the determinants of exchange rate movements, which suggests that rates moved to clear the current account balance or responded to movements in relative money stocks. The exchange rates are determined in the short-run by conditions of asset-market equilibrium, in the same way as asset prices or interest rates, and in the long-run by real conditions affecting the current account. This integrated theoretical view is expressed in two models: flow-oriented and stock oriented model. The flow-oriented models suggest that exchange rate volatility could have positive or negative impact on stock prices depending on whether that firm is an exporting firm or a heavy user of imported inputs. The stock oriented models suggest that stock prices would lead the exchange rates with a negative relationship.

5.2.1 Flow-oriented and stock oriented models

The flow-oriented models of exchange rates determination (see example Dornbusch and Fisher (1980)) focus on the current account or the trade balance. This model hypothesizes that currency movements affect international competitiveness and balance of trade positions, and consequently the real output or income of the country, which in turn affects the current and future expected cash flows of firms and their stock prices. This is because many companies borrow in foreign currency to fund their operations.

Aggarwal (1981) has argued that a change in exchange rates could change the stock prices of multinational firms directly and those of domestic firms indirectly. In the case of a multinational firm, exchange rates fluctuation will change the value of that firm's foreign operation, which will be reflected on its balance sheet's as a profit or loss (depending on whether the foreign currency appreciates or depreciates in value). Consequently, the profits or losses will contribute to its current account's imbalances. Once the profit or the loss is announced, then that firm's stock prices will change. This argument shows that fluctuation in foreign currency could either raise or lower a firm's stock prices depending on whether that firm is an exporting firm or a heavy user of imported inputs, and on whether its transactions are denominated in home or foreign currency. However, if the firm is involved in both activities, its stock prices could move in either way. From this viewpoint, any change in exchange rate is expected to affect a change in the stock price. This causal relationship is known as traditional approach, or flow-oriented models.

An alternative model of exchange rate determination, stock-oriented models or portfolio-balance approach, (see Branson (1983)) contends that innovations in the stock market affect exchange rates via the capital account. This model is based on the notion that agents should allocate their entire wealth among domestic and foreign assets in their portfolio (including currencies). Hence, exchange rate plays the role of balancing the demand for, and supply, of assets. Under the assumption of the portfolio-balance approach, stock price is expected to lead exchange rate with a negative relationship. The central point of such a stock-oriented model or portfolio-approach balance lies in the following logical deductions: An increase in domestic

stock prices leads individuals to demand more domestic assets and to sell foreign assets, as they are relatively less attractive now. As a result, there is an appreciation of local currency due to an increase demand of domestic assets. Bahmani-Oskooee and Sohrabian (1992) also studied the effect that stock prices may have on the exchange rates. They stated that the resulting increase in the real balance will result in an increase in interest rates which would make the domestic financial assets become more attractive. As a result, investors will adjust their domestic and foreign assets portfolios by demanding more domestic assets. These adjustments will subsequently lead to an appreciation of the domestic currency as they will require domestic currency for these.

In addition, monetarist models of exchange rate determination propose that changes in domestic economic activities (proxies by stock returns) lead to changes in demand for real currency balances and consequently to changes in exchange rates (see Gavin (1989)). In particular, reflecting real economic activity, when stock prices increase investors demand for money would increase, which in turn raises the domestic interest rate. A higher interest rate will attract foreign capital, resulting in an appreciation of domestic currency. Solnik (1984) also contended that the stock price may be employed to reflect developments in macroeconomic variables, as it aggregates the market's expectations of real economic activities. Since the monetary models relate the exchange rates to the macroeconomic variables, changes in stock prices can have an effect on the exchange rates.

5.2.2 Micro and macroeconomic foundation

As well as looking at the traditional and portfolio approach of the economic theory between the relationship of exchange rates and stock prices, it is also useful to examine the microeconomic and macroeconomic theoretical foundations of the associations between exchange rates and stock prices. At the micro level, exchange rates volatility influences the portfolio value of both domestic and multinational companies. For example, it is predicted that if the real dollar exchange rate increases, companies' profits would fall, and so does the stock price (see examples Jorian

(1990) and Bodnar and Gentry (1993)). Accordingly, the relationship between exchange rates and stock prices can be specified as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{st} + \varepsilon_{it} \tag{46}$$

where R_{it} is the rate of return on the common stock of company i, R_{st} is the rate of change in a trade-weighted exchange rate and $t = 1,....,T$. However, the behaviour of the stock prices of domestic companies tends to differ from that of multinational companies. Thus, it is important to determine the relationship between exchange rate exposure and the degree of foreign involvement as follows:

$$\beta_{1i} = a_0 + a_1 F_i + \mu_i \tag{47}$$

where F_i is the ratio of foreign to total sales and $i = 1,....,N$. In addition, the foreign exchange exposure of stocks may be examined in an extended framework as follows:

$$R_{it} = \beta_{0i} + \beta_{1i} R_{st} + \beta_{2i} R_{mt} + \varepsilon_{it} \tag{48}$$

where R_{mt} is the return on the domestic stock exchange accumulation index in month t.

At the macro level, the main scenarios relate to the relationship between aggregate stock prices and the floating value of the exchange rate. It is predicted that a negative relationship exists between the strength of the home currency and the aggregate stock prices index, given by:

$$Ds_t = \alpha + \beta DRS_t + \gamma Di_t + \varepsilon_t \tag{49}$$

where Ds_t is the change in the real exchange rate, DRS_t is the real stock return differential (domestic minus foreign) and Di_t is the change in interest rate differential. This specification may be sensitive to the exchange rate regime in force. For example, economic theory suggests that under a floating exchange rate regime, exchange rate appreciation reduces the competitiveness of export markets. This, therefore, has a negative effect on the domestic stock market. Conversely, for an

import denominated country, exchange rate appreciation lowers input costs and generates a positive impact on the stock market. Thus, in a macroeconomic framework, including other macro variables in the model can best capture the relationship between exchange rates and stock prices. Following Smith (1992), a broad model is specified as follows:

$$E_{ug} = \alpha_0 + \alpha_1 E_{uj} - \alpha_2 R_{gu} + \alpha_3 R_{ju} + \alpha_4 S_g + \alpha_5 S_j + \alpha_6 S_u$$

$$+\alpha_7 A_g + \alpha_8 A_j + \alpha_9 A_u + \alpha_{10}(A_g - A_g^{g(D)}) - \alpha_{11} CCAS^g \qquad (50)$$

$$E_{uj} = \beta_0 + \beta_1 E_{ug} + \beta_2 R_{gu} - \beta_3 R_{ju} + \beta_4 S_g + \beta_5 S_j + \beta_6 S_u$$

$$+\beta_7 A_g + \beta_8 A_j + \beta_9 A_u + \beta_{10}(A_j - A_j^{j(D)}) + \beta_{11} CCAS^j \qquad (51)$$

where E_{ug} = US-German exchange rate; E_{uj} = US-Japanese exchange rate; $CCAS^g$ = the German current account surplus; $CCAS^j$ = the Japanese current account surplus; R_{gu} = the German-US interest rate differentials; R_{ju} = the Japanese-US interest rate differentials; S_j, S_u, S_g = the Japanese, US and German equity values, respectively; A_j, A_u, A_g = the Japanese, US and German bond values, respectively; $A_g^{g(D)}$ = the debt of the German government and $A_j^{j(D)}$ = the debt of Japanese government.

5.2.3 Conclusion

In considering the flow and stock-oriented models and the micro and macro levels, there is no overall theoretical consensus on the relationship between exchange rates volatility or exchange rates values and stock prices. However, classical economic theory suggests that intermediate variables could be employed in establishing the relationship between the exchange rate behaviour and the stock market performance.

5.3 Empirical studies on the interaction between exchange rate volatility and stock prices

Empirically, there are quite a number of studies that attempt to determine the impact on stock prices of exchange rates changes. The findings, however, are not uniform across the various studies. Some studies documented positive effects of exchange rate changes on the stock market (Aggarwal (1981), Fang and Miller (2002)), while others found negative effects (Soenen and Hennigar (1988), Chiang, Yang and Wang (2000)) and yet other studies concluded that exchange rate volatility has no significant impact on the stock market (Solnik (1984). Besides investigating the impact of exchange rate volatility on the stock prices, previous studies also examine the interactions between the exchange rate changes and stock prices. The findings also revealed that the interactions between exchange rate volatility and stock prices are inconsistent. We will discuss these two issues below.

5.3.1 Impact of exchange rate volatility on stock prices

5.3.1.1 Positive impact

As mentioned earlier, the impact of exchange rate volatility on stock prices is not uniform. Some examples which revealed positive relationship between exchange rate volatility and stock prices are Aggarwal (1981) and Fang and Miller (2000). Aggarwal (1981) was first to examine the relationship between stock prices and the floating value of the US dollar. He employed monthly data for the period 1974 through to 1978, when in examining the relationship between US stock market indexes and a trade-weighted value of the dollar. He found that US stock prices are positively related to exchange rate volatility as well as to the exchange rates values. His results are in agreement with the theories of exchange rate determination, stating a positive association between economic activity and the exchange rate.

Aggarwal argued that changes in exchange rates could change stock prices of multinational firms directly, and those of the domestic firms indirectly. He said that depreciation of currency value could either raise or lower a firm's stock price

depending on whether that firm is an exporting firm or a user of imported inputs. If its activities involved both, then its stock prices could move in either direction. This is true, especially when most stock prices are aggregated to determine the effects of currency depreciation on stock markets. From this viewpoint, the exchange rate is expected to give rise to stock price change.

Fang and Miller (2000) consider the structural shifts in volatility of stock and foreign exchange markets using Korean data during the Asian financial crisis in order to provide more evidence for the effects of currency depreciation on stock market returns. They applied a bivariate GARCH-M model using data from the daily closing Korea Composite Price Index and the exchange rates from January 3, 1997 to December 21, 2000. Their bivariate GARCH-M model framework is as follows:

$$R_t = d_0 + \sum_{i=0}^{n} a_i E_{t-i} + \sum_{i=0}^{n} b_i h_{E,t-i} + \sum_{i=0}^{n} c_i h_{R,t-i} + \sum_{i=1}^{n} d_i R_{t-i} + \varepsilon_{R,t} \qquad (52\text{ a})$$

$$E_t = \omega_0 + \omega_1 E_{t-1} + \varepsilon_{E,t} \qquad (52\text{ b})$$

$$\varepsilon_{R,t} = v_{R,t}(h_{R,t})^{0.5} \qquad (52\text{ c})$$

$$\varepsilon_{E,t} = v_{E,t}(h_{E,t})^{0.5} \qquad (52\text{ d})$$

$$h_{R,t} = \alpha_0 + \alpha_1 \varepsilon_{R,t-1}^2 + \alpha_2 h_{R,t-1} + \alpha_3 D_t \qquad (52\text{ e})$$

$$h_{E,t} = \beta_0 + \beta_1 \varepsilon_{E,t-1}^2 + \beta_2 h_{E,t-1} + \beta_3 D_{1,t} + \beta_4 D_{2,t} \qquad (52\text{ f})$$

$$h_{RE,t} = \gamma_0 + \gamma_1 \varepsilon_{R,t-1}\varepsilon_{E,t-1} + \gamma_2 h_{RE,t-1} \qquad (52\text{ g})$$

where R is the stock market return; E is the depreciation rate or the exchange rate return; $v_{R,t}$ and $v_{E,t}$ are i.i.d. with constant mean and unit variance; $h_{R,t} = Var(\varepsilon_{R,t})$ and $h_{E,t} = Var(\varepsilon_{E,t})$; $h_{RE,t} = Cov(\varepsilon_{R,t}, \varepsilon_{E,t})$; $\varepsilon_{R,t}$ and $\varepsilon_{E,t}$ are assumed to be white noise stochastic processes. The term D in Equation (52 e) is the dummy variable with value 1 for the period October 24, 1997 to the end of December 2000 and 0 otherwise. The term D_1 and D_2 in Equation (52 f) are two dummies: $D_t = 1$ for the

period October 24, 1997 to August 21, 1998; 0 otherwise, and $D_2 = 1$ for the period August 22, 1998 to December 21, 2000; 0 otherwise, respectively.

Their results revealed that exchange rate volatility has a positive relationship with stock market returns, i.e. higher volatility induces higher stock market returns. Exchange rate volatility is also found to have a positive impact on stock market return volatility. Besides that, their findings also confirmed that the exchange rate adversely affects stock market returns. Their evidence suggests that small open stock markets are vulnerable to exchange rate movements.

5.3.1.2 Negative impact

Some studies inferring exchange rate volatility has a negative impact on stock prices are Soenen and Hennigar (1988), Chiang, Yang and Wang (2000) and Doong, Yang and Wang (2005). Soenen and Hennigar (1988) conducted a similar study to Aggarwal (1981) but with a different time frame. They too employed monthly data of US stock indexes (New York Stock Exchange Index and Standard & Poor's 500 Stock Index) and a fifteen currency-weighted value of the dollar for the period 1980-1986 in order to investigate how exchange rate changes of the US dollar affect US stock prices. The monthly percent changes in each of the two stock market indexes were regressed against the concurrent changes in the effective exchange rate of the US dollar. They hypothesized that a negative long-run relationship should exist between the strength of the home currency and stock prices. Their results revealed that exchange rate changes in the US dollar have a negative relationship with stock prices. Therefore their hypothesis, that a negative long-run relationship should exist between the strength of the home currency and stock prices, cannot be rejected.

Chiang, Yang and Wang (2000) adopted the same approach as Fang and Miller (2000), i.e. using the bivariate GARCH-M model to analyse individual national stock returns in Asian countries and their interaction to the foreign exchange rates changes. They employed daily data for the period January 1, 1990 through to February 10, 1998 from the stock market indexes and exchange rates for Taiwan, Hong Kong,

South Korea, Singapore, Malaysia, Philippines, Indonesia, Thailand, Japan and the United States. Their estimated results suggest that exchange rate volatility has a negative and statistically significant relationship with stock prices, meaning that stock returns are positively correlated with the appreciation of the home currency. Currency appreciation induces higher stock returns. One possible explanation is that an appreciation of the home currency signifies the strength of the home currency and thus an optimistic perspective in the stock market. Their findings also conclude that the regional and world factors proxied by Japanese and US stock returns respectively, have a positive effect on Asian stock returns, although the lag length varies from country to country.

Doong, Yang and Wang (2005) also found a significantly negative relationship between stock returns and change in exchange rates in their study of the dynamic relationship and pricing between stocks and exchange rates for six Asian emerging financial markets. They concluded that currency value has a positive effect on stock price. The six Asian financial markets are Indonesia, Malaysia, Philippines, South Korea, Thailand and Taiwan. Weekly exchange rates and stock indexes from 6 January, 1989 to 3 January, 2003 are employed in this study and the bivariate GARCH-M model is applied to investigate the relationship and pricing between stock prices and exchange rates.

Finally, there also some studies which reveal positive and negative relationships between exchange rate changes and stock prices. Such examples are Solnik (1987) and Bodnar and Gentry (1993). Solnik (1987) had regressed changes in the real exchange rate of US dollar on the real stock returns, as an indicator of changes in the economic activities of the United States, from the period 1973 through to 1983. He separates the study into two periods: 1973 to October 1979 and October 1979 to 1983. In the first period, he found a negative relationship. This indicates that a real appreciation of the US dollar reduces the United States' competitiveness due to a higher relative price, and this is bad for the domestic economy. However, in the second period, he found a weak positive relationship between real stock returns and changes in the real exchange rates. This result supports the idea that anticipated real growth has a positive influence on the exchange rate. Bodnar and Gentry (1993)

explored the relationship between the exchange rate changes and stock returns by modelling exchange rate changes as a function of industry characteristics. Their results indicate that industry export ratios are associated with negative exchange rate exposures and industry import ratios are associated with positive exposures. These show that the relationship between exchange rate exposure and industry characteristics is consistent with economic theory.

5.3.2 Interactions between exchange rate volatility and stock prices

While past studies provide empirical evidence on the relation between stock returns and exchange rates, the issue of interactions between the two variables have not been rigorously established. The regression models used in previous studies have been based on implicit assumptions that some unspecified causal relations exist between stock returns and changes in exchange rates. The knowledge of causal relations between stock and currency markets and the degree of their integration are important information for international investors, multinational companies and policy makers. We now discuss the interactions between exchange rates changes and stock prices in terms of cointegration and causal relationship, as well as impulse response and variance decomposition relationship.

5.3.2.1 Cointegration relationship

Apart from investigating the relationship between exchange rates change and stock prices, empirical studies in the past have also looked at the cointegration relationship between exchange rate volatility and stock prices. Amongst the studies are Abdalla and Murinde (1997), Ibrahim (2000), Phylaktis and Ravazzolo (2000) and Smyth and Nandha (2003). The results of the cointegration relationship are also inconsistent.

Abdalla and Murinde (1997) investigated the cointegration relationship between foreign exchange market and stock market in the emerging financial markets of

India, Korea, Pakistan and the Philippines over the 1985:01 to 1994:07 period. They applied the two-step cointegration procedure suggested by Engle and Granger (1987). On the basis of the results that they obtained from the cointegration tests, they conclude that there is cointegration between the stock price index and the effective exchange rate in India and the Philippines and no cointegration in Korea and Pakistan financial markets.

Ibrahim (2000) studied the stock price and exchange rate interactions in Malaysia that span from January 1979 to June 1996. Unlike previous studies, he employed three alternative measures of exchange rates. He examined the interactions in bivariate and multivariate contexts. The latter approach was intended to reduce the potential omitted variable bias that may arise in the bivariate case. To test for the cointegration, Ibrahim used the residual-based test of Engle and Granger (1987) and the VAR-based tests of Johansen (1988) and Johansen and Juselius (1990). His findings show that in the bivariate framework there is no cointegration between various measures of exchange rates and stock prices when both tests are used. However, in the multivariate framework, no cointegration is found when the Engle and Granger (1987) test is used but there is cointegration when the Johansen (1988) and Johansen and Juselius (1990) test is applied.

Both the Engle-Granger two-step and Johansen cointegration methods are utilized by Smyth and Nandha (2003) when examining the cointegrating relationship between exchange rates changes and stock prices in Bangladesh, India, Pakistan and Sri Langka using daily data over a six-year period from 1995 to 2001. Based on both cointegration methods, their estimations conclude that there is no cointegrating relationships or long-run equilibrium between exchange rate changes and stock prices in any of the four countries. Doong, Yang and Wang (2005) also found that stock prices and exchange rate changes are not cointegrated in the six Asian financial markets in their study (Indonesia, Malaysia, Philippines, South Korea, Thailand and Taiwan).

Another study which revealed inconsistent cointegration relationships between exchange rate volatility and stock prices is that done by Phylaktis and Ravazzolo (2000) through application of the analysis to a group of Pacific Basin countries

(Hong Kong, Indonesia, Malaysia, Singapore, Thailand and Philippines) over the period 1980 through to 1998. Their objective was to examine the impact of stock markets liberalisation on foreign exchange and stock markets by considering liberalisation as relaxing currency restrictions. In doing so they divided the sample period into pre- and post-liberalisation sub-periods and employed bivariate and trivariate cointegration approaches using the Johansen cointegration testing. The trivariate (or multivariate) framework is also applied to reduce the omitted variables biasness. Their bivariate and trivariate models are as follows, respectively.

$$P_t^{PBC} = \alpha_0 + \alpha_1 S_t^{PBC} + v_t \tag{53}$$

and

$$P_t^{PBC} = \alpha_0 + \alpha_1 S_t^{PBC} + \alpha_2 P_t^{US} + v_t \tag{54}$$

where P_t^{PBC} is the domestic stock prices, S_t^{PBC} is the real exchange rate defined as domestic prices relative to foreign prices multiplied by the nominal exchange rate, P_t^{US} is the US stock price and v_t is the disturbance term.

The results for their bivariate case using the Johansen trace statistic (corrected with Reimers (1992) for small sample bias) revealed that no cointegration relationships could be found, either for the first or second sub-period for all the countries except Hong Kong in the second sub-period. In the trivariate case, the researchers found no cointegrating vectors in the first sub-period for any of the countries, but the results for the second sub-period show that there is one cointegrating vector in all the countries under study. When further testing for the long-run cointegrating vector for the second sub-period, they found that the real exchange rate is positively related to the domestic stock market.

Granger, Huang and Yang (2000) applied the recently developed cointegration models to determine the appropriate Granger relations between exchange rate volatility and stock prices in the Asian financial markets. The markets included in the study are Hong Kong, Malaysia, Singapore, Thailand and Taiwan. In order to better dissect the relations between exchange rates and stock prices they divided the sample

period into three sub-periods and applied the Gregory and Hansen (1996) model to establish the cointegration relationship between the two variables when the sample period includes some major events such as oil shocks or stock market crashes. The sample periods are as follows: Period 1 (1987-Crash period) sub-periods that started from January 3, 1986 to November 30, 1987; Period 2 (after-crash periods) sub-periods that started on December 1, 1987 and ended on May 31, 1997 and Period 3 (the Asian-Flu period) sub-periods that started on June 1, 1997 and ended on June 16, 1998.

Gregory and Hansen (1996) revised the Engle and Granger (1987) model to consider the regime shift via a residual-based cointegration technique. Their model is a two-stage estimation process of which the first step is to estimate the following multiple regressions:

$$y_{1t} = \alpha + \beta t + \gamma DU_t(\lambda) + \theta_1 y_{2t} + e_t \tag{55}$$

where y_{1t} and y_{2t} are of I(1) and y_{2t} is a variable or a set of variables and $DU_t(\lambda) = 1$ for $t > T\lambda$, otherwise $DU_t(\lambda) = 0$. And $\lambda = T_B / T$ where T_B is the date when the structural break occurred and T is the sample size. The second step is to set if e_t in Equation (55) is of I(0) or I(1) via the ADF or Phillips-Perron technique. If e_t is found to be consistent with I(0), we could say that cointegration exists between y_{1t} and y_{2t}. Based on their estimations using the Gregory and Hansen model, they conclude that there is no cointegration relationships found between the two variables in any of the countries under study.

5.3.2.2 Causality relationship

The empirical studies on the interactions between exchange rate volatility and stock prices have also looked in terms of the causality between these two variables. Again, the causality relationships are found to be inconsistent. Some studies found causality effects run from exchange rate volatility to stock prices (e.g. Abdalla and Murinde (1997) and Smyth and Nandha (2003)); some results showed causality running from

stock prices to exchange rate volatility (e.g. Ajayi, Friedman and Mehdian (1998) and Hatemi-J and Roca (2005)); some researches revealed that there is a feedback interaction, meaning either variable can take the lead (e.g. Ibrahim (2000) and Caporale, Pittis and Spagnolo (2000)) while yet others concluded that there is no causality between exchange rates volatility and stock returns (e.g. Granger, Huang and Yang (2000) and Mishra (2004)).

5.3.2.2.1 Causality from exchange rate volatility to stock prices

In studying the causal relationship between exchange rate volatility and stock prices in financial markets of India, Korea, Pakistan and Philippines, Abdalla and Murinde (1997) applied Granger (1969) causality testing using the bivariate VAR model. Granger's (1969) causality approach is used because it is simple and straightforward. At the same time, the existence of causal ordering in Granger's estimation, points to a low of causation and implies predictability and exogeneity. Based on Granger's definitions, their BVAR models are as follows:

$$EX_t = \sum_{j=1}^{m} \alpha_j EX_{t-j} + \sum_{j=1}^{n} \beta_j SP_{t-j} + \varepsilon_t \tag{56}$$

$$SP_t = \sum_{j=1}^{m} c_j EX_{t-j} + \sum_{j=1}^{n} d_j SP_{t-j} + \mu_t \tag{57}$$

where $EX =$ exchange rate variable; $SP =$ stock price variable; and ε_t, μ_t are assumed to be serially uncorrelated with zero mean and finite covariance matrix. In this context, four definitions of Granger's (1969) causality effects are: unidirectional causality from EX to SP; unidirectional causality from SP to EX, feedback causality between EX and SP; and independence between EX and SP.

Abdalla and Murinde (1997) applied standard Granger causality testing in the case of Korea and Pakistan, since they had found earlier that the variables in these countries are not cointegrated. For India and the Philippines, since the variables are cointegrated, they applied the VECM Granger causality approaches. This was

because, in these two countries, the Granger representation theorem implies that SP_t and EX_t may be generated by an ECM. It has been confirmed elsewhere that Granger causality tests are misspecified if they are applied in a standard VAR form to differenced data for cointegrated variables (see MacDonald and Kearney (1987) and Miller and Russek (1990)). Based on their estimation results, they concluded that there is a unidirectional causality running from exchange rate volatility to stock prices in all the sample countries - except the Philippines. These findings suggested that respective governments should be cautious in their implementation of exchange rate policies because such policies have impacts on their stock markets.

Smyth and Nandha (2003) also utilized the BVAR Granger causality model for their study of the financial markets in Bangladesh, India, Pakistan and Sri Lanka. Their Granger causality estimations revealed that there is a unidirectional causality running from exchange rate changes to stock prices only in the case of India and Sri Lanka. Hatemi-J and Roca (2005) examined the links between exchange rates and stock prices in Malaysia, Indonesia, Philippines and Thailand for the periods immediately before and during the 1997 Asian financial crisis. To investigate the causal relationship between these variables, they followed VAR model of order p, VAR(p), to allow for the dynamic interaction between the variables, and applied the Toda and Yamamoto (1995) test statistics for tests of causality. The Toda and Yamamoto (1995) test statistics are used to reduce the biasness when the variables in the model are integrated.

Toda and Yamamoto (1995) augmented $VAR(p+d)$ model for testing of causality if the variables are integrated is as follows:

$$y_t = v + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \ldots + A_{p+d} y_{t-p-d} + \varepsilon_t \qquad (58)$$

where y_t, v and ε_t are $n-$dimensional vectors (n is the number of variables in the model) and A_r is an $n \times n$ matrix of parameters for lag r. p is the optimal lag order and d is equal to the integration order of the variables. The f th element of y_t does not Granger cause the j th element of y_t if the following hypothesis is not rejected:

$$H_0: \text{the row } j\text{, column } f \text{ element in } A_r \text{ equals zero for } r = 1,\ldots,p_t \tag{59}$$

Hatemi-J and Roca (2005) found that during the period before the crisis, except for the Philippines, exchange rates and stock prices are significantly related in Malaysia, Indonesia and Thailand. The direction of causality is from foreign exchange rate changes to stock prices in the case of Indonesia and Thailand and so stocks could be used as a hedge for foreign exchange investments since any movement in exchange rates Granger causes stock prices.

Another study that found one causal directional effect running from exchange rate changes to stock prices is a study done by Granger, Huang and Yang (2000). As mentioned in section 5.3.2.1 above, because they did not find cointegration relationships in the variables, they applied the bivariate VAR model to test the Granger causality effects between exchange rate volatility and stock prices. Their findings revealed the following results. They found a causality effect running from exchange rate changes to stock returns only in the case of Singapore in the Period 1 and Period 2 sub-periods; and in Republic of Korea only in the period 3 sub-periods.

5.3.2.2.2 Causality from stock prices to exchange rate volatility

In the Hatemi-J and Roca (2005) study discussed above, during the period before the crisis, they also found a unidirectional causality effect running from stock prices to the exchange rate changes in the case of Malaysia. Here they concluded that foreign exchange could be used to hedge investments in the stock market, since any movement in stock prices Granger causes exchange rates. In the study done by Abdalla and Murinde (1997), applying the VECM Granger causality approaches in cases where the variables are integrated, revealed different results in each of the countries under study. Whereas in India, Korea and Pakistan they found a unidirectional causal effect from exchange rate volatility to stock prices, in the case of the Philippines, they found unidirectional causality from stock prices to exchange rate changes.

The results of Abdalla and Murinde (1997) are supported by Granger, Huang and Yang (2000), who also found causality effect runs in one direction from stock prices to exchange rate volatility in the Philippines. Besides the Philippines, in their Period 3 (the Asian-Flu period) sub-periods, their results also indicated a causality effect from stock prices to exchange rate volatility in Hong Kong. For the results of their Period 2 (after-crash periods) sub-periods, they also found a unidirectional causal effect from stock prices to exchange rate changes in Hong Kong and Taiwan.

Apart from looking at the cointegration relationships, Ibrahim (2000) also investigated the causal relationship between exchange rate volatility and stock returns. As mentioned earlier, he employed three alternative measures of exchange rates and examined the interactions in bivariate and multivariate contexts. The three measures are real effective exchange rates, nominal effective exchange rates and bilateral RM/US$ dollar exchange rates. Ibrahim found that the results of the causality in the bivariate and multivariate framework depend on which exchange rate measure is used. In both regressions, the results revealed that there is a unidirectional causality effect running from stock prices to exchange rate changes when real and nominal effective rates are being used.

Ajayi, Friedman and Mehdian (1998) studied the interactions between exchange rate volatility and stock returns for seven advanced markets (Canada, Germany, France, Italy, Japan, United Kingdom and United States) and eight Asian emerging markets (Taiwan, Korea, Philippines, Malaysia, Singapore, Hong Kong, Indonesia and Thailand) from the period covering April 1985 through to August 1991. They applied the daily and weekly data of stock market indexes and the exchange rate of each country while excluding the data for October 1987 in order to avoid the effects of the stock market crash which occurred in that period. They applied the bivariate Granger causality approaches in their estimations. For the advanced markets scenarios, they found significant causality effects from stock returns to exchange rate volatility in all the advanced markets when daily and weekly data are applied in the regressions. As for the emerging Asian markets, they also found unidirectional effects from stock returns to exchange rate changes in Indonesia and the Philippines when daily data is employed, and in Thailand and Malaysia when weekly data is used instead.

5.3.2.2.3 Feedback interactions between exchange rate volatility and stock prices

As mentioned above, Ibrahim (2000) has shown that causality effects between exchange rate volatility and stock prices depend on the measures of exchange rate applied in the regression. In both the bivariate and multivariate estimations, Ibrahim found bi-directional causality or feedback interactions between exchange rates and stock prices when bilateral RM/US$ exchange rates are utilized. In the Ajayi, Friedman and Mehdian (1998) study, they also found one country with feedback interactions between exchange rate changes and stock prices when the daily data is applied, that is, in Taiwan. The Granger, Huang and Yang (2000) results supported the findings of Ajayi, Friedman and Mehdian (1998) and Ibrahim (2000) in the case of both Taiwan and Malaysia. Besides finding the feedback interactions in Taiwan and Malaysia, Granger, Huang and Yang (2000) also found similar results in the case of Singapore and Thailand in their period 3 sub-periods study.

Another study which supported the findings of the bi-directional causality effects is one by Doong, Yang and Wang (2005). These researchers also examined the financial markets in the emerging Asian markets, and their results based on the Granger causality tests shown that bi-directional causality effects can be detected in the Indonesian, Korean, Malaysian, and Thai markets. Another Asian financial markets' study is done by Caporale, Pittis and Spagnolo (2000), where they examined the relationships between stock prices and exchange rates in six East Asian countries (Malaysia, South Korea, Thailand, Philippines, Indonesia and Japan) using daily data from the period January 1, 1987 through to January 20, 2000. They split the sample for Malaysia and Indonesia into pre- and post-1997 financial crisis. For Malaysia, the pre-crisis period is from January 1, 1987 through to July 20, 1997 and post-crisis from July 21, 1997 through to January 20, 2000. For Indonesia, the pre-crisis period is from January 1, 1987 through to October 1, 1997 and post-crisis from October 2, 1997 through to January 20, 2000. However, the sample data of the other four countries was not split in this way.

They utilized Cheung and Ng's (1996) two-stage procedure test for causality-in-variance model. According to Cheung and Ng (1996), X_t is said to cause Y_t in variance if for some t

$$E\left((Y_{t+1}-\mu_{y,t+1})^2 \middle| \Omega_t\right) \neq E\left((Y_{t+1}-\mu_{y,t+1})^2 \middle| \Omega_t \setminus \{X_s | s \leq t\}\right) \tag{60}$$

$$E\left((Y_{t+1}-\mu_{y,t+1})^2 \middle| \Omega_t \cup \{X_{t+1}\}\right) \neq E\left((Y_{t+1}-\mu_{y,t+1})^2 \middle| \Omega_t\right) \tag{61}$$

where X_t and Y_t are two stationary time series with Ω_t containing all available information up to time t. $\Omega_t \setminus \{X_s | s \leq t\}$ denotes the set of elements of Ω_t that are not in $\{X_s | s \leq t\}$ and $\mu_{y,t+1}$ is the mean of Y_{t+1} conditioned on Ω_t. If Equation (60) is not true, Y_t is not caused by X_t and if Equation (61) does not hold, then Y_t is not caused instantaneously by X_t. If X_t causes Y_t and Y_t causes X_t, then $Z_t' = (Y_t', X_t')$ is a feedback system[10]. Based on the causality-in-variance results, they concluded that there is a feedback interaction in the variance in the case of Japan, Korea, Philippines and the post-crisis samples of Indonesia and Malaysia.

5.3.2.2.4 No causality effect between exchange rate volatility and stock prices

There are some empirical studies which reveal no causality effect between exchange rate volatility and stock prices. Ajayi, Friedman and Mehdian (1998) found no causality effect between exchange rate volatility and stock prices in all six emerging Asian countries when they utilized weekly data in their study. A similar conclusion was reached when they utilized daily data, since four of the six countries (Hong

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[10] See Cheung, Y-W, and Lillian K. Ng, 1996, A causality-in-variance test and its application to financial market prices, *Journal of Econometrics* 72, 33-48. for a more detailed discussion on this model

Kong, Singapore, Thailand and Malaysia) show no causality relationship between exchange rate changes and stock prices. We have mentioned above that, in their study, Hatemi-J and Roca (2005) found causality relationships between exchange rate volatility and stock returns during the period prior to the Asian financial crisis in Malaysia, Indonesia, Philippines and Thailand. However, during the crisis period, they inferred that this relationship ceased to exist in any of the countries under study. They assumed that these scenarios could mean that the foreign exchange and stock markets became segmented, or the transmission of information between the two markets became efficient during the crisis period.

The findings from the Granger, Huang and Yang (2000) study seem to contradict the findings of the Hatemi-J and Roca (2005) study, with regards to the Asian financial markets (Malaysia, Indonesia, Philippines and Thailand). Whereas Hatemi-J and Roca (2005) found no cointegration relationships between exchange rate changes and stock prices in these countries during the crisis periods and cointegration relationships in the periods before the crisis, Granger, Huang and Yang (2000) found the opposite. Granger, Huang and Yang (2000) found little or no causality in these four countries during the period before the crisis, though the contradiction in the results could be due to different approaches in estimating the causality relationship. Granger, Huang and Yang (2000) applied the models developed by Gregory and Hansen (1996), whereas Hatemi-J and Roca (2005) applied the Toda and Yamamoto (1995) test statistics for test of causality.

Other past studies which found no evidence of causality running either way between exchange rate volatility and stock prices are those done by Smyth and Nandha (2003) and Caporale, Pittis and Spagnolo (2000). Based on their estimations, Smyth and Nandha (2003) found that exchange rate changes and stock returns in Bangladesh and Pakistan are independent; while Caporale, Pittis and Spagnolo (2000) found the variables are independent in Thailand and pre-crisis samples in Indonesia and Malaysia. Mishra (2004) did a study on the relationships between stock market and foreign exchange market in India. He employed the Granger causality test and VAR technique on monthly data for the period April 1992 through to March 2002. For the

full sample period, the results suggest that there is no Granger causality between stock prices and exchange rates changes in the Indian financial markets.

5.3.2.3 Impulse response and variance decomposition relationship

In investigating the causal relationship between exchange rate volatility and stock prices, the majority of previous studies confirm the traditional results, i.e. exchange rate changes lead stock returns. However, these studies do not discuss the sign of the causality between exchange rate changes and stock prices. To the best of our knowledge, there are not many studies which do. Examples of studies which do include this discussion are Granger, Huang and Yang (2000) and Mishra (2004).

In their study of the bivariate causality between stock prices and exchange rates in emerging Asian financial markets during the Asian financial crisis, Granger, Huang and Yang (2000) employed impulse response functions to explore the signs and the dynamics between exchange rates and stock prices. The impulse response function is used to trace out the effect of a one-time shock to one of the innovations on current and future values of the endogeneous variables. It shows the dynamic response of all the variables in the system to a shock or innovation in each variable. If the innovations ε_t are contemporaneously uncorrelated, interpretation of the impulse response is straightforward. The i-th innovation $\varepsilon_{i,t}$ is simply a shock to the i-th endogeneous variable $y_{i,t}$. Innovations, however, are usually correlated, and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation P to the innovations so that they become uncorrelated:

$$v_t = P\varepsilon_t \sim (0, D) \tag{62}$$

where D is a diagonal covariance matrix.

Since using monthly data may not be adequate in describing the effect of capital movement, which is intrinsically a short-run occurrence, Granger, Huang and Yang

(2000) employed daily data of the emerging Asian markets in the hope that it would capture such effects. Based on their impulse response functions results, which calculated the standard deviation for each forecasting period, they observed several distinguishing patterns within the nine emerging economies in Asia. Firstly, one-unit shocks from the exchange rates lead to negative responses of stock prices. Secondly, for most countries, the stock market seems to lead foreign exchange market, and feedback interaction did exist during the crisis periods.

As well as using the Granger causality test to examine the relationship of stock market and foreign exchange market in India, Mishra (2004) also utilized the impulse response functions and variance decomposition technique. Based on his analysis of the impulse response functions, even though the results revealed that stock prices and the change in exchange rates in India are interrelated with each other, the relationships go either way. Analysis based on the forecast error variance decomposition technique, revealed that exchange rate changes affects stock returns in India.

5.3.3 Disaggregated studies on the relationship between exchange rate volatility and stock prices

The majority of previous studies of the relationship between exchange rate volatility and stock prices focused on aggregate data. As far as we know, not many studies utilized disaggregated data in their investigations. Disaggregated studies, either in terms of sectors, industries or markets, are important because exchange rate fluctuation can have a substantial impact on the profitability of companies in different sectors, industries or markets. Exchange rate volatility may change the terms of competition with foreign firms for domestic exporters and import competitors; alter input prices for industries that use internationally-priced inputs or companies that import for resale and change the value of foreign currencies' denominated assets. Moreover, a sectoral focus is useful because exchange rate changes may affect industries differently, either because some industries are more exposed to exchange rate risk than others or because industries react differently to

exchange rate risk. Examples studies utilizing disaggregated data are Soenen and Hennigar (1988) and Bodnar and Gentry (1993).

As mentioned earlier in section 5.3.1.2., Soenen and Hennigar (1988) studied the relationship between changes in the value of US dollar and corresponding US stock prices. Besides studying the relationship for the US economy as a whole, Soenen and Hennigar (1988) also studied major US industrial sectors during the period 1980 to 1986. For the sectoral studies, Soenen and Hennigar (1988) used the monthly data on the sectoral stock indexes for seven major US industries with significant international exposure, taken from the Statistical Service: Security Price Index Record published by Standard & Poor's Corporation. The seven industries are: automobile, computer, machinery, paper, textile, steel and chemical.

Based on their findings, they concluded that three of the industries (automobile, computer and steel) show no statistically significant relationship between changes in the value of the US dollar and the stock prices. Their findings could be explained by the fact that automobile and steel industries are typically industries with problems other than exchange rates risk; while in the computer industry, the effects of the relative strength of the US dollar is ambiguous (perhaps because of their overseas manufacturing facilities). In the case of four other industries (machinery, paper, textile and chemicals) the results showed a significantly negative relationship between stock prices and the value of the US dollar.

Bodnar and Gentry (1993) examined the relationship between changes in exchange rate and the value of an industry for Canada, Japan and the United States during the period January 1979 to December 1988 for Canada and the United States, and September 1983 to December 1988 for Japan. They applied the stock price movement model to measure the impact of exchange rate changes on industry portfolios and used the monthly trade weighted nominal exchange rate. To measure an individual industry's exchange rate exposures, they estimated the following equation for each industry in the three countries:

$$(R_{i,t} - rf_t) = \beta_{0,i} + \beta_{1,i}.(R_{m,t} - rf_t) + \beta_{2,i}.PCXR_t + \varepsilon_{i,t} \qquad (63)$$

where $R_{i,t}$ is the return on industry portfolio i in month t, rf_t is the risk-free rate of return in month t, $R_{m,t}$ is the return to the national stock market in month t, $PCXR_t$ is the percentage change in the trade weighted nominal exchange rate in month t, $\beta_{0,i}$, $\beta_{1,i}$ and $\beta_{2,i}$ are parameters and $\varepsilon_{i,t}$ is the residual for the return to industry i in month t . $\beta_{1,i}$ measures the industry's exposure to changes in the overall stock market index and $\beta_{2,i}$ measures the industry's exposure to exchange rate appreciations independent of the overall market's exposure to appreciations. Positive $\beta_{2,i}$ s indicate that the industry benefits from an appreciation of the home currency.

Based on their estimations, less than half of the industries, in all three countries have exposures that are statistically significant at the 10% level: for the US it is 28%; Canada 21% and Japan 35%. Even though many industries do not have significant exposures, Bodnar and Gentry (1993) concluded that changes in the exchange rates help explain industry returns at the overall economic levels in these three countries. The insignificant exposures could be due to industries undertaking a variety of different activities with different exposures and the ability of companies to reduce their exposures through financial hedging mechanisms, such as forward contracts and derivatives contracts.

5.3.4 Conclusion

Based on the discussions above, we could infer that there is no consistent relationship between exchange rate volatility and stock prices either in terms of the impact or the interactions between them. These findings are not only prominent in the aggregate case studies but also in the disaggregated case studies. Even though the classical economic theories hypothesized that exchange rates changes could lead the stock prices and that a negative relationships exist between them, there are many studies that have shown the opposite. In certain circumstances, feedback interactions are found between exchange rate volatility and stock prices. The inconsistent results

could be due to the different countries, different time periods and different measures of exchange rate volatility used in the studies.

6 Exchange Rate Volatility and Foreign Direct Investment

6.1 Introduction

The exchange rate volatility of the post-Bretton Woods era has intensified interest in the effects of such volatility on international transactions. While studies of exchange rate volatility on trade flows are enormous, studies of the effects on direct investment are less abundant. The theoretical and empirical studies on foreign direct investment and exchange rates show that the level and volatility of exchange rates can have significant effects on foreign direct investment. However, the evidence is ambiguous. A survey of past studies on this topic yields negative, positive and indeterminate effects. Furthermore, the impact of exchange rate risk on foreign direct investment depends on many assumptions, such as the types of investment, time period of studies and the countries used in the studies. Before discussing the theoretical and empirical literature on the relationships of exchange rate volatility and FDI, we will introduce the basic concepts and some of the salient facts of foreign direct investment.

6.2 Concepts of Foreign Direct Investment

The term foreign direct investment (FDI) can be viewed from two different, but related, perspectives: macro and micro. The macro perspective, often adopted in international finance, sees FDI as a particular form of capital flows in the Balance of Payment (BOP) statistics. The micro perspective, often associated with industrial organization, views FDI from the viewpoint of the investor.

In the macro perspective, FDI refers to those stocks of capital in host countries which are controlled by a home country's owner or a home country's owner holds a certain share of voting rights of companies in host countries. In other words, the FDI is, namely, the value of home country's investment in entities, typically business corporations. It concerns the size of the flows or the value of the investment position. While in the micro perspective, FDI refers to the consequences of doing FDI, not only to the multinational investors, but also to the home and host countries. These consequences are related to the trade, employment, production and capital that are created by the investing firm and its affiliates through FDI activities.

6.2.1 FDI entity

Firms and individuals could invest in foreign countries in many ways. Any investment that fits the definition of an FDI entity could be considered as FDI. However, the FDI entity is defined differently from the two perspectives mentioned above.

6.2.1.1 Macro perspective

According to the macro perspective, an FDI entity prescribed for BOP compilations by the International Monetary Fund (1993) states that "direct investment is the category of international investment that reflects the objective of a resident entity in one economy obtaining a lasting interest in an enterprise resident in another economy". The resident entity is the direct investor and the enterprise resident is the direct investment enterprise. The lasting interest implies the existence of a long-term relationship between the direct investor and the enterprise, and a significant degree of influence by the investor on the management of the enterprise (p 86).

Another definition of an FDI entity can be found in the System of National Accounts (Inter-Secretariat Working Group on National Accounts (1993)). In these accounts, there is a definition of "foreign controlled resident corporations". This definition

includes *subsidiaries* which have more than 50% of their equity owned by a foreign parent and *associates* which have 10-50% of their equity owned by a foreign parent (which may be included or excluded by individual countries according to their qualitative assessment of foreign control (pp 340-341)).

The scope of the FDI relationship includes indirect as well as direct ownership. Direct ownership includes branches of a parent investor, namely, subsidiaries and associates. Subsidiaries are incorporated enterprises, having more than 50% of the equity owned by the direct investors, whereas associates are incorporated enterprises, having 10-50% of the equity owned by the direct investors. A subsidiary, or an associate of a subsidiary and a subsidiary of an associate, is considered as a direct investment enterprise of the parent even though the parent's interest is below 10%. However, an associate of an associate is not part of the parent's direct investment enterprise, though it is part of the first tier associate's enterprise (International Monetary Fund (1995), pp150-151).

6.2.1.2 Micro perspective

Scholars who study multinational firms define FDI as any operation investment of a firm in a foreign country. As a result of opening operations in foreign countries, a firm is said to become a multinational firm (MNF) or multinational company (MNC). However, there is some debate as to how many countries a firm needs to be operational in before it can be called an MNF. According to Raymond Vernon from a Harvard Business School, an MNF is a firm located in 6 or more foreign countries, and which holds equity of 25% or more of the total equity in each case. Mira Wilkins (1970) defines an MNF as a company with headquarters in its home country, and which conducts business in two or more foreign countries. The MNF not only has direct investment in terms of sales abroad, but must also adapt and giving due regard to foreign local traditions, rules and regulations.

On the other hand, scholars who study the behaviour of MNF argue that FDI is more than just capital flows or capital movements. Kindleberger (1969) argues that when

firms invest in a foreign country, they often fail to take money abroad with them to take control of a company. Instead they borrow in the local market, or the investment takes place in kind, through the exchange of property-patents, technology or machinery against equity claims (without the normal transfer of funds through the foreign exchange market associated with capital movements). John Dunning (1970) also concluded that FDI is more than money capital. He argued that FDI could be an informal managerial or technical guide, responsible for the dissemination of valuable knowledge and/or entrepreneurship in the form of Research & Development, production technology, marketing skills and so on.

6.2.2 FDI flow

According to FDI's perspective, capital flows may be defined as equity capital, reinvested earnings and other capital associated with various inter-company debt transactions (International Monetary Fund (1993)). Other capital covers the borrowing and lending of funds, including the debt securities and suppliers' credits between direct investors and subsidiaries, branches and associates. Associates include inter-company transactions between affiliated banks (depository institutions) and affiliated financial intermediaries (e.g. security dealers) including special purpose entities with the sole purpose of serving as financial intermediaries. However, the associates will only be included in the direct investment if they are associated with permanent debt (loan capital representing a permanent interest) and equity (share capital) investment or, in the case of branches, fixed assets. Deposits and other claims and liabilities related to usual banking transactions of depository institutions, and claims and liabilities of other financial intermediaries are classified under portfolio investment or other investment (International Monetary Fund (1993)). This last distinction is in recognition of the ambiguities which develop when attempting to distinguish between direct investment and other types.

6.2.3 Importance of FDI

The origins of FDI date back to 2500 B.C., when Sumerian merchants stationed their men abroad to receive, store and sell their goods. In the mid-seventeenth century, the English, French, Dutch and Portuguese merchants sailed to the East and West doing trade and set up their own companies. Later still, the American merchants picked up the foreign trade also.

The International Monetary Fund (IMF) and United Nations Conference on Trade and Development (UNCTAD) published comprehensive worldwide estimates of FDI inflows and outflows since 1970. The data on FDI inflows and outflows indicate that FDI has been an increasing phenomenon since the 1970s. As indicated in Table 2.1, the amount of worldwide FDI inflows has increased by 15 and 103 times in 1990 and 2000, respectively (since the 1970 figures). As for the worldwide FDI outflows, the increases are is similar to FDI inflows in 1990, but not as much as the FDI inflows in year 2000 where the increase since 1970 is just about 88. Table 2.1 also shows that the largest net recipient (inflows) and supplier (outflows) of FDI have been developed countries, who contributed almost 100% of capital in the 1970s.

Among the developed countries, the largest source of FDI outflows in the 1970s has been both the United States and Europe (see Table 2.2). However, in the 1990s and early 2000, Europe overtook the United States as the main FDI supplier by contributing 79% of the FDI outflows in developed countries. In terms of the FDI inflows amongst the developed countries, Europe has been the largest recipient since the 1970s. One country, whose role as a provider of capital is not very great, is Japan. It contributed less than 8% of the capital provided by the developed countries in the 1970s, as well as in the late 1990s and early 2000. Its largest contribution was in the late 1980s and early 1990 when it contributed up to 21% of the total amount of funds within the developed countries. It can also be noted from Table 2.2 that Japan is the smallest recipient of FDI inflows amongst the developed countries. It received only about 1% of the total inflows to the developed countries.

Table 2.3 shows FDI flows in the developing economies. Amongst the developing nations, Latin America received the highest FDI inflows, followed with African

countries and developing Asian countries in the 1970. However, in 1975, the developing Asian countries overtook and surpassed the Latin American countries. Then, in the early 1980s, Latin American countries overtook and bypassed the developing Asian countries by more than 80% of the share of the FDI inflows. Furthermore, from the middle of the 1980s, developing Asian countries received the most FDI inflows (almost double the amount received by the Latin American countries). After receiving the largest share in 1970, in the last three decades, the African countries no longer receive the bulk of the FDI inflows any more except in 1985. With regard to the FDI outflows, similar scenarios to the FDI inflows can be seen in the developing economies. In fact, the developing Asia countries supplied more than 80% of the outflows from developing economies during the 1990s period.

PAGE

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Table 2.1. World FDI Inflows and Outflows, 1970-2004 (Millions of US dollars)

Period	World	Developed Economies		Developing Economies	
		Amount	Share to World (%)	Amount	Share to World (%)
FDI Inflows (recipients)					
1970	13,434	9,496	70.7	3,937	29.3
1975	27,380	16,882	61.7	10,498	38.3
1980	55,108	46,629	84.6	8,455	15.3
1985	57,645	42,486	73.7	15,143	26.3
1990	207,878	172,067	82.8	35,736	17.2
1995	341,086	218,738	64.1	117,544	34.5
2000	1,396,539	1,134,293	81.2	253,179	18.1
2004	648,146	380,022	58.6	233,227	36.0
FDI Outflows (suppliers)					
1970	14,150	14,101	99.7	49	0.3
1975	28,705	28,060	97.8	645	2.2
1980	53,743	50,407	93.8	3,336	6.2
1985	62,193	57,911	93.1	4,282	6.9
1990	238,681	225,965	94.7	12,701	5.3
1995	358,177	304,559	85.0	52,981	14.8
2000	1,239,149	1,092,747	88.2	143,226	11.6
2004	730,257	637,360	87.3	83,190	11.4

Note: FDI includes the three following components: equity capital, reinvested earnings and intra-company loans. Data on FDI flows are presented on net bases (capital transactions' credits less debits between direct investors and their foreign affiliates). Net decreases in assets or net increases in liabilities are recorded as credits (with a positive sign), while net increases in assets or net decreases in liabilities are recorded as debits (with a negative sign). Hence, FDI flows with a negative sign indicate that at least one of the three components of FDI is negative and not offset by positive amounts of the remaining components. These are called reverse investment or disinvestment.

Source: UNCTAD World Investment Report 2005

Table 2.2. Developed Economies: FDI Inflows and Outflows, 1970-2004 (Millions of US dollars)

Period	United States		Japan		Europe	
	Amount	% Share	Amount	% Share	Amount	% Share
FDI Inflows (recipients)						
1970	1,260	13.03	94	1.0	5,226	55.0
1975	2,560	15.2	226	1.3	10,071	59.7
1980	16,918	36.3	278	0.6	21,569	46.3
1985	20,490	48.2	642	1.5	16,542	38.9
1990	48,422	28.1	1,753	1.0	104,304	60.6
1995	58,772	26.9	42	0.02	133,693	61.1
2000	314,007	27.7	8,323	0.7	722,762	63.7
2004	95,859	25.2	7,816	2.1	223,400	58.8
FDI Outflows (suppliers)						
1970	7,590	53.8	355	2.5	5,095	36.1
1975	14,244	50.8	1,763	6.3	10,622	37.9
1980	19,230	38.1	2,385	4.7	24,128	47.9
1985	13,388	23.1	6,452	11.1	31,924	55.1
1990	30,982	13.7	48,024	21.3	138,936	61.5
1995	92,074	30.2	22,630	7.4	174,627	57.3
2000	142,626	13.1	31,558	2.9	866,090	79.3
2004	229,294	36.0	30,951	4.9	309,498	48.6

Note: Refer to Table 2.1

Source: UNCTAD World Investment Report 2005

Table 2.3. Developing Economies: FDI Inflows and Outflows, 1970-2004 (Millions of US dollars)

Period	Asia		Africa		Latin America	
	Amount	% Share	Amount	% Share	Amount	% Share
FDI Inflows (recipients)						
1970	854	21.7	1,266	32.2	1,681	42.7
1975	5,265	50.2	906	8.6	4,303	41.0
1980	442	5.2	400	4.7	7,494	88.6
1985	5,329	35.2	2,446	16.2	7,270	48.0
1990	22,614	63.3	2,840	7.9	9,586	26.8
1995	81,099	69.0	5,587	4.8	30,167	25.7
2000	145,725	57.6	9,627	3.8	97,523	38.5
2004	147,545	63.3	18;090	7.8	67,523	29.0
FDI Outflows (suppliers)						
1970	-1	-2.0	19	38.8	31	63.3
1975	250	38.8	173	26.8	222	34.4
1980	1,056	31.7	1,089	32.6	1,174	35.2
1985	2,863	66.9	345	8.1	1,060	24.8
1990	10,945	86.2	689	5.4	1,062	8.4
1995	42,324	79.9	2,942	5.6	7,749	14.6
2000	81,071	56.6	1,573	1.1	60,581	42.3
2004	69,422	83.4	2,824	3.4	10,943	13.2

Note: Refer to Table 2.1.

Source: UNCTAD World Investment Report 2005

6.3 Theoretical models of the impact of exchange rate volatility on Foreign Direct Investment

Studies on the relationship between FDI and exchange rates have been of increasing interest amongst recent researchers. However, to the best of our knowledge, the international investment implications of variable exchange rates have not been the subject of much formal analysis and the theoretical work is not so abundant. The theoretical work on this subject is focused on risk aversion and production flexibility.

6.3.1 Risk aversion

In the risk aversion concept, one approach to viewing the effects of exchange rate variability on FDI is to directly model the utility of expected profits as a decreasing function of exchange rate. Using a two-period model, Goldberg and Kolstad (1995) demonstrated how current assessments of future exchange-rate variability determine the proportion of future market demand to be satisfied by production facilities based in domestic, versus foreign, economies. Their basic model is based on a domestic firm producing only for a foreign market, with a combination of domestic capacity (with output exported) and foreign capacity. In the first period, the horizontally integrated multinational decides on its domestic and foreign plant productivities. It then chooses the productive capacity for both locations based on maximum present values of expected profits, or the utility of those profits. In period two, the uncertainty in exchange rates and demand is resolved where the domestic and foreign facilities are producing at capacity and take prices that clear the market.

In their model, Goldberg and Kolstad (1995) stated that, if the domestic firm is risk neutral and expected production costs are the same in domestic and foreign markets, then the firm is indifferent regarding the location of the production facilities. But if the domestic firm is risk averse and assuming only exchange rate uncertainty existed, then it is always desirable to locate some production abroad. This means that exchange rate uncertainty stimulates FDI. Their model shows that the greater the variability of exchange rates, the larger the share of capacity located offshore, although overall capacity declines.

Yet another approach focuses on the firm's objective of maximizing the certainty of equivalent future real profits expressed in domestic currency. This is what Cushman (1985) focused on in his paper. In this paper, Cushman introduced four models within each of which, a two-period time frame is assumed, where the firm must implement capital investment in the current period in order to realise profits in a future period for which price levels, the nominal exchange rate and the real exchange rate are uncertain. The certainty equivalent is given by:

$$C = E\pi - \gamma\sigma\pi \tag{64}$$

where $\pi =$ future real profits, $E =$ expected value, $\sigma =$ standard deviation and $\gamma =$ the market price of risk ($\gamma > 0$ implies risk aversion). Without perfect knowledge of the underlying probability distribution of π, the firm must estimate E and σ for use in Equation (64).

Cushman (1985) applied the risk adjusted expected proportional change in the real exchange rate, ψ, to capture the effect on the firm's evaluation of future profits from the uncertain real exchange rate change between the current period when capital levels are financed and implemented and the future period when the return is realised. The risk adjusted expected proportional change in the real exchange rate, ψ, is calculated as:

$$\psi = E\theta - \gamma\sigma\theta \tag{65}$$

where θ is the proportional change in R; $\theta = R_{t+1} / R_t$. R is the real exchange rate level and $t =$ current time period. A value of ψ greater than, equal to, or less than 1.0 means that, adjusted for risk, the firm expects real foreign currency to appreciate, remain unchanged or depreciate, respectively.

Cushman (1985) stated that his models considered a two-country world where the international firm must decide where to buy inputs and produce, where to finance capital acquisitions and where to sell output. In Model 1, Cushman assumes that the firm sells output abroad using foreign inputs. However, the capital can be financed at home (direct investment) or abroad. In this model, when risk increases, FDI is reduced. Model 2 assumes foreign production and sale with capital financed domestically. However, the firm does export a domestically produced intermediate good to the foreign subsidiary (exchange risk is thus extended). In this model, Cushman argued that when risk increases, FDI decreases. Model 3, assumes domestic production and sale, though an intermediate good is imported from a foreign subsidiary, whose capital is financed at home. In this case, Cushman claimed that the effect of risk on FDI is ambiguous. FDI could rise or fall when exchange rate variability increases. Finally, Model 4 assumes that the firm chooses between capital purchased and financed at home, with output for sale in the foreign market (domestic

investment for export production), and capital purchased abroad but financed at home (direct investment) with output sold in the foreign country. In this model, Cushman also claimed that the effect of risk on FDI is ambiguous.

6.3.2 Production flexibility

Another concept in the study of the effect of exchange rate risk on FDI is to examine how firms are able to shift production in response to realized exchange rate movements. In this type of models, producers commit to domestic and foreign capacity *ex ante* and commit to employment decisions *ex post*, following the realization of a nominal or real shock. The assumption of *ex post* variable factors of production is more realistic for the long horizon. Effects of exchange rate volatility will in this approach generally depend on sunk costs in capacity, competitive structure and the convexity of the profit function in prices.

Aizenman (1992) was the first to tackle the issue of exchange rate volatility and FDI. His model is based on a macroeconomic modelling strategy where the exchange rate, prices, employment and investment are endogenously determined and may provide a more coherent interpretation of the observable correlations. His objective was to investigate the implications of exchange rate regimes on the patterns of domestic and foreign direct investment, and the correlation between exchange rate volatility and investment. He assumed that producers may diversify internationally in order to increase the flexibility of production and that they are risk neutral. He employed both nominal (monetary) and real shocks in his model.

The key outcome of his analysis is that, for a given volatility of real and nominal shocks, a fixed exchange rate regime is associated with higher domestic and FDI (relative to a flexible exchange rate regime). In terms of the correlation between exchange rate volatility and investment under the flexible exchange rate regime, Aizenman argued that it depends on the nature of the shocks. If the dominant shocks are monetary shocks, the concavity of the production function implies that nominal shocks will reduce expected profits under a flexible exchange rate regime. Fixed

exchange rates are capable of isolating the level of employment and production from monetary shocks and are associated with higher expected profits. This in turn stimulates domestic investment and FDI. If the dominant shocks are real shocks, flexible exchange rates are associated with higher volatility of employment and with lower expected profits. This is due to the fact that a country experiencing a positive productivity shock will tend to experience nominal and real appreciation, which will mitigate the resultant employment expansion. In the fixed exchange rate system positive productivity shock leads to an increase in employment and in expected profits. Therefore, in the presence of productivity shocks the flow of FDI will be larger in a fixed than in a flexible exchange rate system.

One of the latest theoretical works in this area is by Sung and Lapan (2000). Their model is similar to that of Goldberg and Kolstad (1995). But differs by assuming that each plant exhibits decreasing average cost (constant marginal costs in Goldberg and Kolstad(1995)) and that the firm makes production decisions after the exchange rate is known (such decisions were made before the resolution of uncertainty in the Goldberg and Kolstad (1995) model). Sung and Lapan (2000) also used the theory of option pricing developed by Dixit (1989) to analyse investment decisions.

According to Sung and Lapan (2000), the multinational firm's decision to do FDI is likened to the purchasing of a real option, whose value depends on exchange rate variability. The standard result in option pricing theory is that the value of an option increases with an increase in the underlying volatility of the stock. In this case, the value of the option (investment) will increase, the more uncertain the exchange rate is and, therefore, a firm will wait before it decides to exercise this option (i.e. FDI). It means that the more volatile the exchange rate is, the longer a firm will wait before entering foreign markets regardless of whether the firm is risk averse or not, and this will result in the declining of FDI.

6.3.3 Conclusion

As we have shown in the discussion above, theoretical works on the relationship between exchange rate volatility and FDI are scarce and the results are found to be ambiguous. In general, the risk aversion concept implies that exchange rate volatility has a positive correlation with FDI, whereas in the production flexibility concept the correlation between exchange rate volatility and FDI seems to be negative.

6.4 Empirical models of the impact of exchange rate volatility on Foreign Direct Investment

There is growing interest in economic uncertainty and its influence on the level of investment. Recently, following the work of Dixit and Pindyck (1994) there has been a greater emphasis on the deleterious impact of economic and financial volatility on investment. Generally, empirical works tend to imply a negative impact, although some researchers have also found zero or even positive results. We will discuss these ambiguous findings below.

6.4.1 Positive impact of exchange rate volatility on FDI

Even though in general researchers found the impact of exchange rate volatility on FDI to be negative, there are some which report a positive impact. Such examples are Cushman (1985), Goldberg and Kolstad (1995), Byrne and Davis (2003) and Pain and Van Welsum (2003). As discussed above in section 6.3.1, Cushman (1985) proposed four models when investigating the relationship between exchange rate volatility and FDI. To test for the possible risk and expectational effects on FDI Cushman (1985) used annual, bilateral direct investment flows from the United States to the United Kingdom, France, Germany, Canada and Japan for the years 1963 through to 1978 and applied a pooled estimation method. He used a partial adjustment model to obtain the direct investment flow, which is:

$$DI_t = a_1(A_t^* - A_{t-1}) \qquad 0 < a_1 < 1 \tag{66}$$

where DI_t = direct investment flow during time period t; A_t^* = desired stock of direct investment during time period t and A_{t-1} = stock of direct investment at the beginning of the period. His linear equation is:

$$DI_t = a_0 - a_1 A_{t-1} + a_2 C_{t-1} + a_3 Y^* + a_4 Y + a_5 p P_K + a_6 p^* P_K^*$$

$$+ a_7 R + a_8 E\theta + a_9 \sigma\theta + a_{10} DUM \tag{67}$$

where C_{t-1} = corporate cash flow lagged one year; Y and Y^* is domestic and foreign incomes; p and p^* domestic and foreign real interest rates; P_K and P_K^* is current domestic and foreign real prices of capital; R is real exchange rate level; $E\theta$ is expected value of the proportional change in the real exchange rate; $\sigma\theta$ is standard deviation of the proportional change in the real exchange rate and DUM is possible effects of the mandatory controls on direct investment of 1968-1973. Cushman found ambiguous results regarding the effect of real exchange rate level on FDI but positive relationship between exchange rate volatility and FDI in all cases.

Goldberg and Kolstad (1995) also found a positive relationship between exchange rate volatility and FDI. They employed quarterly data from 1978:I through to 1991:IV using bilateral FDI activity between the United States and the United Kingdom, Japan and Canada. Bilateral real exchange rates were used and exchange rate volatility constructed as the standard deviation of the exchange rate over rolling samples of twelve quarters of data (prior to and inclusive of each period), normalized by the mean level of the exchange rate within the interval. This measure of volatility incorporates both the predictable and unpredictable components of exchange rate movements. In this study, they emphasized and explored the implications of short term exchange rate variability for FDI flows.

Their results showed that exchange rate variability had a positive and statistically significant effect on four out of the six bilateral FDI activities. Real exchange rate volatility increased the share of total US investments in Canada and Japan, and

increased the share of Canada and UK investments located in the US. These results are consistent with their predictions that, the greater the variability of exchange rates, the larger the share of capacity located offshore (even though overall capacity declines)[11]. Their empirical findings support their main theoretical results.

Another study which found a positive impact is that done by Byrne and Davis (2003). In this they estimated the impact of transitory and permanent exchange rate uncertainty on private sector investment in a neoclassical investment function, allowing for variants for the influence of Tobin's Q. Estimation was carried out using Pooled Mean Group estimation (PMGE) of Pesaran, Shin and Smith (1999) and Mean Group estimator (MGE) - an average of the individual country coefficients with exchange rate uncertainty proxies estimated by components GARCH (CGARCH) and exponential GARCH (EGARCH) model. They focused on the G7 countries as a whole, as well as on the behaviour of the UK, France, Italy and Germany for the sample period covering 1973Q1 through to 1996Q4.

The PMGE method proposed by Pesaran, Shin and Smith (1999) is an intermediate case between the averaging and pooling methods of estimation, involving aspects of both. The PMGE method restricts the long-run coefficients to be equal over the cross-section, but allows for the short-run coefficients and error variances to differ across groups on the cross-section. We can therefore obtain pooled long-run coefficients and averaged short-run dynamics as an indication of mean reversion. The PMGE is based on an Autoregressive Distributive Lag (ARDL) (p,q,…,q) model

$$y_{it} = \sum_{j=1}^{p} \lambda_{ij} y_{it-j} + \sum_{j=0}^{q} \delta_{ij}' x_{it-j} + \mu_i + \varepsilon_{it} \qquad (68)$$

[11] For further information refer to Proposition 3 in Goldberg, Linda S., and Charles D. Kolstad, 1995, Foreign direct investment, exchange rate variability and demand uncertainty, *International Economic Review* 36, 855-873.

where x_{it} (k x 1) is the vector of explanatory variables for group i, μ_i represents the fixed effects, the coefficients of the lagged dependent variables (λ_{ij}) are scalars and δ_{ij} are (k x 1) coefficients vectors. T must be large enough so that the model can be estimated for each cross section.

Byrne and Davis's (2003) results showed exchange rate volatility to be significant in influencing investment in the G7 countries when the CGARCH volatility measure is employed. The results showed that transitory and permanent volatility are significant when they are entered together, with permanent shocks having a positive sign and temporary shocks having negative sign. However, when the components are entered separately, neither transitory nor permanent volatility has a significant effect on investment. For the EU4 countries, the significant results are found in the temporary components alone and also when the temporary and permanent components are entered together. When EGARCH conditional variance is utilised, the results showed that volatility is significant, but there is no evidence for pooling in the G7 countries. The short-run volatility showed an adverse impact on investment.

Pain and Van Welsum's (2003) study also revealed a positive impact of exchange rate volatility on FDI. They investigated the determinants of inward FDI inflows in a panel of six large economies: United States, United Kingdom, Canada, Germany, France and Italy over the period 1972 through to 2000. The model of their estimation is:

$$\Delta(FDI/Y)_{it} = \alpha_i + \beta_1 \Delta R_{it} + \beta_2 \Delta V_{it}$$

$$+\lambda\left[(FDI/Y)_{i,t-1} - \beta_3 R_{i,t-1} - \beta_4 V_{i,t-1}\right] + \Sigma\gamma_j T_j + \varepsilon_{it} \qquad (69)$$

where FDI_{it} denotes FDI inflows into country i at time t, Y_i is host country GDP, R_i and V_i denote the level and volatility of the host country's real effective exchange rate, measured using economy-wide unit labour costs, and T_j is a time dummy for period $t = j$. Exchange rate volatility is proxied by a three-year moving average of the past standard deviation of the quarterly real exchange rate. The country-specific

fixed effects (α_i) allow for unobserved influences that remain constant over the whole of the sample period. All other influences will be contained in the disturbance term ε_{it}.

Their results revealed that appreciation of the host country's currency has a negative impact on FDI inflows, whilst exchange rate volatility has a positive impact. However, neither is statistically significant at the 5% level, either in the short-run or in the long-run. They explored these impacts further by relaxing the restrictions of the common slope parameters in Equation (69) and re-estimating the model. The results then became significant. Their findings now showed that greater exchange rate volatility has a significant positive impact on FDI flows into UK, in both the short-run and the long-run. Greater exchange rate volatility also has a significant positive effect on inflows into Germany and Canada in the long-run, and on inflows into the US and Italy in the short term. Exchange rate volatility appears to have no significant effects on FDI into France.

6.4.2 Negative impact of exchange rate volatility on FDI

As we mentioned earlier, in general, the empirical studies on the impact of exchange rate volatility on FDI showed a negative sign. These negative results are found, regardless of the different perspectives and assumptions of the studies such as types of investment, aggregate or disaggregate data, time period of studies and the countries used in the studies.

6.4.2.1 Types of FDI flows

The FDI flows could be inflows to a country or outflows from a country. Some of the works which revealed the negative impact of exchange rate volatility on FDI inflows are Darby, Hughes-Hallett, Ireland and Piscitelli (1999), Benassy-Quere, Fontagne and Lahreche-Revil (2001), Serven (2003) and Hara and Razafimahefa (2003); on

FDI outflows are Chakrabarti and Scholnick (2001) and Kiyota and Urata (2004); and on bilateral FDI flows is Crowley and Lee (2002).

Darby, Hughes-Hallett, Ireland and Piscitelli (1999) extended the Dixit-Pindyck model for varying degrees of uncertainty caused by exchange rate volatility. They split the measure of exchange rate variability into two parts: one representing pure volatility and the other misalignment effects. Their measure of exchange rate volatility is:

$$\left[\frac{1}{8}\sum_{i=1}^{8}(\Delta \log e_{t-i})^2\right]^{1/2} \tag{70}$$

where e is used to denote the real effective exchange rate. The misalignment figures are calculated as the deviation from trend in the real effective exchange rate. They then tested the model by analysing the investment performance of the main European economies (France, Germany, Italy, UK) and the US in the 1980s and 1990s. The investment data applied to the business sector. They found significant negative effects of exchange rate volatility and misalignment for all five of the larger OECD economies. Their results revealed that exchange rate volatility has an important long-run impact on investment in the US, Germany and France but only a temporary effect in the UK and Italy.

Benassy-Quere, Fontagne and Lahreche-Revil (2001) considered the case of a risk-averse multinational firm, contemplating relocating to two alternative foreign locations in order to re-export. They also followed a two-period framework: in the first period, the firm decides where to invest and in the second period, the firm produces. To test the theoretical model, they estimated on a panel of 42 developing countries receiving FDI from 17 OECD countries over the period 1984 through to 1996. The dependent variable is the logarithm of the stock of FDI received by country i from country k. Their findings showed that an increase in nominal exchange rate volatility tends to reduce FDI inflows in the developing countries from the OECD countries.

Serven (2003) empirically examined the link between real exchange rate uncertainty and private investment in least developing countries (LDCs) using a large cross-country time series data set, spanning the years 1970 through to 1995. For the measure of volatility he used a GARCH(1,1) specification in a simple equation in which the (log) real exchange rate follows an AR(1) process with trend. For estimating the relationship, he employed the system generalized method of moments (GMM) estimator of Arellano and Bover (1995) and Blundell and Bond (1998) to deal with endogeneity of the lagged dependent variable, as well as the potential endogeneity of the other regressors. Serven found a negative and highly significant impact of real exchange rate volatility on private investment in the overall sample, after controlling for standard investment determinants. After closer inspection, the results revealed that the impact is larger at higher levels of volatility. Moreover, the investment effect of real exchange rate uncertainty is shaped by the degree of trade openness and financial development. Higher openness and weaker financial system are associated with a significantly negative uncertainty-investment link. Conversely, under conditions of high financial development and low openness, real exchange rate uncertainty may actually have a positive impact on private investment.

Hara and Razafimahefa (2003) studied the FDI inflows into Japan covering the period from fiscal year 1980 through to 2001. Their study was motivated by the lack of literature on the empirical work on FDI inflows into Japan. Their model is based on the main factors determining incoming FDI into Japan, and they applied the Ordinary Least Square (OLS) estimation for the regression. The variables considered as main candidates for the determinants of FDI inflows into Japan are: the scale of the economy measured with GDP, strength and stability of the host country's currency measured with the level and volatility of exchange rates, the cost of establishing Greenfield plant measured with the land price, the price of shares measured with the stock price, price movements in the host economy, and the environment for investments such as laws and regulations.

Their findings showed that the volatility of exchange rates stands as an impediment to FDI inflows into Japan. These results are consistent with the theory that high volatility of the host country's exchange rates discourages FDI if the latter uses a

large share of imported inputs in their production process. They found that, indeed, foreign investments operating in Japan import 36.4% of their total purchase. The considerable importance of this imported purchase for FDI in Japan strengthens their results, i.e. that exchange rate volatility obstructs FDI inflows into Japan.

Chakrabarti and Scholnick (2001) studied the FDI flows from the US to 20 OECD countries using annual data covering the period 1982 through to 1995 and employed various panel data estimation to evaluate the relationship between annual FDI flows and exchange rate dynamics, i.e. where the FDI inflows from the US to a country in a year is the dependent variable while the mean, standard deviation and skewness of monthly exchange rate devaluations of the currency of that country during the preceding year are the independent variables. Overall, they found that the results for volatility are not robust, but they agree with previous studies which showed that increased exchange rate volatility reduces FDI flows.

In their study, Kiyota and Urata (2004) looked at the annual FDI outflows of Japan to its partner countries between 1990 through to 2000. They analysed the effects of exchange rate and its volatility on Japan's FDI by extending previous studies in several ways. First, rather than analysing national-level FDI data without considering its destination, they explicitly took into account regional and sectoral differences in FDI. Second, they extended the analytical framework adopted by Froot and Stein (1991) and Klein and Rosengren (1994) by incorporating the impacts of the failures of law of one price between different markets on real exchange rate volatility. They split up real exchange rate volatility into two parts: one explained by the failures of establishing the law of one price, the other being the deviation of the actual value from the value explained by the failure of the law of one price.

Kiyota and Urata (2004) employed the feasible generalised least squares (FGLS) panel data estimation with heteroscedastic error term[12]. In general, their results indicate that depreciation of the host country's currency attracts FDI, and that large

[12] This means that the variance for each country is assumed to differ.

volatility in real exchange rates discourages FDI from Japan. They found differences in the impacts of exchange rate volatility on FDI for East Asia and for Latin America. For the FDI in East Asia volatility in the host currency/yen exchange rate has a substantial impact, whereas for FDI in Latin America the volatility in the host currency/dollar exchange rate also has important consequences, in addition to those of the host currency/yen exchange rate volatility. These findings appear to reflect the importance of the yen in East Asia on the one hand and the US dollar in Latin America on the other hand, with regards to business transactions in these two regions. They found the impacts of exchange rate and its volatility were different across industries, but apparent patterns were not confirmed.

Instead of investigating the FDI inflows or FDI outflows of a country, Crowley and Lee (2002) studied the bilateral FDI flows between 18 OECD countries and the US from 1980 through to 1998. Their regression model to estimate the relationship between volatility in the exchange rate between country i and the US (σ_{it}) and FDI I_{it} between two countries can be written as:

$$\Delta I_{it} = \alpha_i + \beta_1 \sum_{j=1}^{k} \sigma_{i,jt} + \Phi_i \sum_{j=1}^{k} Z_{i,jt} + \varepsilon_{it} \qquad i = 1,\ldots,N; t = 1,\ldots,T \qquad (71)$$

where t is a time subscript, Δ is a first-difference operator, Z_{it} is a vector of conditioning variables included in the regression, α_i, β_i and Φ_i are free parameters, and ε_t is a random error term. In estimation, I_{it} is measured alternatively by the log levels of bilateral FDI inflows and outflows between country i and the US. The exchange rate is measured using the GARCH(1,1) specification. To capture the dynamic effect of exchange rate volatility on FDI, they included 4 lagged values of the explanatory variable, i.e., $k = 4$. For each sampling country, they carried out regressed estimates of exchange rate volatility on bilateral capital flows, as represented by Equation (71). They also examined FDI outflows and inflows separately.

Their empirical evidence based on 18 OECD countries between 1980-98 offers only weak support to the conventional adverse effect of exchange rate volatility on FDI.

Their estimation results for the volatility-investment relationship differ remarkably across countries. This may be partly due to differences in the extent of exchange rate fluctuations. They found that countries with relatively stable exchange rates tend to be least affected by a given currency movement. The panel regressions confirm the presence of disparities across countries as well as over different time periods.

6.4.2.2 Disaggregate studies

Most empirical studies investigated the impact of exchange rate volatility on FDI using the aggregate FDI data. However, disaggregate studies have become popular recently and some examples are Campa (1993), Bell and Campa (1997) and Barrel, Gottschalk and Hall (2003).

Campa (1993) tested the effects of real exchange rate fluctuations on FDI into the United States during the 1980s. He applied the theoretical framework of an option pricing theory developed by Dixit (1989), where he tested if firms exporting to the US market deferred their investments to enter that market during the 1980s (due to the fluctuations of the US real exchange rate). His data consisted of a panel based on 61 US wholesale trade industries for the period 1981 through to 1987 and he used the Tobit model estimation procedure. His results showed that an exchange rate volatility coefficient has a significant negative effect on the level of entry in the industry. This shows that a higher level of uncertainty decreased the number of foreign firms entering the US market.

Bell and Campa (1997) studied the empirical effect of volatility on new, irreversible, investments in capacity. They used a sample of 267 investments in new capacity for 16 commodity chemicals produced in the United States and the European Union between 1977 and 1989. Their dependent variable (i.e. investment in new capacity) is defined as the new or incremental capacity invested for the production of chemical i by company j in country k between years t and $t-1$. The exchange rate volatility is defined as the average and standard deviation of the monthly change in the log of the exchange rate index for country k in the years $t-1$ to $t-2$ (expansions) or

$t-2$ to $t-3$ (greenfields). Their results showed that investment in capacity is a negative function of exchange rate volatility for plants based in the European Union. This negative effect is consistent with the existence of risk aversion or with highly irreversible investments in an imperfectly competitive industry.

Barrel, Gottschalk and Hall (2003) investigated the impact of exchange rate volatility on US FDI in the UK and Euro Area (Austria, Belgium, France, Germany and the Netherlands) during the period 1982 through to 1998. A panel of seven, two-digit, manufacturing industries were considered: Food and Kindred Products, Chemicals and Allied Products, Primary and Fabricated Metals, Machinery, Electrical and Electronic Equipments, Transportation Equipment and Other Manufacturing. They constructed a model based on the hypothesis that risk-averse firms would attempt to reduce the impact of uncertainty on their investment portfolio by exploiting correlations between exchange rates in alternative locations. They found that exchange rate uncertainty in the Euro Area as well as in the UK has a strong negative effect on the US FDI abroad. There is strong evidence that the correlation between the sterling dollar exchange rate and the euro dollar exchange rate influences location decisions of US firms in Europe.

6.4.3 Both or no impact of exchange rate volatility on FDI

In some empirical studies, researchers found exchange rate volatility has both a positive and negative impact on FDI, e.g. are Iannizzotto and Miller (2002) and Alaba (2003). However, there were also some studies which found exchange rate volatility had no impact on FDI, e.g. are Gorg and Wakelin (2001) and Foad (2005).

Iannizzotto and Miller (2002), using a database consisting of investment announcements in the financial press, explored the relationship between FDI and exchange rate variability with respect to both the level and volatility of UK exchange rates between 1997 and 2000. In order to remain consistent, they only included announcements of new investments and excluded any announcements of expansions of existing ventures. They implemented five different measures of exchange rate

volatility, considering both the standard deviation and standard deviation/mean measures, and varying the temporal window and the nature of expectations. Since their model is a count data, they employed a Poisson regression, as pointed out by Green (2000), to take into account the number of zeros and the discrete nature of the regressand. In this paper, their approach is to assume that the dependent variable, which is the number of announcements per month, is related to the regressors in a log linear way so that:

$$PROB(Y_i = y_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} \tag{72}$$

$$\ln y_i = b_i^{'} x_i \tag{73}$$

where x_i is the vector of regressors comprising an index of the trade weighted real exchange rate, a measure of its volatility and a index of relative real wages. The Poisson distribution imposes the restriction that the mean and the variance of the distribution should be the same. To take care of the zero announcements to invest in the UK, they then used the Zero Inflated Poisson (ZIP) model.

Their findings revealed that the level of the exchange rate are all significant and have the expected negative sign for all models. The measures of exchange rate volatility which differentiate the five models give somewhat inconclusive results. The forward-looking measure that assumes perfect foresight, is positively signed and significant for the one-year horizon. For the backward-looking specification, four different specifications are used, but the parameter estimate is significantly different from zero only at the three-year time horizon.

Alaba (2003) did a study on the Nigerian economy. He investigated the magnitude and direction of the effect of exchange rate movement and its volatility on FDI flows to the agricultural and manufacturing sectors in Nigeria. These two sectors are the most important, and are both extremely significant in diversifying the Nigerian economy from the dominance of oil trade. Alaba (2003) used quarterly data from 1984Q1 through to 2001Q4 and employed both the black market and official/IFEM exchange rates as his variables. The volatility of these two variables was measured

using the GARCH model. His results showed that both systematic movement of the exchange rate and its volatility is significant at 1% for flow of FDI to agriculture in Nigeria. For the manufacturing sector movements in both parallel market exchange rate and its volatility are significant at 10%. The exchange rate volatility is found to have a positive impact on FDI in the agricultural sector, while having a negative impact on the manufacturing sector of the Nigerian economy.

Gorg and Wakelin (2001) examined the impact of the level of exchange rate, volatility in the exchange rate and exchange rate expectations on outward US FDI in 12 developed countries and inward FDI to the US from those countries for the period from 1983 through to 1995. Gorg and Wakelin (2001) used two measures of FDI: financial transfer from partner to affiliate, and sales by multinationals in the host country. Different definitions of the dependent variable FDI_{jt} are used for the analyses of outward FDI from, and inward FDI to, the US. For the former, the dependent variable is US FDI in partner country j at time t while for the latter it is inward FDI from partner country j in the US at time t. In both cases the two measures of FDI are used. The exchange rate volatility variable is measured by the standard deviation of the exchange rate. Their empirical model is as follows:

$$FDI_{jt} = \beta_0 + \beta_1 R_{jt} + \beta_2 \sigma_{jt} + \beta_3 trend_{jt} + \beta_4 l_{jt} + \beta_5 k_{jt} + \beta_6 gdpp_{jt}$$

$$+\beta_7 gdpus_t + \beta_8 fc_{jt} + \beta_9 d_j + \beta_{10} lang_j + \varepsilon_{jt} \qquad (74)$$

where R is the level of the exchange rate, σ is the exchange rate volatility, $trend$ is the expectation or trend in the exchange rate, $l, k, gdpp$ and $gdpus$ is the labour, capital costs, host and home economy, fc is the freight costs between the US and the partner country in the equation, d is the distance between host country and the US, $lang$ is the common language dummy and ε is the error term.

They estimated the model under different assumptions of the error term ε_{jt}. First, they assumed that the error term is white noise and estimated Equation (74) using

simple OLS. Second, they allowed for the presence of a country-specific effect in the error term by employing fixed and random effects panel data techniques. Their findings revealed that there is no statistical evidence that exchange rate volatility has an effect on either US outward investment or inward investment. The results are robust to the two measures of FDI and also when different estimation procedures were used.

Foad (2005) examined the interactions between exchange rate volatility, foreign affiliate exports and US FDI in seventeen European countries over the period 1983 through to 2002. He applied a two stage procedure. Firstly, the effect of bilateral exchange rate volatility on exports from a foreign affiliate's host country and a local export market estimated within a gravity equation. The predicted values which form this estimation can be thought of as an export forecast by the multinational. In the second stage, he examined how the multinational's expected exports from this foreign production facility can affect flows between the US and the host country. He applied two proxies of exchange rate volatility measure: twelve month moving average variance of the exchange rate and GARCH model. Specifically, the regression model is as follows:

$$FDI_{i,t} = \Phi(L)FDI_{t-1} + \beta_1 \hat{X}_{i,t} + \beta_2 V_{i,t} + \beta_3 Y_{i,t} + \beta_4 wage_{i,t}$$

$$+\beta_5 Tax_{i,t} + \beta_6 DEP_{i,t} + \varepsilon_{i,t} \qquad (75)$$

$$\varepsilon_{i,t} = \alpha_i + v_{i,t}$$

The inward position of FDI is a function of past values, forecast exports from the foreign affiliate, exchange rate volatility between the host and the US, GDP in the host country, average labour costs in the host country, taxes as a percentage of total sales, an unobserved time invariant fixed effect for each country and a time varying random error term.

Foad (2005) applied the generalised GMM estimators in the dynamic panel procedure. The GMM estimators use all available lags at each period as instruments

for the equation in first differences. Expressing the vector of FDI across countries at time t as FDI_t, the GMM estimator of φ can be written as:

$$\hat{\varphi}_{GMM} = \left[(\Delta FDI_{-1}^T Z)W_n^{-1}(Z^T \Delta FDI_{-1})\right]^{-1}(\Delta FDI_{-1}^T Z)W_n^{-1}(Z^T \Delta FDI_{-1}) \qquad (76)$$

where the matrix of instruments is given by:

$$Z_i = \begin{bmatrix} FDI_{i,0} & 0 & \cdots & 0 \\ 0 & FDI_{i,0}FDI_{i,1} & 0\cdots & 0 \\ \vdots & & \ddots & \vdots \\ 0\ldots & FDI_{i,0\cdots} & \cdots & FDI_{i,T-2} \end{bmatrix} \qquad (77)$$

According to standard GMM theory, an optimal choice for the weighting matrix W_n is the one that yields the smallest asymptotic covariance matrix for $\hat{\varphi}_{GMM}$. If no restriction is imposed on the covariance structure of v_{it}, the optimal weighting matrix is given by:

$$\hat{W}_n^* = \left(\tfrac{1}{n}\Sigma Z_i^T \Delta\hat{v}_i \Delta\hat{v}_i^T Z_i\right)^{-1} \qquad (78)$$

where $\Delta\hat{v}_i$ is a residual vector obtained from a first step consistent estimator with equal weights (W_n equal to the identity matrix). Foad found that exchange rate volatility between the host country and the US has a significant negative effect on inward FDI position (level of FDI) and no effect in terms of FDI inflows.

6.4.4 Conclusion

The interest in the impact of exchange rate volatility on FDI is growing among policy makers, as the number of countries adopting the floating exchange rate system has been increasing. Empirical investigation of the relationship between exchange rate volatility and FDI is very important in the formulation of FDI policies, because FDI brings various benefits to both investing countries (home countries) and recipient countries (host countries). In the light of the important contributions which

FDI delivers to both home and host countries, it is useful to discern the factors that would contribute to the promotion of FDI. In the discussion above, we have shown that empirical research on FDI and exchange rate volatility shows ambiguous effects.

7 Conclusion

In this chapter we began by discussing the definitions of exchange rates and their volatility, as well as the different measures of exchange rate volatility. We then reported the theoretical and empirical literature on the relationship exchange rate volatility has on international trade and trade balance, stock market and foreign direct investment. From our analyses of the literature, we found that exchange rate volatility has an ambiguous impact, both theoretically and empirically, on international trade and trade balance, the stock market and foreign direct investment.

References

Abbot, Andrew, Adrian C. Darnell, and Lynne Evans, 2001, The influence of exchange rate variability on UK export, *Applied Economics Letters* 8, 47-49.

Abdalla, Issam S.A., and Victor Murinde, 1997, Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan and the Philippines, *Applied Financial Economics* 7, 25-35.

Aggarwal, R., 1981, Exchange rates and stock prices: A study of the US capital markets under floating exchange rates, *Akron Business and Economic Review* 12, 7-12.

Agolli, Mimoza, 2004, Exchange rate volatility effect on trade variations, Albanian Center for International Trade.

Aizenman, Joshua, 1992, Exchange rate flexibility, volatility and the patterns of domestic and foreign direct investment, NBER Working Papers Series (Cambridge).

Ajayi, Richard A., Joseph Friedman, and Seyed M. Mehdian, 1998, On the relationship between stock returns and exchange rates: Tests of Granger causality, *Global Finance Journal* 9, 241-251.

Akhtar, M.A., and Spence Hilton, 1984, Effects of exchange rate uncertainty on German and U.S. trade., *Federal Reserve Bank of New York, Quarterly Review* 9, 7-16.

Alaba, Olumuyiwa B., 2003, Exchange rate uncertainty and foreign direct investment in Nigeria, WIDER Conference on Sharing Global Prosperity (Helsinki, Finland).

Arellano, Manuel, and Olympia Bover, 1995, Another look at the instrumental variable estimation of error-components models, *Journal of Econometrics* 68, 29-51.

Aristotelous, Kyriacos, 2001, Exchange rate volatility, exchange rate regime and trade volume: evidence from the UK-US export function (1889-1999), *Economics Letters* 72, 87-94.

Arize, A. C., 1996, The impact of exchange rate uncertainty on export growth:evidence from Korean data, *International Economic Journal* 10.

Arize, A. C., 1998, The effects of exchange rate volatility on US imports: an empirical investigation, *International Economic Journal* 12.

Asafu-Adjaye, John, 1999, Exchange rate variability and export growth in Fiji, Asia Pacific School of Economics and Management, Australian National University (Sydney).

Asseery, A., and D. A. Peel, 1991, The effects of exchange rate volatility on exports, *Economics Letters* 37, 173-177.

Bah, I. , and H. A. Amusa, 2002, Real exchange rate volatility and foreign trade: evidence from South Africa's exports to the United States, School for Economics Sciences, University of Pretoria.

Bahmani-Oskooee, Mohsen, and A. Sohrabian, 1992, Stock prices and the effective exchange rate of the dollar, *Applied Economics* 24, 459-64.

Bailey, Martin J., George S. Tavlas, and Michael Ulan, 1987, The impact of exchange rate volatility on export growth: some theoretical considerations and empirical results., *Journal of Policy Modeling* 9, 225-243.

Bailey, Martin J., George S. Tavlas, and Michael Ulan, 1986, Exchange rate variability and trade performance: Evidence for the big seven industrial countries., *Weltwirtschaftliches Archiv* 122, 466-77.

Baron, David P., 1976, Fluctuating exchange rates and the pricing of exports, *Economic Inquiry* 14, 425-38.

Barrel, R., S.D. Gottschalk, and S.G. Hall, 2003, Foreign direct investment and exchange rate uncertainty in imperfectly competitive industries, NIESR Discussion Paper (London).

Batten, Jonathan, and Robert Mellor, 1993, Foreign exchange risk management practices and products used by Australian firms, *Journal of International Business Studies* 24, 557-573.

Baum, Christopher F., Mustafa Caglayan, and Neslihan Ozkan, 2001, Nonlinear effects of exchange rate volatility on the volume of bilateral exports, *Journal of Applied Econometrics* Forthcoming.

Belanger, Denis, Sylvia Gutierrez, Daniel Racette, and Jacques Raynauld, 1992, The impact of exchange rate variability on trade flows: Further results on sectoral US imports from Canada, *North American Journal of Economics and Finance* 3, 61-82.

Bell, Gregory K., and Jose Manuel Campa, 1997, Irreversible investments and volatile markets: A study of the chemical processing industry, *The Review of Economics and Statistics* 79, 79-87.

Benassy-Quere, Agnes, Lionel Fontagne, and Amina Lahreche-Revil, 2001, Exchange rate strategies in the competition for attracting FDI, *Journal of the Japanese and International Economics* 15.

Bini-Smaghi, L., 1991, Exchange rate variability and trade: why is it so difficult to find any empirical relationship?, *Applied Economics* 23, 927-36.

Blundell, Robert, and Stephen Bond, 1998, Initial conditions and moment restrictions in dynamic panel data models, *Journal of Econometrics*.

Bodnar, Gordon M., and William M. Gentry, 1993, Exchange rate exposure and industry characteristics: Evidence from Canada, Japan and the USA, *Journal of International Money and Finance* 12, 29-45.

Bollerslev, Tim, R.Y. Chou, and K.F. Kroner, 1992, ARCH modeling in finance: A review of the theory and empirical evidence, *Journal of Econometrics* 52, 5-59.

Branson, W.H., 1983, Macroeconomic determinants of real exchange risk, in R.J. Herring, ed.: *Managing Foreign Exchange Risk* (Cambridge University Press, Cambridge, MA).

Broll, U., 1994, Foreign production and forward markets, *Australian Economic Papers* 62, 1-6.

Byrne, Joseph P., and E. Philip Davis, 2003, Panel estimation of the impact of exchange rate uncertainty on investment in the major industrial countries, Department of Economics and Finance Discussion Papers, University of Brunel (Uxbridge).

Campa, Jose Manuel, 1993, Entry by foreign firms in the United States under exchange rate uncertainty, *The Review of Economics and Statistics* 75, 614-622.

Caporale, Guglielmo Maria, Nikitas Pittis, and Nicola Spagnolo, 2000, Feedbacks between stock prices and exchange rates in the East Asian markets, Department of Economics Working Papers, University of East London (Essex).

Caporale, Tony , and Khosrow Doroodian, 1994, Exchange rate variability and the flow of international trade, *Economics Letters* 46, 49-54.

Chakrabarti, Rajesh, and Barry Scholnick, 2001, Exchange rate expectations and FDI flows, Working Paper Series, Georgia Tech Center for International Business Education and Research (Atlanta, Georgia).

Cheong, Chongcheul, 2004, Does the risk of exchange rate fluctuation really affect international trade flows between countries?, *Economics Bulletin* 6, 1-8.

Cheong, Chongcheul, Maozu Lu, and Jan M. Podivinsky, 2004, The effect of exchange rate uncertainty on US imports from the UK: Consistent OLS estimation with volatility measured by an ARCH-type model, (University of Connecticut, Department of Economics).

Cheong, Chongcheul, Tesfa Mehari, Charalambos Pattichis, and Leighton Vaughan Williams, 2002, Exchange rate volatility and UK exports: implications for EMU membership, Department of Economics and Politics, The Nottingham Trent University.

Cheung, Y-W, and Lillian K. Ng, 1996, A causality-in-variance test and its application to financial market prices, *Journal of Econometrics* 72, 33-48.

Chiang, Thomas C., Sheng-Yung Yang, and Tse S. Wang, 2000, Stock return and exchange rate risk: Evidence from Asian stock markets based on a bivariate GARCH model, *International Journal of Business* 5, 97-117.

Chowdhury, A.R., 1993, Does exchange rate volatility depress trade flows? Evidence from error correction models, *Review of Economics and Statistics* 75, 700-706.

Clark, P.B., 1973, Uncertainty, exchange risk and the level of international trade, *Western Economic Journal* 11, 302-13.

Crowley, Patrick, and Jim Lee, 2002, Exchange rate volatility and foreign investment: International evidence, Working Paper, Texas A&M International University (Laredo, Texas).

Cushman, David O., 1983, The effects of real exchange rate risk on international trade, *Journal of International Economics* 15, 45-63.

Cushman, David O., 1985, Real exchange rate risk, expectations and the level of direct investment, *The Review of Economics and Statistics* 67, 297-308.

Cushman, David O., 1986, Has exchange risk depressed international trade? The impact of third-country exchange risk, *Journal of International Money and Finance* 5, 361-379.

Cushman, David O., 1988, U.S. bilateral trade flows and exchange risk during the floating period, *Journal of International Economics* 24, 317-330.

Darby, Julia, Andrew Hughes-Hallett, Jonathan Ireland, and Laura Piscitelli, 1999, The impact of exchange rate uncertainty on the level of investment, *Economic Journal* 109, C55-C67.

Das, Sujit K., 2003, Effects of exchange rates volatility on international trade: an empirical analysis, Department of Economics, Vanderbilt University (Nashville).

De Grauwe, Paul, 1988, Exchange rate variability and the slowdown in growth of international trade, International Monetary Fund Staff Papers (Washington D.C.).

de Vita, Glauco , and Andrew Abbott, 2004, The impact of exchange rate volatility on UK export to EU countries, *Scottish Journal of Political Economy* 51, 62-81.

Dell'ariccia, Giovanni, 1999, Exchange rate fluctuations and trade flows: evidence from the European Union, International Monetary Fund.

Dixit, Avinash, 1989, Entry and exit decisions under uncertainty, *The Journal of Political Economy* 97, 620-638.

Dixit, Avinash, and Robert S. Pindyck, 1994. *Investment under uncertainty* (Princeton University Press, Princeton).

Doong, Shuh-Chyi, Sheng-Yung Yang, and Alan T. Wang, 2005, The dynamic relationship and pricing of stocks and exchange rates: Empirical evidence from Asian emerging markets, *Journal of American Academy of Business* 7, 118-123.

Dornbusch, R., and S. Fisher, 1980, Exchange rate and the current account, *American Economic Review* 70, 960-971.

Dunning, John H., 1970. *Studies in international investment* (George Allen & Unwin Ltd, London).

Engle, Robert F., 1982, Autoregressive conditional heteroskedasticity with estimates of the variance of United Kingdom inflation, *Econometrica* 50.

Engle, Robert F., and C.W.J. Granger, 1987, Cointegration and error correction representation, estimation and testing, *Econometrica* 5, 251-276.

Ethier, W, 1973, International trade and the forward exchange market, *American Economic Review* 63, 494-503.

Fang, WenShwo, and Stephen M. Miller, 2002, Currency depreciation and Korean stock market performance during the Asian financial crisis, Working Paper 2002, University of Connecticut (Storrs, Connecticut).

Foad, Hisham S., 2005, Exchange rate volatility and export oriented FDI, Department of Economics, Emory University (Atlanta, GA).

Franke, Gunter, 1991, Exchange rate volatility and international trading strategy, *Journal of International Money and Finance* 10, 292-307.

Frenkel, Jacob A., 1978, Purchasing power parity: Doctrinal perspectives and evidence from the 1920's, *Journal of International Economics* 8, 169-91.

Froot, Kenneth A. , and Jerome C. Stein, 1991, Exchange rates and foreign direct investment: An imperfect capital markets approach, *The Quarterly Journal of Economics* 106, 1191-1217.

Gagnon, Joseph E., 1993, Exchange rate variability and the level of international trade, *Journal of International Economics* 34, 269-287.

Gavin, M., 1989, The stock market and exchange rate dynamics, *Journal of International Money and Finance* 8, 181-200.

Goldberg, Linda S., and Charles D. Kolstad, 1995, Foreign direct investment, exchange rate variability and demand uncertainty, *International Economic Review* 36, 855-873.

Gorg, Holger, and Katharine Wakelin, 2001, The impact of exchange rate variability on US direct investment, GEP Research Papers Series, School of Economics, University of Nottingham (Nottingham).

Gotur, P, 1985, Effects of exchange rate volatility on trade: Some further evidence, International Monetary Fund Staff Papers (Washington D.C.).

Granger, C.W.J., 1969, Investigating causal relations by econometrics models and cross spectral methods, *Econometrica* 40, 424-38.

Granger, C.W.J., Bwo-Nung Huang, and Chin-Wei Yang, 2000, A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu, *The Quarterly Review of Economics and Finance* 40, 337-354.

Green, W, 2000. *Econometric Analysis* (Prentice Hall, New Jersey).

Gregory, Allan W., and Bruce E. Hansen, 1996, Residual-based tests for cointegration in models with regime shifts, *Journal of Econometrics* 70, 99-126.

Hansen, L.P., and T.J. Sargent, 1980, Formulating and estimating dynamic linear rational expectations models, *Journal of Economic Dynamics and Control* 2, 7-46.

Hara, Masayuki, and Ivohasina F. Razafimahefa, 2003, The determinants of foreign direct investment into Japan, Graduate School of Economics, Kobe University (Kobe, Japan).

Hatemi-J, Abdulnasser, and Eduardo Roca, 2005, Exchange rates and stock prices interaction during good and bad times: Evidence from the ASEAN4 countries, *Applied Financial Economics* 15, 539-546.

Hooper, Peter, and Steven W. Kohlhagen, 1978, The effect of exchange rate uncertainty on the prices and volume of the international trade, *Journal of International Economics* 8, 483-511.

Iannizzotto, Matteo, and Nigel J. Miller, 2002, The effect of exchange rate uncertainty on foreign direct investment in the United Kingdom, Working Paper Series, Department of Economics, University of York (Heslington, York).

Ibrahim, M.H., 2000, Cointegration and Granger causality tests of stock price and exchange rate interactions in Malaysia, *ASEAN Economic Bulletin* 17, 36-47.

International Monetary Fund, 1993. *Balance of Payments Manual* (IMF, Washington DC).

International Monetary Fund, 1995. *Balance of Payments Compilation Guide* (IMF, Washington DC).

Inter-Secretariat Working Group on National Accounts, 1993. *System of National Accounts* (Eurostat, IMF,OECD,United Nations and World Bank, Brussels/Luxembourg, New York, Paris, Washington DC).

Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* 12, 231-254.

Johansen, S. , and K Juselius, 1990, Maximum likelihood estimation and inferences on cointegration - with application to the demand for money, *Oxford Bulletin of Economics and Statistics* 52, 169-210.

Jorian, Philippe, 1990, The exchange rate exposure of US multinationals, *Journal of Business* 63, 331-345.

Kenen, P.B., and D. Rodrik, 1986, Measuring and analyzing the effects of short-term volatility in real exchange rates, *Review of Economics and Statistics* 68, 311-15.

Kindleberger, Charles P., 1969. *American business abroad: Six lectures on direct investment* (Yale University Press, New Haven and London).

Kiyota, Kozo, and Shujiro Urata, 2004, Exchange rate, exchange rate volatility and foreign direct investment, *The World Economy* 27, 1501-1536.

Klein, Michael W., 1990, Sectoral effects of exchange rate volatility on US exports, *Journal of International Money and Finance* 9, 299-308.

Klein, Michael W., and E Rosengren, 1994, The real exchange rate and foreign direct investment in the United States: Relative wealth vs. relative wage effects, *Journal of International Economics* 36, 373-89.

Koray, F., and William D. Lastrapes, 1989, Real exchange rate volatility and US bilateral trade: a VAR approach, *Review of Economics and Statistics* 71, 708-12.

Kroner, Kenneth F. , and William D. Lastrapes, 1993, The impact of exchange rate volatility on international trade: reduced form estimates using the GARCH-in-mean model, *Journal of International Money and Finance* 12, 298-318.

Krugman, Paul R., 1978, Purchasing power parity and exchange rates, *Journal of International Economics* 8, 397-408.

Kumar, Vikram, 1992, Real effects of exchange risk on international trade, *Federal Reserve Bank of Atlanta, Working Papers* 92-5.

Lastrapes, William D., and F. Koray, 1990, Exchange rate volatility and US multilateral trade flows., *Journal of Macroeconomics* 12, 341-362.

Law, Siong Hook , and Hui Boon Tan, 2000, Real exchange rate volatility and the Malaysian exports to its major trading partners, Department of Economics, Universiti Putra Malaysia.

Lucas, R.E., and E.C. Prescott, 1971, Investment under uncertainty, *Econometrica* 39, 659-681.

MacDonald, Ronald, 1993, Long-run purchasing power parity: Is it for real?, *Review of Economics and Statistics* 75, 690-5.

MacDonald, Ronald, and C. Kearney, 1987, On the specification of Granger causality tests using the cointegration methodology, *Economics Letters* 25, 149-53.

Makin, John H., 1978, Portfolio theory and the problem of foreign exchange risk, *Journal of Finance* 33, 517-34.

Mark, Nelson C., 1990, Real and nominal exchange rates in the long run: An empirical investigation, *Journal of International Economics* 28, 115-136.

McKenzie, Michael D., 1998, The impact of exchange rate volatility on Australian trade flows, *Journal of International Financial Markets, Institutions and Money* 8, 21-38.

McKenzie, Michael D., 1999, The impact of exchange rate volatility on international trade flows, *Journal of Economic Surveys* 13, 71-106.

McKenzie, Michael D. , and Robert D. Brooks, 1997, The impact of exchange rate volatility on German-US trade flows, *Journal of International Financial Markets, Institutions and Money* 7, 73-87.

Merton, Robert, 1980, On estimating the expected return to the market: An exploratory investigation., *Journal of Financial Economics* 8, 323-361.

Miller, S.M., and F.S. Russek, 1990, Cointegration and error correction models: The temporal causality between government taxes and spending, *South Economic Journal* 57, 221-9.

Mishra, Alok Kumar, 2004, Stock market and foreign exchange market in India: Are they related?, *South Asia Economic Journal* 5, 209-232.

Newey, W.K., and K.D. West, 1987, A simple positive semi-definite, heteroscedasticity and autocorrelation consistent covariance matrix, *Econometrica* 55, 703-708.

Pagan, A., 1984, Econometric issues in the analysis of regressions with generated regressors, *International Economic Review* 25, 221-247.

Pagan, A., and A. Ullah, 1988, The econometric analysis of models with risk terms, *Journal of Applied Econometrics* 3, 87-105.

Pain, Nigel, and Desiree Van Welsum, 2003, Untying the Gordian Knot: The multiple links between exchange rates and foreign direct investment, *Journal of Common Market Studies* 41, 823-846.

Pattichis, Charalambos, Chongcheul Cheong, Tesfa Mehari, and Leighton Vaughan Williams, 2004, Exchange rate uncertainty, UK trade and the Euro, *Applied Finance Economics* 14, 885-893.

Peree, Eric, and Alfred Steinherr, 1989, Exchange rate uncertainty and foreign trade, *European Economic Review* 33, 1241-1264.

Pesaran, M. Hashem, Yongcheol Shin, and R.J. Smith, 1999, Pooled Mean Group estimation of dynamic heterogeneous panels, *Journal of the American Statistical Association* 94, 621-634.

Pesaran, M. Hashem, Yongcheol Shin, and R.J. Smith, 2001, Bounds testing approaches to the analysis of level relationships, *Journal of Applied Econometrics* 16, 289-326.

Phylaktis, Kate, and Fabiola Ravazzolo, 2000, Stock prices and exchange rate dynamics, Working Paper, City University Business School (London).

Rahmatsyah, Teuku, Gulasekaran Rajaguru, and Reza Y. Siregar, 2002, Exchange rate volatility, trade and "fixing for life" in Thailand, *Japan and the World Economy* 14, 445-470.

Reimers, H-E., 1992, Comparisons of tests for multivariate cointegration, *Statistical Papers* 33, 335-359.

Sercu, Piet, and Cynthia Vanhulle, 1992, Exchange rate volatility, international trade, and the value of exporting firms, *Journal of Banking and Finance* 16, 155-182.

Serven, Luis, 2003, Real exchange rate uncertainty and private investment in LDCs, *Review of Economics and Statistics* 85, 201-234.

Smith, C., 1992, Stock markets and the exchange rate: a multi-country approach, *Journal of Macroeconomics* 14, 607-29.

Smyth, R., and M. Nandha, 2003, Bivariate causality between exchange rates and stock prices in South Asia, *Applied Economics Letters* 10, 699-704.

Soenen, Luc A., and Elizabeth S. Hennigar, 1988, An analysis of exchange rates and stock prices-The US experience between 1980 and 1986, *Akron Business and Economic Review* Winter 19, 7-16.

Solnik, B. H., 1984, Stock and money variables: The international evidence, *Financial Analyst Journal* 69-73.

Solnik, Bruno, 1987, Using financial prices to test exchange rate models: A note, *Journal of Finance* 42, 141-149.

Sung, Hongmo, and Harvey E. Lapan, 2000, Strategic foreign direct investment and exchange rate uncertainty, *International Economic Review* 41, 411-423.

Thursby, Jerry G., and Marie C. Thursby, 1987, Bilateral trade flows, the Linder hypothesis, and exchange risk, *The Review of Economics and Statistics* 69, 488-495.

Toda, H.Y., and T. Yamamoto, 1995, Statistical inference in vector autoregressions with possibly integrated processes, *Journal of Econometrics* 66, 225-50.

Vergil, Hasan, 2002, Exchange rate volatility in Turkey and its effect on trade flows, *Journal of Economic and Social Research* 4, 83-99.

Viaene, Jean-Marie , and Casper G. de Vries, 1992, International trade and exchange rate volatility, *European Economic Review* 36, 1311-1321.

Wilkins, Mira, 1970. *The emergence of multinational enterprise: American business abroad from the colonial era to 1914* (Harvard University Press, Cambridge, MA).

Wolf, A., 1995, Import and hedging uncertainty in international trade, *Journal of Futures Markets* 15, 101-110.

CHAPTER THREE

RINGGIT VOLATILITY AND TRADE BALANCE PERFORMANCE

1 Introduction

The effect of foreign exchange rate volatility on international trade is often discussed in the literature. While most economists believe that exchange rate volatility has a negative effect on international trade, others suggest the opposite. Indeed, theoretical and empirical studies often yield conflicting results on foreign exchange rate volatility and international trade relationships.

As we discussed in the literature survey chapter earlier, early theoretical models on the relationship between exchange rate uncertainty and international trade generally predict a negative relationship between exchange rate volatility and the level of international trade. Ethier (1973), Hooper and Kohlhagen (1978), Cushman (1986) and Peree and Steinherr (1989), are amongst those who suggested that exchange rate volatility may reduce trade flows. They argue that, since exchange rate volatility would increase the risks of foreign traders, the risk-averse traders will tend to reduce their trade levels (especially if forward market facilities do not exist or the hedging facilities are costly). An opposite view contends that exchange rate uncertainty positively affects international trade. Franke (1991), Sercu and Vanhulle (1992) and Viaene and de Vries (1992), argued that exchange rate uncertainty positively affects international trade since firms, on average, enter a market sooner and exit later when exchange rate volatility increases. This phenomenon happens because Franke (1991) regards firms' exports as an option, and hypothesizes that their values may increase with volatility, just like the value of a stock option. The higher the exchange rate

volatility, the higher will be the value of the export. He also analyses firms' decision to enter (exit) foreign markets based on the entry (exit) costs against the profits (losses) created by exports. The firms will enter (exit) a foreign market if the present values of the cash flows of the exports exceed the present values of the entry (exit) costs. Assuming mean-reverting real exchange rates, linearity of log cash flows in exchange rates and risk neutrality, he concludes that, when exchange rate volatility increases, export values increase and, therefore, on average, firms enter a market sooner and exit later. As a result, the number of trading firms will increase, since international trades would benefit from exchange rate volatility.

At the theoretical level, models aimed at examining the effect of foreign exchange rate variability on international trade levels find that the postulated impact may be positive or negative depending on the assumptions employed. The assumptions could be related to the source of uncertainty in exchange rates, model specifications, proxies for exchange rate volatility, traders' attitude towards risk, presence or absence of hedging facilities and the choices of sample periods and countries.

The empirical evidence is also mixed. Klein (1990), Asseery and Peel (1991) and McKenzie and Brooks (1997) find some positive evidences in the relationship between exchange rate variability and trade flows. Meanwhile, Kenen and Rodrik (1986), Koray and Lastrapes (1989), Chowdhury (1993) and Arize, Osang and Slottje (2000) argue that exchange rate variability negatively affects international trade flows. However, Kroner and Lastrapes (1993) discover both positive and negative effects of foreign exchange rate on trade levels, while McKenzie (1998) and Aristotelous (2001) find insignificant relationships between exchange rate volatility and trade flows.

Most of the studies relating to the relationship of foreign exchange rate volatility and international trade focus on the exports and/or imports scenarios. Some examples are Akhtar and Hilton (1984), Cushman (1988), Gagnon (1993), McKenzie and Brooks (1997, Pattichis, Cheong, Mehari and Williams (2004). As far as we know, very few studies have investigated the relationship between foreign exchange rate volatility and trade balance. But there are such studies done and some examples are Bahmani-

Oskooee (1991), Baharumshah (2000), Bahmani-Oskooee and Mirzai (2000) and Onafowora (2003).

The primary purpose of this paper is to analyse the long-run impact of bilateral real exchange rate volatility on Malaysia's bilateral trade balance with its major trading partners, comprising the United States, Singapore, Japan, United Kingdom, and Republic of Korea over the monthly period 1990:1 to 2002:12. The long-run impact will be analysed using the cointegration analysis and a vector error correction model (VECM) framework which treats all variables in the model as potentially endogenous. The Granger causality tests within the VECM would then be applied to investigate causality among the variables.

2 Malaysian Trade Balance

Even though considerable efforts to promote market diversification in terms of trading partners for Malaysian trades have been the main objective of the government in the late 1980s, the bulk of Malaysian trades in 1990s remains dominated by her traditional trading partners, namely Japan, the United States and Singapore. Table 3.1 it shows how these three trading partners accounted for 55.67% of Malaysian exports in 1990 and that they continued to account for 48.49% of Malaysian exports in 2002 (see External Trade Statistics, Department of Statistics, Malaysia). When we include the United Kingdom and the Republic of Korea, the exports from these five countries accounted for 64.25% and 54.18% of Malaysian exports in 1990 and 2002, respectively. This indicates that Malaysia relies heavily on them for her exports. Similar phenomenon is found in terms of imports. Malaysian imports from Japan, the United States and Singapore were 55.95% and 46.12% in 1990 and 2002, respectively. From these statistics, it is clear that Malaysia trades mainly with these three countries.

Table 3.1. The Malaysian International Trade 1990 and 2002 (RM'000)

	1990		2002	
Country	Export	Import	Export	Import
Japan	12,590,469 (15.85%)	19,071,306 (24.13%)	39,689,873 (11.21%)	53,812,618 (17.78%)
U. States	13,489,114 (16.98%)	13,286,755 (16.81%)	71,478,440 (20.19%)	49,490,752 (16.36%)
Singapore	18,141,149 (22.84%)	11,861,387 (15.01%)	60,524,566 (17.09%)	36,242,696 (11.98%)
U. Kingdom	3,136,763 (3.95%)	4,327,391 (5.48%)	8,327,034 (2.35%)	5,965,937 (1.97%)
Korea	3,677,254 (4.63%)	2,037,737 (2.58%)	11,832,388 (3.34%)	16,006,070 (5.29%)

Note: Figures in parentheses refers to percentage of total
Source: Department of Statistics, Malaysia

Taking an overall view, it can be seen that, during the 1990 and early 2000 periods, Malaysia's trade balances were good, even with the occurrence of the 1997 Asia financial crisis. In Figure 3.1, the trade balance[1] on average is at 1.1 times in the early 1990s right up to 1997 when the Asia financial crisis happened, taking a jump up to 1.32 and 1.36 times in 1998 and 1999, respectively. For the periods after 2000, the trade balance is steadily growing at an average of 1.25 times a year.

The steady growth of the trade balance between 1990 and early 2000 was due to good flows of exports and imports which happened during that time. Exports and imports were growing at an average of 18% a year during the early 1990s up to 1996. The 1997 Asia financial crisis did affect Malaysian trades, but only in the first two years of it happening, when exports and imports dropped by 7.29% and 26.54% in 1997 and 1998 respectively. Thereafter, it bounced back by 16.92% for exports and

[1] The trade balance is in terms of the ratio of exports to imports throughout this paper.

12.92% for imports in 1999. These scenarios were due to the economic reforms carried out by the government in an attempt to overcome the financial crisis, such as promoting consumer spending and capital controls and pegging the exchange rate to the US dollar. The dip in exports and imports in the year 2001 was due to the global recession during that period, since Malaysia depended heavily on global economic prospects for her economic growth.

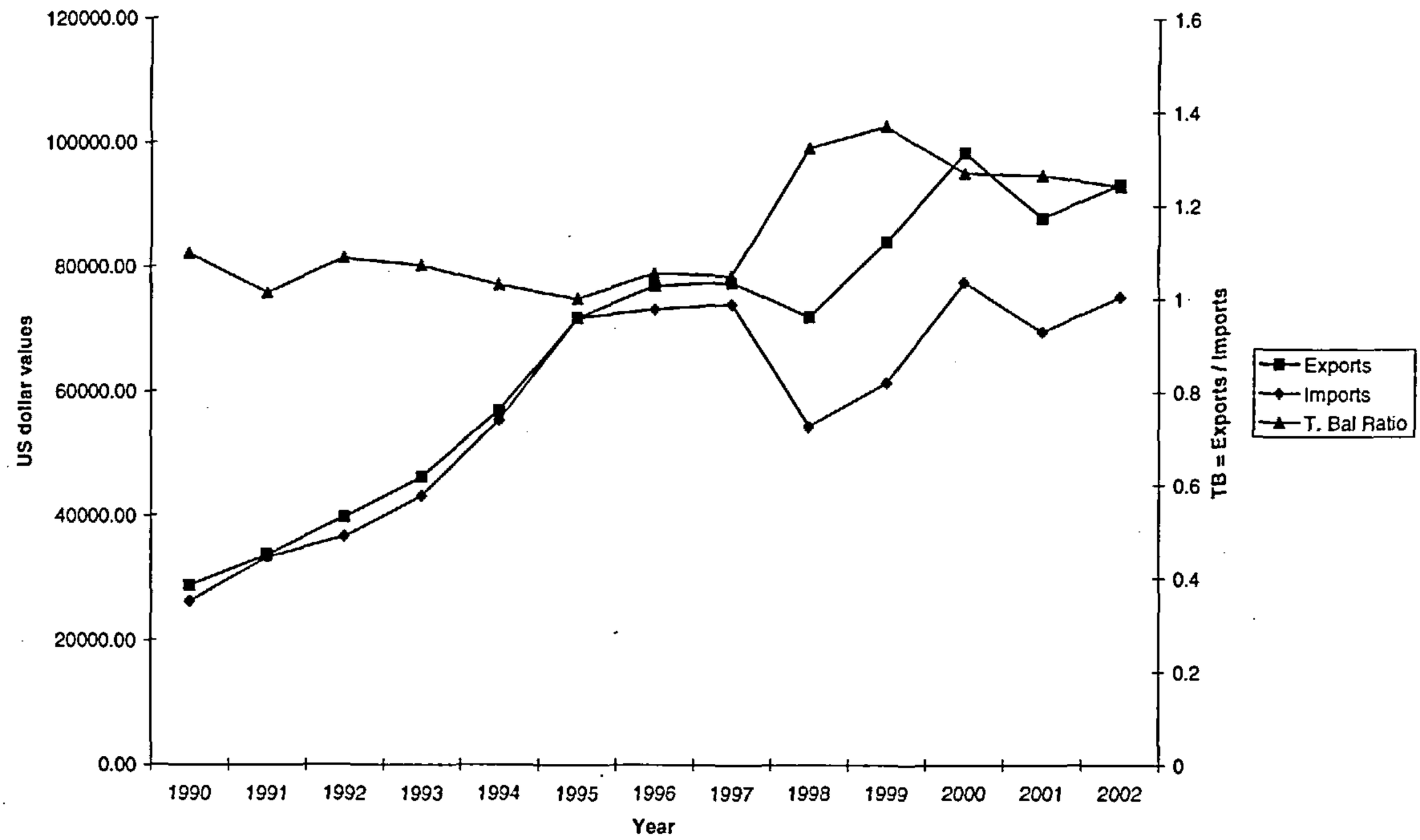

Figure 3.1. Malaysia's Exports, Imports and Trade Balance Flows 1990-2002

Source: International Monetary Fund Statistics.

As reported in Table 3.1, in terms of export markets for Malaysia, the positions of Singapore and the United States are reversed in 1990 and 2002. In 1990, Singapore was the largest market with 22.84% and the United States second with 16.98%. However, in 2002 the United States became the largest market with 20.19% and Singapore became second with 17.09%. Even though Malaysia's total imports from the United States and Singapore were about 32% in 1990 and 28% in 2002, Malaysia still had favourable trade balances with these two countries, and the United States

was the largest market for Malaysia's exports during the 1990s. This could have been due to the lower ringgit value in terms of the US dollar which makes Malaysian products much cheaper for Americans to buy. Moreover, out of the total exports, 62% of them came from semi-conductors and other electrical and electronic goods, of which the United States was the largest buyer.

In 1990 and 2002 Japan ranked third in terms of Malaysia's exports and imports. However, trades with Japan could not be said to be favourable to Malaysia, since there were trade deficits in both these periods. Of the total exports, exports from Malaysia to Japan in 1990 and 2002 were 15.85% and 11.21%, respectively. Of the total imports, Malaysian imports from Japan were 24.13% in 1990 and 17.78% in 2002. One major reason for this trade imbalance was the Japanese trade restriction on Malaysian goods.

Malaysia's trade with the United Kingdom had been deteriorating over a period of years. In the 1970's and 1980's, exports to the United Kingdom were in the range of 10 to 15% but in 1990 it dropped to 3.95% and in 2002 to 2.35%. Imports from the United Kingdom also dropped from 5.48% in 1990 to just 1.97% in 2002. The reduction in imports from the United Kingdom could be due to the government policy of "looking East" i.e. to Japan and Korea, and also because of high exchange rates between ringgit and pound sterling making British goods too expensive for the Malaysians.

One country which emerged as a new trading partner of Malaysia from the late 80s onwards is the Republic of Korea. Even though exports to the Republic of Korea declined in 2002 from 1990, imports from them almost doubled in 2002 to 5.29%. As reported in Table 3.2, the Republic of Korea ranked as the fifth largest market from which Malaysia has been importing from in the last 13 years. The reason behind this increase was due to the favourable exchange rate to Malaysia, since the ringgit was quite strong against the Korean won.

Figure 3.2 - Figure 3.6 show the trade balance (measured in terms of the ratio of exports to imports) of Malaysia with each of the trading partners. The trade balance flows of Malaysia and the United States and Singapore show that the trade balance is

growing steadily throughout the 1990 and 2000 periods. On average, the trade balance with both countries is over 1.5 times a year for most of the 1990s, reaching 2.0 times with the United States and 1.8 times with Singapore during early 2000 and onwards. The Augmented Dickey-Fuller (ADF) tests show a minimum positive trend for Malaysian trade balances with both countries.

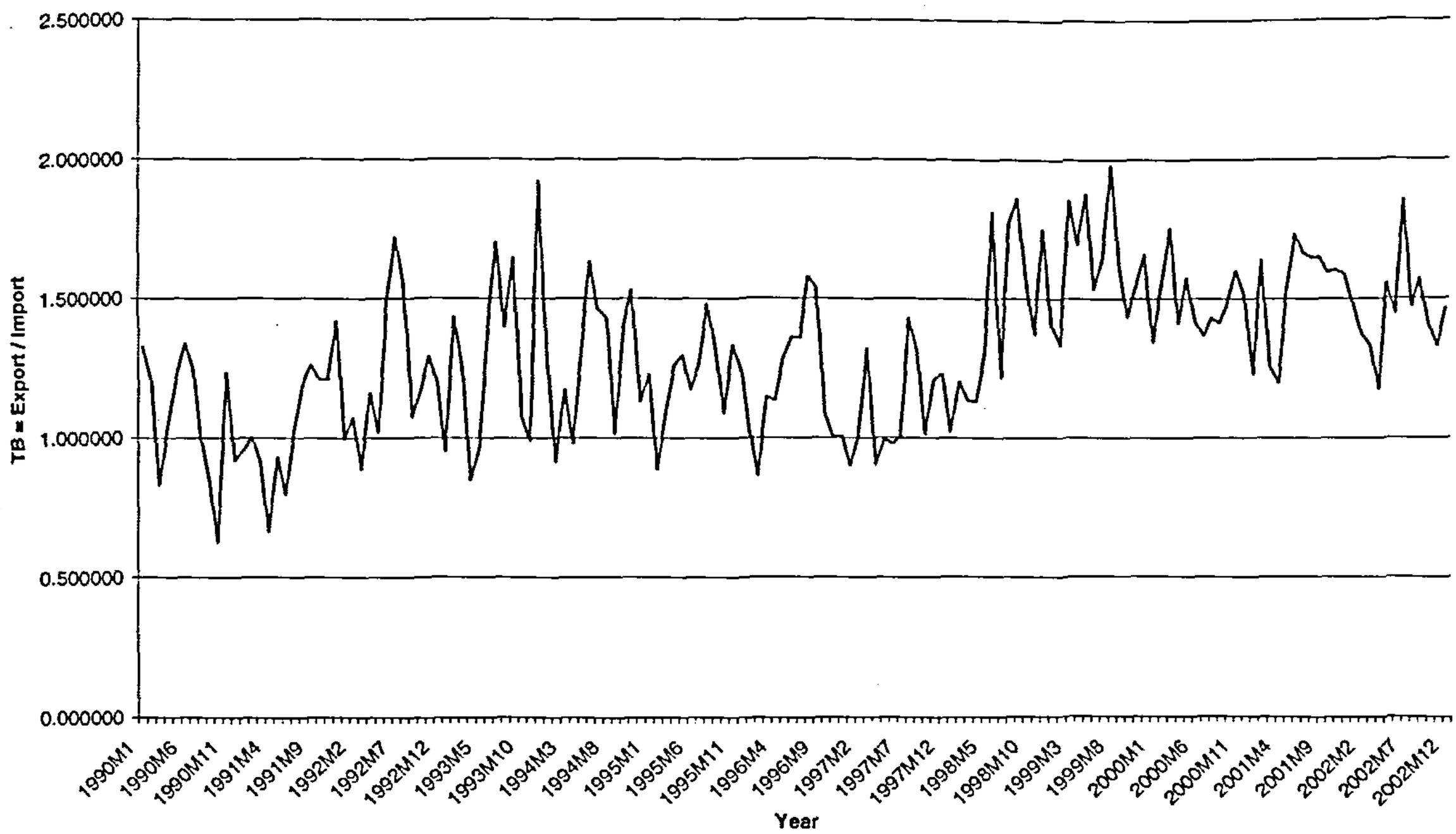

Figure 3.2. Trade Balance: Malaysia with United States

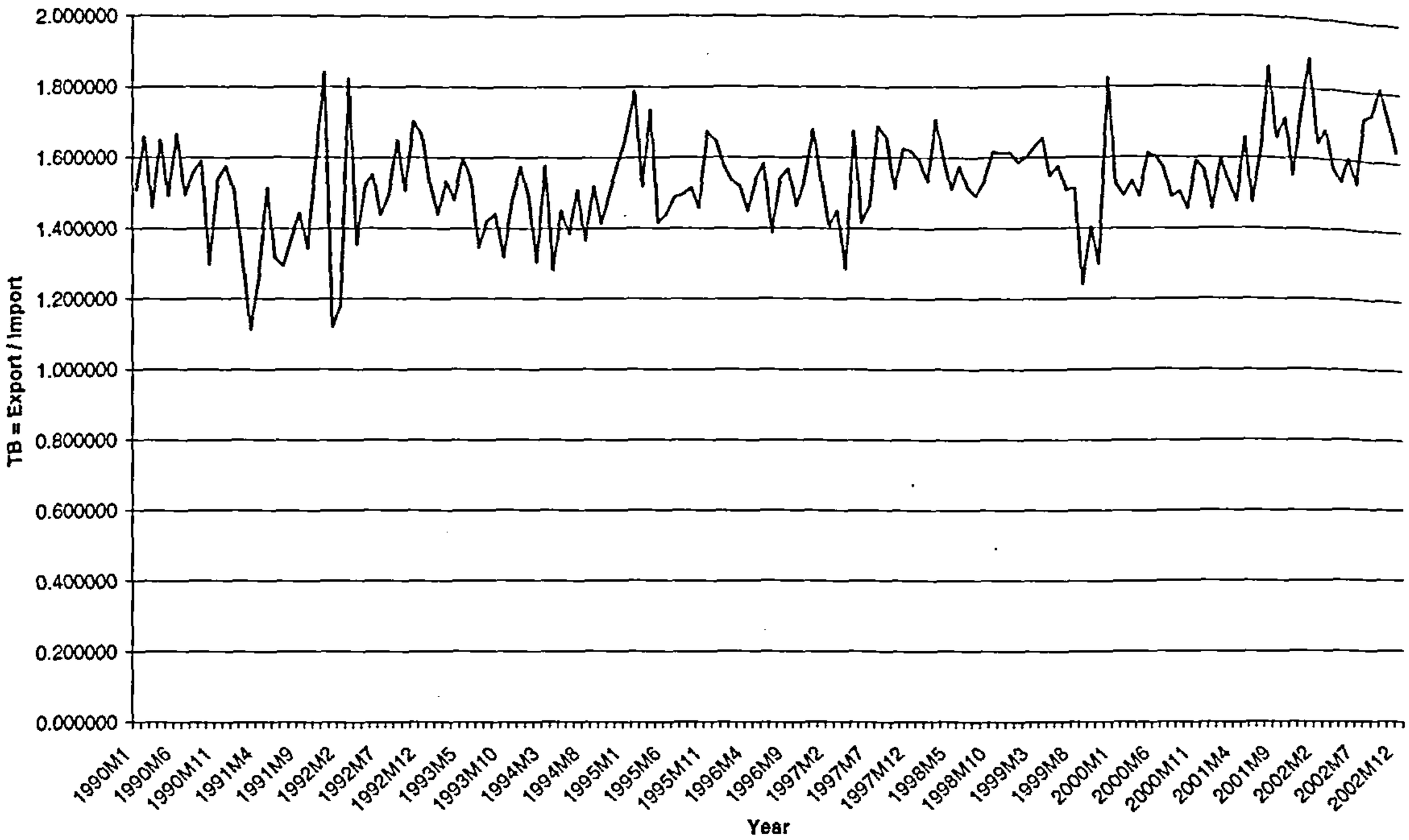

Figure 3.3. Trade Balance: Malaysia with Singapore

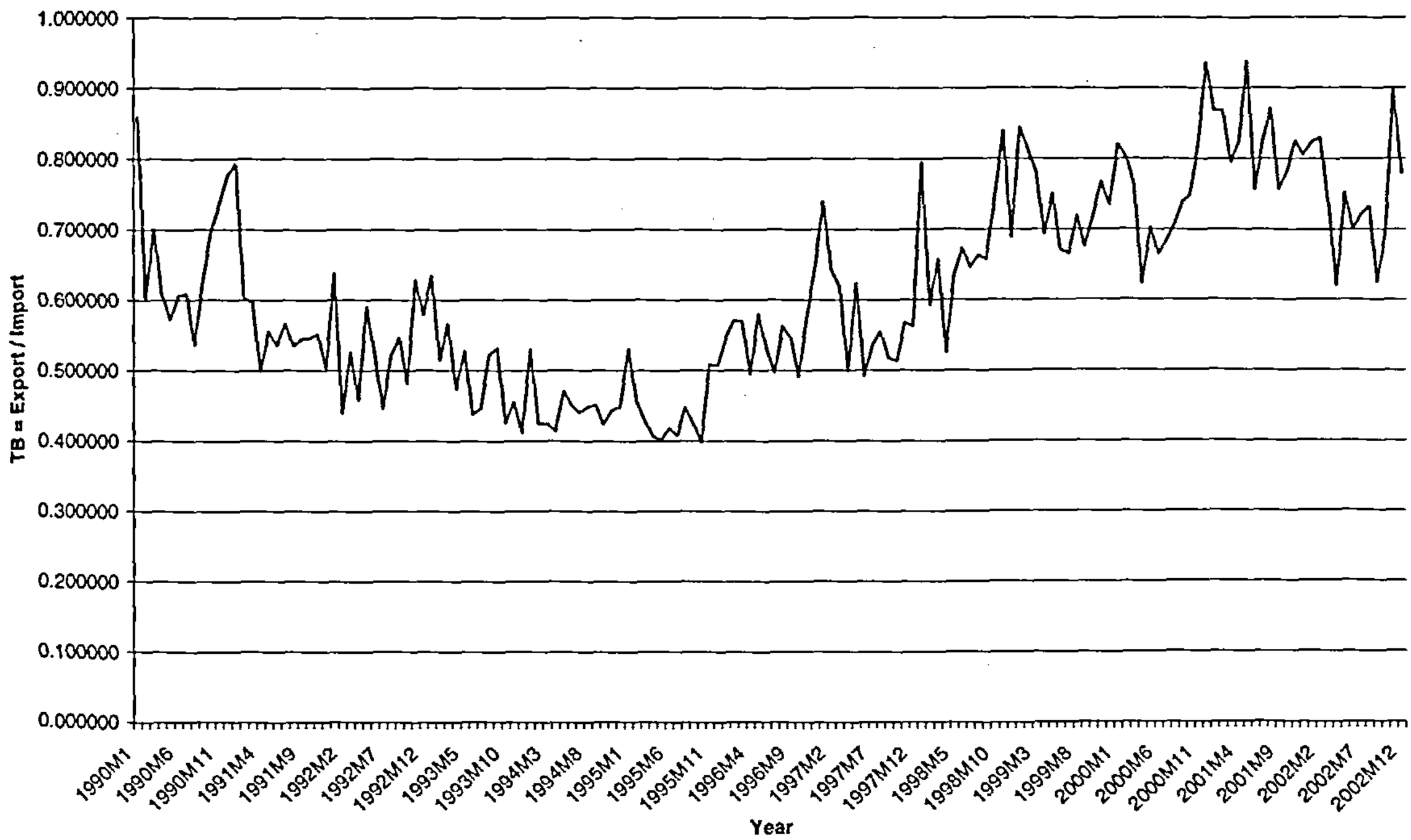

Figure 3.4. Trade Balance: Malaysia with Japan

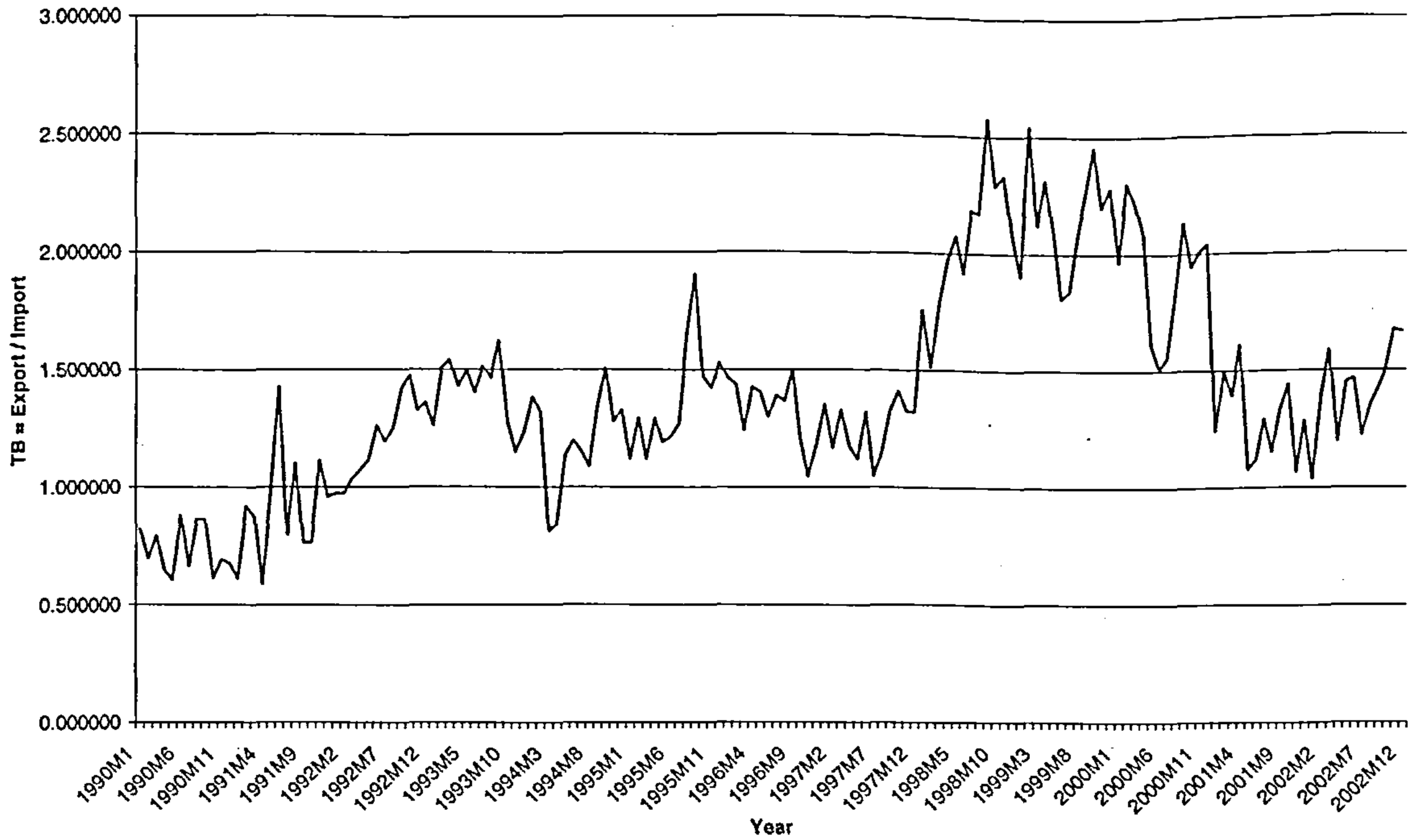

Figure 3.5. Trade Balance: Malaysia with United Kingdom

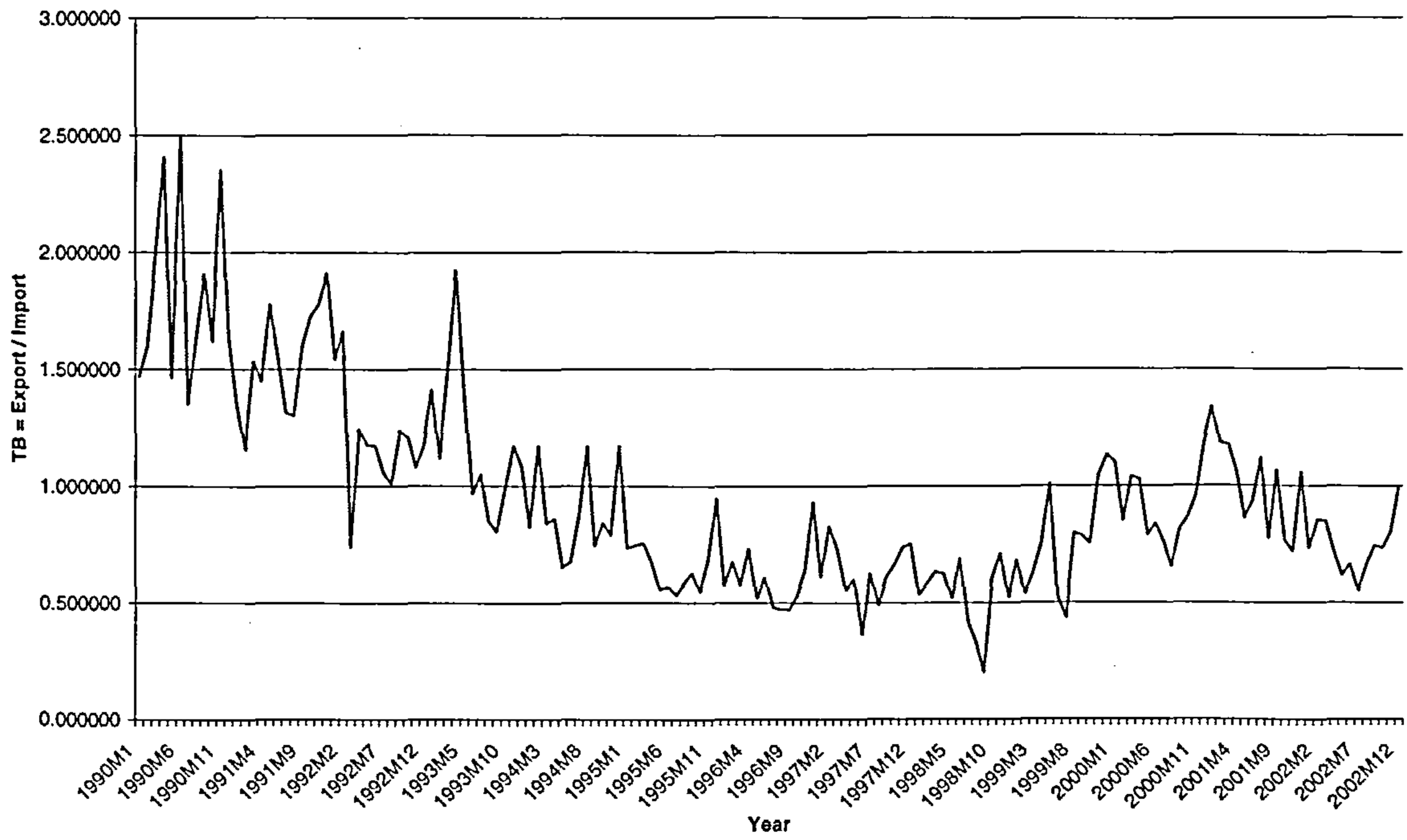

Figure 3.6. Trade Balance: Malaysia with South Korea

The trade balance with Japan is very interesting, with the trend over the sample period changing course. There is a declining trend in the first half and an upward trend in the second half. The ADF test shows that the negative trend in the early 1990's is significant at 0.4% level, while the later stages of the period show a positive trend at 1% significant level. However, for the whole sample period the ADF test shows a positive trend at a 3.18% significance level. This phenomenon is due to the increase in exports from Malaysia into Japan in the mid-1990s after the Japanese government relaxed its protectionism of home industries by allowing more foreign goods to come in.

The Malaysian trade balance with the United Kingdom seems to have a positive trend, but an ADF test does not show that the trend is significant. The graph in Figure 3.5 shows that the trade balance is growing steadily at the range of 0.5 to 1.5 times in the early 1990s before picking up at almost 2.5 times after the financial crisis period. The increase in the trade balance is mainly due to the increase in the exports - they almost double in size after the 1997 Asia financial crisis periods, which could be due to the cheaper price of Malaysian goods to the British.

Figure 3.6 shows that the trend of trade balance between Malaysia and the Republic of Korea seems to be negative, though the ADF test does not prove the trend to be significant. The trade balance seems to be decreasing from 2.5 times in the early 1990s to just over 0.5 times in the period after 1993. This negative trend is due to increased imports, whereby Korean goods are much cheaper compared to other foreign goods (especially those from Japan) making Malaysia now turn to the Republic of Korea for their consumer goods. As shown in Table 3.1, Malaysian imports from the Republic of Korea in 2002 almost doubled in size when compared to 1990.

3 Methodology and Data

3.1 Empirical model and data description

Many of the trade theories relating to the underlying reasons for international trade limit themselves to a discussion on the role of exchange rates in determining international trade or vice versa. The factor-proportions theory, for example, focuses on how differences in factor endowments produce incentives to trade. However, recently, more trade theories have focused on the behaviour of the external balance over time. These works emphasize the role of the external balance in facilitating desirable paths of consumption, saving and investment across countries and exchange rate, as important determinants of such trade flows. Due to these models focusing on the appropriate path for the net trade over time, the study on the relationships between exchange rate and trade flows should be emphasised more.

Even though exchange rate is not so important in much of the theoretical work on trade, it has played a central role in estimated equations for trade volumes. Trade volumes are usually related to changes in relative prices and to changes in real activity, either at home (for imports) or abroad (for exports). For example, in a typical import equation the volume of imports would be related to current and lagged values of the real exchange rate (or the relative price of imports) and of domestic output (or expenditures). The theoretical work between exchange rate and trade flows could be extended to the study between exchange rate volatility and trade flows, where the impact of exchange rate volatility is measured by adding a term representing this volatility into the trade volumes equation.

Conventional theory suggests that trade balance is determined by macro-variables such as real outputs, exchange rates and money supplies. In addition to that, the macro-variables and trade balance have a unidirectional effect. However, recent studies suggest that trade balance could have a direct or indirect effect on the macroeconomics variables. In our study, the trade balance is modelled by considering the model employed by Bahmani-Oskooee (1991) and Rose (1991) because of its ability to capture the effect on macro-variables on trade balance.

Accordingly, we specify the bilateral trade balance as a function of domestic income, foreign income, relative price levels and exchange rate volatility. The reduced form of the equation is given as follows:

$$tb_t = \beta_0 + \beta_1 w_t + \beta_2 w_t^* + \beta_3 p_t + \beta_4 \sigma_t + \varepsilon_t \qquad (1)$$

where tb is the bilateral trade balance, w is Malaysian income, w^* is foreign income, p is the relative price levels, σ is the bilateral exchange rate volatility and ε is the disturbance term. Lower case letters are used to denote the logarithmic form of the series.

The trade balance is usually measured as the difference between the value of total exports and total imports. In this study, we measure the trade balance according to Bahmani-Oskooee's (1991) model. Bahmani-Oskooee (1991) measured trade balance as the ratio of the bilateral exports value (X) to the bilateral imports value (M). According to Bahmani-Oskooee, measuring the trade balance using the ratio offers a number of advantages. The first advantage is that the ratio is insensitive to the units of measurement of the bilateral exports and imports value. Secondly, it is also insensitive to whether the bilateral exports and imports are in real or nominal terms. This X/M ratio, or its inverse, has been used in many empirical investigations of the trade balance-exchange rate relationships, (e.g. Guptor-Kapoor and Ramakrishnan (1999), Bahmani-Oskooee and Brooks (1999) and Boyd, Caporale and Ron (2001).

The relative competitiveness price level is measured by the ratio of Malaysian consumer price index (CPI) to the trading partners' CPI and is a measure of a country's international competitiveness. It is relevant because it indicates whether domestic products are relatively more expensive or cheaper than foreign products. If this index is high, it shows that domestic products are more expensive relative to foreign products. Therefore, demand for the domestic products would fall. The industrial production index is used as a proxy for the income of Malaysia and foreign countries, since the monthly gross domestic products (GDP) is not available. Although the industrial production index is a more restrictive measure (looking only

at the level of manufacturing), it should reflect the overall trend in the GDP. As for the measures of exchange rate volatility as proxies for exchange rate risk, we experimented with two alternatives: the moving average standard deviation (MASD) employed by Kenen and Rodrik (1986) and Bollerslev's (1986) generalized autoregressive conditional heteroskedasticity (GARCH) models. These two measures will be discussed in more detail in the volatility measurements' section later.

Economics theory suggests that the volume of imports to a domestic country ought to increase as the income and purchasing power of the domestic economy rises, and ought to decrease as the income and purchasing power of the domestic economy falls. Thus, we expect β_1 to be negative. However, if the income and purchasing power of the trading partners' rises, then the volume of exports to the foreign partners ought to increase and decrease if the income and purchasing power of the trading partners falls. Therefore, we can expect β_2 to be positive. However, if the rise in income in the countries is due to an increase in the production of import substitutes, then imports of both countries may decline as income increases, in which case β_1 will be positive and β_2 will be negative. As for the relative prices, an increase means that domestic products are more expensive relative to the products in the foreign country. This scenario will generate demand for a fall in exports. Thus, β_3 is expected to be negative. However, as we have seen the theoretical effect of bilateral exchange rate volatility on the bilateral trade balance is ambiguous. It depends on assumptions. For example, it could be positive if we assumed that exporters are risk averse who would increase export in order to avoid any decline in profits caused by an increase in exchange rate volatility. The trade balance could be negative if we assumed exporters to be risk averse, who would increase the price in order to reduce the risk, and importers who could reduce their exchange rate risk due to the availability of hedging facilities. Therefore, the sign on β_4 could be negative or positive and needs to be estimated.

For the econometric analysis, we use monthly data covering the period 1990:1 to 2002:12 drawn from the IMF, International Financial Statistics, 2002 CD-ROM and 2001 to 2003 monthly series publication for the data of 2001 and 2002 (not available

on CD-ROM), and Department of Statistics, Malaysia for the bilateral trade balance with the trading partners.

In this study, we choose five countries as the trading partners of Malaysia: the United States, Singapore, Japan, the United Kingdom and the Republic of Korea. The countries are chosen based on their ranking in the top 10 exports to and imports from Malaysia during the period 1990 through to 2002. The criteria are that each country must be among the top 10 in both exports to and imports from Malaysia (as reported in Table 3.2). Thailand and Taiwan however, are not included due to the absence of sufficient data. Also, Germany is excluded because of the change in her currency from the deutschmarks to euro in January 1999.

Table 3.2. Malaysian Trading Partners Ranking

Country Export To	Ranking	Country Import From	Ranking
United States	1	United States	2
Singapore	2	Singapore	3
Japan	3	Japan	1
Korea	9	Korea	5
Thailand	6	Thailand	7
United Kingdom	5	United Kingdom	8
China	11	China	9
Germany	10	Germany	6
Hong Kong	4	Hong Kong	12
Netherlands	8	Taiwan	4
Taiwan	7	Australia	10
		France	12
		Indonesia	11
		Philippines	13

3.2 Volatility index

There is no definite answer as to which is the best proxy for exchange rate volatility in the study of exchange rate volatility and trade balance. Basically, there are two

important issues that need to be highlighted when calculating the volatility index of exchange rate. First is the issue of what types of exchange rate to use: nominal versus real. Secondly, there is the question of which measurement should be used to calculate the volatility.

3.2.1 Nominal versus real exchange rate

As discussed in Chapter 2, there are conflicting arguments as to whether exchange rate variability is better measured by nominal or real exchange rate variability. Studies by Akhtar and Hilton (1984) and Cheong (2004) proved that, when using nominal exchange rate variability, the results on the relationships between exchange rate volatility and trades were statistically significant. Whereas, Cushman (1983), Kenen and Rodrik (1986) and Arize (1998), amongst others, showed that real exchange rate volatility has statistically significant results on the relationships between exchange rate volatility and international trades. However, some studies have shown that under the flexible exchange rate regime, fluctuations in nominal and real exchange rates are highly correlated (Thursby and Thursby (1987), Mark (1990) and McKenzie and Brooks (1997)). These authors use nominal and real exchange rate volatility in their studies and found significant results using both. Therefore, the use of nominal or real exchange rate volatility does not matter so much since the distinction between nominal or real exchange rate volatility makes no difference to the results. Moreover, both types of exchange rates have shown significant results when investigating the relationship between exchange rate uncertainty and trade flows.

In this study of ringgit volatility and trade balance performance, we generate the bilateral real exchange rate series of exchange rate volatilities. The bilateral real exchange rate is calculated by multiplying nominal bilateral exchange rate by the relative price given as:

$$R_t = E_t(P_t^* / P_t) \tag{2}$$

where R_t is the real exchange rate at period t, E_t is the nominal exchange rate at period t (ringgit price of one unit of foreign currency), P_t^* is the CPI of foreign country at period t and P_t is the CPI of Malaysia at period t.

The nominal exchange rate of ringgit against US dollar is directly obtained from the International Financial Statistics but the other nominal exchange rates are obtained by exploiting triangular arbitrage between the ringgit exchange rate against the US dollar, and the foreign currencies against the US dollar. An increase in real and nominal exchange rate implies a depreciation of the Malaysian ringgit against the foreign currencies.

3.2.2 Volatility measurements

Various measurements have been used to capture exchange rate uncertainty (Chapter 2). While most studies applied only one measure of exchange rate volatility, in this study we apply the two most commonly used measurements of exchange rate volatility. Having more than one measurement of exchange rate volatility allows us to verify the robustness of our regression results.

The first measurement of the exchange rate volatility is a moving average standard deviation (MASD) of the growth rate of the real exchange rate (RER) employed by Kenen and Rodrik (1986):

$$V_t = \left[\left(\frac{1}{m} \right) * \sum_{i=1}^{m} (\ln RER_{t+i-1} - \ln RER_{t+i-2})^2 \right]^{1/2} \tag{3}$$

where m is the order of moving average, and ln implies the logarithmic form of the bilateral real exchange rate series. Our estimations make use of m equals to 4 following the work of Cushman (1983), Cushman (1988), Aristotelous (2001) and Rahmatsyah, Rajaguru and Siregar (2002), amongst others, who found significant results in their studies. Moreover, this measurement of m equals to 4 has an advantage of capturing higher frequency movements of the exchange rate rather than

higher value of m which tend to smooth out the series. Cushman (1983) did mentioned that if lagged m is higher, then the real exchange rate is expected to fall back toward the purchasing power parity and, thus, would not be so volatile.

For the second measurement, we employ Bollerslev (1986) GARCH models to measure the exchange rate volatility. The underlying model is a GARCH (1,1) specification:

$$Y_t = X_t^{'}\theta + \varepsilon_t \tag{4}$$

$$\sigma_t^2 = \alpha + \beta\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2 \tag{5}$$

in which the mean equation given in Equation (4) is written as a function of exogenous variables with an error term. The conditional variance equation, Equation (5), is a function of three terms: (1) the mean α; (2) the news about volatility from the previous period measured as the lag of the square residual from the mean equation ε_{t-1}^2 (the ARCH term); and (3) the last periods forecast error variance σ_{t-1}^2 (the GARCH term).

However, before applying the GARCH estimation procedure, we first test for the stationarity of the real exchange rates, as well as for the presence of ARCH effects in the real exchange rate process. We found that the real exchange rates are not stationary. Therefore, the first difference of the log of the real exchange rate (to correct for non-stationarity) is used in our estimation of the volatility. In addition, we add a dummy variable to capture the effects of the July 1997 Asia financial crisis and the September 1998 shift in the exchange rate policy. We applied the step dummy variable technique where the Dummy97 variable equals zero for the period before the 1997 economic crisis starts (January 1990 to June 1997) and equals one for the period after it started (July 1997 to December 2002). The Dummy98 variable equals zero for the period before the September 1998 fixed rate system (January 1990 to August 1998) and equals one for the period after the fixed system started (September 1998 to December 2002).

Thus, our GARCH (1,1) specification model is as follows:

$$\Delta er_t = a_0 + a_1 dummy_t + \varepsilon_t, \text{ where } \varepsilon_t \sim N(0, \sigma_t^2) \quad (6)$$

$$\sigma_t^2 = \alpha + \beta\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2 + \delta dummy_t + \mu_t \quad (7)$$

where μ_t is a white noise process with mean zero and variance σ_μ^2. When we run Equation (6) and (7), we found that none of the dummy variables were significant, therefore we dropped the dummy variables from our equation of the GARCH model. The results of the GARCH (1,1) are reported in Table 3.3. We found that for all exchange rates volatility (except for ringgit/Singapore dollar volatility) is specified as GARCH (1,1) model. The ringgit/Singapore dollar volatility is specified as GARCH (0,1) model.

We test the adequacy of these GARCH results by computing the histogram of the standardized residuals in order to check whether the standardized residuals are independently identically distributed (i.i.d) with a mean of 0 and a variance of 1. In all cases we found that the mean is close to 0 and the standard deviation close to 1. We also test for no remaining ARCH effects by checking the correlogram of the standardized residuals and doing the ARCH-LM testing. The results of the correlogram of the standardized residuals reveal, that in all cases, no lag length is significant. The results of the ARCH-LM testing show that the null hypothesis of no ARCH effects can be accepted in all the GARCH models, because all the p-values are more than 0.05 (Refer to Table 3.4 for the results). Thus, the results of the two tests for no remaining ARCH effects indicate that GARCH models have successfully accounted for all of the ARCH effects.

Overall, these diagnostic checks indicate that the GARCH models estimation is adequate. Thus, the fitted values of this GARCH models are used to approximate the exchange rate volatility in this study.

Table 3.3. Regression estimates for the GARCH modelling

$\Delta ex_t = a_0 + \varepsilon_t$, where $\varepsilon_t \sim N(0, \sigma_t^2)$,

$\sigma_t^2 = \alpha + \beta\varepsilon_{t-1}^2 + \gamma\sigma_{t-1}^2 + \mu_t$

Sample	**RM/US$**	**RM/S$**	**RM/¥**	**RM/£**	**RM/Won**
Variance Equation					
Constant, α	0.00002 (3.874)	0.0001 (3.492)	0.0002 (2.646)	0.0003 (2.419)	0.00008 (3.528)
ARCH, β	0.706 (5.531)	0.964 (5.600)	0.177 (3.120)	0.337 (2.698)	0.584 (4.710)
GARCH, γ	0.457 (9.725)	0.044 (0.458)*	0.704 (9.356)	0.433 (2.499)	0.440 (5.481)
Process	GARCH (1,1)	GARCH (0,1)	GARCH (1,1)	GARCH (1,1)	GARCH (1,1)

Notes: The values in parenthesis are z-statistic. The * indicates that it is not significant.

Table 3.4. ARCH-LM Testing

Exchange Rates	**F-statistic (p-value)**
RM/US$	0.469(0.929)
RM/S$	1.388(0.179)
RM/¥	0.966(0.485)
RM/£	0.606(0.834)
RM/Won	0.453(0.938)

Notes: H_0: There are no ARCH effects

H_1: There are ARCH effects

Reject H_0 when p-value is less than 0.05.

3.3 Empirical implementation

In line with recent developments in econometric methodology, we first investigate the time series properties of the data. The analysis of cointegration starts with the determination of the univariate properties of the time series. If the series do not follow the same order of integration, then there can be no meaningful relationship among them. We utilize the Augmented Dickey-Fuller (ADF) test for detecting unit roots in the data.

There are two main approaches to establish if a long-run equilibrium relationship exists among the variables in Equation (1) - the Engle and Granger (1987) two step procedure and the Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration procedure. In this study, we employ the Johansen (1988) and Johansen and Juselius (1990) approach, since it is regarded as superior to the regression based on the Engle and Granger procedure. Moreover, the Johansen-Juselius technique is the preferred approach, as it captures the underlying time series properties of the data. This technique is also a system equation test, providing estimates of all the cointegrating vectors which exist within a vector of variables, while allowing for direct hypothesis tests of the coefficients that enter the cointegrating vector. The test for cointegration allows us to estimate a dynamic error correction specification for Equation (1), which provides estimates of both short and long-run dynamics in the trade balance equation.

The Johansen-Juselius method sets out the maximum likelihood procedure for the estimation and determining the presence of cointegrating vectors in a Vector Autoregression (VAR) system. Suppose the vector of n variables, $Z_t = (Z_{1t,....,}Z_{nt})'$ is generated by the $p-$order vector autoregressive process with Gaussian errors:

$$Z_t = A_1 Z_{t-1} + ...A_p Z_{t-p} + \mu + \varepsilon_{t,} \qquad t = 1,...,T \tag{8}$$

where Z_t is a n x1 vector of stochastic variables, $\varepsilon_{1,....,}\varepsilon_T$ are i.i.d with mean zero and covariance matrix $Np(0,\Sigma)$ and μ is a vector of constants. Since we want to

distinguish between stationarity by linear combinations, as well as differencing this process may be written in error correction form as:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + \ldots + \Gamma_p \Delta Z_{t-p+1} + \prod Z_{t-p} + \mu + \varepsilon_t, \qquad t = 1\ldots, T \qquad (9)$$

The matrix $\prod$ contains information about the long-run relationship between the variables in the vector. Information about the number of cointegrating vectors is found in the rank of $\prod$. In other words, the rank of $\prod$ determines how many linear combinations of Z_t are stationary. If the (n x n) matrix has rank zero, $r = 0$, then all elements of Z_t are non-stationary. Thus, there are no cointegrating relationships between the variables. If $\prod$ is of full rank, $r = n$, then all elements of Z_t are stationary. Thus, any combination of the variables results in a stationary series, i.e. cointegrated. In the intermediate case, $r < n$, there is r non-zero cointegrating vectors among the elements of Z_t and $n - r$ common stochastic trends. If a non-zero relationship is indicated by the test, a stationary long-run relationship is implied. In the case where $0 < r < n$, $\prod$ can be factored as $\alpha\beta'$ (or $\prod = \alpha\beta'$) where α and β are both n x r matrices. The matrix α contains the adjustment parameters while the matrix β is called the cointegrating matrix and has the property that $\beta Z_t \sim \mathrm{I}(0)$, where I(0) indicates integrated of order zero. Thus, we can interpret the relations of βZ_t as stationary relations among potentially non-stationary variables, that is, as cointegrating relations.

We test for the existence of cointegration amongst the variables in Z_t using two tests proposed by Johansen: the Trace test and the Maximum eigenvalue test. The Trace test or likelihood ratio statistic for the hypothesis that there are at most r distinct cointegrating vectors is:

$$\mathrm{TR} = T \sum_{i=r+1}^{N} \ln(1 - \hat{\lambda}_i) \qquad (10)$$

where $\hat{\lambda}_{r+1,\ldots,}\hat{\lambda}_N$ are the $N-r$ smallest squared canonical correlations between x_{t-k} and Δx_t series (where all of the variables entering x_t are assumed I(1)), corrected for the effect of the lagged differences of the x_t process.[2]

Additionally, the Maximum eigenvalue statistic test is the likelihood ratio statistic for testing at most r cointegrating vectors against the alternative of $r+1$ cointegrating vectors is:

$$\mathrm{LR} = T\ln(1-\lambda_{r+1}) \tag{11}$$

Johansen (1988) does provide approximate critical values for the statistic, generated by Monte Carlo methods. However, it has been pointed out by, for example Cheung and Lai (1993) and Reimers (1992), that these statistics may be subject to size distortion depending on the chosen DGP and sample size. To correct for such possibility, Reimers (1992) suggests scaling the test statistics down, while Cheung and Lai (1993) suggest scaling the Johansen critical values up. In this study, we follow Reimers' (1992) approach, in addition to Equations (10) and (11). The small sample corrected formulas are:

$$\mathrm{TR} = (T-np)\sum_{i=r+1}^{N}\ln(1-\hat{\lambda}_i) \tag{10a}$$

$$\mathrm{LR} = (T-np)\ln(1-\lambda_{r+1}) \tag{11a}$$

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[2] For details of the tests, see Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* 12, 231-254.and Johansen, S. , and K Juselius, 1990, Maximum likelihood estimation and inferences on cointegration - with application to the demand for money, *Oxford Bulletin of Economics and Statistics* 52, 169-210.

4 Empirical Analysis and Results

4.1 Time series properties

Before estimating the cointegration parameters, the order of integration of each series should be examined. For each series, we examine the time series properties of the variables using the ADF test. The ADF test statistics for variable y_t are given in the following regression:

$$\Delta y_t = \alpha + \gamma^* y_{t-1} + \sum_{j=1}^{p-1} \phi_j \Delta y_{t-j} + \varepsilon_t \tag{12}$$

where

$$\phi_j = -\sum_{k=j+1}^{p} \gamma_k \quad \text{and} \quad \gamma^* = \left(\sum_{i=1}^{p} \gamma_i\right) - 1$$

The unit root test specification is then used to test the null hypothesis $\gamma^* = 0$ against $\gamma^* < 0$.

We conducted both the intercept and intercept and trend assumptions in carrying out the unit root tests. The ADF test with the intercept in the regression, shows that all variables are unit roots, I(1), except for all exchange rate volatility using the GARCH measurements, exchange rate volatility using MASD measurements for RM/£ volatility and trade balance flows between Malaysia and Singapore. For the ADF test with the intercept and trend in the regression, the results show that the variables are non-stationary, I(1), except in the case of Singapore's income, trade balance flows between Malaysia with the US and Singapore, relative price of Malaysia with Japan and exchange rate volatility using the GARCH measurements for RM/S$ and RM/£. Results from the unit root tests provide strong evidence of non-stationarity in the level of all variables. The unit root tests for the series in first differences confirm our expectation that all the series are non-stationary in their level but stationary in their first difference. The results of the unit roots test are reported in Table 3.5.

Table 3.5. ADF Unit Roots Test

	Intercept	Intercept & Trend	Order of Integration
Income:			
Malaysia	-1.705(-6.038*)	-2.462(-6.177*)	I(1)
US	-0.869(-3.495*)	-1.314(-3.507*)	I(1)
Singapore	-1.214(-7.489*)	-3.967**(-7.472*)	I(1)
Japan	-2.510(-4.169*)	-2.550(-4.151*)	I(1)
UK	-1.005(-4.546*)	-0.636(-4.556*)	I(1)
Korea	-0.400(-6.830*)	-2.237(-6.807*)	I(1)
Malaysia Trade Balance with:			
US	-2.346(-9.825*)	-3.615**(-9.792*)	I(1)
Singapore	-3.253**(-8.813*)	-4.459*(-8.829*)	I(0)
Japan	-0.900(-6.754*)	-2.052(-6.838*)	I(1)
UK	-2.239(-6.574*)	-1.962(-6.614*)	I(1)
Korea	-2.071(-8.234*)	-1.920(-8.354*)	I(1)
Malaysia Relative Price with:			
US	-1.241(-5.679*)	-1.472(-5.735*)	I(1)
Singapore	-0.221(-5.127*)	-2.692(-5.105*)	I(1)
Japan	-0.091(-6.321*)	-3.645**(-6.304*)	I(1)
UK	-1.502(-6.516*)	-2.498(-6.481*)	I(1)
Korea	-2.093(-6.888*)	-3.282(-6.979*)	I(1)
MASD Real Exchange Rate Volatility:			
RM/US$	-2.228(-7.869*)	-2.206(-7.856*)	I(1)
RM/S$	-2.614(-7.103*)	-2.616(-7.082*)	I(1)
RM/Yen	-2.750(-8.167*)	-2.716(-8.150*)	I(1)
RM/£	-3.072**(-8.229*)	-3.109(-8.205*)	I(0)
RM/Won	-2.634(-6.873*)	-2.672(-6.854*)	I(1)
GARCH Real Exchange Rate Volatility			
RM/US$	-3.367**(-7.970*)	-3.362(-7.946*)	I(0)
RM/S$	-3.644*(9.254*)	-3.642**(-9.225*)	I(0)
RM/Yen	-3.017**(-7.138*)	-3.007(-7.123*)	I(0)
RM/£	-3.630*(-7.805*)	-3.618**(-7.783*)	I(0)
RM/Won	-3.424**(-5.858*)	-3.436(-5.841*)	I(0)

Notes:
The Null hypothesis is that the series is I(1).
The ADF test for the first difference of each variable is shown in parenthesis.
* (**) indicates rejection is significant at statistic level at 1% (5%).
The critical values for rejection are –3.47(-2.88) at a significant level of 1%(5%) for intercept term.
The critical values for rejection are –4.02(-3.44) at a significant level of 1%(5%) for intercept and trend term.
These values are provided by the Eviews output based on MacKinnon (1996).

4.2 Long-run relationships

It is well known that the results of the Johansen-Juselius procedure are sensitive to lag length. Prior to testing for the cointegration we need to determine the number of lags in each cointegration equation, and to choose the one that seems most plausible for the data in hand. The optimal lag length on each of the VAR/VECM model was sequentially determined by an information criterion, such as AIC or SC, subject to that choice passing a test for the absence of serial correlation (e.g. the Lagrange-Multiplier test).

When the measurement of real exchange rate volatility using the GARCH is applied in the model (based on the AIC criterion and passing the test of serial correlation), the results indicate that the optimum lag length is four for the UK, five for the US and Korea, six for Singapore and seven for Japan. As for the procedure when MASD measurement of volatility is used in the model, the number of lags in the cointegration equations are five for the US and Singapore, six for the UK and Korea and eight for Japan.

In Table 3.6 and Table 3.7 we present our cointegration results and associated statistics. On the basis of a standard set of significance variables (that is, the values unadjusted for small sample bias), there is strong evidence of cointegration for all five countries. The results provide empirical support for the existence of a long-run cointegrating relationship between the variables. Given that our sample size is relatively small, we also adjusted the Trace and Maximum eigenvalue statistics using Reimers's (1992) small sample correction (see Equation (10a) and (11a) above), reported in the columns labelled $T-np$ in Table 3.6 and Table 3.7. With these adjusted statistics, the results indicate that there is a single unique significant vector for all countries and we therefore proceed on this basis. Since we have one cointegrating vector in our model for all the countries, an economic interpretation of the results can be obtained by normalizing the cointegrating vector on the trade balance. In Table 3.8 and Table 3.9 we report the estimated coefficients of the cointegrating vector and the error correction adjustment.

Table 3.6. Cointegration test results: Measurement of real exchange rate volatility: GARCH

	US		Singapore		Japan		UK		Korea	
	T	T-np	T	T-np	T	T-np	T	T-np	T	T-np
TR none	101.92*	84.93*	101.14*	80.78*	116.31*	88.80*	116.56*	97.13*	117.94*	98.28*
TR at most 1	64.70*	53.92	66.06*	52.76	59.38*	45.34	64.74*	53.96	64.29*	53.58
TR at most 2	37.68*	31.40	38.28*	30.57	34.62	26.43	36.71*	30.59	35.69*	29.74
TR at most 3	19.02	15.85	21.64*	17.29	18.50	14.13	17.54	14.61	16.13	13.44
TR at most 4	6.22	5.18	8.16	6.51	5.63	4.30	3.71	3.09	3.88	3.24
LR none	37.22*	31.01	35.08*	28.02	37.31*	28.49	51.81*	43.18*	53.65*	44.70*
LR at most 1	27.02	22.52	27.78	22.19	24.76	18.91	28.04	23.37	28.61*	23.84
LR at most 2	18.66	15.55	16.63	13.28	16.12	12.30	19.17	15.97	19.56	16.30
LR at most 3	12.81	10.67	13.49	10.77	12.87	9.93	13.83	11.53	12.25	10.20
LR at most 4	6.22	5.18	8.15	6.51	5.63	4.30	3.71	3.09	3.88	3.24
E1	0.22		0.21		0.22		0.29		0.30	
E2	0.16		0.17		0.15		0.17		0.17	
E3	0.12		0.11		0.10		0.12		0.12	
E4	0.08		0.08		0.08		0.09		0.08	
E5	0.04		0.05		0.03		0.02		0.03	

Notes: The entries in the rows labelled TR none to TR at most 4 and LR none to LR at most 4 are the estimates of the Trace test and Maximum eigenvalue test, respectively. The entries in the rows labelled E1 to E5 are the eigenvalues for each cointegrating vector.

Table 3.7. Cointegration test results: Measurement of real exchange rate volatility: MASD

	US		Singapore		Japan		UK		Korea	
	T	T-np	T	T-np	T	T-np	T	T-np	T	T-np
TR none	98.21*	78.44*	101.75*	81.26*	107.99*	82.45*	113.17*	94.31*	100.33*	83.61*
TR at most 1	66.76*	53.32	62.97*	50.29	59.71*	45.59	59.00*	49.17	53.32	44.44
TR at most 2	37.94*	30.30	37.53*	29.97	32.78	25.03	33.74	28.11	25.81	21.51
TR at most 3	18.46	14.74	21.04*	16.81	16.89	12.89	16.09	13.41	15.16	12.64
TR at most 4	6.04	4.82	7.82	6.24	5.41	4.13	3.82	3.18	5.25	4.38
LR none	31.45	25.12	38.78*	30.97	35.45*	27.07	45.95*	38.29*	47.00*	39.17*
LR at most 1	28.82*	23.02	25.44	20.32	26.93	20.56	26.41	22.00	27.52	22.93
LR at most 2	19.48	15.56	16.48	13.16	15.90	12.14	17.65	14.71	10.65	8.87
LR at most 3	12.42	9.92	13.23	10.57	11.48	8.76	12.27	10.23	9.91	8.26
LR at most 4	6.04	4.82	7.82	6.24	5.41	4.13	3.82	3.18	5.25	4.38
E1	0.19		0.23		0.21		0.26		0.27	
E2	0.18		0.16		0.17		0.16		0.17	
E3	0.12		0.10		0.10		0.11		0.07	
E4	0.08		0.08		0.07		0.08		0.06	
E5	0.04		0.05		0.04		0.03		0.03	

Notes: The entries in the rows labelled TR none to TR at most 4 and LR none to LR at most 4 are the estimates of the Trace test and Maximum eigenvalue test, respectively. The entries in the rows labelled E1 to E5 are the eigenvalues for each cointegrating vector.

The results are similar in the case of both measures of volatility in the long-run relationship between bilateral exchange rate volatility and the trade balance of Malaysia with the US, Singapore and the UK (but not with Japan and the Republic of Korea). The exchange rate volatility coefficients appear with a positive sign in the trade balance of Malaysia with the US and the UK and a negative sign for Malaysia with Singapore. The results are statistically significant for Malaysia-US and Malaysia-Singapore in both measures, while for Malaysia-UK it is significant according to MASD measure and insignificant according to the GARCH measure. For Malaysia-Japan and Malaysia-Korea model, all the results are statistically insignificant.

Table 3.8. Estimated Cointegration Coefficients and Error Correction Adjustment: GARCH Volatility.

Trade Partner	w	w^*	p	σ	α_{tb}	α_w	α_{w^*}	α_p	α_σ
US	6.30	-20.08	43.32	140.54	-0.05	0.01	-0.001	-0.002	0.002
	(1.60)	(4.70)	(12.18)	(33.91)	(0.02)	(0.01)	(0.001)	(0.001)	(0.001)
	[3.93]	[-4.27]	[3.56]	[4.14]	[-2.06]	[1.54]	[-1.71]	[-2.74]	[3.57]
Spore	-3.01	4.30	-4.30	-251.01	-0.001	-0.02	0.03	-0.0001	-0.001
	(1.55)	(2.10)	(3.80)	(86.55)	(0.02)	(0.01)	(0.02)	(0.001)	(0.0004)
	[-1.94]	[2.05]	[-1.13]	[-2.90]	[-0.04]	[-2.95]	[1.68]	[-0.15]	[-1.81]
Japan	-2.34	2.39	8.17	-9.85	-0.23	-0.25	0.02	0.01	0.003
	(0.19)	(0.33)	(0.57)	(9.21)	(0.11)	(0.06)	(0.02)	(0.01)	(0.001)
	[-11.99]	[7.36]	[14.27]	[-1.07]	[-2.14]	[-4.40]	[0.81]	[1.62]	[2.22]
UK	3.22	18.54	-62.41	124.64	0.02	0.02	0.001	-0.0004	-0.0001
	(1.07)	(6.93)	(14.43)	(90.35)	(0.01)	(0.004)	(0.001)	(0.001)	(0.0002)
	[3.02]	[2.68]	[-4.32]	[1.38]	[1.19]	[6.66]	[1.90]	[-0.96]	[-0.60]
Korea	-3.47	5.42	19.67	5.57	0.05	-0.03	-0.03	0.005	0.001
	(1.38)	(1.20)	(5.95)	(13.02)	(0.04)	(0.01)	(0.01)	(0.001)	(0.001)
	[-2.50]	[4.53]	[3.30]	[0.43]	[1.27]	[-4.05]	[-4.48]	[4.66]	[1.54]

Notes: tb = trade balance, w = domestic income, w^* = foreign income, p = relative price, σ = volatility.
Standard errors are in brackets and t-statistics are in parentheses.

Table 3.9. Estimated Cointegration Coefficients and Error Correction Adjustment: MASD Volatility.

Trade Partner	w	w^*	p	σ	α_{tb}	α_w	α_{w^*}	α_p	α_σ
US	4.83	-17.04	44.22	0.16	-0.06	0.007	-0.003	-0.002	0.50
	(1.33)	(3.90)	(10.49)	(0.06)	(0.03)	(0.008)	(0.001)	(0.001)	(0.21)
	[3.62]	[-4.38]	[4.22]	[2.79]	[-2.04]	[0.85]	[-3.05]	[-2.64]	[2.40]
Spore	-2.72	3.06	-0.18	-0.18	-0.007	-0.04	0.05	0.001	-0.15
	(0.94)	(1.23)	(2.32)	(0.05)	(0.03)	(0.01)	(0.02)	(0.001)	(0.23)
	[-2.90]	[2.48]	[-0.08]	[-3.48]	[-0.28]	[-3.20]	[1.90]	[0.83]	[-0.64]
Japan	-2.10	2.07	7.42	0.002	-0.18	-0.15	0.03	-0.006	1.61
	(0.26)	(0.42)	(0.75)	(0.01)	(0.10)	(0.05)	(0.02)	(0.006)	(1.34)
	[-8.24]	[4.88]	[9.92]	[0.20]	[-1.88]	[-3.15]	[1.60]	[-1.14]	[1.19]
UK	6.21	19.17	-92.13	0.74	-0.004	0.01	-0.0004	-0.001	0.05
	(2.16)	(13.98)	(31.71)	(0.20)	(0.01)	(0.002)	(0.001)	(0.0003)	(0.09)
	[2.87]	[1.37]	[-2.91]	[3.61]	[-0.42]	[5.03]	[-0.76]	[-1.63]	[0.63]
Korea	-2.85	4.82	21.08	-0.03	0.05	-0.02	-0.02	0.003	-0.13
	(2.44)	(2.07)	(10.96)	(0.05)	(0.03)	(0.01)	(0.004)	(0.001)	(0.19)
	[-1.17]	[2.33]	[1.92]	[-0.68]	[1.62]	[-2.70]	[-3.56]	[4.23]	[-0.71]

Notes: tb = trade balance, w = domestic income, w^* = foreign income, p = relative price, σ = volatility.
Standard errors are in brackets and t-statistics are in parentheses.

Based on these results, we found that the impact of exchange rate volatility on trade balance in this study is ambiguous. The results indicate that exchange rate volatility has a statistically significant positive and negative impact on Malaysia's trade balance with the United States and Singapore, respectively, for both measures of volatility. As for the impact on Malaysian trade balance with the United Kingdom, the exchange rate volatility shows an insignificant positive sign in the GARCH measure and a statistically significant positive sign in the MASD measure of volatility. And no significant impact at all on Malaysia's trade balance with Japan and the Republic of Korea. This is in line with theories which say the impact of exchange rate volatility on trade balance is not certain and depends on the nature of the assumptions made.

The effects of exchange rate volatility on Malaysia's trade balance with the five trading partners vary across these partners could be due to the compositions of Malaysia's exports and imports with them. As we will see in the next chapter, Malaysian exports are due primarily to manufacturing sectors and in which more than 60% consists of electrical and electronic products. For the whole of the 1990s, the United States emerged as the largest importer of Malaysian electrical and electronic products, having about one third of the total export shares. Moreover, many electronic products companies in Malaysia are production branches of US companies such as Motorola, Western Digital and Texas Instruments. These semiconductor products are major components for the electrical and electronic industry in the United States. Thus, even though the exchange rate is highly volatile, Malaysia's trade balance is not decreasing with the United States because of the long-run institutional relationships evident in electronics.

The negative impact of exchange rate volatility on Malaysia's trade balance with Singapore could be due to the fact that Singapore's imports were mainly for re-exporting to Malaysia in the form of finished products. Thus, when exchange rate is highly volatile, Malaysian exporters would increase the exports price in order to avoid any decline in profits caused by an increase in exchange rate volatility. As a result of the increase in the price, exports to Singapore would fall and the trade balance with Singapore would deteriorate. The insignificant impact on Malaysia's trade balance with Japan and the Republic of Korea shows that exchange rate volatility is not an important factor in determining trade with these two countries. As for the positive impact between exchange rate volatility and Malaysia's trade balance with the United Kingdom, it could be due to the fact that Malaysian products are much cheaper to the British because of the favourable exchange rate of pound sterling to ringgit Malaysia. Moreover, the "looking East" policy helped to reduce the imports of Malaysia from the United Kingdom and this result in the increase in the trade balance with the United Kingdom.

The results concerning the long-run relationship between the trade balance and domestic income were similar for both measures of exchange rate volatility. While Malaysian domestic income has a statistically significant positive relationship in the

trade balance with the US and the UK for both volatility measures, it has a negative relationship in the trade balance with Singapore, Japan and the Republic of Korea. The negative relationship is statistically significant for the trade balance of Malaysia with Japan for both volatility measures. For the trade balance with Singapore, Malaysian domestic income only has a statistically significant negative relationship for the MASD measure of volatility and a negative significant relationship in the trade balance with the Republic of Korea for the GARCH measure. Theoretically, the results of the coefficients of the domestic income are expected to be negative if the increase in the domestic income was an increase in the real income, and would be positive if the increase in the domestic income was due to an increase in the production activity of import substitutes.

In this study, we could conclude that the increase in Malaysian income during the study periods was due to an increase in real income, rather than an increase in import substitutes because during those periods Malaysia was embarking upon a more advanced stage of industrialisation. So, the negative sign of the Malaysian domestic income coefficients in the trade balance with Singapore, Japan and the Republic of Korea revealed that Malaysia was importing largely from these countries. Moreover, during these periods the Malaysian government had launched a 'look to East' policy as a way to boycott Western products. Apart from that, the goods from these Asian countries are much cheaper compared to the Western goods in terms of ringgit values. This explains why the domestic income coefficients in the trade balance with the US and the UK are positive. It showed that Malaysia is importing less from these two countries.

We found the results for the long-run relationship between the trade balance and foreign income of all the models to be similar for different measures of exchange rate volatility. All the coefficients are found to be positive except in the Malaysia-US model. The Malaysia-US foreign income coefficients are significantly negative in the case of both the measures of volatility. As for the trade balance of Malaysia with Singapore, Japan and the Republic of Korea, the foreign income has a statistically significant positive relationship in case of both measures of volatility. But for the

trade balance of Malaysia with the UK, the results are significant only in the case of GARCH measure of volatility.

The estimated coefficients of the long-run relationship between trade balance and foreign income are expected to be positive if the increase in the foreign partners' income were assumed to be due to an increase in real income. When real income increases, it means more money for consumptions and, therefore, imports from foreign partners would increase. However, if the increases were assumed to be the results of the increase in the production of import substitutes, then the coefficients are expected to be negative. Based on the results, we could conclude that an increase in the income of Malaysia's trading partners (i.e. Singapore, Japan, the United Kingdom and the Republic of Korea) was due to an increase in real income. But in the United States, the increase in the income could be due to an increase in imports substitutes.

The theoretical models reviewed in chapter two stated that the trade balance should show a negative long-run relationship with relative price, since an increase in the domestic price would make exports to fall. However, the results in this study seem to be contradictory in most cases. When the GARCH measure of volatility is used, the coefficients of the relative price have a positive sign for Malaysia's relationships with the US, Japan and the Republic of Korea. However, the relative price coefficients for Malaysian relationships with Singapore and the UK show a negative sign. Similar results followed when the MASD measure of volatility was employed. All the coefficients are statistically significant in both measures of volatility except for the case of Malaysia with Singapore and the Republic of Korea. The positive sign of the relative price coefficients found in the trade balance model of Malaysia with the US and Japan could be due to the fact that domestic products are considered to be superior products or basic necessities for these foreign countries. That is why, even though the price of the domestic products increases exports increases. As for the trade balance model of Malaysia and the UK, the results are consistent with the theories. The negative sign means that the UK imports lesser products from Malaysia when Malaysian products increase in price.

4.3 Granger causality tests

If a set of variables that are non stationary, I(1), are found to be cointegrated, or move together in the long-run, then the Granger causality tests could be constructed. Granger causality says that one variable helps to forecast the other variable at least in one direction. Testing for causality between two variables have been coined by Granger (1969) and popularised by Sims (1972). Specifically, the test is utilized to determine whether the present value of y can be predicted with more accuracy by past values of x, assuming other information is identical. If it can be predicted, then x is said to Granger cause y (denoted as $x \rightarrow y$). The Granger causality test is implemented by calculating the F-statistic based on the null hypothesis that the set of coefficient on the lagged values of independent variables are not statistically different from zero. If the null hypothesis is not rejected, then it can be concluded that the independent variable does not cause dependent variable.

There are two types of possible causality effects between the variables: unidirectional causality and bilateral causality. Unidirectional causality is when x is said to Granger cause of y ($x \rightarrow y$) or y is Granger cause of x ($y \rightarrow x$). Bilateral causality is when x is Granger cause y and at the same time y Granger cause x ($x \rightleftarrows y$). There are various tests for causality proposed. In this study, we employed the Granger causality test within a VECM in order to capture Granger causality among the economic variables. According to Granger, if the variables are cointegrated, the finding of Granger non-causality is ruled out. However, it does not indicate the direction of causality between variables. The direction of Granger causality can only be detected through the VECM derived from the long-run cointegrating vectors.

We report the Granger causality results for both measures of volatility based on the vector error correction model (VECM) in Table 3.10 and Table 3.11. The VECM results indicate that there is no Granger causality effect running from exchange rate volatility to trade balance in any of the models, except for the relationships Malaysia has with the UK and the Republic of Korea in the case of both measures of volatility. The results of Malaysia-UK and Malaysia-Korea revealed a statistically significant

causality effect running from exchange rate volatility to trade balance, only for GARCH measure, and no causality effect for MASD measure. However, there is a Granger causality effect from trade balance to exchange rate volatility in the case of Malaysia with the US and the Republic of Korea for MASD measure, and with Japan for GARCH measure of volatility.

Looking at the relationship between exchange rate volatility and Malaysian income, we found a statistically significant unidirectional causality effect from exchange rate volatility to Malaysian income in the Malaysia-UK model and from Malaysian income to exchange rate volatility in the Malaysia-Korea model for both measures of volatility. At the same time, there is a unidirectional causality effect from exchange rate volatility to Malaysian income in Malaysia-Singapore relationship and from Malaysian income to exchange rate volatility in Malaysia-Japan relationship for GARCH measure of volatility.

The VECM results also indicate that there is a unidirectional causality effect running from exchange rate volatility to foreign income in the Malaysia-US model for GARCH measure and in the case of Malaysia-Korea model for both measures of volatility. However, for the causal relationship from foreign income to exchange rate volatility, there is no effect in all the models except in the case of Malaysia-Singapore for MASD measure of volatility.

Table 3.10. Granger causality results based on VECM: GARCH volatility

	χ^2 - statistics (p-value)				
Dependent Variable	Δtb	Δw	Δw^*	Δp	$\Delta\sigma$
Msia - US					
Δtb	-	1.09(0.95)	3.02(0.70)	8.36(0.14)	10.49(0.06)
Δw	7.62(0.18)	-	17.25(0.00)**	9.13(0.10)	7.67(0.18)
Δw^*	4.44(0.49)	9.97(0.08)	-	9.26(0.10)	17.28(0.00)**
Δp	15.08(0.01)**	12.94(0.02)*	4.97(0.42)	-	10.77(0.06)
$\Delta\sigma$	2.86(0.72)	3.39(0.64)	8.08(0.015)	15.81(0.01)**	-
Msia - Spore					
Δtb	-	2.20(0.90)	3.17(0.79)	6.43(0.38)	2.26(0.89)
Δw	12.20(0.06)	-	12.08(0.06)	30.07(0.00)**	21.12(0.00)**
Δw^*	3.04(0.80)	16.30(0.01)**	-	21.50(0.00)**	4.72(0.58)
Δp	11.97(0.06)	6.48(0.37)	19.77(0.00)**	-	2.85(0.83)
$\Delta\sigma$	2.00(0.92)	3.78(0.71)	6.45(0.37)	14.49(0.02)*	-
Msia - Japan					
Δtb	-	5.61(0.59)	19.31(0.01)**	6.32(0.50)	10.52(0.16)
Δw	4.81(0.68)	-	10.34(0.17)	12.94(0.07)	5.12(0.65)
Δw^*	3.56(0.83)	5056(0.59)	-	6.70(0.46)	8.62(0.28)
Δp	6.00(0.54)	15.15(0.03)*	6.86(0.44)	-	5.15(0.64)
$\Delta\sigma$	17.96(0.01)**	14.09(0.05)*	8.80(0.27)	13.47(0.06)	-
Msia - UK					
Δtb	-	3.78(0.44)	0.54(0.97)	9.39(0.05)*	13.58(0.01)**
Δw	7.24(0.12)	-	1.06(0.90)	49.99(0.00)**	18.54(0.00)**
Δw^*	12.67(0.01)**	3.48(0.48)	-	3.02(0.55)	2.06(0.72)
Δp	1.26(0.87)	4.86(0.30)	2.79(0.59)	-	5.62(0.23)
$\Delta\sigma$	8.00(0.09)	6.16(0.19)	0.38(0.98)	0.53(0.97)	-
Msia - Korea					
Δtb	-	0.39(0.99)	4.58(0.47)	2.27(0.81)	13.38(0.02)*
Δw	9.08(0.11)	-	3.14(0.68)	7.77(0.17)	9.23(0.10)
Δw^*	11.80(0.04)*	7.93(0.16)	-	7.81(0.17)	24.92(0.00)**
Δp	3.24(0.66)	2.88(0.72)	10.22(0.07)	-	3.26(0.66)
$\Delta\sigma$	8.50(0.13)	13.06(0.02)*	10.34(0.07)	11.83(0.04)*	-

Notes: The χ^2 - statistic tests the joint significance of the lagged values of the independent variables. The lagged of the endogenous variables: Msia-US = 5, Msia-Spore = 6, Msia-Japan = 7, Msia-UK = 4, Msia-Korea = 5. The * (**) denotes 5% (1%) significance level.

Table 3.11. Granger causality results based on VECM: MASD volatility

	χ^2 - statistics (p-value)				
Dependent Variable	Δtb	Δw	Δw^*	Δp	$\Delta\sigma$
Msia - US					
Δtb	-	2.76(0.74)	1.82(0.87)	11.45(0.04)*	4.83(0.44)
Δw	6.72(0.24)	-	15.10(0.01)**	8.24(0.14)	1.82(0.87)
Δw^*	3.69(0.59)	6.09(0.29)	-	10.11(0.07)	8.97(0.11)
Δp	16.71(0.01)**	11.86(0.03)*	5.47(0.36)	-	6.39(0.27)
$\Delta\sigma$	12.07(0.03)*	3.49(0.63)	4.43(0.49)	8.77(0.12)	-
Msia - Spore					
Δtb	-	1.24(0.94)	2.06(0.84)	5.93(0.32)	2.08(0.84)
Δw	12.93(0.02)**	-	8.57(0.12)	20.51(0.00)**	7.02(0.22)
Δw^*	3.06(0.69)	13.29(0.02)*	-	9.65(0.08)	4.32(0.50)
Δp	9.48(0.09)	9.32(0.09)	17.00(0.00)**	-	4.13(0.53)
$\Delta\sigma$	2.02(0.85)	3.61(0.61)	10.91(0.05)*	6.38(0.27)	-
Msia - Japan					
Δtb	-	6.61(0.58)	16.07(0.04)*	3.54(0.89)	7.39(0.49)
Δw	7.66(0.46)	-	9.03(0.33)	8.49(0.39)	14.14(0.08)
Δw^*	7.87(0.44)	10.57(0.22)	-	11.36(0.18)	7.45(0.49)
Δp	10.51(0.23)	54.72(0.00)**	26.53(0.00)**	-	6.61(0.58)
$\Delta\sigma$	11.26(0.18)	11.30(0.18)	3.97(0.85)	5.59(0.69)	-
Msia - UK					
Δtb	-	5.81(0.11)	3.31(0.77)	12.42(0.05)*	8.76(0.18)
Δw	9.02(0.17)	-	2.31(0.88)	38.90(0.00)**	18.86(0.00)**
Δw^*	9.44(0.15)	9.84(0.13)	-	13.63(0.03)*	1.93(0.93)
Δp	3.16(0.79)	9.70(0.13)	2.29(0.89)	-	6.83(0.33)
$\Delta\sigma$	3.10(0.79)	9.04(0.17)	11.39(0.07)	6.39(0.38)	-
Msia - Korea					
Δtb	-	2.61(0.86)	5.65(0.46)	2.97(0.81)	8.84(0.18)
Δw	5.20(0.52)	-	5.50(0.48)	8.15(0.23)	3.69(0.72)
Δw^*	4.00(0.68)	9.04(0.17)	-	9.14(0.16)	21.31(0.00)**
Δp	7.39(0.29)	5.13(0.53)	6.95(0.33)	-	12.29(0.06)
$\Delta\sigma$	13.05(0.04)*	16.03(0.01)**	11.76(0.06)	10.83(0.09)	-

Notes: The χ^2 - statistic tests the joint significance of the lagged values of the independent variables. The lagged of the endogenous variables: Msia-US = 5, Msia-Spore = 5, Msia-Japan = 8, Msia-UK = 6, Msia-Korea = 6. The * (**) denotes 5% (1%) significance level.

As to the relationship between exchange rate volatility and relative price, we did not find causality effect in any of the models except for a unidirectional causality from the relative price to exchange rate volatility in the case of Malaysia's model with the US, Singapore and the Republic of Korea for GARCH measure of exchange rate volatility.

Our results show that there is no causality effect running between the relative price and the trade balance in all models, except for the case of Malaysia with the US and the UK. We found bi-directional causality between relative price and trade balance in the Malaysia-US model for MASD measure volatility, and unidirectional causality running from trade balance to relative price for GARCH measure of volatility. As for the Malaysia-UK's model, there is a unidirectional causality effect from relative price to trade balance in the case of both measures of volatility.

The relationship between trade balance and foreign income shows a unidirectional causality effect from foreign income to trade balance in the Malaysia-Japan model for both measures of volatility, and from trade balance to foreign income in the case of Malaysia with the UK and the Republic of Korea for GARCH measure of volatility. As to the relationship of Malaysian income and trade balance, we found no causality effect in any of the models, except for a unidirectional relationship from the trade balance to Malaysian income in the case of the Malaysia-Singapore model for MASD measure of volatility.

The VECM results show that there is a unidirectional causality effect from the relative price to Malaysian income in the case of the Malaysia-Singapore and Malaysia-UK models, and from Malaysian income to relative price in the case of the Malaysia-US and Malaysia-Japan models for both measures of volatility. The VECM results also revealed that there is no causality effect from foreign income to Malaysian income in any of the models, except in the case of Malaysia-US for both measures of volatility, while only a unidirectional causality effect running from Malaysian income to foreign income in the case of Malaysia-Singapore model for both measures of volatility.

Lastly, the VECM results show that there is a bi-directional causality effect between the relative price and foreign income relationships in the Malaysia-Singapore models for GARCH measure of volatility. At the same time, we also found a unidirectional causality effect running from the foreign income to the relative price in the Malaysia-Singapore and Malaysia-Japan models, and from the relative price to the foreign income in the Malaysia-UK model for MASD measures of volatility.

5 Summary and Conclusion

In this study, our primary objective is to assess the long-run impact of bilateral exchange rate volatility on Malaysia's bilateral trade balance. The responsiveness of trade balance to exchange rate volatility is a crucial issue in trade or exchange rate policies. In order to establish the relationship, we focus on five trading partners that Malaysia has the most trade with (i.e. the United States, Singapore, Japan, the United Kingdom and the Republic of Korea). Two measures of exchange rate volatility have been applied - the generalized autoregressive conditional heteroskedasticity (GARCH) and the moving average standard deviation (MASD) approach. The Johansen cointegration test reveals that all five variables: trade balance, domestic income, foreign income, relative price and exchange rate volatility in the trade balance function have a tendency to move together in the long-run.

Overall, the results indicate that exchange rate volatility did have a statistically significant impact on Malaysia's trade balance with the United States and Singapore and no impact at all on its trade balance with Japan and the Republic of Korea. The results show that exchange rate volatility has a positive and negative impact on Malaysia's trade balance with the United States and Singapore, respectively, for both measures of volatility. As for the impact on Malaysian trade balance with the United Kingdom, the exchange rate volatility shows an insignificant positive sign in the GARCH measure and a statistically significant positive sign in the MASD measure

of volatility. These imply that the effects of exchange rate volatility on trade balance would be different across trading partners, and depend on assumptions in the behaviour of the traders and the hedging mechanisms available to them.

We estimate the short-run Granger causality relationship in the context of a vector error correction framework. The results of the Granger causality effect to the trade balance in case of GARCH measure of volatility reveal that there is no significant causality running from the exchange rate volatility to the trade balance in all equations, except in the model of Malaysia with the UK and the Republic of Korea. However, in the case of MASD volatility measure, the results indicate that there are no causality effects running from the exchange rate volatility to trade balance in all the models investigated in this study.

Therefore, we could conclude that, in the short-run, exchange rate volatility does not have an impact on Malaysian trade balance with all the trading partners in this study. But the results of this study revealed that there is a positive long-run impact on the trade balance of Malaysia with the United States and a negative long-run impact on the trade balance of Malaysia with Singapore.

References

Akhtar, M.A., and Spence Hilton, 1984, Effects of exchange rate uncertainty on German and U.S. trade., *Federal Reserve Bank of New York, Quarterly Review* 9, 7-16.

Aristotelous, Kyriacos, 2001, Exchange rate volatility, exchange rate regime and trade volume: evidence from the UK-US export function (1889-1999), *Economics Letters* 72, 87-94.

Arize, A. C., 1998, The effects of exchange rate volatility on US imports: an empirical investigation, *International Economic Journal* 12.

Arize, A. C., T. Osang, and D. Slottje, 2000, Exchange rate volatility and foreign trade: evidence from thirteen LDC's, *Journal of Business and Economic Statistics* 18, 10-17.

Asseery, A., and D. A. Peel, 1991, The effects of exchange rate volatility on exports, *Economics Letters* 37, 173-177.

Baharumshah, Ahmad Zubaidi, 2000, Exchange rate and trade balance: the experience based on two neighbouring ASEAN countries, Department of Economics, Universiti Putra Malaysia.

Bahmani-Oskooee, Mohsen, 1991, Is there a long-run relation between the trade balance and the real effective exchange rate of LDCs?, *Economics Letters* 36, 403-407.

Bahmani-Oskooee, Mohsen , and Aghdas Mirzai, 2000, Real and nominal effective exchange rates for developing countries:1973:1-1997:3, *Applied Economics* 32, 411-428.

Bahmani-Oskooee, Mohsen, and T.J. Brooks, 1999, Bilateral J-Curve between US and her trading partners., *Weltwirtschaftliches Archiv* 135, 156-165.

Bollerslev, Tim, 1986, Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics* 31, 307-327.

Boyd, Derick, Gugielmo Maria Caporale, and Smith Ron, 2001, Real exchange rate effects on the balance of trade: Cointegration and the Marshall-Lerner condition., *International Journal of Finance and Economics* 6, 187-200.

Cheong, Chongcheul, 2004, Does the risk of exchange rate fluctuation really affect international trade flows between countries?, *Economics Bulletin* 6, 1-8.

Cheung, Y-W, and K.S. Lai, 1993, Finite sample sizes of Johansen's likelihood ratio tests for cointegration, *Oxford Bull Econ & Stats* 55, 313-328.

Chowdhury, A.R., 1993, Does exchange rate volatility depress trade flows? Evidence from error correction models, *Review of Economics and Statistics* 75, 700-706.

Cushman, David O., 1983, The effects of real exchange rate risk on international trade, *Journal of International Economics* 15, 45-63.

Cushman, David O., 1986, Has exchange risk depressed international trade? The impact of third-country exchange risk, *Journal of International Money and Finance* 5, 361-379.

Cushman, David O., 1988, U.S. bilateral trade flows and exchange risk during the floating period, *Journal of International Economics* 24, 317-330.

Engle, Robert F., and C.W.J. Granger, 1987, Cointegration and error correction representation, estimation and testing, *Econometrica* 5, 251-276.

Ethier, W, 1973, International trade and the forward exchange market, *American Economic Review* 63, 494-503.

Franke, Gunter, 1991, Exchange rate volatility and international trading strategy, *Journal of International Money and Finance* 10, 292-307.

Gagnon, Joseph E., 1993, Exchange rate variability and the level of international trade, *Journal of International Economics* 34, 269-287.

Granger, C.W.J., 1969, Investigating causal relations by econometrics models and cross spectral methods, *Econometrica* 40, 424-38.

Guptor-Kapoor, Anju, and Uma Ramakrishnan, 1999, Is there a J-Curve? A new estimation for Japan, *International Economic Journal* 13, 71-79.

Hooper, Peter, and Steven W. Kohlhagen, 1978, The effect of exchange rate uncertainty on the prices and volume of the international trade, *Journal of International Economics* 8, 483-511.

Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* 12, 231-254.

Johansen, S. , and K Juselius, 1990, Maximum likelihood estimation and inferences on cointegration - with application to the demand for money, *Oxford Bulletin of Economics and Statistics* 52, 169-210.

Kenen, P.B., and D. Rodrik, 1986, Measuring and analyzing the effects of short-term volatility in real exchange rates, *Review of Economics and Statistics* 68, 311-15.

Klein, Michael W., 1990, Sectoral effects of exchange rate volatility on US exports, *Journal of International Money and Finance* 9, 299-308.

Koray, F., and William D. Lastrapes, 1989, Real exchange rate volatility and US bilateral trade: a VAR approach, *Review of Economics and Statistics* 71, 708-12.

Kroner, Kenneth F. , and William D. Lastrapes, 1993, The impact of exchange rate volatility on international trade: reduced form estimates using the GARCH-in-mean model, *Journal of International Money and Finance* 12, 298-318.

Mark, Nelson C., 1990, Real and nominal exchange rates in the long run: An empirical investigation, *Journal of International Economics* 28, 115-136.

McKenzie, Michael D., 1998, The impact of exchange rate volatility on Australian trade flows, *Journal of International Financial Markets, Institutions and Money* 8, 21-38.

McKenzie, Michael D. , and Robert D. Brooks, 1997, The impact of exchange rate volatility on German-US trade flows, *Journal of International Financial Markets, Institutions and Money* 7, 73-87.

Onafowora, Olugbenga, 2003, Exchange rate and trade balance in East Asia: is there a J-curve?, *Economics Bulletin* 5, 1-13.

Pattichis, Charalambos, Chongcheul Cheong, Tesfa Mehari, and Leighton Vaughan Williams, 2004, Exchange rate uncertainty, UK trade and the Euro, *Applied Finance Economics* 14, 885-893.

Peree, Eric, and Alfred Steinherr, 1989, Exchange rate uncertainty and foreign trade, *European Economic Review* 33, 1241-1264.

Rahmatsyah, Teuku, Gulasekaran Rajaguru, and Reza Y. Siregar, 2002, Exchange rate volatility, trade and "fixing for life" in Thailand, *Japan and the World Economy* 14, 445-470.

Reimers, H-E., 1992, Comparisons of tests for multivariate cointegration, *Statistical Papers* 33, 335-359.

Rose, K. Andrew, 1991, The role of exchange rates in a popular model of international trade: Does the "Marshall-Lerner" condition hold?, *Journal of International Economics* 30, 301-316.

Sercu, Piet, and Cynthia Vanhulle, 1992, Exchange rate volatility, international trade, and the value of exporting firms, *Journal of Banking and Finance* 16, 155-182.

Sims, C.A., 1972, Money, income and causality, *American Economic Review* 62, 540-52.

Thursby, Jerry G., and Marie C. Thursby, 1987, Bilateral trade flows, the Linder hypothesis, and exchange risk, *The Review of Economics and Statistics* 69, 488-495.

Viaene, Jean-Marie , and Casper G. de Vries, 1992, International trade and exchange rate volatility, *European Economic Review* 36, 1311-1321.

CHAPTER FOUR

THE IMPACT OF EXCHANGE RATE VOLATILITY ON MALAYSIAN MAJOR EXPORTS: A SECTORAL STUDY

1 Introduction

Most of the earlier studies considering the relationship between foreign exchange rate volatility and international trade levels use aggregate bilateral or multilateral data. However, it is well known that aggregate data may discard information on the relationship between variables because data aggregation does not distinguish between volatility across countries and sectors of the economy (Bini-Smaghi (1991)). Disaggregated data, however, will do so. As for the difference between bilateral and multilateral studies, bilateral studies generally find more significant results than multilateral studies, the reason being that bilateral studies look at the relationship of two countries with one another at one point of time, whereas multilateral studies look at the relationship of many countries at certain points of time.

However, of the recent empirical studies of exchange rate volatility and trade, few have considered using a sectoral breakdown of trade data (see McKenzie (1998), Cheong, Mehari, Pattichis and Williams (2002), Pattichis, Cheong, Mehari and Williams (2004) and de Vita and Abbott (2004)). A sectoral focus is important because exchange rate risk may affect industries differently, with some industries more exposed to risk than others. A number of factors contribute to these differences in effects. Sectors may differ as to their openness to international trade, the length of contracts and the extent of the trade contracts being denominated in foreign currencies.

Industries react differently to a given level of exchange risk for several reasons. One is due to differences in profitability. Highly profitable firms, or highly concentrated industries, may have a relatively low response to exchange rate risk due to their ability to absorb risk without cutting back on trade. A second reason is due to multinational operations. Industries with multinational operations may have a relatively low response to risk because of their ability to diversify. Other factors include the importance of internationally traded inputs to production, the ease of reducing domestic costs of importing and exporting, the structure of trade restrictions and attitudes toward risk.

As we discussed earlier in the literature survey in Chapter Two, most of the studies on foreign exchange rate uncertainty and international trade (regardless of aggregated or disaggregated studies), focus on the relationship of exchange rate uncertainty and exports and/or imports. Further, it has been noted theoretically and empirically that the relationship between exchange rate volatility and exports and/or imports is indeterminant. Some examples of theoretical models predicting a negative relationship are Ethier (1973), Hooper and Kohlhagen (1978) and Cushman (1986), while those predicting a positive relationship include Franke (1991), Sercu and Vanhulle (1992) and Viaene and de Vries (1992). With regard to empirical studies, examples showing a negative relationship between exchange rate volatility and trade are: Kenen and Rodrik (1986), Koray and Lastrapes (1989) and Chowdhury (1993), while Klein (1990), Asseery and Peel (1991) and McKenzie and Brooks (1997) predict a positive relationship.

In this paper, we investigate the impact of exchange rate volatility on Malaysia's major export categories using disaggregated data. We have chosen five major export categories to be included in our studies: electrical and electronic, palm oil, timber, apparel and rubber categories. As for the markets for these products, we include the same five countries as in the earlier studies in Chapter Three, namely, the United States, Singapore, Japan, United Kingdom and the Republic of Korea. We use fixed effect panel data estimation to study the relationship between exchange rate variability and these markets.

2 Direction of Malaysia's Major Exports Categories

After gaining independence in 1957, Malaysia's economy was, initially, mainly dependent on tin and rubber, with these two primary commodities accounting for more than 50% of the Gross Domestic Product. The policy at that time was to nurture economic growth through the sustenance and development of these two export commodities. However, as early as the 1960s, the government recognized the need to expand the narrow base of its economy and diversify into other economic activities in order to generate growth. This diversification strategy involved initiatives to develop manufacturing through the establishment of industrial estates and also to diversify agricultural output and exports.

Over the next three decades Malaysia showed remarkable economic performance as a result of its outward looking strategies. From 1970 Malaysia, like other first generation Asian tiger economies (the Republic of Korea, Taiwan, Singapore and Hong Kong), used its exports as the engine of growth and development. Singapore, Japan, United States and the United Kingdom emerged as Malaysia's traditional major trading partners. Since becoming prominent in the 1990s, Korea could be considered as a new market. The combined export shares to all the traditional major export countries has always constituted more than 60% of Malaysia's total exports.

2.1 Electrical and electronic products

On an individual major exports category basis, Malaysia is one of the leading exporters of electrical and electronic products in the world. As one of the leading exporters of electronics in the world, Malaysia markets such goods as, electronic components, consumer electronics and industrial electronics. These are sold globally, with semiconductor devices being the biggest export item, accounting for more than 40% of Malaysia's total electronics exports almost every year. The semiconductor devices are used in a diverse range of industries such as automotive and telecommunications. The export-oriented electronics industry has now more than 900

companies in production. Local companies are traditionally strong in semiconductor packaging and assembly. At the same time international manufacturers like Intel, Motorola, Texas Instruments and Western Digital base their plants here, attesting to the quality and competitiveness of Malaysia's electronic sector. In fact, Western Digital's Malaysian plant is the only assembly plant in the world for the company.

With regards to electrical products, Malaysia manufactures and exports a sophisticated range of household appliances, e.g. televisions, washing machines and air-conditioners and industrial appliances, e.g. wires and cables, electrical industrial equipments, dry cells and batteries and other electrical apparatus and supplies. Major brands include Panasonic, Sony, Philips and Samsung, while home-grown brands like MEC, Khind and Pensonic are also making inroads into the export markets. Notably, Malaysia is the world's largest exporter of room air-conditioners, which are sold under global brands like National/Panasonic.

The United States has emerged as the largest importer of Malaysia's electrical and electronic products, having about one third of the total export shares throughout the 1990s, followed by Singapore and Japan as the second and third largest importers, respectively. From Figure 4.1 we see that the percentage share of electrical and electronic goods in total exports to these three countries was 69% in 1990 and, throughout the 1990s, was consistently more than 55%. Even though the Malaysian government is aiming for a broad-based export destinations profile, the exports of electrical and electronic products are still primarily to these three countries. The generally weak global economic climate in early 2000s has seen an economic slowdown in the US and Japan. This economic downturn, together with the slump in the Information Technology sector in 2001, caused a major decline in Malaysia's electrical and electronic exports to these two countries during those periods.

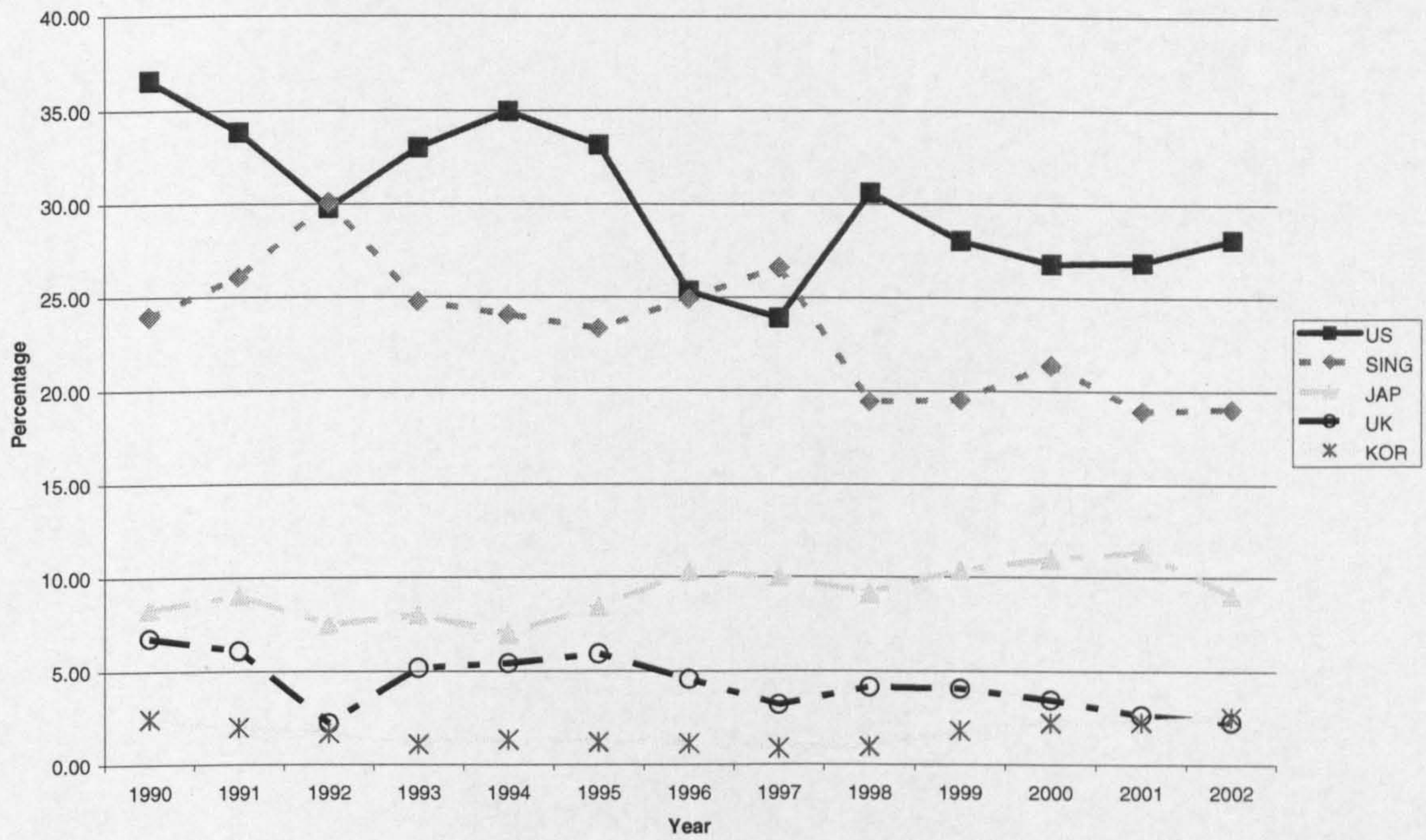

Figure 4.1. Exports of electrical & electronic products to each individual country as a percentage of total exports of electrical & electronic products

2.2 Palm oil

Malaysia is currently the world's biggest producer of palm oil. It was reported in 2004 that Malaysia accounted for 51% of world palm oil production and 62% of world exports. Malaysia also contributed to 8% and 22% of the world's total production and exports of oils and fats respectively. The emergence of palm oil in the Malaysian economy during the 1960s assisted Malaysia in diversifying its primary commodity export base. Apart from this, the palm oil industry has also helped the government in its fight against rural poverty. This has been achieved through a number of land development programmes, such as the Federal Land Development Authority (FELDA) which undertakes development of new lands for agricultural settlements.

In the 1970s and 1980s, India and Singapore were the two leading importers of Malaysian palm oil, with Singapore emerging as the leader. However, during the

1990s this trend changed course, with the major importers of Malaysian palm oil now India, Pakistan, China, Singapore and the Netherlands. In Figure 4.2, we see that from the five countries under study, Singapore is the largest importer in the early 1990s, but trails behind Japan and the US in the late 1990s and early 2000s. The UK was one of the largest palm oil importers in the 1970s, but has decreased its import level to an average of slightly over 1.5% during the 1990s and early 2000s.

The United States was never one of the major markets for Malaysian palm oil until the early 2000s. This was due to the big anti-palm oil movement in the US during the 1980s which attempted to protect its own soybean oil industry. The United States anti-palm oil movement labelled palm oil as "bad oil", claiming it is high in saturated fat and is bad for the heart. However, medical research has shown that partially hydrogenated soybean oil contains trans fats (which palm oil does not) which has a higher link with coronary heart disease. Based on these findings, more food maker companies like Kraft Foods are replacing partially hydrogenated soybean oil with palm oil. Even though soybean oil still dominates the US markets, Malaysian palm oil quickly entered the US markets in the early 2000s.

In Figure 4.2 we see that the exports of palm oil to all these five countries decline in the middle of 1990s. This phenomenon is in line with the decreasing trend of Malaysian total exports of palm oil to the world market during those periods. There are several factors contributing to this decrease. One is that palm oil export prices were high during those periods, which made consumers reduce their demands. The higher export prices were due to lower production, which was caused by lower yield from fresh fruit bunches (due to stress experienced cyclically by the oil palm trees once every three or four years). The declines were also associated with the haze and prolonged dry spell that hit Malaysia in the second half of 1997 due to the El-Nino phenomenon.

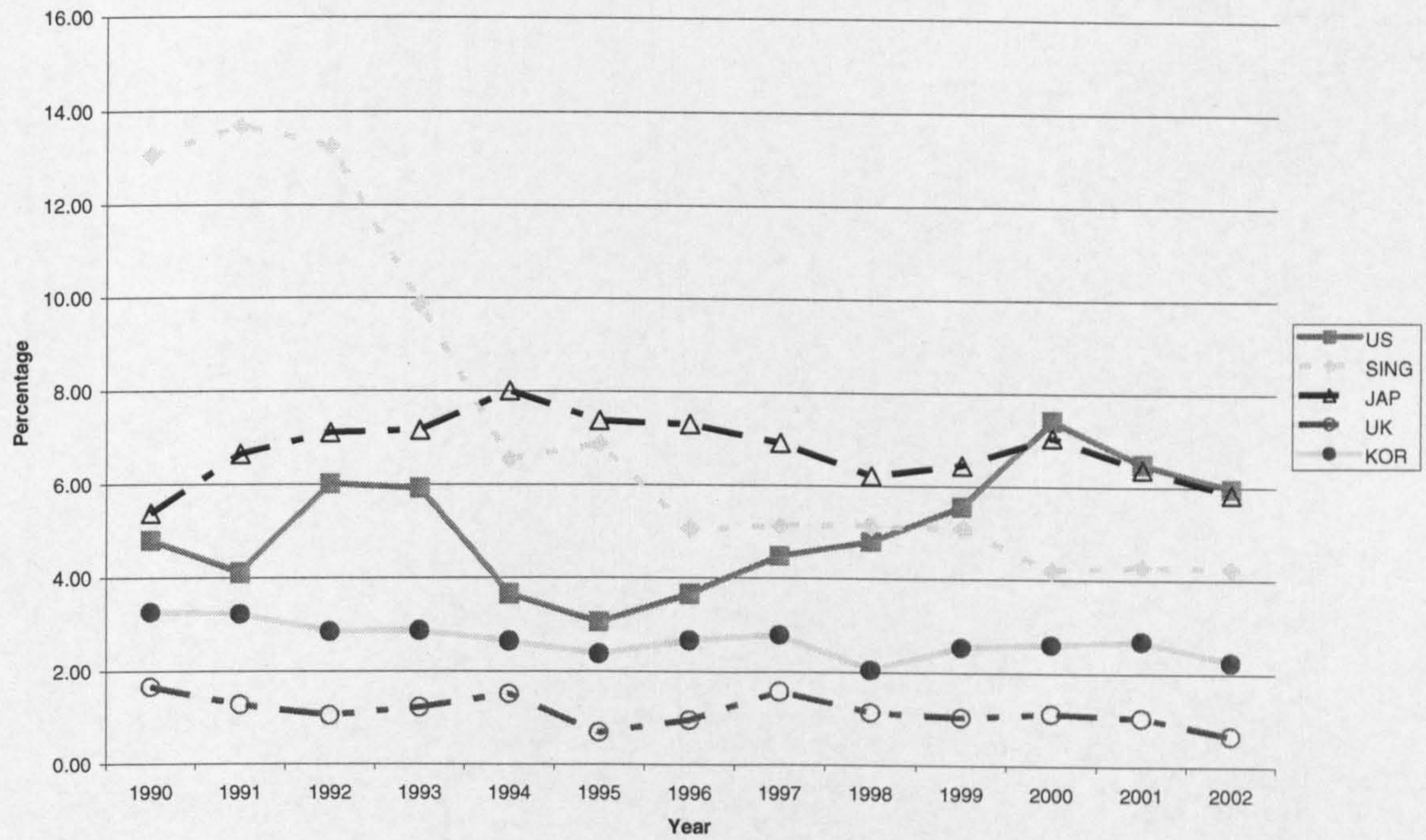

Figure 4.2. Exports of palm oil to each individual country as a percentage of total exports of palm oil

2.3 Timber

Timber, comprising both saw logs and sawn timber, was Malaysia's third largest commodity export in the early 1990s after petroleum and palm oil. Moreover, since the late 1980s Malaysia has emerged as the world's largest tropical log producer and exporter, outpacing her neighbouring country, Indonesia. These was due to rampant logging in the Bornean states of Malaysia (Sabah and Sarawak), during the 1980s, despite major protests from domestic and international environmental organizations and from the indigenous forest peoples of Sarawak. About 80% of Malaysian timber comes from Sarawak. The environmentalists accused the loggers of destroying the rainforest and argued that a sustainable forest management policy is non-existent. Meanwhile, the indigenous forest nomads, who depend on the forest for survival, protested because they believed that they were being deprived of their traditional lands.

The major importers of Malaysian timber in the past have been Japan, the Republic of Korea and Taiwan. During the 1970s and 1980s, they had collectively accounted for more than 90% of Malaysian exports of timber, with Japan predominating. Besides these three major countries, Malaysian timbers were also imported by the US and the EC countries, especially the Netherlands and the UK, during those two decades. From Figure 4.3, we see that exports of timber between 1990 and 2002 have been predominantly to Japan and the US. Between the two of them, their total imports increased from 26% in 1990 to more than double in the mid 1990s and slightly above 40% in the late 1990s. We also see that between 1992 and 1995, the US overtook Japan to become the number one importer of Malaysian timber.

However, since the mid-1990s, Malaysian exports of timbers have declined due to the anti-tropical timber campaign by non-government organizations (NGOs) in consumer countries, especially the US and EC countries. They now apply trade sanctions and other unilateral trade measures on tropical timber and demand the issue of timber certification systems (to prove that the timbers are from sustainably managed forests, being harvested in accordance with good environmental practices). As a result of this anti-tropical timber campaign, the US and EC countries stopped, or reduced, their imports of Malaysian timbers. On the other hand, consumers in the Asian regions did not impose this sanction and greater demands for timbers occurred from countries such as Japan, China, Korea, Taiwan and Thailand.

Apart from the US and EC boycott, another factor leading to declining Malaysian timber exports since the mid-1990s is the rapid expansion of its timber downstream processing industry. In the early 1990s, the Malaysian government launched an industrial policy promoting local manufacturing of timber products such as plywood/veneer, mouldings and furniture, rather than exports of commodity timber. Between 1996 and 2000, Malaysia's annual saw log production averaged around 26 million cubic meters, a decline of 32% from the 1991-1995 annual figures of around 38 million cubic meters. This decrease is seen as being in line with the government's conservation policy and commitment to the International Tropical Timber Organisation (ITTO) Year 2000 objective's of sustainable forest management. As for the export of timber products, it has been increasing steadily during the 1990 periods,

from US$3.57 billion in 1990 to US$4.65 billion in 2000. Even though Malaysia increasingly uses her logs as raw material in her own downstream processing facilities, Malaysia is still the world's largest exporter of tropical logs.

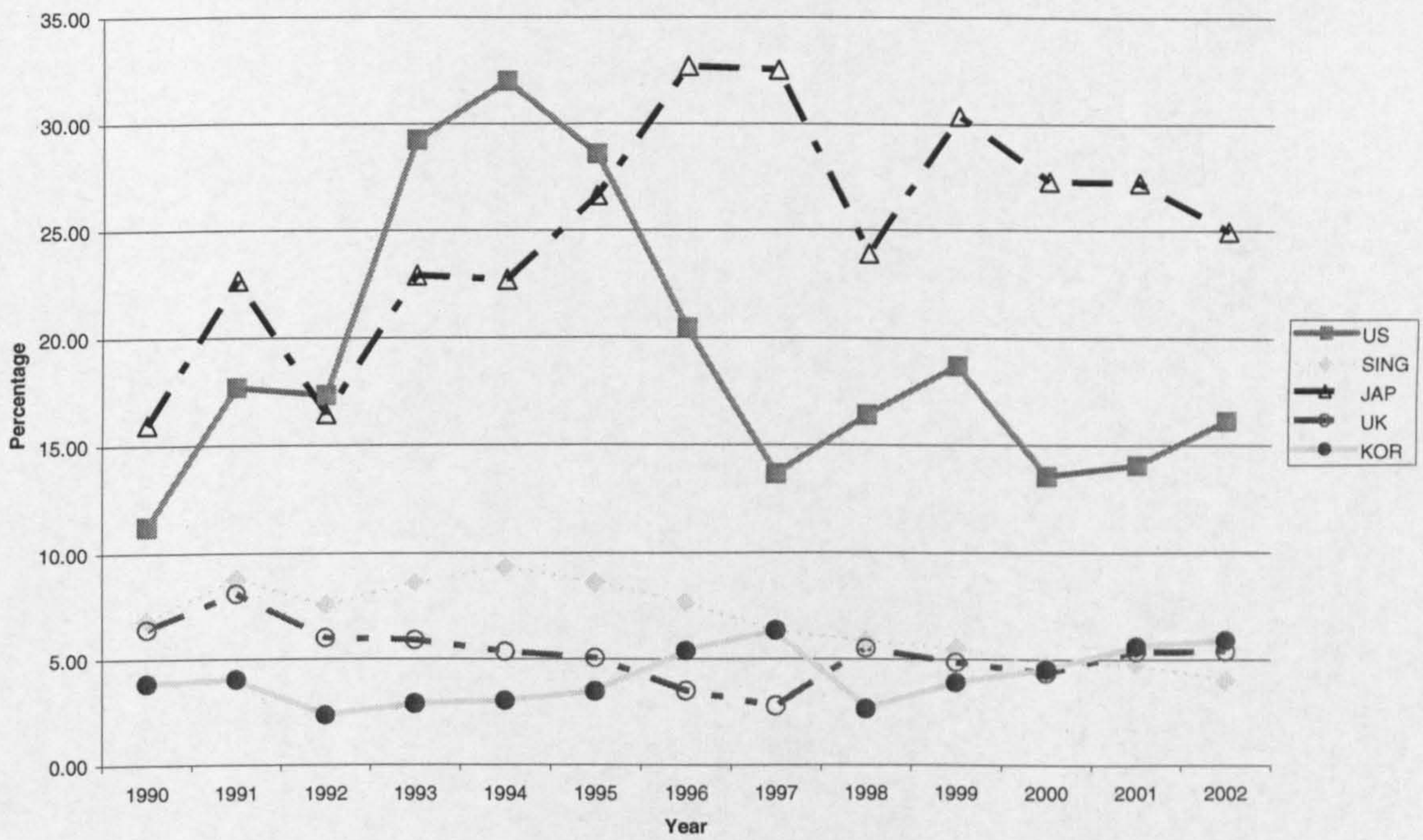

Figure 4.3. Exports of timber to each individual country as a percentage of total exports of timber

2.4 Apparel

The growth in the Malaysian textiles and apparel industry accelerated in the early 1970s when the country embarked on a path of export-oriented industrialisation. Backed by vast experience, superior quality and reasonable prices, as well as the three decades of protectionism that Malaysian apparel industry gained in the form of the Multi Fibre Agreement (MFA), Malaysian textiles and apparel have gained a strong foothold in global markets. The MFA was signed by the US, Canada and European Union in 1974, essentially to protect their textile and clothing industries from the growing competition of the developing countries, able to produce products

more cheaply due to low labour costs. Based on the MFA, industrialised countries have maintained quotas, limiting the amount of textiles products (textiles and apparels) imported from major developing countries. The MFA acted as an incentive to large name brands to move their production units to multiple countries and to the developing countries to open up to foreign investors. The MFA was eliminated entirely by January 1, 2005 according to the rules established by World Trade Organization (WTO).

Malaysian apparel manufactures have always had an excellent reputation for quality, reliability and prompt delivery, making their products a favoured choice in competitive markets such as the US, Japan and Singapore. Diverse apparel goods produced in Malaysia include jackets, overcoats, skirts, T-shirts, blouses, pants, undergarments and scarves. By using processes such as computer-aided design (CAD) and computer-aided manufacturing (CAM), Malaysian manufacturers can easily meet clients' rigid production time-frames and requirements for prompt delivery. These qualities ensure that Malaysia remains an attractive outsourcing destination for international brands, especially the US brands, such as Adidas, BUM Equipment, Calvin Klein, GAP, Guess, JC Penny, Nike, Polo and Timberland.

Over the years, Malaysian apparel producers have differentiated themselves from competitors by stressing their commitments to worker safety, employee welfare, reliability and quality. Malaysian manufacturers have also implemented automated and computerised manufacturing to cut production cycle time and, therefore, increase productivity. By increasing efficiency and productivity, Malaysia intends to maintain its desirability as an international producer of premium quality and reasonably priced apparel goods. In particular, it is determined not to lose out to China and India after the phasing out of the MFA in 2005. With the full liberalization of the textiles and apparel trades in 2005, China and India, with their enormous work force and low wages, are expected to be the major global textile and clothing manufacturers in the coming decade.

Malaysian apparel consumers have always been the US, the UK, Japan, Singapore and other European Union countries. For exports of Malaysian apparel during the period 1990 through to 2002, we see in Figure 4.4 that the US is the main importer,

with 39% of the total exports in 1990 and 53% in 2002. This statistic is understandable as there are many US owned apparel companies operating in Malaysia. Of the five countries in this study, the Republic of Korea is the only importing country that has very minimum import levels, barely 1% throughout those years. This could be due to the fact that Korea is also one of the Asian countries that exports apparel goods to the world markets. Therefore, the Republic of Korea would not need to import large volumes of apparel from Malaysia.

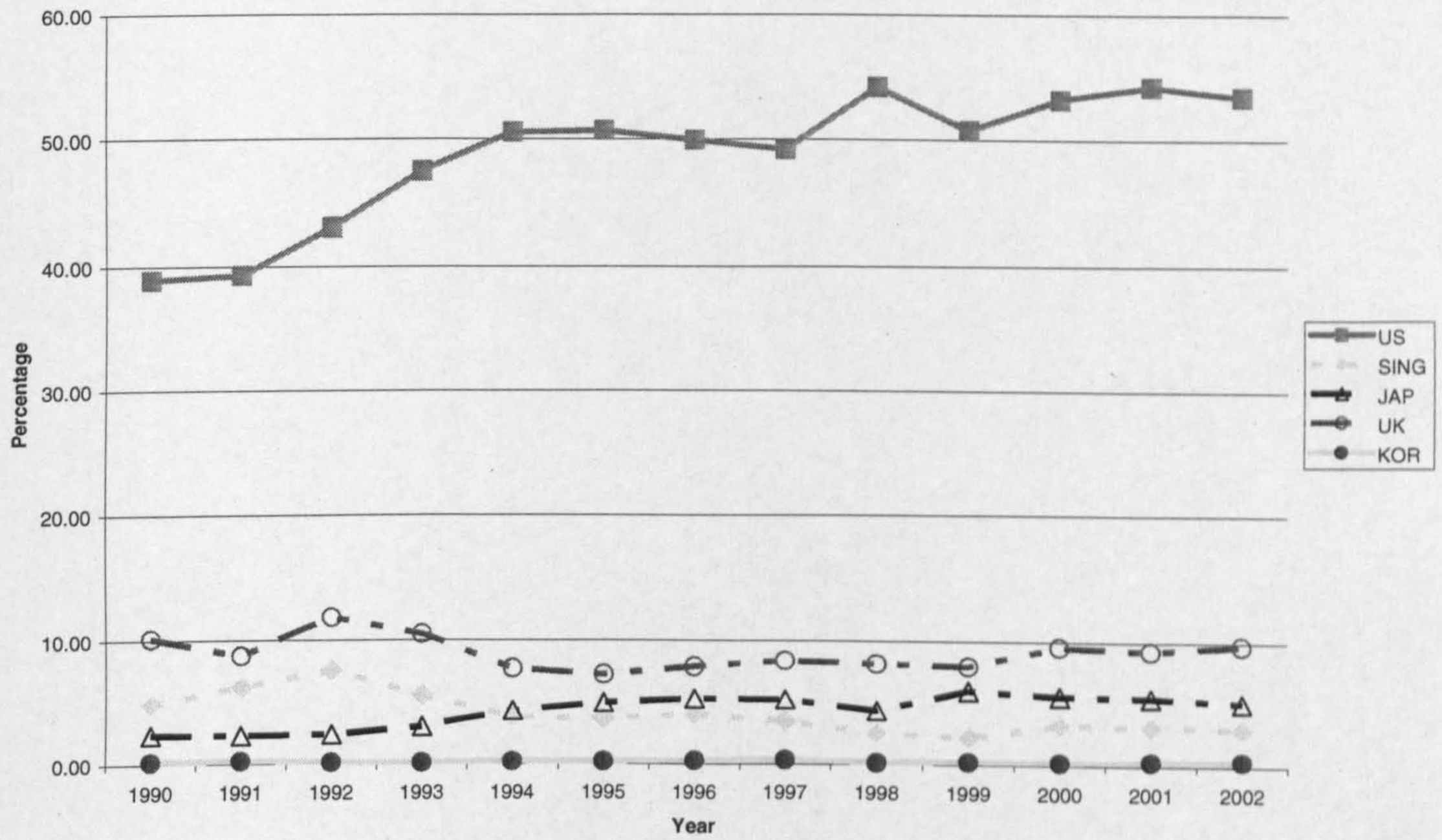

Figure 4.4. Exports of apparel to each individual country as a percentage of total exports of apparel

2.5 Rubber

During its formative years, Malaysia depended heavily upon rubber as a resource of economic growth. It was the world's largest producer and exporter of natural rubber in 1957, constituting 60% of her export earnings and contributing 33.3% to the total world output. However, Malaysia's record as the world's largest rubber producer

only lasted until the late 1980s. At the beginning of the 1990s Thailand and Indonesia surpassed Malaysia as the world's largest exporter of natural rubber. This slow down in Malaysia's growth in natural rubber production and export was basically due to a shortage of labour and high production cost in the rubber plantations. Apart from these factors, a fall in world rubber prices also contributed to the decrease in Malaysian exports of rubber. More importantly, the decrease in the export of natural rubber was due to a government policy aimed at adding value to its rubber output by processing rubber into various finished products, rather than exporting it in the form of unsmoked rubber sheet. This policy has been extremely successful and today Malaysia is the world's largest producer of rubber gloves, condoms and catheters.

In the 1970s and 1980s, China, West Germany, Italy, the UK and Japan were the major importers of Malaysian rubber. However, in the 1990s, this changed. Apart from these traditional importers, the Republic of Korea and the US also became the leading importers of Malaysian rubber. In Figure 4.5, in the first half of the 1990s, the Republic of Korea was leading the US with average imports of rubber of 14% annually, while in the second half of the 1990s and into the 2000s, the US was the leader with an average of 11% annually. This phenomenon is due to the large demand in natural rubber from the US's advanced automobile industries (in particular the market for tyres). Surprisingly, Singapore's share of the imports declined tremendously in the late 1990s from 8.5% in 1990 to only 0.98% in 2002. This could be due to the fact that Singapore's imports were mainly for re-exporting to Malaysia in the form of finished products. At the same time, during those periods, Malaysia concentrated on its rubber-based industries policy. Since the expansion of its rubber-based industries, Malaysia has been exporting the rubber products to Singapore instead, and this could have made Singapore reduce its imports of natural rubber from Malaysia.

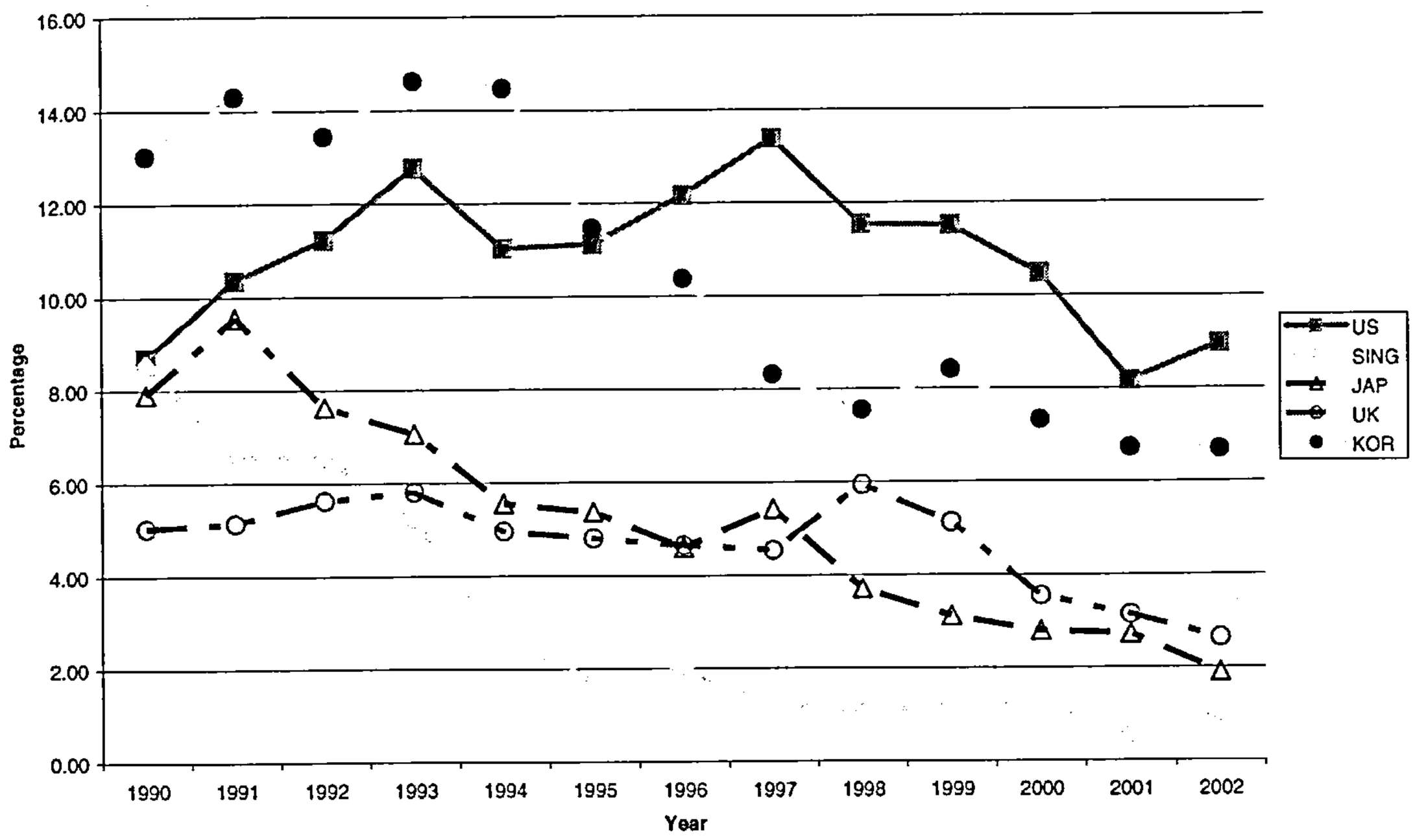

Figure 4.5. Exports of rubber to each individual country as a percentage of total exports of rubber

The Malaysian government's policy of agricultural diversification (started in the 1960s) saw new commodities such as palm oil and timber gaining significance on her export list. The impact of the primary commodity export diversification policy has transformed the economy from one depending largely on rubber to one with a diversified basket of commodity exports, consisting of rubber, tin, palm oil and timber. The share of rubber in total exports contracted from 55% in 1960 to 33% in 1970, while palm oil and timber increased from 1.7% and 3.3% to 5.1% and 12.5% in 1960 and 1970, respectively.

Given the economic curse of being a primary producer, Malaysia has pursued industrialisation programmes, which initially focused on import substitution (in the 1960s), export promotion (in early 1970s) and then heavy industrialisation (in the 1980s and the 1990s). Predictably, such shifts in the industrial policy impacted upon the structure of Malaysia's exports. The contribution of manufactured exports to total exports expanded significantly from 12% in 1970 to 22% in 1980 and,

correspondingly, the share of non-manufactured exports decreased from 88% to 78% over the same period. Manufactured goods now make up more than 70% of the country's total exports. Within the manufactured exports, electrical and electronic goods and apparel are the main items.

The launching of such a heavy industrialisation phase in the early 1980s has seen Malaysia achieve fairly rapid industrial growth, pertinent for the country to embark upon a more advanced stage of industrialisation in the 1990s. Thus, as shown in Figure 4.6, we see an increasing trend in electrical and electronic exports from just 14% of the gross domestic products (GDP) in 1990 to 64% in 2000. It is reported that the manufacturing sector still accounts for more than 32% of Malaysia's GDP. As for the exports of non-manufactured goods such as palm oil, timber and rubber, their total combined shares of the GDP were 8% in 1990 and 11% in 2000. We see from the graph that exports of rubber were severely affected, whereby their shares of the GDP decreased from 2.3% in 1990 to 0.75% in 2000.

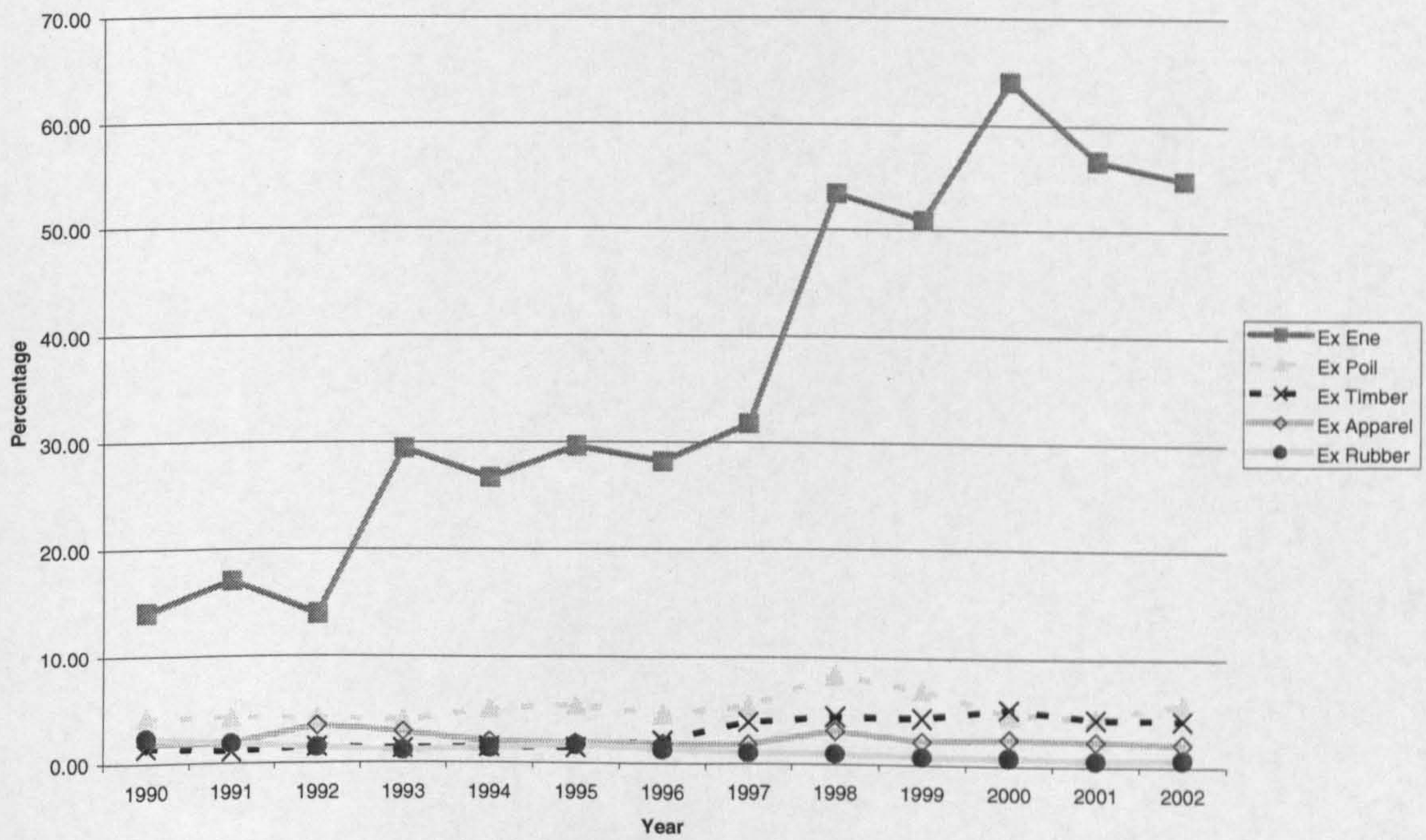

Figure 4.6. Major Export Categories as a percentage of Gross Domestic Products.

3 Modelling Methods and Sources of Data

3.1 Modelling methods

Due to data limitations, the bilateral disaggregated export data of Malaysia applied in this study are reported in current Malaysian ringgit only, since appropriate price deflators are not available. Thus, the test in this study is the effect exchange rate volatility has on the value of the bilateral exports of five categories of major exports by Malaysia to her five trading partners during the period 1990 through to 2002. This test has been done by Klein (1990) where he adopted Thursby and Thursby's (1987) derivation of an equation of this nature from the export demand and supply relationships.[1] In our study, using a traditional export demand function with an addition of a measure of exchange rate volatility, our regression equation that captures the impact of exchange rate volatility on the value of bilateral exports of a particular category of major exports by Malaysia to a particular country is:

$$P_{it}Q_{it} = \alpha + \beta_1 Y_{it} + \beta_2 P_{it} + \beta_3 R_{it} + \beta_4 V_{it} + \varepsilon_{it} \qquad (1)$$

where P_{it} represents the domestic currency price and Q_{it} is the volume of exports to country i in period t, Y_{it} is a measure of economic activity in the importing country, P_{it} is the relative price between Malaysia and country i, R_{it} represents the level of bilateral exchange rate between Malaysia and country i (an increase denotes a depreciation of Malaysia's currency), V_{it} is a measure of the volatility of the bilateral exchange rate between Malaysia and country i, ε_{it} is an error term and t is the time period.

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[1] See Thursby, Jerry G., and Marie C. Thursby, 1987, Bilateral trade flows, the Linder hypothesis, and exchange risk, *The Review of Economics and Statistics* 69, 488-495. for the derivation of the equation.

Economic theory suggests that the volume of exports to foreign trading partners ought to increase if the income of the partners' rises, and decrease if their income were to fall. Therefore, we should expect β_1 to be positive. As for the relative prices, we assume these to be a measure of a country's international competitiveness. An increase shows that domestic goods have increased in price relative to the foreign goods' price, causing demand for exports to fall (with β_2 is expected to be negative). In the case of the level of bilateral exchange rate, the increase in this indicates that the exchange rate has depreciated in value and, therefore, the country would gain competitiveness due to domestic goods being cheaper in terms of the foreign currency. As a result, foreigners' demand for domestic goods will increase, thus improving the level of exports. So, we could expect β_3 to be positive. However, the effect of bilateral exchange rate volatility on the exports is ambiguous, and depends on traders' attitude to risk. If traders are risk-neutral, taking exchange rate uncertainty as an opportunity to increase profits, the overall trade flows will be increasing (see Franke (1991) and Sercu and Vanhulle (1992)). On the other hand, if traders are risk-averse and consider exchange rate risk as an additional cost, then the overall trade volumes will be depressed (see Ethier (1973), Brodsky (1984) and Gagnon (1993). Therefore, the sign for β_4 could be positive or negative and must be tested empirically.

In this study, using a panel fixed effects framework, we examine the effects of exchange rate volatility on the value of the bilateral exports of five categories of major exports by Malaysia to five of her top trading partners over two time periods: 1990:1 to1998:8 and 1998:9 to 2002:12. The first time period is the period during the floating exchange rate regime (before the Malaysian government changed the foreign exchange rate regime as a consequences of the 1997 Asian economic crisis). The second time period is the period after the Malaysian government fixed the foreign exchange rate of RM3.8000 to every US$ (one of the measures taken to overcome the economic crisis). The five categories of major exports are: electrical and electronic goods, palm oil, timber, apparel and rubber. The five trading partners are: the United States, Singapore, Japan, the United Kingdom and the Republic of Korea.

The panel fixed effects model is used when we want to know the effect independent variables have on the dependent variable by taking into account the specific independent variables of each individual effects across a cross-section and/or across a time dimension. Examples of these specific independent variables would be sex, race, ability, language and distance, and these individual effects are accounted for by absorbing the omitted variables into the intercept term of the regression model. There are a few assumptions that we could make with regards to the specific individual effects: (a) we could fix the specific variable of each individual by making the intercepts vary across individual, but remain constant across time, (b) we could fix the specific variable of each time period by making the intercepts vary across time but remain constant across individual, or (c) we could fix the specific variable of each individual and time period by making the intercepts vary across individual and time period. Based on these assumptions, the fixed effects models are as follows:

The fixed effects model (assuming individual effect only) is:

$$y_{it} = \alpha_i + \beta' x_{it} + \varepsilon_{it} \qquad i = 1,\ldots\ldots,N \quad \text{and} \quad t = 1,\ldots\ldots,T \qquad (2)$$

The fixed effects model (assuming time effect only) is:

$$y_{it} = \alpha_t + \beta' x_{it} + \varepsilon_{it} \qquad i = 1,\ldots\ldots,N \quad \text{and} \quad t = 1,\ldots\ldots,T \qquad (3)$$

The fixed effects model (assuming individual and time effect) is:

$$y_{it} = \alpha_{it} + \beta' x_{it} + \varepsilon_{it} \qquad i = 1,\ldots\ldots,N \quad \text{and} \quad t = 1,\ldots\ldots,T \qquad (4)$$

where α_i represents the effects of those variables peculiar to the ith individual in more or less the same fashion over time, α_t is the effect of the variables peculiar to the tth time period, α_{it} is the effect of those variables peculiar to both the individual and time period and β' is a vector of constant slope parameters. The error term ε_{it} represents the effects of the omitted variables peculiar to both the individual units and time periods. We assume that ε_{it} can be characterized by an independently, identically distributed, random variable with mean zero and variance σ_ε^2.

In this study, we only want to look at the factors pertaining to each of the countries included in the study. Therefore, our panel fixed effects estimation would only be based on the individual effects assumption. By assuming the individual effects in the model, we assume that each country's characteristics vary from one another but stay constant over the time periods.

3.2 Sources of Data

In this study, we use monthly data covering the period January 1990 to December 2002, extracted from the IMF International Financial Statistics and Department of Statistics, Malaysia. The countries chosen in this study are the same as those in the trade balance study discussed in Chapter Three, namely the United States, Singapore, Japan, the United Kingdom and the Republic of Korea. The rationale for choosing these countries is due to them being amongst the top 10 trading partners, both in exports and imports with Malaysia, during the same period (i.e. 1990 and 2002), as explained in the previous chapter.

The dependent variable in our specification is the value of exports to one country, of one category of major exports, by Malaysia. For the foreign income variable we use the monthly Industrial Production index, even though this is more restrictive when measuring the level of manufacturing (it should still reflect the overall trend of GDP and is thus applied as a proxy for monthly foreign income since monthly GDP data is not available). As for the relative price variable, we measure it in terms of the ratio of Malaysia CPI to foreign country's CPI.

The bilateral nominal exchange rate level of ringgit/foreign currencies quotations were not obtained directly from the International Financial Statistics, except for the ringgit/US dollar exchange rates. We applied the triangular arbitrage procedure between the ringgit exchange rate against the US dollar and the foreign currencies against the US dollar to obtain the other ringgit/foreign currencies nominal exchange rates. As for the bilateral real exchange rates level of ringgit/foreign currencies

quotations, they are computed by multiplying the nominal exchange rates by the ratio of the foreign country's CPI to the Malaysian CPI.

As discussed in Chapter Two, there are various methods to calculate the measurement of bilateral exchange rate volatility, as a proxy to capture exchange rate risks. In this study of determining the effects of exchange rate uncertainty to Malaysia major exports categories, we are using the same measurements as those being used in the trade balance study. The volatility measures applied are: moving average standard deviation (MASD) of the growth rate of the exchange rate employed by Kenen and Rodrik (1986) and the generalized autoregressive conditional heteroskedasticity (GARCH) model introduced by Bollerslev (1986).

As noted by Cushman (1986) and Klein (1990) in their studies, bilateral studies may have ignored the so called 'third-country' effects. The volatility of a bilateral exchange rate may only affect the value of export between two countries to the extent that this volatility differs from the volatility of other bilateral exchange rates (between either of these trading partners and other countries). Therefore, in this study, apart from estimating the effects of bilateral exchange rate volatility using the MASD and GARCH approaches, we are also looking at the effects of a third country's volatility. In order to capture the third country's effects, we adopted Klein's (1990) approaches by considering the exports of Malaysian major exports categories as a function of comparative bilateral volatility. Using these, the comparative bilateral volatility term represents the volatility of the bilateral exchange rate between Malaysia and the importing country, relative to a weighted average of the volatility of the bilateral ringgit exchange rates of all the importing countries in the sample.

The comparative bilateral exchange rate volatility is obtained by:

$$V_{it}^{*} = V_{it} - \sum_{i=1}^{5} w_i V_{it} \qquad (5)$$

where V_{it}^{*} is comparative bilateral exchange rate volatility, V_{it} is the bilateral exchange rate volatility between Malaysia and country i in period t, and w_i is a

constant, relative weight of the importing countries as export markets for Malaysia. These weights represent the proportion of the sum of all categories of major exports going to each respective country over the entire sample period. Thus, the same weights are used for each category. For the comparative bilateral exchange rate volatility, we use the MASD and GARCH approaches to derive for the bilateral volatility index between Malaysia and country i.

4 Empirical Analysis and Results

Prior to estimation of the panel fixed effects model, all variables were transformed into logarithms in order to reduce the variability of our datasets and also to take care of the heteroskedasticity problems in the data. Lower case letters denote the logs of the corresponding capitals in Equation (1). All equations are estimated, correcting for autocorrelation and for heteroskedasticity across countries.

4.1 Panel unit root test

The properties of the panel data set in both periods were examined before any panel fixed effects are estimated. We examined the non-stationarity of the panel data using the Levin, Lin and Chu (2002) test and the Im, Pesaran and Shin (2003) test. In both tests we include an intercept without trend, and intercept with trend, in the equation. The test results for the floating exchange rate periods are reported in Table 4.1 and Table 4.2, while the results for the fixed exchange rate periods are presented in Table 4.3 and Table 4.4. We found that both tests seemed to have similar results in both equations. In the floating periods, most of the panel data are non-stationary, I(1), when just the intercept is included in the regression, but the majority of them are found to be stationary, I(0), when intercept and trend assumption are included in the equation. For the fixed exchange rate periods, we found that the panel data are

mostly stationary, I(0), when we include an intercept without trend, and intercept with trend, in the equation.

Table 4.1. Panel unit root test: Floating Period: Individual Intercept

	Individual Intercept					
	Levin, Lin & Chu			Im, Pesaran & Shin		
Variable	**Level**	**First Difference**	**Order of Integration**	**Level**	**First Difference**	**Order of Integration**
Electrical & Electronic	-1.55	-32.79*	I(1)	0.10	-29.72*	I(1)
	(0.06)	(0.00)		(0.54)	(0.00)	
Palm Oil	-0.68	-20.83*	I(1)	-0.72	-27.11*	I(1)
	(0.25)	(0.00)		(0.24)	(0.00)	
Timber	-0.41	-39.26*	I(1)	1.80	-34.88*	I(1)
	(0.34)	(0.00)		(0.96)	(0.00)	
Apparel	-1.52	-38.31*	I(1)	-1.70**	-35.04*	I(0)
	(0.06)	(0.00)		(0.04)	(0.00)	
Rubber	-4.45*	-30.11*	I(0)	-4.34*	-28.53*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Income	3.29	-23.71*	I(1)	3.42	-20.96*	I(1)
	(0.99)	(0.00)		(0.99)	(0.00)	
Relative Price	2.15	-18.23*	I(1)	3.36	-15.16*	I(1)
	(0.98)	(0.00)		(0.99)	(0.00)	
Nominal Exchange Rate	2.77	-26.97*	I(1)	2.38	-23.86*	I(1)
	(0.99)	(0.00)		(0.99)	(0.00)	
MASD	2.50	-11.96*	I(1)	2.05	-14.26*	I(1)
	(0.99)	(0.00)		(0.98)	(0.00)	
GARCH	-2.78*	2.24	I(0)	-6.16*	-10.77*	I(0)
	(0.00)	(0.98)		(0.00)	(0.00)	
Comparative MASD	-0.99	-17.08*	I(1)	-3.30*	-18.82*	I(0)
	(0.16)	(0.00)		(0.00)	(0.00)	
Comparative GARCH	-3.09*	-9.88*	I(0)	-6.55*	-14.73*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	

Notes: The null hypothesis is that the panel is I(1). The * (**) denotes rejection at 1% (5%) significant level. P-values are in the bracket.

Table 4.2. Panel unit root test: Floating Period: Individual Intercept and Trends

	Individual Intercept and Trends					
	Levin, Lin & Chu			Im, Pesaran & Shin		
Variable	**Level**	**First Difference**	**Order of Integration**	**Level**	**First Difference**	**Order of Integration**
Electrical & Electronic	-2.86*	-36.13*	I(0)	-3.60*	-30.98*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Palm Oil	-16.54*	-18.30*	I(0)	-14.30*	-25.82*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Timber	-3.49*	-43.66*	I(0)	-2.66*	-36.74*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Apparel	-1.92**	-42.42*	I(0)	-2.40*	-36.89*	I(0)
	(0.03)	(0.00)		(0.00)	(0.00)	
Rubber	-10.64*	-33.57*	I(0)	-8.76*	-29.66*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Income	-1.93**	-26.98*	I(0)	0.24	-21.82*	I(1)
	(0.03)	(0.00)		(0.60)	(0.00)	
Relative Price	0.80	-20.62*	I(1)	-1.99**	-15.27*	I(0)
	(0.79)	(0.00)		(0.02)	(0.00)	
Nominal Exchange Rate	2.48	-30.30*	I(1)	1.22	-24.92*	I(1)
	(0.99)	(0.00)		(0.89)	(0.00)	
MASD	2.48	-12.50*	I(1)	2.71	-14.42*	I(1)
	(0.99)	(0.00)		(0.99)	(0.00)	
GARCH	-2.78*	4.37	I(0)	-5.58*	-10.38*	I(0)
	(0.00)	(1.00)		(0.00)	(0.00)	
Comparative MASD	-1.54	-17.72*	I(1)	-3.33*	-19.14*	I(0)
	(0.06)	(0.00)		(0.00)	(0.00)	
Comparative GARCH	-3.65*	-1.14	I(0)	-6.46*	-11.28*	I(0)
	(0.00)	(0.13)		(0.00)	(0.00)	

Notes: The null hypothesis is that the panel is I(1). The * (**) denotes rejection at 1% (5%) significant level. P-values are in the bracket.

Table 4.3. Panel unit root test: Fixed Period: Individual Intercept

	Individual Intercept					
	Levin, Lin & Chu			Im, Pesaran & Shin		
Variable	**Level**	**First Difference**	**Order of Integration**	**Level**	**First Difference**	**Order of Integration**
Electrical & Electronic	-1.53	-17.25*	I(1)	-1.80**	-18.44*	I(0)
	(0.06)	(0.00)		(0.04)	(0.00)	
Palm Oil	-7.86*	-11.52*	I(0)	-9.37*	-19.39*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Timber	-1.59	-16.67*	I(1)	-3.36*	-18.26*	I(0)
	(0.06)	(0.00)		(0.00)	(0.00)	
Apparel	-3.34*	-21.67*	I(0)	-3.88*	-21.23*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Rubber	-5.26*	-21.67*	I(0)	-4.42*	-20.93*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Income	-1.47	-18.64*	I(1)	-0.44	-18.60*	I(1)
	(0.07)	(0.00)		(0.33)	(0.00)	
Real Exchange Rate	-1.08	-13.74*	I(1)	-0.77	-14.67*	I(1)
	(0.14)	(0.00)		(0.22)	(0.00)	
MASD	-6.19*	-14.62*	I(0)	-7.03*	-15.07*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
GARCH	-7.72*	-13.77*	I(0)	-5.13*	-18.81*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Comparative MASD	-4.20*	-14.33*	I(0)	-7.08*	-17.45*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Comparative GARCH	-15.30*	-18.77*	I(0)	-15.80*	-21.10*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	

Notes: The null hypothesis is that the panel is I(1). The * (**) denotes rejection at 1% (5%) significant level. P-values are in the bracket.

Table 4.4. Panel unit root test: Fixed Period: Individual Intercept and Trends

	Individual Intercept and Trends					
	Levin, Lin & Chu			Im, Pesaran & Shin		
Variable	**Level**	**First Difference**	**Order of Integration**	**Level**	**First Difference**	**Order of Integration**
Electrical & Electronic	0.19	-16.69*	I(1)	0.09	-18.40*	I(1)
	(0.58)	(0.00)		(0.54)	(0.00)	
Palm Oil	-7.82*	-4.71*	I(0)	-7.98*	-17.35*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Timber	-4.72*	-15.70*	I(0)	-7.17*	-18.05*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Apparel	-3.68*	-16.70*	I(0)	-4.28*	-18.08*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Rubber	-6.57*	-23.31*	I(0)	-5.37*	-22.14*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Income	-1.17	-18.82*	I(1)	-0.23	-18.95*	I(1)
	(0.12)	(0.00)		(0.41)	(0.00)	
Real Exchange Rate	-0.57	-14.23*	I(1)	-0.59	-14.53*	I(1)
	(0.28)	(0.00)		(0.28)	(0.00)	
MASD	-4.38*	-14.62*	I(0)	-5.12*	-15.10*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
GARCH	-8.80*	-12.08*	I(0)	-12.60*	-17.10*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Comparative MASD	-2.84*	-13.50*	I(0)	-5.75*	-17.28*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	
Comparative GARCH	-13.99*	-20.16*	I(0)	-14.09*	-22.75*	I(0)
	(0.00)	(0.00)		(0.00)	(0.00)	

Notes: The null hypothesis is that the panel is I(1). The * (**) denotes rejection at 1% (5%) significant level. P-values are in the bracket.

4.2 Floating exchange rate periods

In the floating exchange rate periods study, we apply Equation (1) to examine the effects of exchange rate volatility on the value of the bilateral exports of five categories of major Malaysian exports. In this regression, the nominal bilateral exchange rate is used for the level of exchange rate variable, and also in deriving the proxy for the exchange rate volatility index. As mentioned earlier, we are using the panel individual fixed effects estimation for our study. The results for the panel individual fixed effects estimation using the bilateral and comparative bilateral

exchange rate volatility for the floating exchange rate periods are reported in Table 4.5 and Table 4.6, respectively.

Table 4.5. Regression results for floating period: Bilateral exchange rate volatility - Individual effects

Categories	*y*	*p*	*ner*	*v*	R^2
GARCH Volatility					
Electrical & Electronic	2.46(0.00)	8.34(0.00)	-0.05(0.79)	16.62(0.00)	0.92
Palm Oil	1.07(0.00)	2.54(0.00)	0.67(0.00)	15.02(0.00)	0.75
Timber	3.58(0.00)	6.93(0.00)	0.20(0.37)	17.64(0.00)	0.82
Apparel	1.48(0.00)	3.24(0.00)	-0.08(0.68)	18.39(0.00)	0.91
Rubber	-0.86(0.00)	-2.12(0.00)	-0.20(0.17)	-4.21(0.01)	0.69
MASD Volatility					
Electrical & Electronic	2.44(0.00)	8.20(0.00)	-0.17(0.35)	0.04(0.00)	0.92
Palm Oil	0.99(0.00)	2.47(0.00)	0.50(0.03)	0.05(0.00)	0.76
Timber	3.48(0.00)	6.87(0.00)	0.003(0.98)	0.05(0.00)	0.83
Apparel	1.38(0.00)	3.16(0.00)	-0.29(0.16)	0.06(0.00)	0.91
Rubber	-0.87(0.00)	-2.08(0.00)	-0.18(0.23)	-0.01(0.07)	0.69

Notes: P-values are in brackets. Method of estimation: OLS, fixed effects panel model. t-statistic computed with the use of White heteroskedasticity-consistent standard errors.

The estimated coefficients of exchange rate volatility in this panel estimation are found to be statistically significant in all the major export categories in the case of both types and both measures of volatility, except in the rubber category according to the bilateral exchange rate volatility (using the MASD measure of volatility). The exchange rate volatility coefficients appear with a positive sign in all these categories, except in the rubber category. As discussed earlier, exporters may regard the volatility as an opportunity to make profits (i.e. when the exporters are assumed to be risk-neutral in nature and having their exports invoiced in their home currency). Therefore, as exchange rate uncertainty increases, they may reduce their prices leading to an increase in the volume of exports and, thus, the positive sign in the volatility coefficients. As for the negative sign coefficients, we could assume that the

exporters are risk-averse and invoiced their exports in foreign currency. In this case, they would consider the volatility as an additional cost since they have to cover their foreign currency transactions in the forward market. Thus, exchange rate volatility serves as a negative supply shock, with exporters increasing export prices and decreasing the volume of exports.

Table 4.6. Regression results for floating period: Comparative bilateral exchange rate volatility - Individual effects

Categories	y	p	ner	v	R^2
GARCH Volatility					
Electrical & Electronic	2.53(0.00)	8.44(0.00)	0.12(0.50)	20.97(0.00)	0.92
Palm Oil	1.13(0.00)	2.63(0.00)	0.82(0.00)	19.09(0.00)	0.75
Timber	3.66(0.00)	7.03(0.00)	0.37(0.10)	21.92(0.00)	0.82
Apparel	1.57(0.00)	3.32(0.00)	0.09(0.66)	22.13(0.00)	0.90
Rubber	-0.86(0.00)	-2.22(0.00)	-0.26(0.07)	-8.68(0.00)	0.69
MASD Volatility					
Electrical & Electronic	2.56(0.00)	8.29(0.00)	0.09(0.62)	0.05(0.00)	0.92
Palm Oil	1.11(0.00)	2.68(0.00)	0.84(0.00)	0.08(0.00)	0.75
Timber	3.60(0.00)	7.19(0.00)	0.42(0.06)	0.11(0.00)	0.82
Apparel	1.51(0.00)	3.48(0.00)	0.14(0.49)	0.11(0.00)	0.91
Rubber	-0.88(0.00)	-2.11(0.00)	-0.24(0.10)	-0.01(0.03)	0.69

Notes: P-values are in brackets. Method of estimation: OLS, fixed effects panel model. t-statistic computed with the use of White heteroskedasticity-consistent standard errors.

The foreign income coefficients in the case of bilateral and comparative bilateral exchange rate volatility are found to be statistically significant in all the major export categories, for both measures of volatility. Economic theory stated that when the importers' income increases, so would their demand for the home country's exports. Thus, as expected, the sign for the estimated foreign income coefficients in all the categories is positive (except in the rubber category). The negative coefficients in the rubber category indicate that the importing countries in this study reduce their imports whenever their income increases. This could be due to the fact that natural

rubber is a substitute product in these countries and they could be relying more on artificial rubber for their rubber-based industries. Another reason could also be that these countries are importing more rubber from other Malaysia's neighbouring countries (e.g. Thailand and Indonesia). As discussed above, since the 1990's Malaysia has no longer been the world's top producer and exporter of natural rubber (with most of her rubber production being used in her own rubber-based industries).

The relative price variable is used to measure a country's international competitiveness. The coefficients of this variable are expected to be negative since higher relative price means that home products are perceived to be relatively higher than foreign products (therefore reducing demand for the home products). However, the results in this panel study indicated a positively significant relationship between relative price and all the Malaysian major export categories (with the exception of rubber) in the case of both types and both measures of volatility. These contradicting results suggest that most of Malaysia's major export categories are important to the countries included in this study.

As mentioned earlier, Malaysian electrical and electronic products are extremely important to both the United States and Japan, since the semiconductor products made in Malaysia are major components for the main electrical and electronic brand names in these countries. We also noted that Malaysian palm oil is an important vegetable fat for the Singapore and Japanese markets, and Malaysian tropical timbers are sought by Japanese, Korean and United States traders. Malaysian textiles and apparels are important for the United States market since many of their top brand name apparel companies have their factories located here. For these reasons we can see that, even though the price of Malaysian exports increases, the exports supplies to these countries do not decline. In the case of rubber, the results seemed to be in line with economic theory (we assume that rubber is not a necessity product to these countries and that is why, when its prices go up, importing countries reduce their demands).

The increase in the nominal exchange rate variable indicates that ringgit values depreciate in terms of the foreign currencies. Therefore, the estimated coefficients of this variable are expected to have a positive sign (since the depreciation of the

nominal exchange rate of the ringgit would make Malaysian products much cheaper to the foreigners). However, the majority of nominal exchange rate coefficients are found to have a positive, insignificant, result for comparative bilateral exchange rate volatility in the case of both measures of volatility. In the case of bilateral exchange rate volatility, the results showed a negative, insignificant, coefficient in most of the major export categories for both volatility measurements.

4.3 Fixed exchange rate periods

In our fixed exchange rate periods, we did not include the relative price variable in our regression equation, as presented in Equation (1). This is because we are using real bilateral exchange rates instead of nominal bilateral exchange rates for the level of bilateral exchange rates variable. Since the real exchange rate is an effectively relative price's term, for consistency with the floating exchange rate periods, we use the real bilateral exchange rates in the regression equation in order to capture the impact of relative price and the depreciation of the ringgit value. The real exchange rate is also being used to calculate the exchange rate volatility index. Further, panel individual fixed effects estimations are used to study the relationship between exchange rate volatility and Malaysian major export categories in the fixed exchange rate periods. Thus, the regression equation is as follows:

$$P_{it}Q_{it} = \alpha + \beta_1 Y_{it} + \beta_2 R_{it} + \beta_3 V_{it} + \varepsilon_{it} \qquad (6)$$

The results of the panel study in the fixed exchange rate periods, using the bilateral and comparative bilateral exchange rate volatility, are presented in Table 4.7 and Table 4.8, respectively.

Table 4.7. Regression results for fixed period: Bilateral exchange rate volatility - Individual effects

Categories	y	rer	v	R^2
GARCH Volatility				
Electrical & Electronic	2.21(0.00)	0.31(0.17)	-40.82(0.00)	0.97
Palm Oil	-0.72(0.02)	1.41(0.00)	54.44(0.00)	0.85
Timber	1.25(0.00)	0.42(0.03)	-57.67(0.00)	0.95
Apparel	2.17(0.00)	-0.65(0.03)	6.33(0.51)	0.98
Rubber	-0.16(0.61)	3.31(0.00)	98.40(0.00)	0.83
MASD Volatility				
Electrical & Electronic	2.25(0.00)	0.33(0.17)	-0.005(0.50)	0.97
Palm Oil	-0.59(0.06)	1.37(0.00)	0.03(0.00)	0.85
Timber	1.18(0.00)	0.45(0.03)	-0.02(0.00)	0.95
Apparel	2.32(0.00)	-0.66(0.02)	0.02(0.00)	0.98
Rubber	0.01(0.97)	3.24(0.00)	0.05(0.00)	0.83

Notes: P-values are in brackets. Method of estimation: OLS, fixed effects panel model. t-statistic computed with the use of White heteroskedasticity-consistent standard errors.

The estimated coefficients of exchange rate volatility in the fixed exchange rate periods using the bilateral exchange rate volatility are found to be significant in all major export categories (for both measures of volatility) except in the electrical and electronic category and apparel category in the case of MASD and GARCH volatility, respectively. When the GARCH volatility is used, the exchange rate volatility coefficients have a positive sign in the palm oil and rubber category, and a negative sign in the electrical and electronic and timber category. However, when the MASD volatility is employed, the coefficients are positive in palm oil, apparel and rubber category, and negative in the timber category.

When we applied the comparative bilateral exchange rate volatility in the regression, we found the results are negative in all categories (except rubber) for GARCH volatility measure. These coefficients are statistically significant in all the major export categories (except palm oil). In all categories (except apparel and rubber), we found a negative sign for MASD volatility measure. However, the exchange rate volatility coefficients are only statistically significant in the timber category. As

discussed in the study during the floating exchange rate periods, the ambiguity in the sign of the exchange rate volatility depends on the risk acceptance levels of the exporters.

Table 4.8. Regression results for fixed period: Comparative bilateral exchange rate volatility - Individual effects

Categories	*y*	*rer*	*v*	R^2
GARCH Volatility				
Electrical & Electronic	2.25(0.00)	0.27(0.21)	-65.81(0.00)	0.97
Palm Oil	-0.82(0.00)	1.37(0.00)	-11.21(0.51)	0.85
Timber	1.33(0.00)	0.40(0.03)	-43.70(0.00)	0.95
Apparel	2.13(0.00)	-0.70(0.02)	-52.57(0.00)	0.98
Rubber	-0.31(0.34)	3.32(0.00)	72.42(0.02)	0.83
MASD Volatility				
Electrical & Electronic	2.26(0.00)	0.29(0.22)	-0.01(0.19)	0.97
Palm Oil	-0.83(0.01)	1.36(0.00)	-0.01(0.68)	0.84
Timber	1.31(0.00)	0.37(0.07)	-0.03(0.02)	0.95
Apparel	2.16(0.00)	-0.65(0.03)	0.002(0.93)	0.98
Rubber	-0.29(0.38)	3.35(0.00)	0.03(0.14)	0.83

Notes: P-values are in brackets. Method of estimation: OLS, fixed effects panel model. t-statistic computed with the use of White heteroskedasticity-consistent standard errors.

Estimated coefficients of foreign income level are found to be positively significant in the electrical and electronic, timber and apparel categories - both measures of volatility in the case of bilateral and comparative bilateral exchange rate volatility estimations. For the palm oil category, foreign income is negatively significant for GARCH and negatively insignificant for MASD measures of volatility (in the case of the bilateral exchange rate volatility estimation). However, the coefficients are found to be negatively significant for both volatility measures in the case of the comparative bilateral exchange rate estimation. In the rubber category, we found an insignificant negative sign for both measures of volatility (in the case of the bilateral and comparative bilateral exchange rate volatility estimations). Positive signs of

foreign income coefficients are expected in the electrical and electronic, timber and apparel categories when there is an increase in the income level of the importing countries. However, the negative sign of foreign income coefficients in the palm oil category could imply that palm oil is a substitute product in these countries. Moreover, as mentioned above, the export prices of Malaysian palm oil in the late 1990s were very high due to lower production. This phenomenon could have made the importing countries substitute palm oil with other vegetable oils, thus reducing their export demands (even though their income level increases).

In the case of bilateral exchange rate volatility estimation, the real exchange rate coefficients are significant in all major export categories (except the electrical and electronic category) for both MASD and GARCH measures of volatility. For the most significant results, the sign is positive in the palm oil, timber and rubber categories, and negative in the apparel category. Similar results were found when we estimated the panel study using the comparative bilateral exchange rate volatility for the MASD measure (except in the timber category). As mentioned earlier, an increase in real exchange rates indicates a depreciation of the ringgit values. Moreover, since the real exchange rate is also an effective indicator of relative price, we should expect a positive sign in the real exchange rate coefficients (since depreciation in the ringgit would make Malaysian products relatively cheaper than foreign products). This would result in foreign countries demanding more Malaysian products. As for the negative sign in the apparel category, it could mean that trading partners are out sourcing their apparel supplies from other, cheaper, countries, e.g. China, India and Vietnam who are known to produce apparels products at a much cheaper cost than Malaysia (especially since the late 1990s).

5 Summary and Conclusion

Our objective in this study is to investigate the relationship of the bilateral and comparative bilateral exchange rate volatilities with the major export categories of

Malaysia during the floating and fixed exchange rate periods. For each type of volatility we employed the MASD and GARCH measurements of volatility index. Five major export categories have been chosen for five trading partners, covering the period 1990 through to 2002. The panel individual fixed effects model has been used to study the relationship of the bilateral and comparative bilateral exchange rate uncertainty and Malaysian major export categories during the two time periods. By looking at the disaggregated bilateral data, we show the different effects across particular categories of Malaysian major exports.

During the floating exchange rate periods, we found positive, statistically significant, coefficients in most of the categories in the case of the bilateral and comparative bilateral exchange rate volatility estimations. We could conclude that the results are robust, since we have similar results whether or not the third country effects are taken into consideration. We could infer that, during the floating exchange rate periods, bilateral exchange rate volatility promotes trades between Malaysia and these five trading partners. We could also assume that the firms involved are mostly risk-neutral in nature, who would take advantage of the uncertainty by using it as an opportunity to increase profits. This assumption is based on the theoretical models (see Franke (1991) and Sercu and Vanhulle (1992)) that say that traders that are risk-neutral (and able to have their exports invoiced in home currency) would increase their trades when exchange rate volatility increases. This is done by reducing export prices, which leads to an increase in trade volumes as well as profits.

On average, the exchange rate volatility coefficients during the fixed exchange rate periods showed a negative statistically significant relationship with most categories of Malaysian major exports. However, the results in the case of the bilateral exchange rate volatility are found to be more significant than in the case of comparative bilateral exchange rate volatility, especially for the MASD measure of volatility. Since the results are similar for both types of volatility index, we could conclude that these results are robust. We could further conclude that during the fixed exchange rate periods, traders are on average risk-averse in nature, assuming them to reduce their trade transactions when the volatility of the bilateral exchange rate increases. Based on the theoretical analyses (see Ethier (1973), Brodsky (1984)

and Gagnon (1993)), when traders are assumed to be risk-averse in nature (and invoice their exports in foreign currency), they would reduce their trades when exchange rate volatility increases. This is because in this case, they would consider the volatility as an additional cost since they have to cover their foreign currency transactions in the forward market. Exchange rate volatility also serves as a negative supply shock, which would make exporters increase export prices which would reduce the volume of exports. This phenomenon also suggests that they are taking such precautions because they fear the Malaysian government could lift the fixed rate of RM 3.8000 to every US dollar unexpectedly at any point in the future.

References

Asseery, A., and D. A. Peel, 1991, The effects of exchange rate volatility on exports, *Economics Letters* 37, 173-177.

Bini-Smaghi, L., 1991, Exchange rate variability and trade: why is it so difficult to find any empirical relationship?, *Applied Economics* 23, 927-36.

Bollerslev, Tim, 1986, Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics* 31, 307-327.

Brodsky, D. A., 1984, Fixed versus flexible exchange rates and the measurement of exchange rate instability, *Journal of International Economics* 16.

Cheong, Chongcheul, Tesfa Mehari, Charalambos Pattichis, and Leighton Vaughan Williams, 2002, Exchange rate volatility and UK exports: implications for EMU membership, Department of Economics and Politics, The Nottingham Trent University.

Chowdhury, A.R., 1993, Does exchange rate volatility depress trade flows? Evidence from error correction models, *Review of Economics and Statistics* 75, 700-706.

Cushman, David O., 1986, Has exchange risk depressed international trade? The impact of third-country exchange risk, *Journal of International Money and Finance* 5, 361-379.

de Vita, Glauco , and Andrew Abbott, 2004, The impact of exchange rate volatility on UK export to EU countries, *Scottish Journal of Political Economy* 51, 62-81.

Ethier, W, 1973, International trade and the forward exchange market, *American Economic Review* 63, 494-503.

Franke, Gunter, 1991, Exchange rate volatility and international trading strategy, *Journal of International Money and Finance* 10, 292-307.

Gagnon, Joseph E., 1993, Exchange rate variability and the level of international trade, *Journal of International Economics* 34, 269-287.

Hooper, Peter, and Steven W. Kohlhagen, 1978, The effect of exchange rate uncertainty on the prices and volume of the international trade, *Journal of International Economics* 8, 483-511.

Im, Kyung So, M. Hashem Pesaran, and Yongcheol Shin, 2003, Testing for unit roots in heterogeneous panels, *Journal of Econometrics* 115, 53-74.

Kenen, P.B., and D. Rodrik, 1986, Measuring and analyzing the effects of short-term volatility in real exchange rates, *Review of Economics and Statistics* 68, 311-15.

Klein, Michael W., 1990, Sectoral effects of exchange rate volatility on US exports, *Journal of International Money and Finance* 9, 299-308.

Koray, F., and William D. Lastrapes, 1989, Real exchange rate volatility and US bilateral trade: a VAR approach, *Review of Economics and Statistics* 71, 708-12.

Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu, 2002, Unit root tests in panel data: Asymptotic and finite-sample properties, *Journal of Econometrics* 108, 1-24.

McKenzie, Michael D., 1998, The impact of exchange rate volatility on Australian trade flows, *Journal of International Financial Markets, Institutions and Money* 8, 21-38.

McKenzie, Michael D. , and Robert D. Brooks, 1997, The impact of exchange rate volatility on German-US trade flows, *Journal of International Financial Markets, Institutions and Money* 7, 73-87.

Pattichis, Charalambos, Chongcheul Cheong, Tesfa Mehari, and Leighton Vaughan Williams, 2004, Exchange rate uncertainty, UK trade and the Euro, *Applied Finance Economics* 14, 885-893.

Sercu, Piet, and Cynthia Vanhulle, 1992, Exchange rate volatility, international trade, and the value of exporting firms, *Journal of Banking and Finance* 16, 155-182.

Thursby, Jerry G., and Marie C. Thursby, 1987, Bilateral trade flows, the Linder hypothesis, and exchange risk, *The Review of Economics and Statistics* 69, 488-495.

Viaene, Jean-Marie , and Casper G. de Vries, 1992, International trade and exchange rate volatility, *European Economic Review* 36, 1311-1321.

CHAPTER FIVE

EQUITY MARKET AND EXCHANGE RATE VOLATILITY INTERACTIONS IN MALAYSIA

1 Introduction

Traditionally, stock markets and foreign exchange markets have been regarded as sensitive segments of the financial market, as the impact of any policy change gets quickly reflected in both of these. At the same time, crashes in either or both markets can cause concern among policy makers. It is this dynamic interrelationship between the two markets which has prompted researchers, policy makers and analysts to carry out detailed analyses of this relationship.

As we discussed in the literature survey chapter earlier, there is no theoretical consensus on the interaction between stock prices and exchange rate values or exchange rate volatility. However, classical economic theory suggests intermediate variables (such as wealth, demand for money and interest rates), play a vital role in establishing the relationship between exchange rate behaviour and stock market performance. For instance, flow-oriented models of exchange rates determination (see Dornbusch and Fisher (1980)) posit that currency movements affect international competitiveness and balance of trade positions and, consequently, the real output or income of the country. This in turn affects the current and future expected cash flows of firms and their stock prices. An alternative model of exchange rate determination, i.e. a stock-oriented models (see Branson (1983)), contends that innovations in the stock market affect exchange rates via the capital account. This model is based on the notion that agents should allocate their entire wealth among domestic and foreign assets. Hence, the exchange rate plays the role of

balancing the demand for and supply of assets. In addition, the traditional money demand equation proposes that changes in domestic economic activities (proxied by stock returns) lead to changes in demand for real currency balances and, consequently, to changes in exchange rates (see Gavin (1989)).

Apart from theoretical investigation, there are well-documented empirical studies that attempt to determine the relationship between stock prices and exchange rate volatility or exchange rate values. The findings, however, are not uniform across the various studies. As discussed in the literature survey chapter, some studies report on the positive impact of exchange rate volatility on stock prices, for example Aggarwal (1981) and Fang and Miller (2002), while those reporting a negative impact include Soenen and Hennigar (1988) and Chiang, Yang and Wang (2000).

On the impact of exchange rates values on stock prices, some studies documented positive effects, e.g. Abdalla and Murinde (1997), Phylaktis and Ravazzolo (2000), Granger, Huang and Yang (2000) and Islam (2003), while Soenen and Hennigar (1988) and Ajayi and Mougoue (1996) reported a significant negative relationship between stock prices and exchange rates. On the other hand, some studies such as those of Solnik (1987) and Fang and Miller (2002), found both a significant positive and negative relationship between the two variables, while Frank and Young (1972) and Solnik (1984) found any relationship to be weak or non-existent. On the issue of causation, most of the studies had mixed results. Among the relevant studies are Ajayi, Friedman and Mehdian (1998), Ibrahim (2000) and Mishra (2004).

Most of the studies concerning the relationship between stock prices and exchange rates tend to focus on the performance of the overall stock market of a particular country and changes in the exchange rates (e.g. Fang and Miller (2002), Smyth and Nandha (2003) and Yucel and Kurt (2003)). However, relatively few studies have focused on the relationship between stock prices and exchange rates in terms of **sectoral basis performance.** Some examples of this type of analysis include Soenen and Hennigar (1988) and Bodnar and Gentry (1993). A sectoral focus is useful because exchange rate changes may affect industries differently, either because some industries are more exposed to exchange rate risk than others or because some react differently to exchange rate risk. Furthermore, there are many more factors (other

than the relative strength of the home currency) which can determine the overall performance of an industrial sector.

To the best of our knowledge, most empirical studies focus on changes in the exchange rate when investigating the relationship between exchange rates behaviour and stock prices. However, one exception is the study done by Bartov, Bodnar and Aditya (1996). In their study, Bartov, Bodnar and Aditya (1996) employed exchange rate variability, or volatility, to look at the impact of exchange rate changes on multinational stock returns. The relationship between second moments provides an additional framework for determining the importance of exchange rate changes and stock prices, especially when the study involves multinational companies. Previous studies used a variety of exchange rate measures, namely, the nominal and real exchange rate and the nominal and real effective exchange rate index. Furthermore these studies tended to focus on the relationship between stock prices and exchange rates in developed countries. However, after the 1997 Asian financial crisis more studies were done on the Asian economies (including Malaysia). Examples of such studies include Caporale, Pittis and Spagnolo (2000), Phylaktis and Ravazzolo (2000), Doong, Yang and Wang (2005) and Hatemi-J and Roca (2005). Two other studies by Ibrahim (2000) and Islam (2003) focus mainly on the Malaysian economy. However, these studies, concern themselves with overall market performance only – there was no attempt to analyse the relationship between stock prices and exchange rates using a sectoral focus. They also applied the change in exchange rate as their variable, but not exchange rate volatility.

As discussed in the literature survey chapter, most past studies on the relationship between stock prices and exchange rates are based on bivariate estimation (see Abdalla and Murinde (1997), Granger, Huang and Yang (2000) and Smyth and Nandha (2003) amongst others). However, in order to obtain convincing evidence for a relationship between these two variables, use of the bivariate framework itself may not be adequate. The theoretical explanations given in the literature survey chapter indicate the existence of some other variables, which may interact with exchange rates and stock prices. In fact, further studies have been carried out employing a

multivariate framework, including Ibrahim (2000) and Phylaktis and Ravazzolo (2000).

In our study, therefore, we aim to look at the interactions between the stock market and the foreign exchange market in Malaysia using a bivariate as well as a multivariate, framework. Our study will focus on the overall and sectoral performance of the Malaysian stock market with Malaysian ringgit exchange rate volatility. We have chosen to use the Kuala Lumpur Stock Exchange (KLSE)[1] Composite Index (CI) in our study of overall stock market performance, while in the sectoral study, we will use the KLSE Industrial Index (IND), KLSE Finance Index (FIN), KLSE Properties Index (PRP), KLSE Tin & Mining Index (TIN) and KLSE Plantation Index (PLN). The study covers the monthly period from January 1990 through to December 2002 and we employed the real effective exchange rate index as our measure of exchange rate.

2 Malaysia Securities Industry

2.1 A History of the Malaysian stock market

The securities industry in Malaysia effectively began in the late 19th century, due to the presence of British companies in the rubber and tin industries during that era. In 1930, the first formal organization in the securities business in Malaysia was established, named the Singapore Stockbrokers' Association (subsequently re-registered as the Malayan Stockbrokers' Association). However, at that time, there was still no public trading of shares. In early 1960, the Malayan Stock Exchange was

[1] The KLSE was renamed Bursa Malaysia effective from May 1, 2004. Since the analysis of this study covers the period from 1990 to 2002 inclusive, the term KLSE is used throughout the paper.

formed and only then did the public trading of shares begin (on May 9 of the same year). In 1961, the Board system was introduced with two trading rooms, one in Singapore the other in Kuala Lumpur. The two trading rooms were linked by direct telephone lines into a single market with the same stocks and shares listed at a single set of prices on both Boards.

In 1964, the Stock Exchange of Malaysia was formed. When Singapore left Malaysia in September 1965, the common stock exchange continued to function, but as the Stock Exchange of Malaysia and Singapore (SEMS). The Companies Act of 1965 then came into force which provided a comprehensive legal framework for governing companies. However, with the termination of currency convertibility between Malaysia and Singapore in 1973, the SEMS was divided into the Kuala Lumpur Stock Exchange Berhad (KLSEB) and the Stock Exchange of Singapore (SES). Nevertheless, Malaysian companies continued to be listed in the SES and vice-versa. In 1976, a new, "limited by guarantee", company, the Kuala Lumpur Stock Exchange (KLSE) took over the operation of KLSEB and the Malaysian stock exchange.

The launching of the KLSE Composite Index in 1986 fulfilled the need for a main market barometer of Malaysia's securities industry. To start with, the KLSE Composite Index comprised the 80 largest companies listed on the KLSE. The component stocks of the KLSE Composite Index were increased to 100 in 1995. Then, in order to accommodate the smaller companies stock's trading, a Second Board was launched in 1988. With the launching of this Second Board, KLSE now had two trading Boards - the Main Board for large companies and the Second Board for small companies. The issued and paid-up capital of the companies determined which Board the companies could be listed on. The amount has since been revised and the current amount of issued and paid-up capital required for the Main Board is a minimum of RM60 million. For the Second Board the minimum is RM40 million. As well as this capital requirement, the companies must also have been operating 5 years prior to the listing application <u>and</u> have an uninterrupted profit record of 3 to 5 full financial years. The companies are listed according to the sector their companies are involved in.

A signal event in the Malaysian securities industry was the de-listing of Singapore-incorporated companies from the KLSE, (and vice versa), on January 1, 1990. Then in 1991, the Exchange Main Board All Shares (EMAS) Index was launched as a complement to the existing KLSE Composite Index (as well as the Industrial Index). In September 1993, four new sectors were launched to replace the former Industrial sector on the Main Board, with the main objective being to improve the reflection of the core business of the companies.

Another important event happened in December 15, 1995 when the Kuala Lumpur Options and Financial Futures (KLOFFE) began trading. KLOFFE is an electronic-based private Exchange that trades on stock index futures based on the KLSE Composite Index. On April 17, 1999, KLSE launched a new index called the KLSE Syariah Index as a benchmark for making better informed decisions on behalf of local and foreign investors seeking to invest in securities consistent with the Islamic principles of Syariah. These principles refer to activities which do not involve interest (*riba*), gambling (*maisir*), uncertainty (*gharar*) and forbidden (*haram*) products such as liquor, non-halal meats and pork. The securities classified as Syariah-approved securities are free from prohibited activities or elements which contravene Islamic teaching and are, therefore, suitable for Muslim investors. A milestone in the Malaysian securities industry happened in January 2004 when KLSE became a demutualized exchange market and, in April of the same year, KLSE changed its name to Bursa Malaysia.

A demutualized exchange market differs from the traditional mutualized exchange market in the sense that it is a profit driven organization. It has to focus on the business aspects of operating a marketplace, and be able to raise capital from the public. Such as exchange market will divide current members' ownership rights from their trading rights and create value in both of these. Members' ownership rights are transformed into shares, while their trading rights may be maintained. If the demutualized exchange becomes a listed company, its shares will also be freely tradeable. After becoming a demutualized exchange market in January 2004, Bursa Malaysia made its debut on the Main Board of Bursa Malaysia on March 18, 2005 selling at 16.7% above the announced price of RM3.00 listed that morning.

2.2 Stock market trends

The Malaysian stock market's first experience of a booming condition was in the early/mid-1980s. Increased portfolio capital inflows during those periods were in tandem with a decade of direct foreign investment inflows from Japan, Singapore, the United States, the Republic of Korea and Taiwan. In the mid-1980s, these booming conditions slowed due to the world economic recession of the mid-1980s. Since the KLSE Composite Index was only around the 200 points mark, the Malaysian authorities actively encouraged the development of the capital market in Malaysia - promoting Kuala Lumpur as a newly emerging stock market in the world. Such developments and promotions succeeded in attracting considerable portfolio capital inflows to Malaysia during the early to mid-1990s. The KLSE Composite Index reached the 1000 points mark for the first time in December 1993, at 1015.42 points. This influx of capital was also the result of higher interest rates, a floating stock market and the expectation of ringgit's appreciation. However, high interest rates cause instability in the financial markets and, as a result, cause a country's inflation rate to rise. This phenomenon forced the government to adjust and lower the interest rate late in 1993. The effect of this adjustment was a drop in the stock markets in early 1994, due to massive portfolio capital outflows. This subsiding phenomenon was only temporary, however, as during 1995-96 the stock market bounced back in response to the massive foreign portfolio capital inflows entering Malaysia (the KLSE Composite Index was more than 1200 points in both years).

Such massive portfolio capital inflows during the early and mid-1990s fundamentally transformed the nature of the Malaysian capital market. The Malaysian stock market was now very volatile due to the international portfolio capital inflows. Foreign investors are believed to hold almost 2/3 of the 100 largest companies in the KLSE Composite Index components. It is said that foreign investors have shaped the Malaysian stock market, because local institutions were too small in comparison and generally took a long-term stock position (as well as being less active in day-to-day trading activity). Local retail investors had little influence on the stock market but aggravated the market volatility by their speculative behaviour. At the same time, international portfolio capital inflows created "wealth effects" which greatly

benefited the locals and created asset price bubbles and consumer binges in the country during the mid-1990s.

When Malaysia's foreign currency market was affected by the Asian financial currency crisis of July 1997, so too was it's stock market. One of the reasons why the stock market also plummeted was because of a phenomenon referred to as "contagion", involving a cross-border investment trends. Foreign investors encourage "followership", and in the market downturns and uncertainty conditions, they also contribute to "herd" behaviour. The Malaysian stock market is extremely vulnerable to both irrational enthusiasm and pessimism, amongst the countries most affected by the financial crisis. During the third quarter of July-September 1997, a net of RM16 billion of portfolio capital investments left the country. Malaysia's reliance on the capital market makes it very vulnerable and, therefore, hostage to international portfolio investors' confidence. Hence, when the government engages in any policies which might upset investors' confidence, portfolio divestment accelerates. For example, in September 1998 the government imposed some capital controls as one of their measures to overcome the 1997 financial crisis. This led to a dramatic drop in the stock market Composite Index from 1237.96 points in January 1997 to a low of 528.45 points by the end of the year. In September 1999, almost a year after the capital controls were introduced, it had dropped still further, to a low of 262.70 points. Figure 5.1 shows the trend of Malaysia's stock market during the understudy period.

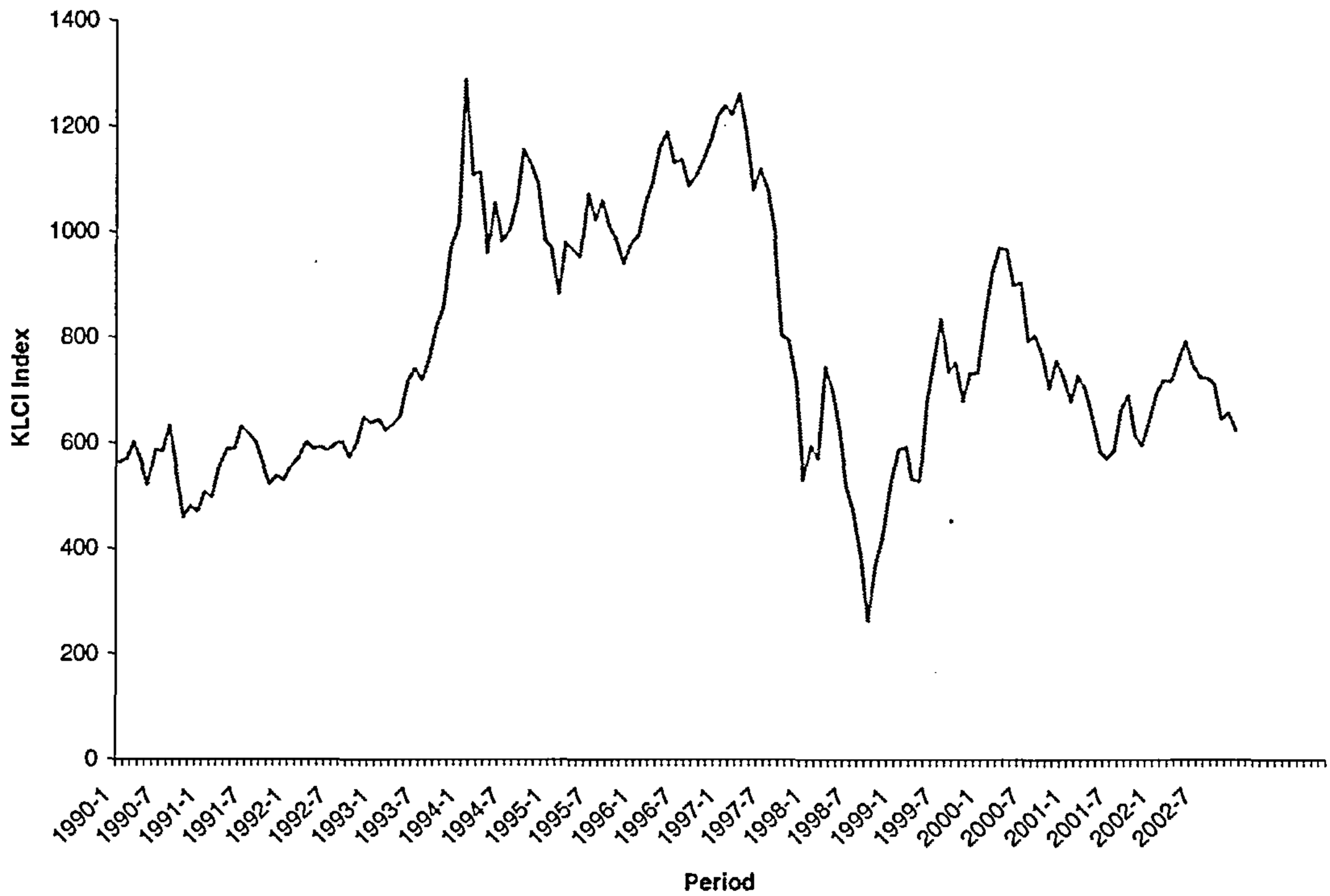

Figure 5.1. KLCI Index Trends

3 Empirical Methodology and Data Description

3.1 Methodology modelling

To capture the interactions between stock market performance and exchange rate volatility, we utilize bivariate and multivariate framework in our estimation. We look at the cointegration and Granger causality effect, as well as the impulse response and variance decomposition test. However, before any of these analyses are done, we first examine the stationary properties of the data series.

3.1.1 *Unit root test*

It is well known in econometric literature that it is important to check the time series properties of data in order to make sure that the drawn inference is not spurious and misleading. It has also been established that standard tests for integration order have low power if the effect of structural breaks occurring during the period of study are not explicitly taken into account. This is because standard tests for integration would definitely conclude that a time series would have the unit root properties when the sample period includes some major events or structural breaks such as the great depression, oil shocks and the Asian financial crisis. The impact of ignoring these structural breaks can lead to erroneous conclusions in the case when the null is not rejected. In our study, the effect of the Asian crisis is taken into account by making use of the Perron (1989) test, whereby tests for integration order are conducted[2]. Other studies that have applied Perron's (1989) test to take into account structural breaks are Granger, Huang and Yang (2000) and Hatemi-J and Roca (2005). Perron developed a procedure for testing the null hypothesis that a given series $\{y_t\}$ has a unit root with drift and that an exogenous structural break occurs at time $1 < T_B < T$ versus the alternative hypothesis that the series is stationary about a deterministic time trend with an exogenous change in the trend function at time T_B.

In this study, we apply the Model (B) of Perron's unit root test that allows an exogenous change in the rate of growth of the series. The test for one unit root of variable is based on the following augmented regression equation:

$$y_t = \mu + \theta DU_t + \beta t + \gamma DT_t^* + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t \qquad (1)$$

where $DU_t = 1$ if $t > T_B$, and 0 otherwise. $DT_t^* = t - T_B$ if $t > T_B$, and 0 otherwise. The number k of extra regressors is determined by a test of the significance of the

[2] Further explanation on this test can be found in Perron, Pierre, 1989, The great crash, the oil price shock and the unit root hypothesis, *Econometrica* 57, 1361-1400.

estimated coefficients c_i, that is, working backward from $k = \bar{k}$, chose the first value of k such that the t statistic on c_k was greater than 1.6 in absolute value and the t statistic on c_l for $l > k$ was less than 1.6.

To formally test for the presence of a unit root, Perron considered the following statistic:

$$t_\alpha(\lambda) \tag{2}$$

which represents the standard t statistic for testing $\alpha = 1$. This statistic depends on the location of the break fraction (or breakpoint) $\lambda = T_B / T$, where T_B the date when the structural break occurrs and T is the sample size. Perron's test for a unit root using Equation (2) can be viewed as follows: Reject the null hypothesis of a unit root if

$$t_\alpha(\lambda) < K_\alpha(\lambda) \tag{3}$$

where $K_\alpha(\lambda)$ denotes the size α critical value from the asymptotic distribution of Equation (2) for a fixed $\lambda = T_B / T$.

Since in this study the Asian financial crisis is considered as a structural break during the sample period, applying Perron's unit root test is the most appropriate approach. This is due to the ability of the test to distinguish between both the null and alternative hypothesis for the presence of a one-time change in the level or in the slope of the trend function when a structural break is present.

3.1.2 Cointegration test

To investigate the stationarity assumption of several I(1) variables, the majority of researchers still rely on the widely accepted, and easy to apply model, proposed by Engle and Granger (1987) and Johansen (1988) and Johansen and Juselius (1990) cointegration test, despite the normalization problem. Just as the Augmented Dickey

and Fuller (ADF) unit root test fails to consider problems associated with structural breaks, Engle and Granger (1987) and Johansen (1988) bypass the same difficulty. To circumvent this problem, Gregory and Hansen (1996) revised the Engle and Granger (1987) model to consider residual-based cointegration tests with structural breaks – either a change in the intercept (level shift), a change in the intercept with a time trend (level shift with trend) or a change in the cointegrating coefficients (regime shift)[3].

In this study, we apply Gregory and Hansen's cointegration test because of its ability to allow the cointegrating vector to change at a single time during the sample period (as in our case, during the 1997 Asian financial crisis). The Gregory and Hansen (1996) model is a two-stage estimation process of which the null hypothesis of no cointegration is tested against the alternative, that the relation is cointegrated in the sense of Engle and Granger (1987). This means that a linear combination of the integrated variables has a stationary distribution. When carrying out this two-stage residual-based cointegration technique, the first step is to estimate the candidate cointegrating relation by ordinary least squares (OLS). The second step is to conduct a unit root test to the regression errors, via the ADF or Phillips-Perron technique. Gregory and Hansen (1996) derived on asymptotic distribution of the critical values for the unit root test of the regression errors. The null hypothesis is rejected if the ADF t statistic for the regression errors is smaller than the critical values. Rejection of the null hypothesis in this context implies strongly that the variables are cointegrated. Acceptance of the null hypothesis is often taken as evidence of a lack of cointegration. Some examples of past studies employing the Gregory and Hansen (1996) model are Granger, Huang and Yang (2000) and Fang and Miller (2002).

In this study, we employ Gregory and Hansen's Model 3: Level shift with trend as our model to test for the cointegration relationship. The multiple regression of this model is as follows:

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[3] Further understanding of this test, refer to Gregory, Allan W., and Bruce E. Hansen, 1996, Residual-based tests for cointegration in models with regime shifts, *Journal of Econometrics* 70, 99-126.

$$y_{1t} = \alpha + \beta t + \gamma DU_t + \theta_1 y_{2t} + \varpi_t \quad (4)$$

in which y_{1t} and y_{2t} are of I(1) and y_{2t} is a variable or a set of variables, $DU_t = 1$ for $t > T_B$ and 0 otherwise and T_B is the date of the structural break.

3.1.3 Causality tests

Once the statistical property of the regression errors, ϖ_t, in Equation (4) is established, we can then adopt the bivariate VAR and the multivariate VAR model to test the Granger causality amongst the variables. The VAR system consists of a set of regression equations in which all the variables are considered to be endogenous. In VAR methodology, each endogenous variable is explained by its lagged or past values and the lagged values of all other endogenous variables included in the model. In general, there are no exogenous variables in the model. Thus, by avoiding the imposition of a priori restriction on the model, the VAR adds significantly to the flexibility of the model. A VAR in the standard form may be represented as follows:

$$y_{1t} = \alpha_{10} + \alpha_{11} y_{1t-1} + \alpha_{12} y_{2t-1} + e_{1t} \quad (5)$$

$$y_{2t} = \alpha_{20} + \alpha_{21} y_{1t-1} + \alpha_{22} y_{2t-1} + e_{2t} \quad (6)$$

where y_{1t} is variable y_{1t} at the time period t, y_{2t} is the variable y_{2t} at the time period t, α_{10} is element i of the vector A_0, α_{ij} is the element in row i and column j of the matrix $A1$ and e_{it} as the element i of the vector et, it represents in the above equation as e_{1t} and e_{2t} respectively, are white noise error term and both have zero mean and constant variances and are individually serially uncorrelated.

Granger causality test states that if y_1 and y_2 are two time series variables and if past values of a variable y_1 significantly contribute to forecast the value of another variable y_2, then y_1 is said to Granger cause y_2 and vice versa. Our bivariate test involves the following:

$$S_t = \gamma_0 + \sum_{i=1}^{k1} \delta_i S_{t-i} + \sum_{i=1}^{k2} \phi_i V_{t-i} + \varepsilon_t \tag{7}$$

where S is the stock price measure and V is an exchange rate volatility measure. From the equation, the null hypothesis of no causation from V to S, $\sum \phi = 0$, can be tested using standard F tests. The reverse causation from S to V may also be evaluated by reversing the role of S and V in the equation. From the tests, four alternative patterns of causality may be observed: (i) unidirectional causality from V to S, (ii) unidirectional causality from S to V, (iii) bi-directional causality and (iv) no causality. For the multivariate case, the causality model may be expressed as:

$$S_t = \alpha + \sum_{i=1}^{k1} \delta_i S_{t-i} + \sum_{i=1}^{k2} \phi_i V_{t-i} + \sum_{i=1}^{k3} \theta_i M2_{t-i} + \sum_{i=1}^{k4} \gamma_i R_{t-i} + \varepsilon_t \tag{8}$$

where $M2$ is the M2 money supply term and R is the interest rate term.

There are two important steps involved with Granger's Causality test. First, stationary data is required for Equation (7) and (8). Second, in addition to the need to test the stationarity property of the data, the Granger methodology is somewhat sensitive to the lag length used in the equations. In the implementation of Equation (7) and (8) we use the Akaike's information criteria (AIC) to determine the lag lengths of the right-hand-side variables. However, the Granger Causality test does not provide signs of the relationship between the variables. Therefore, to examine the short-run dynamic relations of the variables, we use other tools in the VAR, i.e. the Impulse Response Function (IRF) and Variance Decomposition (VD). The Impulse Response Function is used to trace out the dynamic interaction among variables. It shows the dynamic response of all the variables in the system to a shock or innovation in each variable. For computing the IRF, it is essential that the variables in the system are ordered and that a moving average process represents the system. Variance decomposition is used to detect the causal relations among the variables. It explains the extent at which a variable is explained by the shocks in all the variables in the system. The forecast error variance decomposition explains the proportion of the movements in a sequence due to its own shocks versus shocks to the other variables.

3.2 Variables and Data descriptions

Our data set consists of monthly observations from January 1990 to December 2002. Monthly data on the Malaysian Stock Market Indexes were obtained from Datastream International, while data on other economic variables were obtained from the IMF International Financial Statistics (IFS), 2002 CD-ROM and 2001 to 2003 monthly series publication for the data of 2001 and 2002 not available on the CD-ROM. All the series are expressed in logarithm form except for the money market interest rate.

In our overall market performance investigation, the variable used as a proxy for the whole stock market barometer is the Kuala Lumpur Composite Index (KLCI). For the sectoral study, the sectoral stock market indexes variables are: Industrial Index (IND), Finance Index (FIN), Properties Index (PRP), Tin & Mining Index (TIN) and Plantation Index (PLN). We did not include other sectoral indexes such as Consumer Product Index, Industrial Product Index, Construction Index and Trading/Services Index since data from these sectors only become available from October 1993 onwards.

For the bivariate VAR system, the variables considered are the growth rate of stock price index (SP) and exchange rate volatility (V). The monthly growth rate of the stock price index is defined as the natural log-difference of monthly stock price index. As mentioned in earlier chapters, exchange rate volatility is not directly observed. Given that volatility in exchange rates is generally characterized as the clustering of large shocks to conditional variance, a GARCH model developed by Bollerslev (1986) is formulated to capture non-constant time varying conditional variance. Then the standard deviation obtained from the conditional variance is used as a proxy for exchange rate volatility. The underlying model is a GARCH (1,2) based on an autoregression model of order 1 (AR(1)) of the first difference of the real effective exchange rate index in logarithm (ex_t) which takes the following form:

$$\Delta ex_t = \delta_0 + \delta_1 \Delta ex_{t-1} + \delta_2 Dummy_t + \varepsilon_t, \qquad \varepsilon_t \big| I_{t-1} \sim N(0, h_t^2),$$

$$h_t^2 = \rho_0 + \rho_1 \varepsilon_{t-1}^2 + \rho_2 \varepsilon_{t-2}^2 + \rho_3 h_{t-1}^2 \tag{9}$$

where $dummy_t$ is the dummy variable to capture the Asian financial crisis. It equals to zero for period up to June 1997 and equals to one in July 1997 and later.

The estimated equation is:

$$\Delta ex_t = \underset{(0.183)}{-0.074} + \underset{(0.079)}{0.179}\, \Delta ex_{t-1}$$

$$h_t^2 = \underset{(0.078)}{0.061} + \underset{(0.029)}{0.151}\, \varepsilon_{t-1}^2 + \underset{(0.175)}{0.499}\, \varepsilon_{t-2}^2 + \underset{(0.094)}{0.296}\, h_{t-1}^2 \tag{10}$$

where the values in parenthesis represent standard errors. All the coefficients in Equation (10) are statistically significant at the 1% significance level. The coefficients of ρ_0, ρ_1, ρ_2 and ρ_3 exceed zero, and $\rho_1 + \rho_2 + \rho_3 = 0.94 < 1$. The coefficient for the dummy variable is insignificant and therefore the variable is excluded from the regressions. We tested the adequacy of these GARCH (1,2) results for no remaining ARCH effects and for no serial correlations and found both tests did not fail. Based on the AIC criterion and the parameter testing, these models seem to appropriately capture the underlying data generation process, and thus are used as a proxy for our exchange rate volatility variable.

In our four-variable multivariate VAR system, we extend the bivariate analysis to include the growth rate of money supply ($M2$) and money market interest rate, which is expected to serve as the proxy for the interest rate (R). The growth rate of money supply is derived by the natural log-difference of the monthly money supply series.

4 Empirical Results and Analysis

4.1 Unit root test and cointegration results

As a prerequisite for later analysis, we first examine the stationarity properties of the data series. As mentioned in section three above, we employed Perron's (1989) unit root test model since a structural break does occur in our period of study i.e. the 1997 Asian financial crisis. We apply the Model (B) of Perron's unit root test that allows an exogenous change in the rate of growth of the series. Our break fraction is $\lambda = 0.58$ ($\lambda = T_B / T$), and in our analysis, we followed the Perron procedure in setting the maximum value for k, $\bar{k}$. The unit root results are presented in Table 5.1.

A perusal of Table 5.1 reveals that the null hypothesis of a unit root in all stock indexes, except in the Plantation index is easily rejected using the Perron (1989) approach. The money supply and interest rate series are also found to have a unit root property. Based on the results, we could assume that the 1997 Asian financial crisis is not realisation of an underlying time-invariant stochastic process but can be modelled as exogenous. Thus, we could conclude that most of the time series are not characterised by the presence of a unit root. The fluctuations are indeed stationary around a deterministic trend function. The only "shocks" which have had persistent effects are the Asian financial crisis.

The lack of the unit root property within the sample periods enables us to readily apply the statistical model, in terms of exchange rate volatility and stock prices. It should be noted that cointegration analysis is not needed for the time periods in which the logarithmic variables are I(0). For that matter, given the outcome of the unit root test, we conduct the bivariate cointegration test only for the Plantation sector and all the multivariate cointegration cases using the Gregory and Hansen (1996) model. The results of the Gregory and Hansen (1996) test are shown in Table 5.2.

Table 5.1. Perron (1989) Unit Root Test

Series	t_α	Lag (k)	Order of Integration
KLCI	-4.90**	2	I(0)
IND	-5.38**	2	I(0)
FIN	-4.40*	2	I(0)
PLN	-3.55	2	I(1)
PRP	-4.05*	2	I(0)
TIN	-4.40*	2	I(0)
M2	-2.94	3	I(1)
INTEREST	-1.71	1	I(1)
EXCH. VOLATILTIY	-8.30**	1	I(0)

Note: The estimation result is based on $y_t = \mu + \theta DU_t + \beta t + \gamma DT_t^* + \alpha y_{t-1} + \sum_{i=1}^{k} c_i \Delta y_{t-i} + e_t$, where $DU = 1$ for $t > T_B$, otherwise equals 0. $DT^* = 1$ for $t - T_B$ if $t > T_B$, otherwise equals 0. The critical values are from Table V.B of Perron (1989). ** (*) denote 1% (5%) significance level. The value of $\lambda = 0.58$ at 1% is -4.56 and at 5% is at -3.96.

In Table 5.2, for the bivariate cointegration framework of stock prices in Plantation sector, the first-stage estimation (when plantation stock prices are regressed on exchange rate volatility) is based on: $PLN_t = \alpha + \beta t + \gamma DU_t + \theta V_t + \varpi_t$ and the reverse-order regression applied when exchange rate volatility is regressed on plantation stock prices. As for the multivariate cointegration framework, the first-stage estimation (when stock prices indexes are regressed on exchange rate volatility) is based on $SP_t = \alpha + \beta t + \gamma DU_t + \theta_1 M2_t + \theta_2 INT_t + \theta_3 V_t + \varpi_t$ and the reverse-order regression applied when exchange rate volatility is regressed on the stock prices indexes. The second-stage estimation is then to apply the traditional ADF approach, to test if ϖ_t is of I(0) or I(1). If ϖ_t is found to be consistent with I(0), we may claim that cointegration exists between stock prices indexes and exchange rate volatility. Based on the results presented in Table 5.2, we reject the null hypothesis that no cointegration exists between stock prices indexes and exchange rate volatility at the 1% significance level (in both the bivariates and multivariate cases). Comparing the results with other studies done on Malaysia, the bivariate cointegrating relationships would seem to be in line with the results in Islam (2003) but differ from those of Ibrahim (2000), Phylaktis and Ravazzolo (2000) and Doong, Yang and Wang (2005).

These differing results could be due to the different time period and the frequency of the data used. However, for the multivariate study, the results are the same as in the study conducted by Ibrahim (2000).

Table 5.2. Results of Gregory and Hansen cointegration test

	t-statistics
Bivariate Framework	
PLN on Volatility	-7.85**
Volatility on PLN	-10.17**
Multivariate Framework	
KLCI on Volatility	-11.80**
Volatility on KLCI	-11.57**
IND on Volatility	-12.55**
Volatility on IND	-11.64**
FIN on Volatility	-11.93**
Volatility on FIN	-11.71**
PLN on Volatility	-8.14**
Volatility on PLN	-11.62**
PRP on Volatility	-12.14**
Volatility on PRP	-11.65**
TIN on Volatility	-13.00**
Volatility on TIN	-11.70**

Note: The critical values are taken from Table 1 in Gregory and Hansen (1996). The bivariate framework, the regressor, m=1 and the significant values at 1% is –5.13 and at 5% is at –4.61. The multivariate framework, the regressors, m=3 and the significant values at 1% is –5.77 and at 5% is at –5.28. ** (*) denotes 1% (5%) significant levels.

4.2 Granger Causality results

According to Granger, if the variables are cointegrated, the finding of Granger non-causality is ruled out. There must be at least one direction of causation in the Granger sense. Since we found cointegration existed between the variables in the bivariate and multivariate cases, we employed Granger causality tests within a vector error

correction model (VECM) in order to capture Granger causality among the economic variables. Before applying these tests, we determined the optimum lag length (k) for our estimations based on the AIC criterion. The causality results for the bivariate framework are presented in Table 5.3 and the multivariate framework in Table 5.4.

According to VAR methodology, ordering the variables in the system will give a different result. Therefore, our ordering of the variables in the bivariate study is as follows:

$$\{SP, V\} \tag{11}$$

and the ordering of the variables in the multivariate study is:

$$\{M2, R, SP, V\} \tag{12}$$

The implication for such ordering is that current shocks in money supply $(M2)$ can affect the entire system contemporaneously but shocks in interest rate, (R) cannot affect the current period money supply, $(M2)$. Similarly, a shock in stock prices, (SP) cannot affect the current period money supply $(M2)$ and interest rate, (R) but does affect all the remaining variables in the system. Therefore, the exchange rate volatility (V) variable was placed at the end of the ordering, with the presumption that current shocks in all the variables affect the current-period exchange rate (volatility) (V), whereas current change in the exchange rate (volatility) (V) cannot affect any of the variables in the current-period in the system, besides itself.

The above ordering is, to some extent, in line with macroeconomic logic. Assuming that a positive shock is injected to the demand for money, it will push the interest rate up and a higher interest rate will attract more foreign investment into the domestic country. This will ultimately result in a boom in the stock market and, thus, higher returns from stocks. An increase in domestic stock prices leads to demand for more domestic assets. In order to buy more domestic assets, individuals must sell foreign assets. As a result, there is an appreciation of local currency due to an increased demand for domestic assets.

Table 5.3. Granger causality results based on VECM: Bivariate estimation

Dependent Variable	χ^2 – statistics (p-value) ΔSP	ΔV	Lag Length
KLCI Index			7
ΔSP	-	62.87(0.00)**	
ΔV	26.17(0.00)**	-	
IND Index			7
ΔSP	-	24.72(0.00)**	
ΔV	34.14(0.00)**	-	
FIN Index			7
ΔSP	-	7.94(0.34)	
ΔV	51.94(0.00)**	-	
PLN Index			6
ΔSP	-	30.27(0.00)**	
ΔV	21.88(0.00)**	-	
PRP Index			6
ΔSP	-	9.91(0.13)	
ΔV	47.51(0.00)**	-	
TIN Index			7
ΔSP	-	41.76(0.00)**	
ΔV	19.26(0.00)**	-	

Note: The χ^2 – statistic tests the joint significance of the lagged values of the independent variables. The * (**) denotes 5% (1%) significance level.

Table 5.4. Granger causality results based on VECM: Multivariate estimation

Dependent Variable	χ^2 – statistics (p-value) $\Delta M2$	ΔR	ΔSP	ΔV
KLCI Index				
$\Delta M2$	-	19.03(0.12)	15.72(0.26)	17.07(0.19)
ΔR	4.25(0.98)	-	10.46(0.66)	26.01(0.02)*
ΔSP	11.79(0.54)	41.31(0.00)**	-	49.02(0.00)**
ΔV	18.76(0.13)	391.90(0.00)**	68.18(0.00)**	-
IND Index				
$\Delta M2$	-	12.04(0.28)	9.29(0.50)	12.42(0.26)
ΔR	3.15(0.98)	-	12.11(0.28)	35.24(0.00)**
ΔSP	7.41(0.69)	29.75(0.00)**	-	28.80(0.00)**
ΔV	18.76(0.04)*	251.61(0.00)**	53.54(0.00)**	-
FIN Index				
$\Delta M2$	-	12.68(0.24)	10.16(0.42)	12.04(0.28)
ΔR	4.17(0.94)	-	13.20(0.21)	36.94(0.00)**
ΔSP	11.96(0.29)	44.97(0.00)**	-	13.12(0.22)
ΔV	19.99(0.03)*	255.46(0.00)**	77.83(0.00)**	-
PLN Index				
$\Delta M2$	-	11.91(0.37)	6.53(0.84)	9.29(0.60)
ΔR	5.27(0.92)	-	18.76(0.07)	54.80(0.00)**
ΔSP	11.70(0.39)	22.11(0.02)*	-	28.97(0.00)**
ΔV	24.14(0.01)**	258.81(0.00)**	41.84(0.00)**	-
PRP Index				
$\Delta M2$	-	18.21(0.05)*	8.71(0.56)	19.52(0.03)*
ΔR	12.60(0.25)	-	15.04(0.13)	42.06(0.00)**
ΔSP	14.11(0.17)	31.30(0.00)**	-	17.96(0.05)*
ΔV	17.80(0.05*)	223.05(0.00)**	44.92(0.00)**	-
TIN Index				
$\Delta M2$	-	12.95(0.29)	3.75(0.97)	10.23(0.51)
ΔR	4.90(0.93)	-	13.61(0.25)	51.66(0.00)**
ΔSP	14.78(0.19)	22.09(0.02)*	-	44.54(0.00)**
ΔV	21.22(0.03)*	268.75(0.00)**	48.78(0.00)**	-

Note: The χ^2 – statistic tests the joint significance of the lagged values of the independent variables. The lagged of the endogenous variables: KLCI Index = 13, IND Index = 10, FIN Index = 10, PLN Index = 11, PRP Index = 10 and TIN Index = 11. The ** = 1% and * = 5% significance levels.

4.2.1 Overall stock market performance

The results of the Granger causality effects between KLCI (serving as a proxy for Malaysian overall stock performance), and exchange rate volatility have shown that there are bi-directional causality effects running between these two variables in the bivariate estimation (see Table 5.3). Our results are consistent with Doong, Yang and Wang's (2005) results for Malaysia. However, any consistency with other studies, including Caporale, Pittis and Spagnolo (2000), Granger, Huang and Yang (2000) and Hatemi-J and Roca (2005), is mixed. In these studies, the researchers divided the time frame before and after the Asian financial crisis, with varying results. Hatemi-J and Roca (2005) found no causality effects during the crisis period, while Granger, Huang and Yang (2000) and Caporale, Pittis and Spagnolo (2000) both found bi-directional causality effects between the two variables. However, while they found no causality effect during the pre-crisis period, Hatemi-J and Roca (2005) found a unidirectional effect from stock prices to the exchange rates.

Our findings also differ from the findings of Ibrahim (2000) with real effective exchange rates used as the variable. Ibrahim found only a unidirectional causality effect from KLCI to exchange rates when applying the exchange rate index as his variable. Even though we both employed real effective exchange rates, our fluctuation of exchange rates is measured in terms of volatility using the GARCH model, whereas Ibrahim used only the change in the real effective exchange rates as his measurement. The differences in the results could be due to many factors, e.g. the different time period of study, different measures of exchange rates or exchange rate variability.

As pointed out by Ibrahim (2000), there is an element of doubt in the findings of the bivariate estimations as the regressions may suffer from omitted variable bias or fail to take account other variables which could drive both stock prices and exchange rates. To overcome this problem, we also carried out multivariate estimation. As well as stock prices and exchange rate volatility, we add in money supply and interest rates as our variables. In our multivariate estimation, we also found a bi-directional causality between KLCI and exchange rate volatility (refer to Table 5.4).

Our results confirm bivariate findings that stock prices are causally linked, in the Granger sense, to exchange rate volatility with feedback interactions. In addition, we also found bi-directional effects running between interest rates and exchange rate volatility. This relationship is not unexpected, because even though the Malaysian government practiced floating exchange rates before the Asian financial crisis, it was never a free float. Thus, the central bank would use the interest rate as a way to correct exchange rates, if they are desired. With a high interest rate, foreigners would come and invest in Malaysia and ringgit values would appreciate. However, in the long-run, with ringgit values too high (for many sectors of the economy), interest rates have to be reduced in order to discourage foreign investment. Our findings also indicate that exchange rate volatility and money supply do not have any relationship.

In the multivariate estimation, we also found a unidirectional causality effect running from interest rates to KLCI. This phenomenon implies that a change in interest rates will cause a change in KLCI. For example, when interest rates are high, investors would invest more in interest-earning investment rather than in the equities market. As a result, the stock market would be bearish. Alternatively, with interest rates high, the public would not want to borrow to invest in the equities market causing the stock market to fall.

These results (consistent with the findings of Ibrahim (2000)) show that the Malaysian stock market is not very informationally efficient. Ibrahim (2000) extended his multivariate analysis by adding in money supply and reserves aggregate as his variables. He found a unidirectional effect from money supply to KLCI. In the case of stock prices and real effective exchange rate, he found a unidirectional causal effect running from stock prices to the exchange rate. The findings also indicate the importance of domestic monetary policies in explaining the movements of the Malaysian equity market and foreign exchange market. They show that interest rates and the foreign exchange market do have feedback interactions, but a unidirectional effect running from interest rates to the equity market. In terms of monetary policy, only interest rates have an impact on both markets.

4.2.2 Sectoral stock market performance

4.2.2.1 Bivariate framework

In our study we looked at five sectoral stock market indexes - Industrial, Finance, Plantation, Properties and Tin and Mining. In all of these sectors (except Finance and Properties), we found a bi-directional causality effect running between stock prices and exchange rate volatility (see Table 5.3). These results would seem to be consistent with bivariate Granger causality in overall market performance, and indicate that there is uniformity in the performance of stock prices in different sectors with the market as a whole. In the Finance and Properties sectors, we found only a unidirectional causality effect running from the stock price index to exchange rate volatility. This could be due to the fact that higher stock prices in these sectors imply that the sectors are a good prospect for investments, thus attracting foreign capital inflows and explaining any change in the exchange rates.

4.2.2.2 Multivariate framework

With regard to Table 5.4, in the sectoral multivariate Granger causality framework, we found that the sectoral results are similar to the overall market's multivariate framework results. In all sectors (except Finance), we found a bi-directional causality effect running between stock prices and exchange rate volatility. However, in the Finance sector, it is the Granger causality effect which runs from the stock prices to exchange rate volatility. Moreover, this phenomenon existed in the bivariate framework estimation, and we found feedback interactions between interest rate and exchange rate volatility in all the other sectors too. When discussing the overall market performance (see above), it is apparent that this relationship is consistent with economic theory which proclaims interest rates and exchange rates to be causative.

As per the overall market results, we also found uni-causal effects running from interest rates to stock prices in all the sectors under study. As explained earlier, this scenario resulted from investors having an option not to invest in the equities market when interest rates are high. The results also indicate unidirectional effects running

from the money supply to exchange rate volatility in all sectors (except Properties). In the Properties sector, feedback interaction exists between money supply and exchange rate volatility. The explanation for this bi-causal relationship is that demand in the money supply when foreign investors buy properties in Malaysia will result in a change in exchange rates. Also, in the Properties sector, we found a unidirectional effect from interest rates to the money supply. However, this relationship is expected as interest rates determine the demand for money with which to invest in property.

From these findings, we could infer that the results in each sector are consistent showing that each sector is not dissimilar from the other, except perhaps in the case of the Properties sector where interest rates and exchange rate volatility play important roles. The findings also seem to be consistent with those found in the multivariate framework of the overall market. It seems that there is no difference between a sectors market performance and the overall market performance. Therefore, the results clearly indicate relationships between the stock market and the foreign exchange market with other economic variables. The findings are important, especially to the central bank in choosing the mechanism between the use of money supply and interest rates, and when making economic decisions pertaining to domestic monetary policies.

4.3 Impulse response function results

The Granger causality effects suggest that the relationship between any two variables may show no causal effect, one causal effect, or a causal effect in both directions. Unfortunately it does not provide evidence of this. Therefore, to examine the short-run dynamic relations of the variables, we take advantage of the VAR tools and apply the impulse response functions (IRF) to calculate standard deviation for each regression.

4.3.1 Overall stock market impulse response functions

We present the one standard deviation shock of impulse response functions of the bivariate framework in Figure 5.2, and the multivariate framework in Figures 5.3 – 5.6 for the overall stock market analysis. In the bivariate framework, a one standard deviation shock in the stock prices induces an initial short-run decline in the exchange rate volatility, followed by a slight increase in volatility after period 4. This is followed by long-run stability in exchange rate volatility beyond period 16. We could imply that one unit change in the stock prices has a largely negative relationship with exchange rate volatility. As for the responses of stock prices to a one standard deviation shock in exchange rate volatility, it can be seen that while there is an initial improvement in the stock prices, they fall by more than 3% in period 7. The stock prices then rise in the next 4 periods before falling slightly to a mere 1%, settling to their long-run level thereafter. Exchange rate volatility seems to have a largely negative impact on stock prices.

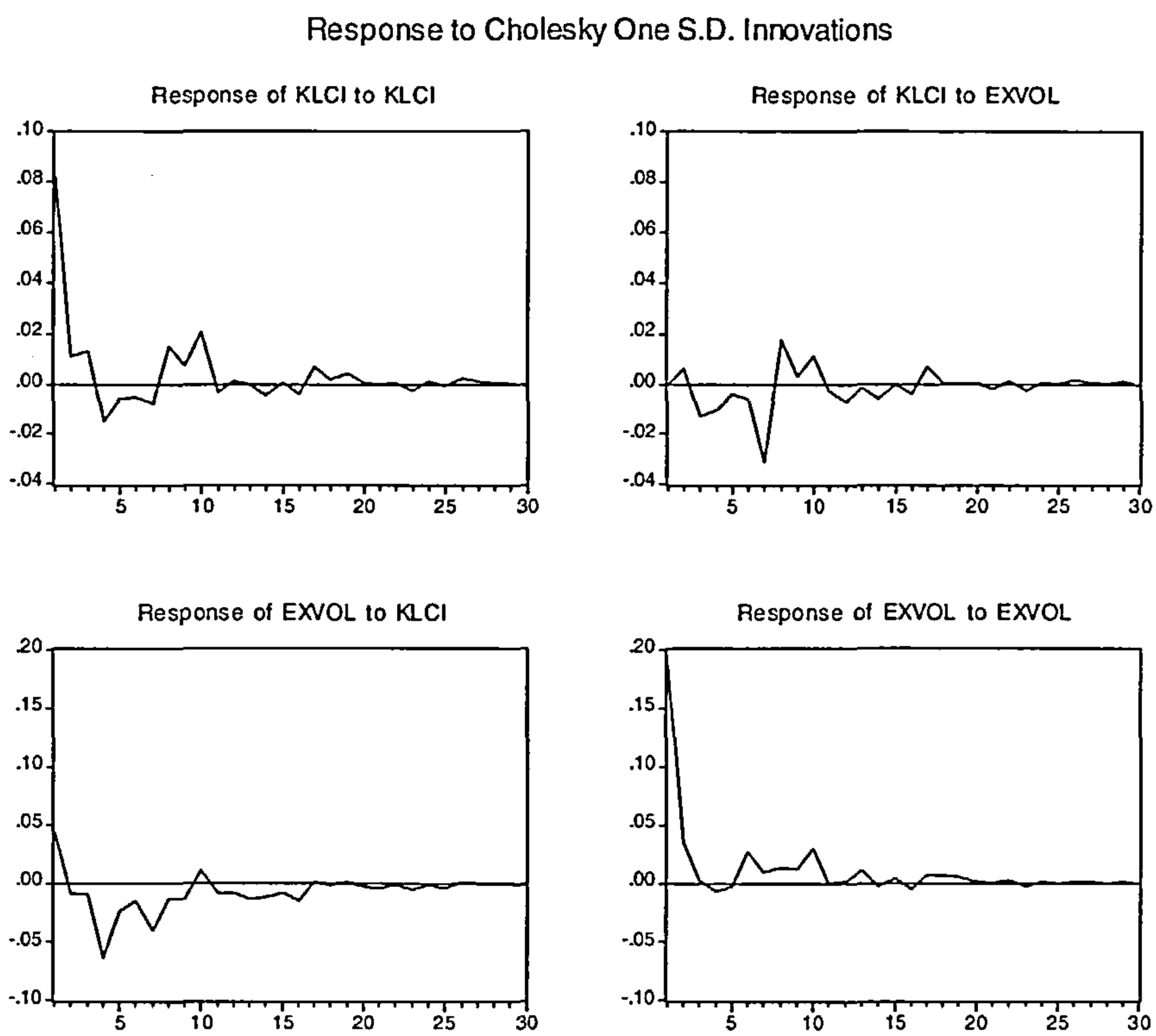

Figure 5.2. KLCI Bivariate Impulse Response: Response of KLCI to Exchange Rate Volatility and Response of Exchange Rate Volatility to KLCI

In Figure 5.3, a one standard deviation shock in the money supply encourages an increase in interest rates up to period 5, before declining to just over than 0.2% in period 14. Beyond period 14, interest rates increase with a long-run improvement. While money supply could be concluded to have a largely negative impact on interest rates, stock prices seem to have an inconsistent relationship with money supply. A one standard deviation shock in the money supply causes an initial increase in stock prices before causing them to decline in a cyclical pattern beyond period 2. With regard to exchange rate volatility, in the initial period up to period 8, money supply causes exchange rate volatility to increase. However, between periods 8 to 13, exchange rate volatility declines and seems to be inconsistent beyond period 14.

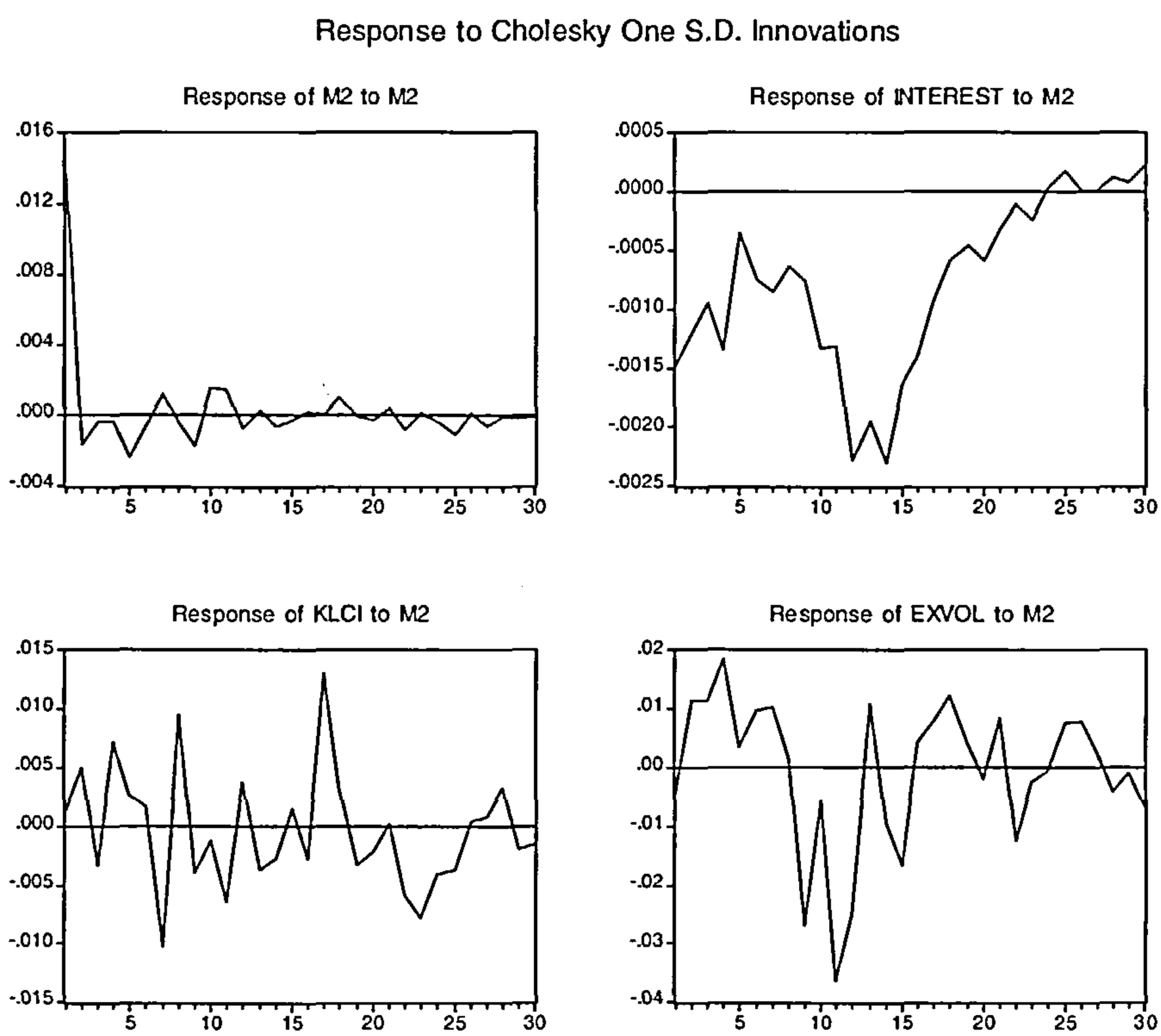

Figure 5.3. KLCI Multivariate Impulse Response: Response of Interest Rates, KLCI and Exchange Rate Volatility to Money Supply

Figure 5.4 shows that a one standard deviation shock in the interest rates causes a positive long-run relationship with the money supply, an inconsistent long-run relationship with stock prices and a largely positive long-run relationship with exchange rate volatility. We see that interest rates induce an improvement in the initial periods in the money supply and stock prices, but a decrease in exchange rate volatility.

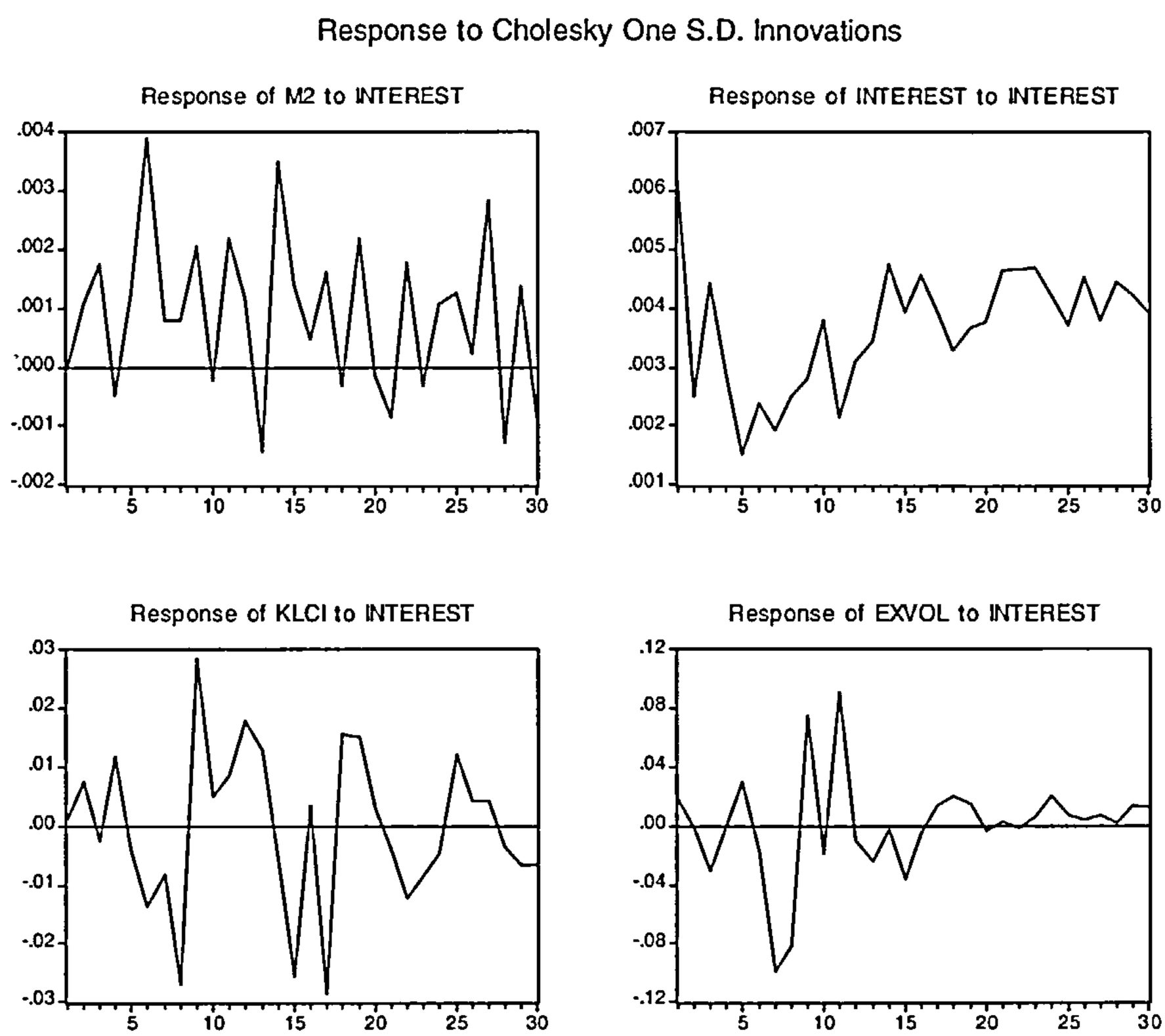

Figure 5.4. KLCI Multivariate Impulse Response: Response of Money Supply, KLCI and Exchange Rate Volatility to Interest Rates

Figure 5.5 shows that a one standard deviation shock in the stock prices causes an increase in the money supply in the initial period followed by a decline in period 2 to period 5. After period 5, there is a long-run positive improvement in the money supply before it falls and settles into a negative trend beyond period 19. We see an

improvement in the interest rates during the initial period, followed by a fall until period 9. Beyond period 10, the interest rates seem to have an increasing long-run relationship with the stock prices. In terms of exchange rate volatility, a change in stock prices has a largely negative relationship with this. The exchange rate volatility declines up to period 7 before increasing for a short period, settling with a positive long-run level thereafter.

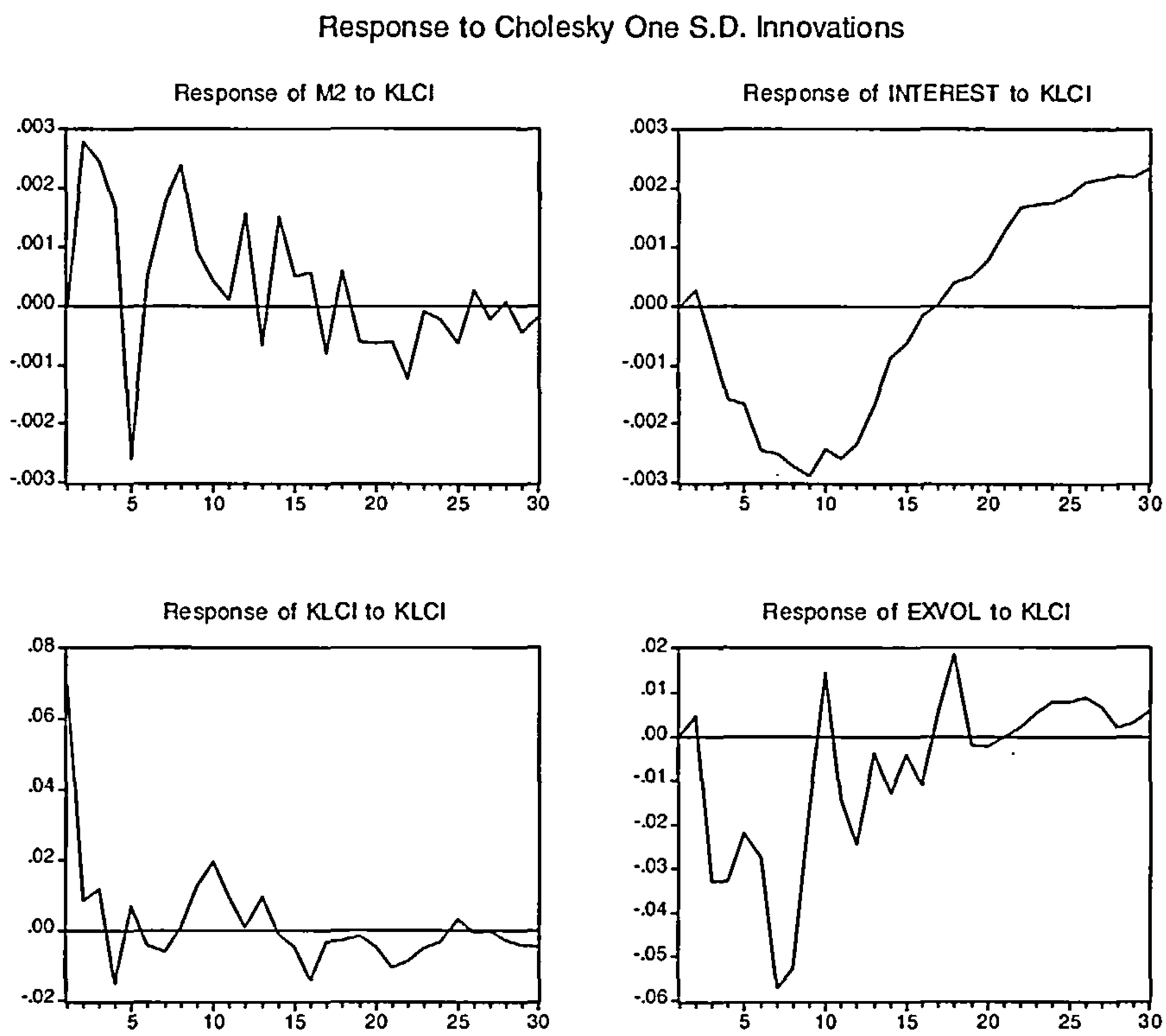

Figure 5.5. KLCI Multivariate Impulse Response: Response of Money Supply, Interest Rates and Exchange Rate Volatility to KLCI

Lastly, Figure 5.6 shows a one standard deviation shock in the exchange rate volatility causes a long-run decline in money supply. Money supply seems to have a short-run cyclical impact on exchange rate volatility and there is a cyclical, positive,

short-run relationship between exchange rate volatility and the interest rates in the early periods. Then, beyond period 7, interest rates seem to have a declining long-run relationship with exchange rate volatility. With regard to stock prices, exchange rate volatility has an inconsistent long-run relationship. However, its short-run dynamic seems to be cyclical, with a negative sign in the early periods and a positive sign beyond period 12.

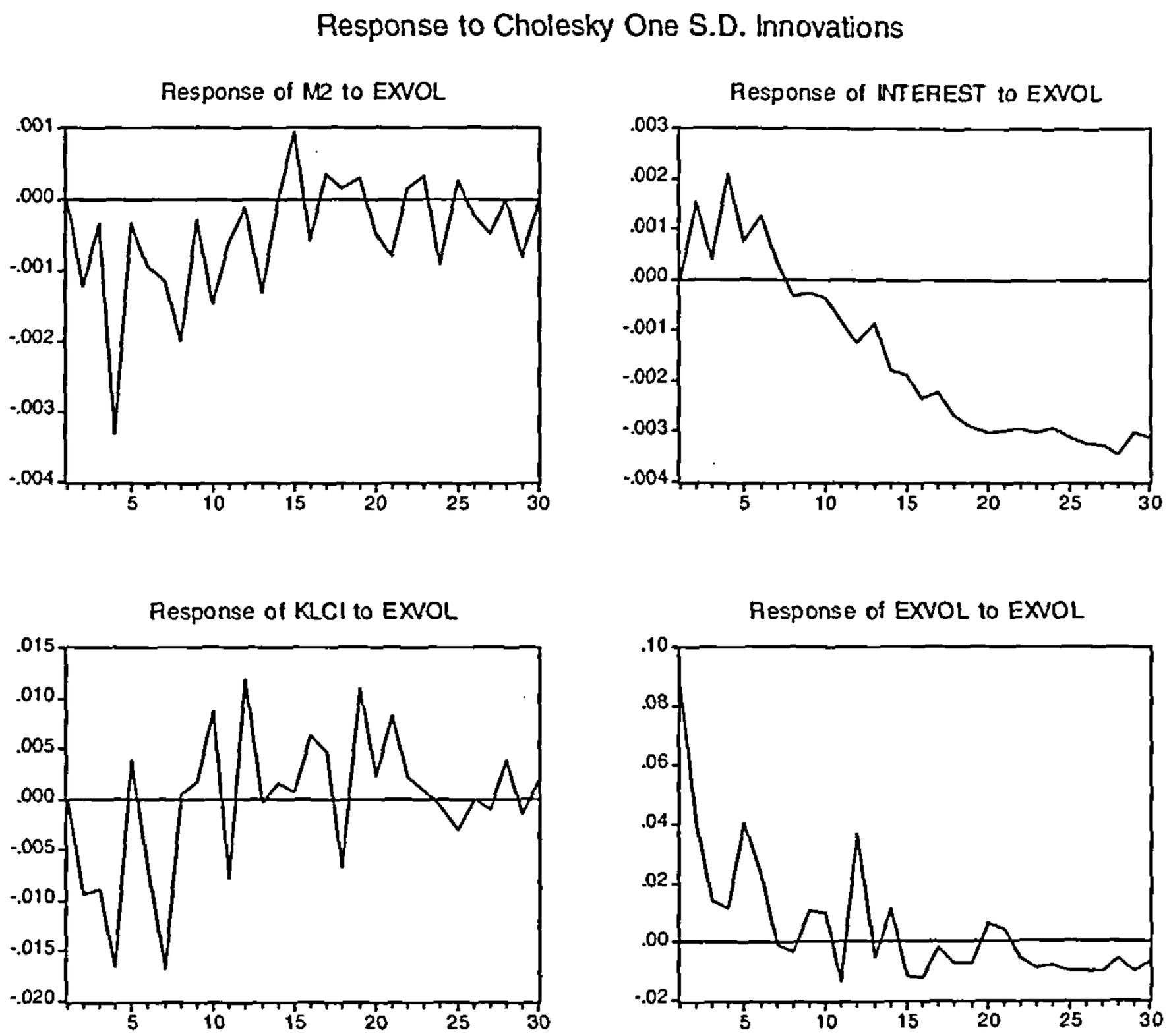

Figure 5.6. KLCI Multivariate Impulse Response: Response of Money Supply, Interest Rates and KLCI to Exchange Rate Volatility

4.3.2 Sectoral stock market impulse response functions

4.3.2.1 Industrial sector results

In Figure 5.7, we present the results of the bivariate impulse response functions for the Industrial sector. A one standard deviation shock in the stock prices of the Industrial sector induces an increase in exchange rate volatility in the initial period. Between periods 2 and 5, there is a decrease in exchange rate volatility which increases later, before settling with a long-run stability. Looking at Figure 5.7, we also see that a one standard deviation shock in exchange rate volatility causes a decline in the stock prices of the Industrial sector in the initial stage. In the next 4 periods, there is an increase in the stock prices before they decline for one period, to be followed by long-run stability thereafter.

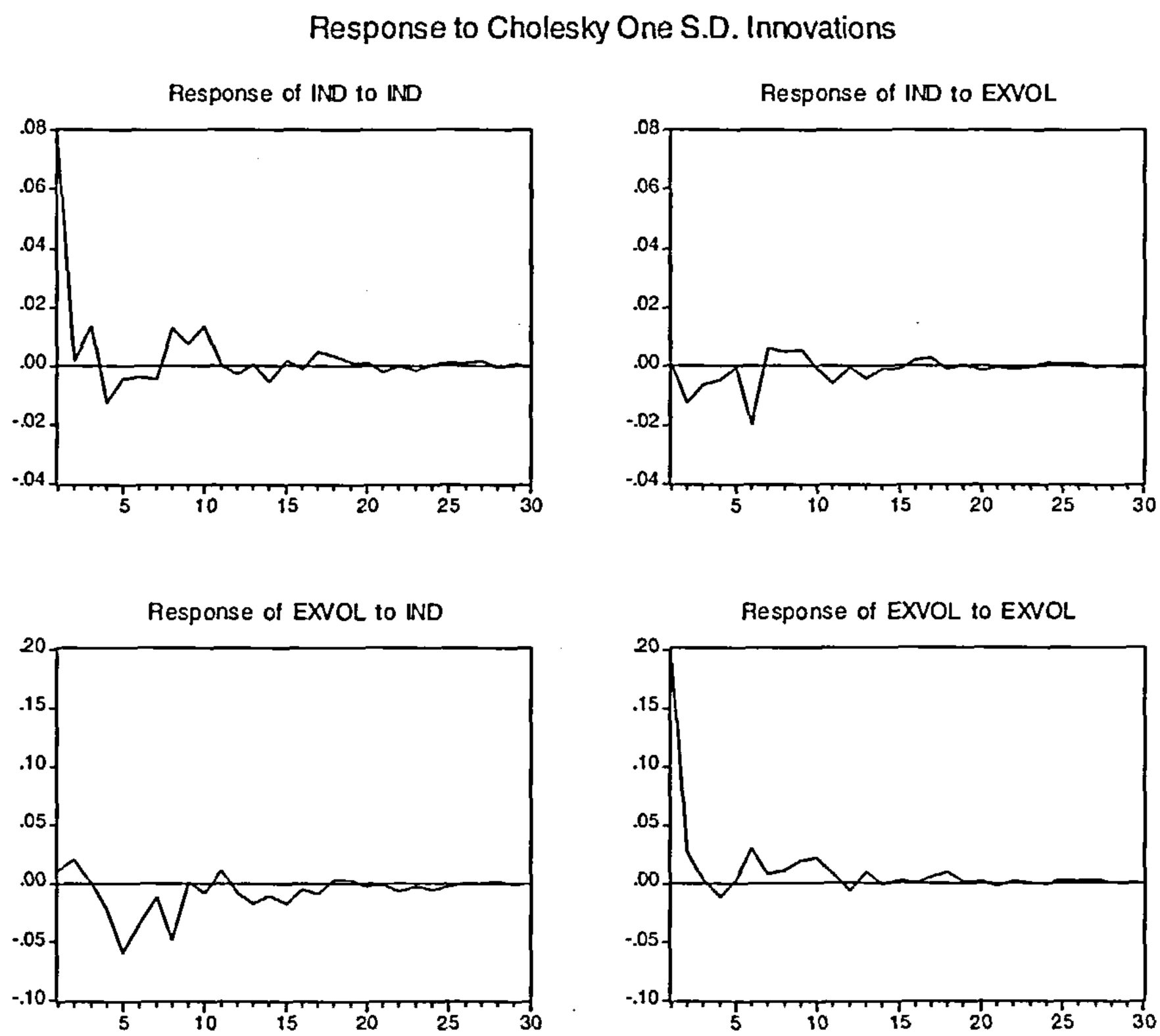

Figure 5.7. Industrial Sector Bivariate Impulse Response: Response of Stock Prices to Exchange Rate Volatility and Response of Exchange Rate Volatility to Stock Prices

The results of the multivariate impulse response functions for the Industrial sector are shown in Figures 5.8 – 5.11. As shown in Figure 5.8, a one standard deviation shock in the money supply induces a long-run negative relationship with interest rates. In the early periods (up to period 10), a change in the money supply increases interest rates before they dip down in the middle period, settling thereafter to a long-run trend. With regard to stock prices and exchange rate volatility, it can be observed that money supply has an inconsistent relationship with these two variables. Initially, a one standard deviation shock in the money supply induces decreases in the stock prices, but increases in the exchange rate volatility.

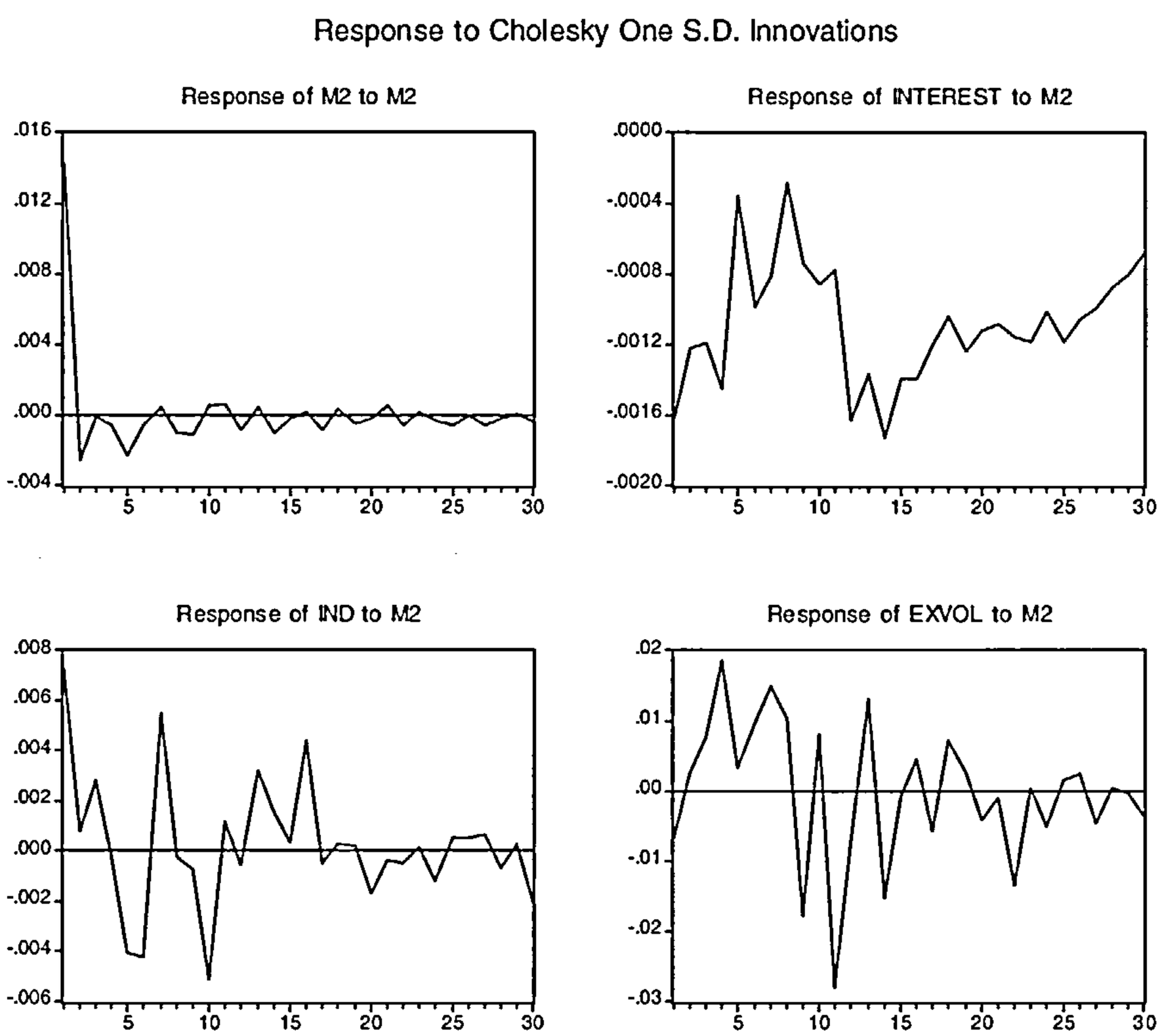

Figure 5.8. Industrial Sector Multivariate Impulse Response: Response of Interest Rates, Stock Prices and Exchange Rate Volatility to Money Supply

In terms of interest rates, in Figure 5.9 we see that a standard deviation shock in the interest rates results in a cyclical, positive, long-run relationship with the money supply. Initially, a change in the interest rates causes the money supply to increase and decrease. In the long-run interest rates seem to have an inconsistent relationship with stock prices of the Industrial sector. A change in the interest rates causes stock prices to decline initially, followed by an increase in periods 2 and 3, before declining with a short-run trend thereafter. A change in the interest rates causes a decline in the exchange rate volatility in the initial periods followed by short-run increases and decreases. Then, exchange rate volatility increases before settling with a positive long-run stability.

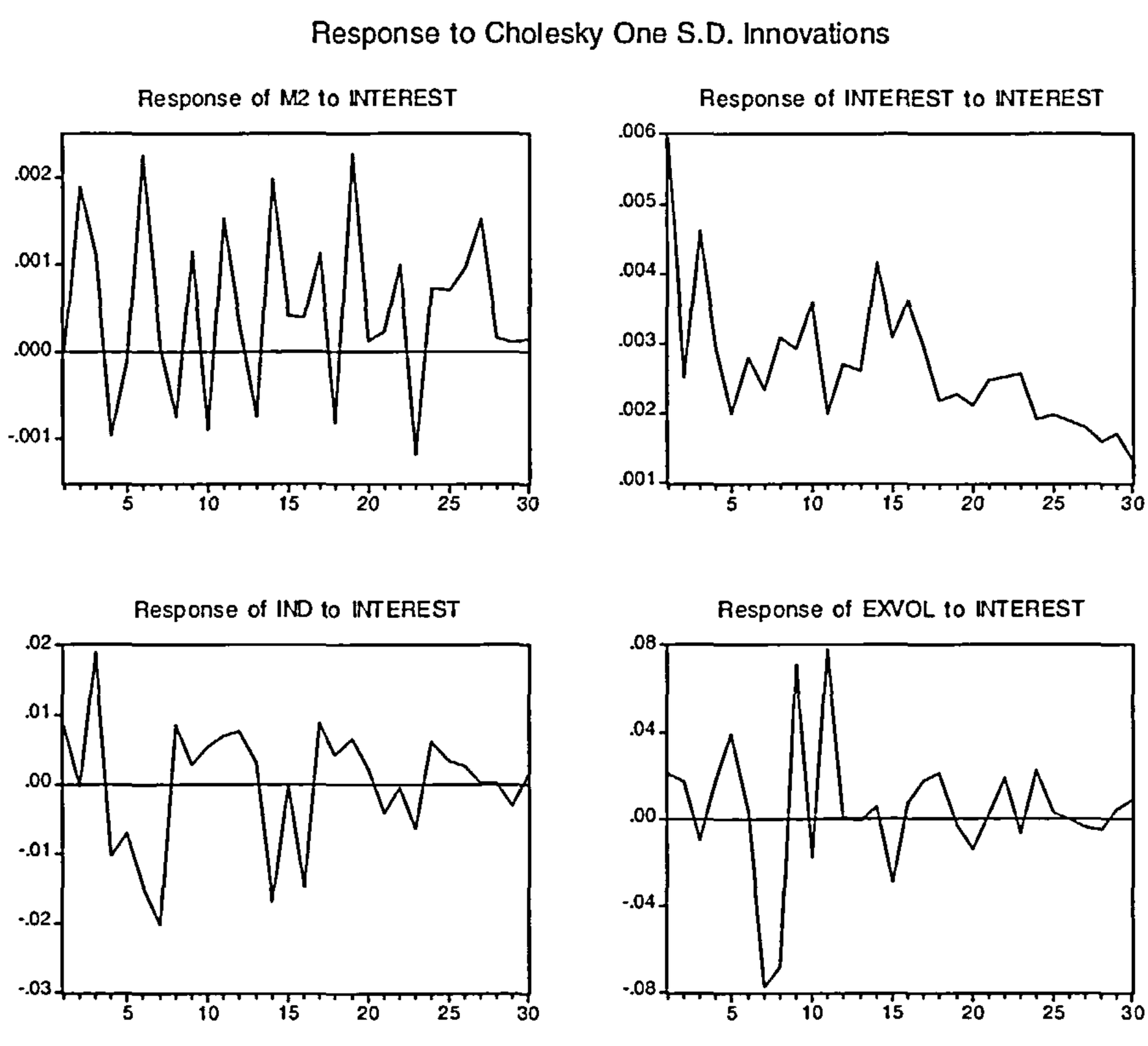

Figure 5.9. Industrial Sector Multivariate Impulse Response: Response of Money Supply, Stock Prices and Exchange Rate Volatility to Interest Rates

Figure 5.10 shows that a one standard deviation shock in the stock prices of the Industrial sector induces a positive long-run relationship with the money supply. In the short-run, stock prices cause the money supply to increase in the initial periods before declining over the next 4 periods. Then, the money supply rises for a short while, followed by positive long-run declining rates. In the long-run, interest rates responded inconsistently with stock prices. However, in the short-run, interest rates improve initially before decreasing up to period 8. Beyond period 9, interest rates improve with an increasing long-run positive trend. As to the impact on exchange rate volatility, stock prices seem to have a negative long-run relationship. A one standard deviation shock in interest rates causes a decline in exchange rate volatility in the early periods, increasing from period 8 and beyond. Exchange rate volatility then declines for a few periods before settling with positive long-run stability.

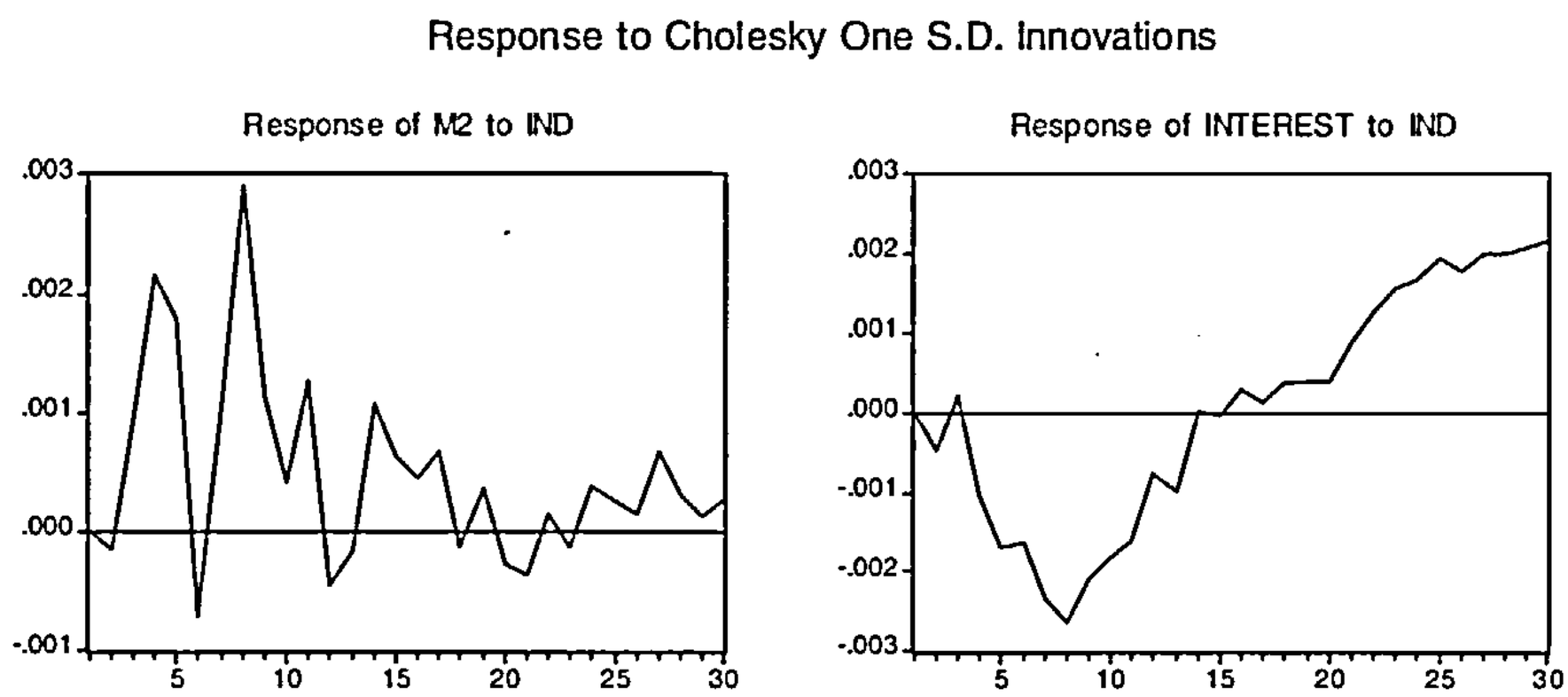

Figure 5.10. Industrial Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Exchange Rate Volatility to Stock Prices

As shown in Figure 5.11, a one standard deviation shock in exchange rate volatility seems to have a negative long-run relationship with the money supply. A change in exchange rate volatility decreases the money supply initially, followed by a short-run improvement and then a decline up to period 8. Beyond period 9, the money supply seems to have a cyclical long-run pattern. A one standard deviation shock in exchange rate volatility results in an improvement in the interest rates up to the first 8 periods. Interest rates then appear to settle into a declining long-run negative relationship with exchange rate volatility. With regard to its impact on stock prices, exchange rate volatility has a largely positive long-run impact. In the initial period, any change in exchange rate volatility causes stock prices to decline, then increase and decrease again for a short period. After period 7, stock prices increase and settle with positive long-run stability.

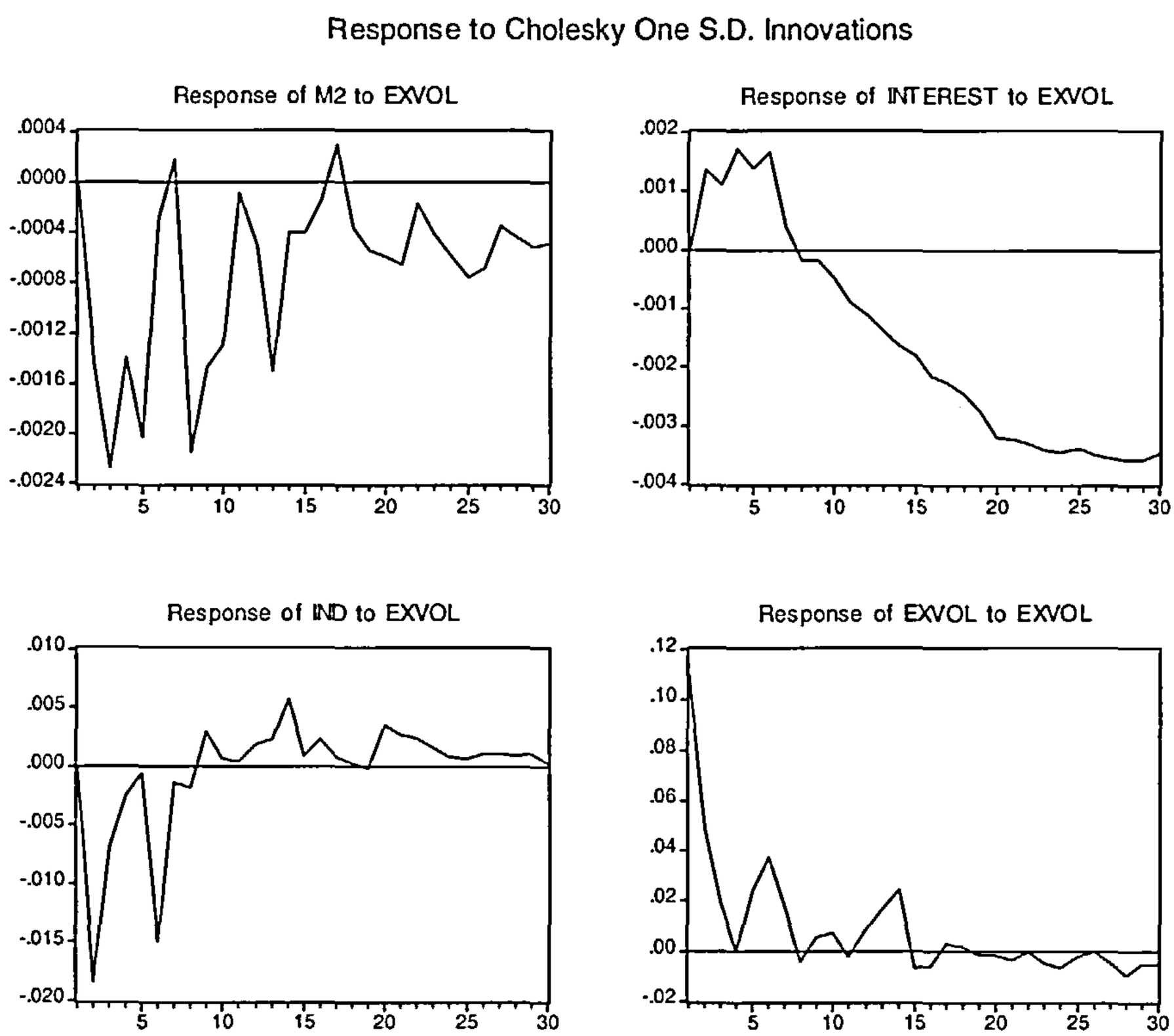

Figure 5.11. Industrial Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Stock Prices to Exchange Rate Volatility

4.3.2.2 *Financial sector results*

As shown in Figure 5.12 for the bivariate impulse response functions for the Finance sector, a one standard deviation shock in stock prices causes an increase in exchange rate volatility in the initial period, followed by several declines before settling with a long-run stability. We could say that stock prices in the Finance sector have a negative long-run relationship with exchange rate volatility and that a one standard deviation shock in exchange rate volatility causes a decline in stock prices within the Finance sector in the initial period. From period 2 onwards, stock prices increase, followed by inconsistent long-run stability around their mean values.

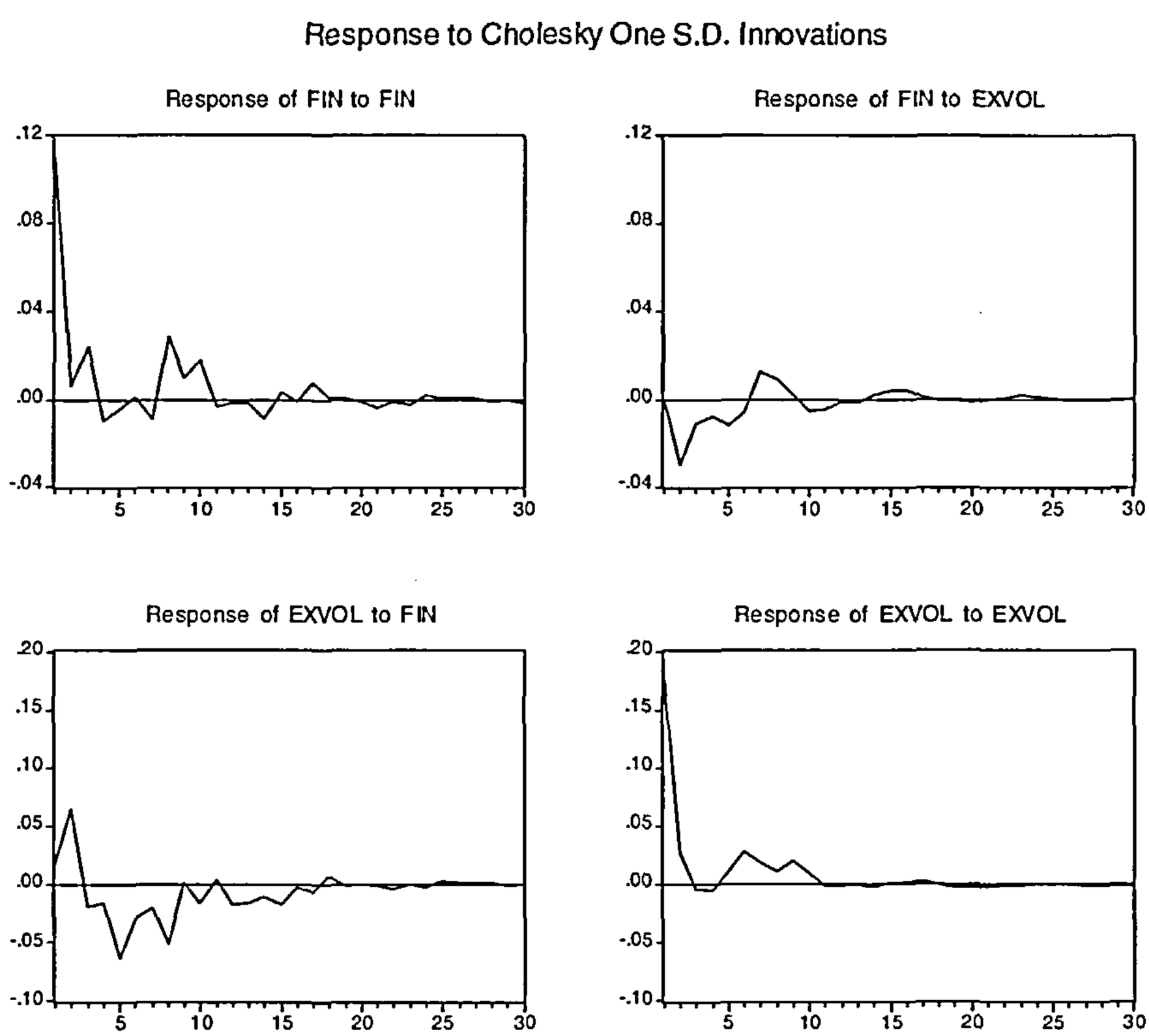

Figure 5.12. Finance Sector Bivariate Impulse Response: Response of Stock Prices to Exchange Rates Volatility and Response of Exchange Rate Volatility to Stock Prices

As shown in Figure 5.13, for the multivariate impulse response functions for the Finance sector, a one standard deviation shock in the money supply induces an increase in interest rates up to period 8, decreasing thereafter up to period 14. Beyond that period, interest rates have an increasing long-run trend. The stock prices are observed to have a short-run cyclical relationship with the money supply. A change in the money supply causes exchange rate volatility to increase in the initial period up to period 8, before settling with a short-run cyclical trend beyond that period. The money supply seems to have a negative long-run relationship with the interest rates and an inconsistent long-run relationship with stock prices and exchange rate volatility.

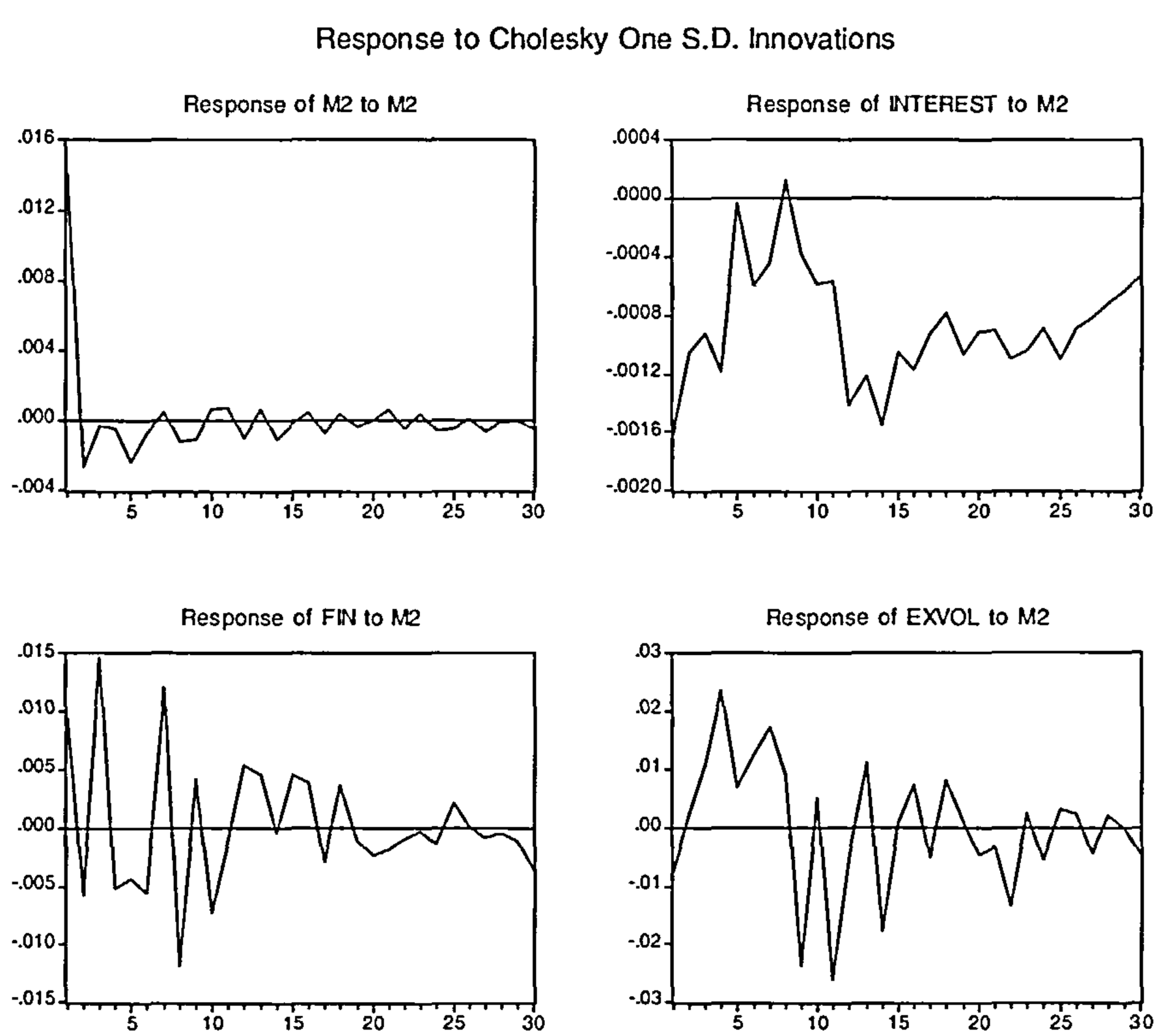

Figure 5.13. Finance Sector Multivariate Impulse Response: Response of Interest Rates, Stock Prices and Exchange Rate Volatility to Money Supply

Figure 5.14 show how a one standard deviation shock in interest rates causes a positive long-run cyclical relationship with the money supply. In the short-run, a change in the interest rates results in the money supply increasing in the initial period, before declining over the next few periods. The interest rates seem to have an inconsistent long-run relationship with both stock prices in the Finance sector and exchange rate volatility. In both variables, a change in interest rates decreases stock prices and exchange rate volatility in the initial period, before increasing then decreasing briefly over the next few periods. Thereafter, the short-run dynamic in the interest rates and the exchange rate volatility settle with a positive cyclical pattern.

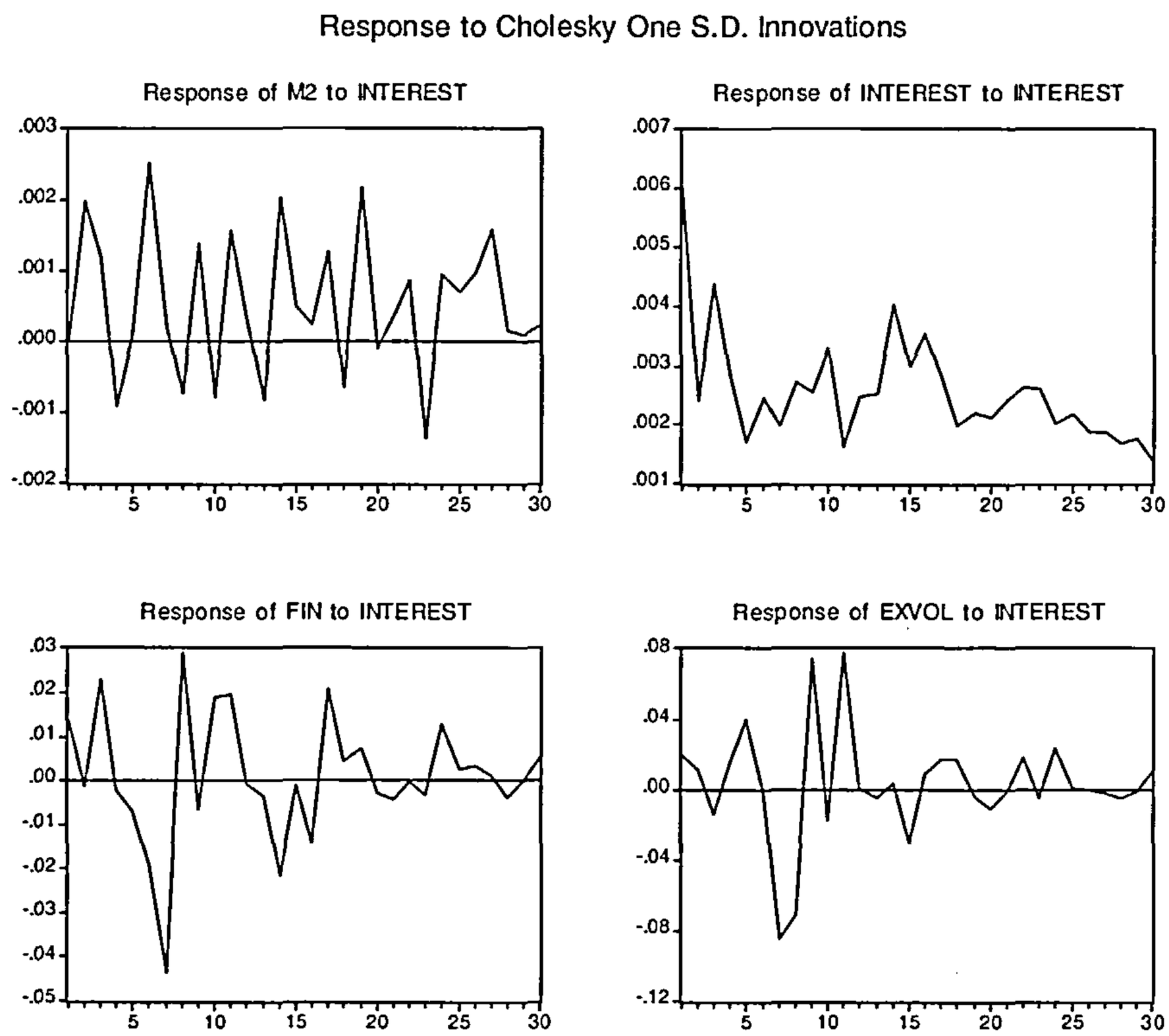

Figure 5.14. Finance Sector Multivariate Impulse Response: Response of Money Supply, Stock Prices and Exchange Rate Volatility to Interest Rates

As shown in Figure 5.15, a one standard deviation shock in stock prices within the Finance sector induces a positive long-run impact on the money supply, an inconsistent impact on interest rates and a negative impact on exchange rate volatility. In the short-run, the money supply increases up to period 4, before declining in period 5, with a cyclical short-run pattern beyond period 6. A change in the stock prices causes interest rates to decline initially up to period 8, before settling with an increasing upward trend beyond that period. With regard to exchange rate volatility, a change in stock prices improves exchange rate volatility in the initial period before declining shortly, with short-run increases thereafter. Then, after another short-run decline, exchange rate volatility rises and stays with a negative short-run cyclical pattern beyond period 10.

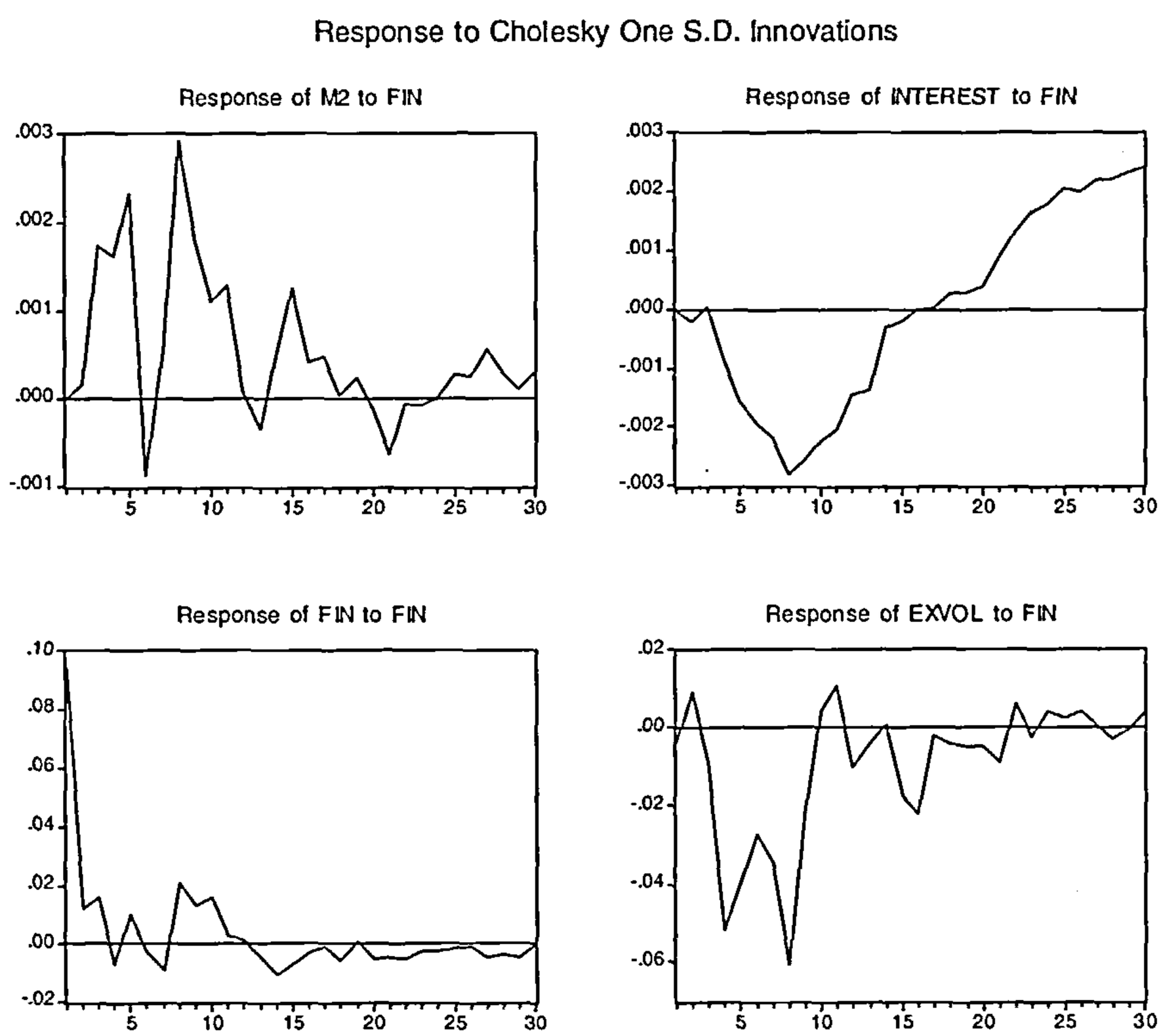

Figure 5.15. Finance Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Exchange Rate Volatility to Stock Prices

From Figure 5.16 we could see that a one standard deviation shock in exchange rate volatility induces a negative long-run association with the money supply, a largely negative long-run association with interest rates and a largely positive long-run association with stock prices in Finance sector. Short-run exchange rate volatility causes the money supply to decline during the initial period before pushing upwards, then declining again in the next few periods. After period 8, the money supply increases and settles with a negative cyclical upward trend relationship. As for the short-run relationship with interest rates, exchange rate volatility seems to have a cyclical positive trend up to period 6, followed by a decreasing negative trend, before stabilizing beyond period 20. The stock prices seem to initially decline before they improve with a short-run cyclical positive trend.

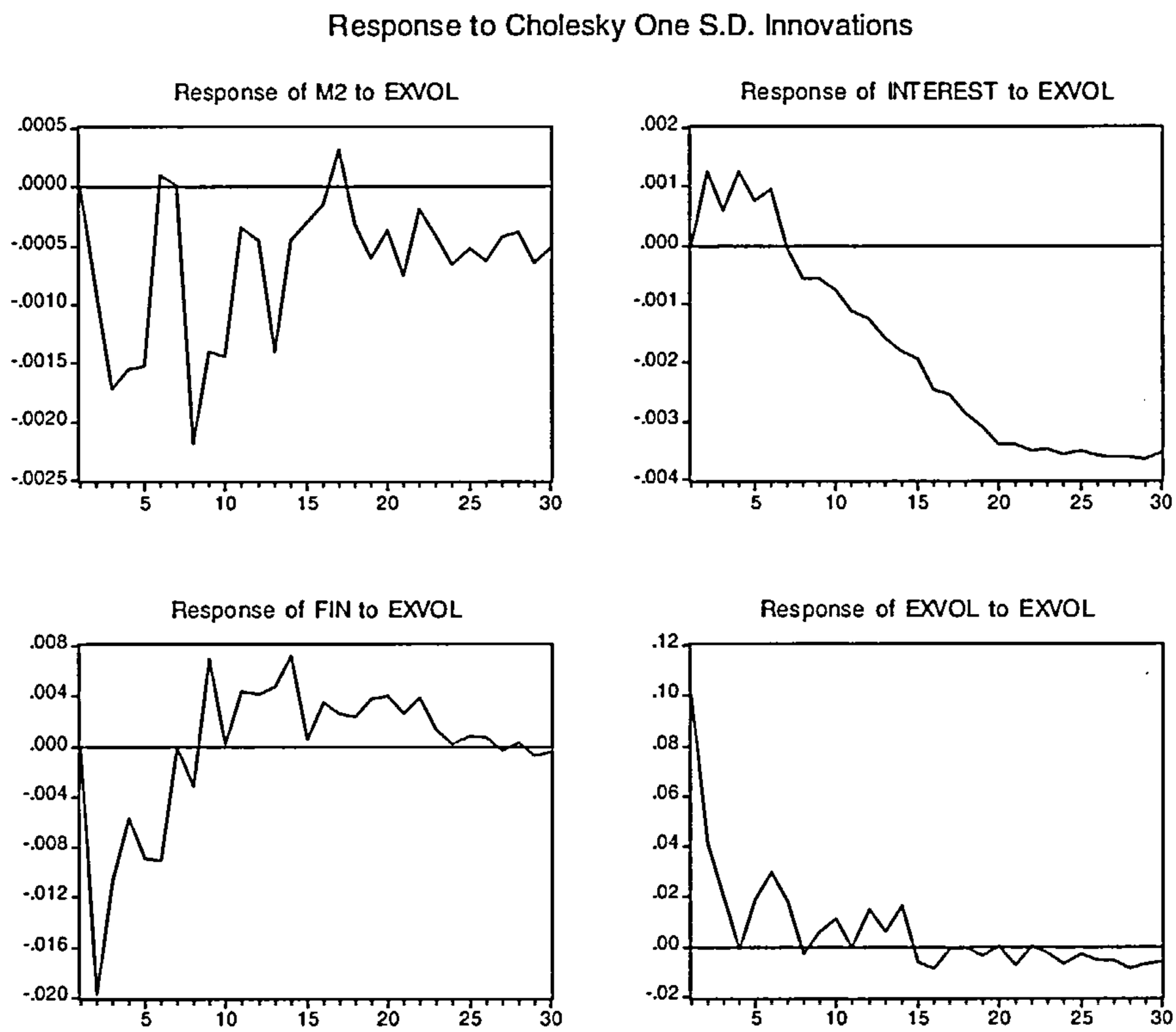

Figure 5.16. Finance Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Stock Prices to Exchange Rate Volatility

4.3.2.3 Plantation sector results

We present the results of the bivariate impulse response functions for the Plantation sector in Figure 5.17. A one standard deviation shock in the stock prices within this sector brings an initial increase in exchange rate volatility before declining over the next 4 periods. After period 5, this improves, stabilizing till period 8 and beyond. It could be implied that these stock prices have a largely negative relationship with exchange rate volatility. Figure 5.17 shows that a one standard deviation shock in exchange rate volatility induces stock prices to decline in the first 4 periods before showing an improvement in period 5, with a further decline in period 6. Beyond period 7 the stock prices are more stable. Overall, we could say that exchange rate volatility has a negative long-run relationship with the stock prices in the Plantation sector.

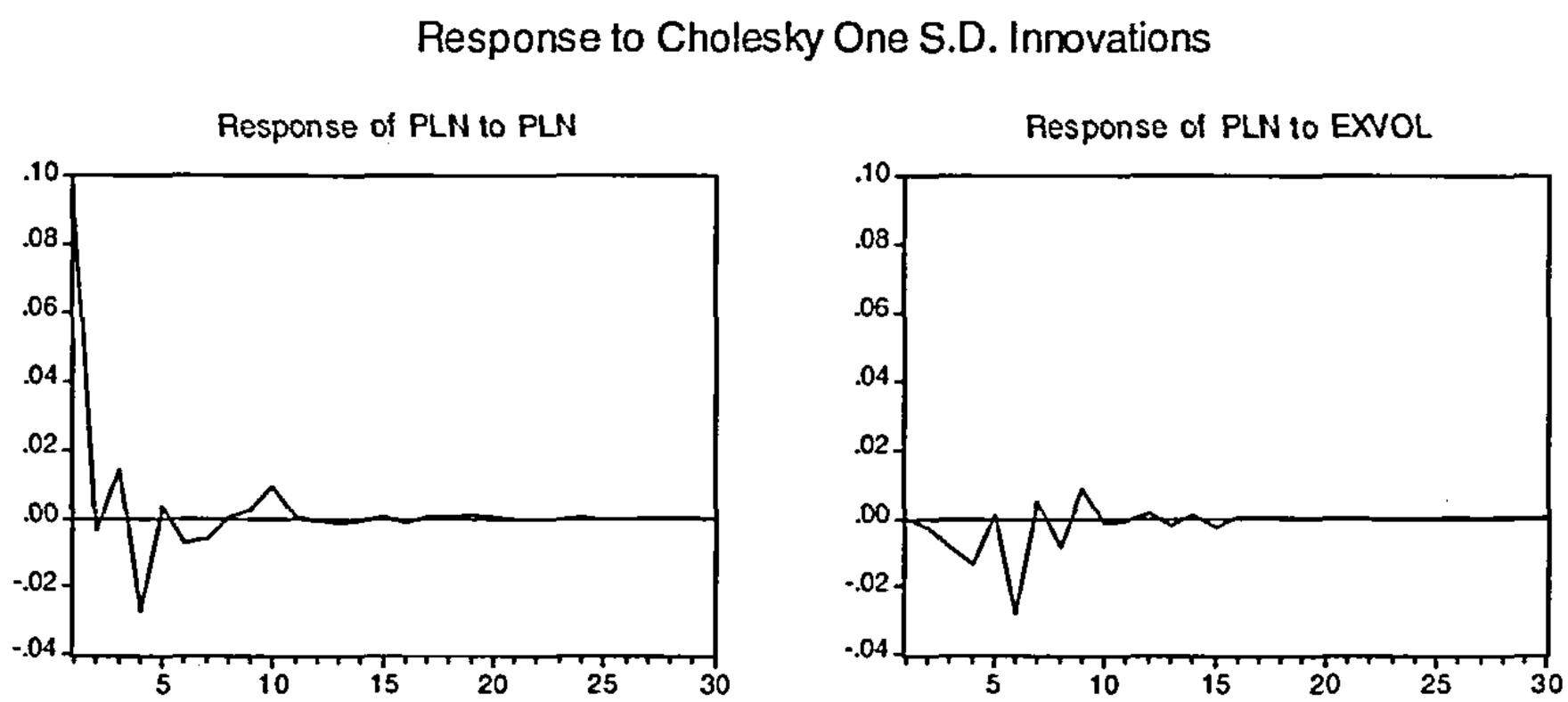

Figure 5.17. Plantation Bivariate Impulse Response: Response of Stock Prices to Exchange Rate Volatility and Response of Exchange Rate Volatility to Stock Prices

We present the results of the multivariate impulse response functions for the Plantation sector in Figures 5.18 – 5.21. In Figure 5.18, a one standard deviation shock in the money supply induces a long-run negative relationship with interest rates. In the short-run, a change in the money supply causes interest rates to have a cyclical upward trend until period 8, followed by a decreasing trend until period 12. Beyond this period, interest rates appear to improve, with a cyclical upward trend (even though the relationship is still negative). The money supply seems to have an inconsistent long-run association with stock prices and exchange rate volatility. In the short-run, stock prices are can be seen to have a recurring pattern - a decreasing impact in the initial period before improving in the next few periods. As for exchange rate volatility, it increases in the early periods before declining in periods 5 and 6. Beyond period 7 exchange rate volatility appears to have a largely cyclical short-run negative relationship.

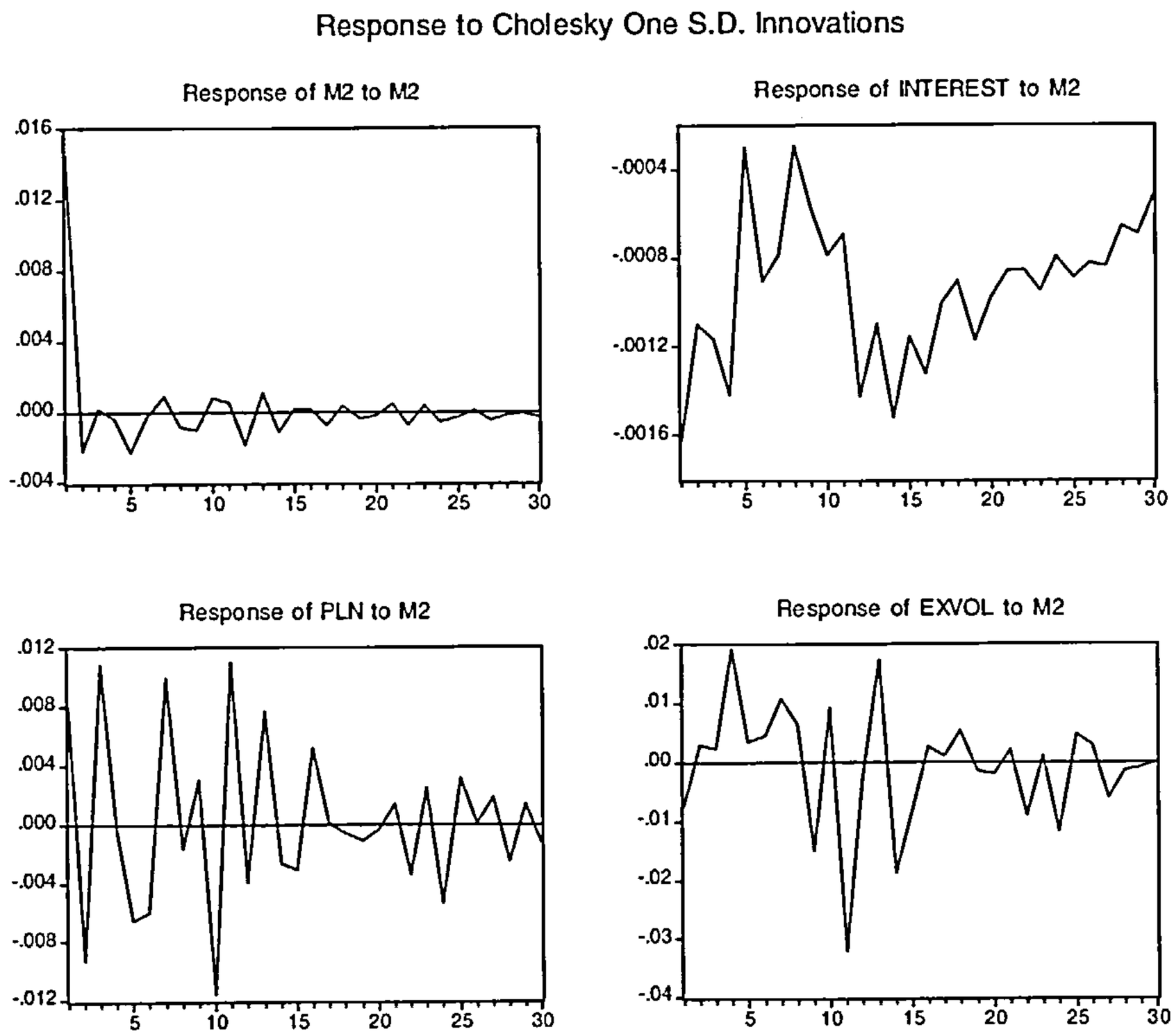

Figure 5.18. Plantation Sector Multivariate Impulse Response: Response of Interest Rates, Stock Prices and Exchange Rate Volatility to Money Supply

Figure 5.19 shows that a one standard deviation shock in interest rates causes a long-run positive association with the money supply, a long-run inconsistent association with stock prices in the Plantation sector and a largely long-run positive association with exchange rate volatility. The short-run impact of interest rates on the money supply initially seems to create a cyclical increasing impact in the money supply (causing stock prices to decline in the initial period before improving then declining again in the next few periods). The interest rates also cause a decline in exchange rate volatility during this initial period, though this then improves up to period 5. After period 5, exchange rate volatility decreases before it rises again in period 8, settling with a cyclical short-run positive relationship with interest rates thereafter.

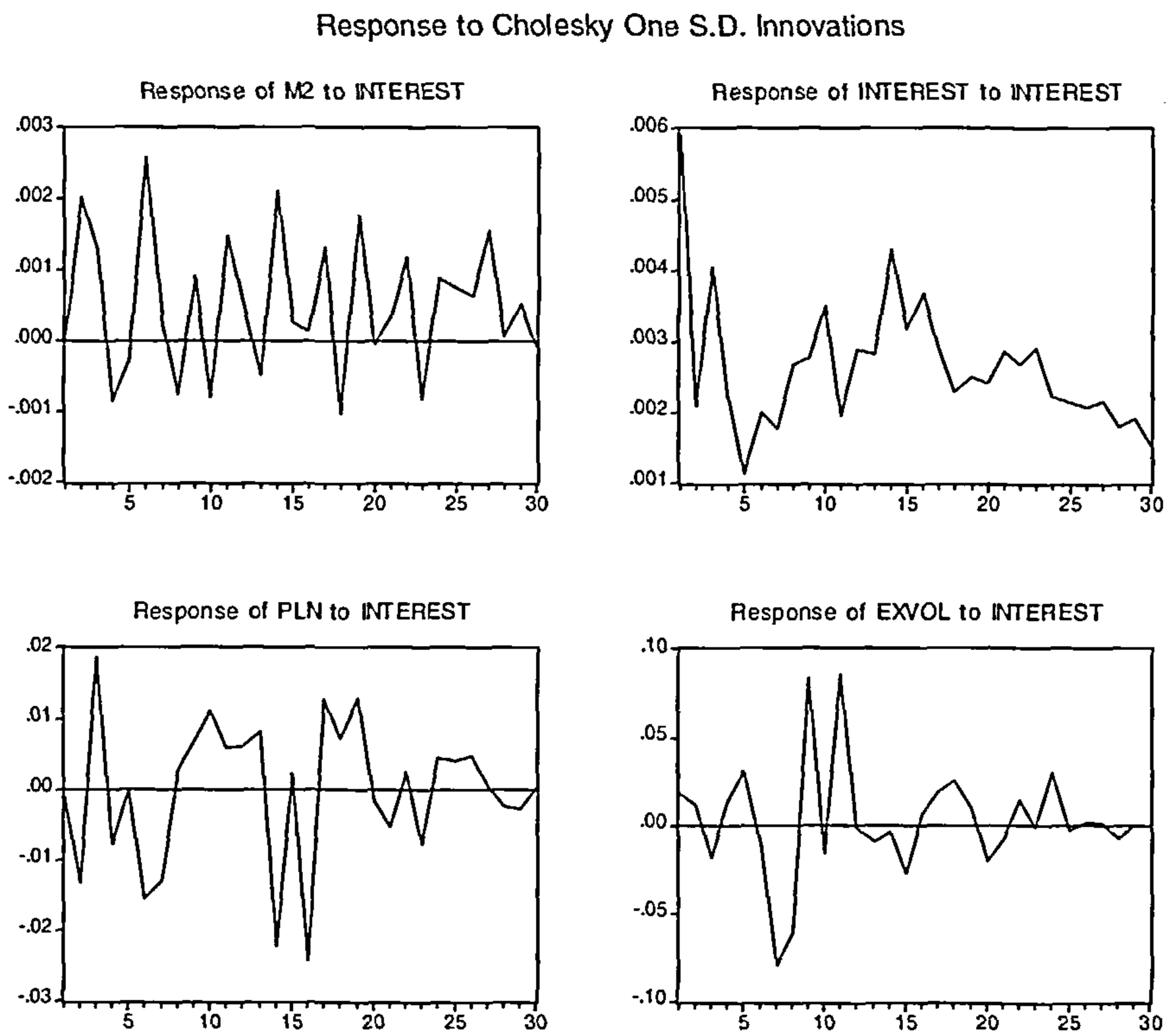

Figure 5.19. Plantation Sector Multivariate Impulse Response: Response of Money Supply, Stock Prices and Exchange Rate Volatility to Interest Rates

As shown in Figure 5.20, a one standard deviation shock in stock prices in the Plantation sector induces a long-run inconsistent relationship with the money supply, and a long-run negative relationship with interest rates and exchange rate volatility. In the short-run, a change in stock prices causes an initial decrease in the money supply, before improving thereafter over the next 3 periods. After period 5, money supply declines and improves after period 8, before settling into a cyclical short-run trend beyond period 12. A change in stock prices induces interest rates to decline initially before improving in periods 2 and 3. Thereafter, interest rates seem to decline from period 4 before they improve with an upward trend from period 8 and beyond.

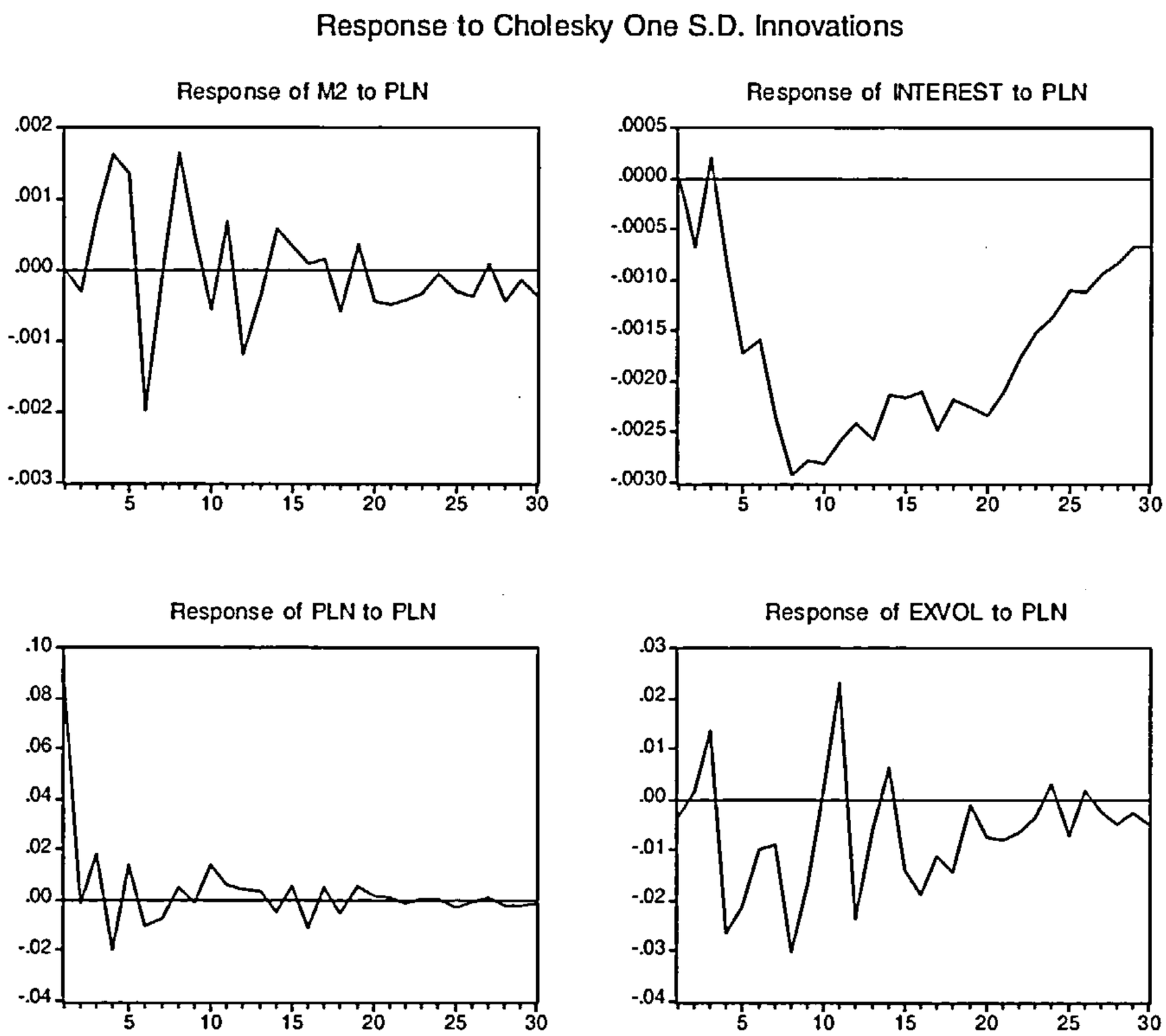

Figure 5.20. Plantation Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Exchange Rate Volatility to Stock Prices

Results in Figure 5.21 show that a one standard deviation shock in the exchange rate volatility results in a long-run negative relationship with the money supply, interest rates and stock prices in the Plantation sector. This causes an initial decrease in the money supply before improving somewhat over the next 5 periods. Thereafter, the money supply declines and is followed by an upward cyclical trend beyond period 12. With regard to interest rates, exchange rate volatility increases these in the early periods, but this is followed by a gradual downward trend beyond period 6. In terms of stock prices, exchange rate volatility causes a decline in these during the initial period before showing an improvement in the next 3 periods. In period 6, stock prices decline, and then improve, before settling with a cyclical short-run pattern.

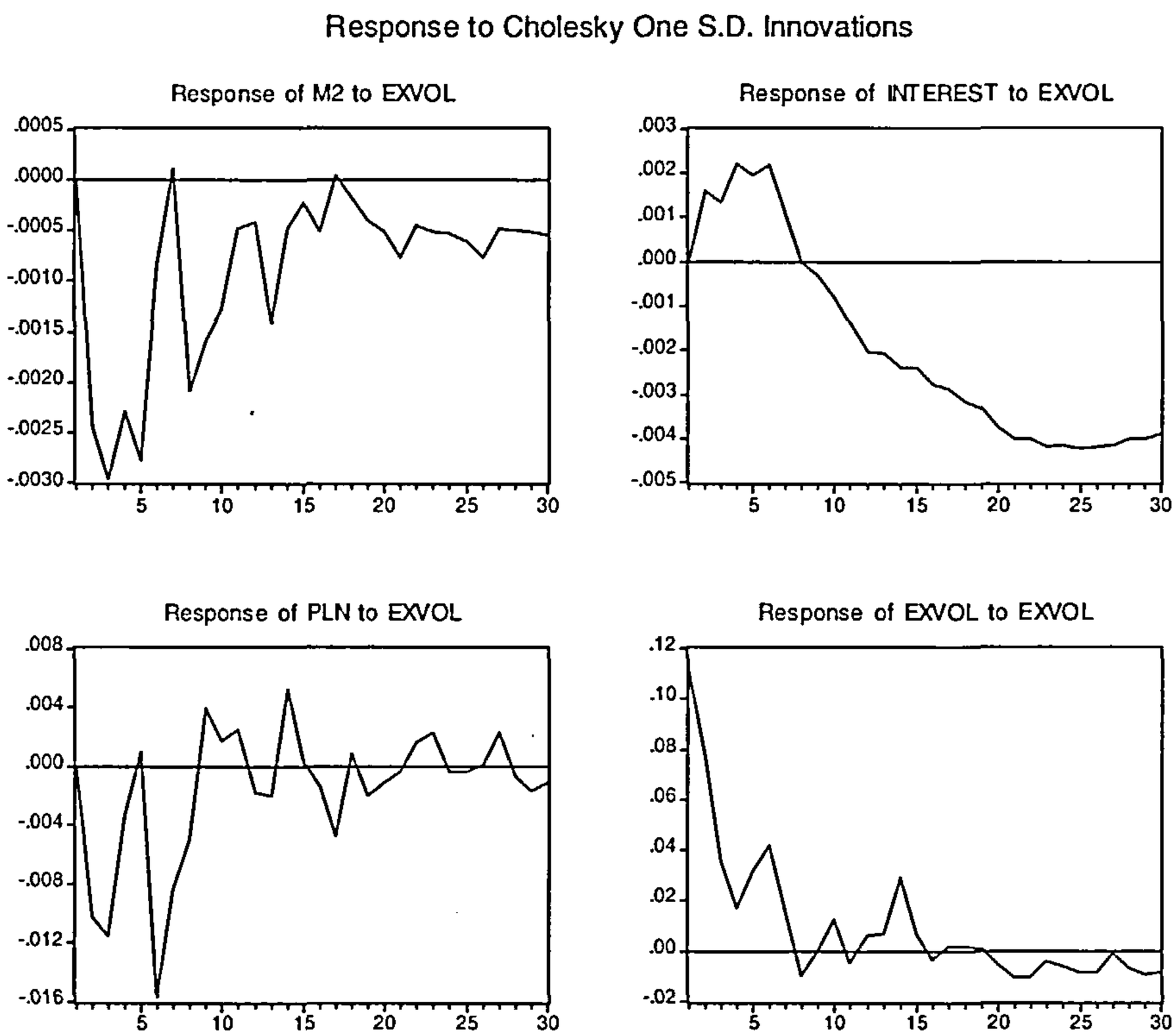

Figure 5.21. Plantation Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Stock Prices to Exchange Rate Volatility

4.3.2.4 *Properties sector results*

In our analysis of the Properties stock market, we present the one standard deviation shock of impulse response functions of the bivariate framework in Figure 5.22 and the multivariate framework in Figures 5.23 – 5.26. A one standard deviation shock in stock prices in this sector induces an increase in exchange rate volatility during the initial period. This then declines, and is followed by an improving trend beyond period 7. The long-run relationship between stock prices and exchange rate volatility seems to indicate negative behaviour. Figure 5.22 also shows that a one standard deviation shock in exchange rate volatility causes an initial decrease in stock prices before improving, then settling with an upward trend beyond period 3. Exchange rate volatility can be seen to have a long-run negative relationship with stock prices in the Properties sector.

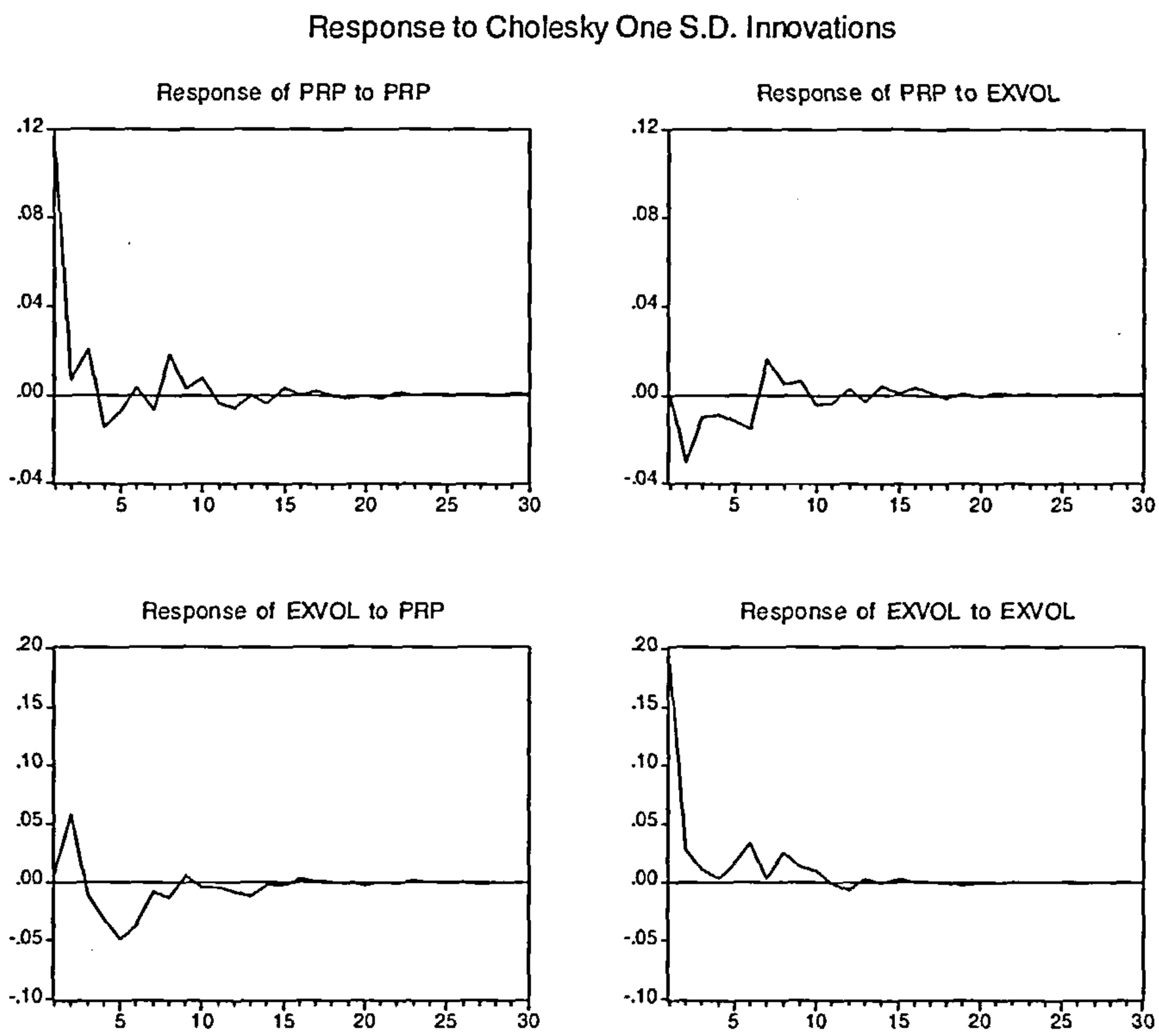

Figure 5.22. Properties Sector Bivariate Impulse Response: Response of Stock Prices to Exchange Rate Volatility and Response of Exchange Rate Volatility to Stock Prices

As shown in Figure 5.23, for the multivariate impulse response functions for the Properties sector, a one standard deviation shock in the money supply has a long-run negative association with interest rates, and a long-run inconsistent association with stock prices and exchange rate volatility. In the short-run, the money supply causes interest rates to increase initially, before pushing them to decline over the next few periods. Beyond period 5, interest rates improve then decline up to period 14. Thereafter they improve again, with an upward trend. The short-run shock in the money supply causes stock prices to decline initially followed by short-run increases thereafter. Beyond period 5, stock prices increase before falling shortly in period 10, settling with a short-run cyclical pattern thereafter. A change in the money supply causes exchange rate volatility to increase in the early periods followed by short-run decreases, then improvements in the next few periods. Then, exchange rate volatility decreases to be followed by a largely negative short-run recurring trend from period 7 and beyond.

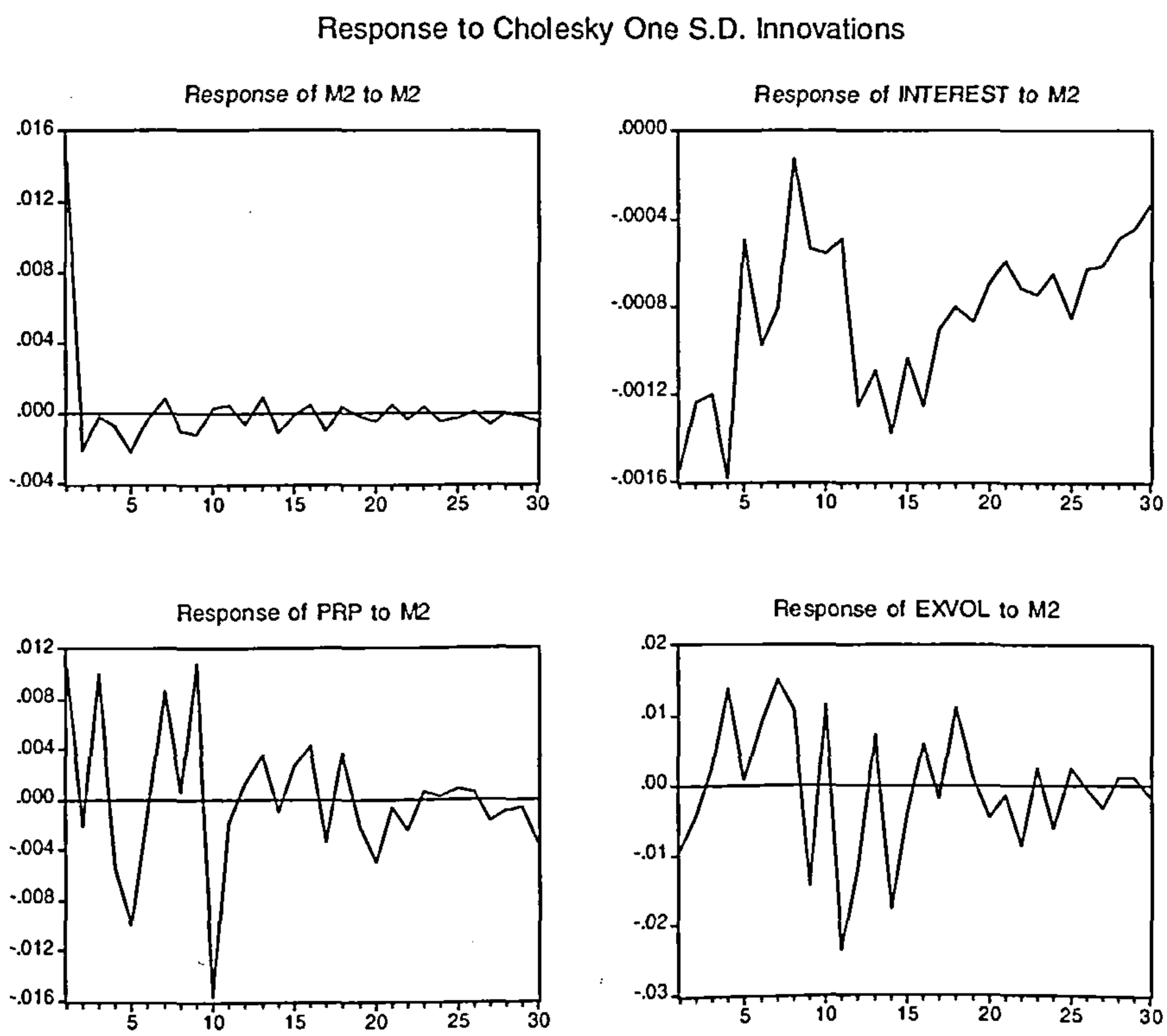

Figure 5.23. Properties Sector Multivariate Impulse Response: Response of Interest Rates, Stock Prices and Exchange Rate Volatility to Money Supply

The Impulse Response results in Figure 5.24 show that a one standard deviation shock in interest rates cause a long-run positive relationship with the money supply, and a long-run inconsistent relationship with stock prices and exchange rate volatility. Interest rates changes cause the money supply to increase initially before declining for a short time. This is followed by a largely positive short-run cyclical pattern. The stock prices decline initially before showing a brief improvement, then decline for few periods. Beyond period 7, the stock prices rise up and settle with an inconsistent short-run recurring trend. The exchange rate volatility decreases in the initial period before a brief improvement, then decline in the next few periods. Beyond period 8, exchange rate volatility increases before settling with a largely inconsistent short-run recurring trend.

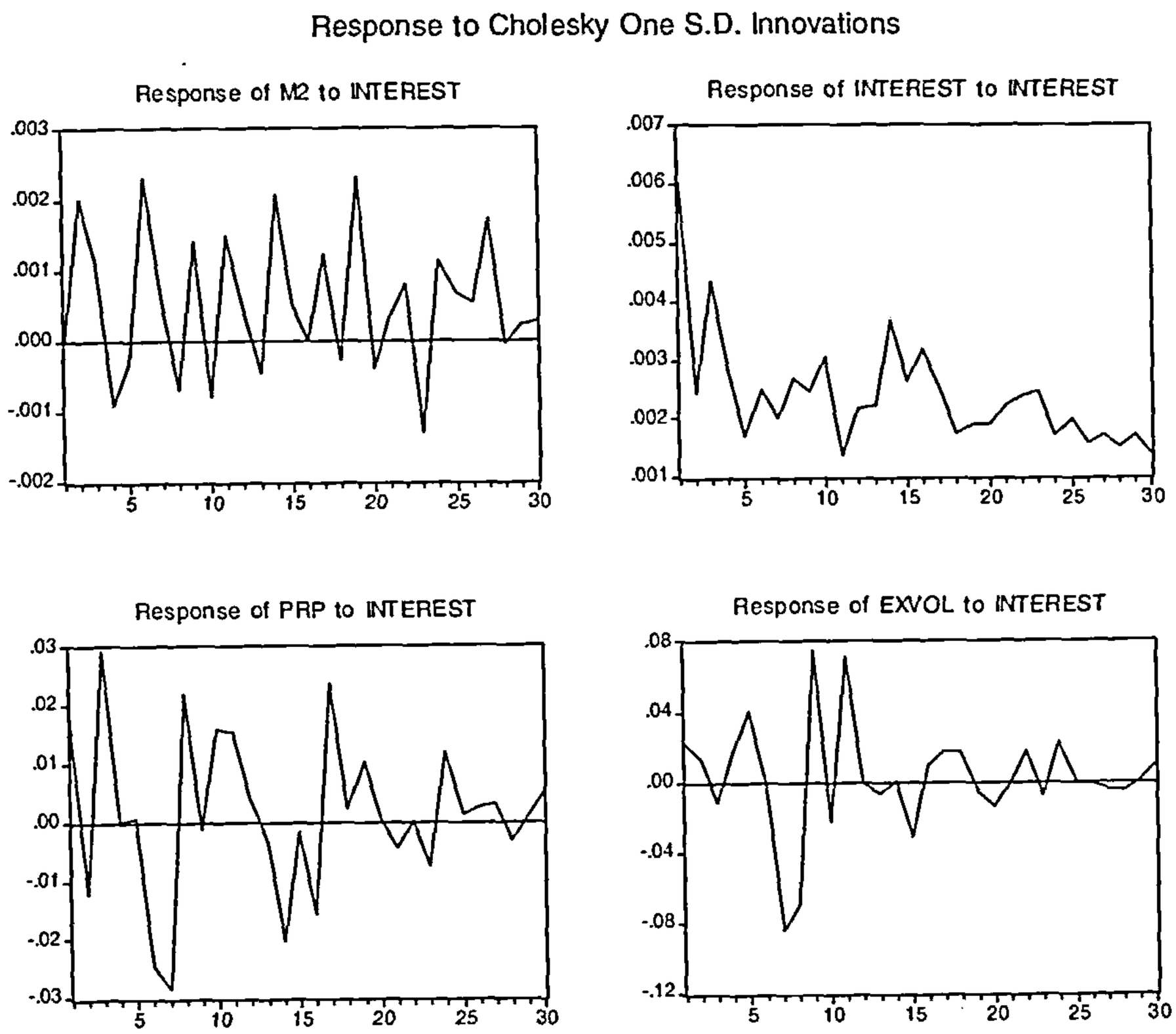

Figure 5.24. Properties Sector Multivariate Impulse Response: Response of Money Supply, Stock Prices and Exchange Rate Volatility to Interest Rates

As shown in Figure 5.25, a one standard deviation shock in stock prices for the Properties sector results in a long-run positive association with the money supply and a long-run negative association with interest rates and exchange rate volatility. In the initial period, money supply decreases before improving for a short period. It then, falls, and later improves, settling with a short-run recurring trend. The interest rates are inconsistent in the early periods before declining up to period 8. This is followed by a gradual increase from this period and beyond. The exchange rate volatility increases initially before dropping in the next 3 periods, to be followed with a short-run improvement. It then declines, before increasing and settling with a largely negative short-run pattern.

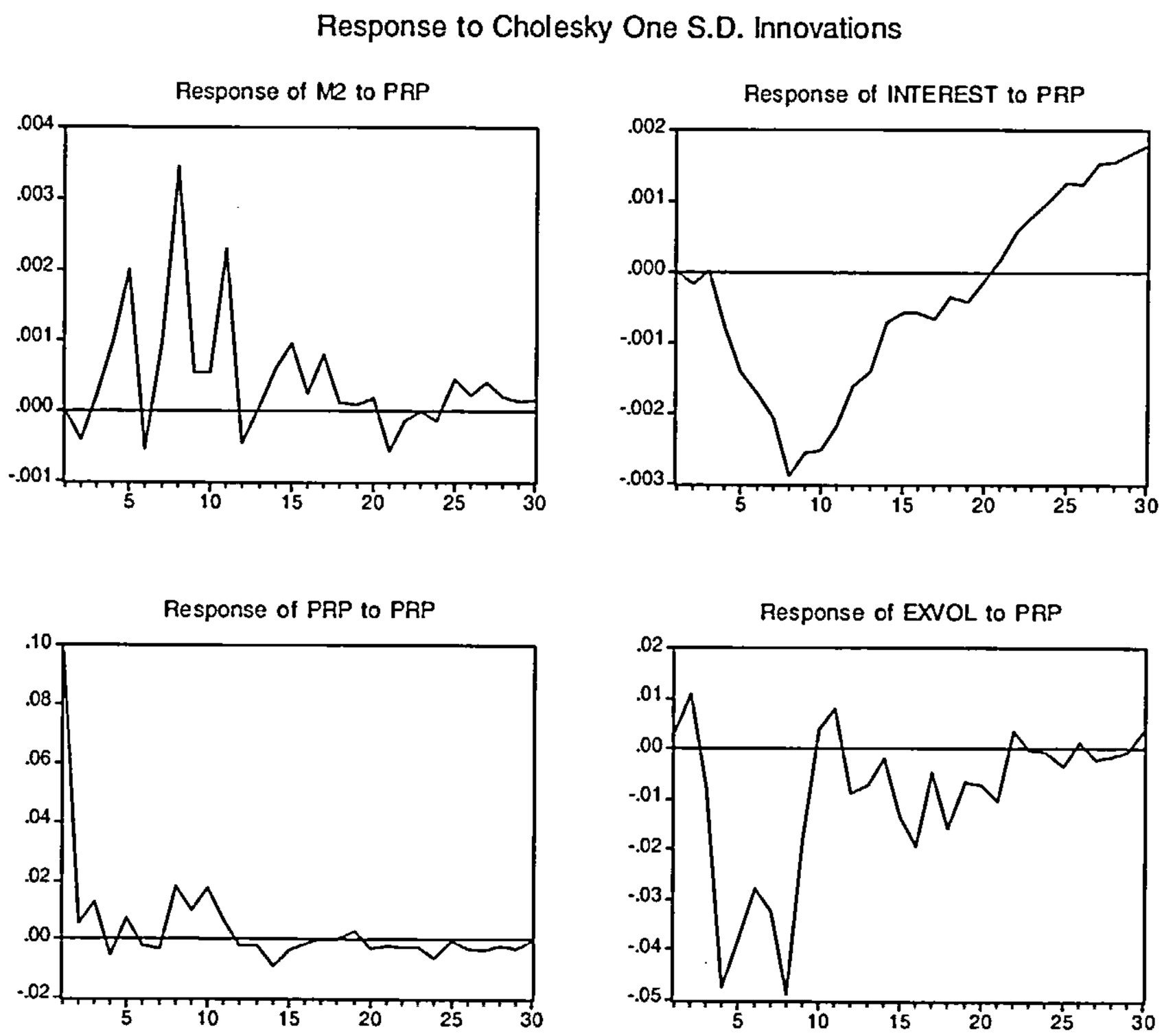

Figure 5.25. Properties Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Exchange Rate Volatility to Stock Prices

Figure 5.26 shows how a one standard deviation shock in exchange rate volatility induces long-run negative relationship between money supply and interest rates, and a long-run positive relationship with stock prices in the Properties sector. The short-run changes in exchange rate volatility produce an initial decline in the money supply before showing an improvement over the next 5 periods. Beyond period 6, the money supply drops briefly then improves, and then settles with a recurring short-run negative pattern. Interest rates increase in the early periods before declining gradually with a negative trend beyond period 8. As for stock prices, they initially decrease before gradually increasing and settling with a short-run positive cyclical pattern.

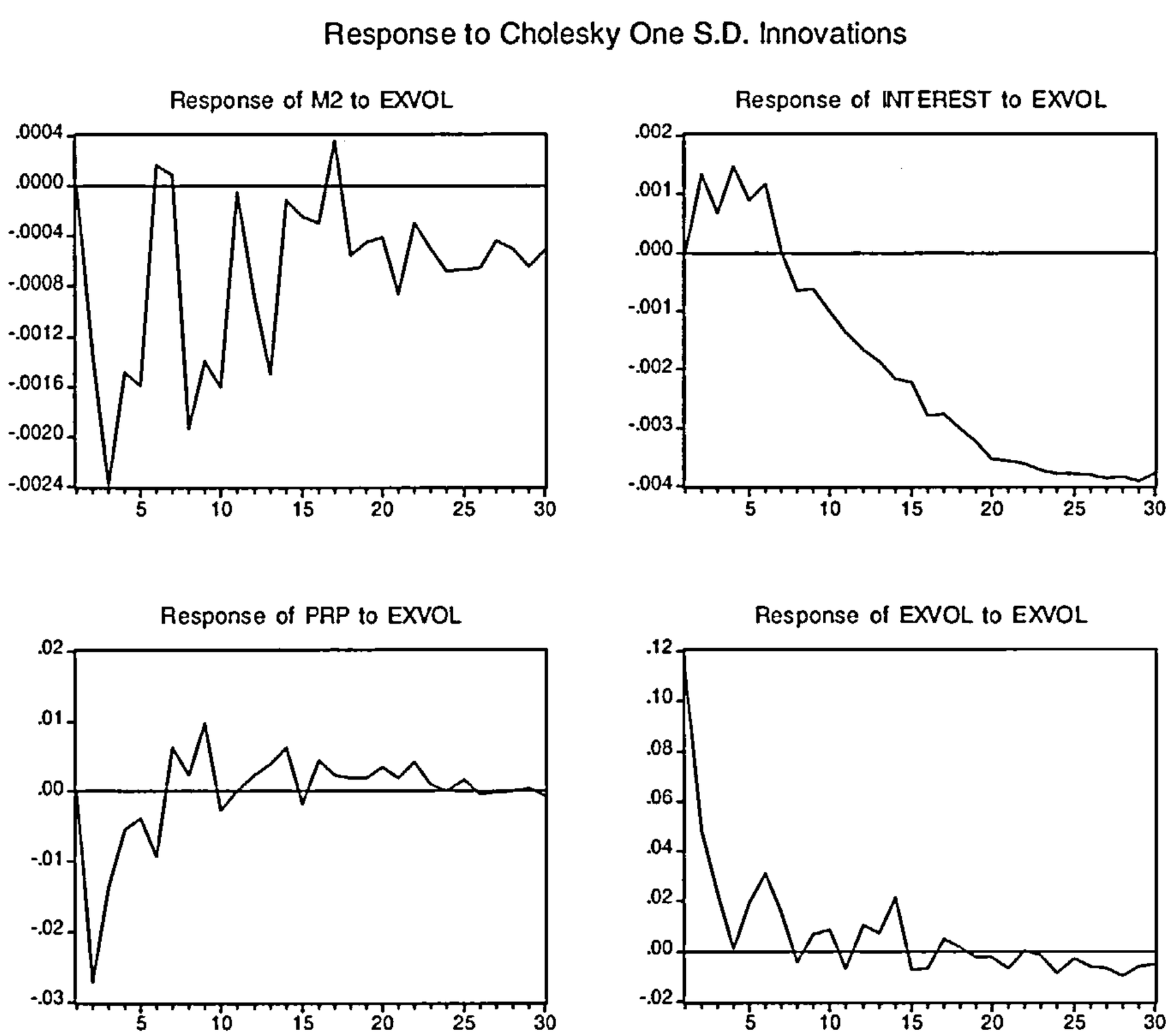

Figure 5.26. Properties Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Stock Prices to Exchange Rate Volatility

4.3.2.5 Tin and Mining sector results

As shown in Figure 5.27, for the bivariate impulse response functions for the Tin and Mining sector, a one standard deviation shock in stock prices causes a long-run negative relationship with exchange rate volatility. In the initial period, exchange rate volatility increases before declining for a short period. This is followed by gradual increases, settling with a short-run cyclical pattern. Figure 5.27 also shows how a one standard deviation shock in the exchange rate volatility has induces largely a long-run negative relationship with the stock prices. The stock prices decline initially before they improve for a short while. Thereafter, stock prices drop, then improve, resulting in a short-run stability beyond period 11.

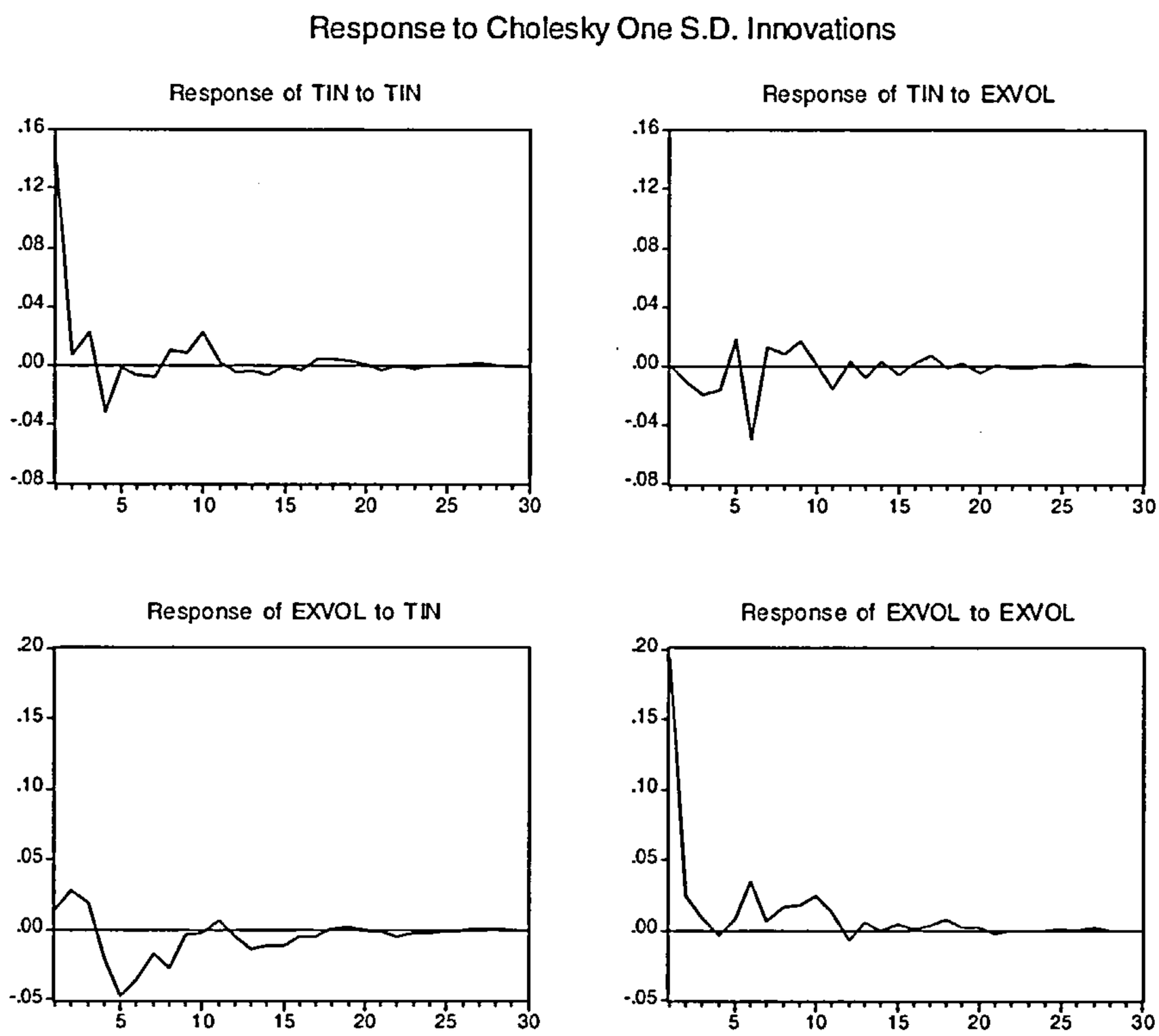

Figure 5.27. Tin and Mining Sector Bivariate Impulse Response: Response of Stock Prices to Exchange Rate Volatility and Response of Exchange Rate Volatility to Stock Prices

As shown in Figure 5.28, for the multivariate impulse response functions for the Tin and Mining sector, a one standard deviation shock in the money supply induces a long-run negative association with the interest rates and long-run inconsistent relationships with stock prices and exchange rate volatility. Interest rates can be seen to have an increasing short-run trend in the early periods before declining beyond period 5. This is followed by a gradual improvement from period 15 onwards. The stock prices seem to decline initially, improve in the next period, and then decline in the next few periods. Beyond period 7 the stock prices are observed to have an inconsistent short-run pattern. A change in the money supply causes exchange rate volatility to increase in the first few periods before briefly declining from period 4. From period 7 onwards, exchange rate volatility seems to have a recurring short-run trend with a largely negative relationship with the money supply.

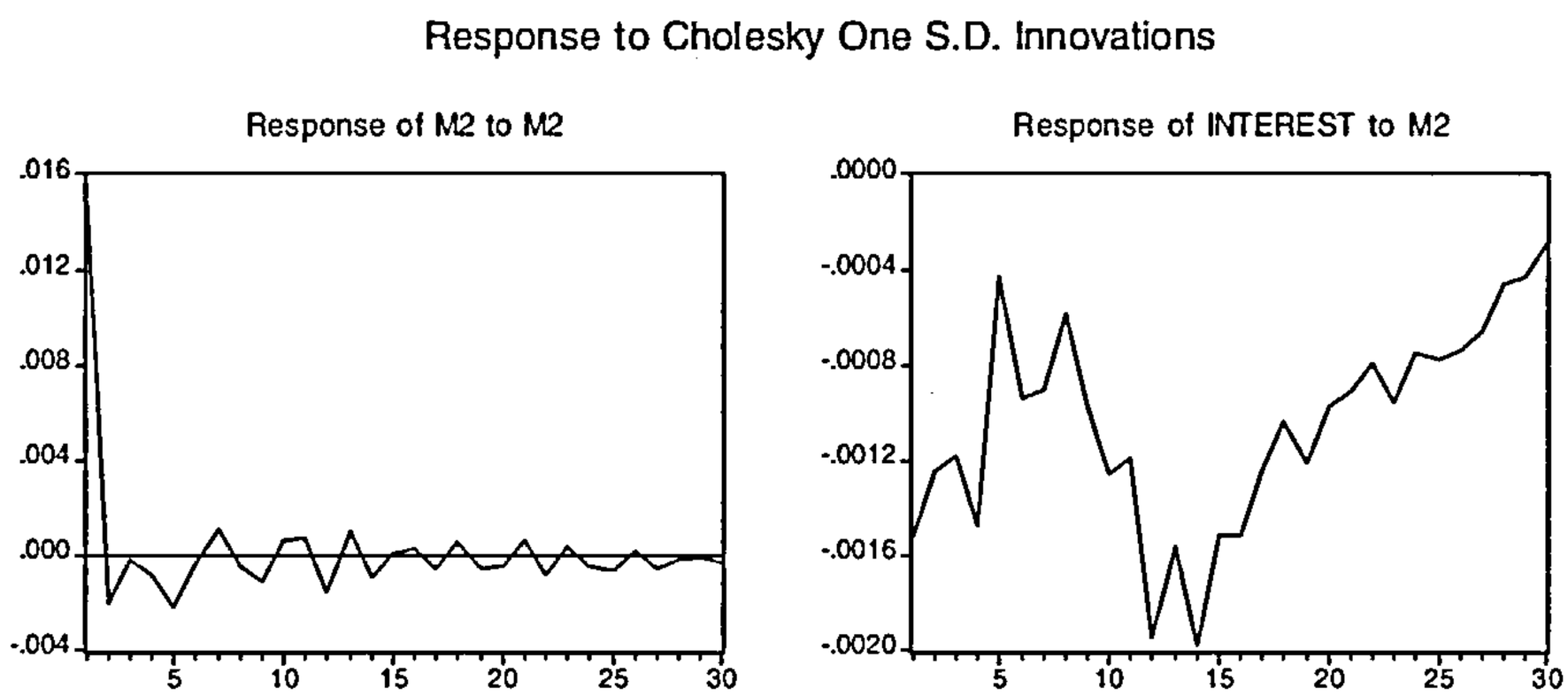

Figure 5.28. Tin and Mining Sector Multivariate Impulse Response: Response of Interest Rates, Stock Prices and Exchange Rate Volatility to Money Supply

As shown in Figure 5.29, a one standard deviation shock in interest rates in the multivariate impulse response framework, causes a long-run positive relationship with the money supply and long-run inconsistent relationships with stock prices and exchange rate volatility. A change in interest rates causes the money supply to have an inconsistent short-run cyclical trend with an increase in the money supply in the initial period. A change in interest rates causes initial decline in the stock prices. This is followed by short term increases before they decline once more for a few periods. Beyond period 6, the stock prices increase and are followed with some weak periods until period 14 when they bounce up and settle with a short-run recurring pattern. The exchange rate volatility decreases in the initial period before increasing briefly, followed by a downward trend in the next few periods. Beyond period 7, exchange rate volatility increases and decreases in a recurring short term trend.

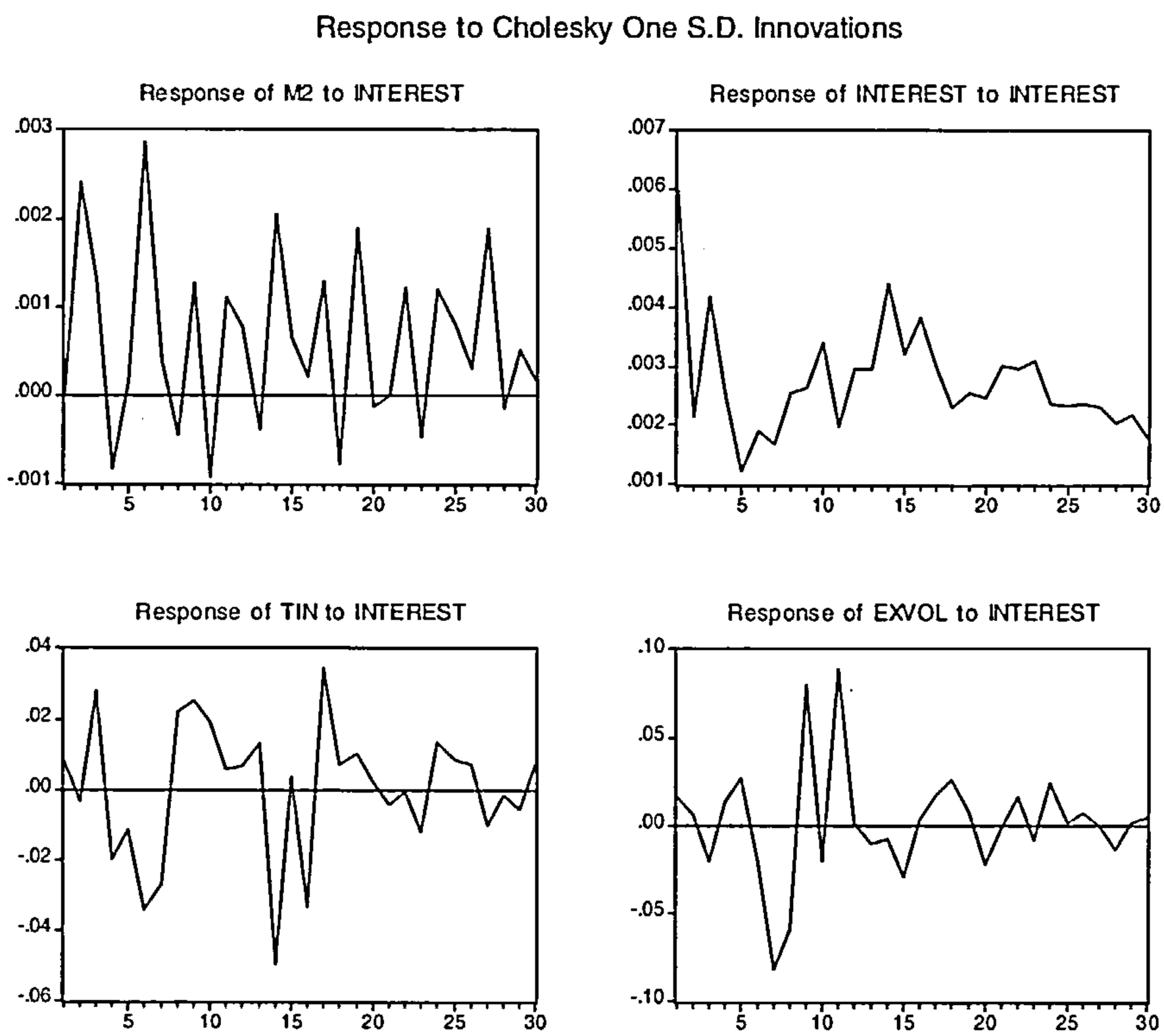

Figure 5.29. Tin and Mining Sector Multivariate Impulse Response: Response of Money Supply, Stock Prices and Exchange Rate Volatility to Interest Rates

The results in Figure 5.30 show how a one standard deviation shock in stock prices for the Tin and Mining sector causes a long-run positive association with the money supply and long-run negative associations with interest rates and exchange rate volatility. The money supply shows a short-run cyclical positive change early on (up to period 10). Thereafter, it declines and settles with an inconsistent short-run recurring trend. For interest rates, the short-run trend is gradually weakening from the initial period (up to period 10) before this reverses, and increasing gradually thereafter. A change in stock prices causes exchange rate volatility to decline initially before improving briefly, followed by another decline until period 5. Beyond period 7, the exchange rate volatility increases before declining briefly in period 11. From period 12, exchange rate volatility increases with a short-run inconsistent relationship thereafter.

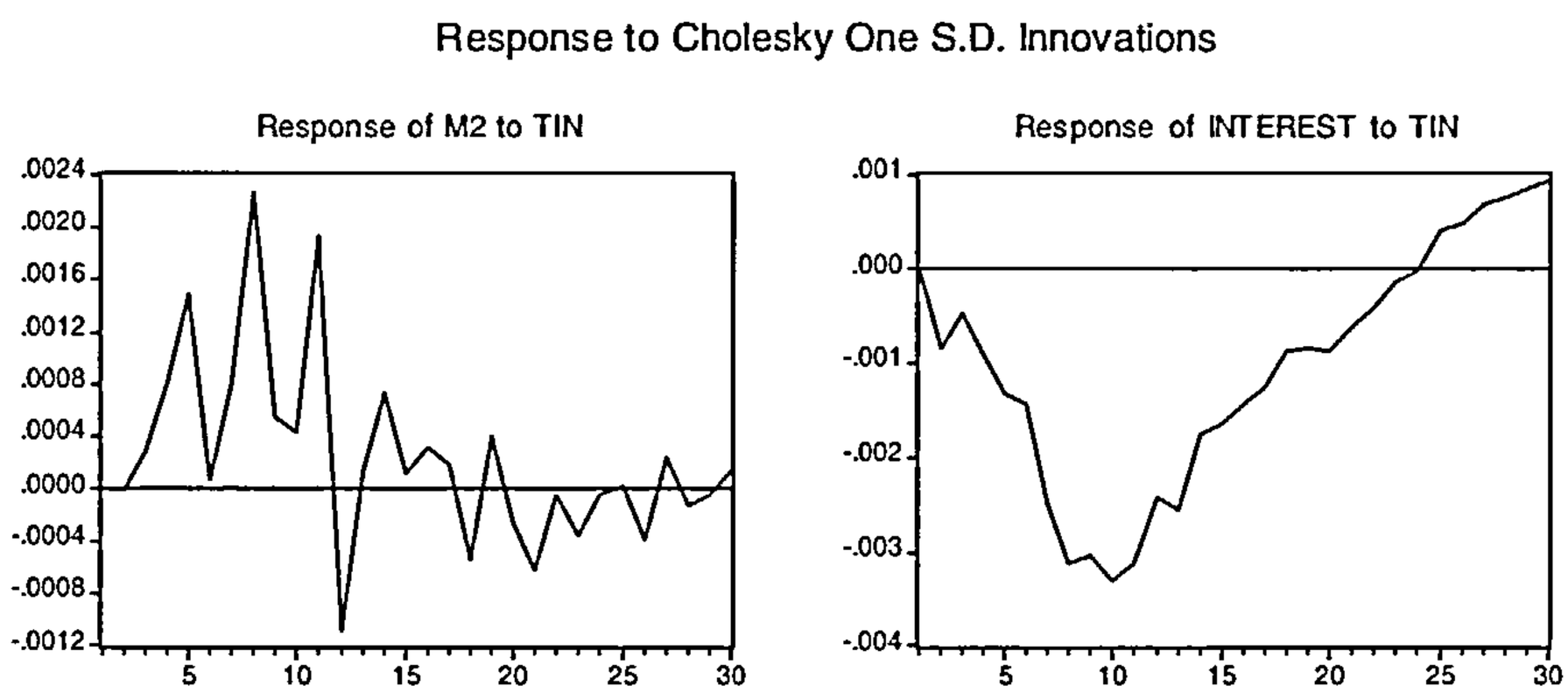

Figure 5.30. Tin and Mining Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Exchange Rate Volatility to Stock Prices

As shown in Figure 5.31, a one standard deviation shock in exchange rate volatility induces a long-run negative relationship between money supply and interest rates, and a long-run inconsistent relationship with stock prices. A change in exchange rate volatility causes an initial decrease in the money supply. This improves slightly in the next 2 periods, before weakening again in periods 4 and 5. Beyond period 5, the money supply increases but then declines in period 8, after which it improves and then settles into a short-run cyclical trend. The interest rates can be seen to have an increasing pattern in the early periods before settling into a gradual decline from period 7 and beyond. A change in exchange rate volatility causes stock prices to decline initially before these begin to improve over the next few periods. In period 5, stock prices decline, and then improve, with a short-run cyclical trend (from period 6 onwards).

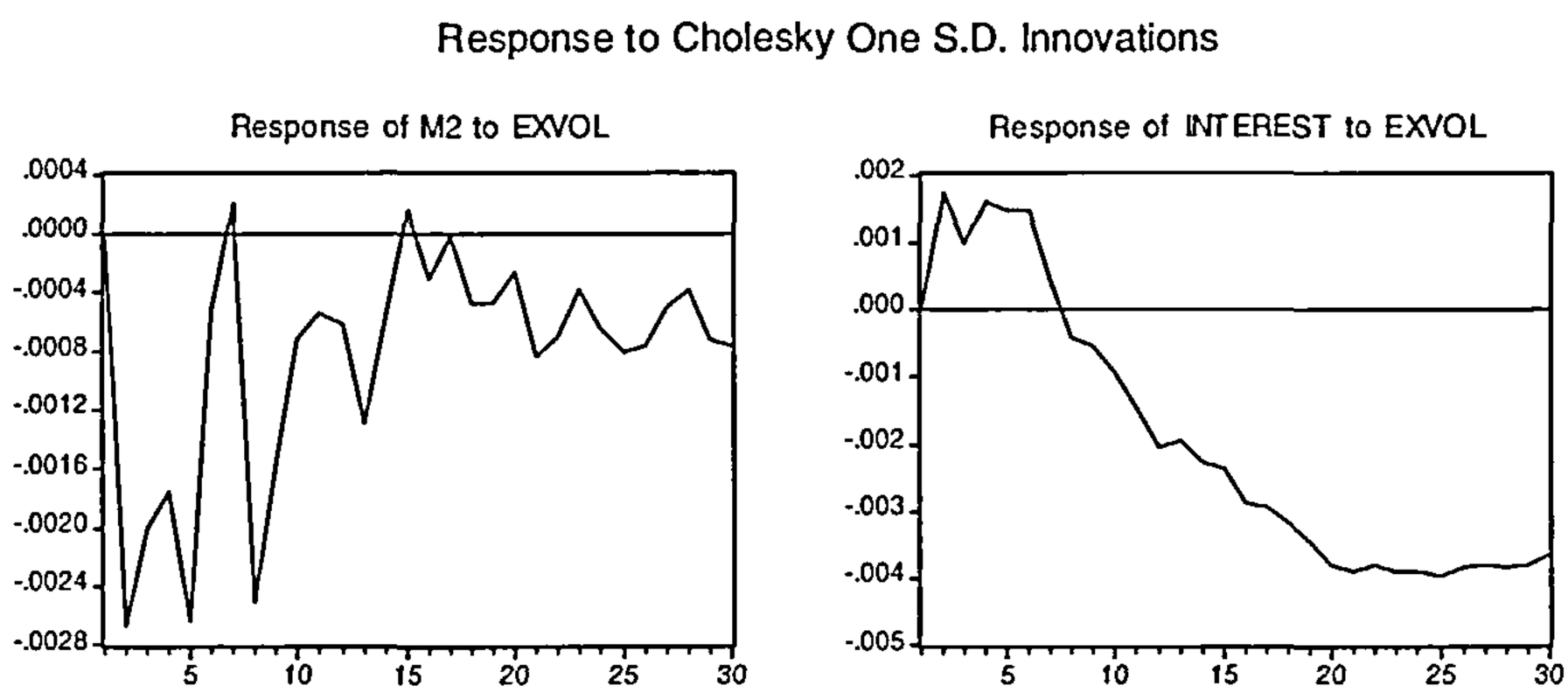

Figure 5.31. Tin and Mining Sector Multivariate Impulse Response: Response of Money Supply, Interest Rates and Stock Prices to Exchange Rate Volatility

4.4 Variance decomposition results

While the impulse response function is used to trace the effects of a one standard deviation shock in one endogeneous variable on other variables within the VAR, variance decomposition detects the extent of any causal relationship (whereby a variable is explained by shocks in all the variables in the VAR). Thus, the variance decomposition provides information about the relative importance of each random shock in affecting variables in the VAR.

4.4.1 Overall stock market variance decomposition

Tables 5.5 and 5.6 show the forecast error variance decomposition of variables in the bivariate and multivariate system, respectively. In the bivariate system, at 24-period ahead horizon, 19.10% of the forecast error variance in the stock prices may be explained by the shock in exchange rate volatility, with stock prices responsible for 20.21% of the forecast error variance in exchange rate volatility during the same period. This shows that the causation runs from the stock prices to exchange rate volatility.

Table 5.5. Bivariate Variance Decomposition: KLCI

		By Innovation in	
Variables Explained	**Periods**	**KLCI (%)**	**Volatility (%)**
KLCI	1	100.00	0.00
	3	97.23	2.76
	6	95.31	4.68
	12	81.62	18.37
	24	80.89	19.10
Volatility	1	5.05	94.94
	3	5.27	94.72
	6	15.75	84.24
	12	19.33	80.66
	24	20.21	79.78

In the multivariate system, at 24-period ahead horizon, 18.28% of the forecast error variance in the money supply may be explained by the shock in interest rates, whereas in the same period, 6.30% of the forecast error variance in interest rates is explained by the money supply. The implications of this are that causation runs from interest rates to the money supply. At the same period horizon, 12.69% of the forecast error variance in the money supply may be explained by the stock prices, with stock prices responsible for 5.24% of the forecast error variance in the money supply. This shows that the stock prices affect the money supply. In the same 24-period ahead horizon, exchange rate volatility explains 7.91% of the forecast error variance in the money supply and the money supply explains 6.78% of the forecast error variance in exchange rate volatility. Thus, based on these findings, we are able to say that the effect runs from exchange rate volatility to the money supply.

Table 5.6 also shows that, at 24-period ahead horizon, 12.88% of the forecast error variance in the interest rates may be explained by the stock prices. At the same time, the interest rates explain 36.15% of the forecast error variance in the stock prices. This observation implies that interest rates affect stock prices. In the same 24-period ahead horizon, 17.06% of the forecast error variance in the interest rates may be explained by the shock in the exchange rate volatility, whereas 54.67% of the forecast error variance in exchange rate volatility is due to the interest in the same period. We could say that the interest rates affect exchange rate volatility and, therefore, the causation is running from interest rates to exchange rate volatility. Finally, at the 24-period ahead horizon, 10.14% of the forecast error variance in the stock prices is due to a shock in exchange rate volatility, but 17.29% of the forecast error variance in the exchange rate volatility can be explained by the stock prices. Based on this, we are able to say that stock prices cause a change in exchange rate volatility.

Table 5.6. Multivariate Variance Decomposition: KLCI

Variables Explained	Periods	M2 (%)	By Innovation in Interest (%)	KLCI (%)	Volatility (%)
M2	1	100.00	0.00	0.00	0.00
	3	90.47	2.05	6.67	0.79
	6	76.81	8.40	9.34	5.42
	12	69.24	11.17	12.20	7.37
	24	61.10	18.28	12.69	7.91
Interest	1	5.40	94.59	0.00	0.00
	3	6.31	89.47	0.68	3.52
	6	6.45	74.26	10.88	8.39
	12	8.37	60.95	25.07	5.59
	24	6.30	63.74	12.88	17.06
KLCI	1	0.04	0.03	99.92	0.00
	3	0.70	1.19	94.94	3.15
	6	1.55	6.56	84.04	7.83
	12	3.71	24.83	60.70	10.74
	24	5.24	36.15	48.45	10.14
Volatility	1	0.23	4.36	0.00	95.39
	3	2.32	10.79	9.13	77.74
	6	3.98	13.66	18.63	63.71
	12	5.84	54.59	17.61	21.95
	24	6.78	54.67	17.29	21.24

4.4.2 Sectoral stock market variance decomposition

4.4.2.1 Industrial sector results

In Table 5.7, we present the results of the bivariate variance decomposition for the Industrial sector. The results show that, at 24-period ahead horizon, 11.26% of the forecast error variance in stock prices in the Industrial sector can be attributed to the shock in exchange rate volatility, whereas 19.47% of the forecast error variance in exchange rate volatility may be explained by stock prices in the Industrial sector. Thus, we are able to say that the effect runs from the stock prices to the exchange rate volatility.

Table 5.7. Bivariate Variance Decomposition: IND

Variables Explained	Periods	By Innovation in IND (%)	Volatility (%)
IND	1	100.00	0.00
	3	96.52	3.47
	6	90.11	9.88
	12	89.14	10.85
	24	88.73	11.26
Volatility	1	0.30	99.69
	3	1.40	98.59
	6	13.23	86.76
	12	18.00	81.99
	24	19.47	80.52

The results of the multivariate variance decomposition for the Industrial sector are shown in Table 5.8. At 24-period ahead horizon, 10.15% of the forecast error variance in the money supply is expressed by a change in the interest rates, whereas the money supply explains 8.33% of the forecast error variance in the interest rates. What this means is that the interest rates affect the money supply and the causation runs from the interest rates to the money supply. At the same 24-period ahead horizon, 8.21% of the forecast error variance in the money supply is explained by the shock in stock prices in the Industrial sector, whereas the money supply explains 2.29% of the forecast error variance in stock prices in this sector. From the result we could imply that the causation runs from stock prices within the Industrial sector to the money supply. We could also see that, in Table 5.8, at the 24-period ahead horizon, exchange rate volatility explains 8.71% of the forecast error variance in the money supply but the money supply explains only 4.79% of the forecast error variance in exchange rate volatility in the same period. Thus, in this case, the causation runs from exchange rate volatility to the money supply.

Table 5.8 also shows how, at 24-period ahead horizon, 9.98% of the forecast error variance in the interest rates is expressed by the shock in stock prices in the Industrial sector, whereas interest rates explain 26.06% of the forecast error variance in stock prices in this sector. From this finding, we could say that the interest rates affect

stock prices in the Industrial sector. In the same 24-period ahead horizon, 25.13% of the forecast error variance in the interest rates is explained by the change in exchange rate volatility, but in the forecast error variance of the exchange rate volatility, interest rates contribute to 46.74% of the variance. This result shows that the causality runs from the interest rates to the exchange rate volatility. Lastly, we also see that at the 24-period ahead horizon, 8.53% of the forecast error variance in stock prices in the Industrial sector may be explained by the shock in exchange rate volatility, and 17.56% of the forecast error variance in the exchange rate volatility is expressed by the stock prices of Industrial sector. This means that the causation runs from stock prices in the Industrial sector to exchange rate volatility.

Table 5.8. Multivariate Variance Decomposition: IND

			By Innovation in		
Variables Explained	**Periods**	**M2 (%)**	**Interest (%)**	**IND (%)**	**Volatility (%)**
M2	1	100.00	0.00	0.00	0.00
	3	94.16	2.15	0.41	3.26
	6	86.51	4.35	3.74	5.38
	12	78.38	5.71	7.96	7.92
	24	72.91	10.15	8.21	8.71
Interest	1	6.87	93.12	0.00	0.00
	3	7.70	87.64	0.38	4.26
	6	7.94	76.05	6.30	9.69
	12	7.41	69.53	16.07	6.97
	24	8.33	56.54	9.98	25.13
IND	1	1.14	1.49	97.36	0.00
	3	1.12	7.85	84.00	7.02
	6	1.52	12.70	75.96	9.80
	12	2.08	19.24	70.06	8.60
	24	2.29	26.06	63.11	8.53
Volatility	1	0.35	3.39	0.00	96.25
	3	0.69	5.18	0.45	93.67
	6	2.14	10.23	22.55	65.06
	12	3.92	46.61	17.19	32.25
	24	4.79	46.74	17.56	30.90

4.4.2.2 *Financial sector results*

As shown in Table 5.9, for the bivariate variance decomposition for the Finance sector, at the 24-period ahead horizon, 10% of the forecast error variance in stock prices in the Finance sector is explained by the shock in exchange rate volatility, whereas stock prices in the Finance sector explain 30.04% of the forecast error variance in the exchange rate volatility in the same period. This shows that the causation runs from stock prices in the Finance sector to exchange rate volatility.

Table 5.9. Bivariate Variance Decomposition: FIN

		By Innovation in	
Variables Explained	**Periods**	**FIN (%)**	**Volatility (%)**
FIN	1	100.00	0.00
	3	92.55	7.44
	6	91.12	8.87
	12	90.13	9.86
	24	89.99	10.00
Volatility	1	1.08	98.91
	3	13.57	86.42
	6	23.69	76.30
	12	28.92	71.07
	24	30.04	69.95

As shown in Table 5.10, for the multivariate variance decomposition for the Finance sector, at the 24-period ahead horizon, 11% of the forecast error variance in the money supply is expressed by the change in the interest rates whereas only 6.01% of the forecast error variance in the interest rates is explained by the money supply in the same period. This shows that the causation runs from the interest rates to the money supply. At the same period horizon, we could see that 9.67% of the forecast error variance in the money supply is expressed by stock prices in the Finance sector but the forecast error variance in the stock prices of this sector is explained by 4.79% of the money supply at the same period. This indicates that the effect runs from stock prices in the Finance sector to the money supply. In the same 24-period ahead

horizon, exchange rate volatility explains 7.11% of the forecast error variance in the money supply and the money supply explains 5.83% of the forecast error variance in exchange rate volatility. Thus, based on these findings, we are able to say that the effect runs from exchange rate volatility to the money supply.

Table 5.10. Multivariate Variance Decomposition: FIN

			By Innovation in		
Variables Explained	**Periods**	**M2 (%)**	**Interest (%)**	**FIN (%)**	**Volatility (%)**
M2	1	100.00	0.00	0.00	0.00
	3	94.44	2.45	1.39	1.70
	6	86.63	5.08	4.81	3.46
	12	77.66	6.46	9.57	6.29
	24	72.20	11.00	9.67	7.11
Interest	1	6.72	93.27	0.00	0.00
	3	6.79	90.36	0.05	2.77
	6	6.59	81.01	7.24	5.13
	12	5.45	67.30	22.05	5.18
	24	6.01	53.10	12.65	28.22
FIN	1	0.94	1.99	97.05	0.00
	3	3.07	6.55	85.70	4.65
	6	3.52	9.66	80.82	5.97
	12	4.80	27.97	62.45	4.76
	24	4.79	32.42	57.68	5.09
Volatility	1	0.52	3.74	0.12	95.60
	3	1.36	5.54	1.30	91.78
	6	4.27	11.40	23.55	60.76
	12	4.84	49.09	19.922	26.13
	24	5.83	49.40	19.927	24.83

Table 5.10 also shows that, at the 24-period ahead horizon, 12.65% of the forecast error variance in the interest rates is explained by stock prices in the Finance sector and 32.42% of the forecast error variance in the stock prices in this sector is expressed by the interest rates for the same period. This finding implies that the causation runs from interest rates to stock prices in the Finance sector. At the 24-period ahead horizon, we could also see that 28.22% of the forecast error variance in the interest rates is caused by the change in exchange rate volatility, and 49.40% of

the forecast error variance in exchange rate volatility is expressed by interest rates for the same period. Thus, we could say that interest rates affect exchange rate volatility. In the same 24-period ahead horizon, we could also see that 5.09% of the forecast error variance in the stock prices in the Finance sector is explained by the exchange rate volatility, whereas the stock prices explain 19.92% of the forecast error variance in the exchange rate volatility. From this finding we may imply that stock prices in the Finance sector affect exchange rate volatility.

4.4.2.3 Plantation sector results

We present the results of the bivariate variance decomposition for the Plantation sector in Table 5.11. At 24-period ahead horizon, 12.10% of the forecast error variance in stock prices in the Plantation sector may be explained by the change in exchange rate volatility, whereas only 7.61% of the forecast error variance in exchange rate volatility is expressed by the shock in stock prices in this sector for the same period. This shows that exchange rate volatility affects the Plantation sector stock prices and that the causation runs from exchange rate volatility to these stock prices.

Table 5.11. Bivariate Variance Decomposition: PLN

		By Innovation in	
Variables Explained	**Periods**	**PLN (%)**	**Volatility (%)**
PLN	1	100.00	0.00
	3	99.03	0.96
	6	89.41	10.58
	12	88.02	11.97
	24	87.89	12.10
Volatility	1	0.15	99.84
	3	1.58	98.41
	6	6.92	93.07
	12	7.51	92.48
	24	7.61	92.38

We present the results of the multivariate variance decomposition for the Plantation sector in Table 5.12. It shows that at 24-period ahead horizon, 9.70% of the forecast error variance in the money supply is caused by a shock in the interest rates, whereas 5.19% of the forecast error variance in the interest rates is explained by money supply for the same period. This result indicates that the causation runs from the interest rates to the money supply. At the same period horizon, 4.95% of the forecast error variance in the money supply is expressed by a shock in the stock prices and 6.67% of the forecast error variance in the stock prices is caused by the change in the money supply. This result shows that the effect runs from the money supply to the stock prices. In the same period, 12.91% of the forecast error variance in the money supply is explained by the shock in exchange rate volatility, but only 4.79% of the forecast error variance in exchange rate volatility is explained by the money supply. Thus, we could say that the causation runs from exchange rate volatility to the money supply.

Table 5.12 also shows that at 24-period ahead horizon, 20.46% of the forecast error variance in the interest rates is expressed by a shock in stock prices in the Plantation sector, whereas 21.97% of the forecast error variance in stock prices in this sector is expressed by the interest rates. This observation indicates that interest rates affect stock prices in the Plantation sector. In the same period, 31.83% of the forecast error variance in the interest rates explains the change in exchange rate volatility, whereas 48.14% of the forecast error variance in exchange rate volatility explains the shock in interest rates during the same period. We could imply that, between exchange rate volatility and the interest rates, it is exchange rate volatility which affects the interest rates. Finally, at the 24-period ahead horizon, we could also see that 5.21% of the forecast error variance in stock prices in the Plantation sector is caused by the change in the exchange rate volatility, and 7.98% of the forecast error variance in exchange rate volatility is explained by the change in stock prices in the Plantation sector. From this we could imply that stock prices in the Plantation sector affect the exchange rate volatility.

Table 5.12. Multivariate Variance Decomposition: PLN

Variables Explained	Periods	M2 (%)	By Innovation in Interest (%)	PLN (%)	Volatility (%)
M2	1	100.00	0.00	0.00	0.00
	3	91.07	2.42	0.29	6.20
	6	81.45	4.82	3.32	10.39
	12	76.82	5.91	4.75	12.50
	24	72.43	9.70	4.95	12.91
Interest	1	7.01	92.98	0.00	0.00
	3	7.91	84.65	0.73	6.68
	6	8.22	66.88	6.77	18.10
	12	6.27	55.45	25.08	13.18
	24	5.19	42.50	20.46	31.83
PLN	1	0.88	0.01	99.09	0.00
	3	3.14	6.24	87.80	2.80
	6	3.53	8.48	82.92	5.05
	12	6.59	11.23	76.57	5.59
	24	6.67	21.97	66.14	5.21
Volatility	1	0.44	2.44	0.08	97.02
	3	0.34	3.72	0.99	94.93
	6	1.78	7.50	5.49	85.21
	12	3.60	47.74	6.93	41.72
	24	4.79	48.14	7.98	39.07

4.4.2.4 Properties sector results

For the Properties stock market analysis, we present the variance decomposition of the bivariate framework in Table 5.13 and the multivariate framework in Table 5.14. In Table 5.13, at the 24-period ahead horizon, 12.47% of the forecast error variance in stock prices in the Properties sector is explained by the shock in exchange rate volatility, whereas 18.99% of the forecast error variance in exchange rate volatility is explained by stock prices in the Properties sector. This shows that stock prices in this sector affect the exchange rate volatility.

Table 5.14 shows that at the 24-period ahead horizon, 10.71% of the forecast error variance in the money supply is expressed by the change in interest rates whereas

5.94% of the forecast error variance in the interest rates is being explained by the change in the money supply in the same period. The result tells us that the interest rates affect the money supply. In the same period, 8.71% of the forecast error variance in the money supply is expressed by a shock in the stock prices, and 4.87% of the forecast error variance in the stock prices is expressed by a change in the money supply. Thus, we could say that the causation runs from the stock prices to the money supply. At the same 24-period ahead time horizon, 8.50% of the forecast error variance in the money supply is caused by the shock in exchange rate volatility but only 4.18% of the forecast error variance in exchange rate volatility is caused by the change in the money supply. We could imply from the result that the exchange rate volatility is causing the money supply.

Table 5.13. Bivariate Variance Decomposition: PRP

		By Innovation in	
Variables Explained	**Periods**	**PRP (%)**	**Volatility (%)**
PRP	1	100.00	0.00
	3	92.33	7.66
	6	89.51	10.48
	12	87.72	12.27
	24	87.52	12.47
Volatility	1	0.19	99.80
	3	9.19	90.80
	6	18.51	81.48
	12	18.73	81.26
	24	18.99	81.00

Table 5.14 also shows that at 24-period ahead horizon, 11.80% of the forecast error variance in the interest rates is expressed by the change in stock prices in the Properties sector and that stock prices in this sector explain 28.66% of the forecast error variance in the interest rates. This result shows that the causation runs from the interest rates to stock prices in the Properties sector. For the same period, 33.65% of the forecast error variance in the interest rates is expressed by a shock in exchange

rate volatility and 48.80% of the forecast error variance in exchange rate volatility is caused by the change in the interest rates. We could say that the interest rates cause a change in the exchange rate volatility. Lastly, in the same period, 7.31% of the forecast error variance in the stock prices is expressed by the change in exchange rate volatility, whereas the stock prices explain 16.46% of the forecast error variance in the exchange rate volatility. This shows that stock prices in the Properties sector affect the exchange rate volatility.

Table 5.14. Multivariate Variance Decomposition: PRP

Variables Explained	Periods	M2 (%)	By Innovation in Interest (%)	PRP (%)	Volatility (%)
M2	1	100.00	0.00	0.00	0.00
	3	94.12	2.39	0.10	3.37
	6	87.92	4.79	2.23	5.04
	12	77.45	6.21	8.712	7.61
	24	72.06	10.71	8.711	8.50
Interest	1	6.14	93.85	0.00	0.00
	3	7.76	88.91	0.04	3.27
	6	9.10	78.60	5.67	6.62
	12	6.92	63.63	22.02	7.40
	24	5.94	48.59	11.80	33.65
PRP	1	1.09	2.55	96.35	0.00
	3	1.76	10.29	80.28	7.65
	6	2.63	14.23	75.07	8.05
	12	4.84	22.56	65.16	7.42
	24	4.87	28.66	59.14	7.31
Volatility	1	0.64	3.82	0.10	95.42
	3	0.66	4.85	1.18	93.29
	6	1.53	11.22	19.13	68.10
	12	3.30	48.44	16.07	32.17
	24	4.18	48.80	16.46	30.55

4.4.2.5 Tin and Mining sector results

As shown in Table 5.15 for the bivariate variance decomposition for the Tin and Mining sector, at 24-period ahead horizon, 17.81% of the forecast error variance in the stock prices is caused by the shock in exchange rate volatility but only 14.35% of the forecast error variance in exchange rate volatility is explained by the shock in stock prices during the same period. The result shows that exchange rate volatility affects stock prices in the Tin and Mining sector.

Table 5.15. Bivariate Variance Decomposition: TIN

		By Innovation in	
Variables Explained	**Periods**	**TIN (%)**	**Volatility (%)**
TIN	1	100.00	0.00
	3	97.43	2.56
	6	84.84	15.15
	12	82.68	17.31
	24	82.18	17.81
Volatility	1	0.55	99.44
	3	3.41	96.58
	6	11.81	88.18
	12	13.47	86.52
	24	14.35	85.64

As shown in Table 5.16 for the multivariate variance decomposition for the Tin and Mining sector, at 24-period ahead horizon, 10.75% of the forecast error variance in the money supply is caused by the shock in the interest rates, whereas the money supply explains only 7.58% of the forecast variance in the interest rates. From such an observation, we could imply that the causation runs from the interest rates to the money supply. In the same period, 4.91% of the forecast error variance in the money supply is expressed by the change in the stock prices, whereas 6.66% of the forecast error variance in the stock prices is caused by the change in the money supply. Thus, we could say that the money supply affects the stock prices. At the same period horizon, 11.03% of the forecast error variance in the money supply is explained by

the shock in exchange rate volatility, but for the same period, only 4.74% of the forecast error variance in the exchange rate volatility is caused by the change in the money supply. This finding shows that the causation runs from exchange rate volatility to the money supply.

Table 5.16. Multivariate Variance Decomposition: TIN

Variables Explained	Periods	M2 (%)	By Innovation in Interest (%)	TIN (%)	Volatility (%)
M2	1	100.00	0.00	0.00	0.00
	3	92.20	3.13	0.03	4.62
	6	84.75	6.13	1.11	7.98
	12	77.74	7.03	4.73	10.47
	24	73.29	10.75	4.91	11.03
Interest	1	6.09	93.90	0.00	0.00
	3	7.78	84.93	1.37	5.91
	6	9.08	73.45	5.91	11.53
	12	8.61	54.05	28.15	9.18
	24	7.58	46.20	15.72	30.48
TIN	1	1.76	0.38	97.84	0.00
	3	2.30	4.62	91.85	1.21
	6	2.76	11.82	79.68	5.72
	12	6.95	18.66	67.34	7.03
	24	6.66	31.37	54.62	7.33
Volatility	1	0.38	2.04	0.08	97.49
	3	0.77	3.85	0.79	94.57
	6	1.83	7.98	12.14	78.03
	12	3.80	47.92	11.67	36.59
	24	4.74	48.86	12.13	34.26

Table 5.16 also shows that at 24-period ahead horizon, 15.72% of the forecast error variance in the interest rates is caused by the shock in the stock prices, whereas 31.37% of the forecast error variance in the stock prices is expressed by the change in interest rates in the same period. We could say that the causal effect runs from interest rates to the stock prices. In the same period, 30.48% of the forecast error variance in the interest rates is explained by the change in exchange rate volatility and the interest rates explain 48.86% of the forecast error variance in exchange rate

volatility. From the finding we could say that interest rates affect exchange rate volatility. Finally, at the same 24-period ahead horizon, 7.33% of the forecast error variance in the stock prices is explained by the change in exchange rate volatility whereas 12.13% of the forecast error variance in exchange rate volatility is expressed by the change in the stock prices. It shows that stock prices of the Tin and Mining sector affect exchange rate volatility.

5 Summary and Conclusion

In this study, we have examined the links between stock prices in the Malaysian market and ringgit Malaysia volatility using a bivariate and multivariate VAR framework of cointegration and Granger causality test, as well as impulse response and variance decomposition estimation. Whilst the existing literature only considers the exchange rate volatility in levels, the approach we have taken allows for interactions in the second moments of the exchange rate using the GARCH model. Furthermore, contrary to the vast majority of studies, we have also looked at the links between stock prices and exchange rates by separate industrial sector instead of simply in the aggregate.

In the overall and sectoral market performance, we reject the null hypothesis of no cointegration in the bivariate and multivariate framework. The results showed that there is a negative long-run relationship between stock market and exchange rate volatility. Examining the Granger causality effect, we found bi-directional Granger causality effects between stock market and exchange rate volatility in an overall analysis of the Malaysian market, for both bivariate and multivariate approaches. In the sectoral market analysis, we found bi-directional Granger causality effect between stock prices and exchange rate volatility in all sectors except in Finance and Properties for bivariate framework. There is a unidirectional effect running from stock prices to exchange rate volatility in these two sectors. When we employed the

multivariate estimation, we also found bi-directional Granger causality effect running between stock prices and exchange rate volatility in all sectors except in Finance. In the Finance sector, the Granger causality runs from stock prices to exchange rate volatility. Based on this Granger causality effect testing, we could infer that a sectors market performs similarly to that of the overall market

Analysing the results of the impulse response functions of the overall market, we found that a one standard deviation shock in exchange rate volatility and stock prices produces a negative short-run relationship within the bivariate framework. In the multivariate estimation, we found the shock in the stock prices has a negative short-run relationship with exchange rate volatility but the exchange rate volatility shock seems to have an inconsistent short-run relationship with stock prices. In the sectoral market, the results are similar to the overall market for bivariate estimation. When we used the multivariate approach, we found that a one standard deviation shock in the stock prices has a negative short-run relationship with exchange rate volatility in all sectors, but a mixed result in the case of exchange rate volatility shock on stock prices.

In the overall market, the variance decomposition results show that stock market prices affect exchange rate volatility for both bivariate and multivariate estimations. The results also show that interest rates affect the money supply, stock prices and exchange rate volatility. Apart from this, money supply is also affected by stock prices and exchange rate volatility. In the sectoral market, the findings of the variance decomposition revealed that stock prices affect exchange rate volatility in the Industrial, Finance and Properties sectors, while exchange rate volatility affects stock prices in the Plantation and Tin and Mining sectors for bivariate framework. For the multivariate framework, the results of the variance decomposition indicated that the effect runs from the stock prices to the exchange rate volatility in all sectors. We also found similar results to the overall market estimation whereby the interest rates affect money supply, stock prices and exchange rate volatility in all sectors. The findings also showed that stock prices affect the money supply in the Industrial, Finance and Properties sectors, while the money supply is found to affect stock

prices in the Plantation and Tin and Mining sectors. Lastly, we found that exchange rate volatility affects money supply in all sectors in this study.

These findings reveal that exchange rate volatility has a negative relationship with the Malaysian stock market and, based on the Granger causality effects and variance decomposition analysis, we could conclude that the Malaysian stock market leads the exchange rate volatility.

References

Abdalla, Issam S.A., and Victor Murinde, 1997, Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan and the Philippines, *Applied Financial Economics* 7, 25-35.

Aggarwal, R., 1981, Exchange rates and stock prices: A study of the US capital markets under floating exchange rates, *Akron Business and Economic Review* 12, 7-12.

Ajayi, Richard A., Joseph Friedman, and Seyed M. Mehdian, 1998, On the relationship between stock returns and exchange rates: Tests of Granger causality, *Global Finance Journal* 9, 241-251.

Ajayi, Richard A., and M. Mougoue, 1996, On the dynamic relations between stock prices and exchange rates, *The Journal of Financial Research* XIX, 193-207.

Bartov, Eli, Gordon M. Bodnar, and Kaul Aditya, 1996, Exchange rate variability and the riskiness of US multinational firms: Evidence from the breakdown of the Bretton Woods system, *Journal of Financial Economics* 42, 105-132.

Bodnar, Gordon M., and William M. Gentry, 1993, Exchange rate exposure and industry characteristics: Evidence from Canada, Japan and the USA, *Journal of International Money and Finance* 12, 29-45.

Bollerslev, Tim, 1986, Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics* 31, 307-327.

Branson, W.H., 1983, Macroeconomic determinants of real exchange risk, in R.J. Herring, ed.: *Managing Foreign Exchange Risk* (Cambridge University Press, Cambridge, MA).

Caporale, Guglielmo Maria, Nikitas Pittis, and Nicola Spagnolo, 2000, Feedbacks between stock prices and exchange rates in the East Asian markets, Department of Economics Working Papers, University of East London (Essex).

Chiang, Thomas C., Sheng-Yung Yang, and Tse S. Wang, 2000, Stock return and exchange rate risk: Evidence from Asian stock markets based on a bivariate GARCH model, *International Journal of Business* 5, 97-117.

Doong, Shuh-Chyi, Sheng-Yung Yang, and Alan T. Wang, 2005, The dynamic relationship and pricing of stocks and exchange rates: Empirical evidence from Asian emerging markets, *Journal of American Academy of Business* 7, 118-123.

Dornbusch, R., and S. Fisher, 1980, Exchange rate and the current account, *American Economic Review* 70, 960-971.

Engle, Robert F., and C.W.J. Granger, 1987, Cointegration and error correction representation, estimation and testing, *Econometrica* 5, 251-276.

Fang, WenShwo, and Stephen M. Miller, 2002, Currency depreciation and Korean stock market performance during the Asian financial crisis, Working Paper 2002, University of Connecticut (Storrs, Connecticut).

Frank, P., and A. Young, 1972, Stock price reaction of multinational firms to exchange realignments, *Financial Management* 307-325.

Gavin, M., 1989, The stock market and exchange rate dynamics, *Journal of International Money and Finance* 8, 181-200.

Granger, C.W.J., Bwo-Nung Huang, and Chin-Wei Yang, 2000, A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu, *The Quarterly Review of Economics and Finance* 40, 337-354.

Gregory, Allan W., and Bruce E. Hansen, 1996, Residual-based tests for cointegration in models with regime shifts, *Journal of Econometrics* 70, 99-126.

Hatemi-J, Abdulnasser, and Eduardo Roca, 2005, Exchange rates and stock prices interaction during good and bad times: Evidence from the ASEAN4 countries, *Applied Financial Economics* 15, 539-546.

Ibrahim, M.H., 2000, Cointegration and Granger causality tests of stock price and exchange rate interactions in Malaysia, *ASEAN Economic Bulletin* 17, 36-47.

Islam, Mazhar M., 2003, Cointegration and the causality between the real sector and the financial sector of the Malaysian economy, *Journal of American Academy of Business* 2, 560-566.

Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* 12, 231-254.

Johansen, S. , and K Juselius, 1990, Maximum likelihood estimation and inferences on cointegration - with application to the demand for money, *Oxford Bulletin of Economics and Statistics* 52, 169-210.

Mishra, Alok Kumar, 2004, Stock market and foreign exchange market in India: Are they related?, *South Asia Economic Journal* 5, 209-232.

Perron, Pierre, 1989, The great crash, the oil price shock and the unit root hypothesis, *Econometrica* 57, 1361-1400.

Phylaktis, Kate, and Fabiola Ravazzolo, 2000, Stock prices and exchange rate dynamics, Working Paper, City University Business School (London).

Smyth, R., and M. Nandha, 2003, Bivariate causality between exchange rates and stock prices in South Asia, *Applied Economics Letters* 10, 699-704.

Soenen, Luc A., and Elizabeth S. Hennigar, 1988, An analysis of exchange rates and stock prices-The US experience between 1980 and 1986, *Akron Business and Economic Review* Winter 19, 7-16.

Solnik, B. H., 1984, Stock and money variables: The international evidence, *Financial Analyst Journal* 69-73.

Solnik, B. H., 1987, Using financial prices to test exchange rate models. A Note, *Journal of Finance* 42, 141-149.

Yucel, Tulay, and Guluzar Kurt, 2003, Foreign exchange rate sensitivity and stock price: Estimating economic exposure of Turkish companies, Working Paper, Dept. of Business Administration Accounting and Finance, Dokuz Eylul University (Buca-Izmir, Turkey).

CHAPTER SIX

FOREIGN DIRECT INVESTMENT IN MALAYSIA AND EXCHANGE RATE VOLATILITY

1 Introduction

Foreign direct investment represents the movement of capital across national borders in a manner that grants the investor controls over the acquired asset. The term *foreign direct investment* or FDI can be viewed from two different but related perspectives: macro and micro. In the macro perspective, FDI refers to the stocks of capital in host countries that are controlled by a home country's owner, or when a home country's owner holds a certain share of voting rights of companies in host countries. In other words, the FDI is, namely, the value of a home country's investment in entities (typically business corporations) and concerns the size of the flows or the value of the investment position. In the micro perspective, however, FDI refers to the actual consequences of doing the FDI - not only to the multinational investors, but also to the home and host countries. These consequences are related to the trade, employment, production and capital created by the investing firm, and its affiliates, through FDI activities.

In both perspectives, FDI can be divided into two types: *Greenfield investment* and *Mergers and Acquisitions*. Greenfield investment refers to direct investment in new facilities or the expansion of existing facilities in a host country. This type of investment would create new production capacity, jobs and transfer of technology and know-how in the host country that can lead to the global marketplace. Mergers and Acquisitions occur when existing assets are transferred from local firms to

foreign firms takes place. The foreign company now has control of the assets and operations and the local company becomes an affiliate of the foreign company. FDI has become an increasingly important economic link between countries (see Table 2.1 in the literature survey chapter for the growth of FDI worldwide). However, since the breakdown of the Bretton Woods fixed exchange rates system, exchange rates have fluctuated widely, adding extra uncertainty to the decision by multinational companies to invest in a foreign market.

In the literature survey chapter, it is mention that the literature exploring the effects of exchange rate variability on FDI is small and relatively inconclusive. Although the impact of exchange rate volatility on FDI has been established, no consensus has been reached. Studies exploring the relationship between exchange rate variability and aggregate investment broadly indicate that aggregate investment is negatively related to the volatility of the exchange rate. In contrast, studies which focus exclusively on FDI tend to find a positive relationship between exchange rate volatility and the flow of FDI.

In light of the indefiniteness of previous empirical work, and the underlying theoretical uncertainty, there is a clear case for an empirical investigation into the effects of exchange rate volatility on investment. Thus this study aims to examine the impact of ringgit volatility on inward foreign direct investment into Malaysia. It is hoped that this study will contribute further to the debate on the relationship between the variability of exchange rates and the FDI. For the past two decades, Malaysia has been receiving a lot of foreign direct investments, the majority of these being in the manufacturing sectors. Even though Malaysia's total foreign investment inflows have generally increased over the years, there have been several periods of slowdowns since the early 1990s. Some of the main reasons for these episodes of decline in FDI inflows are the rise in wage rates in Malaysia relative to other Southeast Asian countries (e.g. Vietnam and Indonesia) and also the aftermath of the Asian currency crisis of 1997.

This study focusses on the aggregated and disaggregated inward FDI to Malaysia for the period covering 1981 through to 2002. It is hoped the aggregate study will reveal the main factors which determine incoming FDI into Malaysia. The disaggregate

study aims to investigate the relationship of FDI into Malaysia from her top four sources, namely, Japan, Singapore, the Republic of Korea and the United States.

2 Foreign Direct Investment in Malaysia

2.1 Overview of the FDI in Malaysia

FDI policies have formed an integral part of overall development strategies in Malaysia. Whether for import substitution (in the 1960s), export promotion (in the early 1970s) or heavy industrialisation (in the 1980s and the 1990s), foreign investors have been welcomed (in certain cases), subject to strict criteria. Malaysia's investment regime is designed to serve the changing needs and directions of the country's industrial policy, and the government has always played an active role in this. By opening itself to foreign direct investment relatively early in the 1960s Malaysia experienced a period of then rapid industrialisation.

Malaysia has been one of the major recipients of FDI amongst the Association of Southeast Asian Nations[1] (ASEAN) countries since the years of regional structural adjustment in the late 1980s. FDI is said to be an important role in capital formation and, hence, in the development of the country's economy. As can be seen in Table 6.1, in the early 1990s, net FDI inflows contributed to almost a quarter of the country's annual Gross Fixed Capital Formation, equivalent to over 8% of the

[1]The Association of Southeast Asian Nations or ASEAN was established on 8 August 1967 in Bangkok by the five original Member Countries, namely, Indonesia, Malaysia, Philippines, Singapore, and Thailand. Brunei Darussalam joined on 8 January 1984, Vietnam on 28 July 1995, Laos and Myanmar on 23 July 1997, and Cambodia on 30 April 1999.

country's GDP. Partly as a result of these FDI inflows, Malaysia was one of the world's fastest growing economies in the 1990s.

Through export-oriented FDI, Malaysia was able to shift quickly towards a manufacturing-based economy where economic growth was driven by rapidly expanding exports. As discussed in Chapter Four, the contribution of manufactured exports to total exports expanded significantly from just 12% in 1970 to more than 70% presently, with this sector now accounting for 32% of Malaysia's GDP. According to Tham (2003), the contribution of foreign involvements to the total value-added of the manufacturing sector increased from 33.4% in 1986 to 44.2% in 1999, and their share of employment has increased from 30.3% to 38.1% during the same period. Due to rapid expansion within the manufacturing sector, Malaysia ceased to be a labour surplus country and began to face labour shortages in the early 1990s. Consequently, this excess demand for labour pushed wages up considerably.

Table 6.1. Trend of FDI in Malaysia, 1991-2002 (RM Million)

Year	Net* FDI in Malaysia	Nominal GDP	FDI as a % of GDP	Gross Fixed Capital Formation (GFCF) in current prices	FDI as a % of GFCF
1991	11,118	135,124	8.2	30,599	23.1
1992	13,088	150,682	8.7	53,497	24.5
1993	14,799	172,194	8.6	63,356	23.4
1994	12,017	195,461	6.1	76,357	15.7
1995	14,586	222,473	6.6	107,825	13.5
1996	18,356	253,732	7.2	121,384	15.1
1997	17,790	281,795	6.3	121,494	14.6
1998	10,648	283,243	3.8	75,982	14.0
1999	14,801	300,764	4.9	65,841	22.5
2000	14,393	342,157	4.2	87,729	16.4
2001	2,105	334,589	0.6	83,345	2.5
2002	12,173	361,597	3.4	86,010	14.2

Note: Net*: Inflows after taking into account the outflows arising from liquidation of FDI in Malaysia and loan repayments to related companies.

Source: Tham (2003)

Malaysia was quick to recognise the powerful role which foreign investors could play in fuelling export-led growth and was well placed to attract foreign investment to the country. The most intense period of foreign investment activity occurred during the late 1980s, when firms from Japan and the Newly Industrialising Economies[2] (NIEs) were looking for production bases abroad to escape appreciating home currencies. At the same time, these NIE countries were losing preferential access to many OECD (Organisation for Economic Co-operation and Development) markets. Table 6.2 shows how total FDI inflows to Malaysia during the period 1980 to 2000 were around 28% of those in developing economies.

Malaysia's role in attracting inward investment during the past two decades is apparent. Being one of the smallest economies in the Southeast Asia region, Malaysia was the first to reach the limits of import substitutions policies, as the market became saturated and economies of scale were limited. Thus, Malaysia was forced to change its development strategies into export promotion strategies and Malaysia's efforts in sustaining this early move to export promotions helped to attract inward investments by export-oriented firms. Furthermore, in the 1980s, Malaysia was able to attract labour-intensive manufacturing companies due to its cheap and abundant labour force. External factors, such as the appreciation of the yen, and the loss of preferential access to major developed markets for the NIEs of Asia, also helped increase inward investment to Malaysia.

In terms of the origin of these inward investments, about two thirds came from within the region itself. Thomsen (1999) reports that Japan and the NIEs contributed evenly to the supply of inward investment in Malaysia, contributing 32% and 34% respectively (followed by the United States at 14% and the European countries at 13%). In terms of FDI inflows by sector, this was dominated by the manufacturing sector, especially for the electrical and electronic projects, with significantly more investment in that sector compared to any other manufacturing activity.

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[2] The NIE countries are: Hong Kong, Republic of Korea, Singapore and Taiwan

Table 6.2. Malaysia's FDI Inflows and Outflows, 1970-2004 (Millions of US dollar)

Period	Amount	% Share to Developing Economies	% Share to Developing Asia
FDI Inflows (recipients)			
1970	94	2.4	11.0
1975	350	3.3	6.6
1980	934	11.0	211.3*
1985	695	4.6	13.0
1990	2,611	7.3	11.5
1995	5,815	4.9	7.2
2000	3,788	1.5	2.6
2004	4,624	2.0	3.1
FDI Outflows (suppliers)			
1970	-	-	-
1975	-	-	-
1980	201	6.0	19.0
1985	210	4.9	7.3
1990	129	1.0	1.2
1995	2,488	4.7	5.9
2000	2,026	1.4	2.5
2004	2,061	2.5	3.0

Note: FDI includes the three following components: equity capital, reinvested earnings and intra-company loans. Data on FDI flows are presented on net bases (capital transactions' credits less debits between direct investors and their foreign affiliates). Net decreases in assets or net increases in liabilities are recorded as credits (with a positive sign), while net increases in assets or net decreases in liabilities are recorded as debits (with a negative sign). Hence, FDI flows with a negative sign indicate that at least one of the three components of FDI is negative and not offset by positive amounts of the remaining components. These are called reverse investment or disinvestment.

The * shows that Malaysia has large percentage share to developing Asia economies in 1980 due to the high negative balance in West Asia reducing the net developing Asia amount in that year.

Source: UNCTAD World Investment Report 2005

Since the economic crisis of 1997, and the persistent downturn of the Japanese economy (Malaysia's major investor) net FDI inflows into the country have declined accordingly. Applications by foreign firms fell 12% in ringgit terms in 1998, after declining 18% in 1997. Given the depth of the economic slump in Malaysia, these declines can be considered moderate and contrast forcefully with the 68% drop in investment applications by domestic companies. The controversial policy of capital

control, implemented by Malaysia in 1998 as a measure to overcome the 1997 Asian financial crisis, was targeted at stemming the flow of short-term volatile portfolio investments but there is no evidence that such a policy affects FDI inflows. This is because the capital control policy did not include controls on current account transactions, or the repatriation of profits, dividends, interest, fees and other incomes. Since the financial crisis, neighbouring countries like Indonesia, the Philippines and Singapore also experienced lower FDI inflows. However, unlike Thailand, Malaysia's financial sector did not bear the large, non-performance loans which led to a spate of mergers and acquisitions, drawing FDI inflows into Thailand.

The post-crisis decline in the FDI inflows prompted Malaysia to take major step to liberalise its investment regime. This was in line with the outcome of the Sixth ASEAN Summit meeting in 1998 which urged members to take drastic measures to facilitate a speedy recovery from the crisis. As a result, Malaysia offered 100% foreign ownership in all manufacturing sectors, without any export conditions, for all new investment projects or expansion/diversification projects applied for by December 31, 2003 - except in 7 activities[3] reserved for local small-medium enterprises. In June 2003, the Ministry of Trade and Industry (MITI) decided to make the liberalisation permanent and the entire Malaysian manufacturing sector is now fully open to foreign investment, with the exception of the seven reserved activities. This effort to liberalise its investment regime paid off, because FDI inflows to Malaysia shot up from 1999 onwards, to more than US$3000 million every year, except in 2001. The decline in 2001 was mainly due to the slow down of the Japanese economy, Malaysia's major investor.

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[3] These activities include metal stamping, metal fabrication, wire harness, printing, paper and plastic packing, plastic injection moulded components and steel service centres.

2.2 The FDI Regime

In Malaysia, the authority responsible for investment regulation and promotion is the Malaysian Industrial Development Authority (MIDA) which resides under MITI. The Malaysian FDI regime is tightly regulated, in that all foreign manufacturing activities must be licensed, regardless of the nature of the business in which they are engaged. The most interesting feature is that Malaysia does not have laws governing the FDI i.e. laws which lay down general principles and rules for foreign participation in the local businesses. Instead it has "Foreign Equity Guidelines" which allow the government maximum policy and regulatory space to screen and control the FDI in order to suit the economic and industrial needs of a particular time. In the past, the size of foreign equity share allowed for investment in the manufacturing sector was based on the share of products being exported (as part of an effort to support the country's export-oriented industrial policy). For example, FDI projects exporting at least 80% of production, or production involving advanced technology promoted by the state, have no equity conditions imposed on them.

As part of the country's long-standing social policy of redistributing wealth in favour of ethnic Malays and other indigenous people, known as *bumiputras*, Malaysia's government has restricted that a portion of the residual corporate equity not held by the foreign investor must be reserved for the *bumiputras*. Only when this equity is not taken up by the *bumiputras* can it be allocated to the *non-bumiputras*. Similar restrictions apply to employment. Indeed, this policy is contrary to the principle of non-discrimination advocated by the World Trade Organisation (WTO), and that of most bilateral and regional trade and investment treaties. However, Malaysia managed to ensure that this particular restriction did not hinder potential FDI flows into the targeted industries by providing attractive incentive packages and world-class infrastructures and facilities, which more than offset any negative impacts. These restrictions were, however, suddenly abolished when MITI decided that the country was in urgent need of the FDI after the aforementioned economic crisis of 1997. Such sudden shifts in policy prove that when economic necessity dictates, Malaysia is able to forego its long-standing socio-political goal of the past three decades.

In terms of protection of foreign investment, foreign investors are theoretically guaranteed by virtue of Article 13 of the Federal Constitution. For a long time, Malaysia took steps to minimize negative incentives such as nationalisation and appropriation, double taxation, joint venture requirements, domestic employment restrictions and restrictions on remittance of profits. As there were no domestic laws setting out general rules or standards on these issues, Malaysia relied extensively on bilateral investment guarantee agreements (IGA) to:

i. Protect against nationalisation and expropriation

ii. Ensure prompt and adequate compensation in the event of nationalisation or expropriation

iii. Provide free transfer of profits, capital and other fees

iv. Ensure settlement of investment disputes between private parties and the Government under the International Convention on the Settlement of Investment Disputes (ICSID) of which Malaysia has been a member since 1966[4]. Besides these IGAs, Malaysia also has bilateral Avoidance of Double Taxation Agreements.

2.3 Investment and Industrial Policy

Malaysia's industrial policy during the 1970s and 1980s was focused on promoting exporting industries. Thus, export performance was used as the main conditional for foreign equity ownership. The greater the percentage of the products exported, the higher the foreign equity share. For example, as mentioned earlier, if projects were exporting more than 80% of their products, then 100% foreign ownership would be allowed. Consequently, foreign activities in Malaysia have been confined to the

[4] Details of the disputes settlement mechanism can be found at the APEC Secretariat web site at www.apecsec.org.sg.

exporting industries, though in 1998 restrictions were lifted in order to stimulate the sluggish FDI inflows that had resulted from the 1997 financial crisis.

In terms of incentives, before the mid 1980s, incentives were based on the investment project. Thereafter, incentives were provided according to the product and activity-base in order to steer investment towards the 12-targeted industries specified in the First Malaysian Industrial Plan (1986-1995). Since then, investment incentives have become much more selective and have changed over time depending on the priority sectors specified in subsequent industrial plans (which focused increasingly on high technology industries, research and development, development of human resources, development of industrial linkages and manufacture of machinery and equipment).

3 Data and Methodology

3.1 Data sources

Annual time series data from 1981 to 2002 was used as our data set. All variables were obtained from the IMF International Financial Statistics (IFS) 2002 CD-ROM and 2001 to 2003 monthly series publication for the data from 2001 and 2002 which was not available on CD-ROM (except for the FDI inflows from source countries and per capita GDP for Malaysia and Singapore). The annual FDI inflows from source countries were extracted from MIDA and the per capita GDP for Malaysia and Singapore were obtained from the Asian Development Bank. Logarithms of the variables were taken so that the coefficients represented the elasticity of FDI inflows with respect to each variable.

As mentioned in earlier chapters, exchange rate volatility is not directly observed. In this study two approaches of exchange rate volatility are also employed, both of which have been applied in the earlier studies. These are the moving average

standard deviation (MASD) of the growth rate of the exchange rate employed by Kenen and Rodrik (1986) and the generalized autoregressive conditional heteroskedasticity (GARCH) model introduced by Bollerslev (1986). These calculations give a measure of the volatility for each month in the sample. Since in this study we apply annual data, we must convert exchange rate volatility into an annual figure. To prevent against any aggregation bias, the annual volatility is obtained by taking the average volatility across the twelve months in each year.

For our aggregate FDI study, the real effective exchange rate is used to calculate the monthly volatility index. The Kenen and Rodrik (1986) measurement of volatility is based on:

$$V_t = \left[\left(\frac{1}{m}\right) * \sum_{i-1}^{m} (\ln ER_{t+i-1} - \ln ER_{t+i-2})^2\right]^{1/2} \tag{1}$$

where m is the order of moving average, while ln implies the logarithmic form of the exchange rate series. To be consistent with our earlier studies, in this paper we will also make use of m equals to 4. As mentioned in earlier chapters, this estimation is employed by Cushman (1983), Cushman (1988) and Aristotelous (2001), amongst others, who have all found significant results in their studies. The underlying GARCH model is a GARCH (0,1) based on an autoregression model of order 1 (AR(1)) of the first difference of the real effective exchange rate index in logarithm (ex_t) which takes the form:

$$\Delta ex_t = \delta_0 + \delta_1 \Delta ex_{t-1} + \varepsilon_t \qquad \varepsilon_t \big| I_{t-1} \sim N(0, h_t^2),$$

$$h_t^2 = \rho_0 + \rho_1 Dum + \rho_2 \varepsilon_{t-1}^2 + \mu_t \tag{2}$$

where Dum_t is the dummy variable to capture the Asian financial crisis. It equals to zero for period up to June 1997 and equals to one in July 1997 and later. The estimated equation is:

$$\Delta ex_t = \underset{(0.116)}{-0.139} + \underset{(0.059)}{0.213} \Delta ex_{t-1}$$

$$h_t^2 = -0.012 + 1.392Dum + 0.334\varepsilon_{t-1}^2 \qquad (3)$$
$$\quad (0.071) \quad (0.873) \qquad (0.149)$$

where the values in the parenthesis represent standard errors and all coefficients in Equation (3) are statistically significant at the 1% significance level.

In our disaggregate FDI study by country, the bilateral real exchange rate is applied to calculate the monthly volatility index. We generated the bilateral real exchange rate series in the same manner as per the earlier chapters. For the calculation of the volatility based on Kenen and Rodrik (1986), we follow the same procedure as in the aggregate FDI study. Based on the GARCH model, our estimation varies from one bilateral RM/foreign currency to another. The mean equation for all bilateral RM/foreign currency exchange rates is based on a constant except for the bilateral RM/Won currency that is based on AR(1) estimation. The results of the GARCH volatility estimations are presented in Table 6.3. In all cases, the dummy variable is dropped since the coefficients for the dummy variable is insignificant.

We test for the adequacy of all the GARCH results for no remaining ARCH effects and for no serial correlations and found both tests did not failed. Based on the AIC criterion and the parameter testing, these models seem to appropriately capture the underlying data generation process, and thus are used as a proxy for one of our exchange rate volatility variables.

Table 6.3. Regression estimates for the GARCH modelling

$$\Delta ex_t = \delta_0 + \delta_1 \Delta ex_{t-1} + \varepsilon_t, \text{where } \varepsilon_t \middle| I_{t-1} \sim N(0, h_t^2),$$

$$h_t^2 = \rho_0 + \rho_1 \varepsilon_{t-1}^2 + \rho_2 h_{t-1}^2 + \mu_t$$

Sample	RM/US$	RM/S$	RM/¥	RM/Won
Mean Equation				
δ_0	0.232	0.166	0.245	0.168
	(0.152)	(0.120)	(0.240)	(0.237)
$\delta_1 \Delta ex_{t-1}$				-0.269
				(0.059)
Variance Equation				
ρ_0	0.092	0.090	0.089	0.095
	(0.054)	(0.074)	(0.210)	(0.091)
$\rho_1 \varepsilon_{t-1}^2$	0.490	0.431	0.309	0.833
	(0.093)	(0.149)	(0.117)	(0.388)
$\rho_2 h_{t-1}^2$	0.509	0.021		
	(0.092)	(0.119)		
$\rho_2 h_{t-2}^2$		0.352		
		(0.159)		
Process	GARCH (1,1)	GARCH (2,1)	GARCH (0,1)	GARCH (0,1)

Notes: The values in parenthesis are the standard errors and all coefficients are statistically significant at 1% significance level.

3.2 Methodology and Variables descriptions

As mentioned earlier, our aim in this study is to capture the impact of exchange rate volatility on FDI inwards to Malaysia using aggregated and disaggregated data. Previous studies have mainly been based on the determinants of inward FDI model (e.g. Froot and Stein (1991), Gorg and Wakelin (2001), Brzozowski (2003), Hara and Razafimahefa (2003) and Kiyota and Urata (2004)). In our aggregate and disaggregate study, we follow a model used in Froot and Stein (1991), Klein and Rosengren (1994) and Kiyota and Urata (2004), modified to allow for analysis of the impact of exchange rate volatility on FDI.

3.2.1 *Aggregate study's model*

In our aggregate study, our model to investigate the relationship between exchange rate volatility and inwards FDI into Malaysia is as follows:

$$\ln FDI_t = \alpha + \beta_1 Vol_t + \beta_2 \ln R_t + \beta_3 \ln GDP_t + \beta_4 \ln Wages_t$$

$$+\beta_5 \ln CPI_t + \beta_6 \ln SH_t + \varepsilon_t \qquad (4)$$

where FDI is the total inward FDI to Malaysia, Vol is the real effective exchange rate volatility, R is the real effective exchange rate (an increase denotes a depreciation of Malaysia's currency), GDP is Malaysian GDP as proxy for the size of the economy, $Wages$ is the per capita GDP as proxy for wages cost, CPI as proxy for inflation or competitive price level, SH is the Kuala Lumpur Composite Index (KLCI) as proxy for the share market index and ε is the error terms. Total inward FDI to Malaysia is taken from the IMF International Financial Statistics. The data is in US dollars, converted into ringgit Malaysia using the annual average nominal exchange rate (also taken from the IMF International Financial Statistics).

Exchange rate volatility, or the instability of the host country's currency, has been extensively found to be a significant impediment for inflows of FDI. Income stream from a highly volatile currency area is associated, in the long run, with high exchange rate risk. This factor is a particular determinant for risk-averse investors since, for a long-run horizon project such as FDI, hedging through the derivative market is not possible. Moreover, exchange rate volatility reduces the certainty equivalent expected exchange rate level and since the latter enters the profit function of the firm, it can be established that larger variability of the exchange rate hinders inflows of FDI. Finally, instability of the host country's currency also discourages repatriation of investment returns and, hence, is detrimental to FDI inflows. β_1 is, therefore, expected to be negative. On the contrary, a positive relationship between FDI inflows and exchange rate volatility might be found in the short-run, if investment in the local market is used as an alternative to exporting. Thus, when variance is judged to be too high, investors will skip the craziness of the currency market in order to engage in FDI in the local market.

In addition to the stability, the strength of the host country's currency measured against the level of exchange rates is also an important determinant. A depreciation of the host country's currency might attract FDI inflows for two main reasons. First, a depreciation of the host country's currency leaves the shares of the host country's firms' relatively cheaper and this might motivate mergers and acquisitions from foreign firms. Secondly, if the aim of FDI was to provide a base for re-exporting back to home or to a third country, the depreciation of the host country's currency would enhance the investors' competitiveness and wealth by producing in the host country. However, if the FDI were intended to sell in the host market, a depreciation of the country's currency might hinder FDI inflows, again for two main reasons. First, since the FDI is a long-term horizon project, the stream of returns on investments might become lower in terms of the home currency's value. Secondly, a depreciation of the host country's currency lowers the relative purchasing power of its consumers. Briefly, the effects of the level of exchange rates on the FDI inflows are rather ambiguous and β_2 could have a positive or a negative sign. In this study, the real effective exchange rate has been used as our variable.

Besides the exchange rate and exchange rate volatility, most of the literature pertaining to the determinants of FDI inflows has included the size of the host market. Market size, measured with the GDP, has been widely found to be an important incentive for FDI. A larger market allows a more efficient utilization of resources and the exploitation of economies of scale, and therefore a higher return to investment. Thus, it is expected that β_3 will be positive. However, the market size might be less influential if the FDI is merely using the host country as a base for production, exploiting the cost advantages of using the host economy to export their production more competitively, to a third or home markets.

One other main attraction of investing in a foreign country is the cheap wages on offer. This factor is particularly determinant for a labour intensive FDI aiming to make FDI a base for re-exporting to home or a third country. An increase in the wages cost in the host country would discourage FDI inflows. In this study, per capita GDP is used to represent the wages cost in Malaysia, since the wages cost data is not available. Using the per capita GDP as a proxy for wages has been applied by

other researchers such as Kiyota and Urata (2004) and Brzozowski (2003), who found statistical significance results in their studies. The problem with using the per capita GDP variable as the implicit measure of wage rates is that it is also intended to measure labour productivity (since wage rates are highly correlated with productivity levels also). High labour productivity is likely to encourage FDI. Therefore, we could not a priori assign a specific sign to β_4.

Another potential determinant of FDI inflows is movement in the level of price. An overwhelming, large increase in prices, or high inflation, might reflect instability in the host country's macroeconomic policy. Such instability creates an uncertain environment for investments. Moreover, high inflation specifically discourages re-exporting FDI, since the relative costs of production in the host country rise. So, we would expect β_5 to be negative. In contrast, a decrease in the level of prices could lead to a reduction in economic activities within the host country, which could result in a deflationary spiral and, eventually, bankruptcy for firms. This might push local investors to sell their ownership in the host country's companies to foreign investors at low prices, which would result in an expansion of the FDI inflows. For our study, we use CPI as the proxy for the price level variable.

One other straightforward determinant of FDI inflows is the cost of acquiring firms already established inside the host country. The cost of acquiring the firms could be proxied with the stock price. The share price represents a direct motive for investing in one country through buying part, or entire ownership of an established firm. Such a practice often occurs through Mergers and Acquisitions. If the share price were high, this would mean that the cost of acquiring the established firm in the host country is high and this would discourage FDI inflows. Therefore, we would expect that β_6 to have a negative sign. In this study, the KLCI is employed as an indicator for the Malaysian share market

Based on the determinants of the inward FDI model, Ordinary Least Squares (OLS) estimations are employed in this study to establish the impact of exchange rate volatility on the total inward FDI to Malaysia.

3.2.2 *Disaggregate study's model*

In the disaggregate study, we examine the impact of exchange rate volatility on inward FDI to Malaysia from her top four sources of FDI inflows, namely, Japan, Singapore, the Republic of Korea and the United States. As reported in Thomsen (1999), the major sources of FDI into Malaysia came from Japan, NIEs and the United States. However, two of the NIEs countries, Hong Kong and Taiwan, are not included in this study due to a lack of sufficient data. This disaggregate study also uses the determinants of the inward FDI model to establish the relationship between exchange rate variability and FDI inflows from the source countries. In this study, panel data techniques are used in regression analysis, which has obvious advantages over other estimation methods. The panel fixed effects model allows one to take into account the specific independent variables of each individual across a cross-section and/or across a time dimension. There are also a few assumptions which could be made regarding specific individual effects, such as individual effect, time effect or individual and time effect. For this study, our panel fixed effects estimation has been based on the individual effects assumption in order to look only at those factors pertaining to each of the countries included in this study. By assuming the individual effects in the model, we assumed that each country's characteristics vary from one another but stay constant over the time periods. Thus, the model is as follows:

$$\ln FDI_{it} = \alpha_i + \beta_1 Vol_{it} + \beta_2 \ln R_{it} + \beta_3 \ln Wages_{it}$$

$$+\beta_4 \ln CumFDI_{it} + \varepsilon_{it} \qquad (5)$$

where FDI_{it} is inward FDI from country i, Vol_{it} is a measure of the volatility of the bilateral exchange rate between Malaysia and country i, R_{it} represents the level of bilateral real exchange rate between Malaysia and country i (an increase denotes a depreciation of Malaysia's currency), $Wages_{it}$ is a measure of the relative wages cost between Malaysia and country i and $CumFDI_{it}$ is the cumulative FDI from country i and ε_{it} is an error term and t is the time period.

In this study, we use a similar specification adopted by Froot and Stein (1991), Klein and Rosengren (1994), Pain and Van Welsum (2003) and Kiyota and Urata (2004) when defining the dependent variable as FDI from country i, FDI_t^i, as a proportion to Malaysia's GDP, GDP_t, in year t. Bilateral exchange rate volatility is expected to discourage FDI from the source country into Malaysia and so β_1 would have a negative sign. As mentioned earlier, the depreciation in the ringgit is an incentive for firms in the source countries to invest in Malaysia – especially if they intend to use Malaysia as a based for re-exporting! On the other hand, depreciation might hinder FDI inflows if the firms in the source countries fear that the stream of returns in the long-run might become lower in terms of their home currency's value. Thus, β_2 could have a positive or a negative sign.

The relative cost of wages between Malaysia and the source countries is measured in terms of the ratio of wages cost in Malaysia, $Wages_t$, to the wages cost in the source countries, $Wages_t^i$, in year t. For the wages variable, the labour cost as reported in the IMF International Financial Statistics for the United States, Japan and the Republic of Korea is used, while the per capita GDP data is used as a proxy for the wages cost in Malaysia and Singapore since labour cost data is not available for these two countries. Higher wages cost in a host country would discourage FDI inflows and so β_3 could be expected to be negative.

Lastly, the cumulative FDI variable is used to capture the agglomeration effects (important for potential investors looking to find ample business opportunities in a host country with a huge FDI stock). The cumulative FDI from country i is the stock of FDI and measured by the sum of the cumulative FDI from 1980 to year $t-1$. Therefore, the sign for β_4 is expected to be positive.

4 Empirical Results and Analysis

4.1 Aggregate study

Some attention should be paid to the lag structure of the inwards FDI position. Direct investment requires a considerable amount of commitment, as once an investment is made, the multinational firm cannot recoup the costs of investment through divestiture. As such, a unit root in inward FDI position is likely. In order to specify our model, we start by testing for the existence of a unit root in each variable using the Dickey-Fuller GLS (DF-GLS) unit root test developed by Elliot, Rothenberg and Stock (1996). This unit root test has been employed by other researchers in this area, such as Hara and Razafimahefa (2003) and Foad (2005). Elliot, Rothenberg and Stock (1996) proposed point-optimal tests of a unit root in the autoregressive representation of a Gaussian time series under various trend specifications. A modified version of the Dickey and Fuller (1981) t test is proposed which has substantially improved power when an unknown mean or trend is present. A Monte Carlo experiment indicates that the modified test works well in small samples.

If we fail to reject a unit root on the dependent variable in Equation (4), then the dependent variable must be differenced. In doing so the effect of exchange rate volatility on *inflows* of FDI to Malaysia will be tested. If we reject a unit root on the dependent variable, then we are testing the effect of exchange rate volatility on *levels* of FDI to Malaysia. Both the intercept and intercept and trend assumptions were used when carrying out the unit root tests. Results of the tests for each of the variables are given in Table 6.4. In both assumptions, the results showed that the FDI, GARCH volatility and MASD volatility variables are stationary, I(0); while the other variables are non-stationary, I(1).

Table 6.4. Dickey-Fuller GLS Unit Root test: Aggregated inward FDI into Malaysia

Variables	Intercept		Intercept and Trend		Order of Integration
	t -statistics	Lag length	*t* -statistics	Lag length	
FDI	-2.678**(-2.247**)	3	-3.666**(-2.069)	3	I(0)
GARCH Vol.	-3.615*(-6.378*)	0	-4.100*(-6.387*)	0	I(0)
MASD Vol.	-3.834*(-6.093*)	0	-4.184*(-6.153*)	0	I(0)
REER	-0.867(-3.553*)	0	-2.626(-3.218**)	1	I(1)
GDP	-0.050(-2.181**)	3	-2.178(-3.230**)	1	I(1)
Wages	-0.661(-2.855*)	3	-2.407(3.170**)	3	I(1)
CPI	0.372(-2.495**)	1	-2.766(-3.271**)	2	I(1)
Share Market	-1.504(-5.106*)	0	-2.592(-5.452*)	0	I(1)

Notes: The null hypothesis is that the series is I(1). Critical values are tabulated in Elliot, Rothenberg and Stock (1996). The *t* -statistics for the first difference of each variable is shown in parenthesis. *(**) indicates rejection is significant at statistic level at 1%(5%). The optimal lag length is chosen by the Akaike Information Criteria.

From the DF-GLS unit root test results in Table 6.4, all independent variables are introduced in first difference form in Equation (4), except for the exchange rate volatility variable. Thus, Equation (4) will be re-estimated as follows:

$$\ln FDI_t = \alpha + \beta_1 Vol_t + \beta_2 \ln \Delta R_t + \beta_3 \ln \Delta GDP_t + \beta_4 \ln \Delta Wages_t$$

$$+ \beta_5 \ln \Delta CPI_t + \beta_6 \ln \Delta SH_t + \varepsilon_t \qquad (6)$$

We estimated the model by OLS estimation. First, the full model was estimated using the entire sample period, and two different measures of exchange rate volatility. The results are presented in the Benchmark model column in Table 6.5. Next, the insignificant variables were successively dropped and the final results displayed in the Specific Model column in Table 6.5. Our main findings of the aggregate studies are put forward as follows.

Table 6.5. OLS Regression results for Aggregated Inward FDI. Dependent Variable: $\ln FDI$

Independent Variables	Benchmark Model	Specific Model
GARCH Volatility		
Constant, α	7.63(0.00)*	7.81(0.00)*
Vol, β_1	0.16(0.03)**	0.15(0.01)*
$\ln \Delta R$, β_2	5.68(0.07)***	6.60(0.01)*
$\ln \Delta GDP$, β_3	3.09(0.47)	
$\ln \Delta Wages$, β_4	6.52(0.03)*	7.63(0.00)*
$\ln \Delta CPI$, β_5	-1.91(0.82)	
$\ln \Delta SH$, β_6	0.09(0.88)	
R^2	0.55	0.51
BG-LM Test	2.39(0.11)	1.79(0.09)
ARCH –LM Test	0.39(0.75)	1.21(0.34)
MASD Volatility		
Constant, α	7.49(0.00)*	7.61(0.00)*
Vol, β_1	0.66(0.02)**	0.64(0.00)*
$\ln \Delta R$, β_2	6.77(0.04)**	7.43(0.00)**
$\ln \Delta GDP$, β_3	2.43(0.57)	
$\ln \Delta Wages$, β_4	6.73(0.03)**	7.55(0.00)**
$\ln \Delta CPI$, β_5	-2.83(0.73)	
$\ln \Delta SH$, β_6	0.12(0.85)	
R^2	0.57	0.54
BG-LM Test	2.03(0.16)	1.43(0.27)
ARCH –LM Test	0.63(0.60)	1.31(0.30)

Notes: The *, ** and *** denote statistically significant at 1%, 5% and 10%, respectively. P-values are in the bracket.

First, the exchange rate volatility does not discourage inward FDI into Malaysia, though most of the literature in this area suggested the opposite! For both types of exchange rate volatility, the results showed that exchange rate volatility has a positive significant relationship with inward FDI into Malaysia, even though the positive impact is very minimal. When the variables were controlled, by being more specific in the model, the results slightly improved and the exchange rate volatility still showed a positive significant impact on inward FDI into Malaysia. The results,

therefore, can be considered to be quite robust. Theoretically, exchange rate volatility should impede inward FDI, but the minimal positive relationships between exchange rate volatility and inward FDI into Malaysia might be found in the short-run projects, particularly those projects that are used as a substitute to exporting. This is what has been happening in Malaysia since the mid-1990s as more foreign companies set up in Malaysia to serve the Malaysian market and the East Asian region (taking advantage of the ASEAN Free Trade Area (AFTA)[5] agreed and implemented by ASEAN in January 2005).

Second, in line with most of the literature concerning exchange rates and inwards FDI, the results revealed that depreciation in the real effective exchange rates encourages inward FDI into Malaysia. The coefficients of the real effective exchange rates in both the benchmark and specific models are found to be significantly positive in the case of the MASD and GARCH volatility measures. Theoretically, it is stated that depreciation in the host country's currency would attract inward FDI, if the FDI is aimed as a base for re-exporting back home or to a third country, and would hinder inward FDI if the FDI is intended to sell in the host market. In line with its objective of becoming an industrialised country, Malaysia has adopted an export-oriented FDI regime and this can be seen through the many FDI projects centred in the manufacturing sectors (such as electrical and electronic products).

Next, the results on the size of the Malaysian economy in the benchmark model appear to have a positive insignificant relationship with inward FDI into Malaysia. These insignificant results are found for both types of exchange rate volatility measurement. In most of the literature about the determinants of FDI inflows, the market size of the host country is considered to be an important incentive for FDI. However, it is noted that the market size might be less influential if the FDI is only using the host country as a production base from which to export their production, more competitively, to a third or home markets. This is exactly the scenario found in the Malaysian FDI inflows. As we mentioned earlier, FDI projects in Malaysia are

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[5] Further information on AFTA can be found at the ASEAN Secretariat web site at www.aseansec.org

mostly export-oriented projects as opposed to for the domestic usage. In summary then, it could be said that the size of the Malaysian market is not an important factor in determining the inflows of FDI into Malaysia.

Somewhat surprisingly, our results of this study revealed that inward FDI into Malaysia appear to be positively affected by wages costs. For both measures of exchange rate volatility, the benchmark model showed that wages costs are significantly positive at 5% level. Moreover, even in the specific model, the results showed that wages costs improved to 1% significant level. This is a surprise, as we would expect a multinational firm to increase production when labour costs fall, and to decrease production when labour costs rise. However, as mentioned earlier, when per capita GDP is used as a proxy for wages costs, there are two possible explanations for these positive results: increased productivity and skill-intensive production by multinationals. This is what has happened in Malaysia. The contribution of manufactured exports to total exports has increased from 12% in 1970 to more than 70% now, with an increase in both inward FDI and the nominal cost of labour likely. It may also be the case that the majority of foreign affiliates demand skilled labour to work in their manufacturing companies, especially those in the electrical and electronic projects.

As per existing literature, we also found a negative relationship between inward FDI into Malaysia and the price level or inflation rate in Malaysia, though this was found to be insignificant for both measures of exchange rate volatility. An increase in prices or high inflation is associated with instability of the macroeconomic policy of the host country, which would discourage inward FDI, specifically re-exporting FDI (as in the case of Malaysia), because the relative costs of production in the host country rise. Since the results showed that the coefficients of the price level are insignificant, it may be concluded that the level of prices is not a key determinant factor for inward FDI into Malaysia.

Lastly, the results of the share price coefficients are found to have a positive insignificant relationship with inward FDI into Malaysia. The share price, which could represent the cost of acquiring local firms and be a direct motive for investing

in the host country through Mergers and Acquisitions, does not seem to be an important determinant factor of FDI inflows (in the case of Malaysia).

4.2 Disaggregate study

As mentioned above, for our disaggregate study, we employed the panel fixed effects model estimation to investigate the relationship between inward FDI into Malaysia from her main top suppliers. A recent study by Baltagi (2001) noted two potential problems concerned with macro panel study. One is the heterogeneity of the regression parameters across countries and the other is the non-stationarity of the panels. To deal with these two issues, we conducted a panel-based unit root test proposed by Im, Pesaran and Shin (2003) (IPS), which can be applied whenever the panel data are heterogeneous. Their test statistic is constructed by averaging the statistics from the augmented Dickey-Fuller (ADF) tests with the following equation:

$$y_t^i = \gamma_t Trend_t^i + \rho_i y_{t-1}^i + \sum_{j=1}^{p^i} \varphi_{ij} \Delta y_{t-j}^i + \varepsilon_t^i \tag{10}$$

where y_t^i is a variable under consideration, $\Delta y_{t-s}^i = y_t^i - y_s^i$ and ρ^i is a lag. The null hypothesis is that all the series in the panel contain a unit root $(\rho_i = 1)$ while the alternative hypothesis is that at least one of the series in the panel is stationary ($\rho_i < 1$ for at least one country). The IPS t-bar test statistic is constructed by averaging the ADF t-statistic as:

$$\bar{t} = \frac{1}{N} \sum_{i=1}^{N} t_{\rho_i} \tag{11}$$

where t_{ρ_i} is the ADF t-statistic for country i and N represents the number of countries. Although other panel unit root tests have been proposed such as Levin, Lin and Chu (2002), the IPS method imposes fewer restrictions in the sense that it allows ρ to be heterogeneous across countries. Therefore IPS tests were used in this study to examine the non-stationarity of the panels.

Table 6.6 presents the results of the panel unit root tests. The figures indicate the value of the t-bar. The test results showed that most variables, except the exchange rate volatility, do not reject the null hypothesis that the series are non-stationary.

Table 6.6. IPS Panel Unit Root test t-statisitics: Disaggregated Inward FDI into Malaysia

Variables	Intercept	Intercept and Trends
FDI	-1.09(0.14)	-0.46(0.32)
GARCH Volatility	-4.93(0.00)*	-3.47(0.00)*
MASD Volatility	-4.84(0.00)*	-3.43(0.00)*
Real Exchange Rate	-1.23(0.11)	-0.42(0.33)
Relative Wages	1.04(0.85)	-2.37(0.00)*
Cum FDI	-4.18(0.00)*	1.16(0.87)
GDP	-0.88(0.19)	2.16(0.98)

Notes: Null hypothesis is that each series of the countries contains unit root while alternative hypothesis is that at least one of the countries is stationary. Figures indicate ADF t-statistics. The * (**) indicate statistically significant at 1% (5%) respectively.

The next step is to test for panel cointegration using the Pedroni (2004) approach among the variables in Equation (5). Pedroni's (2004) approach is chosen because of its power performance, even in the case of small sample size data. Pedroni's (2004)[6] panel cointegration test is based on the residual-based tests that allow information regarding common long-run relationships from across the panel to be pooled, while allowing the associated short-run dynamics and fixed effects to be heterogeneous

[6] This is Pedroni's latest version on the panel cointegration work. Earlier versions of this work are Pedroni, Peter, 1995, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis, Indiana University Working Papers in Economics., Pedroni, Peter, 1997, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis: New results, Indiana University Working Papers in Economics. and Pedroni, Peter, 2001, Panel cointegration: Asymptotic and finite sample properties of pooled time series with an application to the PPP hypothesis. Revised working paper, Indiana University Working Papers in Economics.

across different members of the panel. The null hypothesis of the panel cointegration test is that, for each member of the panel, the variables are not cointegrated. The alternative hypothesis is taken to be that, for each member of the panel, there exists a single cointegrating vector. Pedroni's panel cointegration test also allows the dynamics and fixed effects to differ across members of the panel and, under the alternative hypothesis, the cointegrating vector may differ across members.

In the tests for the null of no cointegration in the panel, the regression residuals from the hypothesized cointegration regression are computed, which generally take the form:

$$y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \ldots + \beta_{Mi} x_{Mi,t} + e_{i,t}$$

$$\text{for } t = 1,\ldots,T \quad i = 1,\ldots,N \quad m = 1,\ldots,M \tag{12}$$

where T refers to the number of observations over time, N refers to the number of individual members in the panel and M refers to the number of regression variables. The parameter α_i is the member-specific intercept, which is allowed to vary across individual members. The slope coefficients $\beta_{1i}, \beta_{2i}, \ldots \beta_{Mi}$ are also permitted to vary across individual members of the panel. The deterministic time trends $\delta_i t$, which are specific to individual members of the panel may also be included, if required.

Pedroni considers two classes of statistics: panel cointegration (or within-dimension-based) and group mean panel cointegration (or between-dimension-based) statistics[7]. The usage for these statistics is the same as for the single series case where the statistics are compared to the appropriate tails of the normal distribution. For the panel variance statistics, large positive values indicate rejections, whereas for the

[7] For further discussion on these statistics, see Pedroni, Peter, 2004, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Revised working paper, *Econometric Theory* 20, 597-625.

panel-rho and panel-t statistics, large negative values indicate rejections of the null hypothesis of no cointegration.

In carrying out the panel cointegration tests, both the intercept and intercept and trend assumptions were used. Results of the tests for both types of exchange rate volatility are presented in Table 6.7. Our main findings for both assumptions showed that the null hypothesis of no cointegration cannot be rejected, even at 10% significance levels in the case of both measures of volatility, when both panel and group mean panel cointegration statistics are considered.

Table 6.7. Pedroni's Panel Cointegration test results: Disaggregated Inward FDI into Malaysia

Statistics	Intercept	Intercept and Trends
GACRH Volatility		
Panel variance-stat	1.940*	0.676
Panel rho-stat	-0.006	0.618
Panel t-stat	-1.482	-1.314
Panel adf-stat	-1.735	-1.705
Group mean rho-stat	0.613	1.151
Group mean t-stat	-1.620	-1.431
Group mean adf-stat	-2.306*	2.376*
MASD Volatility		
Panel variance-stat	1.957*	0.698
Panel rho-stat	-0.022	0.610
Panel t-stat	-1.541	-1.357
Panel adf-stat	-1.679	-1.644
Group mean rho-stat	0.577	1.125
Group mean t-stat	-1.731	-1.526
Group mean adf-stat	-2.202*	-2.274*

Notes: All of the panel and group mean statistics have been standardized so that they are distributed as N(0,1) under the null hypothesis. An asterik indicates rejection at the 5% level or better.

Since there is no cointegration relationship, econometric theory dictates that estimating Equation (5) using only first differences of the series is the right approach. OLS estimations were used in this study to estimate the model. The results for the

panel individual fixed effects estimation with the two different measures of exchange rate volatility are presented in Table 6.8.

Table 6.8. Regression results for panel study of Disaggregated Inward FDI into Malaysia.

Variables	GARCH Volatility	MASD Volatility
Constant	-5.33(0.00)	-5.17(0.00)
Volatility	0.001(0.39)	-0.02(0.57)
Real Exchange Rate	1.77(0.02)**	1.71(0.02)**
Wages	-1.19(0.02)**	-1.17(0.02)**
Cumulative FDI	0.23(0.07)***	0.26(0.06)***
R^2	0.76	0.76

Notes: Method of estimation: OLS, panel individual fixed effects model. t −statistics computed with the use of White Heteroskedasticity-consistent standard errors. P-values are in the brackets. The *, ** and *** denote statistically significant at 1%, 5% and 10%, respectively.

The estimated coefficients of the bilateral exchange rate volatility in the panel study are found to be insignificant for both types of volatility measures. The results showed that exchange rate volatility has a positive and a negative insignificant relationship with disaggregate inward FDI into Malaysia (in the case of GARCH and MASD volatility measures respectively). Theoretically, exchange rate variability would discourage inward FDI if investors are risk averse and associate high risk with exchange rate variability in long-run projects such as FDI, and would encourage inward FDI if they used the local market as a substitute to exporting. From these insignificant results it could be concluded that exchange rate volatility is not an important factor for all countries in the panel study when deciding whether or not to invest in Malaysia. The results seem to support the results from the aggregate study which showed a positive significant relationship between exchange rate volatility and aggregate inward FDI into Malaysia. As we mentioned earlier, the bulk of inward FDI into Malaysia came from these four countries. Thus, an indifferent attitude towards the risks associated with exchange rate volatility may be expected, when these countries are making the decision to invest in Malaysia.

In line with most literature about exchange rate and inward FDI, the results in this panel study showed that depreciation in the bilateral real exchange rates encourages inward FDI into Malaysia from these four countries. The coefficients of the bilateral real exchange rate are found to be significantly positive for both types of volatility measures. These results are similar to the results of the aggregate study. It is stated that when a host country is used as a base for re-exporting to home country or a third country, depreciation in the host country's currency attracts foreign investors to the host country. This is the scenario with the countries in the panel study. They have set up their production facilities in Malaysia and export the finished products back to their home countries or to third countries. Some examples of multinational companies from these countries operating in Malaysia are Sony, Phillips, Texas Instruments, Motorola and Samsung.

Cheap wages in the host country is an incentive to foreign investors, particularly for a labour intensive FDI. An increase in the wages cost in the host country would discourage FDI inflows. In this study, the coefficients of the relative wages costs variable appeared to be significantly negative, in line with the theory. The results imply that the countries used in the panel study do consider this factor when making a decision to invest in a foreign country, especially in labour intensive projects. That is why in the late 1990s and early 2000 periods, the amount of inward FDI from these countries into Malaysia dropped due to shortage of labour and high wages costs. However, these results contradict those from the aggregate study. As mentioned earlier, there are two possible explanations for the positive relationship between wages cost and inward FDI in the aggregate study: increased productivity and skill-intensive production by multinationals.

The cumulative FDI variable is used to capture the co-location or agglomeration effects. Co-location or agglomeration effects are said to have a greater influence on multinational firms' location choices due to the presence of spillover effects from being located near to other plants in the same industry (see Head, Ries and Swenson (1995), Ellison and Glaeser (1997) and Devereux, Griffith and Simpson (2004)). In this study, the coefficients of the cumulative FDI variables appeared to be positive, but only at 10% significance level for both measures of exchange rate volatility. This

showed that the existence of other multinational firms is not an important factor for foreign firms when deciding to invest in Malaysia. The results are in line with the theory that agglomeration effects have a positive relationship with inward FDI into a country. This can be seen in Malaysia where most multinational companies are from Japan, the United States and the Republic of Korea. Since the significant level of the coefficients is low, it may be concluded that the main factor which attracted foreign firms to invest in Malaysia was not, perhaps, the existence of other firms but the sound economy in Malaysia and good investment incentives provided by the Malaysian government.

5 Summary and Conclusion

In this study, we examined the impacts of the exchange rate and its volatility on inward FDI into Malaysia at the aggregated and disaggregated, by country, level. The responsiveness of inward FDI to exchange rate volatility is a crucial issue because of the benefits which FDI brings to the host countries, such as job creation, transfer of technology and managerial know-how resulting in improved productivity and the development of infrastructure. These benefits are important, especially for a developing country such as Malaysia, which is aiming to become an industrialised country by the year 2020. Our focus in this study is on inward FDI into Malaysia covering the period 1981 through to 2002. We applied the moving average standard deviation (MASD) and the generalized autoregressive conditional heteroskedasticity (GARCH) measures of exchange rate volatility, with the real effective exchange rate used in the aggregate study and the bilateral real exchange rate used in the disaggregate study.

In the aggregate study, we aim to determine whether exchange rate volatility discourages inward FDI into Malaysia and also which are the factors that would attract incoming foreign investors to Malaysia. Based on OLS estimations, our

results of the study revealed that exchange rate uncertainty has a positive significant impact on inward FDI into Malaysia. Therefore, we could conclude that exchange rate volatility does not discourage foreign investments into Malaysia (unlike the conclusions of most of the other literature in this area). In terms of the factors which would attract incoming foreign investors to Malaysia, depreciation in exchange rate and wages costs were found to have a positive significant relationship, market size and market shares had a positive insignificant relationship, with price level having a negative insignificant relationship. Based on these results, we could summarize that depreciation of ringgit and abundant skilled labour are the factors which attract inwards FDI into Malaysia.

In the disaggregate study by country, we aim to analyse the impact of exchange rate volatility into Malaysia from four sources - Japan, Singapore, the Republic of Korea and the United States. Pedroni's panel cointegration and panel individual fixed effects estimations were applied and, based on Pedroni's panel cointegration results, the conclusion is that a long-run relationship does not exist among the variables in the panel study. Overall, the results indicate that exchange rate volatility has a positive insignificant relationship with inward FDI from these four countries in the case of GARCH measure, and a negative insignificant relationship in the case of MASD measure of volatility. Thus, it may be concluded that investors from these countries do not consider exchange rate volatility to be an important factor when deciding whether to invest in Malaysia.

The results of the aggregate and disaggregate study seemed to be different especially for the exchange rate volatility and wages costs variables. In the aggregate study, exchange rate volatility and wages costs have a positive significant impact on inward FDI, while in the disaggregate study, exchange rate volatility has a positive insignificant impact and wages costs has a negative significant impact on inward FDI from the four source countries. The exchange rate volatility variable is not so different in both studies since it shows a positive sign in both studies. It seemed to be insignificant in the disaggregate study which could mean that it is not an important factor for the investors from these four countries in deciding to invest in Malaysia. As for the wages costs variable, the results appear contradictory, i.e. positive in the

aggregate study and negative in the disaggregate study. This could be due to the proxy of the wages costs used in the studies. We have used the per capita GDP as a proxy for wages costs in Malaysia and Singapore, and applied the labour cost in the United States, Japan and the Republic of Korea in the estimations of our studies. Other reasons could also contribute to the differences. In the aggregate study, we have applied real effective exchange rates to calculate the volatility indexes, while bilateral exchange rates have been applied in the disaggregate study. Another reason could be due to the estimations technique. We have applied the OLS and the panel fixed effects estimations in the aggregate and disaggregate study, respectively. Further research needs to be done and should take all these factors into considerations.

References

Aristotelous, Kyriacos, 2001, Exchange rate volatility, exchange rate regime and trade volume: evidence from the UK-US export function (1889-1999), *Economics Letters* 72, 87-94.

Baltagi, Badi H., 2001. *Econometric Analysis of Panel Data* (John Wiley & Sons, Chichester, UK).

Bollerslev, Tim, 1986, Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics* 31, 307-327.

Brzozowski, Michal, 2003, Exchange rate variability and Foreign Direct Investment - Consequences of EMU enlargement, Studies & Analyses No. 258, Center for Social and Economic Research (Warsaw).

Cushman, David O., 1983, The effects of real exchange rate risk on international trade, *Journal of International Economics* 15, 45-63.

Cushman, David O., 1988, U.S. bilateral trade flows and exchange risk during the floating period, *Journal of International Economics* 24, 317-330.

Devereux, Michael P., Rachel Griffith, and Helen Simpson, 2004, Agglomeration, regional grants and firms location, The Institute for Fiscal Studies (London).

Dickey, D.A., and W.A. Fuller, 1981, Likelihood ratio statistics for autoregressive time series with a unit root, *Econometrica* 49, 1057-72.

Elliot, Graham, Thomas J. Rothenberg, and James H Stock, 1996, Efficient tests for an autoregressive unit root, *Econometrica* 64, 813-836.

Ellison, G., and E. Glaeser, 1997, Geographic concentration in US manufacturing industries: A dartboard approach, *Journal of Political Economy* 105, 889-927.

Foad, Hisham S., 2005, Exchange rate volatility and export oriented FDI, Department of Economics, Emory University (Atlanta, GA).

Froot, Kenneth A. , and Jerome C. Stein, 1991, Exchange rates and foreign direct investment: An imperfect capital markets approach, *The Quarterly Journal of Economics* 106, 1191-1217.

Gorg, Holger, and Katharine Wakelin, 2001, The impact of exchange rate variability on US direct investment, GEP Research Papers Series, School of Economics, University of Nottingham (Nottingham).

Hara, Masayuki, and Ivohasina F. Razafimahefa, 2003, The determinants of foreign direct investment into Japan, Graduate School of Economics, Kobe University (Kobe, Japan).

Head, K., J. Ries, and D. Swenson, 1995, Agglomeration benefits and location choice: Evidence from Japanese manufacturing investments in the United States, *Journal of International Economics* 38, 223-247.

Im, Kyung So, M. Hashem Pesaran, and Yongcheol Shin, 2003, Testing for unit roots in heterogeneous panels, *Journal of Econometrics* 115, 53-74.

Kenen, P.B., and D. Rodrik, 1986, Measuring and analyzing the effects of short-term volatility in real exchange rates, *Review of Economics and Statistics* 68, 311-15.

Kiyota, Kozo, and Shujiro Urata, 2004, Exchange rate, exchange rate volatility and foreign direct investment, *The World Economy* 27, 1501-1536.

Klein, Michael W., and E Rosengren, 1994, The real exchange rate and foreign direct investment in the United States: Relative wealth vs. relative wage effects, *Journal of International Economics* 36, 373-89.

Levin, Andrew, Chien-Fu Lin, and Chia-Shang James Chu, 2002, Unit root tests in panel data: Asymptotic and finite-sample properties, *Journal of Econometrics* 108, 1-24.

Pain, Nigel, and Desiree Van Welsum, 2003, Untying the Gordian Knot: The multiple links between exchange rates and foreign direct investment, *Journal of Common Market Studies* 41, 823-846.

Pedroni, Peter, 1995, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis, Indiana University Working Papers in Economics.

Pedroni, Peter, 1997, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis: New results, Indiana University Working Papers in Economics.

Pedroni, Peter, 2001, Panel cointegration: Asymptotic and finite sample properties of pooled time series with an application to the PPP hypothesis. Revised working paper, Indiana University Working Papers in Economics.

Pedroni, Peter, 2004, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Revised working paper, *Econometric Theory* 20, 597-625.

Tham, Siew-Yean, 2003, Foreign Direct Investment in Malaysia, Asian Development Bank RETA 5994: A study on regional integration and trade-emerging policy issues for selected developing member countries (Asian Development Bank, Manila).

Thomsen, Stephen, 1999, Southeast Asia: The role of foreign direct investment policies in development, Organisation for Economic Co-operation and Development.

CHAPTER SEVEN

SUMMARY AND CONCLUSION

The overall aim of this research was to examine the impact of foreign exchange risk on the Malaysian economy, focusing on the impact of exchange rate risk on four related economic issues, i.e. Malaysia's trade balance and major exports categories to its major trading partners, its market shares performance and inward foreign direct investment (FDI) from its major suppliers. For our empirical estimations, exchange rate volatility was used as a proxy for foreign exchange rate risk and two measures of exchange rate volatility were applied – the moving average standard deviation (MASD) of the growth rate of the exchange rate employed by Kenen and Rodrik (1986), and the generalised autoregressive conditional heteroskedasticity (GARCH) model introduced by Bollerslev (1986). Both the unconditional (i.e. the MASD) and conditional (i.e. the GARCH) variance for our volatility measure was applied in order to verify the robustness of our regression results.

In this research, the first objective was to analyse the relationship between exchange rate volatility and Malaysia's trade balance with its major trading partners (i.e. the United States, Singapore, Japan, the United Kingdom and the Republic of Korea). Monthly data covering the period 1990:1 to 2002:12 was used and the bilateral real exchange rate applied to generate the exchange rate volatility series. Trade balance was measured as the ratio of the bilateral exports value to the bilateral imports value, following a model introduced by Bahmani-Oskooee (1991), and the Johansen (1988) and Johansen and Juselius (1990) multivariate cointegration technique was also employed. The impact of exchange rate volatility on the trade balance is very important to Malaysia's overall economy, because if exports increase (decrease) then, assuming others remain the same, will result an increase (decrease) or a surplus (deficit) in the trade balance. This in turn indicates a growing (stagnant) and sound (bad) economy. A good economy helps promote a positive image of a country,

especially important for a country like Malaysia which is working to achieve developed status by the year 2020.

The findings of this first objective reveal that, according to GARCH and MASD measures of volatility, exchange rate risk has a significant positive and negative long-run impact on Malaysia's trade balance with the United States and Singapore, an insignificant impact on its trade balance with Japan and the Republic of Korea, an insignificant and significant positive impact in Malaysia's trade balance with the United Kingdom. These ambiguous results are in line with those economic theories which say that the impact of exchange rate uncertainty on trade balance cannot be certain, but depends on assumptions such as traders' attitude towards risk, availability of hedging facilities and ability to diversify the risk. Therefore, based on the results, we could conclude that in the long-run, exchange rate volatility increases Malaysia's trade balance with the United States but in the case of Singapore it decreases. Further, there is no impact on Malaysia's trade balance with Japan and the Republic of Korea and no conclusive impact in the case of the United Kingdom. This implies that the effects of exchange rate volatility on Malaysia's trade balance with these trading partners will differ, depending on the assumptions used.

Since these countries are Malaysia's major trading partners, this information is important to the Malaysian government when formulating its long-term policies. In the case of the Malaysia-US trade balance, one explanation for the positive impact could be because exports to the United States mainly consist of manufacturing products (e.g. semiconductor devices). These are vital components of US industries and, even when exchange rates are volatile, the US will still import them. With regards to the Malaysia-Singapore trade balance, this is in line with the theories which say that exchange rate volatility deters international trade. As for the other trading partners (i.e. Japan, the Republic of Korea and then UK), it could mean that exchange rate volatility is not a factor affecting the trade balance in the long-run.

We also employed the Granger (1969) causality test within a vector error correction model (VECM) in order to capture Granger causality effect amongst the economic variables used in this study. The results of the Granger test showed that, in the short-run, there is no significant causality effect running from exchange rate volatility to

the trade balance in any of the equations, except in the model of Malaysia with the United Kingdom and the Republic of Korea when the GARCH measure of volatility was applied. As for the Granger causality effect from the trade balance to exchange rate volatility, the results are not robust. The only causality effects to be found were in the case of Malaysia with the United States and the Republic of Korea, when applying the MASD measure, and with Japan when the GARCH measure of volatility was applied. Therefore, in the short-run, it could be said that Malaysia's trade balance with these countries is **not** caused by exchange rate volatility, but by other factors instead. When formulating short-term strategies, the Malaysian government should not employ only the exchange rate as a mechanism to improve its trade balance with these major trading partners.

In order to establish the link between exchange rate volatility and the Malaysian economy, our second objective of this research was to investigate the impact of exchange rate volatility on Malaysia's five major exports categories to its five major trading partners. This would also provide further information of relevance to our earlier objective, in terms of the importance of these major exports categories to Malaysia's primary trading partners. Monthly data covering the period 1990 through to 2002 was used and panel individual fixed effects estimations were applied. The study was divided into two sub-periods: during the floating exchange rate regime (between 1990:1 to 1998:8) and the fixed exchange rate regime (between 1998:9 to 2002:12). The five categories of major exports studied included: electrical and electronics goods, palm oil, timber, apparel and rubber. We used bilateral exchange rate volatility in the analysis, as well as comparative bilateral volatility (a model introduced by Klein (1990) in order to capture the third country's effects).

In the floating exchange rate periods, the results revealed that exchange rate volatility has a positive impact in all the major exports categories in the case of both types and both measures of volatility (with the exception of rubber). However, in the fixed exchange rate periods, the relationship is significantly negative in most of the major exports categories. Theoretically, when exchange rates are volatile, yet the volume of exports increase, exporters may be deemed to be risk-neutral in nature, invoicing their transactions in their home currency and viewing exchange rate volatility as an

opportunity to make profits. However, if the volume of exports decreases, exporters are seen to be risk-averse in nature, invoicing their transactions in foreign currency. In the latter case, when exchange rate volatility increases, the exporters would increase the export prices and view forward hedging as additional costs.

Based on the results, it may be concluded that these five trading partners are the main sources of income to the Malaysian economy. Our conclusion is based on the fact that (with the exception of rubber) these major exports categories were found to be extremely important to these trading partners. Our conclusion was well supported in this study since a significant positive relationship was also found to exist between the exports of these major exports categories and the relative prices (again, with the exception of rubber). In the case of rubber, the reduced significance could mean that it is not a necessity product to these countries and that they are able to substitute the natural rubber with synthetic rubber, if so desired. This information proves again that Malaysia's economy relies on these five major exports categories and these five trading partners. This information is vital to the government in formulating its exports strategies. The Malaysian government should diversify its exports market and should look for new markets in order not to be affected should something happen to these trading partners, as experienced during the 2000-2001 periods when the economies of both the United States and Japan slowed down.

The results from this study also provide valuable information to the policy makers, suggesting that Malaysia should stick to the managed floating exchange rate regime rather than changing to the fixed or pegging regime. The reason for this is that, during the floating exchange rate regime, even though exchange rates are volatile, exports of the major exports categories to these trading partners was positive. However, when the exchange rate was pegged at RM3.8000 per US dollar, exports of most of these major exports categories declined. Based on the assumptions associated to the theories, these scenarios may be explained as follows. Malaysian exporters have the advantage of invoicing their transactions in the home currency during the floating exchange rate regime (thus avoiding exchange rate risk). During the fixed exchange rate regime, however, exporters invoice their transactions in foreign currency and on average they are risk-averse in nature. They would take

precautions by reducing their exports when exchange rate volatility increases, fearing that the government could lift the fixed rate unexpectedly in the future.

An increase in trade balance is normally associated with an increase in exports, indicating increased productivity. Such an increase means a rise in firms' profits leading to higher share prices. Thus, our third objective in this research of the relationship between exchange rate volatility and the Malaysian economy is to look at interactions between the stock market and the foreign exchange market in Malaysia. This is particularly significant because the evolution of a country's stock market has a great impact on its economic growth, and this is especially true for an emerging economy like Malaysia (see Levine and Zervos (1998)). As explained in Levine and Zervos (1998), a well-established stock market can mobilise capital and diversify risks between market agents thus stimulating economic growth.

Our study has focussed on the overall performance (using the Kuala Lumpur Stock Exchange (KLSE) Composite Index) as well as on the sectoral performance of the Malaysian stock market (using the KLSE Industrial Index, Financial Index, Properties Index, Tin and Mining Index and Plantation Index). Bivariate and multivariate frameworks have been employed in our estimations using monthly data from January 1990 through to December 2002 and the real effective exchange rate volatility index applied. To capture the interactions between exchange rate volatility and the stock market performance, the Gregory and Hansen (1996) cointegration test, Granger causality effects test and VAR's impulse response functions and variance decomposition tests were carried out.

The cointegration results showed that cointegration existed between the variables in both the overall and sectoral market studies for both bivariate and multivariate estimations. The cointegration test suggested that exchange rate volatility and stock market has a significant negative, long-run relationship. Bi-directional Granger causality effects were found between exchange rate volatility and stock market in Malaysia's overall market analysis for both bivariate and multivariate approaches. As for the sectoral market performance, the results showed bi-directional Granger causality effects between exchange rate volatility and stock market within all sectors for bivariate (with the exception of Finance and Properties) and multivariate (with

the exception of Finance) estimations. In the Finance and Properties sector, there was found to be a unidirectional effect running from the stock prices to the exchange rate volatility.

The short-run dynamic relationship between the variables is revealed in the impulse response functions and variance decomposition tests results. In general, the impulse response functions test results showed that exchange rate volatility and stock prices have a negative short-run relationship for both bivariate and multivariate approaches (in both the overall and the sectoral market studies). Based on the variance decomposition test, the findings revealed that stock prices affect exchange rate volatility in the overall market study in the case of both bivariate and multivariate estimations. Similar results are found for all sectors in the sectoral study - except in the Plantations and Tin and Mining sectors for bivariate estimations. In these sectors the results showed that exchange rate volatility affects the stock prices (using the bivariate estimations).

Based on these results, it may be concluded that exchange rate volatility has negative long-run as well as short-run relationships with the Malaysian stock market. Further, it may also be concluded that the Malaysian stock market leads exchange rate volatility, meaning that an increase in market shares will result in less volatility of the exchange rates. This then signifies an important message to the policy makers that, to improve the real economy of the country, the government must formulate strategies to develop and keep the stock market industry growing. When the stock market is stabilised and growing, it is more likely to stimulate and promote economic growth which will make exchange rates less volatile and more stable. Less volatility in exchange rates and higher stock prices would then attract foreign investors to invest in Malaysia, either investing in the securities industry or through direct foreign investment. Thus, our final objective in establishing the link between exchange rate volatility and the Malaysian economy is to determine whether exchange rate volatility discourages inward direct investments into Malaysia.

FDI has been viewed as an important and stable means of financing growth in emerging countries. In order to determine the nature of any relationships between exchange rate volatility and inward FDI into Malaysia, this research has focused on

annually aggregate and disaggregate inward FDI data for the period covering 1981 through to 2002. For our disaggregate FDI study, our focus has been on the inward FDI from the top four sources of FDI into Malaysia, i.e. Japan, Singapore, the Republic of Korea and the United States. Real effective exchange rate volatility was applied in the aggregate study and bilateral real exchange rate volatility in the disaggregate study. OLS estimation was employed to establish the impact of exchange rate volatility on inward FDI into Malaysia in the aggregate study, while Pedroni (2004) panel cointegration test and panel individual fixed effects estimations were used in the disaggregate study.

In the aggregate study, the OLS results showed that exchange rate volatility has a significant positive relationship with inward FDI into Malaysia, for both types of exchange rate volatility. The results also revealed that depreciation of the ringgit and positive wages costs (signifying skilled labour) are factors which attract foreign investors to Malaysia. In the disaggregate study, the panel cointegration test findings revealed that the null hypothesis of no cointegration cannot be rejected for both measures of volatility. The panel individual fixed effects results showed that exchange rate volatility has insignificant relationships with disaggregate inward FDI into Malaysia from the four countries, in the case of both measures of volatility. Depreciation in the ringgit and negative wages costs were also found to be the factors which would attract investment from these source countries.

Based on these results, it could be concluded that exchange rate volatility does not discourage inward FDI into Malaysia, and is not an important factor in investment decisions for the top four source countries. Skilled labour and cheap labour however, are revealed to be the main attractions for foreign direct investments into Malaysia. That is why one of the incentives which Malaysia offered during the 1980s was abundant cheap labour, whereas in the 1990s, it was abundant skilled labour. This pattern could be seen with the source countries, whereby in the 80s, their investments were in the form of labour incentives project, but in the 90s, consisted of skilled labour projects. The Malaysian government should therefore, invest in people's development in order to produce a skilled labour force which would attract future foreign investors. It should allocate more of its budget to build vocational schools

and universities to provide knowledge and equip Malaysians with the required skills. Moreover, skilled labour is very important, not only to foreign investors, but also in assisting Malaysia in its objective to become a developed country by the year 2020.

In conclusion, we could say that foreign exchange risk or volatility has an inconsistent impact on the Malaysian economy, no impact on its trade balance with its major trading partners and no impact on inward FDI from its source countries. Exchange rate volatility, however, has a positive impact on Malaysia's major exports categories with its main trading partners, but a negative impact on its stock market. These ambiguous results seemed to be the same across other similar studies, done either on developing or developed countries. The exchange rate volatility has no impact on Malaysia's trade balance with its major trading partners and on inward FDI from its main source countries means that exchange rate uncertainty is not a contributing factor in the decision making to determine trade with Malaysia and inward FDI into Malaysia, respectively, in these countries. The positive relationship between exchange rate volatility and Malaysia's major exports categories with its main trading partners shows that these exports are important to these countries and they appear to be the main sources of income to Malaysia. As for the negative impact of exchange rate volatility on the Malaysia's stock market signifies that foreign investors would not demand for Malaysia's stock when exchange rates are volatile, fearing their wealth would be declining due to the foreign exchange risk.

While acknowledging the need for further research on this subject, it is hoped that this analysis contributes to discussions on the impact of exchange rate volatility on the Malaysian economy through the study of related issues such as trade balance, major exports categories, stock market and inward foreign direct investment.

In terms of the study on the impact of exchange rate volatility on Malaysia's trade balance and major exports categories, future research is recommended which focuses on using medium or long-run exchange rate volatility, because the decisions to trade are actually influenced by expected variability and not past variability. Even though short-run volatility (as employed in this research) implies risk, there are many ways in which companies can cope with this (e.g. through hedging). By contrast, it is difficult to find financial instruments to hedge against exchange rate volatility when

the time horizon becomes longer. The inclusion of more trading partners is also recommended in order to justify why the five trading partners used in this research are the most important partners for Malaysia's economy. In addition, it is suggested that any future research should use a longer time span since 13 years (the time span used in this research) is not a 'true' long-run period able to offer conclusive evidence for the impact of exchange rate volatility on trade balance and major exports categories. In this regard this research was limited by difficulties obtaining data as well as a lack of sufficient data.

It has been debated that using monthly data may not be adequate in describing the effect of capital movement, which is intrinsically a short-run occurrence in terms of the study on the impact of exchange rate volatility on Malaysia's stock market. For future research, the use of daily data is recommended, which, hopefully, could effectively capture such effects in Malaysia's economy. It would be interesting also to look at the substantial impact of exchange rate volatility on the profitability of Malaysia's domestic industries. This is because any price change caused by movements in the exchange rate may: (1) change the terms of competition with foreign firms for domestic exporters and import competitors; (2) alter input prices for industries that use internationally-priced inputs or firms that import for resale; and (3) change the value of assets denominated in foreign currencies. The correlation between an industry's profitability and exchange rate volatility depends on what the industry does. To measure the exposure of industry portfolios to exchange rate volatility, the contemporaneous change in the exchange rate could be added to the capital assets pricing model of the Malaysian domestic market.

On the study of exchange rate volatility on inward FDI into Malaysia, our sample size is rather small, therefore the accuracy of the results for the purpose of policy implications might be restricted. Future research should include a longer time span and should investigate the impacts of exchange rate volatility by disaggregating national-level inward FDI into industry-level inflows and disaggregating by top sources countries by region or zone. By doing industry-level analysis, we could establish which industry would be most severely affected by exchange rate volatility and, thus, should be provided with more investment incentives should Malaysia

really want to expand that industry. Moreover, to disaggregate by region or zone, would give a better picture in terms of which region or zone would be most affected by risk and by the decision not to invest in Malaysia. At the same time, further research on the impact of exchange rate volatility should also include outward FDI from Malaysia. This would provide an insight into the reactions of Malaysian investor when facing foreign exchange risk.

References

Bahmani-Oskooee, Mohsen, 1991, Is there a long-run relation between the trade balance and the real effective exchange rate of LDCs?, *Economics Letters* 36, 403-407.

Bollerslev, Tim, 1986, Generalized Autoregressive Conditional Heteroskedasticity, *Journal of Econometrics* 31, 307-327.

Granger, C.W.J., 1969, Investigating causal relations by econometrics models and cross spectral methods, *Econometrica* 40, 424-38.

Gregory, Allan W., and Bruce E. Hansen, 1996, Residual-based tests for cointegration in models with regime shifts, *Journal of Econometrics* 70, 99-126.

Johansen, S., 1988, Statistical analysis of cointegration vectors, *Journal of Economic Dynamics and Control* 12, 231-254.

Johansen, S. , and K Juselius, 1990, Maximum likelihood estimation and inferences on cointegration - with application to the demand for money, *Oxford Bulletin of Economics and Statistics* 52, 169-210.

Kenen, P.B., and D. Rodrik, 1986, Measuring and analyzing the effects of short-term volatility in real exchange rates, *Review of Economics and Statistics* 68, 311-15.

Klein, Michael W., 1990, Sectoral effects of exchange rate volatility on US exports, *Journal of International Money and Finance* 9, 299-308.

Levine, Ross, and Sara Zervos, 1998, Stock markets, banks and economic growth, *American Economic Review* 88, 537-558.

Pedroni, Peter, 2004, Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. Revised working paper, *Econometric Theory* 20, 597-625.