

Economic structures, the nature of shocks and the role of exchange rate in the monetary policy formation in the emerging countries of East-Asia

Inaugural-Dissertation
zur Erlangung des akademischen Grades eines Doktors
der Wirtschafts- und Sozialwissenschaften
der Christian-Albrechts-Universität zu Kiel

Vorgelegt von
Siok Kun Sek
[Master in Economics (UKM),
Master in Science (UKM)]
aus Malacca, Malaysia

Kiel, November 2009

Gedruckt mit Genehmigung der
Wirtschafts- und Sozialwissenschaftlichen Fakultät
der Christian-Albrechts-Universität zu Kiel

Dekan:
Professor Dr. Thomas Lux

Erstberichterstattender:
Professor Dr. Hans-Werner Wohltmann

Zweitberichterstattender:
Professor Dr. Vasyl Golosnoy

Tag der Abgabe der Arbeit: 22nd September 2009
Tag der mündlichen Prüfung: 18th November 2009

Contents

Table of Contents	iii
--------------------------	------------

List of Tables	vii
-----------------------	------------

Chapter One: Introduction and Summary

Abstract	1
1.1 Research background and motivation	2
1.2 Objectives and scope	4
1.3 Model structure	5
1.4 Model and methodologies	6
1.5 Outline of the chapters	6
1.6 Main results	8
1.7 Summary	10
1.8 Contributions	11
1.9 Suggestions/ recommendations	12
References	13

Chapter Two: The Economic Structures and Monetary Policy of East-Asia – Some Reviews

Abstract	18
2.1 Introduction	19
2.2 The economy of East-Asia	19
2.2.1 The economic features	19
2.2.2 The economy in the pre- and post-crisis	20
2.2.3 Business cycle fluctuations and the structure of shocks	22
2.3 The monetary policy in East-Asia	22
2.4 Summary	24
References	25
Appendix I	27

Chapter Three: The Exchange Rate Pass-Through Into Domestic Prices: An Empirical Study in Several East-Asian Countries

Abstract	38
3.1 Introduction and motivation	39
3.2 Exchange rate pass-through – some reviews	40
3.2.1 Exchange rate pass-through and policy regime	43
3.2.2 Exchange rate pass-through in East-Asia	44
3.2.3 Modeling the exchange rate pass-through	46
3.2.4 Empirical estimation issues	47
3.3 Methodologies	48
3.3.1 Seemingly unrelated regression (SUR)	49
3.3.1.1 Diagonality tests	51
3.3.2 Generalized method of moments (GMM)	52

3.3.2.1	The concept of GMM	52
3.3.2.2	Applying GMM to the exchange rate pass-through model.....	54
3.3.2.3	Hypothesis tests	55
3.3.3	Data and estimations.....	58
3.4	Results – econometrics counterpart	59
3.4.1	Results – SUR	59
3.4.2	Results – GMM	67
3.5	Results – economic interpretations	73
3.6	Conclusions.....	74
	References	75
	Appendix II	79

Chapter Four: Trade Openness, Exchange Rate Pass-Through and Simple Policy Rules in the Small Open Economy

	Abstract	83
4.1	Introduction	84
4.1.1	The role of exchange rate in the monetary policy	85
4.1.2	The role of exchange rate in the monetary policy from different aspects	86
4.2	The model	88
4.2.1	Imperfect pass-through, terms of trade and real exchange rate	89
4.2.2	Aggregate supply and Phillips curve	90
4.2.3	Aggregate demand and IS curve	91
4.2.4	Uncovered interest parity (UIP)	93
4.2.5	Net foreign assets and real profits	93
4.2.6	Foreign sector and exogenous shocks	94
4.3	Monetary policy rule	95
4.3.1	Optimal and simple rule	95
4.3.2	The formation/ setting of optimal simple rule	96
4.3.3	Highlighted issues.....	98
4.4	Methodology and parameterization	101
4.5	Results.....	105
4.5.1	The degree of exchange rate pass-through	105
4.5.2	The effects of trade openness	110
4.5.3	Analyzing the effects of structural shocks	112
4.5.4	CPI versus domestic inflation targeting	114
4.6	Robustness issue	120
4.6.1	Robustness under alternative parameterization	120
4.6.2	Uncertainty about the persistency of shocks	121
4.6.3	Robustness under different policy weighting	122
4.6.4	Robustness under different targeting policy	123
4.7	Evaluating the exchange rate regimes	123
4.7.1	Results.....	125
4.8	Conclusions.....	130
	References	132
	Appendix III-A	141
	Appendix III-B	152

Chapter Five: An Empirical Analysis on the Monetary Policy Regimes in Crisis-Hit East-Asian Countries

Abstract	155
5.1 Introduction	156
5.2 Economic and policy regimes in East-Asia	157
5.2.1 Some debates on the choice of regimes	157
5.2.2 Middle solutions/ intermediate regimes	159
5.2.3 Economics and policy regimes in East-Asia – some reviews.....	159
5.3 Do the central banks in East-Asia react directly to exchange rate?	161
5.3.1 Approximating monetary policy reaction function	161
5.3.2 Data and methodologies.....	164
5.3.2.1 GMM	164
5.3.2.2 Hypothesis tests	166
5.3.2.3 Augmented Dicky-Fuller and Wald test	168
5.3.3 Data and estimations.....	169
5.3.4 Results – econometrics counterpart	170
5.3.4.1 Statistical tests	170
5.3.4.2 Estimation results	174
5.3.4.3 Robustness checking	179
5.3.5 Results – economic interpretations	181
5.4 How flexible the exchange rate regimes in East-Asia?	182
5.5 Conclusions	184
References	185
Appendix VI	191

Chapter Six: Economic structure, the source of shocks and the effectiveness monetary policy in the emerging countries of East-Asia

Abstract	201
Introduction.....	202
6.1 Introduction	202
6.2 The source of shocks in East-Asia – some empirical reviews	203
6.2.1 Is exchange rate a shock absorber or a source of shock?	204
6.3 Methodology and data	205
6.3.1 Model setup	205
6.3.2 Impulse response function and FEVD	207
6.3.3 Identifications.....	209
6.3.4 Estimations.....	210
6.3.5 Diagnostic tests	213
6.3.6 Data and empirical analyses	214
6.4 Results – econometrics counterpart	216
6.4.1 Statistical and diagnostic checking	216
6.4.2 Estimation results and robustness comparisons	217
6.5 Results – economic interpretations	221
6.5.1 The source and structure of shocks	222
6.5.2 The role of exchange rate: absorber or source of shocks?	224
6.5.3 Exchange rate regime and the shock transmission mechanism	225
6.5.4 The effectiveness of monetary policy	227
6.6 Conclusions	228

References	229
Appendix V-A	233
Appendix V-B	238
Curriculum vitae	248
Affirmation	250

List of Tables

I-A(1)	Main trade partners based on total trade (Mn. USD).....	27
I-A(2a)	Regional trade patterns, 1980-98.....	27
I-A(2b)	Direction of trade (imports in percentage).....	28
I-A(2c)	Direction of trade (exports in percentage).....	29
I-A(3)	Invoicing currencies in Asian trade as percent of overall trade.....	30
I-A(4a)	Intermediate goods.....	30
I-A(4b)	Philippines: composition of imports (percentage), 1993-98.....	30
I-A(4c)	Malaysia: composition of imports (percentage), 1997-2003.....	31
I-A(5)	Economic indicators, 1985-2006.....	31
I-A(6)	Inflation rate (annual change, percentage).....	32
I-A(7)	GDP growth rate (annual change, percentage).....	32
I-A(8)	Monetary policy framework.....	33
I-A(9)	Shocks and business cycle fluctuations in East-Asia.....	34
I-B(1)	Log exchange rate movements.....	35
I-B(2)	Inflation.....	37
A.1	LM test.....	60
A.2	Regression result of SUR – equation (5c) given $m=0$	63
A.3a	Exchange rate pass-through coefficient using SUR technique - equation (5c) given $m=0$	64
A.3b	Exchange rate pass-through coefficient using SUR technique - equation (5c) given $m=3$	65
A.3c	Exchange rate pass-through coefficient using SUR technique - equation (5c) given $m=6$	66
A.4	Testing for endogeneity (Hausman test).....	69
A.5	Testing for relevance of instruments.....	70
A.6	Regression result of GMM – equation (5c) given $m=0$	71
A.7	Exchange rate pass-through coefficient using GMM technique - equation (5c) given $m=0$	72
II(1a)	Central bank assessments of exchange rate pass-through.....	79
II(1b)	Exchange rate pass-through in emerging Asian countries.....	80
II(2)	List of series, definitions and data sources.....	81
II(3)	Augmented Dicky-Fuller unit-root test.....	81
II(4)	Johansen Trace Test for cointegration.....	82
B.1	Degrees of exchange rate pass-through (ERPT).....	99
B.2	Degrees of trade openness.....	100
B.3	Parameterization.....	104
B.4	Policy rules based on CPI inflation targeting.....	107
B.5	Effects of higher trade openness on performances of simple rules.....	111
B.6	Effects of trade openness – comparisons of variances.....	111
B.7	Policy rules – domestic inflation targeting.....	117
B.8a	Specifications for shocks (1).....	121
B.8b	Specifications for shock (2).....	125
B.9a	The effect of individual shock in the performance of policy rules (Lower Openness case).....	127
B.9b	The effect of individual shock in the performance of policy rules (higher openness case).....	128

B.10a	Simultaneously effect of shocks on the performance of policy rules (lower trade openness case).....	129
B.10b	Simultaneously effect of shocks on the performance of policy rules (higher trade openness case).....	130
III-A(1)	Share of exports in domestic production.....	141
III-A(2a)	Components of imported goods.....	141
III-A(2b)	Intermediate goods and consumption goods.....	141
III-A(3)	Notations for the parameters.....	142
III-A(4)	Alternative parameterization.....	142
III-A(5a)	Performances of simple rules, persistency=0.8 and std. error=0.4.....	143
III-A(5b)	Higher persistency and standard error of domestic shocks.....	143
III-A(5c)	Higher persistency and standard error of foreign shocks.....	143
III-A(6)	Policy rules under different weighting.....	144
III-A(7)	Relative loss of policy rules by targeting at interest rate.....	145
III-A(8)	Impulse response functions (IRF).....	146
III-B	Solution and estimation of rational expectation model.....	152
C.1	Augmented Dicky-Fuller (ADF) unit-root test.....	171
C.2	Endogeneity test.....	172
C.3a	Testing for relevance of instruments – instrument set 1.....	172
C.3b	Testing for relevance of instruments – instrument set 2.....	172
C.4a	Overidentifying test – instrument set 1.....	173
C.4b	Overidentifying test – instrument set 2.....	174
C.5a	Policy reaction function (case I: $p1=p2=p3=0$) – equation (3).....	175
C.5b	Forward-looking reaction function: (case II) - equation (3).....	176
C.5c	Forward-looking reaction function: (case III) - equation (3).....	177
C.6	Wald test.....	178
C.7	Robustness checking (case I) – equation (6).....	180
C.8	Wald test – equation (6), instrument set 1.....	181
C.9	Indicators for exchange rate flexibility.....	184
IV-(1)	Monetary policy in East-Asia after the crisis.....	191
IV-(2)	Highlights of inflation targeting arrangements in selected Asian economies (as of June 2008).....	192
IV-(3)	Empirical results on monetary policy in Asia.....	193
IV-(4)	Definition of variable for policy reaction function.....	195
IV-(5a)	Forward-looking reaction function, case II (instrument set 2).....	196
IV-(5b)	Forward-looking reaction function, case III (instrument set 2).....	197
IV-(6)	Wald test – equation (3), instrument set 2.....	198
IV-(7)	Residual, actual and fitted policy reaction function - equation (3).....	199
IV-(8)	Residual, actual and fitted policy reaction function - equation (6).....	200
D.1	Diagnostic test – case I.....	217
D.2	Long-run impact matrix – case I.....	219
D.3	Forecast error variance decomposition – case I.....	220
D.4	Descriptive statistics.....	222
D.5	Correlations of structural shocks.....	224
V-A(1)	Augmented Dicky-Fuller unit-root test.....	233
V-A(2a)	Diagnostic test – case II.....	234
V-A(2b)	Diagnostic test – case III.....	234
V-A(3a)	Long-run impact matrix – case II.....	234

V-A(3b)	Long-run impact matrix – case III.....	235
V-A(4a)	Forecast error variance decomposition – case II.....	236
V-A(4b)	Forecast error variance decomposition – case III.....	237
V-B(1)	Impulse response function (IRF): case I.....	238
V-B(2)	Impulse response function (IRF): case II.....	242
V-B(3)	Impulse response function (IRF): case III.....	244

CHAPTER ONE

INTRODUCTION AND SUMMARY

Abstract

This thesis investigates the role of exchange rate in a small open economy policy framework. Focusing the analysis on the crisis-hit East-Asian countries, the main objective of this thesis is to investigate the necessity of the monetary authority to concern about the exchange rate stability by reacting directly to the exchange rate movements under the flexible exchange rate regime. This thesis conducts both numerical simulations and empirical analyses and it is organized in six chapters. Chapter One is the introduction about the content of each chapter and the summary of the main findings. Chapter Two is the overview about the economic and monetary policy of East-Asian countries. Chapter Four applies a model of Lindé, Nessén & Söderström (2004) and conducts simulations to compare the performances of various policy rules in terms of policy loss and variations. The remaining chapters are about the empirical analyses, i.e. Chapter Three applies GMM technique and SUR model to estimate the degree of exchange rate pass-through in East-Asia in the pre- and post-crisis of 1997/98, Chapter Five applies GMM technique to estimate the policy reaction function for East-Asia and the last chapter conducts a SVAR model to investigate the change in the economic structure, the dynamic of shocks and the performances of the policy regimes in East-Asian countries. The simulations reveal some evidences on more effective monetary policy rules/ regimes that react directly to the exchange rate terms, taking into account for different degrees of exchange rate pass-through, trade openness, policy objective, the source and persistency of shocks. However, the size of improvements depends on country specific factors. Empirical results report different results for the degree of exchange rate pass-through along the pricing chain, over time and across countries. Besides, there are empirical evidences that the monetary authorities in East-Asian countries influence the exchange rate movements through short-term interest rate adjustments and foreign market intervention under the floating regime aftermath the crisis. Empirical findings indicate that the policy regimes aftermath the crisis is more effective. The source of shocks and the change in the economic structure matters in determining the performances of policy regimes. The empirical results are in line with the theoretical outcomes that favor the reaction to the exchange rate movements under the flexible exchange rate regime in the emerging countries of East-Asia.

1.1 Research background and motivation

What policy rule should a central bank adopt in a small open economy? Should a central bank concern about the exchange rate stability and does the exchange rate play an improving role in the formation of monetary policy? Do the economic structures, the source of shocks and other country specific factors matter in determining the performance of a policy rule/ regime over time? These are the main questions addressed in this thesis.

The development of international macroeconomics literatures such as the New Keynesian model and the so called New Open Economy Macroeconomics model (NOEM) have contributed to the understanding of both micro-founded and macro-founded economic analyses. These analyses include the transmission mechanism of shocks, the macroeconomics effects of uncertainty, exchange rate determination and pass-through, the implication of different pricing rules for trade and optimal monetary policy rules.

The constructions of the theoretical models before are confined to the closed economy context. By assuming the law of one price (LOOP) and purchasing power parity (PPP) hold, exchange rate does not play an explicit role in the design of monetary policy (Smets & Wouters (2002)). However, when the model is extended to the open economy context, it is arguably that the policy maker should consider a direct role for the exchange rate in the design of monetary policy due to different structures between the two economies. One of the main issues that explain the differences between the open and closed economies is the issue of exchange rate pass-through. Exchange rate pass-through is defined as the percentage change in the domestic/ imported prices led by a one percent change in the exchange rate between the importer and exporter currency. Empirical studies show that exchange rate pass-through is partial and the law of one price does not hold in the short run (for example Campa & Goldberg (2002) and Campa & González-Mínguez (2002)). Besides, the degree of exchange rate pass-through also varies across countries.

The research in the exchange rate pass-through shows that exchange rate and monetary policy are correlated to each other. Many studies show that exchange rate pass-through in emerging countries is higher than that in the developed countries. Therefore, it is more difficult for emerging countries to achieve the inflation targets (Minella et al. (2003) and Nogueira Junior (2007)). However, many studies show that the pass-through rate has declined in many countries and researchers have different explanations for that. One of the famous explanations is that the low pass-through rate correlates with the low inflation rate as a consequence of strong commitment towards price stability by Taylor (2000). The view of Taylor is supported by many empirical studies such as Edwards (2006), Gagnon and Ihrig (2004) and Nogueira Junior (2007).

The degree of exchange rate pass-through also closely links to the monetary policy in the sense that it influences the performances of the policy rules/ regimes. Previous studies show that the degree of exchange rate pass-through matters in determining the policy trade-off and welfare performances ranking of policy rules (for example Devereux et al. (2005), Flamini (2004) and Adolfson (2007)). According to Campa & Goldberg (2002), the effectiveness of a monetary policy is determined by the degree of exchange rate pass-through i.e. monetary policy is more effective under the low

degree of pass-through given that the expenditure switching effect is lower. On the other hand, including the exchange rate term in the non-optimized policy rule enhances higher welfare when pass-through is higher (Adolfson (2001)).

Closely related to this issue is the issue of trade openness. Trade openness is correlated with the exchange rate movements. Adolfson (2001) states that exchange rate channel may play a greater role in the monetary policy transmission in a more open economy. The more open economy faces greater effects of external shocks through changes in terms of trade.

Both issues imply that exchange rate may play a crucial role in the open economy context. Senay (2001) discusses the role of exchange rate in the setting of monetary policy rules context. First, exchange rate creates transmission channels of monetary policy. It affects the domestic demand through its effects on the relative price of foreign and domestic goods besides affecting the domestic price directly through its impacts on the domestic currency prices of foreign produced goods. Second, exchange rate transmits the effects of foreign disturbances which will affect the aggregate demand for domestic goods.

Based on the importance roles played by the exchange rate in the small open economy, some researchers propose to include the exchange rate term in the policy reaction function as the modification to the closed economy rule when applying it to the open economy context. They claim that such modification enhances higher stability and welfare (Ball (1999), Batini, Millard & Harrison (2001) and Senay (2001)).

Contrary to the above arguments on the role of exchange rate in the open economy, some studies suggest little role for exchange rate. For instance, Taylor (2001) argues that adding exchange rate into the interest rate policy rule may induce loss of credibility in targeting inflation. As explained in Edwards (2006), the reasons are: first, there is no need to give a direct role to exchange rate in the policy reaction function as exchange rate already plays an indirect role through its effects on inflation and output in the policy rule; second, adding the exchange rate term in the Taylor rule is redundant and may generate higher volatility to the monetary policy. In line with the opinion of Taylor, Mishkin (2000) claims that central bank should not react directly to exchange rate. Rather, they should pay attention at the effects of exchange rate fluctuations on inflation and output gap.

On the other hand, the results from the empirical studies and numerical simulations are controversial. Empirically, Brischetto and Voss (1999) in their results show that the short-term interest rate in Australia reacts to the exchange rate term. On the other hand, Gerlach and Smets (2000) find that the short-term interest rate of New Zealand and Canada respond significantly to changes in the nominal exchange rate whereas that of Australia does not. In the case of emerging market, Osawa (2006) in his study on three inflation targeting Asian countries show no evidence of response from the monetary policy to the exchange rate term in these countries as reported in Mohanty and Klau (2005). He argues that the excessive responses of policy reaction function to the exchange rate terms in Mohanty and Klau (2005) are due to the inclusion of the crisis periods with no dummy on the structural break included in their studies. As in the case of empirical studies, some results from the numerical simulations find improvement in the policy rules with exchange rate terms (for example Batini et al.

(2001) and Wohltmann & Winkler (2008)) while others show the opposite or mixed outcomes (for example Côté et al. (2002) and Taylor (1999)). Apart from these studies that focus on the comparisons of different types of policy rules with certainty in exchange rate, Wollmershäuser (2006) and Leitimo & Söderström (2005) compare the performances of policy rules from the aspect of exchange rate uncertainty. While Leitimo & Söderström (2005) find the simple Taylor rule is sufficient to stabilize a small open economy under the exchange rate uncertainty, Wollmershäuser (2006) demonstrates that simple policy rules that react to the contemporaneous and lagged movements in real exchange rate are superior to the closed economy rule under high uncertainty in exchange rate. He argues that, the conflicting result of previous studies is due to the fact that these studies do not consider the exchange rate uncertainty in their analyses.

While recent researches are more concentrated on the monetary policy rules for the small open economies, for example, Ghironi (2000) focuses on Canada, Ghironi & Rebucci (2001) focus on Argentina, Lipinska (2005) focuses on EMU countries, this research is focused on the crisis-hit East-Asian emerging countries. These countries exhibit some economic features which differentiate them from the developed countries. Devereux et al. (2005) mention two main features of emerging countries. First, the emerging countries are afraid to float the exchange rate due to the liability dollarization effects on the balance sheet. Second, the price levels in these countries are highly affected by the exchange rate movements. Exchange rate shocks in these economies tend to pass-through into aggregate inflation faster than in industrial economies. Apart from these economic features, East-Asian countries also experience different structure of shocks due to the structure of production and direction of trade. Previous studies show that the structure and the nature of shocks matter in determining the performance of a policy regime (for example Drine & Rault (2004), Artis & Ehrmann (2006) and Alexius & Post (2008)).

Additionally, most of the crisis-hit East Asian countries have switched from the rigid exchange rate regime to the flexible one and inflation targeting after the financial crisis of 1997-98. Does this change is appropriate and induce higher welfare? Does exchange rate still play an important role in stabilizing the shocks in these emerging countries as claimed in many studies?

1.2 Objectives and scope

This research is focused on the small open economies of crisis-hit East-Asian countries. Under the two-country model in Lindé, Nessén & Söderström (2004), the foreign economy is represented by the U.S. and the small open economy refers to the East-Asian countries as a whole. As each East-Asian country may exhibit different economic structures, the numerical investigations also consider different cases/possibilities (for instance different degrees of exchange rate pass-through and trade openness and different parameterizations). On the other hand, the empirical estimations apply the dataset of each individual country. Comparisons on the results are made across countries and over time (between the pre- and post-crisis periods).

In general, this thesis has three main objectives:

First, this thesis seeks to investigate how the monetary policy rule in East-Asia should look like. Or more precisely how relevant or important for the monetary authority in East-Asia to react to the exchange rate movements i.e. if include the exchange rate term in the policy rule enhances higher policy improvement. Comparisons on the performances of various policy rules intend to suggest the most effective or most appropriate policy rule for East-Asia.

Second, the first objective is investigated by considering different economic conditions. In particular, it seeks to find out if the country specific factors (the degree of exchange rate pass-through and trade openness, different economic structure/parameterization, the source and persistency of shocks) matter in determining the performance of a policy rule or the size of improvement.

Third, it investigates empirically the change in the economic structures across countries and between the two sub-periods in East-Asia. In particular, it seeks to investigate the link between the change in economic structures/ shocks and the change in policy regimes in determining the performance of a policy regime.

The answers to the first and second objectives can be found by solving the stochastic dynamic general equilibrium model by Lindé, Nessén & Söderström (2004) numerically (see **Chapter Four**). Comparisons on the performances of various rules to that of the closed economy rule under different degrees of exchange rate pass-through and trade openness, parameterizations, the source and persistency of shocks provide clearer idea on which policy rule works more effectively for the emerging East-Asian countries. The third objective is realized through empirical analyses, i.e. estimating the degree of exchange rate pass-through and monetary policy reaction function for individual East-Asian countries between the two sub-periods (Chapter Three and Five) and running the structural VAR model to analyze the dynamic of shocks for policy evaluations (Chapter Six).

1.3 Model structure

This study applies a two-country stochastic dynamics general equilibrium (SDGE) model in Lindé, Nessén & Söderström (2004). The model consists of one large foreign economy (U.S.) and a small open economy (crisis-hit East-Asian countries as a whole). The structure of the model is as depicted in **Diagram 1** below:

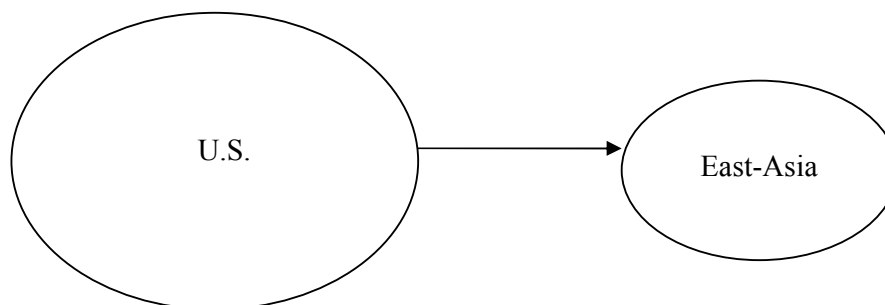


Diagram 1

Diagram 1 shows that the large foreign economy (U.S.) has great influences on the

small open economy (East-Asia). In turn, the small open economy is assumed to be relatively small to the rest of the world and has no influence on the large foreign economy but only receives the shocks as given.

1.4 Model and methodologies

This thesis applies the model in Lindé, Nessén & Söderström (2004). The model is a two-country stochastic dynamics general equilibrium (SDGE) model that captures the main features and economic environment of emerging East-Asian countries. It features the stickiness in import price and the imperfect pass-through in exchange rate in the short-run. The basic blocks of the model consist of the aggregate demand/ IS curve, aggregate supply/ Phillips curve, the UIP (uncovered interest parity) condition, the net foreign assets and real profits equations, the terms of trade equations (foreign and domestic), the foreign sector equations, the nominal and real exchange rate equations, the exogenous shocks equations and the monetary policy rule equations.

For the purpose of this research, numerical simulations are conducted. The values of parameters are obtained through calibrations without any attempt to estimate. In order to consider the economic changes in the pre- and post-crisis periods, simulations are repeated by undertaking different source and persistency of shocks, different degrees of exchange rate pass-through and trade openness and parameterizations. Assuming that the monetary policy reaction function can be represented by a linear short-run interested rate rule, this thesis conducts comparisons on the performances of various simple rules, in particular the rules that react to the exchange rate terms with the rule of closed economy. The performances of policy rules are evaluated in term of the policy loss and variations in output and inflation.

Included also in this thesis are some empirical analyses based on the dataset of East-Asian countries. These analyses include applying econometric techniques to estimate the policy reaction function, the degree of exchange rate pass-through into domestic prices (import price, PPI and CPI) and the dynamic and structure of shocks and its interlink with the policy regime. The empirical analyses provide evidences on the change in the degree of exchange rate pass-through, the change in economic structural and the source of shocks, the policy reaction function and the macroeconomic and monetary policy performances across country and over time in the pre- and post-crisis periods (or between the two different policy regimes). The econometric approaches applied include the Generalized Method of Moments (GMM), Seemingly Unrelated Regression (SUR) with Generalized Least Square (GLS) and the system equation of structural Vector Autoregressive Regression (SVAR) model.

1.5 Outline of the chapters

The thesis consists of an overview about East-Asian countries (in Chapter Two) and four short independently essays (Chapter Three to Six), analyzing the effect of shocks, the degree of exchange rate pass-through and trade openness on the performances of various optimized simple monetary policy rules for the East-Asian countries. Additionally, empirical evidences are provided through empirical analyses that apply to the individual East-Asian countries dataset.

This thesis is organized as follows:

Chapter Two is an overview about the economic features/ structures and monetary policy of several East-Asian countries before and after the financial crisis of 1997-98. The country specific economic features and the dramatic changes in the monetary policy regimes between the two sub-periods in East-Asia are the attractions for researches especially in the topic of macroeconomics and monetary policy framework.

Chapter Three is the empirical estimation on the degree of exchange rate pass-through into domestic prices in several crisis-hit East-Asian countries namely Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand. Applying the Seemingly Unrelated Regression (SUR) model or Generalized Least Square (GLS) method, this chapter aims to compare the degree of exchange rate pass-through into different domestic prices (import price, producer price or PPI and consumer price or CPI) in these crisis-hit East-Asian countries before and after the financial crisis of 1997-98. The exchange rate pass-through equation constructed is based on the concept of the law of one price (LOOP). For robustness purpose, the results obtained applying GLS method are compared with the results obtained under Generalized Method of Moments (GMM) estimations.

Chapter Four is the analysis about the openness, the degree of exchange rate pass-through, the source and persistency of shocks and the performances of monetary policy rules. This chapter utilizes the model in Lindé, Nessén & Söderström (2004) to compare various restricted optimized simple rules in the open economy to the one in the closed economy. The model is solved through numerical simulations. This chapter can be divided into two main parts. The first part of this chapter compares the performances of various optimized simple rules with the baseline Taylor rule of closed economy. Evaluations on the performances of rules are made based on the absolute loss, relative loss and variability of the rules. In particular, the investigation is focused on the impacts of exchange rate pass-through and trade openness. Comparisons are also made between a battery of CPI inflation targeting rules and domestic inflation targeting rules. Apart from these, the second part of this chapter conducts different approaches of analysis, i.e. evaluates the performances of policy regimes (pegged, managed floating and freely floating exchange rate rules) between the two sub-periods by focusing on the impacts of the nature and persistency of shocks i.e. domestic versus foreign shocks and nominal versus real shocks by considering three cases of exchange rate pass-through: high, medium and low pass-through.

Chapter Five seeks to find out if the central banks in East-Asian countries concern about the exchange rate movements through the adjustments of the short-run interest rate (policy reaction function) and intervention in the foreign exchange market between the two sub-periods. Assuming the policy reaction function of a central bank is linear and can be represented by a short-term interest rate reaction function, the Generalized Method of Moments (GMM) is applied to estimate the policy reaction function for several East-Asian countries for the two sub-periods of pre- and post-crisis of 1997-98. In particular, empirical estimations are conducted to reveal if these central banks follow as claimed officially that they do not consider a direct role for exchange rate term in their monetary policy functions in the periods aftermath the adoption of inflation targeting regime. Apart from the empirical estimation, two

indicators are constructed to compare the willingness of the policy maker to float the exchange rate for the periods of pre- and post-crisis or the change of policy regimes in several East-Asian countries. Four developed countries (Canada, Japan, U.K. and U.S.) are included as control cases for comparisons. The first indicator measures the attempt of the policy maker to influence the movements in exchange rate through intervention in the foreign exchange market. The second indicator measures the intention of the policy maker to stabilize the exchange rate via interest rate adjustments.

Chapter Six investigates the role of exchange rate as a shock absorber/ generator from the aspect of the source of shocks and policy regime. In particular, the analysis is focused on the change in the structure or the source of shocks and policy regime between the pre- and post-crisis periods and the inter-relationship between the source of shocks and the change in the policy regimes in determining the role of exchange rate in the monetary policy framework. A structural VAR model is constructed for the purpose of this analysis. The Blanchard and Quah (1989) technique is applied to identify the structural of various shocks. The results provide evaluations on the policy regimes. Forecast error variance decomposition provides the relative importance of various shocks on the variation of domestic variables. Impulse response function reveals changes in the responses of domestic variables to various shocks across countries after the shift in the policy regimes aftermath the crisis.

1.6 Main results

This section summarizes the main results of each chapter.

Chapter Three conducts empirical estimations on the degree of exchange rate pass-through into domestic prices (import price, PPI and CPI) for several East-Asian countries in the periods of pre- and post-crisis of 1997-98. The results show that the pass-through is partial and varies along the pricing chain, across countries and over time. Not all countries experience declines in the pass-through rate in the post-crisis period. Indeed the results show that the pass-through into import price has increased substantially in the post-crisis period. The degree of exchange rate pass-through is the highest on import prices, followed by the producer price and the lowest on consumer price. The degree of exchange rate pass-through into consumer price is very low and even leads to a decline in the price in some cases.

The first part of Chapter Four conducts simulations to compare the performances of various optimized simple rules. Assuming all shocks are same persistent and occur simultaneously, the results from this chapter suggest that the superior rule should react to the exchange rate and movements in hybrid form. Adding the history dependence term (including the smoothing term) and exchange rate term to the baseline policy rule are able to reduce the welfare loss. These more complicated rules work more efficient under high pass-through case as the size of improvement is larger under higher pass-through case. These more complicated rules are robust to different policy weighting, parameterizations, trade openness and persistency of shocks. The strict inflation targeting rule performs badly in all cases. Comparing the rules based on the CPI inflation and domestic inflation targeting, the results indicate that the CPI inflation targeting rules outperform the domestic inflation targeting rules in term of welfare loss. However, more complicated domestic inflation targeting rules generate

lower loss in term of relative loss to the loss of baseline Taylor rule, implying larger improvement of domestic inflation targeting to CPI inflation targeting rules when the exchange rate and other terms are added to the baseline Taylor rule. These results are robust under different degrees of exchange rate pass-through and persistency of shocks.

The second part of Chapter Four evaluates the performances of different policy regimes under different source and persistency of shocks. The results indicate that the effectiveness of monetary policy regimes depends crucially on the nature/ source of shocks, the persistency and variation of shocks besides other factors (the degree of exchange rate pass-through and trade openness). Depending on a country's specific characteristics, different countries may experience different economic conditions and the effectiveness of the policy rules to react to exchange rate terms could be different across countries and over time. The policy rule with exchange rate term works well under high pass-through case and when nominal shocks are more prevail. The effectiveness of this regime is getting lower under higher persistency and variation of real shocks. In other words, the results suggest for the opt of floating regime under greater real shocks but in favor of exchange rate pegged or managed regime when nominal shocks are more prevail.

Chapter Five seeks to compare the policy reaction function and exchange rate flexibility in East-Asia between the two sub-periods. Empirical results find some evidences that the policy reaction function in East-Asia react to the exchange rate movements in the two sub-periods. Besides, the policy reaction functions in these countries also react differently to the inflation and output gap variables. Although officially these countries have implemented the managed and freely floating regimes, the exchange rate in these countries does not float freely as the free floaters in developed countries. There are evidences that the authorities limit the movements in exchange rate through intervention in the foreign exchange market and interest rate adjustments. The empirical findings are in line with the theoretical outcomes in Chapter Four, in which the central banks in East-Asia are implementing the effective policy rule, i.e. reacting to the exchange rate movements under the flexible exchange rate regime.

Chapter Six demonstrates that shocks in East-Asia are asymmetric and of country specific. Domestic shocks are the main determinant to the variation in domestic economies whereas external shocks have low effect on the domestic variables in the pre-crisis period. The effect of external shocks has increased significantly in the post-crisis period. The increasingly effect of external shock and that shocks are asymmetric implies greater flexibility in the exchange rate regime in these countries aftermath the crisis. There are evidences on greater role of exchange rate to act as a shock absorber after moving to the flexible regime. At the same time, exchange rate also a source of shock to itself but the effect of shock has declined significantly after the shift to the flexible regime in the post-crisis period. The results also reveal changes in the monetary policy to emphasize more on inflation targeting in the post-crisis period. At the same time, monetary authorities in these countries still concern about the output growth and exchange rate stability. The results imply more effective monetary policy aftermath the crisis, i.e. monetary policy shock is more influential in determining the movements in output, inflation and exchange rate. Since exchange rate reacts to monetary policy shock in the post-crisis period, stabilizing it through the exchange rate adjustments is possible. Overall, the results favor the flexibility in exchange rate.

Stability in exchange rate also important as exchange rate plays a conflicting role as a shock absorber and shock-generator and that the effects of external shocks on the domestic economy are increasing over time. Therefore, flexibility and stability in exchange rate should be of emphasized in the monetary policy setup in East-Asia.

1.7 Summary

This thesis conducts both theoretical simulations and empirical analyses in analyzing the role of exchange rate in the monetary policy framework for the emerging East-Asian countries. The main purpose of this thesis is to investigate the role of exchange rate in the monetary policy formation for the emerging East-Asian countries and seeks to suggest the robust and effective policy rule for these economies. The investigation is conducted by considering the country specific factors such as the degree of exchange rate pass-through and trade openness, policy targets, the source and persistency of shocks between the two sub-period of pre- and post-crisis 1997/98. Empirical estimations are carried out to provide evidences on the change in the economic structure, the source of shocks, the policy reaction function and the degree of exchange rate pass-through across East-Asian countries in the pre- and post-crisis periods.

The results provide information on the change in the economic structure and policy regimes in these countries over time and also suggest an effective monetary policy rule for these countries. The findings provide important information for the policy decisions and evaluations.

The theoretical simulated results indicate that reacting directly to the exchange rate movements in the policy rule is welfare enhancing. Other more complicated rules such as the rule with history dependent terms also outperform the baseline rule. The best rule is the hybrid (with forward- and backward-looking components) rule that react to the exchange rate movements. These rules are robust as they always show improvements under different parameterizations, policy weightings and persistency of shocks. However, the size of improvement may vary depending on the country's specific factors such as the source of shocks, the persistency of shocks, trade openness and the degree of exchange rate pass-through. In particular, the size of improvement is large when the pass-through is high and under the condition where nominal shocks are more prevails. Since these factors are of country specific, the size of improvement to react to the exchange rate movements may vary across countries and change over time.

Should a central bank targets on CPI inflation or domestic inflation? The simulated results show that targeting on CPI inflation generates lower welfare loss and variability. Moreover, the policy maker can influence the domestic inflation indirectly by reacting to the exchange rate movements. On the other hand, exchange rate plays a more prominent role in adjusting prices under domestic inflation targeting. Including the exchange rate term in the baseline domestic inflation targeting rule induces larger improvement compared to that in CPI inflation targeting.

Overall, the theoretical simulations suggest that East-Asian countries that experience high exchange rate pass-through into import price and face prominent nominal shocks should react to the exchange rate movements under the flexible exchange rate regime.

How about the empirical outcomes? Do the empirical results support the theoretical findings? The empirical results reveal some economic structures which favor the reaction of monetary policy to exchange rate movements. The empirical estimations show that the degree of exchange rate pass-through into import price has increased significantly in East-Asia aftermath the crisis. Besides, shocks are asymmetric across these countries with the main shocks are domestic (nominal) shocks. These results support the results of theoretical outcomes, i.e. reacting to exchange rate movements in the policy rule is welfare improving under higher pass-through case and more prominent nominal shocks.

The empirical analysis on the policy reaction function also reveals the evidences that the central banks in East-Asian countries still react to the exchange rate movements under the flexible exchange rate regime aftermath the crisis. The results imply that these countries do not implement the purely floating exchange rate regime as they declared officially. Indeed, these countries are implementing the effective monetary policy rule suggested by the theoretical outcomes, i.e. reacting to the exchange rate movements under the flexible exchange rate and inflation targeting regimes.

The empirical evaluations show that this monetary policy rule/ regime is more effective and influential as the inflation rate is lower and exchange rate acts a better role as a shock absorber. The monetary policy is also more influential in determining the movements in exchange rate, the demand and supply.

As a conclusion, the empirical results are in line with the theoretical outcomes in which it is more effective and welfare improving to react to the exchange rate movements under the flexible exchange rate regime. There are evidences the central banks in these countries implement the effective policy rule suggested by the empirical outcomes, i.e. reacting to exchange rate movements under the flexible exchange rate regime aftermath the crisis. This policy rule/ regime is more effective as inflation remains low and exchange rate plays a greater role as a shock absorber.

1.8 Contributions

This thesis contributes to the monetary policy analysis and evaluation in the context of a small open economy, in particular the emerging countries of East-Asia. It provides better understanding in the economic structures, the main factors/ shocks to the economic fluctuations, exchange rate flexibility and monetary policy across East-Asian countries and the change in these aspects over time, in particular in the pre- and post-crisis periods of 1997-98. This thesis also conducts analyses to investigate the links between these aspects to the change in the policy regimes and how these factors determine the performances of policy regimes, or in other word, how these country specific factors influence the role of exchange rate in the monetary policy framework in these countries over time. The main discussions or investigations on the performances of policy rules/ the merits of policy regimes are focused on the degree of exchange rate pass-through, trade openness, policy targeting, the source and persistency of shocks.

Applying both theoretical and empirical approaches in analyzing the monetary policy setup for East-Asia, this thesis reports consistent results from both approaches that favor the reaction to exchange rate movements under the flexible exchange rate

regime for East-Asia. The results provides useful information for the monetary policy decisions and evaluations for the emerging (East-Asian) countries.

1.9 Suggestions/ recommendations

In general, this thesis demonstrates that the policy reaction function in East-Asia can be more effective if it reacts to the exchange rate movements. Empirical results also support the necessity to concern on exchange rate stability for East-Asia. As the size of improvement on the performance of policy rule is endogenous to country specific factors such as the economic structure, the degree of exchange rate pass-through and trade openness, the source and persistency of shocks and policy objectives, the effectiveness of the same policy rule could be different when applying it to different countries and over time. Hence, it is important for the monetary authority to concern the change in these country specific factors from time to time when making the policy decisions.

Additionally, empirical results also demonstrate that flexibility in exchange rate provides more space for exchange rate to act as a shock absorber aftermath the crisis in East-Asia. At the same time, stability in exchange rate reduces the excessive volatility caused by flexibility in exchange rate. Therefore, flexibility and stability in exchange rate should be emphasized in the monetary policy setup. Stability in exchange rate is achieved through intervention in the foreign exchange market and also through interest rate adjustments (i.e. policy reaction function reacts to the exchange rate term).

Apart from these, the capacity of monetary authority to implement the monetary policy is closely related to the central bank's credibility and independence issues and political aspect. The effective monetary policy requires the inflation credibility or commitment from both the public and monetary institutions to price stability. Therefore, these institutional arrangements and politic aspects should not be ignored in the setup of monetary policy. Calvo and Mishkin (2003) suggest greater focus on the institutional arrangements in emerging countries than the exchange rate regime. They believe that better developments in the institutional reforms such as better fiscal restraint, improvement in financial system and regulations, the setup of consensus for a sustainable and predictable monetary policy is a key to macroeconomic success in emerging market countries.

Overall, the study in the monetary policy/ regime requires a deep understanding of a country economic, financial, monetary and politic structure. These aspects could be different across countries and change over time. Therefore, there is no single policy rule or policy regime that can suit for every country and forever.

As the main factor that leads to very different monetary policy setup in emerging countries to that in developed countries is the weaknesses and undeveloped in economic, financial system, institutional reforms and politic culture in emerging countries, greater concern has to be put on these aspects besides studying and suggesting a more effective monetary policy for these economies. These aspects also determine the effectiveness of a policy rule or regime in emerging economies.

References

- Adolfson,M., Linde,J & Villani,M. 2006. Forecasting performance of an open economy dynamic stochastic general equilibrium model. Working paper. Sveriges Riksbank.
- Adolfson,M. 2001. Monetary policy and exchange rates-breakthrough of pass-through. Stockholm School of Economics, The Economic Research Institute.
- Adolfson,M. 2007. Incomplete exchange rate pass-through and simple monetary policy rules. *Journal of International Money and Finance* 26: 468-494.
- Aizenman,J. & Marion,N. 2003. Foreign exchange reserves in East Asia: why the high demand? FRBSF Economic Letter. No. 2003-11.
- Alexius,A. & Post,E. 2008. Exchange rates and asymmetric shocks in small open economies. *Empirical Economics* 35: 527-541.
- Amato,J. et al. 2005. Research on exchange rates and monetary policy: an overview. BIS working papers no. 178.
- Ambler,S., Dib,A. & Rebei,N. 2003. Nominal rigidities and exchange rate pass-through in a structural model of a small open economy. Bank of Canada.
- Artis,M. & Ehrmann,M. 2006. The exchange rate – a shock absorber or source of shocks? A study of four open economies. *Journal of International Money and Finance* 25: 874-893.
- Ball,L. 2000. Policy rules and external shocks. NBER working paper series 7910.
- Ball,L. 1998. Policy rules for open economies. NBER working paper series 6760.
- Batini,N., Harrison,R. & Millard,S.P. 2001. Monetary policy rules for an open economy. Bank of England.
- Benigno,G. & Benigno,P. 2000. Monetary policy rules and the exchange rate. University of California.
- Bodnar,G.M. & Gentry,W.M. 1993. Exchange rate exposure and industry characteristics: Evidence from Canada, Japan & USA. *Journal of International Money and Finance*.12: 29-45.
- Brischetto,A & Voss,G. 1999. A structural vector auto regression model of monetary policy in Australia. Bank of Australia Research Discussion paper 1999-11.
- Burstein,A., Eichenbaum,M. & Rebelo,S. 2005. Large devaluation and the real exchange rate. *Journal of Political Economy* (forthcoming).
- Calvo,G. 2000. Capital markets and the exchange rate with special reference to the dollarization. Debate in Latin America. Mimeo University of Maryland at College Park.

-
- Calvo,G.A. & Mishkin,F.S. 2003. The mirage of exchange rate regimes for emerging market countries. NBER working paper 9808.
- Campa,J.M. & Goldberg, L.S. 2002. Exchange rate pass through into import prices: A macro or micro phenomenon? NBER working paper no. 8934.
- Campa,J.M. & González-Mínguez,J.M. 2002. Differences in exchange rate pass-through in Euro area. Universidad de Navarra.
- Clarida,R.H., Gali,J. & Gertler,M. 2001. Optimal monetary policy in closed versus open economies: An integrated approach. NBER no 8604.
- Corsetti,G. 2005. Openness and the case for the flexible exchange rate. European University Institute, University of Rome III & CEPR.
- Côté,D. et. al. 2002. The performance and robustness of simple monetary policy rules in models of the Canadian economy. Manuscript, Bank of Canada.
- Desroches,B. 2004. The transmission of world shocks to emerging market countries: an empirical analysis. Bank of Canada working paper 2004-44.
- Devereux,M.B & Lane,P.R. 2001. Exchange rate and monetary policy in emerging market economics. CEPR.
- Devereux, M.B., Lane, P.R. and Xu,J. 2005. Exchange rate and monetary policy in emerging market economies. The Institute for International Integration Studies Discussion paper series.
- Edwards, S. 2006. The relationship between exchange rates and inflation targeting revisited. NBER working paper series no. 12163.
- Eichengreen,B. 2004. Monetary and exchange rate policy in Korea: assessments and policy issues. University of California.
- Faia,E. & Monacelli,T. 2006. Optimal monetary policy in a small open economy with home bias. Universitat Pompeu Fabra & Universita Bocconi & CEPR.
- Flamini,A. 2004. Inflation targeting and exchange rate pass-through. Graduate Institute of International Studies. Working paper no. 04/2004.
- Fraga, A. et al. 2003. Inflation targeting in emerging market economies. In: getler, Mark & Keneth Rogoff, orgs. NBER Macroeconomics Annual 18. MIT Press: 365-400.
- Frankel,J.A. & Rose,A.K. 1998. The endogeneity of the optimum currency area criteria. The Economic Journal 108: 1009-1025.
- Gagnon,J.E. & Ihrig,J. 2001. Monetary policy and exchange rate pass-through. International Finance Discussion papers.

-
- Gali, J. & Monacelli, T. 2004. Monetary policy and exchange rate volatility in a small open economy. CEPR.
- Garton, P. 2004. Foreign reserve accumulation in Asia: can it be sustained? Australia Treasury.
- Gerlach, S. & Smets, F. 2000. MCIs and monetary policy. *European Economic Review* 44: 1677-1700.
- Ghironi, F. & Rebucci, A. 2001. Monetary policy rules for emerging market economies. Borton College & IMF.
- Ghironi, F. 2000. Alternative monetary rules for a small open economy: The case of Canada. Borton College.
- Ghironi, F. 2000. Towards new open economy macroeconometrics. Federal Reserve Bank of New York.
- Goldfajn, I. & Sergio, W. 2001. The pass through from depreciation to inflation: A panel study. PUC-Rio working paper no. 423.
- Ito, T., Sasaki, Y.N. & Sato, K. 2005. Pass-through of exchange rate changes and macroeconomic shocks to domestic inflation in East Asian countries. RIETI discussion paper series 05-E-020.
- Kamps, A. 2006. The Euro as invoicing currency in international trade. Working paper series no. 665. European Central Bank.
- Karame, F., Paturean, L. & Sopraseuth, T. 2003. Limited participation and exchange rate dynamics: does theory meet the data? Universite D'Evry.
- Lane, P. 2001. The new open macroeconomics: a survey. *Journal of International Economics*. 54: 235-266.
- Leitemo, K. & Söderström, U. 2004. Robust monetary policy in the New Keynesian framework. Discussion paper no. 4805. Centre for Economic Policy Research.
- Leitemo, K. & Söderström, U. 2005. Simple monetary policy rules and exchange rate uncertainty. *Journal of International Money and Finance* 24: 481-507.
- Lindé, J., Nessén M. & Söderström, U. 2004. Monetary policy in an estimated open economy model with imperfect pass-through. Sveriges Riksbank.
- Lipinska, A. 2005. Monetary regime choice in the accession countries – theoretical analysis (preliminary). Universitat Autònoma de Barcelona.
- Lubik, T. & Schorfheide, F. 2005. A Bayesian look at new open economy macroeconomics. Johns Hopkins University & University of Pennsylvania.
- Maih, J. 2005. Wage-price dynamics in a Bayesian DSGE model with imperfect exchange rate pass-through. University of Oslo.

-
- Marcos,A.C. 2006. Two-country New Keynesian DSGE model in a small open economy as a limit case. IPEA-Rio.
- McCallum, B.T. 2007. Monetary policy in East Asia: the case of Singapore. IMES discussion paper series 2007-E-10.
- McCauley, R.N. 2006. Understanding monetary policy in Malaysia and Thailand: objectives, instruments and independence. BIS papers no. 31.
- McKinnon,R. & Schnabl,G. 2003. A return exchange rate stability in East Asia? Mitigating conflicted virtue. Stanford University & Tübingen University.
- Minella,A. et al. 2003. Inflation targeting in Brazil. Constructing credibility under exchange rate volatility. *Journal of International Money and Finance*. 22: 1015-1040.
- Mishkin,F.S. 2000. Inflation targeting in emerging market countries. NBER working paper series no. 7618.
- Mohanty,M.S. & Klau,M. 2004. Monetary policy rules in emerging market economies: issues and evidence. BIS working papers no. 149.
- Mohanty,M.S. & Klau,M. 2005. Monetary policy rules in emerging market economies: Issues and evidence.: in *Monetary policy and macroeconomic stabilization in Latin America*, eds. Rolf J. Langhammer and Lucio Vinhas de Souza. The Kiel Institute.
- Monacelli,T. 2003. Monetary policy in a low pass through environment. European Central Bank working paper no. 227.
- Moron,E. & Winkelried,D. 2001. Monetary policy rules for financially vulnerable economies. University del Pacífico & Banco Central de Reserva del Perú.
- Nogueira Junior,R.P. 2007. Inflation targeting and the role of exchange rate pass-through. University of Kent.
- Obstfeld,M. & Rogoff,K. 1996. *Foundations of international macroeconomics*. Harvard University.
- Osawa,N. 2006. Monetary policy responses to the exchange rate: empirical evidence from three East Asian inflation targeting countries. Bank of Japan working paper series no. 06-E-14.
- Parrado,E. 2004. Singapore's unique monetary policy: how does it work? IMF working paper.
- Ruge-Murcia,F. 2003. Methods to estimated dynamic stochastic general equilibrium models. Université de Montréal.
- Pierdzioch,C. 2003. Home-product bias, capital mobility and the effects of monetary policy shocks in open economies. Kiel Institute for World Economic.

-
- Ramayandi,A. 2005. ASEAN monetary cooperation: Issues and prospects. Pacific Economic papers no. 349. Australia-Japan Research Centre. The Australian National University.
- Santoso,W. 2000. Exchange rate policy in the post financial crisis: the case of SEACEN countries. SEACEN Research & Training Centre. Kuala Lumpur.
- Schmidt-Hebbel,K. & Werner,A. 2002. Inflation targeting in Brazil, Chile and Mexico: performance, credibility and the exchange rate. *Economia*. 2(2): 31-89.
- Senay,O. 2001. The role of exchange rate in monetary policy rules. Middle East Technical University & University of York.
- Smets,F. & Wouters,R. 2002. Openness, imperfect exchange rate pass-through and monetary policy. NBB working paper no. 19.
- Smets,F. & Wouters,R. 2002. Openness, imperfect exchange rate pass-through and monetary policy. European Central Bank working paper no. 128.
- Smets,F. & Wouters,R. 2003. Forecasting with a Bayesian DSGE model: an application to the Euro area. Working paper. National Bank of Belgium.
- Soto,C. & Selaive,J. 2003. Openness and imperfect pass through: implications for the monetary policy. Central Bank of Chile working papers no. 26.
- Sutherland,A. 2002. Incomplete pass through and the welfare effects of exchange rate variability. University of St. Andrew & CEPR discussion paper series no. 212.
- Taylor,J.B. 2000. Using monetary policy rules in emerging market economies. Stanford University.
- Taylor, J.B. 2001. The role of the exchange rate in monetary policy rules. *American Economic Review* 91(2): 263-267.
- Walsh,C.E. 2003. Monetary theory and policy. Second edition. Cambridge MA.
- Warnock,F.E. 2000. Exchange rate dynamics and the welfare effects of monetary in a two-country model with home bias. Board of Governors of the Federal Reserve System.
- Welz,P. 2005. Transmission of exchange rate variations in an estimated, small open economy model. Uppsala University.
- Wohltmann,H-W. & Winkler,R. 2008. Anticipated and unanticipated oil price shocks and optimal monetary policy. Christian-Albrechts-Universitat Kiel. Economic working paper no. 2008-05.
- Wollmershäuser,T. 2006. Should central banks react to exchange rate movements? An analysis of the robustness of simple policy rules under exchange rate uncertainty. *Journal of Macroeconomics* 28: 493-519.

CHAPTER TWO

THE ECONOMIC STRUCTURES AND MONETARY POLICY OF EAST-ASIA – SOME REVIEWS

Abstract

Included in this chapter are some reviews about the economic and monetary policy in East-Asia. This chapter also discusses some economic features and structures in these countries that require greater concerns from the authorities. Due to the weaknesses in the economic and financial systems, these emerging countries conduct a quite different monetary policy framework compare to the developed economies. The link between the economic country specific factors and the monetary policy framework in these countries is worth for further research and attention.

2.1 Introduction

This chapter provides some reviews about the economic features/ structures and monetary policy in East-Asia. The countries that included in the discussion are Indonesia, Korea, Malaysia, Philippines, Thailand and Singapore. These countries suffered from the economic downturn caused by the Asian financial crisis of 1997-98 and have reconstructed their monetary policy framework¹. Most of these crisis-hit countries experience drastic changes in the policy regimes from fixity to floating exchange rate regime aftermath the crisis. Besides, East-Asian countries also exhibit some economic structures/ features that are very different from the other countries. This thesis seeks to analyze the links between the economic structures/ features in East-Asia to the change in the policy regimes and how the country specific factors matter in determining the performances of the monetary policy in these countries over time.

2.2 The economy of East-Asia

2.2.1 The economic features

As mentioned earlier, the main focus of this thesis is on the design of monetary policy rules in the small open economics of crisis-hit East-Asian countries. These countries are of interest as they exhibit some economic features that are different from the other countries. They are small, open economies with high rate of growth, but financially unstable. These economies are influenced greatly by the large economies such as Japan and U.S.

One of the great influences of U.S. on the East-Asian economies is that most of the East-Asian countries pegged their currencies to USD as single peg or basket peg in previous years. For example, Thailand pegged its currency to USD from 1963 to 1984 and later basket pegged the Japan yen, USD and Singapore Dollar until 1994. Malaysia and Singapore also pegged their currencies to USD before year 1974 (IFS, IMF).

From the aspect of international trade, U.S. and Japan appear to be the main trade partners for these countries over decades. The IMF's Direction of Trade Statistics Yearbook, various publications show that U.S. and Japan are the main trade partners in most of the East-Asian countries (**see Table I-A(1), Appendix I-A**). The trade with U.S. and Japan in most of the East-Asian countries are more than 30% on average. Singapore becomes a third larger trade partners to Thailand, Malaysia and Indonesia. This pattern of trade remains in these countries after the financial crisis of 1997-98 as shown in **Table I-A(1)**.

Table I-A(1 & 2a)

However, regardless the individual trade partner and focus on the regional trade area, Asia is the main direction of trade for both import and export in East-Asian countries. Asia amounts for more than 50% of the trade (import and export) in most of the East-Asian countries since 1990s.

¹ With the exception of Singapore that only experience relatively low effects from the crisis.

Table I-A(2b & 2c)

Besides being the main trade partner, U.S also has great influences on East-Asian economies as most of the international trade in Asian countries are traded in USD. For example, 85% export and about 80% of imports in Korea are invoiced in USD and with about 12.4% of import are invoiced in yen. USD is more important than Yen in the trade between Japan and East Asia (Sato, 1999). USD also appear as the main invoicing currency in the trades between other East-Asian countries.

Table I-A(3)

Due to the currency asymmetry and high dollar standard, the capital markets in these countries are incomplete as well (McKinnon & Schnabl (2003)). Therefore, the other main feature of East-Asian countries is that they are financially vulnerable and market imperfection.

Another feature of East-Asian countries is that the trade components comprise a large portion of intermediate goods. For example, data shows more than 70% of imports of Malaysia are intermediate goods. In Philippines, more than 40% of its imports are raw materials and intermediate goods. Under this condition, the prices stability in these countries is easily affected by external shocks through imported inflation intermediate goods.

Table I-A(4a, 4b & 4c)

Due to these economic features and structures, these emerging markets may experience different economic outcomes as compare to the large and closed economy like U.S. This thesis seeks to analyze how the different economic features and structures of emerging market influences the setup of monetary policy and which monetary policy rule works efficiently in these economies.

2.2.2 The economy in the pre- and post-crisis

The financial crisis of 1997-98 brought many changes to the crisis-hit East-Asian countries, both the economics conditions and developments and the policies setup. Referring to the economics indicators in these countries over time, it is observed that the large effects of crisis are on the current account, exchange rate volatility and total external debt.

Table I-A(5, 6 & 7)

As shown in the table, the financial crisis of 1997-98 brought the economies to the bad situation with higher inflation rate, lower GDP growth and higher money supply rate especially in year 1997 and 1998. Indonesia was the most crisis affected country. Indonesia experienced very large increase in CPI inflation rate and decline in GDP growth rate during the crisis. **Appendix I-B** shows the line graph of CPI and imported inflation for six Asian countries before and after the crisis. As can be seen from the graphs, Indonesia experienced relatively higher CPI inflation rate than the other crisis-hit Asian countries. In general, imported inflation is higher and more fluctuate than the CPI inflation.

The inflation rate and M2 growth rates show the same co-movement. Indeed, some studies show that the high inflation rate in Indonesia was due to the excessive money supply (for example Ito et al. (2005)). The crisis also contributed to the large increases in the external debt during the crisis periods especially in Indonesia.

Turning to the current account balance, we can see that all the six East-Asian countries experienced surpluses in their current accounts during the crisis, i.e. year 1998. The current account surpluses can be explained by the large depreciation in the domestic currencies exchange rate. The depreciation of the domestic currencies implies cheaper domestic goods prices relative to the foreign one and this raises the competitiveness of domestic goods in the international market. However, it is not surprising that Indonesia only experienced a very low surplus of about 4% compared to Singapore with 22%. The reason is although Indonesia experienced very high depreciation in the exchange rate, the positive effect of depreciation was offset by the high inflation rate.

The financial crisis led to large depreciation in the domestic currencies with the exception of Singapore. Indonesia and Korea experienced very large depreciation in their currencies exchange rate at the end of 1997 of 95.13 and 100.78 percent respectively. The change in exchange rate also can be observed through the line graph of three exchange rate series in **Appendix I-B**. From these graphs, one can observe that the crisis-hit countries experienced large depreciation in the nominal bilateral exchange rate per USD, real and nominal effective exchange rate during the crisis.

Comparing the economic performances before and after the crisis, one can observe that the economies in these countries have recovered and returned to the better levels. The GDP growth rates are positive in general but lower compared to the periods before the crisis. The CPI inflation rates become stable and even lower than the rates before the crisis in some countries such as Thailand and Singapore. The money supply (M2) rates are lower after the crisis with the exception of Philippines.

Table I-A(6 & 7) show the annually inflation rate and GDP growth rate from 1990-2006. In general, one can observe that these crisis-hit East-Asian countries have gained the stable and low inflation rates after the crisis of 1997-98 with the exception of Indonesia. On the other hand, the GDP growth rates have declined in Indonesia, Korea, Malaysia and Thailand. This implies the trade-off between inflation rate and GDP growth rate targeting in the open economy framework. After the financial crisis, Indonesia, Korea, Philippines and Thailand have adopted the inflation targeting regime. These countries gain lower and stable inflation rates but at the same time, face declines in the GDP rates as shown by the data.

On the other hand, the current account balance in these countries have changed from negative to positive values after the financial crisis of 1997-98 with the exception of Singapore which was the positive values before crisis. Malaysia and Singapore exhibit higher positive values in current account balance. The external debt also shows a tendency of converging to the stable and lower level as before the crisis.

Although East-Asian countries are considered to be open in trade, they have different degree of trade openness. The degree of trade openness can be measured by the trade dependency ratio (TDR), which is the ratio of trade (import and export) over GDP (in

billion USD). The higher the TDR, the more open one economy. All the six East-Asian countries show higher degree of trade openness after the crisis.

2.2.3 Business cycle fluctuations and the structure of shocks

Literatures in the business cycle features provide some light about the macroeconomic dynamics and the source of economic fluctuations in emerging countries. Due to the economics structure, East-Asian countries exhibit different structures of shocks compare to the other developing countries such as Latin America and transition Europe countries. Investigating the business cycle features in Asian and G7 countries, Kim, Kose and Plummer (2000) find that Asian economies are more open in trade to G7 economies. At the same time, East-Asian economies exhibit higher diversification in export over time. These economies experience significant increase in the ratio of investment, export and import to output over time. These economies also show a tendency to grow simultaneously in their industrial production and service sector. On the other hand, the agricultural sector share is diminishing over time. The trade in total export within the Asian region has increased over time as well. The main factors that contribute to the macroeconomic fluctuations in Asian countries are investment, government spending and consumption. Besides, the business cycle fluctuations in Asian countries exhibit some degrees of co-movements.

Empirical studies show that East-Asian countries are subject to country specific shocks where supply shock leads to the main fluctuations in these economies. External shocks only explain a small part of the economic fluctuations in these countries (for example Sun and An (2008)).

Table I-A(9)

Hoffmaister and Roldós (1997) also report quite similar results: Asian countries is driven by domestic shocks where the main shock is supply shock; external shocks play a small role in determining the output growth in Asia but it is important in explaining the trade balance in these countries. Other studies find correlation in shocks in a subset of East-Asian countries which favor the formation of Optimum Currency Area in a subset of these countries (Kwan (1994), Eichengreen & Bayoumi (1996) and Bayoumi et al. (2000)).

2.3 The monetary policy in East-Asia

Most of the crisis-hit East-Asian countries have moved from the rigid exchange rate regime to the flexible one and inflation targeting after the crisis of 1997-98. The countries that have shifted to the inflation targeting regime include Indonesia, Korea, Philippines and Thailand. These countries have adopted the inflation targeting regime at different time. Korea was firstly adopted the inflation targeting regime in April 1998, followed by Indonesia, in January, 2000, Thailand in May 2000 and later Philippines in January 2002.

Table I-A(8)

The monetary policy in Thailand has gone through three different periods and regimes, i.e. pegged exchange rate regime (Second World War – June 1997),

monetary targeting regime (July 1997 – May 2000) and inflation targeting regime (May 2000 – present). Thailand shows a long history of pegging since the Second World War either pegging baht to a major currency/ gold or to a basket of currencies. From November 1984 until June 1997, the baht was pegged to a basket regime and the Exchange Equalization Fund (EEF) was set up in order to monitor the Baht value against the US dollar daily.

In the beginning of crisis in July 1997 to May 2000, Thailand released the pegged system and adopted the monetary targeting regime. The main objective to target at domestic money supply was to ensure macroeconomic consistency as well as to sustain growth and price stability. During these periods, the daily liquidity was monitored through the setting of daily and quarterly monetary base targets.

Under the inflation targeting regime, the core inflation is set consistent to the trading partners' average inflation rate to enhance export competitiveness. The core inflation rate is in quarterly. At the same time, Thailand adopts the managed floating exchange rate regime. The bank of Thailand manages the exchange rate movements through intervention in the foreign exchange market. According to McCauley (2006), the objectives of monetary policy in Thailand and Malaysia are quite similar. The main objectives for both central banks are to achieve low inflation and stability in exchange rate by intervening in the foreign exchange market, controlling the capital transactions and influencing the short term interest rate.

Malaysia was moving from monetary targeting towards interest rate targeting in the mid 1990s. Prior to the mid 1990s, Bank Negara Malaysia (BNM) targeted on monetary aggregates by influencing the day-to-day volume of liquidity in the money market in order to achieve price stability (Cheong (2005)). However, due to the large capital inflows in 1992-93 and the reversal in the following year, the monetary aggregate became unstable. Due to this reason, BNM shifted to target at interest rate. At the same time, BNM did not abandon the monetary aggregates monitoring. The interest rate targeting was implemented to achieve financial stability.

The exchange rate policy has been implemented in Singapore since 1981. The main objectives are to achieve price stability and economic growth. The exchange rate policy in Singapore has four main features. First, the Singapore dollar is weighted by a basket of currencies of its major trading partners where the composition of the basket is revised periodically. Second, Singapore implements the managed floating exchange rate regime where the movements of trade-weighted exchange rate are managed within a policy band. Third, MAS periodically reviews the exchange rate policy band. Lastly, MAS does not influence the movements in domestic interest rates and money supply. According to McCallum (2007), the monetary policy in Singapore can be regarded as a variant of inflation targeting. MAS does not peg the exchange rate. The exchange rate is used as the instrument to achieve the target of low inflation. In the estimation of the monetary policy for Singapore, Parrado (2004) and McCallum (2007) use the change in exchange rate as the policy reaction function rather than interest rate.

The exchange rate regimes in Indonesia show a tendency to move to more flexible regimes, i.e. from fixed exchange rate in 1970's to managed floating (1970's to 1990's) and free floating regime after the financial crisis of 1997-98. The central bank

of Indonesia influences the movements of exchange rate through intervention in the foreign exchange market (Bandyopadhyay (2008)).

Inflation targeting regime has implemented in Indonesia since July 2005. As stated in Bandyopadhyay (2008)), the main elements in the framework include BI rate replaces the monetary base operational target to control the money supply; the monetary policy making process takes the form of forward looking and a more clear and transparent communication strategy.

The short term interest rate is not the only toolkit in the monetary policy framework. The central bank may control the exchange rate movements through the foreign exchange intervention. In East Asia, the foreign exchange intervention is very common and become more prominent after the financial crisis of 1997-98. At the end of May 2002, East-Asia held 845 billion USD or 38% of the world's foreign exchange reserves. China, Taiwan, Hong Kong, South Korea and Singapore are the countries after Japan that hold the world's biggest portion of foreign exchange reserves (Aizenman & Marion (2003)). The accumulation of large foreign reserve reflects the discretionary intervention in the foreign exchange market.

As mentioned in Amato et al. (2005), intervention affects exchange rate through four main channels: the monetary channel, the portfolio channel, signaling effects and market microstructure effects. Intervention operates through the monetary channel, i.e. affecting the interest rate when the central bank does not offset completely the effect of intervention on the domestic bank reserves. Apart from this, the monetary channel can also be discussed in the context of sterilized and non-sterilized intervention. The portfolio channel operates through the effects of relative supply of assets on asset prices that are imperfect substitutes. The signaling channel reflects the information on future monetary policy intentions. The effects of this channel on exchange rate depend on the changes of exchange market's expectations or public's perceived on the intervention. The market microstructure channel influences the exchange rates based on the informational asymmetries. The effectiveness of this channel depends on the market structure and also the composition of participants.

Although most of the East-Asian countries have moved to more the flexible exchange rate regimes after the financial crisis of 1997-98, the central banks in these countries still concern about the exchange rate stability through intervention in the foreign exchange market.

2.4 Summary

The East-Asian countries exhibit very different economic structures and features to the other countries. Due to the weaknesses in economic and financial counterparts, these countries are weak to the exposure of external shocks especially the impacts from U.S. The financial crisis of 1997-98 has induced the monetary authorities to reconstruct their monetary policy framework. Drastic changes in the monetary policy regimes are observed aftermath the crisis.

References

- Aizenman, J. & Marion, H. 2003. The high demand for international reserves in the Far East: what is going on? *The Japanese and International Economies* 17: 370-400.
- Amato, J. et al. 2005. Research on exchange rates and monetary policy: an overview. BIS working papers no. 178.
- Cheong, L.M. 2005. Globalization and monetary policy in emerging markets. Vol. 23: 209-15. Bank for International Settlements.
- Alexius, A. & Post, E. 2008. Exchange rates and asymmetric shocks in small open economies. *Empirical Economics* 35: 527-541.
- Artis, M. & Ehrmann, M. 2006. The exchange rate – a shock absorber or source of shocks? A study of four open economies. *Journal of International Money and Finance* 25: 874-893.
- Bandyopadhyay, S. 2008. Monetary policy by Indonesia, Malaysia and Thailand in the era of excess Forex reserve.
- Bayoumi, T., Eichengreen, B. & Mauro, P. 2000. On regional monetary arrangements for ASEAN. *Journal of the Japanese and International Economies* 14: 121-148.
- Cheong, L.M. 2005. Globalization and the operation of monetary policy in Malaysia. In: *Globalisation and monetary policy in emerging markets*. BIS paper no. 23. pg. 209-15. Bank for International Settlements.
- Cheong, L.M. 2005. Globalization and monetary policy in emerging markets. Vol. 23: 209-15. Bank for International Settlements.
- Drine, I. & Rault, C. 2004. The sources of real exchange fluctuations in developing countries: an econometric investigation. The William Davidson Institute. Working paper no. 653.
- Eichengreen, B. & Bayoumi, T. 1996. Is Asia an optimum currency area? Can it become one? Regional, global and historical perspectives on Asian monetary relations. Center for International and Development Economics Research. University of California, Berkeley.
- Hernández, L. & Montiel, P. 2001. Post-crisis exchange rate policy in five Asian countries: filling the “hollow middle”? IMF working paper 01/170.
- Hoffmaister, A.W. & Roldós, J.E. 1997. Are business cycles different in Asia and Latin America? IMF working paper WP/97/9.
- Hochreiter, E. & Siklos, P.L. 2002. Alternative exchange rate regimes: the options for Latin America. *The North American Journal of Economics and Finance* 13: 195-211.

-
- Ito,T., Sasaki,Y.N. & Sato,K. 2005. Pass-through of exchange rate changes and macroeconomic shocks to domestic inflation in East Asian countries. RIETI discussion paper series 05-E-020.
- Kamps,A. 2006. The Euro as invoicing currency in international trade. ECB working paper no. 665.
- Kim, S., Kose,M.A. & Plummer, M.G. 2000. Dynamics of business cycles in Asia: differences and similarities. Brandeis University. Working paper series vol. 2000-15.
- Kim, S., Kose,M.A. & Plummer, M.G. 2003. Dynamics of business cycles in Asia: differences and similarities. *Review of Development Economics*. Vol. 7: 462-477.
- Kwack,S.Y. 1999. Capital inflows and monetary policy in Asia before the financial crisis. KIEP working paper 99-12. Korea Institute for International Economics Policy.
- Kwan,C.H. 1994. Economic interdependence in the Asia-Pacific region. Routledge, London.
- McCallum, B.T. 2007. Monetary policy in East Asia: the case of Singapore. IMES discussion paper series 2007-E-10.
- McKinnon,R. & Schnabl,G. 2003. The East Asian Dollar standard, fear of floating and original sin. HKIMR working paper no. 11/2003.
- Parrado,E. 2004. Inflation targeting and exchange rate rules in an open economy. IMF working paper WP/04/21.
- Saucier,P. 2002. The case for an Asian exchange rate mechanism In: *Proceedings of the International Conference Towards regional currency areas*. Santiago, Chile.
- Sun,W. & An,L. 2008. Asymmetric shocks and exchange rate regimes in East Asia. *International Research Journal of Finance and Economics* 22: 38-48.
- The Monetary Authority of Singapore. 2001. Singapore's exchange rate policy. Singapore
- Zhang,Z. et al. 2004. Is a monetary union feasible for East Asia? *Applied Economics* 36: 1031-1043.

APPENDIX I-A

Table I-A(1): Main Trade Partners Based on Total Trade (Mn. USD)

Periods	Indonesia	Malaysia	Korea	Philippines	Singapore	Thailand
1990-96	1. Japan (127229) 2. U.S. (61067) 3. Singapore (37044) 4. Korea (29061) 5. China (17429)	1. Japan (144061) 2. Singapore (129243) 3. U.S. (127229) 4. Korea (25489) 5. Thailand (22636)	1. U.S. (334489) 2. Japan (293442) 3. China (68053) 4. Germany (65780) 5. Hong Kong (54089)	1. U.S. (58647) 2. Japan (46066) 3. Singapore (10993) 4. Hong Kong (10727) 5. Germany (9549)	1. U.S. (216133) 2. Malaysia (197040) 3. Japan (179240) 4. Thailand (63094) 5. Germany (43356)	1. Japan (153234) 2. U.S. (98187) 3. Singapore (55160) 4. Malaysia (23444) 5. Germany (19059)
2000-06	1. Japan (148739) 2. Singapore (108064) 3. U.S. (85359) 4. China (61284) 5. Korea (52366)	1. U.S. (256981) 2. Singapore (212060) 3. Japan (197238) 4. China (108222) 5. Thailand (69715)	1. China (471489) 2. U.S. (459480) 3. Japan (413818) 4. Germany (98716) 5. Hong Kong (92640)	1. U.S. (113182) 2. Japan (97320) 3. China (43000) 4. Singapore (42358) 5. Hong Kong (26680)	1. Malaysia (353153) 2. U.S. (285150) 3. Japan (204854) 4. China (187592) 5. Hong Kong (114347)	1. Japan (223159) 2. U.S. (159804) 3. China (94001) 4. Singapore (13490) 5. Malaysia (66715)

Notes:

All the figures are in Million U.S. Dollar

The figures shown represent the total trade (import plus export) for the given periods

All the series are from Asia Development Bank (ADB) key indicators, 2007 and the figures are calculated by the author

Table I-A(2a): Regional Trade Patterns, 1980–98 (selected years)
(In percent of total regional trade)

ASEAN*	1980		1985		1990		1995		1998	
	export	import	export	import	export	import	export	import	export	import
Within ASEAN	17.4	14.6	18.6	17.2	19.0	15.2	24.6	18.0	22.1	24.1
With Japan	29.6	22.3	25.1	20.5	18.9	23.1	14.2	23.8	11.1	16.9
With U.S.	16.3	15.3	19.5	15.2	19.4	14.4	18.6	13.8	20.6	13.8
With Euro area	10.4	9.6	8.4	10.0	11.7	11.2	10.8	11.1	11.9	8.9
With other ind. Countries	6.1	10.3	6.2	9.7	7.6	9.8	6.9	8.1	8.6	6.7
With other developing count.	20.2	28.6	21.5	26.7	23.1	25.2	24.3	24.3	25.2	28.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: IMF Direction of Trade Statistics

* (Association of Southeast Asian Nations): Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand, and Vietnam (Brunei data are not available).

Table I-A(2b): Direction of trade (imports in percentage)

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Asia					
1990	43.4	50.6	39.9	48.2	53.3
2000	65.8	64.9	53.8	57.0	60.8
2006	70.3	59.6	57.1	54.2	55.9
Europe					
1990	22.5	17.9	13.2	15.9	19.7
2000	13.1	12.5	12.5	14.4	12.2
2006	9.1	12.7	9.3	12.9	11.0
North & Central America					
1990	13.7	18.1	21.1	16.9	12.1
2000	9.3	17.1	22.4	16.7	12.4
2006	4.7	13.6	14.6	13.5	7.4
Middle East					
1990	5.0	1.2	11.8	11.0	4.1
2000	2.9	1.6	6.3	8.4	9.8
2006	5.7	4.2	8.4	9.8	14.3
South America					
1990	2.0	1.6	2.5	0.9	4.1
2000	1.4	0.6	0.6	0.4	9.8
2006	1.5	1.2	1.2	0.6	14.3
Africa					
1990	0.7	0.5	0.7	0.7	0.9
2000	1.0	0.5	0.3	0.4	0.5
2006	1.8	0.8	0.1	0.5	1.6
Oceania					
1990	6.0	4.3	4.3	2.2	2.0
2000	6.0	2.4	2.9	2.1	2.4
2006	4.8	2.2	2.2	1.7	3.1
Rest of the world					
1990	6.7	5.8	6.5	4.3	6.1
2000	0.5	0.5	1.2	0.6	0.7
2006	2.3	6.0	0.9	6.8	5.6

Notes:

The data are obtained from Asia Development Bank (ADB), direction of trade: Merchandise Imports (2001, 2007)

The figures show the import in percentages

Table I-A(2c): Direction of trade (exports in percentage)

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Asia					
1990	64.3	58.0	34.8	47.1	37.8
2000	58.0	53.8	42.1	57.2	48.9
2006	63.2	55.0	64.9	63.4	53.3
Europe					
1990	12.8	16.6	18.8	17.2	25.3
2000	15.3	14.9	19.7	15.4	18.0
2006	13.0	13.5	12.4	11.8	15.1
North & Central America					
1990	13.9	18.1	40.2	23.0	25.3
2000	17.9	24.9	35.9	20.4	24.7
2006	12.7	20.2	16.8	12.1	15.1
Middle East					
1990	3.0	2.5	1.6	2.7	5.4
2000	2.8	1.9	0.5	1.8	3.1
2006	2.7	3.0	0.6	2.2	4.4
South America					
1990	0.1	0.3	0.1	0.4	0.2
2000	0.8	0.6	0.4	0.4	0.7
2006	0.9	0.6	0.3	0.6	1.3
Africa					
1990	0.5	0.4	0.2	2.0	2.1
2000	1.2	0.6	0.1	1.2	1.2
2006	1.5	1.1	0.2	1.1	2.2
Oceania					
1990	1.9	2.0	1.6	4.0	1.9
2000	2.9	2.9	0.9	3.2	2.8
2006	3.3	3.3	1.1	5.1	3.9
Rest of the world					
1990	3.5	2.2	2.6	3.7	2.1
2000	0.9	0.4	0.3	0.3	0.8
2006	2.7	2.8	3.6	3.7	2.9

Notes:

The data are obtained from Asia Development Bank (ADB), direction of trade: Merchandise Exports (2001, 2007).

The figures show the exports in percentages

Table I-A(3): Invoicing Currencies in Asian Trade as Percent of Overall Trade

Countries	Year	Exports in goods			Imports in goods		
		EUR	USD	Home	EUR	USD	Home
Indonesia	1991	4.5	89.7	0.0	10.8	70.6	0.0
	1993	-	-	-	9.0	73.3	0.0
	1995	0.5	83.5	0.0	6.6	77.7	0.2
	1997	1.2	91.9	1.7	6.6	78.7	0.5
	1999	1.2	92.9	0.0	4.1	83.3	0.6
	2001	2.2	91.0	0.0	5.8	80.0	0.6
	2003	1.5	92.8	0.0	5.8	80.3	0.4
South Korea	1980	0.4	96.1	-	0.5	93.2	-
	1985	0.3	94.7	-	0.5	82.4	-
	1990	2.1	88.0	-	4.1	79.1	-
	1995	2.4	88.1	-	3.8	79.4	-
	2000	1.8	84.8	-	1.9	80.4	-
	2001	4.5	87.4	-	4.0	82.2	-
	2003	7.6	84.6	-	6.1	78.3	-
Malaysia	1995	3.2	61.7	18.7	8.2	1.2	-
	1996	2.8	66.0	17.8	6.8	1.0	-
	2000	-	90.0	-	-	-	-
Thailand	1993	1.0	91.8	0.9	5.1	74.3	0.6
	1995	0.5	91.0	2.4	3.6	80.7	0.5
	1997	0.4	92.0	2.1	3.5	80.4	1.7
	1999	1.7	87.6	3.7	3.0	79.2	2.2
	2001	2.8	85.7	4.0	5.1	77.9	3.5
	2003	2.7	84.4	5.0	4.3	76.0	5.6

Source: Kamps (2006)

Table I-A(4a): Intermediate goods

Countries	Average % consumption goods on total imports		Average % intermediate goods on total imports	
	1980-1996	1999-2005	1980-1996	1999-2005
Indonesia	6.58	7.10	57.03	61.00
Korea	4.82	8.19	45.39	54.83
Malaysia	12.64	7.75	59.62	71.71
Philippines	8.41	8.00	53.31	72.13
Singapore	13.97	11.41	46.89	62.82
Thailand	8.61	7.77	58.95	60.64
Average1	9.17	8.37	53.53	63.86
Average2	7.11	7.77	53.67	62.15

Source: the original series for annually imported intermediate and consumption goods are obtained from RIETI-TID (Research Institute of Economy, trade and Industry).

The values in the table are calculated by the author.

Average1 is the average values of all countries

Average2 is the average values of all countries but exclude Malaysia and Singapore

Table I-A(4b): Philippines: Composition of Imports (In Percent of total), 1993-98

	1993	1994	1995	1996	1997	1998
Mineral fuels and lubricants	11.5	9.6	9.3	9.4	8.5	6.8
Non-fuel imports	88.5	90.4	90.7	90.6	91.5	93.2
Capital goods	31.9	32.2	30.4	32.8	39.5	40.8
Raw Materials. & intermediate goods	44.6	45.0	46.1	44.1	40.3	39.2
Consumer goods	9.0	9.9	10.5	10.4	8.5	8.9
Special transactions*	3.0	3.3	3.6	3.2	3.3	4.2
Total	100.0	100.0	100.0	100.0	100.0	100.0

Source: Data provided by the Philippine authorities.

* Imports on consignment (for export use).

Table I-A(4c): Malaysia: Composition of Imports (In Percent of total), 1997-2003

	1997	1998	1999	2000	2001	2002	2003
Retained imports	96.67	95.28	96.46	97.91	97.38	96.69	97.26
Consumption goods	6.32	5.75	5.97	5.47	5.92	6.24	5.94
Capital goods	19.64	15.85	12.83	14.18	14.71	14.23	13.69
Intermediate goods	65.69	70.16	73.90	74.71	72.61	71.94	73.34
Dual use goods	2.81	1.67	1.99	2.05	2.08	2.02	2.22
Others	2.20	1.85	1.78	1.49	2.06	2.26	2.06
Imports for re-export	3.33	4.72	3.54	2.09	2.62	3.31	2.74
Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Sources: Data provided by the Malaysia authorities.

Table I-A(5): Economic indicators, 1985-2006

Indicators	Countries	1985	1990	1995	1997*	1998*	2000	2005	2006
GDP (Annual change,%)	Indonesia	2.5	9.0	8.2	4.7	-13.1	5.5	5.7	5.5
	Korea	6.5	9.2	9.2	4.7	-6.9	8.5	4.2	5.0
	Malaysia	-1.1	9.0	9.8	7.3	-7.4	8.9	5.0	5.9
	Philippines	-7.3	3.0	4.7	5.2	-0.6	4.4	4.9	5.4
	Singapore	14.6	9.2	8.1	8.3	-1.4	10.0	6.6	7.9
	Thailand	4.6	11.2	9.2	-1.4	-10.5	4.8	4.5	5.0
Inflation (Annual change,%)	Indonesia	4.7	-	9.5	6.2	58.5	9.3	10.9	12.7
	Korea	2.4	8.6	4.4	4.4	7.5	2.3	2.8	2.2
	Malaysia	0.4	3.1	4.0	2.8	5.2	1.5	3.1	3.6
	Philippines	23.4	12.4	6.7	5.6	9.3	4.0	7.6	6.2
	Singapore	0.5	3.5	1.8	2.0	-0.3	1.3	0.4	1.0
	Thailand	2.4	5.9	5.7	5.6	8.1	1.7	4.5	4.7
M2 (Annual change,%)	Indonesia	29.1	44.2	27.6	23.2	62.4	15.6	16.4	14.9
	Korea	15.6	17.2	23.3	19.7	23.7	5.2	7.0	12.5
	Malaysia	5.6	12.8	24.0	22.7	1.5	5.2	15.4	16.6
	Philippines	12.9	27.6	39.6	43.4	42.7	42.4	42.6	46.3
	Singapore	3.8	20.0	8.5	10.3	30.2	-2.0	6.2	19.4
	Thailand	10.3	26.7	17.0	16.4	9.5	3.7	8.2	6.0
CA (% of GDP)	Indonesia	-2.2	-2.6	-3.2	-2.3	4.3	4.8	0.1	2.6
	Korea	-0.9	-0.8	-1.7	-1.6	11.7	2.4	1.9	0.7
	Malaysia	-2.0	-2.1	-8.6	-4.4	16.6	9.0	14.5	16.4
	Philippines	-0.3	-5.8	-4.4	-5.3	2.4	-2.9	2.0	4.3
	Singapore	0.3	8.5	17.1	15.5	22.2	11.6	24.5	27.5
	Thailand	-3.9	-8.3	-7.9	-2.1	12.8	7.6	-4.5	1.6
Unemployment (%)	Indonesia	2.1	2.5	7.2	4.7	5.5	6.1	11.2	10.4
	Korea	4.0	2.4	2.1	2.6	7.0	4.1	3.7	3.5
	Malaysia	6.9	5.1	3.1	2.4	3.2	3.0	3.5	3.3
	Philippines	7.1	8.4	9.5	8.8	10.3	11.2	7.8	7.9
	Singapore	4.1	1.7	2.7	1.9	2.5	4.4	4.2	3.4
	Thailand	3.7	2.2	1.7	1.5	4.4	3.6	1.8	1.5
External Debt per GNI (%)	Indonesia	-	64.0	63.4	65.1	168.0	93.6	50.6	-
	Korea	-	13.3	16.7	26.7	40.9	26.4	23.8	29.7
	Malaysia	-	36.4	40.6	49.8	62.1	50.6	41.1	-
	Philippines	-	69.4	51.7	59.1	78.2	72.7	57.3	-
	Singapore	-	12.4	9.8	13.7	-	-	-	-
	Thailand	-	33.3	60.6	74.6	97.2	66.0	30.3	-
Growth of nominal exchange rate per USD (%), end of year	Indonesia	4.75	5.79	4.91	95.13	72.58	35.43	5.81	-8.24
	Korea	7.59	5.41	-1.78	100.78	-28.97	11.12	-2.27	-8.09
	Malaysia	0.06	-0.07	-0.70	53.89	-2.36	0.00	-0.53	-6.57
	Philippines	-3.68	24.78	7.36	52.07	-2.29	24.02	-5.69	-7.42
	Singapore	-3.35	-7.91	-3.18	19.70	-0.90	3.93	1.86	-7.85
	Thailand	-1.84	-1.56	0.40	84.49	-22.34	15.47	5.04	-12.15
Trade openness*	Indonesia	-	0.4152	0.4257	0.4409	0.7982	0.5796	0.4996	0.4439
	Korea	-	0.2976	0.4296	0.5107	0.6489	0.6504	0.7728	0.7984
	Malaysia	-	1.34332	1.7051	1.5679	1.8171	1.9212	1.8631	1.8680
	Philippines	-	0.4461	0.5636	0.6668	0.7749	0.8877	0.9686	0.9192
	Singapore	-	3.1324	2.8134	2.7697	2.6852	2.7312	3.4645	3.6847
	Thailand	-	0.6349	0.6907	0.7037	0.7884	0.8890	1.1828	1.2972

Notes: All the data are obtained from Asia Development Bank (ADB) key indicators, 2007

Table I-A(6): Inflation rate (annual change, %)

Year	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
1990	-	8.6	3.1	12.4	3.5	5.9
1991	9.3	9.4	4.4	17.7	3.4	5.7
1992	7.6	6.3	4.6	7.9	2.2	4.2
1993	9.7	4.8	3.6	5.6	2.3	3.3
1994	8.5	6.2	3.1	8.3	3.0	5.0
1995	9.5	4.4	4.0	6.7	1.8	5.7
1996	7.9	5.0	3.4	7.5	1.4	5.9
1997	6.2	4.4	2.8	5.6	2.0	5.6
1998	58.5	7.5	5.2	9.3	-0.3	8.1
1999	20.3	0.8	2.8	5.9	0.1	0.2
2000	9.3	2.3	1.5	4.0	1.3	1.7
2001	12.5	4.1	1.4	6.8	1.0	1.6
2002	10.0	2.7	1.8	3.0	-0.4	0.6
2003	5.1	3.5	1.2	3.5	0.5	1.8
2004	6.1	3.6	1.4	6.0	1.7	2.8
2005	10.9	2.8	3.1	7.6	0.4	4.5
2006	12.7	2.2	3.6	6.2	1.0	4.7

Notes:

All the data are obtained from Asia Development Bank (ADB) key indicators, 2007

Korea is considered as East Asian countries but has mentioned here as Korea is one of the financial crisis-hit Asian countries of 1997-98

Table I-A(7):: GDP Growth Rate (Annual change, %)

Year	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
1990	9.0	9.2	9.0	3.0	9.2	11.2
1991	8.9	9.4	9.5	-0.6	6.6	8.6
1992	7.2	5.9	8.9	0.3	6.3	8.1
1993	7.3	6.1	9.9	2.1	11.7	8.3
1994	7.5	8.5	9.2	4.4	11.6	9.0
1995	8.2	9.2	9.8	4.7	8.1	9.2
1996	7.8	7.0	10.0	5.9	7.8	5.9
1997	4.7	4.7	7.3	5.2	8.3	-1.4
1998	-13.1	-6.9	-7.4	-0.6	-1.4	-10.5
1999	0.8	9.5	6.1	3.4	7.2	4.4
2000	4.9	8.5	8.9	4.4	10.0	4.8
2001	3.8	3.8	0.5	1.8	-2.4	2.2
2002	4.3	7.0	5.4	4.4	4.2	5.3
2003	4.8	3.1	5.8	4.9	3.1	7.1
2004	5.0	4.7	6.8	6.4	8.8	6.3
2005	5.7	4.2	5.0	4.9	6.6	4.5
2006	5.5	5.0	5.9	5.4	7.9	5.0

Notes:

All the data are obtained from Asia Development Bank (ADB) key indicators, 2007

Korea is considered as East Asian countries but has mentioned here as Korea is one of the financial crisis-hit Asian countries of 1997-98

Table I-A(8): Monetary Policy Framework

No	Countries	Monetary Policy Framework
1	Indonesia	<p>Two periods:</p> <ol style="list-style-type: none"> 1. Monetary targeting In the past, monetary base was used as the operational target 2. Inflation targeting (2000 onwards) In the mid to late 1990s, a gradual shift to inflation targeting was launched. The 1999 central Bank Law gave the autonomy to Bank of Indonesia to adopt inflation targeting The inflation target is based on a core CPI with an explicit inflation target where monetary base is used as the operational target (policy instrument). From July 2005, Bank of Indonesia rate is used as the policy instrument. <p>Official exchange rate regimes:</p> <ol style="list-style-type: none"> 1. 1970 – 1978 ---- fixed exchange rate 2. November 1978-June 1997----Managed floating 3. July 1997-present----Independently floating
2	Korea	<p>Three main periods:</p> <ol style="list-style-type: none"> 1. Monetary targeting Since 1957, M1 was pre-announced quarterly or yearly as a macroeconomics policy. In 1979, monetary target changed to a M2 growth rate till mid 1990s After crisis 1997-98, accepted IMF rescue financing plan, used M3 as reference value of monetary base, at the same time, adopted inflation targeting (two pillar system) In 2001, M3 growth rate only monitored, and the monitoring ended in 2003 with a pure inflation targeting 2. Interest rate as an operational target After 1997-98, the interest rate was accepted as an operational target. Since 1999, Monetary Policy Committee (MPC) announced the target call rate for interest rate. 3. Inflation targeting Since 2000, core CPI inflation rate has been chosen as the benchmark inflation indicator. The target rate is determined annually with the range of +/-1%. <p>Official exchange rate regimes:</p> <ol style="list-style-type: none"> 1. March 1980-October 1997----Managed floating 2. November 1997-present----Independently floating
3	Malaysia	<p>Official exchange rate regimes:</p> <ol style="list-style-type: none"> 1. January 1986-February 1990----Limited flexibility 2. March 1990-November 1992----Fixed 3. December 1992-September 1998----Managed floating 4. September 1998-July 2005----Pegged arrangement 5. July 2005-present ----Managed floating
4	Philippines	<p>Two periods:</p> <ol style="list-style-type: none"> 1. Monetary targeting In the past, monetary policy framework based on base or reserve money programming. 2. Inflation targeting (2002 onwards) Inflation targeting policy adopted formally in January 2000 and the implementation started in January 2002. CPI or headline inflation is used as its monetary policy target and overnight repurchase rate and reverse repurchase rate are used as the main instrument of monetary policy. <p>Official exchange rate regimes:</p> <ol style="list-style-type: none"> 1. January 1988-present----Independently floating
5	Singapore	<p>Official exchange rate regime:</p> <ol style="list-style-type: none"> 1. June 1973-November 1998----De facto moving band around the US Dollar 2. December 1998-present ----Managed floating
6	Thailand	<p>Three main periods:</p> <ol style="list-style-type: none"> 1. Pegged exchange rate regime (2nd World War-June 1997) The value of Baht was pegged to a major currency/ gold or to a basket of currencies 2. Monetary targeting regime (July 1997-May 2000) Beginning the periods of floating exchange rate. Received assistance from IMF, targeted at domestic money supply. Set daily and quarterly monetary base targets. 3. Inflation targeting regime (May 2000-present) Inflation targeting is more effective as the relationship between money supply and output growth was becoming less stable after financial crisis. <p>Official exchange rate regimes:</p> <ol style="list-style-type: none"> 1. January 1970-June 1997----fixed 2. July 1997-present----Independently floating

Sources: Hernández & Montiel (2001), IMF & BIS

Table I-A(9): Shocks and business cycle fluctuations in East-Asia

Countries	K	The k-step ahead forecast error variance of domestic GDP (%) explained by							
		Foreign shocks			Domestic shocks			Total foreign shocks	Total domestic shocks
		ε^{s*}	ε^{m*}	ε^{d*}	ε^s	ε^f	ε^d		
China	1	3.0	9.6	0.1	55.7	12.7	18.8	12.7	87.2
	5	2.5	12.3	11.0	70.0	1.6	2.5	25.8	74.1
H. Kong	1	0.4	5.1	6.6	67.5	19.9	0.4	12.1	87.8
	5	1.2	26.0	1.5	68.0	3.2	0.1	28.7	71.3
Indonesia	1	12.3	0.2	5.1	81.1	0.7	0.6	17.6	82.4
	5	14.9	1.7	4.0	79.3	0.1	0.1	20.6	79.5
Korea	1	1.5	13.4	1.2	55.8	4.0	24.1	16.1	83.9
	5	4.8	7.2	3.5	75.5	1.8	7.2	15.5	84.5
Malaysia	1	9.3	0.1	20.4	64.2	2.3	3.7	29.8	70.2
	5	21.8	6.7	23.6	46.6	0.5	0.9	52.1	48.0
Philippines	1	1.0	1.0	0.2	94.8	0.2	2.9	2.2	97.9
	5	1.9	3.0	6.0	88.5	0.0	0.6	10.9	89.1
Singapore	1	8.9	0.9	14.3	68.5	6.2	1.2	24.1	75.9
	5	16.8	7.5	12.2	62.4	0.9	0.3	36.5	63.3
Thailand	1	0.0	4.4	1.4	90.2	2.8	1.0	5.8	94.0
	5	0.0	3.5	0.6	95.4	0.4	0.1	4.1	95.9
Taiwan	1	20.0	1.3	3.4	65.1	0.8	9.4	24.7	75.3
	5	13.2	3.1	1.5	80.3	0.0	1.9	17.8	82.2

Notes:

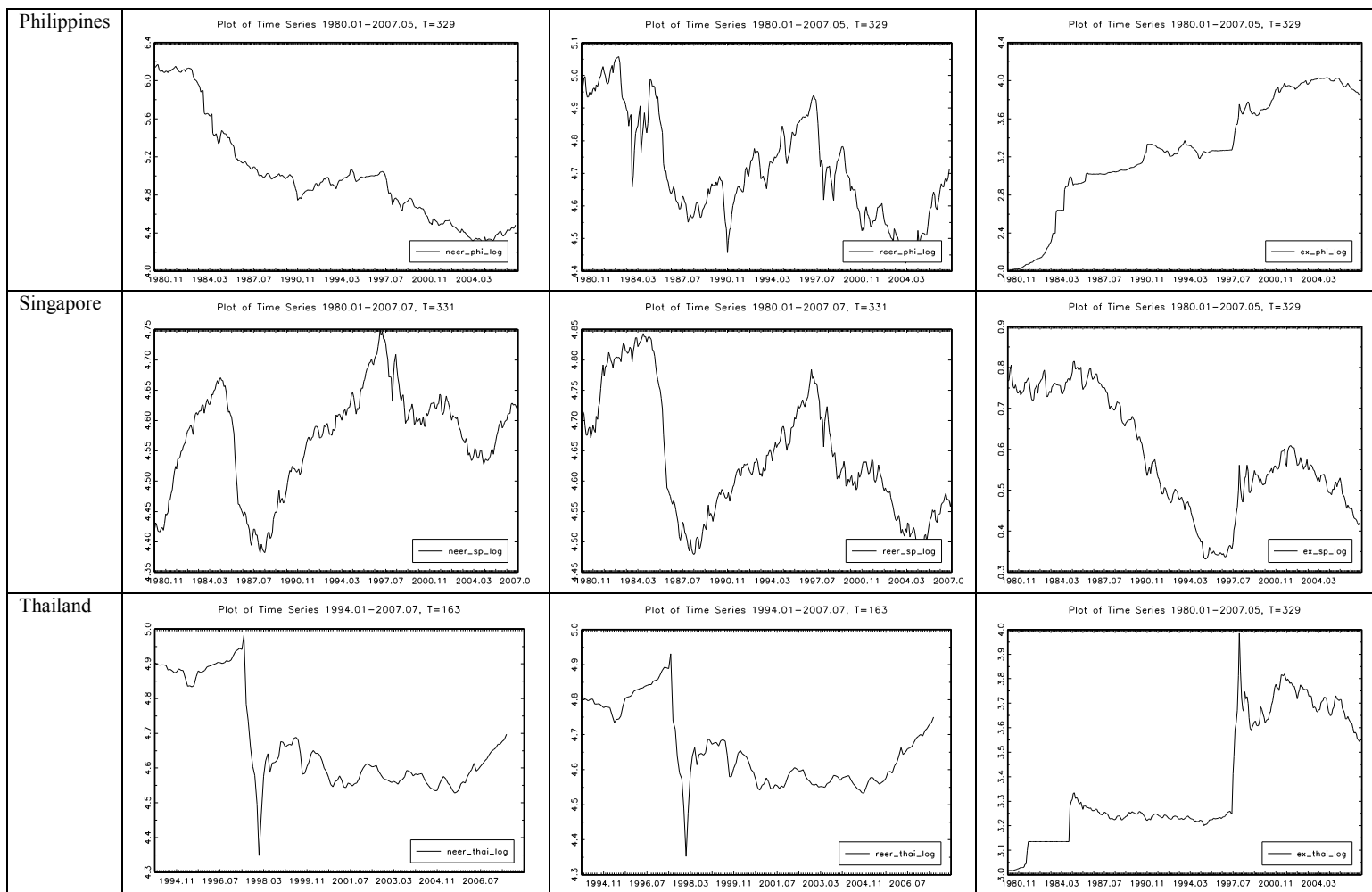
The foreign country is represented by US. The foreign shocks are supply, monetary and demand shocks from left to right; the domestic shocks are supply, exchange rate and demand shocks from left to right. Data are spanning from 1960 to 2004. κ indicates the time horizons.

Source: Sun and An (2008)

APPENDIX I-B

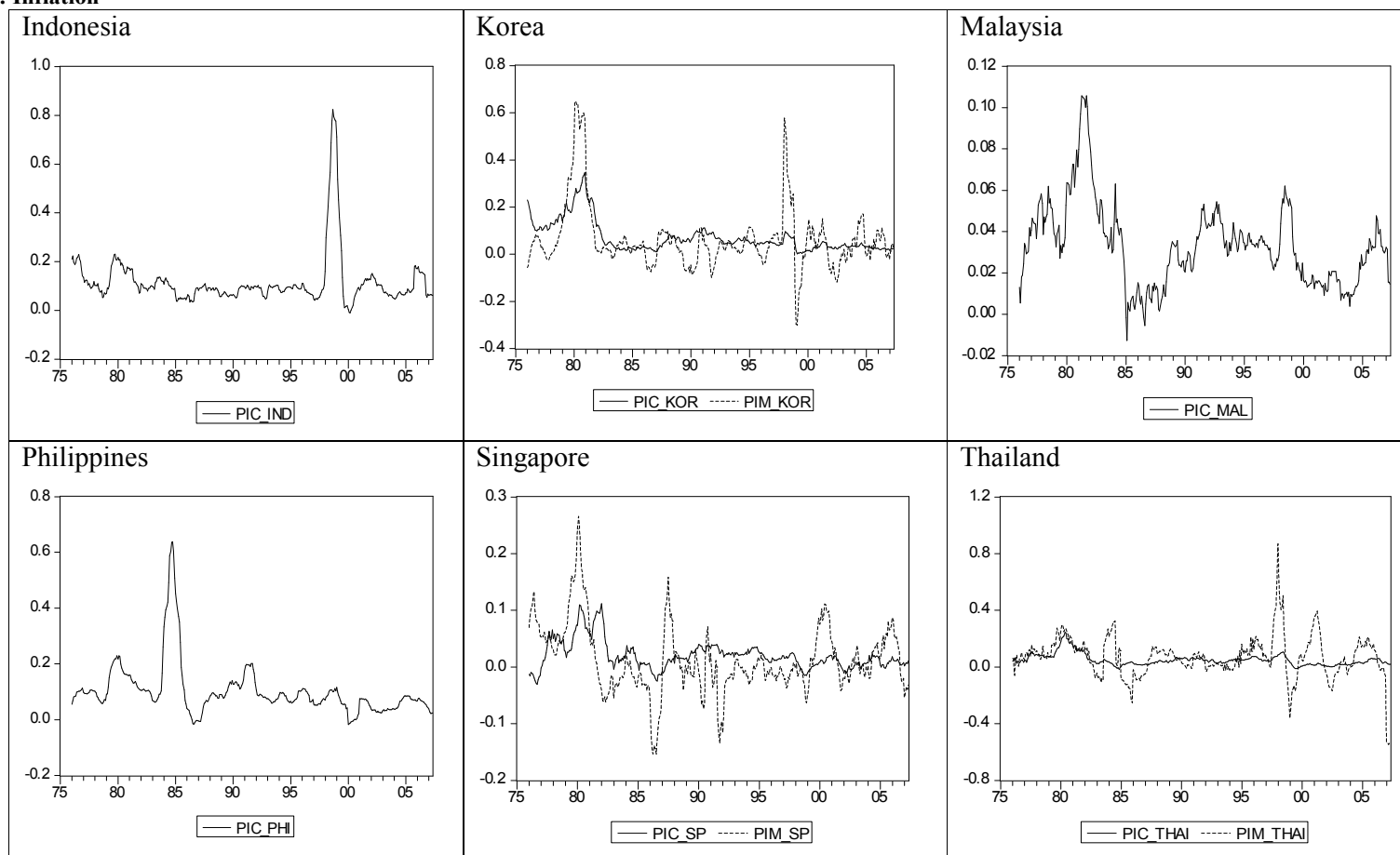
Table I-B(1): Log exchange rate movements

Countries	Log Nominal effective exchange rate, NEER	Log Real effective exchange rate, REER	Log Bilateral exchange rate with USD, EX
Indonesia	<p>Plot of Time Series 1994.01–2007.07, T=163</p> <p>neer_ind_log</p>	<p>Plot of Time Series 1994.01–2007.07, T=163</p> <p>reer_ind_log</p>	<p>Plot of Time Series 1980.01–2007.05, T=329</p> <p>ex_ind_log</p>
Korea	<p>Plot of Time Series 1980.01–2007.07, T=331</p> <p>neer_kor_log</p>	<p>Plot of Time Series 1980.01–2007.07, T=331</p> <p>reer_kor_log</p>	<p>Plot of Time Series 1980.01–2007.05, T=329</p> <p>ex_kor_log</p>
Malaysia	<p>Plot of Time Series 1980.01–2007.05, T=329</p> <p>neer_mal_log</p>	<p>Plot of Time Series 1980.01–2007.05, T=329</p> <p>reer_mal_log</p>	<p>Plot of Time Series 1980.01–2007.05, T=329</p> <p>ex_mal_log</p>



Data source: IFS, IMF

Table I-B(2): Inflation



Data source: IFS, IMF

Inflation is defined as the percentage change of price indices (CPI and import price) from the price indices of the same month from previous year.

PIC denotes the CPI inflation and PIM denotes the import inflation.

CHAPTER THREE**EXCHANGE RATE PASS-THROUGH INTO DOMESTIC PRICES: AN
EMPIRICAL STUDY IN SEVERAL EAST-ASIAN COUNTRIES****Abstract**

This chapter conducts empirical analyses to reveal the change in the exchange rate pass-through coefficients in East-Asia between the pre- and post-crisis periods. Two estimation approaches are applied here, namely the Generalized Method of Moments and the system equation model of Seemingly Unrelated Regression. Comparison of the pass-through coefficients is made along the different pricing chain, across countries and over time. The main findings include the degree of exchange rate pass-through differs across countries, along pricing chain and changes over time. Not all countries experience the decline in pass-through rate. The pass-through rate is the highest on import price, moderate on producer price and the lowest on consumer price.

3.1 Introduction and motivation

One of the main topics in the international macroeconomics is exchange rate pass-through which is defined as the percentage change in the domestic/ imported prices led by a one percentage change in the exchange rate between the importer and exporter currency. Exchange rate movements can be transmitted to the domestic prices through three channels: imported consumption goods, imported intermediate goods and domestic goods priced in foreign currency prices (Sahminan (2002) and An (2006)).

Exchange rate pass-through provides information about the underlying relationship between exchange rate movements and price level and also the transmission of shocks which are important for the policy assessment and inflation forecast. An (2006) mentions three main reasons that are important for the understanding of exchange rate pass-through. First, the understanding of the timing and the degree of exchange rate pass-through helps to ensure proper assessments for the monetary policy transmissions. Second, it explains the change in price level and provides information for better forecast in inflation which is helpful for the better implementation of inflation targeting. Third, it explains the implication of expenditure switching effects. Lower degree of exchange rate pass-through leads to lower expenditure switching effects of the domestic monetary policy. The trade flows are insensitive to the movements of exchange rate. The opposite holds when the pass-through rate is high.

Exchange rate pass-through is complete if there is a one-to-one response from the domestic prices to the exchange rate changes. On the other hand, partial/incomplete pass-through occurs when there is less than one-to-one response in the prices led by the exchange rate changes. The degree of exchange rate pass-through is crucially determined by the pricing behavior of importing and exporting firms. When the goods are traded in the destination local currency (the so-called local currency pricing), the pass-through rate on the domestic import price is zero. On the other end, if exporters set the price in their own currency (the so-called producer currency pricing) to the destination markets, the exchange rate pass-through into import price in the destination markets is unity or complete (Fluentes (2007) and Mihaljek & Klau (2008)). However for most emerging countries, foreign exporters set prices in their own currency to the local importers in which the local importers will resell the goods to the local competitive market in local currency. As the market is competitive, the local importers absorb the effects of exchange rate changes, which lead to incomplete pass-through (Mihaljek & Klau (2008)).

As mentioned in An (2006), the literature on the exchange rate pass-through can be divided into micro and macro levels. The literature of exchange rate pass-through on the micro level includes the foreign firm's pricing behavior, disaggregated product bundles/ industries and the market structures. The second strand of the literature on macro level investigates the exchange rate pass-through from the monetary policy view. It estimates exchange rate pass-through into different domestic prices, e.g. producer prices index (PPI), import price index (IMP) and consumer prices index (CPI). This chapter contributes to this strand of the literature.

Most of the empirical studies on the exchange rate pass-through are focused on industrial countries. The studies based on the emerging Asian economies are limited

(Sahminan, (2002) and Ito et al., (2005)). To fill this gap this chapter focuses on some economies of East-Asia, namely Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand. As discussed in **Chapter Two**, these countries are financially unstable and are very open to external shocks. Prices in these countries might be strongly affected by external shocks through imported inflation of intermediate goods as the fraction of imported intermediate goods for production is very high. Besides, exchange rate is more volatile as many of these countries have abandoned the pegged system and adopt the floating regime aftermath the crisis.

Previous studies show that the exchange rate pass-through is very high and fast in emerging countries (for example, Devereux and Lane (2001)). Exchange rate pass-through has declined over time in many countries. Previous studies show that import price and producer price are more sensitive to exchange rate movements. On the other hand, consumer price is weakly linked to the exchange rate movements. How true these statements apply to East-Asian countries?

This chapter seeks to answer the above questions and has two main objectives. First, it seeks to compare the degree of exchange rate pass-through into different domestic prices in several East-Asian countries before and after the financial crisis of 1997-98 (or after moving to the new monetary policy regimes). Second, this study also intends to compare the degree of exchange rate pass-through across three domestic prices namely the import, producer and consumer prices. Two estimation approaches i.e. the system equation model of Seemingly Unrelated Regression (SUR) using Generalized Least Square (GLS) technique and the single equation method using Generalized Method of Moments (GMM) technique are applied here.

The findings are in line with the results of previous studies where exchange rate pass-through is incomplete in the short-run and long-run in most cases. In some extreme cases, depreciation in the exchange rate leads to a decline in consumer price. The pass-through rate is the highest on import price, followed by the producer price and the lowest on consumer price. Exchange rate pass-through does not decline in all countries considered in this study.

The chapter is organized as follows. Section two discusses the empirical reviews, the construction of pass-through equation and the issues in empirical estimation. Section three explains the data and methodologies. Section four summarizes the econometric results. Section five interprets the results and section six concludes.

3.2 Exchange rate pass-through - some reviews

The results of the empirical studies on the topic of exchange rate pass-through are mixed and vary across countries, industries, perspectives, methodologies and periods. However, in general the empirical findings/ outcomes can be summarized as follows: exchange rate pass-through into domestic prices in the short-run and long-run are incomplete for majority countries. The degree of exchange rate pass-through is higher in the long-run compare to that of the short-run. Besides, the degree of exchange rate pass-through varies across countries, industries and periods. For example, Campa and Goldberg (2002) show that the average pass-through rate into import prices for 25 OECD (Organization for Economic Co-operation and Development) countries are

61% and 77% in the short-run and long-run respectively. U.S. has the lowest degree of pass-through i.e. 26% in the short-run and 41% in the long-run. In the industrial level, the results show that raw material has the highest pass-through rate while food industry has the lowest rate.

Focusing in the Euro area, Campa & Goldberg (2005) estimate the average pass-through rate into import prices for the Euro area to be 66% and 81% in the short-run and long-run respectively. The investigation of the pass-through into import prices by industries reveals that the pass-through rate is different across industries. Mineral fuels industry has the highest rate and beverages and tobacco industry has the lowest rate.

In general, empirical results also show that the exchange rate pass-through into import prices is higher than that of producer (PPI) and consumer prices (CPI) (for example Ito, Sasaki & Sato (2005) and An (2006)). CPI is insensitive to the exchange rate movements due to some main reasons. As explained in Burstein, Eichenbaum & Rebelo (2002) who focus the study on low inflation rate after large devaluations, high fraction of distribution costs or nontradable goods lead to the violation of purchasing power parity and low pass-through for tradable consumer goods. Second, some inferior tradable goods are produced solely for the domestic market. These inferior goods may substitute for imported goods. Third, domestic consumers may switch their demand from imported goods to local tradable (inferior) goods during the crisis periods or devaluations of the domestic currency. Therefore, the pass-through into consumer price is low due to the distribution cost of production, low inflation rate in the nontradable goods, local goods and the “flight from quality”. Other reason why the pass-through rate of import price is higher as explained in Mihaljek & Klau (2008) is imports consist large fraction of intermediate goods which are invoiced in foreign currency in compare to the retail prices. Retail prices as a combination of both imported and local goods price are set in the local currency and tends to have lower pass-through rate.

Focusing on the role of distribution margin and imported input on the sensitivity of domestic prices to exchange rate movements, Campa & Goldberg (2006) show that production costs are more sensitive to exchange rate and import prices as it relies on imported components, domestic suppliers and distributors on imported input. High distribution cost and low reliance on imported inputs induce low pass-through into consumer price. However, distribution margin can lead to more sensitivity in consumer price if imported inputs are used in production of nontradables.

Some studies seek to uncover the link between monetary policy and the degree of exchange rate pass-through. In particular, these studies aim to investigate if the inflation targeting policy or low inflation environment induces lower degree of exchange rate pass-through as claimed by Taylor (2000). Using a large database includes 1979-2000 for 71 countries, Choudhri & Hakura (2006) and Bussière & Peltonen (2008) find a strong evidence of a positive and significant relationship between the pass-through rate and the average inflation rate across countries and periods. The same result is reported in Gagnon & Ihrig (2004) who focus their studies on 20 industrial countries for the periods of 1971 to 2003. Campa & Goldberg (2005, 2002) in their research find that exchange rate and inflation variations are negatively correlated with low rate of exchange rate pass-through into import price.

Besides these general results, some results are conflicting and still open for debates. As discussed in Campa & Goldberg (2002), some researchers argue that exchange rate pass-through has been declining over time (for example, Taylor (2001) and Goldfajn & Werlang (2001)). Researchers have different explanations on the decline of pass-through rate. Taylor argues that the decline in the exchange rate pass-through is endogenous to the low inflation where the low pass-through rate leads to the lower mark-ups and less inflationary and the continued low mark-ups. Besides, globalization also contributes to the decline of pass-through by inducing higher competition and lower pricing power of firms (Mihaljek & Klau (2008)). Under both low inflationary environment (as argued by Taylor) and the impacts of globalization, firms have to absorb the costs due to the exchange rate fluctuations which lead to the lower pass-through rate. The third factor that contributes to the lower pass-through rate is the composition of import by Campa & Goldberg (2002). The shift from the high pass-through rate goods to the low pass-through rate goods of importers tends to reduce the overall pass-through rate of import price. Pricing to market and market share also matter in determining the pass-through rate. High-cost producers always have low market share. In order to maintain the market share, producers tends to set low markup and absorb the cost caused by exchange rate fluctuations, which reduces the pass-through rate. Exchange rate pass-through also will be lower if there is cross-border production which involves several stages of production in different countries (Mishkin (2008)).

The decline in the degree of exchange rate pass-through does not hold for every country. Campa & Goldberg (2005, 2002) in their studies show that the exchange rate pass-through has declined significantly in four countries but increase in the other two countries. They argue that Taylor's results should not represent the general feature of OECD countries. They also show that the level of pass-through does not correlate with the level of inflation, money growth rates/ aggregate country size. These macro factors have no significant explanatory power for the pass-through evolution in OECD countries. Although variation in the exchange rate and inflation are associated with the low pass-through rate into import price in OECD countries, they are not the main explanatory factor. The main factor that contributes to the change in pass-through rate is the change in the composition of industries from energy to manufactured product. Fluentes (2007) also finds no evidence in the decline of exchange rate pass-through into import price in four emerging countries. As discussed in Fluentes (2007), there are three main factors contribute to the higher pass-through rate (in emerging countries). The first factor that determines the higher degree of exchange rate pass-through in emerging countries is the inflationary environment as proposed by Taylor. Fluentes (2007) finds that emerging countries tend to have higher money growth and inflation than the advanced countries, which leads to the higher pass-through rate. The second reason is the composition of import. Some of the emerging countries show low increase in the manufactured imported components which have low pass-through rate. The third reason is the volatility of exchange rate which is high in emerging countries. Producers prefer to trade in the currency with low volatility. This explains the reason why trades are made in foreign currencies in emerging countries and this leads to higher pass-through rate.

Other conflicting issue in the study of exchange rate pass-through is related to the country's size. McCarthy (1999) finds that the pass-through rate is negatively correlated with the country's size. In contrast to this result, Hung, Kim & Ohno

(1993), Campa & Goldberg (2005) and Bussière & Peltonen (2008) find no significant correlation between the pass-through rate and the country's size.

On the other hand, empirical results show that trade openness does not necessary positively correlated with the pass-through rate. For example, Romer (1993) finds a negative correlation between the trade openness and the pass-through rate by taking into account the Taylor's inflation hypothesis (Ca'Zorzi et al. (2007)). Ca'Zorzi et al. (2007) also find a weak correlation support results between the trade openness and pass-through rate based on the studies in 12 emerging countries.

Most of the studies show that emerging countries have higher pass-through rate compare to that of the developed countries. However, this result does not hold in all countries. Ca'Zorzi et al. (2007) in their studies on the exchange rate pass-through focused on emerging countries and developed countries as benchmark countries show that the low inflation emerging countries have low pass-through rate and the rate is not very dissimilar to that in the developed countries. Bussière & Peltonen (2008) also report the same result as in Ca'Zorzi et al. (2007).

Apart from these differences and conflicting results, empirical studies show that exchange rate pass-through is very sensitive to the estimation techniques, specifications of the model and timing. Mihailov (2005) in his study on exchange rate pass-through in U.S., Germany and Japan finds that exchange rate pass-through varies across countries, data frequencies, time periods, econometric techniques, the proxy for prices and model specifications. Comparing the results of pass-through from three econometric methods (OLS, Two Stage Least Square and VAR), he shows that it is hard to precisely estimate the magnitude and the pattern of exchange rate pass-through as the results are sensitive to the econometric methods, measurement proxy and model specifications applied.

3.2.1 Exchange rate pass-through and policy regime

Previous literatures show that exchange rate pass-through and monetary policy or regime is closely linked to each other. Taylor argues that the strong inflationary anchor or low inflation environment leads to the lower pass-through rate. This view is supported by many empirical results (for instance, Choudhri & Hakura (2006) and Gagnon & Ihrig (2004)). The results imply that the effective monetary policy is able to reduce the rate of pass-through. In turn, the degree of exchange rate pass-through could have influences on the effectiveness of the monetary policy. For instance, lower degree of pass-through leads to lower expenditure switching effects of domestic monetary policy. Hence, monetary policy may deal more effectively with real shocks. The opposite outcome holds for the high pass-through rate.

Indeed, historical data show that exchange rate depreciation and consumer inflation are closely correlated under an unstable monetary policy environment in the absence of nominal anchor. On the other hand, the correlation is weak under a stable monetary policy. Stable monetary policy with inflationary anchor is able to maintain the low/stable inflation rate, insulating the economy from exchange rate fluctuations (Mishkin (2008)).

The exchange rate regime also has some impacts on the degree of exchange rate pass-through. As discussed in Mihaljek & Klau (2008), countries that set the exchange rate as a nominal anchor tend to experience higher pass-through rate as changes in exchange rate would incorporate immediately into expectations. On the other hand, countries that implement the floating regime or inflation targeting regime set inflation as the anchor may exhibit lower pass-through rate since the effect of exchange rate on domestic CPI is smaller. These conditions are observed in the central bank's assessments on exchange rate pass-through as the outcomes from the survey by Bank for International settlements (BIS) on 15 emerging central banks (see **Table II(1a), Appendix II**). The results from the survey indicate that 10 out of 15 central banks in emerging countries experience decline in exchange rate pass-through into CPI. The main reasons for the decline are greater flexibility of exchange rate and decline in inflation (Mihaljek & Klau (2008)). Hence, flexibility regime is associated with lower pass-through rate.

3.2.2 Exchange rate pass-through in East-Asia

This section summarizes the results of exchange rate pass-through in East-Asian countries from previous empirical studies. In general, the degree of exchange rate pass-through varies across countries (see **Table II(1b), Appendix II**).

After the financial crisis of 1997-98, most of the crisis-hit East-Asian countries have moved from the rigid exchange rate regime to the more flexible regimes and at the same time, some countries have adopted the inflation targeting monetary policy. The changes in the exchange rate regimes and monetary policies have induced many researches on the monetary policy for emerging market and in particular the role and effect of exchange rate in the economies of emerging countries. Applying a vector error correction model to nine Asia-Pacific countries, Webber (1999) finds that the degree of exchange rate pass-through is the highest for the lowest income countries (Pakistan 109 percent and Philippines 89.6 percent) and partial for the other countries.

Sahminan (2005) compare the exchange rate pass-through into import price in Indonesia, Philippines, Singapore and Thailand for the periods of 1974-1991 using both quarterly and monthly data. Applying the error correction model, his results show that the long-run exchange rate pass-through into import price is the highest in Philippines but the lowest in Singapore.

Using a single equation method and a structural VAR analysis and focusing on several East-Asian countries, Ito et al. (2005) demonstrate that the pass-through rate is the highest on import price, followed by PPI and then CPI. The degree of pass-through into import price is particularly high in Thailand and Indonesia but very low in Singapore.

Ito & Sato (2007) compare the exchange rate pass-through into domestic prices between East-Asia and Latin American countries in the post-crisis periods. Their results show that the exchange rate pass-through is high in Latin American countries and Turkey than in East-Asian countries with the exception of Indonesia. Base money has contributed to high inflation in Indonesia and that the degrees of exchange rate pass-through into import price, PPI and CPI are large in Indonesia.

Ca'Zorzi et al. (2007) examine the degree of exchange rate pass-through into domestic prices in 12 emerging markets in Asia, Latin America and Central and Eastern Europe. Based on the results, they conclude that the pass-through rates into import and consumer prices in some emerging countries are low and not very different from the levels of developed economies. They also find a positive relationship between the degree of exchange rate and the inflation rate but only a weak relationship between the import openness and the degree of exchange rate pass-through.

The results from these previous studies are summarized in **Table II(1b), Appendix II**. These studies apply different methods of analysis with different number of lags specification and use different data to represent the exchange rate, different variables and periods of analysis. These differences of analysis generate quite different results for the degree of exchange rate pass-through. For example in the case of Singapore, the pass-through rate into import price is very low and even negative (-0.59 for the short-run and 0.01 for the long-run) as shown in Ito et al. (2005) who use the monthly data of 1995M1-2004M8. However using a longer quarterly data from 1975Q1-2004Q1, Ca'Zorzi et al. (2007) show a very different result. The pass-through rates into import price for Singapore are 0.13 and 0.76 for the short-run and long-run respectively.

Besides these differences, some main general results can be drawn from these studies. First, the pass-through rate is very high and even more than complete in the high inflation rate and low income countries. Second, the pass-through rate is higher on import price than that of CPI. Third, the long-run pass-through rate does not necessary higher than that of the short run rate, depending on the speed of pass-through. For example, Korea has higher short-run pass-through rate into import price compares to the long-run one (as shown in Ito et. al (2005) and Ca'Zorzi et al. (2007)). This means the effects of exchange rate shock in Korea are transmitted into the domestic prices very fast or immediately in the short-run in compare to the other countries that exhibit the gradual or low speed of pass-through rate.

These empirical results on exchange rate pass-through in emerging (East-Asia) countries provide us with some general ideas about the effects of exchange rate pass-through into domestic prices across countries. On the other hand, these studies do not compare the degree of exchange rate pass-through into domestic prices in East-Asian countries for the period before and after the crisis of 1997-98. Although Ito and Sato (2007) seek to compare the degree of exchange rate pass-through of Latin American and East Asia countries for the period of post-crisis, their data include the crisis periods of 1997-98. However it is more appropriate to exclude the crisis periods in the analysis as include the crisis periods may generate excessive responses of domestic prices to exchange rate fluctuations caused by the crisis.

As shown in **Appendix I-B, Chapter Two**, most of the crisis-hit East-Asian countries experienced great devaluations in their currencies. On the other hand, CPI inflation did not show very large fluctuations in contrast to import inflation. How does the pass-through into domestic prices (import price, PPI and CPI) change over time? This chapter seeks to answer this question.

3.2.3 Modeling the exchange rate pass-through

As shown in many empirical studies, exchange rate pass-through is modeled based on the concept of the law of one price (LOOP). LOOP assumes that the price of imported goods invoiced in domestic importing country's currency (P_t^{imp}) is equal to the price of import price denominated in exporter's currency (P_t^{ex}) multiplied by the exchange rate of importing country (E_t).

$$P_t^{imp} = P_t^{ex} \cdot E_t \quad (1)$$

The price of exporter P_t^{ex} is set based on the mark-up (Λ_t) over marginal cost of production (C_t^*).

$$P_t^{ex} = \Lambda_t \cdot C_t^* \quad (2)$$

Substituting equation (2) to (1):

$$P_t^{imp} = \Lambda_t \cdot C_t^* \cdot E_t \quad (3)$$

where C_t^* is the exporting producer's cost and Λ_t is the mark-up. The mark-up is determined by the demand pressure in the destination market. It can be represented by the real GDP of importing country. Due to the difficulty in obtaining the data for the mark-up, this variable is excluded in the pass-through equation (for example de Bandt et al. (2008), Edwards (2006) and so on). Equation (3) is transformed into log form (which is denoted in lowercase letters):

$$p_t^{imp} = \alpha_1 \lambda_t + \alpha_2 c_t^* + \alpha_3 e_t \quad (4)$$

Based on this pass-through equation, the degree of exchange rate pass-through is the partial elasticity of import price with respect to exchange rate, which is captured by the coefficient of α_3 . Theoretically, depreciation in the exchange rate leads to the increase in price level. This implies a positive value for α_3 when exchange rate is proxied by the exchange rate of domestic currency per USD but in negative value when exchange rate is proxied by the nominal or real effective exchange rate. This is because the increase in the bilateral exchange rate of domestic currency per USD means depreciation but it implies appreciation in the case of nominal or real effective exchange rate series. Based on the proxy of exchange rate of domestic currency per USD, exchange rate pass-through is complete when $\alpha_3 = 1$, but zero when $\alpha_3 = 0$. In reality, exchange rate pass-through is partial or incomplete where $0 < \alpha_3 < 1$. Besides, the theoretical condition where $0 \leq \alpha_3 \leq 1$ does not necessitate in reality. Many empirical studies show that although in most cases, the degree of exchange rate pass-through into import price is incomplete, it can exceed unity in some extreme cases (for example Campa & Goldberg (2005), Sahminan (2005), Ito and Sato (2007) and so on). Besides estimating the degree of exchange rate pass-through into import price, many studies extend the analysis to include the exchange rate pass-through into other prices such as the producer, consumer and export prices.

3.2.4 Empirical estimation issues

Previous empirical studies apply different methodologies to estimate the coefficient of exchange rate pass-through. In general, these methodologies can be categorized into two strands. The first strand applies the single equation approaches (such as OLS, IV and GMM methods) while the second strand uses the system equation approaches (VAR and VECM models). However, there is no consensus on the best method to be applied as each method has its own shortcomings. Under the single equation method of Ordinary Least Square (OLS), the exchange rate pass-through equation (4) is modified and takes the following form (after omitting the mark-up):

$$\Delta p_t = \beta_1 + \sum_{k=0}^m \beta_{2,k} \Delta c_{t-k}^* + \sum_{k=0}^m \beta_{3,k} \Delta e_{t-k} + \varepsilon_t \quad (5a)$$

$$\Delta p_t = \beta_1 + \beta_2 \Delta c_t^* + \beta_3 \Delta e_t + \beta_4 \Delta p_{t-1} + \varepsilon_t \quad (5b)$$

$$\Delta p_t = \beta_1 + \sum_{k=0}^m \beta_{2,k} \Delta c_{t-k}^* + \sum_{k=0}^m \beta_{3,k} \Delta e_{t-k} + \sum_{k=0}^m \beta_{4,k} \Delta p_{t-1-k} + \varepsilon_t \quad (5c)$$

where p_t is the domestic price variable (import, producer or consumer prices); c_t^* is the exporter's production cost and e_t denotes the nominal exchange rate. All the variables are in the first differenced logarithms form; m is the number of lag and it is of arbitrary, depending on the frequencies of data and interpretations of the authors. Some studies apply equation (5a) and calculate the short-run pass-through as $\beta_{3,0}$ and the long-run pass-through as the summation on the coefficients of $\beta_{3,k}$ for $k=0$ to m (for example Campa and González-Mínguez (2005), de Bandt et.al (2008), Campa & Goldberg (2002) and others). Other studies applies equation (5b) to obtain the short-run and long-run coefficients pass-through as β_3 and $\left(\frac{\beta_3}{1-\beta_4}\right)$ respectively (for example Edwards (2006) and Bussière & Peltonen (2008)). Bussière & Peltonen (2008) find that both approaches lead to the similar results. On the other hand, some authors modify equation (5b) to include more lagged terms (Edwards (2006), Coricelli et al. (2006) and Mihaljek & Klau (2008)) as shown in equation (5c). Equation (5c) is equal to equation (5b) when $m=0$. The short-run pass-through coefficient now is

$$\sum_{k=0}^m \beta_{3,k} \text{ and the long-run pass-through coefficient is } \sum_{k=0}^m \beta_{3,k} \left/ \left(1 - \sum_{j=0}^m \beta_{4,j} \right) \right.$$

The main issue in applying the Ordinary Least Squares (OLS) method is that this method may generate inconsistent results if the regressor is correlated with the error tem (Mihailov (2005)). Besides, this method also fails to capture the effects of adjustments in other endogenous variables to exchange rate changes and always underestimates the pass-through effects (Coricelli et al. (2006)).

In order to overcome the problem in OLS estimation, Instrument Variable (IV) and Generalized Method of Moments (GMM) methods are applied to estimate the pass-through coefficients. These methods are able to solve the endogeneity problem that is arisen under the OLS method. However, the problem in these methods is the difficulty to find good instruments for the exchange rate variable (Edwards (2006)).

Other alternative to the single equation approach of Ordinary Least Square method is the Error Correction model (ECM). However, the problem with ECM is the difficulty in finding the cointegrating relation in the equation. Many studies find weak evidence of cointegrating relation among variables in the pass-through equation, for example Bussière & Peltonen (2008) and Campa & Goldberg (2005). Due to weak cointegration of variables but non-stationarity in price index and exchange rate data, ECM is not apply and the exchange rate pass-through equation is estimated in the first differenced form using the Ordinary Least Squares method (for example Campa & Goldberg (2002, 2005) and Ito et al. (2005)) or Generalized Method of Moments (Bussière & Peltonen (2008)).

Some papers apply the system equation approaches such as the structural VAR model to estimate the exchange rate pass-through coefficients. The advantages in applying the structural VAR model are: it solves the endogeneity problem that is arisen under the single equation method. It allows identifications on the structural shocks through Cholesky decomposition of innovations and it provides the analysis on the effect of exchange rate on a chain of domestic prices (import, producer price and consumer price) in the same system equation. On the other side, the drawbacks with this model are the outcome of this model is sensitive to the ordering of variables and the restrictions or identifications imposed on the structural shocks. There are criticisms that such identifications could be arbitrated or not convincing (Edwards (2006) and Mihailov (2005)).

Apart from the methodology issues, the results of pass-through obtained using both the single equation and system equation approaches could be sensitive to the number of lags include in the pass-through equation. The definition for the long-run pass-through is questionable as there is no certain answer on the number of lags one should include in the model and if all the lagged terms of exchange rate have significant effects on the domestic prices. Due to these methodologies drawbacks and uncertainty in specifying the model (the number of lags), it is difficult to estimate the coefficients of exchange rate pass-through precisely. The result of exchange rate pass-through could be different by applying different estimation techniques and imposing different number of lags as demonstrated in Mihailov (2005) and de Bandt et al. (2008).

3.3 Methodologies

Previous studies apply different techniques to estimate the exchange rate pass-through equations. All these techniques have their shortcomings and there is no agreement on the best estimation technique in the empirical studies for exchange rate pass-through (Cortinhas (2007)). The main problems in estimating the pass-through equations are the endogeneity problem and the correlation in the disturbances of the pass-through equations for different domestic prices. In order to undertake the possibility of these problems, this chapter conducts a system equation model of Seemingly Unrelated Regressions (SUR) and a single equation method of Generalized Method of Moments (GMM).

3.3.1 Seemingly unrelated regression (SUR)

The system equation model of SUR is applied as the error term of the three exchange rate pass-through equations are likely to be correlated (Edwards (2006)). Seemingly Unrelated Regression (SUR) is applied for analyzing a system equation when there are correlations in the disturbances of equations in the system. Suppose there are M equations to be estimated, the generalized regression model can be written as:

$$y_{it} = x_{it}\beta_i + \varepsilon_{it} \quad i=1, \dots, M \quad (6)$$

x_{1t} contains $(g_1 \times 1)$ explanatory variables, x_{2t} contains $(g_2 \times 1)$ variables and x_{it} contains $(g_i \times 1)$ variables. Collecting the number of coefficients to be estimated $g = g_1 + g_2 + \dots + g_M$ in a $(g \times 1)$ vector:

$$\beta = [\beta_1 \quad \beta_2 \quad \dots \quad \beta_M]'$$

Then equation (6) can be written in the following vector form:

$$y_i = X_i\beta_i + \varepsilon_i \quad i=1, \dots, M \quad (7)$$

with M equations and T observations where y_i and ε_i are $(T \times 1)$ vector of observations on the dependent variables and disturbance term respectively; X_i is a $(T \times g_i)$ matrix of sample values on the g_i independent variables and β_i is a $(g_i \times 1)$ vector of unknown coefficients.

We can also write the stacked system in the compact form (Baltagi (2002)):

$$y = X\beta + \varepsilon \quad (8)$$

$$\begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_M \end{bmatrix} = \begin{bmatrix} X_1 & 0 & \dots & 0 \\ 0 & X_2 & 0 & \vdots \\ \vdots & \vdots & 0 & \vdots \\ 0 & \dots & \dots & X_M \end{bmatrix} \begin{bmatrix} \beta_1 \\ \beta_2 \\ \vdots \\ \beta_M \end{bmatrix} + \begin{bmatrix} \varepsilon_1 \\ \varepsilon_2 \\ \vdots \\ \varepsilon_M \end{bmatrix}$$

where y and ε are $(MT \times 1)$, X is $(MT \times (g_1 + g_2 + \dots + g_M)) = (MT \times g)$ and β is $((g_1 + g_2 + \dots + g_M) \times 1) = (g \times 1)$. The error term is denoted as $(MT \times MT)$ covariance matrix V where:

$$E[\varepsilon] = 0$$

$$E[\varepsilon\varepsilon'] = V = \Sigma \otimes I_T = \sigma_{ij} I_T$$

$\Sigma = [\sigma_{ij}]$ for $i, j=1, \dots, M$ measures the correlations of the M regression equations.

In this chapter, $M=3$ as there are three equations in the system which represent the three exchange rate pass-through equations (import, producer and consumer prices):

$$\Delta p_{1t}^{imp} = \beta_{11} + \sum_{k=0}^m \beta_{12,k} \Delta c_{1t-k}^* + \sum_{k=0}^m \beta_{13,k} \Delta e_{1t-k} + \sum_{k=0}^m \beta_{14,k} \Delta p_{1t-1-k}^{imp} + \varepsilon_{1t} \quad (9a)$$

$$\Delta p_{2t}^{ppi} = \beta_{21} + \sum_{k=0}^m \beta_{22,k} \Delta c_{2t-k}^* + \sum_{k=0}^m \beta_{23,k} \Delta e_{2t-k} + \sum_{k=0}^m \beta_{24,k} \Delta p_{2t-1-k}^{ppi} + \varepsilon_{2t} \quad (9b)$$

$$\Delta p_{3t}^{cpi} = \beta_{31} + \sum_{k=0}^m \beta_{32,k} \Delta c_{3t-k}^* + \sum_{k=0}^m \beta_{33,k} \Delta e_{3t-k} + \sum_{k=0}^m \beta_{34,k} \Delta p_{3t-1-k}^{cpi} + \varepsilon_{3t} \quad (9c)$$

$k=0, 1, \dots, m$ is the lag length for the independent variables.

$$\begin{aligned}
 y_i &= [\Delta p^{imp} \quad \Delta p^{ppi} \quad \Delta p^{cpi}]' \\
 X_1 &= [1 \quad \Delta c_{1t}^* \quad \dots \quad \Delta c_{1t-m}^* \quad \Delta e_{1t} \quad \dots \quad \Delta e_{1t-m} \quad \Delta p_{1t-1}^{imp} \quad \dots \quad \Delta p_{1t-m}^{imp}] \\
 X_2 &= [1 \quad \Delta c_{2t}^* \quad \dots \quad \Delta c_{2t-m}^* \quad \Delta e_{2t} \quad \dots \quad \Delta e_{2t-m} \quad \Delta p_{2t-1}^{ppi} \quad \dots \quad \Delta p_{2t-m}^{ppi}] \\
 X_3 &= [1 \quad \Delta c_{3t}^* \quad \dots \quad \Delta c_{3t-m}^* \quad \Delta e_{3t} \quad \dots \quad \Delta e_{3t-m} \quad \Delta p_{3t-1}^{cpi} \quad \dots \quad \Delta p_{3t-m}^{cpi}] \\
 \beta_1 &= [\beta_{11} \quad \beta_{12,0} \quad \dots \quad \beta_{12,m} \quad \beta_{13,0} \quad \dots \quad \beta_{13,m} \quad \beta_{14,0} \quad \dots \quad \beta_{14,m}]' \\
 \beta_2 &= [\beta_{21} \quad \beta_{22,0} \quad \dots \quad \beta_{22,m} \quad \beta_{23,0} \quad \dots \quad \beta_{23,m} \quad \beta_{24,0} \quad \dots \quad \beta_{24,m}]' \\
 \beta_3 &= [\beta_{31} \quad \beta_{32,0} \quad \dots \quad \beta_{32,m} \quad \beta_{33,0} \quad \dots \quad \beta_{33,m} \quad \beta_{34,0} \quad \dots \quad \beta_{34,m}]'
 \end{aligned}$$

Under the OLS assumptions with homoskedasticity and no correlation in the error term, Ordinary Least Square is the best linear unbiased estimator (BLUE). However, when the assumption is relaxed, OLS may generate misleading inference. Due to this reason, Generalized Least Squares (GLS) is used under the case of heteroskedasticity and autocorrelation. The idea and concept of GLS are as follows (Baltagi (2002)):

Assume that there appear a positive definite matrix Ω where $\Omega = GG'$ so that the variance covariance matrix is $\Sigma = E(\varepsilon\varepsilon') = \sigma^2\Omega$ but not $\Sigma = E(\varepsilon\varepsilon') = \sigma^2I_M$ (under the assumption of OLS). Premultiplying the original model (8) by G^{-1} :

$$\begin{aligned}
 G^{-1}y &= G^{-1}X\beta + G^{-1}\varepsilon \quad \text{or} \\
 y^* &= X^*\beta + \varepsilon^* \tag{8*}
 \end{aligned}$$

where ε^* with zero mean and $\text{var}(\varepsilon^*) = G^{-1}\text{var}(\varepsilon)(G^{-1})' = \sigma^2G^{-1}\Omega(G^{-1})' = \sigma^2I_M$. The estimator is BLUE in the OLS transformed form (8*) and is called GLS estimator:

$$\hat{\beta}_{GLS} = (X^*X^*)^{-1}X^*y^* = (X'G^{-1}G^{-1}X)^{-1}X'G^{-1}G^{-1}y = (X'\Omega^{-1}X)^{-1}X'\Omega^{-1}y$$

Alternatively,

$$\begin{aligned}
 \hat{\beta}_{GLS} &= (X'\Sigma^{-1}X)^{-1}X'\Sigma^{-1}y \quad \text{and} \\
 \text{var}(\hat{\beta}_{GLS}) &= \sigma^2(X^*X^*)^{-1} = \sigma^2(X'\Omega^{-1}X)^{-1} = (X'\Sigma^{-1}X)^{-1}
 \end{aligned}$$

Since $\text{var}(\hat{\beta}_{OLS})$ is no longer $\sigma^2(X'X)^{-1}$ but $\sigma^2(X'X)^{-1}(X'\Omega X)(X'X)^{-1}$ under the heteroskedasticity or autocorrelation case which should be $\text{var}(\hat{\beta}_{GLS}) = \sigma^2(X^*X^*)^{-1}$, its estimator is misleading. For example, consider a case with heteroskedasticity but no correlation in the error term where $\Omega = \text{diag}[\sigma_i^2]$, $G = \text{diag}[\sigma_i] = \Omega^{1/2}$ and $\Omega^{-1} = \text{diag}[1/\sigma_i^2]$. Premultiplying the equation (8) by $\Omega^{-1/2}$ may generate a new disturbance series of $\frac{\varepsilon_i}{\sigma_i}$ with zero mean and homoskedastic variance σ^2 (Baltagi

(2002)). This technique also solves the problem under the case of autocorrelation and heteroskedasticity. The discussion is based on the known Ω .

When Ω is unknown, we need to estimate it. The OLS residuals e_t are used to estimate the elements σ_{ij} . The estimated σ_{ij} is denoted as $\hat{\sigma}_{ij}$:

$$\hat{\sigma}_{ij} = \hat{s}_{ij} = \sum_{t=1}^T \frac{e_{it}e_{jt}}{T} \text{ or} \\ \hat{s}_{ij} = \sum_t (y_{it} - \hat{y}_{it})(y_{jt} - \hat{y}_{jt}) / \max(T_i, T_j) \text{ for } i, j=1, 2 \text{ and } i \neq j \quad (10)$$

The max function aimed to down-weight the covariance terms of unbalanced data. This approach generates consistent and invertible estimator of Ω and hence asymptotically efficient estimates of Feasible Generalized Least Square or FGLS given that the number of missing values is asymptotically negligible². Substitute the consistent estimate of $\hat{\Omega}$ into $\hat{\beta}_{GLS}$ give the feasible estimator:

$$\hat{\beta}_{FGLS} = (X' \hat{\Omega}^{-1} X)^{-1} X' \hat{\Omega}^{-1} y$$

The feasible GLS estimation involves the following procedures or corrections (see Baltagi (2002)):

$$\tilde{s}_{ii} = \sum_{t=1}^T \frac{e_{it}^2}{(T - g_i)} \quad (11a)$$

$$\tilde{s}_{ij} = \sum_{t=1}^T \frac{e_{it}e_{jt}}{[(T - g_i)(T - g_j)]^{1/2}} \text{ and } i \neq j \quad (11b)$$

The second correction/ weight is unbiased only if $i=j$. However, the unbiasedness estimator of Σ does not affect the asymptotic properties of feasible GLS estimator $\hat{\beta}_{FGLS}$.

The iteration procedure involves two stages. In the first stage, OLS regression is conducted to estimate σ_{ij} which is denoted as $\hat{\sigma}_{ij}$. In the second stage, the parameter estimates and covariance matrix Σ are computed based on the estimates of the error terms $\hat{\sigma}_{ij}$. The iteration procedure is repeated until the convergence of coefficients and weights. This iteration process may lead to maximum likelihood estimates of the regression coefficients (Baltagi (2002)).

Few points are worth-noting regarding the efficiency of GLS regression under the SUR model. First, GLS is identical to OLS regression if (1) the regressors are identical, i.e. $X_i = X_j$, (2) the error term vector is diagonal and (3) if the equations are a subset of another, then no efficiency is gained from GLS over OLS of the smaller set equations. Second, higher efficiency is gained using GLS over OLS if (1) the errors are highly correlated and (2) the correlation between the X matrices is lower (Greene (2000)).

3.3.1.1 Diagonality tests

Two approaches are suggested to test the diagonality of Σ , i.e. the Lagrange Multiplier (LM) test and the Likelihood Ratio test (Baltagi (2002), Greene (2003) and

² See the manual of EViews 3.0

Kennedy (2008)). The LM test is used to test the null hypothesis that Σ is diagonal based on the sample correlation coefficients of OLS residuals:

$$\lambda_{LM} = T \sum_{i=2}^M \sum_{j=1}^{i-1} r_{ij}^2 \quad (12)$$

where $r_{ij} = \hat{s}_{ij} / (\hat{s}_{ii} \hat{s}_{jj})^{1/2}$ which is computed from the OLS residuals. λ_{LM} is asymptotically chi-square distributed, i.e. $\lambda_{LM} \overset{a}{\sim} \chi_{M(M-1)/2}^2$. In case the $\lambda_{LM} > \chi_{M(M-1)/2}^2$, we reject the null hypothesis. Since the diagonality is rejected, the test suggests the use of GLS regression rather than OLS.

Alternatively, the diagonality condition of Σ can be checked through the Likelihood Ratio test. The Likelihood Ratio statistic is constructed based on the variance covariance matrices estimated by MLE for both the restricted and unrestricted models (Baltagi (2002)):

$$\lambda_{LR} = T \left[\sum_{i=1}^M \log \hat{s}_{ii} - \log |\hat{\Sigma}| \right] \quad (13)$$

where \hat{s}_{ii} is the restricted MLE of σ_{ii} and $\hat{\Sigma}$ as the unrestricted MLE of Σ obtained from running the OLS. λ_{LR} is asymptotically $\chi_{M(M-1)/2}^2$ distributed. As in the case of LM test, the reject of the null hypothesis implies the use of GLS as the error terms are correlated.

3.3.2 Generalized method of moments (GMM)

3.3.2.1 The concept of GMM

Consider a simple single equation model³:

$$y_t = x_t \beta + \varepsilon_t \quad (14)$$

where β is a $(p \times 1)$ vector of unknown parameters, y_t is a $(d \times 1)$ vector of dependent variables and x_t is a $(d \times p)$ vector of independent variables that observed at date t ; $t=1, 2, \dots, T$. Assume also that $H = (h_T', h_{T-1}', \dots, h_1')$ is a $(Td \times 1)$ vector that contains all the observations in a T size sample given that $H = (y_T, X_T, Z_T)$ and $h = (y_t, x_t, z_t)$ so that

$$y_T = X_T \beta + \varepsilon_T \quad (15)$$

where y_T and ε_T are $(Td \times 1)$ vectors, X_T is a $(Td \times p)$ vector and β is a $(p \times 1)$ vector.

The main idea of GMM is to choose a set of parameter estimates in order to match the theoretical relation as closely as possible. If β_0 is the true value of β , we seek to achieve the following moment condition:

$$E[m(\beta_0, y_t, x_t, z_t)] = 0 \quad (16)$$

³ The notations in the single equation representation here are different to the notations for the system equations in SUR as both representations have different theoretical interpretations.

where β_0 is a $(p \times 1)$ vector of unknown parameters, z_t is a $(n \times 1)$ vector of instrument variables or information set that orthogonal to $m(\beta_0, y_t, x_t, z_t)$. The theoretical moment is replaced by the sample moment of T observations:

$$\bar{m}(\beta, y_T, X_T, Z_T) = \sum_{t=1}^T [m(\beta, y_t, x_t, z_t)] / T = 0.$$

When the number of moment conditions, n equals the number of unknown parameters p (exact identified case), the unknown parameters are found by solving the $n=p$ equations, i.e. the GMM estimator $\hat{\beta}_T$ is obtained by minimizing the criteria:

$$\bar{m}(\hat{\beta}_T, y_T, X_T, Z_T) = 0 \quad (17)$$

In case there are more moment and orthogonality conditions than unknown parameters i.e. $n > p$ (over-identified case), the criteria in (17) will not hold exactly here and there will be no unique solution. The problem is solved by minimizing the weighted sum squares of the violation of the moment conditions in the data with respect to β . In other word, we seek to minimize the weighted distance between the theoretical and actual values by considering p linear combinations of the n moment conditions:

$$Q(\beta, y_T, X_T, Z_T) = \min_{\beta} \bar{m}[(\beta, y_T, X_T, Z_T)]' A [(\beta, y_T, X_T, Z_T)] \bar{m}[(\beta, y_T, X_T, Z_T)] \quad (18)$$

A is a $(n \times n)$ weighting matrix. Any positive definite matrix of A will yield a consistent estimator of β . According to Hansen (1982), a necessary (but not sufficient) condition to obtain an (asymptotically) efficient estimate of β is to set A as the inverse of the covariance matrix of the sample moments (Favero (2001)). If the optimal weighting matrix is $\Psi = \lim_{T \rightarrow \infty} T.E \left\{ \left[\bar{m}(\beta_0, y_T, X_T, Z_T) \right] \left[\bar{m}(\beta_0, y_T, X_T, Z_T) \right]' \right\}$, the minimization problem for the GMM estimates (18) becomes:

$$Q(\beta, y_T, X_T, Z_T) = \min_{\beta} \bar{m}[(\beta, y_T, X_T, Z_T)]' \Psi^{-1} \bar{m}[(\beta, y_T, X_T, Z_T)] \quad (19)$$

In case z_t is stationary and $m(\cdot)$ is continuous, we expect the law of large numbers holds where $\bar{m}(\beta, y_T, X_T, Z_T) \xrightarrow{p} E \{ m(\beta, y_t, x_t, z_t) \}$.

Under the case where $m(\beta, y_t, x_t, z_t)$ is not serially correlated (but allow for possible heteroskedasticity), the optimal weighting matrix Ψ can be consistently estimated as proposed by White (1980) (see Hamilton (1994)) by:

$$\hat{\Psi}_T \equiv \frac{1}{T} \sum_{t=1}^T \left[m(\hat{\beta}_T, y_t, x_t, z_t) \right] \left[m(\hat{\beta}_T, y_t, x_t, z_t) \right]' \xrightarrow{p} \Psi$$

where $\hat{\beta}_T$ is the consistent estimate of β_0 . On the other hand, if $m(\beta, y_t, x_t, z_t)$ is heteroskedastic and autocorrelated, GMM estimation involves two stages. In the first stage, a consistent estimation procedure is carried out to estimate the element of variance covariance matrix. In the second stage, the estimated elements of variance covariance matrix are used to minimize the objective function in order to get the GMM estimate.

The Newey-West (1987) estimate gives (Hamilton (1994)):

$$\hat{\Psi}_T = \hat{\Gamma}_{0,T} + \sum_{v=1}^q \{1 - [v/(q+1)]\} (\hat{\Gamma}_{v,T} + \hat{\Gamma}'_{v,T}) \text{ where}$$

$$\hat{\Gamma}_{v,T} = \frac{1}{T} \sum_{t=v+1}^T [(\hat{\beta}_T, y_t, x_t, z_t)] [(\hat{\beta}_T, y_t, x_t, z_t)]'$$

The Newey-West applies a weighting matrix that is robust to heteroskedasticity and autocorrelation of unknown form. Other alternative methods include Andrews and Variable-Newey-West.

3.3.2.2 Applying GMM to the exchange rate pass-through model

In this chapter, each exchange rate pass-through equation (import, producer and consumer prices) alone can be characterized as a linear regression model of (14). The vector y_t consists of the observable dependent variables. The dependent variables are represented by Δp^{imp} , Δp^{ppi} and Δp^{cpi} for equation (9a), (9b) and (9c) respectively. The independent variables include the lagged terms of the change in foreign production cost, the lagged terms of the change in exchange rate and the lagged terms in the dependent variables for each single pass-through equation. β_0 or the unknown parameters to be estimated consists of the constant term and the coefficients of the independent variables in each pass-through equation.

If there exists correlations of elements in the independent variables and the error term i.e. $cov(\varepsilon_t, x_t) \neq 0$, then OLS estimator is inconsistent and biased. GMM should be applied. The main idea of GMM is to achieve the moment criteria in (16), i.e. $E[m(\beta_0, y_t, x_t, z_t)] = 0$. Based on the concept of GMM, a set of instrument variables (denoted as z_t matrix) is chosen to construct a GMM estimate where $cov(\varepsilon_t, z_t) = 0$. The instrument variables are chosen by referring to the previous studies application (see **Section 3.4.2**).

This chapter considers the over-identification case where ($n > p$) as the number of instrument variables exceeds the number of parameters to be estimated. The validity of the instruments for over-identification can be checked using the J-test. Applying the minimization criteria in (16), the objective function of GMM is to solve the following problem⁴:

$$\min_{\beta} (\varepsilon' Z \Psi^{-1} Z' \varepsilon)$$

This chapter considers the possible case of heteroskedasticity by applying White's Heteroskedasticity Consistent Covariance Matrix estimation method in GMM in constructing the weighting matrix. This option uses a weighting matrix that is robust to heteroskedasticity and contemporaneous correlation of unknown form. The concept and idea of White (1980) are as follows:

⁴ Z is the matrix notation for z_t

Consider a case of no serial correlation in the errors but allows conditional heteroskedasticity for the errors by assuming the population moment $E[\varepsilon_i^2 x_{it} x_{ij}] = \Omega_i = \Omega$ is a positive definite matrix. The sample moment for T observations estimated by its ij th elements is:

$$\Omega_T^* = \frac{1}{T} \sum_{i=1}^T \varepsilon_i^2 x_{it} x_{ij}$$

By the law of large numbers, Ω_T^* will converge to the population moment Ω i.e.

$$\Omega_T^* \xrightarrow{p} \Omega. \text{ Denoting } \hat{\Omega}_T = \frac{1}{T} \sum_{i=1}^T \hat{\varepsilon}_i^2 x_{it} x_{ij}, \hat{\Omega}_T \text{ gives a consistent estimate of } \Omega, \text{ i.e.}$$

$\hat{\Omega}_T \xrightarrow{p} \Omega$ if $\hat{\Omega}_T - \Omega_T^* \rightarrow 0$. This proposition is proved and shown in Hamilton (1994).

Under the Heteroskedasticity of Consistent Covariance matrix option, the asymptotic variance covariance of OLS coefficient vector is estimated consistently by:

$$\hat{Q}_T^{-1} \hat{\Omega}_T \hat{Q}_T^{-1} \xrightarrow{p} Q_T^{-1} \Omega_T Q_T^{-1} \text{ where}$$

$$\hat{Q}_T = \frac{1}{T} \sum_{i=1}^T x_{it} x_{ij}$$

$$\hat{\Omega}_T = \frac{1}{T} \sum_{i=1}^T \hat{\varepsilon}_i^2 x_{it} x_{ij}$$

and $\hat{\varepsilon}_i$ is the OLS residual. As mentioned in Greene (2003), the result implies that inferences based on OLS are appropriate without precise specification on the nature of heteroskedasticity (since this option is robust to heteroskedasticity and contemporaneous correlation of unknown form).

Applying the concept of White (1980) to GMM estimator, the weighting matrix can be consistently estimated.

$$\Psi = Z' \Omega Z = E[\varepsilon^2 z_{it} z_{ij}] \text{ as the population counterpart}$$

$$\Psi^* = \frac{1}{T} \sum_{i=1}^T \varepsilon_i^2 z_{it} z_{ij} \text{ as the sample counterpart}$$

$$\hat{\Psi} = \frac{1}{T} \sum_{i=1}^T \hat{\varepsilon}_i^2 z_{it} z_{ij} \text{ as the estimated sample counterpart}$$

By the law of large numbers, $\Omega_T^* \xrightarrow{p} \Omega$, so that $Z' \hat{\Omega} Z \xrightarrow{p} Z' \Omega Z$ or $\hat{\Psi} \xrightarrow{p} \Psi$

3.3.2.3 Hypothesis tests

The decision on the appropriateness of GMM and the instrument set involves three tests:

- (1) The endogeneity test of regressors
- (2) The exogeneity test for instruments
- (3) The test for the relevance of instruments

Testing for endogeneity

Before deciding the application of GMM over OLS, one should check the heteroskedasticity condition of the disturbance term. Take the linear regression representation of (14):

$$y_t = x_t\beta + \varepsilon_t$$

Then we can write $y_t = \Delta p_t$ and $x_t = (\Delta e_t, \Delta c_t^*, \Delta p_{t-1})$ based on the exchange rate pass-through equation (5b). It is assumed that there is no correlation between the regressor and the error term, i.e. $\text{cov}(\varepsilon_t, x_t) = 0$. In this case, the regressors are exogenous and OLS is unbiased. However, when at least one of the regressors are correlated with the error term, this condition is violated i.e. $\text{cov}(\varepsilon_t, x_t) \neq 0$ or $\text{cov}(\varepsilon_t, \Delta e_t) \neq 0$. The regressors that are correlated with the error term are called as the endogenous regressors. Under this condition, OLS is no longer consistent and one should call for the instrument variable (IV) method or GMM. On the other hand, if both the regressor and disturbance term are not correlated, performing the IV or GMM may generate larger asymptotic variance of the estimators (Baum et al. (2003)). Therefore, the test for endogeneity of the regressors is helpful in suggesting the appropriate estimation methods.

The specification test for the null hypothesis $H_0: \text{cov}(\varepsilon_t, x_t) = 0$ is called the Hausman test. The main idea of Hausman test is to compare two sets of estimates, where the first estimator $\hat{\beta}_c$ is consistent and efficient estimator of β under both the null and alternative hypotheses whereas the second estimator $\hat{\beta}_e$ is only consistent and efficient under the null hypothesis. The Hausman statistic can be written as:

$$H = \hat{q}' [\text{var}(\hat{q})]^{-1} \hat{q} \quad (20)$$

which is asymptotically χ_K^2 distributed under the null hypothesis. K is the dimension of β . The difference between these two estimators and the difference in variance are defined as:

$$\hat{q} = \hat{\beta}_c - \hat{\beta}_e$$

$$\text{var}(\hat{q}) = \text{var}(\hat{\beta}_c) - \text{var}(\hat{\beta}_e)$$

According to Baum et al. (2003), the Hausman statistic can be constructed in different flavors depending on the estimates of the asymptotic variances. The first possibility is to construct the statistic using the estimates of asymptotic variances from IV and OLS estimations, i.e. IV estimator as $\hat{\beta}_c$ and OLS estimator as $\hat{\beta}_e$. This form of statistic has a drawback of generating a negative Hausman statistic in finite samples. The second possibility to form the Hausman statistic is to use the IV estimates of the error variance. The third possibility is to use the OLS estimates of the error variance. Both the IV and OLS give consistent estimators of σ and the common estimate of σ guarantees a positive test statistic. There are different ways to conduct the Hausman test. The first testing strategy is to compute the Wald statistic of (20) by comparing the estimates of IV and GMM. The null hypothesis testing is:

$$H_0 : \text{plim}\hat{q} = 0$$

If the difference between the two estimators is large and one is able to reject the null hypothesis, the result implies non-consistency of OLS method and one should look for the alternative estimator. Alternatively, the Hausman test can be obtained through the auxiliary regression (Baltagi (2002) and Baum et al. (2003)). Under the auxiliary regression strategy, the Hausman test is carried out by running two OLS regressions (equations (22) and (23)) where the structural equation is based on the difference between OLS and IV estimation in the following matrix form (Baum et al. (2003)):

$$y_t = x_{1t}\beta_1 + x_{2t}\beta_2 + \varepsilon_t = x_t\beta + \varepsilon_t \quad (21)$$

$$x_{1t} = z_{1t}\Gamma_1 + x_{2t}\Gamma_2 + v_t = z_t\Gamma + v_t \quad (22)$$

such that the regressors $x_t = [x_{1t} \ x_{2t}] = [x_{1t} \ z_{2t}]$ where x_{1t} and x_{2t} are the endogenous and exogenous regressors respectively. The instrument variable set z_t is partitioned as the excluded z_{1t} and included instruments z_{2t} respectively or $z_t = [z_{1t} \ z_{2t} \equiv x_{2t}]$ (see Baum et al. (2003)).

Referring to the exchange rate pass-through equation (5b), $x_{1t} = \Delta e_t$ represents the right hand side endogenous variables and $x_{2t} = (\Delta c_t^*, \Delta p_{t-1})$ represents the exogenous variables. The instrument variables z_t is assumed to be the current and one to four lagged terms of the level in nominal exchange rate, nominal effective exchange rate, foreign cost and commodity price and one to four lagged terms in the change in domestic price. The instrument set is correlated with x_{1t} but uncorrelated with ε_t . Under this assumption, estimating on (22) is equivalent to test the correlation of v_t and ε_t . Exogeneity of z_t implies that \hat{v} is a consistent estimate of v_t under the OLS estimation on (22). The endogeneity test is simply based on the t-test of the significant of \hat{v} in the following auxiliary regression:

$$y_t = \beta_1 x_{1t} + x_{2t}\beta_2 + \phi \hat{v}_t + \mathcal{D}_t \quad (23)$$

The null hypothesis is OLS is consistent estimates or $\phi=0$. The rejection of the null hypothesis (i.e. t-statistic is significant) suggests the call for IV or GMM as IV or GMM estimates are more efficient than the OLS estimates.

Testing for the relevance and the validity of instruments

Under the standard IV or GMM estimator, the instrument z_t should fulfill two requirements (Davis & Kim (2002) and Baum et al. (2003)) i.e. (1) relevance, i.e. the endogenous variable should have strong correlation with the instruments or $\text{cov}(x_{1t}, z_t) \neq 0$. If the instruments are weak, the IV or GMM estimator will be misleading (Davis & Kim (2002)); (2) exogeneity where z_t is uncorrelated with the disturbance term. Exogeneity of the instruments implies the satisfactory of the orthogonality conditions at the true value of parameters β_0 or $E[m(\beta_0, y_t, x_t, z_t)] = 0$.

The relevance of the instruments condition can be tested by examining the fit of the first stage regression, i.e. the reduced form regression of the suspected endogenous variable on the instrument and exogenous variables. The weak instrument problem is detected if the first stage regression is significant at a given critical level. A rule of thumb for a single endogenous regressor is the joint significant of the instrument F-

statistic should be greater than 10 in order to satisfy the relevance condition (Baum et. al (2003)).

The overidentifying restriction test is carried out to check the orthogonality conditions and correct model specification under overidentification case such that $E(\varepsilon_t | z_t) = 0$ or $\text{cov}(\varepsilon_t, z_t) = 0$. In order to get the identified GMM estimator, the number of instrumental variables should at least the same or greater than the number of parameters $n \geq p$. J-test is used to test the validity of overidentifying restrictions. The J-statistic multiplied by the size of sample/ observations (T) is an asymptotically χ^2_{n-p} distribution with degrees of freedom ($n-p$).

$$T \cdot \left\{ \bar{m} \left[\left(\hat{\beta}, y_T, X_T, Z_T \right) \right]' \hat{\Psi}^{-1} \bar{m} \left[\left(\hat{\beta}, y_T, X_T, Z_T \right) \right] \right\}_{H_0} \overset{a}{\sim} \chi^2_{n-p}$$

The main idea of this test is to check if all the sample moments of $\bar{m} \left[\left(\hat{\beta}, y_T, X_T, Z_T \right) \right]$ are expected to be zero if the population moments $E \left[m \left[\left(\beta_0, y_t, x_t, z_t \right) \right] \right]$ are zero. The validity of overidentifying restrictions is satisfied when one cannot reject the null hypothesis of valid over-identification.

3.3.3 Data and estimations

The data used in the analysis are in monthly and most of them are obtained from the IFS, IMF. The data take the range from 1985M1 to 2008M5. As the financial crisis started in July 1997, the monthly data are divided into two sub-periods: the pre-crisis period or period I (1985M1-1997M6) and the post-crisis period or period II (1999M1-2008M5)⁵. The countries that include in the analysis are Indonesia, Korea, Malaysia, Philippines, Singapore and Thailand. The data include the domestic price or price indices (import, producer and consumer prices) and the nominal and real effective exchange rate (NEER and REER). Due to the data availability problem, the estimation for the pass-through into import price is not possible for Indonesia, Malaysia and Philippines. The data are in the log-first differenced term.

Following Campa & Goldberg (2002), the exporter's production cost is constructed as $C_t^{*x,j} = (NEER_t^j \cdot P_t^j) / REER_t^j$. This measurement of trading partner costs takes into account the relative weights of trade partners in the importing country's trade (x trading partners of importing country j). P_t^j in this construction is represented by the producer price index. The exchange rate term is represented by the nominal effective exchange rate (NEER). The domestic price variable is represented by three domestic price indices (see **Table II-(2), Appendix II**).

Three exchange rate pass-through equations are considered for each country to represent the pass-through equations for the import, producer and consumer prices. The exchange rate pass-through equation to be estimated is equation (5b) or equation (5c) given $m=0$. Later following the step of previous studies, modification is made on

⁵ For period I, the data for Indonesia span from 1994M1-1997M6, Malaysia (1986M1-1997M6), Philippines (1993M1-1997M6) and Thailand (1991M1-1997M6).

this equation to allow gradual pass-through of exchange rate into domestic prices (which is given as equation (5c)). This chapter considers the case of $m=3$ and 6.

Before conducting the estimation, the property of the data is examined. Consistent to the previous studies, the Augmented Dicky-Fuller unit-root test shows that the series used in this chapter, i.e. log domestic prices (consumer price, producer price and import price), log foreign production cost and log nominal effective exchange rate series are not stationary at the given critical level (1%, 5% and 10%). Therefore, the pass-through equations should be estimated in the differenced form and in case a cointegrating relationship is revealed, the error correction term should be considered in the equation (see **Table II-(3), Appendix II**).

Turning to the cointegration test, the Johansen Trace Test shows mixed results. Long-run cointegrating relationship does not appear in every case especially in the post-crisis period (see **Table II-(4), Appendix II**). In case there is no significant long-run cointegrating relationship found in the pass-through equation, ECM may not be applicable. Comparisons of the results on the degree of exchange rate pass-through (based on the same method) across countries, along the chain of prices and over time become difficult since estimation of pass-through using ECM cannot apply to all cases. Due to the weak evidence of cointegrating relation among variables and for the purpose of comparison, ECM may not apply here.

The next step is to decide the modeling approach and estimation technique after checking the possible problems encountered such as endogeneity. This chapter considers two modeling approaches namely the system equation model of SUR and the single equation method of GMM. First, the exchange rate pass-through equation is modeled in a system equation model in which each country considered in the estimation has three pass-through equations (the pass-through into import, producer and consumer prices equations). Therefore, each country has a system equation that consists of three pass-through equations.

The main reason to form this system equation is to encounter the problem of correlations in the disturbance terms of three pass-through equations. As the Lagrange Multiplier (LM) test reveals correlations in the disturbance terms of three pass-through equations, it is reasonable to apply this system equation model. Next, this chapter separates the three pass-through equations for each country in which each pass-through equation is a single equation model and they are estimated separately. The endogeneity test for the regressor is carried out to detect the problem of endogeneity. Since evidences about the endogeneity are reported, GMM is applied.

Both the single equation method and system equation model are estimated using EViews 3.0. The GMM estimation applies the White covariance weighting matrix while the GLS estimation applies the one-step weighting matrix procedure.

3.4 Results – econometrics counterpart

3.4.1 Results of system equation SUR model – GLS technique

This section presents the empirical results of SUR for GLS technique on exchange rate pass-through into domestic prices in six East-Asian countries namely Indonesia,

Korea, Malaysia, Philippines, Singapore and Thailand. Each country has three exchange rate pass-through equations which represent the pass-through into import, producer and consumer prices. These three equations are estimated simultaneously in a system equation using Seemingly Unrelated Regression (SUR).

Before conducting the estimation, the (Lagrange Multiplier) LM test is applied to check the diagonality condition of the error term of the three exchange rate pass-through equations. The null hypothesis of the test is Σ is diagonal based on the sample correlation coefficients of OLS residuals. In case the null hypothesis is rejected, i.e. the error terms are correlated, the result suggests the use of the GLS technique rather than OLS. Applying the LM test to the three pass-through equations ($M=3$) on (5b) or (5c) given $m=0$ gives us the following results (see **Table A.1**). The results indicate the rejection of the null hypothesis and suggest to the choice of GLS regression or SUR model. Since the three pass-through equations are correlated in their error terms, it is reasonable to apply the SUR model with GLS regression.

Table A.1: LM test

λ_{LM}	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
LM1	26.9067	121.4250	43.0312	12.9014	184.9800	56.7948
LM2	102.7138	108.3105	55.7979	78.5605	130.5715	92.1628

Notes:

The LM statistics are constructed as $\lambda_{LM} = T \sum_{i=2}^M \sum_{j=1}^{i-1} r_{ij}^2$ which is computed using the coefficients of

correlation in OLS residuals by running the OLS for the three exchange rate equations of (5b) or (5c) given $m=0$ (import, producer and consumer prices) simultaneously

LM1 indicates the LM statistic for the sub-sample for pre-crisis period

LM2 indicates the LM statistic for the sub-sample for the post-crisis period

The chi-square at 5% level given $M=3$ is 7.8147. Since the LM statistics are greater than this chi-square value in all cases, the results indicate the rejection of diagonality in the variance covariance matrix and GLS should be used to estimate the pass-through equations.

Next, we turn to the estimation results of GLS. The results are summarized in **Table A.2** and **A.3(a – c)**. **Table A.2** summarizes the estimated coefficients of pass-through equation (5c) given $m=0$ using the SUR model. The nominal effective exchange rate (NEER) is used to represent exchange rate in the equation. The increase in the NEER implies appreciation. The appreciation in exchange rate leads to the decline in domestic prices (which is in negative sign) or equivalently, depreciation in exchange rate induces higher prices. This condition can be observed from the results reported in **Table A.2**. On the other hand, the results also indicate the situation where appreciation (depreciation) in exchange rate leads to higher (decline) domestic prices especially in the consumer price level in Singapore. The same results also found in previous studies (for example Choudhri and Hakura (2006)). Apart from these results, the foreign production cost has a significant impact on the movements in domestic prices. The increase in foreign cost induces higher domestic import and producer prices but it tends to reduce the domestic consumer price.

Comparing the results across three domestic prices, it is observed that the exchange rate pass-through equations fit the data better for the import price equation as shown by a higher value of R-square. In most cases, R-square is higher for the estimated import price pass-through equation than that of the pass-through into producer and consumer prices equation. R-square is very small for the pass-through into consumer price equation. This result implies a closer link between the import price and

exchange rate movements and a weak relation between the consumer price and exchange rate movements as indicated by many studies (for instance Campa & Goldberg (2006)). On the other hand, the results between the two sub-periods are mixed. The pass-through equations do not show better goodness of fit in the second sub-period data in all cases.

Table A.3(a) summarizes the results of the short-run and long-run coefficients for exchange rate pass-through using the baseline equation of (5b) or (5c) with $m=0$. Due to the data availability problem, only three countries appear to have the data for import price. Comparing the results of pass-through into import price in these three countries (the pre- and post-crisis periods), all these countries show very large increase in pass-through rate especially in the case of Korea. The pass-through rate in Singapore is relatively very low as compare to Korea and Thailand.

At the producer and consumer price levels, the results are mixed and the change in the pass-through rate is smaller compare to that of the import price level. Among these six countries, Indonesia, Korea and Malaysia exhibit the increase of exchange rate pass-through into producer and consumer prices. On the other hand, Philippines, Singapore and Thailand show the decline of pass-through rate into the producer and consumer prices although Singapore and Thailand experience large increases of pass-through into their import prices. In general, the results show that the pass-through rates into the producer and consumer prices are very low in Malaysia and Singapore but relatively high in Indonesia and Korea.

Comparing the pass-through across three domestic prices, it is observed that the exchange rate pass-through is the highest on the import price, followed by producer price and the lowest on consumer price. Besides, countries that experience very high pass-through rate into import price do not necessarily exhibit higher pass-through rate into producer and consumer price compare to the countries with lower pass-through rate into import price. For example, Thailand experiences very high pass-through rate into import price in the post-crisis period. However, the pass-through rates at the producer and consumer prices in the post-crisis period are lower than that of the pass-through rate in the pre-crisis period. These pass-through rates are also lower than that the pass-through rate in Thailand although Korea exhibits higher pass-through rate into import price in the post-crisis period than Korea.

Comparing the results for the two sub-periods in these six countries, it is observed that the pass-through rate is different across countries, over time and along the chain of domestic prices. Exchange rate pass-through does not decline in all these six countries as reported by many studies that the pass-through rate tends to decline over time. The results show that Philippines, Singapore and Thailand are the only countries that reveal the decline in the pass-through rate into producer and consumer prices. Other cases show increase in exchange rate pass-through.

In order to check the robustness of the results, the result of estimation given $m=0$ is compared with the results in which the equation includes more lagged terms to capture the gradual pass-through ($m=3$ and 6). The same technique of GLS is used to estimate equation (5c) given $m=3$ and 6 . The results are summarized in **Table A.3(b-c)**. The results show that including more lagged terms in the pass-through equation improve the estimation with higher R-square and lower standard error of regression

and determinant of residual covariance (compare the results of **Table A.3(b-c)** with **A.3(a)**). The main results of the baseline equation (5c) given $m=0$ still hold in the case where $m=3$ and 6. However, the coefficients of the pass-through tend to be larger when more lagged terms are included in the baseline equation. Although the lag length matters in determining the pass-through coefficients, the results are robust as the pattern and direction of pass-through (for each country, over time and along the pricing chain) still hold across different lag lengths.

Table A.2: Regression result of SUR model – equation (5c) given $m=0$

Coeff.	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
<u>IMP</u>												
C(0)			0.0009	0.0041***					-0.0009***	0.0000	0.0045**	0.0016
DC(t)			0.6545***	2.3630***					0.8001***	0.5666***	0.4776*	0.2925***
DP(t-1)			0.4384***	-0.1730**					-0.0669***	0.0043	-0.5449***	0.1025
DE(t)			-0.0859	-0.8121***					0.0153	-0.1414***	-0.4595	-0.9050***
R-sq			0.3403	0.5731					0.9238	0.8759	0.3467	0.5919
DW			1.8045	1.7098					2.0149	2.0801	1.8116	1.7249
SE			0.0102	0.0163					0.0042	0.0036	0.0206	0.0103
<u>PPI</u>												
C(0)	0.0034***	0.0062***	0.0019***	0.0013***	-0.0007**	0.0004	0.0028**	0.0030***	-0.0011***	0.0004	0.0007*	0.0002
DC(t)	0.5610***	0.6869***	0.4450***	0.6822***	0.9246***	0.8906***	0.4868***	0.8465***	0.9713***	0.8602***	0.8826***	1.1019***
DP(t-1)	0.1400*	-0.0109	0.0371	0.0644	-0.0347	-0.0310*	-0.0599	0.0117	-0.0169	-0.0101	0.0383	0.0348
DE(t)	-0.0115	-0.1066***	-0.0021	-0.0666***	0.0125	-0.0081	-0.0155	0.0240	0.0886***	0.0929	-0.1326**	-0.0105
R-sq	0.4436	0.6639	0.2548	0.6037	0.9090	0.92290	0.4928	0.9032	0.9638	0.9176	0.7881	0.8659
DW	1.6381	1.7045	1.6946	1.5609	2.0120	2.3029	1.6267	1.4762	2.0608	2.1975	1.9193	1.6939
SE	0.0054	0.0104	0.0037	0.0034	0.0030	0.0027	0.0034	0.0050	0.0035	0.0042	0.0040	0.0039
<u>CPI</u>												
C(0)	0.0060***	0.0074***	0.0032***	0.0023***	0.0022***	0.0018***	0.0062***	0.0043***	0.0016***	0.0013***	0.0041***	0.0011***
DC(t)	-0.3374**	-0.1739**	-0.3046***	-0.0650	0.0163	-0.0532**	-0.5887***	-0.1205	0.0084	-0.0548**	-0.0233	0.2330***
DP(t-1)	0.1683*	0.0052	0.2681***	0.1241**	0.0579	0.0241	0.0849	0.0322	-0.1154**	0.0423	0.0327	0.1665***
DE(t)	-0.0245	-0.0736**	0.0097	-0.0716***	0.0301	-0.0042	0.0101	-0.0501*	0.1043***	0.1353**	-0.1287*	-0.0151
R-sq	0.1678	0.0645	0.1878	0.1355	0.0235	0.0401	0.3892	0.1497	0.0870	0.0695	0.0512	0.3202
DW	1.7346	1.6142	1.7563	1.6778	2.0355	2.1163	1.5786	1.4221	2.1070	2.2926	1.7651	1.6614
SE	0.0063	0.0098	0.0043	0.0039	0.0031	0.0027	0.0050	0.0054	0.0031	0.0045	0.0045	0.0038
Det. Resid cov.	1.43E-10	5.13E-10	6.05E-15	1.17E-14	5.73E-11	2.40E-11	1.93E-10	1.72E-10	4.16E-16	3.87E-16	2.35E-14	4.33E-15

Notes:

The representations for the notations are as follows:

 $C(0) = \beta_1$; $DC(t) = \beta_2$; $DP(t-1) = \beta_4$; $DE(T) = \beta_3$

SE = standard error of regression and DW = Durbin-Watson statistic

I indicates the use of sub-sample pre-crisis data and II the post-crisis data

*** denotes the 1% significant level; ** the 5% significant level and * the 10% significant level

Table A.3a: Exchange rate pass-through coefficient using SUR model/ GLS method – equation (5c) given $m=0$

	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
<u>Import price</u>												
ERPT – SR			-0.0859	-0.8121					0.0153	-0.1414	-0.4595	-0.9050
ERPT – LR			-0.1529	-0.6923					0.0143	-0.1420	-0.2974	-1.0083
R-square			0.3403	0.5731					0.9238	0.8759	0.3467	0.5919
SE			0.0102	0.0163					0.0042	0.0036	0.0206	0.0103
DW			1.8045	1.7098					2.0149	2.0801	1.8116	1.7249
<u>Producer price</u>												
ERPT – SR	-0.0115	-0.1066	-0.0021	-0.0666	0.0125	-0.0081	-0.0155	-0.0240	0.0886	0.0929	-0.1326	-0.0105
ERPT – LR	-0.0134	-0.1054	-0.0022	-0.0712	0.0121	-0.0078	-0.0146	-0.0243	0.0871	0.0920	-0.1379	-0.0109
R-square	0.4436	0.6639	0.2548	0.6037	0.9090	0.9290	0.4928	0.9032	0.9638	0.9176	0.7881	0.8659
SE	0.0054	0.0104	0.0037	0.0034	0.0030	0.0027	0.0034	0.0050	0.0035	0.0043	0.0040	0.0039
DW	1.6381	1.7045	1.6946	1.5609	2.0120	2.3029	1.6267	1.4762	2.0608	2.1975	1.9193	1.6939
<u>Consumer price</u>												
ERPT – SR	-0.0245	-0.0736	0.0097	-0.0716	0.0300	-0.0041	0.0101	-0.0501	0.1043	0.1353	-0.1287	-0.0151
ERPT – LR	-0.0294	-0.0740	0.0132	-0.0817	0.0318	-0.0042	0.0110	-0.0518	0.0935	0.1413	-0.1330	-0.0181
R-square	0.1687	0.0645	0.1878	0.1355	0.0235	0.0401	0.3892	0.1497	0.0870	0.0695	0.0512	0.3202
SE	0.0063	0.0098	0.0043	0.0039	0.0031	0.0027	0.0050	0.0054	0.0031	0.0045	0.0045	0.0038
DW	1.7346	1.6142	1.7563	1.6778	2.0355	2.1163	1.5786	1.4221	2.1070	2.2925	1.7651	1.6614
Det. Resid. Cov.	1.43E-10	5.13E-10	6.05E-15	1.17E-14	5.73E-11	2.40E-11	1.93E-10	1.72E-10	4.16E-16	3.87E-16	2.35E-14	4.33E-15

Notes:

Short-run exchange rate pass-through (ERPT-SR) and long-run pass-through (ERPT-LR)

SE indicates the standard error of regression and DW as Durbin-Watson statistic.

I indicates the use of sub-sample pre-crisis data and II the post-crisis data.

All the results are obtained by regressing the SUR model except the long-run exchange rate pass-through which is obtained through calculations.

TableA.3b: Exchange rate pass-through coefficient using SUR model/ GLS method – equation (5c) given $m=3$

	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
<u>Import price</u>												
ERPT – SR			-0.0593	-0.9927					-0.0367	-0.2482	-0.4207	-0.8519
ERPT – LR			-0.1363	-0.6548					-0.0400	-0.1926	-0.3801	-1.0979
R-square			0.4111	0.6065					0.9259	0.8891	0.4290	0.6243
SE			0.0100	0.0163					0.0043	0.0036	0.0231	0.0103
DW			1.9989	1.8533					2.0315	2.1678	2.0312	1.9329
<u>Producer price</u>												
ERPT – SR	0.0225	-0.1947	-0.0049	-0.1292	-0.0178	-0.0393	-0.0461	-0.0153	-0.0815	0.1226	-0.1282	0.0360
ERPT – LR	0.0234	-0.1908	-0.0053	-0.1051	0.0241	-0.0311	-0.0583	-0.0178	-0.0686	0.1130	-0.1231	0.0330
R-square	0.5984	0.6809	0.3375	0.6953	0.9081	0.9372	0.5820	0.9074	0.9680	0.9326	0.8017	0.8690
SE	0.0055	0.0105	0.0036	0.0031	0.0030	0.0027	0.0036	0.0051	0.0034	0.0040	0.0041	0.0040
DW	1.7254	1.8022	1.9896	1.9242	2.0739	2.1144	2.1473	1.7128	2.1454	2.0190	1.9829	1.5574
<u>Consumer price</u>												
ERPT – SR	-0.0049	-0.1612	0.0130	-0.1142	0.0377	0.0057	-0.0810	-0.0457	0.1378	0.1986	-0.1495	0.0356
ERPT – LR	-0.0060	-0.1676	0.0200	-0.0872	0.0392	0.0058	-0.1003	-0.0491	0.1294	0.2145	-0.1283	0.0412
R-square	0.4682	0.1192	0.3253	0.3118	0.0478	0.1297	0.5866	0.2079	0.2031	0.2620	0.2291	0.3544
SE	0.0058	0.0099	0.0040	0.0036	0.0032	0.0027	0.0047	0.0055	0.0030	0.0041	0.0044	0.0039
DW	1.7966	1.6933	1.9607	1.8307	1.9416	2.0488	2.0021	1.5854	2.0997	2.1653	1.8246	1.5695
Det. Resid. Cov.	5.48E-11	4.46E-10	4.15E-15	7.02E-15	4.80E-11	1.91E-11	9.75E-11	1.47E-10	2.96E-16	2.40E-16	1.58E-14	3.38E-15

Notes:

Short-run exchange rate pass-through (ERPT-SR) and long-run pass-through (ERPT-LR)

SE indicates the standard error of regression and DW as Durbin-Watson statistic.

I indicates the use of sub-sample pre-crisis data and II the post-crisis data

All the results are obtained by regressing the SUR model except the short-run and long-run exchange rate pass-through which are obtained through calculations

Table A.3c: Exchange rate pass-through coefficient using SUR model/ GLS method – equation (5c) given $m=6$

	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
<u>Import price</u>												
ERPT – SR			-0.0656	-1.1367					-0.0682	-0.4860	-0.0248	-0.8614
ERPT – LR			-0.1067	-0.5777					-0.1041	-1.0724	0.0305	-0.9823
R-square			0.4239	0.6346					0.9388	0.9053	0.5482	0.6435
SE			0.0102	0.0165					0.0040	0.0034	0.0214	0.0106
DW			1.9624	1.8059					2.0521	2.2226	1.8952	1.8998
<u>Producer price</u>												
ERPT – SR	0.1124	-0.2794	-0.0127	-0.1665	0.0073	-0.0366	-0.1215	-0.0488	0.1101	-0.0933	-0.0812	0.0823
ERPT – LR	0.1416	-0.3141	-0.0255	-0.1197	0.0133	-0.0330	-0.1820	-0.0733	0.1175	-0.1169	-0.0904	0.0655
R-square	0.6242	0.6991	0.3849	0.7364	0.9157	0.9412	0.6490	0.9068	0.9738	0.9392	0.8129	0.8834
SE	0.0070	0.0107	0.0036	0.0030	0.0030	0.0027	0.0037	0.0054	0.0032	0.0040	0.0043	0.0040
DW	1.7245	1.9427	1.8450	1.8673	2.0891	2.2159	1.9985	1.8064	2.2224	2.1090	2.0608	1.6005
<u>Consumer price</u>												
ERPT – SR	0.1805	-0.2544	0.0208	-0.1241	0.0165	0.0089	-0.1678	-0.0372	0.1798	0.0391	-0.0166	0.0989
ERPT – LR	0.3288	-0.2985	0.0468	-0.1126	0.0262	0.0080	-0.4465	-0.0593	0.1739	0.0641	-0.0146	0.0996
R-square	0.5507	0.1730	0.3623	0.3661	0.1049	0.2279	0.7294	0.2359	0.2827	0.3501	0.2600	0.4210
SE	0.0073	0.0100	0.0040	0.0037	0.0032	0.0026	0.0045	0.0056	0.0029	0.0041	0.0047	0.0038
DW	1.7860	1.8335	1.8758	1.7702	1.9371	2.1165	1.8072	1.7014	2.1464	2.2062	1.9016	1.7101
Det. Resid. Cov.	3.70E-11	4.03E-10	2.90E-15	5.19E-15	4.10E-11	1.46E-11	4.37E-11	9.89E-11	1.83E-16	1.30E-16	1.12E-14	2.69E-15

Notes:

Short-run exchange rate pass-through (ERPT-SR) and long-run pass-through (ERPT-LR)

SE indicates the standard error of regression and DW as Durbin-Watson statistic.

I indicates the use of sub-sample pre-crisis data and II the post-crisis data

All the results are obtained by regressing the SUR model except the short-run and long-run exchange rate pass-through which are obtained through calculations

3.4.2 Results of single equation approach - GMM technique

In order to consider the possibility of endogeneity problem, i.e. the correlation of regressors with the error terms in the pass-through equations, this chapter conducts the Generalized Method of Moments (GMM) technique. Since previous section reports very similar results using different lag lengths under GLS technique, this section only considers one case, i.e. $m=0$. Previous studies in the exchange rate pass-through apply different instrument variables. However, most studies set the lagged term of dependent and independent variables in pass-through equation as instrument variables⁶. For example, (Bussière & Peltonen (2008) apply the third and fourth lags of dependent variable in level and the second to fourth lag of independent variables in level as instrument variables. Mihailov (2005) includes the current and different lagged terms of dependent and independent variables in the pass-through equation as instrument set. Following the step of previous studies, the instrument set in this chapter includes the current and lagged terms of dependent and independent variables in level plus the current and the lagged terms of the level bilateral nominal exchange rate of domestic currency per USD and the current and the lagged terms of the commodity price index⁷. In some cases, the domestic interest rate is added in the instrument set in case it improves the result⁸. These instrument variables take the length up to four lags. For the countries that have shorter data in the pre-crisis period, the lag lengths two is applied to the instrument set. These countries include Indonesia, Philippines and Thailand.

The GMM technique is encountered for three important tests, namely the endogeneity test (the Hausman test), the relevance and validity of the instruments tests. Before conducting the GMM estimation, it is important to check the endogeneity condition of each pass-through equation, i.e. if the endogenous variable Δe_t is correlated with the error term ε_t . If $\text{cov}(\varepsilon_t, \Delta e_t) = 0$ does not hold, one should apply GMM rather than OLS. The test is conducted by running the auxiliary regression. **Table A.4** summarizes the estimation result for the auxiliary equation (23). If the t-statistic for the coefficient of residual is significant, $\text{cov}(\varepsilon_t, x_t) \neq 0$. If this is the case, one should apply GMM rather than OLS. As can be seen, there are evidences of non-zero correlation between the regressor and the error term in the pass-through equation (5b) and it is reasonable to apply the GMM technique here.

After deciding on GMM technique, the next step is to test the relevance and validity of the instruments. The relevance test is based on the first stage regression of the pass-through equation (5b), i.e. by running the endogenous regressor Δe_t to all the exogenous and instrument variables. If the joint-significant statistic, i.e. F-statistic is greater than 10 and the probability of significant is zero, the instruments satisfy the relevance condition. The results are summarized in **Table A.5**. As the results report the F-statistic greater than 10 in all cases, the instruments have strong enough correlation with the endogenous regressor.

⁶ Different lagged terms are used by different authors. The lagged terms also vary across countries.

⁷ The lagged terms of dependent variables are in growth rate. In most cases, the lagged terms are from one to 4 of each instrument variable. In some cases different lag lengths are used as they generate better results (higher R-square and lower standard error) and satisfy the overidentifying test.

⁸ The interest rate is used as the instrument as it is likely to explain the movements in exchange rate based on the theory of uncovered interest parity (UIP).

The validity test for the instruments is based on the J-statistic. The validity condition is satisfied if the value of the J-statistic multiplied by the size of sample/ observations (T) is lower than the chi-square statistic at the given critical level (5%). **Table A.6** summarizes the results of J-test. Since the value of $(T \times J)$ is smaller than the chi-square statistic at 5% level in all cases, the instrument set satisfies the validity condition of GMM.

The pass-through equation to be estimated is equation (5b) or (5c) given $m=0$. Each country has three exchange rate pass-through equations to represent the pass-through into the import, producer and consumer prices. The regression results are summarized in **Table A.6** and **A.7**. Comparing the results of GMM with SUR, it is observed that although different methods produce quite different pass-through coefficients, the main outcomes hold using both estimation techniques: exchange rate pass-through is the highest on import price but the lowest on consumer price; Philippines, Singapore and Thailand reveal decline of pass-through into the producer and consumer prices while in other cases, exchange rate pass-through have increased; the pass-through into producer and consumer prices in Singapore are relatively very low compare to the other countries. The degree of exchange rate pass-through into domestic prices (import, producer and consumer prices) does not decline in every case. Indeed, there are cases where the pass-through rate has increased over time.

Comparing the results of SUR for GLS and GMM and lag lengths, it is observed that although the estimated coefficients of pass-through are quite different under different estimation approaches and lag lengths, the main results hold in each case.

Table A.4: Testing for endogeneity (Hausman test)

Coeff.	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
<u>IMP</u>												
C(0)			0.0010	0.0040**					-0.0008**	-0.0001	0.0050**	0.0016
DC(t)			0.6614***	2.1244***					0.7909***	0.5626***	0.4776	0.2917**
DP(t-1)			0.4325***	-0.0927					-0.0282	0.0400	-0.5465***	0.1076
DE(t)			-0.0796	-0.7986***					-0.0149	-0.1478***	-0.3981	-0.9024
RES			-0.5996	-1.4744					0.1914	0.0465	-30.8630	-0.3899
R-sq			0.3463	0.5796					0.9260	0.8771	0.3582	0.5920
DW			1.8034	1.7722					2.0875	2.1723	1.7969	1.7302
SE			0.0102	0.0162					0.0042	0.0036	0.0213	0.0104
<u>PPI</u>												
C(0)	0.0018	00054***	0.0017***	0.0011***	-0.0007**	0.0004	0.0029***	0.0029***	-0.0010***	0.0002	0.0005	0.0001
DC(t)	0.5613***	0.6685***	0.4454***	0.6171***	0.9167***	0.8895***	0.4985***	0.8472***	0.9603***	0.8435***	0.8743***	1.0890***
DP(t-1)	0.3913***	0.0726	0.1769**	0.1810**	-0.0099	-0.0183	-0.0467	0.0369	0.0244	0.0665**	0.1062**	0.0630
DE(t)	0.0043	-0.1130***	0.0029	-0.0658***	0.0070	-0.0071	-0.0273	-0.0263	0.0593*	0.0748	-0.1263**	-0.0107
RES	-1.2355	0.6203*	-0.3816**	-0.3411	0.4148	0.4508	0.1294	0.1379	0.1438	0.1283	-7.8252*	-0.3734
R-sq	0.5076	0.6814	0.2954	0.6159	0.9027	0.9294	0.5045	0.9041	0.9656	0.9230	0.8013	0.8667
DW	2.1476	1.8982	1.9008	1.7465	2.0281	2.3306	1.6922	1.5234	2.1466	2.2883	2.0796	1.7168
SE	0.0052	0.0101	0.0036	0.0034	0.0030	0.0027	0.0035	0.0050	0.0034	0.0041	0.0039	0.0039
<u>CPI</u>												
C(0)	0.0064***	0.0059***	0.0032***	0.0019***	0.0024***	0.0020***	0.0060***	0.0037***	0.0016***	0.0015***	0.0036***	0.0009***
DC(t)	-0.3175**	-0.1535**	-0.3025***	-0.1035	0.0006	-0.0509**	-0.5934***	-0.1253***	0.0083	-0.0438*	-0.0131	0.2094***
DP(t-1)	0.0866	0.1984**	0.2853***	0.2620***	0.0322	-0.0906	0.1306	0.2076**	-0.1248	-0.1581*	0.1098	0.2870***
DE(t)	-0.0090	0.0763**	0.0131	-0.0715***	0.0147	-0.0015	0.0122	-0.0518*	0.1027	0.1189*	-0.1196*	-0.0124
RES	-1.9560	0.6484**	-0.3378	-0.0004	-0.0079	-0.0504	0.1652	0.3122	0.0261	0.1678	-7.2736	-0.2005
R-sq	0.1520	0.1369	0.2016	0.1521	0.0051	0.0532	0.3915	0.1898	0.0875	0.1143	0.0815	0.3309
DW	1.6218	1.9949	1.7845	1.8572	1.9653	1.8849	1.6271	1.7702	2.0918	1.9303	1.8671	1.8405
SE	0.0063	0.0094	0.0043	0.0039	0.0031	0.0027	0.0052	0.0053	0.0031	0.0044	0.0045	0.0038

Notes:

The test is based on equation (5c) given that $m=0$.The representations for the notations are as noted under **Table A.2**

*** denotes the 1% significant level; ** the 5% significant level and * the 10% significant level

The instrument set includes one to four lagged term of the change in domestic prices (different price index depending on the exchange rate pass-through equations) plus the current and one to four lagged terms in the level of the these variables: nominal exchange rate, nominal effective exchange rate, commodity price and foreign cost. The instruments up to lagged two are considered for the shorter dataset in period I for the case of Indonesia, Philippines and Thailand.

Table A.5: Testing for relevance of instruments

ERPT	Period	First stage regression	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
IMP	I	F-stat Prob.		458.5202 0.0000			45.0490 0.0000	17886.74 0.0000
	II	F-stat Prob.		1305.255 0.0000			27.0353 0.0000	3086.48 0.0000
PPI	I	F-stat Prob.	3612.122 0.0000	450.7310 0.0000	1557.360 0.0000	1154.488 0.0000	44.6169 0.0000	16238.48 0.0000
	II	F-stat Prob.	597.9058 0.0000	1282.977 0.0000	3245.358 0.0000	300.4365 0.0000	26.4011 0.0000	2949.252 0.0000
CPI	I	F-stat Prob.	3357.409 0.0000	438.2931 0.0000	1559.535 0.0000	1158.919 0.0000	44.8883 0.0000	16369.69 0.0000
	II	F-stat Prob.	603.2719 0.0000	1279.175 0.0000	3384.758 0.0000	306.4619 0.0000	27.9916 0.0000	2966.689 0.0000

Notes:

The instrument set includes one to four lagged term of the change in domestic prices (different price index depending on the exchange rate pass-through equations) plus the current and one to four lagged terms in the level of the these variables: nominal exchange rate, nominal effective exchange rate, commodity price and foreign cost. The instruments up to lagged two are considered for the shorter dataset in period I for the case of Indonesia, Philippines and Thailand.

The first stage regression gives the information on the F-statistic and the significant probability.

Period I indicates the pre-crisis period and period II indicates the post-crisis period.

Table A.6: Regression result of GMM – equation (5b) or (5c) given $m=0$

Coeff.	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
IMP												
C(0)			0.0002	0.0072***					-0.0009***	-0.0003	0.0023	0.0014
DC(t)			0.5244***	2.0248***					0.7817***	0.5675***	-0.5373*	0.1555**
DP(t-1)			-0.0936**	-0.7468***					0.0116	-0.1679***	-0.2370	-0.8578***
DE(t)			0.4769***	-0.1739**					-0.0220	0.0446	-0.3462***	0.1312**
R-sq			0.3352	0.5504					0.9248	0.8763	0.1860	0.5831
DW			1.8213	1.5671					2.0985	2.1806	2.2916	1.7586
SE			0.0103	0.0167					0.0042	0.0036	0.0232	0.0104
J-stat			0.1871	0.2607					0.1276	0.2288	0.2441	0.3065
($T \times J$)			28.0650	29.4591					19.1400	25.8544	19.2839	34.6345
Chi-sq			31.4	31.4					31.4	31.4	22.4	37.7
PPI												
C(0)	0.0013**	-0.0041***	0.0014***	0.0006**	-0.0006**	0.0001	0.0016***	0.0022***	-0.0007***	-0.0005*	0.0002	0.0003
DC(t)	0.6930***	0.6875***	0.3997***	-0.5195***	0.9029***	0.8995***	0.7136***	0.9523***	0.9537***	0.8705***	0.9194***	1.0341***
DP(t-1)	0.0085	-0.1294**	0.0231	-0.0808***	0.0020	0.0238	-0.0560***	0.0242*	0.0595**	0.0398	-0.2235***	-0.0178
DE(t)	0.3442***	0.0644**	0.2533***	0.3159***	0.0058	-0.0431***	0.0506	0.0153	0.0307**	0.0464**	0.1389***	0.0359
R-sq	0.4805	0.6618	0.2548	0.5930	0.9013	0.9267	0.3509	0.8879	0.9649	0.9190	0.7847	0.8628
DW	2.0482	1.8212	2.0370	1.9628	2.0820	2.2668	1.4134	1.6146	2.1429	2.2561	2.0529	1.5591
SE	0.0053	0.0104	0.0037	0.0034	0.0030	0.0027	0.0039	0.0054	0.0035	0.0042	0.0040	0.0040
J-stat	0.1680	0.2306	0.1979	0.2378	0.1576	0.2397	0.3165	0.2769	0.1652	0.2569	0.1725	0.2332
($T \times J$)	6.7200	26.0578	29.6850	26.8714	20.9608	27.0861	16.1415	31.2897	24.7800	29.0297	15.1800	26.3516
Chi-sq	18.3	31.4	31.4	31.4	31.4	31.4	18.3	31.4	37.7	37.7	18.3	31.4
CPI												
C(0)	0.0054***	0.0036***	0.0019***	0.0017***	0.0027***	0.0014***	0.0051***	0.0024***	0.0014***	0.0008***	0.0040***	0.0009***
DC(t)	-0.1552**	-0.1575***	-0.3693***	-0.2237***	-0.0057	-0.0351*	-0.5711***	-0.0380	0.0142	-0.0061	-0.0267	0.2211***
DP(t-1)	0.0383	-0.1089***	0.0689***	-0.0846***	-0.0028	0.0015	0.0383	-0.0024	0.0740***	0.0455	-0.1794**	-0.0125
DE(t)	0.1085*	0.3722***	0.5235***	0.5727***	-0.0881*	0.0668	0.2768***	0.2833***	-0.0480	-0.1125	0.0798	0.2047
R-sq	0.1014	0.0431	0.0722	0.0550	0	0.0074	0.3650	0.0803	0.0742	0.0505	0.0464	0.3245
DW	1.7361	2.2680	2.0167	2.1430	1.7078	2.2096	1.8339	2.0085	2.1966	2.1247	1.8386	1.7069
SE	0.0063	0.0099	0.0046	0.0041	0.0032	0.0027	0.0052	0.0056	0.0031	0.0045	0.0045	0.0038
J-stat	0.3166	0.2138	0.2349	0.2400	0.1367	0.1498	0.3767	0.2315	0.2431	0.1945	0.2077	0.2300
($T \times J$)	12.6640	24.1594	35.2350	27.1200	18.3178	16.9274	19.5884	26.1595	36.4650	21.9785	18.2776	25.9900
Chi-sq	18.3	31.4	37.7	31.4	31.4	31.4	22.4	37.7	37.7	31.4	18.3	31.4

Notes:

The explanations for the notations are as Table A.2

Table A.7: Exchange rate pass-through coefficient using GMM technique – equation (5b) or (5c) given $m=0$

	Indonesia		Korea		Malaysia		Philippines		Singapore		Thailand	
	I	II	I	II	I	II	I	II	I	II	I	II
<u>Import price</u>												
ERPT – SR			-0.0936	-0.7468					0.0116	-0.1679	-0.2370	-0.8578
ERPT – LR			-0.1789	-0.6362					0.0113	-0.1757	-0.1760	-0.9873
R-square			0.3352	0.5504					0.9248	0.8763	0.1860	0.5816
SE			0.0103	0.0167					0.0042	0.0036	0.0232	0.0105
DW			1.8213	1.5671					2.0985	2.1806	2.1916	1.7699
<u>Producer price</u>												
ERPT – SR	0.0085	-0.1294	0.0231	-0.0808	0.0020	0.0238	-0.0560	0.0242	0.0595	0.0398	-0.2235	-0.0178
ERPT – LR	0.0129	-0.1383	0.0310	-0.1181	0.0020	0.0228	-0.0590	0.0246	0.0614	0.0417	-0.2595	-0.0184
R-square	0.4805	0.6618	0.2548	0.5930	0.9013	0.9267	0.3509	0.8628	0.9649	0.9190	0.7847	0.8628
SE	0.0053	0.0104	0.0037	0.0034	0.0030	0.0027	0.0039	0.0040	0.0035	0.0042	0.0040	0.0040
DW	2.0482	1.8212	2.0370	1.9628	2.0820	2.2668	1.4134	1.5591	2.1429	2.2561	2.0529	1.5591
<u>Consumer price</u>												
ERPT – SR	0.0383	-0.1089	0.0689	-0.0846	-0.0028	0.0015	0.0383	-0.0024	0.0740	0.0455	-0.1794	-0.0125
ERPT – LR	0.0429	-0.1734	0.1446	-0.1980	-0.0026	0.0016	0.0529	-0.0033	0.0706	0.0409	-0.1949	-0.0157
R-square	0.1014	0.0431	0.0722	0.0550	0	0.0074	0.3650	0.0803	0.0742	0.0505	0.0464	0.3245
SE	0.6063	0.0099	0.0046	0.0041	0.0032	0.0027	0.0052	0.0056	0.0031	0.0045	0.0045	0.0038
DW	1.7361	2.2680	2.0167	2.1430	1.7078	2.2096	1.8339	2.0085	2.1966	2.1247	1.8386	1.7069

Notes:

Short-run exchange rate pass-through (ERPT-SR) and long-run pass-through (ERPT-LR)

SE indicates the standard error of regression and DW as Durbin-Watson statistic

I indicates the use of sub-sample pre-crisis data and II the post-crisis data

All the results are obtained by regressing the SUR model except the long-run exchange rate pass-through which is obtained through calculations

3.5 Results – economic interpretations

As demonstrated in the previous section, the estimation results generated by the system equation model using GLS technique and the single equation method of GMM are very similar and consistent to each other.

The foreign production cost has a significant impact on the movements in domestic prices. The increase of foreign cost induces higher domestic import and producer prices but it tends to reduce the domestic consumer price. The results indicate that although the increase in the foreign production cost is transmitted to the domestic imported and producer prices, it does not pass-through to the consumer price level. Indeed domestic producer tends to reduce the consumer price when there is an increase in the foreign production cost in order to maintain high competitive of the product in the domestic market.

East-Asian countries exhibit different degrees of exchange rate pass-through along the pricing chain and over time. Comparing the results of exchange rate pass-through along the pricing chain, majority countries show the highest pass-through rate on the import price, followed by producer price and the lowest rate on consumer price. In some extreme cases, the pass-through into consumer price even leads to the opposite outcome, i.e. the depreciation in exchange rate leads to the decline in consumer price. The same result also reported in the previous studies such as in Choudhri & Hakura (2006) and Ito et al. (2005). These results indicate that the pass-through into consumer price is very low in which the consumer price has a very weak correlation with the exchange rate movements. Why the pass-through into consumer price is so low? Previous studies show that this low relationship is due to the high distribution cost (for example the services and transportation costs) and the low reliance on imported inputs of consumer goods (Campa & Goldberg (2006)). Besides, the low sensitivity of consumer price to exchange rate movements can be explained by the consumer inferior goods that only produce for the domestic market. These inferior goods substitute the imported goods especially during the economic devaluations. High competition in the consumer market also leads to the low pass-through in consumer price in order for the producer/ retailer to maintain their market share or competitive power.

Comparing the results across countries and over time, it is observed that East-Asian countries experience very large increase in the pass-through rate into import price especially in the case of Korea. The pass-through rate in Singapore is relatively very low as compare to Korea and Thailand. At the producer and consumer price levels, the results are mixed and the change in the pass-through rate is smaller compare to that of import price level. However, the pass-through rates in producer and consumer prices are relatively very low in Malaysia and Singapore compare to Indonesia and Korea. In general, the results indicate that not all the countries considered in the analysis experience decline in the degree of exchange rate pass-through. Indeed, these countries experience very large increase in the degree of pass-through into import price.

What are the factors that contribute to the increase in the degree of exchange rate pass-through in East-Asia? The possible factor that contributes to the increase in the

pass-through rate into domestic prices can be explained by the imported components (Campa & Goldberg (2006)). As explained in Campa & Goldberg (2006), the expansion of the imported inputs used in the production may induce greater sensitivity of local costs to exchange rate movements which could raise the pass-through into final consumer price. As the import components in East Asian countries consist a large fraction of intermediate goods for production and the imported intermediate goods has increased over time (see **Table I-A(4) in Chapter One**), the expansion in imported intermediate goods may induce greater sensitivity of the domestic prices to the exchange rate movements. Besides, the emerging East-Asia countries tend to be more open in trades and have switched to the more flexible exchange rate regimes. This implies that the domestic market could be more sensitive to the exchange rate movements.

3.6 Conclusions

How large is the degree of exchange rate pass-through into domestic prices in emerging East-Asian countries? Does the pass-through rate vary across countries and change over time? Does the pass-through rate different along the pricing chain, i.e. the import, producer and consumer prices? This study attempts to answer these questions by estimating the degree of exchange rate pass-through into the import, producer and consumer prices in six emerging East-Asian countries before and after the financial crisis of 1997-98. Two approaches namely the single equation and the system equation models are conducted to estimate the degree of exchange rate pass-through into domestic prices in East-Asian countries. The main findings are as follows:

First, the degree of exchange rate pass-through varies across countries and change over time. Not all countries experience decline in the pass-through rate over time. Indeed, the pass-through into import price has increased substantially. Second, exchange rate pass-through is partial in most cases. Third, the pass-through rate is the highest on import price, followed by producer price and the lowest on consumer price. The degree of exchange rate pass-through into consumer price is very low and even leads to the decline in consumer price in some cases. These results are robust using two different econometric techniques and lag length specifications.

The literatures of the exchange rate pass-through have suggested many factors that contribute to the change in the degree of exchange rate pass-through, for example trade openness, component of imported goods and monetary policy. These factors are of country specific. In this study, the results show that not all countries experience the decline in the degree of exchange rate pass-through. One possible factor that contributes to the higher pass-through rate is the fraction of imported inputs. Expansions in the imported intermediate goods for production raise the sensitivity of domestic prices to exchange rate movements and hence higher pass-through rate into import price. Although the pass-through rate into import price is very large for some countries, however the pass-through rate into consumer price is relatively very small and even shows a decline in consumer price. This implies that consumer price is not sensitive to the movements in exchange rate. The possible explanations as indicated in previous studies are the margin of distribution costs and the sensitivity to imported inputs. High margin of distribution costs and low reliance on imported inputs in

consumer level induce low sensitivity of consumer price to exchange rate movements. The shift to the flexible exchange rate regime and inflation targeting policy in most of the East-Asian countries aftermath the crisis may also contribute to the low pass-through rate into consumer price as shown in the result of central bank assessment.

References

- An, L. 2006. Exchange rate pass-through: evidence based on vector autoregression with sign restrictions. Munich Personal RePEc Archive.
- Baltagi, B.H. 2002. *Econometrics*. Springer. Third edition.
- Baum, G.F., Schaffer, M.E. & Stillman, S. 2003. Instrumental variables and GMM: estimation and testing. Boston college. Working paper no. 545.
- Billmeier, A. 2002. Current account fluctuations: how important are nominal shocks? European University Institute.
- Burstein, A., Eichenbaum, M. & Rebelo, S. 2002. Why are rates of inflation so low after large devaluations? RCER working paper 486. University of Rochester Center for Economic Research RCER.
- Burstein, A., Eichenbaum, M. & Rebelo, S. 2005. Large devaluation and the real exchange rate. *Journal of Political Economy* (forthcoming).
- Bussière, M. & Peltonen, T. 2008. Exchange rate pass-through in the global economy: the role of emerging market economies. ECB working paper no. 951/October 2008.
- Ca'Zorzi, M. et al. 2007. Exchange rate pass-through in emerging markets. ECB working paper no. 739.
- Campa, J.M. & Goldberg, L.S. 2002. Exchange rate pass-through into import prices. NBER working paper.
- Campa, J.M. & Goldberg, L.S. 2002. Exchange rate pass-through into import prices: a macro or micro phenomenon? NBER working paper.
- Campa, J.M. and Goldberg, L.S. 2005. Exchange Rate Pass-Through into Import Prices. *Review of Economics and Statistics* 87:4, forthcoming.
- Campa, J.M., Goldberg, L.S. & González-Mínguez, J.M. 2005. Exchange rate pass-through to import prices in the Euro area. NBER working paper.
- Campa, J.M. & Goldberg, L.S. 2006. Pass-through of exchange rates to consumption prices: what has changed and why? NBER working paper 12547. National Bureau of Economic Research.

-
- Carstensen, K. (2006) Applied Econometrics II. ASP Program. Kiel Institute for the World Economy. Unpublished lecture notes.
- Cavoli, T. & Rajan, R. 2003. Designing appropriate exchange rate regimes for East Asia: inflation targeting and monetary policy rules. University of Adelaide. Discussion paper no. 0309.
- Choudhri, E.U. & Hakura, D.S. 2006. Exchange rate pass-through to domestic prices: Does the inflationary environment matter? *Journal of International Money and Finance* 25: 614-639.
- Coricelli, F., Jazbec, B. & Masten, I. 2006. Exchange rate pass-through in EMU ascending countries: empirical analysis and policy implications. *Journal of Banking & Finance* 30: 1375-1391.
- Cortinhas, C. 2007. Exchange rate pass-through in ASEAN: implications for the prospects of monetary integration in the region. NIPE working paper 2/2007.
- Davis, G.C. & Kim, S.Y. 2002. Measuring instrument relevance in the single endogenous regressor - multiple instrument case: a simplifying procedure. *Economics Letters* 74: 321-325.
- de Bandt, O., Banerjee, A. & Kozłuk, T. 2008. Measuring Long Run Exchange Rate Pass-Through. *Economics: The Open-Access, Open-Assessment E-Journal* vol. 2, 2008-6.
- Devereux, M.B. & Lane, P.R. 2001. Exchange rate and monetary policy in emerging market economies. CEPR.
- Dholakia, R.H. & Raveendra, S.V. 2000. Exchange rate pass-through and volatility: impact on Indian foreign trade. *Economic and Political Weekly*.
- Edwards, S. 2006. The relationship between exchange rates and inflation targeting revisited. NBER working paper series no. 12163.
- Favero, C.A. 2001. Applied macroeconometrics. Oxford University Press.
- Fuentes, M. 2007. Pass-through to import prices: evidence from developing countries. Instituto de Economía.
- Gagnon, J.E. & Ihrig, J. 2004. Monetary policy and exchange rate pass-through. Board of Governors of the Federal Reserve System, Washington.
- Goldfajn, I. & Sergio, W. 2001. The pass through from depreciation to inflation: A panel study. PUC-Rio working paper no. 423.
- Greene, W.H. 2000. Econometric analysis. Prentice Hall International Inc. Fourth edition.

-
- Greene, W.H. 2003. *Econometric analysis*. Pearson Education International, Inc. Fifth edition.
- Hahn, E. 2003. Pass-through of external shocks to Euro area inflation. ECB working paper no. 243.
- Hamilton, J.D. 1994. *Time series analysis*. Princeton University Press.
- Hansen, L.P. 1982. Large sample properties of Generalized Method of Moments estimators. *Econometrica* 50: 1029-54.
- Hung, W., Kim, Y. & Ohno, K. 1993. Pricing exports: a cross-country study. *Journal of International Money and Finance*. 12: 2-28.
- Ito, T., Sasaki, Y.N. & Sato, K. 2005. Pass-through of exchange rate changes and macroeconomic shocks to domestic inflation in East Asian countries. RIETI discussion paper series 05-E-020.
- Ito, T. & Sato, K. 2006. Exchange rate changes and inflation in post-crisis Asian economies: VAR analysis of the exchange rate pass-through. University of Tokyo and Yokohama National University.
- Ito, T. & Sato, K. 2007. Exchange rate pass-through and domestic inflation: a comparison between East Asia and Latin American countries. RIETI discussion paper series 07-E-040.
- Kamps, A. 2006. The Euro as invoicing currency in international trade. ECB working paper series no. 665.
- Kennedy, P. 2008. *A guide to econometrics*. Blackwell Publishing Ltd. Sixth edition.
- McCarthy, J. 1999. Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies. BIS working papers no. 79.
- McCarthy, J. 2006. Pass-through of exchange rates and import prices to domestic inflation in some industrialized economies. Federal Reserve Bank of New York.
- Mihailov, A. 2005. Exchange Rate Pass-Through on Prices in macrodata: A Comparative Sensitivity Analysis. Working Paper. University of Essex.
- Mihaljek, D. & Klau, M. 2008. Exchange rate pass-through in emerging market economies: what has changed and why? BIS paper no. 35.
- Mirzoev, T. 2004. A dynamic model of endogenous exchange rate pass-through. The Ohio State University.
- Mishkin, F.S. 2000. Inflation targeting in emerging market countries. NBER working paper series no. 7618.

-
- Mishkin,F.S. 2008. Exchange rate pass-through and monetary policy. NBER working paper no. 13889.
- Mishkin,F.S & Savastano, M.A. 2001. Monetary policy strategies for Latin America. *Journal of Development Economics*. 66: 415-444.
- Osawa,N. 2006. Monetary policy responses to the exchange rate: Empirical evidence from three East Asian inflation-targeting countries. Bank of Japan working paper series no. 06-E-14.
- Parsley,D.C. & Cai,Z. 1995. Exchange rate uncertainty and traded goods prices. *International Economic Journal*. Vol. 9(2): 27-35.
- Romer,D. 1993. Openness and inflation: theory and evidence. *Quarterly Journal of Economics* 4: 869-903.
- Sahminan.2002. Exchange rate pass-through into import prices: empirical evidences from some Southeast Asian countries. The University of North Carolina at Chapel Hill.
- Sahminan. 2005. Exchange rate pass-through into import prices in major Southeast Asian Countries. The University of North Carolina at Chapel Hill.
- Taylor,J.B. 2000. Low inflation, pass-through and the pricing power of firms. *European Economic Review*. 44: 1389-1408.
- Taylor, J.B. 2001. The role of the exchange rate in monetary policy rules. *American Economic Review* 91(2): 263-267.
- Webber,A.G. 1999. Dynamic and long run responses of import prices to the exchange rate in the Asia-Pacific. University of Wollongong. Working paper series WP99-11.
- White,H. 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* 48: 817-38.
- Wickremasinghe,G. & Silvapulle,P. 2003. Role of exchange rate volatility in exchange rate pass-through to import prices: some evidence from Japan. Monash University.

APPENDIX II

Table II-(1a): Central bank assessments of exchange rate pass-through

Country	ERPT* (CPI)	Decline in PT?	Main reason of decline	Relative size of PT to different price indices	Other
Hong Kong		No evidence that PT declined			
India	8-17%	Yes, since 1990's	Decline in inflation; lower tariffs		
Malaysia		No, PT relatively stable in 1990-2006			
Philippines	1.2%	Yes, from 23% before 1993			PT is generally very low
Singapore	3%			$CPI^{PT} < IMP^{PT}$	Complete PT after 2 years
Thailand	Small	Increased slightly	Exchange rate flexibility	$CPI^{PT} \ll PPI^{PT} \ll IMP^{PT}$	PT to import prices full and rapid; PT to CPI not full even in the long-run
Columbia	3% (2006)	Yes, from 4-5% in mid-1980's			
Peru	10% (2006)	Yes, from 10-20% in 2001-04			
Venezuela		Yes, during 2005-06	Foreign exchange reserves increase; oil prices increase; lower exchange rate volatility		
Czech Republic	0-40%	Yes	Inflation targeting, exchange rate flexibility	$CPI^{PT} \ll IMP^{PT}$	
Hungary		Yes	Widening of exchange rate band, inflation targeting		
Poland	12% (2006)	Yes, from 24% in 2002	Inflation targeting, exchange rate float		Asymmetric response of PT ($ER \downarrow > ER \uparrow$)
Israel	23% (1999-2004)	Yes, from 33% in 1991-98	Decline in inflation, exchange rate stabilization		Half of PT via rental contracts fixed to USD
Turkey	42% since 2001	Yes, from 63% before the float			Full PT takes 1 year (vs 4-5 months before)
South Africa	7.8%	Not clear that PT declined			Asymmetric, threshold effects apply

* Percentage increase in the CPI following a 10% depreciation of the exchange rate (individual country definitions may differ slightly)

Sources: Central bank answers to the BIS questionnaire; central bank studies in Mihaljek & Klau (2008)

Table II-(1b): Exchange rate pass-through in emerging East-Asian countries

No.	Authors	Data for exchange rate	Methods	Periods	Countries	Short-run (SR) ERPT		Long-run (LR) ERPT	
						IMP	CPI	IMP	CPI
1	Webber (1999)	EX-USD	VECM	1978Q1-1994Q2 1978Q1-1990Q4 1978Q1-1994Q4	Korea Philippines Singapore	0.126 0.180 0.225		0.403 0.896 0.771	
2	Hausmann et.al (2001)	EX-USD	ECM	1990-1999 (monthly)	Indonesia Korea Philippines Singapore Thailand		0.49 0.18 0.3 0.02 0.03		0.92 0.59 1.16 0.16 0.19
3	Sahminan (2005)	EX-USD	ECM 3-5 lags	1985Q1-2000Q3 1974Q1-1991Q4 1974Q1-2000Q3 1974Q1-2000Q3 1985M1-2000M9 1974M1-1991M12 1974M1-2000M9 1974M1-2000M9	Indonesia Philippines Singapore Thailand Indonesia Philippines Singapore Thailand			0.880 1.179 0.163 0.866 0.876 1.529 0.072 0.552	
4	Ito et.al (2005)	REER	OLS 4 lags	1986Q1-2004Q2 1990Q1-2002Q3 1990Q1-2004Q2 1984Q3-2001Q1 1993Q1-2004Q2 1990Q1-2004q2 1988Q1-2004Q2 1990Q1-2004Q2	HK Indonesia Korea Singapore Thailand Malaysia Philippines Taiwan	0.23 0.53 1.05 -0.59 1.27 - - -0.09	-0.09 0.11 0.08 -0.1 0.08 -0.01 -0.02 0.1	0.49 1.04 0.17 0.01 1.66 - - -0.3	-0.07 0.57 0.13 -0.2 0.26 0.03 0.15 -0.17
5	Ca'Zorzi et.al (2007)	NEER	SVAR 4 lag	1986Q1-2004Q1 1976Q4-2004Q1 1975Q1-2004Q1 1980Q2-2004Q1	HK Korea Singapore Taiwan	0.43 0.78 0.13 0.12	0.07 0.19 -0.15 0.01	0.93 0.57 0.76 -0.12	0.37 0.13 -0.06 0.01
6	Ito & Sato (2007)	NEER	SVAR ≤ 5 lags	1998M1-2005M8 1997M12-2005M8 1997M7-2004M10 1998M9-2005M8	Indonesia Korea Thailand Malaysia	1.31 0.38 1.00 -	0.02 0.04 0.01 0.02	1.17 0.51 0.86 -	0.41 0.08 0.05 0.00

Notes:

Exchange rate pass-through:

1. Webber (1999) uses first lag coefficient for SR and ECM coefficient for LR
2. Hausmann et. al (2001) – short-run pass-through is 12 months and long-run pass-through takes the coefficient of ECM
3. Sahminan (2005) uses the long-run cointegration error term as long-run pass-through
4. Ito et.al (2005) use current coefficient of exchange rate for SR pass-through rate and the summation of 4-lag coefficients for LR pass-through rate
5. Ca'Zorzi et.al (2007) use 4 quarters for SR and 8 quarters for LR
6. Ito & Sato (2007) use first lag for SR and 12 lags for LR

The studies may include more countries but this table only summarizes the results for emerging Asian countries consistent to the aims of this study that focused on the crisis-hit East-Asian countries.

In all cases, negative sign implies declines in domestic prices in response to exchange rate changes.

Table II-(2): List of Series, Definitions and Data sources

No.	Variable	Data	Source
1	Domestic price P_t	Import price (IMP) Producer price index (PPI) Consumer price index (CPI)	International Financial Statistics (IFS), IMF, Bank for International Settlements (BIS)
2	Exchange rate E_t	Nominal effective exchange rate (NEER)	International Financial Statistics (IFS), IMF (for Malaysia and Philippines) Bank for International Settlements (BIS) for the case in other countries
3	Exporter/ foreign cost $C_t^{*x,j} = (NEER_t^j . P_t^j) / REER_t^j$	Real effective exchange rate (REER) P_t^j is represented by PPI	International Financial Statistics (IFS), IMF (for Malaysia and Philippines) Bank for International Settlements (BIS) for the case in other countries

Table II-(3): Augmented Dicky-Fuller Unit-root Test

Variable	Country	Test-statistic		Specifications
		Period I	Period II	
C(t)	Indonesia	-0.3038**	1.3062	c, t, 2 lags
	Korea	-2.5532	0.7988	
	Malaysia	-1.3460	1.3319	
	Philippines	-2.3971	3.1352**	
	Singapore	2.8531*	0.3693	
	Thailand	1.7049	1.9904	
CPI(t)	Indonesia	-2.9216	-3.4643**	c, 2 lags
	Korea	-1.8160	-3.4019*	
	Malaysia	-2.7981	-1.1847	
	Philippines	-2.3933	-2.0416	
	Singapore	-3.4635**	-2.4823	
	Thailand	-2.5763	-0.1114	
IMP(t)	Korea	-2.4927	-0.0031	c, t, 2 lags
	Singapore	-3.2349*	-2.8040	
	Thailand	-1.8794	-2.8402	
NEER(t)	Indonesia	-2.2582	-1.2884	c, 2 lags
	Korea	-2.2345	-1.9854	
	Malaysia	-2.5543	-1.6199	
	Philippines	-3.3611**	-2.2792	
	Singapore	-0.5553	-0.3913	
	Thailand	-1.7544	-2.0280	
PPI(t)	Indonesia	-0.9054	1.9214	c, t, 2 lags
	Korea	1.8935	1.2303	
	Malaysia	-1.3443-	1.4366	
	Philippines	1.5094-	-2.1149	
	Singapore	2.6633*	0.3419	
	Thailand	-1.0721	2.1672	

Notes:

** denotes the significant statistic at 5% level

* denotes the significant statistic at 10% level

c is constant and t is trend

All the variables are in logarithm form

Table II-(4): Johansen Trace Test for Cointegration

Null hypothesis	Likelihood ratio (LR)					
	Indonesia	Korea	Malaysia	Philippines	Singapore	Thailand
PERIOD I						
<u>IMP</u>						
R0=0		48.49**			64.31***	44.70**
R0=1		24.74*			21.69	16.15
R0=2		8.15			3.84	5.21
No. of lag		3			1	6
Cointegr.		2			1	1
<u>PPI</u>						
R0=0	223.76***	51.25***	45.52**	38.57	58.84***	35.91
R0=1	100.60***	19.63	12.56	14.63	14.19	12.39
R0=2	33.78***	7.73	3.20	3.62	4.80	4.22
No. of lag	9	2	3	1	1	1
Cointegr.	-	1	1	-	1	-
<u>CPI</u>						
R0=0	222.79***	41.27*	65.67***	50.67***	53.47***	39.04
R0=1	88.00***	14.08	22.75	22.08	19.70	11.47
R0=2	25.61***	3.7	9.64	8.62	4.44	3.81
No. of lag	9	4	2	2	2	1
Cointegr.	-	1	1	1	1	-
PERIOD II						
<u>IMP</u>						
R0=0		36.95			32.78	28.56
R0=1		11.86			14.91	13.92
R0=2		2.64			4.94	5.33
No. of lag		2			1	2
Cointegr.		-			-	-
<u>PPI</u>						
R0=0	46.23**	36.91	24.64	34.83	27.66	42.42*
R0=1	23.73*	11.10	12.31	18.16	13.76	22.83
R0=2	3.32	2.94	5.51	7.14	3.87	7.17
No. of lag	1	2	1	1	2	2
Cointegr.	2	-	-	-	-	1
<u>CPI</u>						
R0=0	56.86***	47.39**	36.55	40.59*	36.20	48.12**
R0=1	30.43**	8.49	20.91	22.44	18.73	25.22*
R0=2	8.70	2.71	8.62	7.67	6.06	8.16
No. of lag	1	2	1	1	2	2
Cointegr.	2	1	-	1	-	2

Notes:

*** denotes the significant statistic at 1% level

** denotes the significant statistic at 5% level

* denotes the significant statistic at 10% level

All series are assumed to have constant and trend

All the variables are in logarithm form

The number of lags is selected referring to the optimal lags suggested by Akaike Info Criterion (AIC), Final Prediction Error (FPE) and Schwarz Criterion (SC).

The cointegrating rank (R0) is selected when one cannot reject the null hypothesis for the first time.

CHAPTER FOUR**TRADE OPENNESS, EXCHANGE RATE PASS-THROUGH, THE SOURCE OF SHOCKS AND SIMPLE POLICY RULES IN THE SMALL OPEN ECONOMY****Abstract**

Applying a stochastic dynamic general equilibrium model, the performance of various simple rules is analyzed in a small open economy context. The aspects that are considered in the analysis include the degree of exchange rate pass-through, trade openness, the policy objective and the source and persistency of shocks. The main objective of this analysis is to investigate if the rule reacts to exchange rate performs better than the basic closed economy rule without exchange rate term. Comparison on the performances is also made between the consumer inflation targeting and domestic inflation targeting rules. The results show that adding the exchange rate term to the policy rule enhances improvement especially in the higher pass-through case. The superior rule is the hybrid rule that reacts to the exchange rate term. CPI inflation targeting rules outperform the domestic inflation targeting rules in term of welfare loss. However, more complicated domestic inflation targeting rules generate lower loss in term of relative loss. On the second part of this chapter, comparisons on the performances of different exchange rate regimes are made under different source and persistency of shocks. The floating (pegged) regime is favored under more prominent real (nominal) shocks. The results suggest that emerging countries that experience very large real shocks should float their exchange rate.

4.1 Introduction

Should the policy reaction function in emerging market react to the exchange rate movements? Given that emerging market is financially unstable and vulnerable to shocks and leads a different economic structure from the closed economy, it is argued that the monetary policy reaction function in the small open economy should consider a direct role for the exchange rate.

The main reasons for such monetary policy are: first, monetary policy rule that contains the exchange rate term may internalize the total effects of policy adjustment on economy; second, this augmented rule improves the effectiveness of simple rule as it incorporates a faster adjustment of interest rate and exchange rate effects on inflationary impulse; third, it prevents the destabilizing effects of real shocks led by the exchange rate misalignment (Adolfson (2007)).

Contrary to this view, some economists and researchers hold the opposite view to prefer the policy rule without a direct exchange rate term. The explanations as mentioned in Taylor (2001) are: first, there is an indirect effect of exchange rate on inflation and output in the policy reaction function; second, the deviation of exchange rate from purchasing power parity such as productivity should not be offset through interest rate adjustments. Adjusting the changes in exchange rate may generate negative effects on real output and inflation.

Apart from the theoretical arguments, the results from the empirical studies are controversial as well. The issue regarding the role of exchange rate in the monetary policy framework for the open economies still open for debates. Focusing on the effects of exchange rate pass-through and trade openness in emerging market environment, this chapter seeks to compare the performances of various simple policy rules with the closed economy rule and if the augmented Taylor rules with exchange rate terms perform better compare to the other rules. Taking into account the economic characters for the emerging East-Asian countries, this chapter seeks to evaluate the role of exchange rate in the design of monetary policy for the emerging countries. This chapter applies two different approaches of analysis which divides it into two main parts. In the first part of this chapter, simulations are carried out to compare a battery of restricted optimized simple policy rules under different degrees of exchange rate pass-through and trade openness. For the robustness purpose, simulations are repeated by considering different persistency and variation of shocks and policy weightings. In the second part of this chapter, a different approach of analysis is conducted to evaluate the exchange rate regimes (flexible, managed floating and fixed exchange rate regimes). Simulations are based on several simple rules which represent different exchange rate regimes. Evaluations on the regimes are based on the source, the persistency and variation of shocks, given different cases of exchange rate pass-through. Evaluations are followed by robustness checking.

The results from the first part of simulations show that modifications on the baseline Taylor rule by adding the exchange rate terms and history dependent term (interest rate smoothing term or lagged inflation) improve the baseline rule. These rules perform better under higher exchange rate pass-through but the size of improvement could be smaller for the very high pass-through case when the economy is more open

as the price distortion is smaller and the role of exchange rate in adjusting price is smaller under more open economy case. These results are robust under different policy weightings and persistency of shocks. The hybrid rule with exchange rate term outperforms all the other rules. On the other hand, the strict inflation targeting rule performs badly. Comparing the rules based on CPI inflation and domestic inflation targeting, the results indicate that CPI inflation targeting rules outperform the domestic inflation targeting rules in term of welfare loss. However, more complicated domestic inflation targeting rules generate lower loss in term of relative loss to the loss of baseline Taylor rule, implying larger improvement of domestic inflation targeting to CPI inflation targeting when the exchange rate and other terms are added to the baseline Taylor rule. These results are robust under different degrees of exchange rate pass-through and persistency of shocks.

The results from the second part of this chapter show that the effectiveness of the exchange rate regime depends crucially on the source and persistency of shocks. The policy rule with exchange rate term or the managed floating regime works well in the presence of nominal and domestic shocks. The effectiveness of this rule is lower when the real shocks are more prevail. On the other hand, the floating regime is favored under more prominent real shocks. The results suggest that emerging countries that experience very large effects from foreign/ real shocks should float their exchange rate.

The remainder of this paper proceeds as follows. Section one discusses the role of exchange rate in the monetary policy framework. Section two presents the model. Section three discusses the structures of different monetary policy rules. Section four is about the methodology and parameterization. Section five summarizes the main results of first approach. Section six discusses the robustness issues. Section seven applies second approach to evaluate the exchange rate regimes. The last section concludes.

4.1.1 The role of exchange rate in the monetary policy

Emerging economies exhibit very different economic structures/ features compare to the developed economies. One of the main differences is that these economies are strongly affected by external shocks. This feature has been incorporating into the small open economy model, for instance the New Keynesian model and the New Open Economy Macroeconomic (NOEM) model setups. In the small open economy setup, the foreign sector and external shocks equations are added to the domestic sector counterpart. The monetary policy setup and the economic transmission mechanisms in the open economy also differ to that of the closed economy context.

According to Monacelli (2003), the closed and open economy models are not isomorphic to each other in which the inclusion of the incomplete pass-through in the open economy counterpart differentiates the analysis in its monetary policy from the closed economy counterpart. By allowing the incomplete exchange rate pass-through and deviations from the law of one price in the short-run, exchange rate plays an important role in the economic transmission and monetary policy assessment in the small open economy. Exchange rate can influence the domestic inflation directly through its impacts on import price or indirectly via aggregate demand which is

affected by the change in the relative prices between the foreign and domestic goods. Aggregate demand affects inflation via aggregate supply. Due to the exchange rate effect on both aggregate demand and supply relations, the monetary authority in the open economy faces a trade-off between inflation and output variability.

Apart from these, exchange rate also adds to the monetary policy transmission channel in addition to the interest rate channel. As in the case of closed economy, a rise in a shock (for example demand shock) leads to the increase in the interest rate. However, unlike the case in the closed economy that the rise in interest rate does not affect inflation, the rise in interest rate in the open economy may lead to appreciation in exchange rate which may influence the inflation and output movements (Adolfson (2001)). This leaves the monetary authority in the trade-off between inflation and output variability. On the other hand, responding to the exchange rate movements may affect the inflation rate. Therefore, the monetary policy problem in the open economy is no more limited to the trade-off between inflation and output variability, but an additional trade-off between inflation and exchange rate targeting (Dobrynskaya (2008)).

4.1.2 The role of exchange rate in the monetary policy from different aspects

The role of exchange rate in the monetary policy framework and the effectiveness of a monetary policy are determined by the economic conditions and country specific factors. Among these factors include the degree of exchange rate pass-through and trade openness, the source and persistency of shocks. This section explains how these factors are relevant or link to the choice and effectiveness of monetary policy rule/ regime.

Exchange rate pass-through is the percentage change in the domestic/ imported prices led by a one percentage change in the exchange rate between the importer and exporter currency. Previous studies show that both the exchange rate pass-through and monetary policy rule/ regime are closely linked to each other. According to Dobrynskaya (2008), the optimal degree of intervention depends on the pass-through effect in an economy. In turn, pass-through effect is endogenous to the monetary policy, i.e. pass-through tends to be larger under no exchange rate management case. According to Devereux & Yetman (2009), if the incomplete pass-through is due to the stickiness in price, the degree of pass-through is likely to be determined by the stance of monetary policy such as the one suggested by Taylor (2000). Taylor argues that the decline in the exchange rate pass-through is endogenous to low inflation. Commitment to low inflationary pressure induces lower pass-through rate. In turn, low pass-through rate leads to lower mark-ups and less inflationary and continued low mark-ups. This view is supported by many empirical results, for example Choudhri & Hakura (2006) and Bussière & Peltonen (2008). According to Devereux & Yetman (2009), the change in the exchange rate pass-through has important implications on the monetary policy stance due to three main reasons. First, the introduction of the partial pass-through feature in the open economy model provides analysis of monetary policy in the open economy which is fundamentally different from the one of a closed economy. Second, due to the deviations from the law of one price, incomplete pass-through generates a short-run trade-off in inflation and output stability. Third, the trade-off in the policy in the forward-looking setup implies

different features in commitment and discretionary policy in which the discretionary policy is of sub-optimal.

There are many papers that investigate the implications of incomplete exchange rate pass-through on the monetary policy stance. These studies analyze the change in the degree of exchange rate pass-through due to the change in price stickiness and its implications on the welfare gain of different policy rules or the change in the inflation rate. Devereux et al. (2006) compare three types of policy rules, i.e. the fixed exchange rate, the CPI inflation targeting and the nontraded price targeting rules for an emerging market economy. They demonstrate that the degree of exchange rate pass-through matters in determining the ranking of policy rules. In the high pass-through case, stabilizing exchange rate induces the trade-off between inflation and output stability and the best rule is the nontraded price targeting rule. In the low pass-through case, the best rule is the CPI inflation targeting rule. The reason is when the pass-through is low, the exchange rate movement is not desirable as it no longer acts as an expenditure switching device and the trade-off disappears. Lower pass-through rate implies smaller role of exchange rate channel in transmitting policy and lower impacts of external shocks on domestic economy. In the case of partial pass-through, the response of optimal monetary policy to shock may imply different adjustments in aggregate supply. Adolfson (2001) demonstrates that the performance of a monetary policy rule can be improved marginally by including the exchange rate term in the policy rule. Accounting for the price stickiness and distribution of shocks in the exchange rate pass-through model, Devereux & Yetman (2009) find that exchange rate pass-through is positively correlated with average inflation. Flamini (2005) conducts an analysis on the effect of imperfect pass-through on optimal monetary policy in a new Keynesian small open economy model. The main finding is both the type and the rate of pass-through determine the ability of a central bank to stabilize the short-run CPI inflation but not domestic inflation. Delayed pass-through reduces the effectiveness in monetary policy more than incomplete pass-through. The results favor for domestic inflation targeting in the case of incomplete and delayed pass-through as incomplete pass-through reduces the variability of economy with domestic inflation but turns out to increase the trade-off in monetary policy with CPI inflation targeting. The trade-off is larger the more the central bank is emphasized on CPI inflation relative to output stability.

There are many studies that examining how openness is related to the choice or performance of monetary policy. Wang (2005) finds significant correlation between the trade openness and the choice of fixed exchange rate regime. Kollmann (2004) finds higher welfare gain of a monetary union compare to the floating regime under higher openness case. Other studies reveal negative relationship between openness and inflation. The negative relationship is due to the dynamic inconsistency of optimal unrestricted discretionary monetary policy (Alfaro, 2002).

The degree of trade openness could be matter in determining the role of exchange rate in the monetary policy. Theoretically, a more open economy means higher exposure of domestic economy to foreign shocks. Hence, exchange rate plays a greater role in transmitting monetary policy under more open economy, analog to the case of higher pass-through rate (Adolfson (2001)).

The source of shocks is closely linked to the choice and performance of policy regimes. Exchange rate literatures tells us that floating regimes work more effectively in the presence of large external or real shocks as these regimes provide less costly adjustments through relative prices. On the other hand, fixed regimes work well in dealing with more prominent domestic or nominal shocks (Cavoli & Rajan (2003) and Calvo & Mishkin (2003)). This implies that the nature of shocks is crucial in determining the performance of a policy regime. At the other end, the policy regimes could be matter in determining the transmissions and influences of shocks (Desroches (2004) and Hoffmaister et al. (1997)).

Apart from this, the source of shocks also matters in determining the role of exchange rate as a shock absorber. Exchange rate has a room for stabilizing and can act as a shock absorber only when an economy experiences asymmetric shocks compare to its trading partner (Artis & Ehrmann (2006)). Therefore, under the existence of asymmetric shocks, the cost of relinquish the exchange rate will be high. Using a sample of 38 developing countries, Hoffmann (2005) seeks to compare to what extent the exchange rate regimes matter in utilizing the role of exchange rate as a shock absorber. His results indicate that economies with floating exchange rate regimes tend to experience real exchange rate depreciation, hence more prominent role for the exchange rate to act as a shock absorber under floating regimes.

Previous studies show that emerging countries experience higher pass-through rate into domestic prices (Devereux et al. (2005)). The emerging East-Asian countries also exhibit higher trade openness over time. Higher openness induces greater aggregate volatility. Previous studies indicate that the rise in aggregate volatility due to the same size increase in trade openness in the developing countries is five times higher in that in the developed countries (Giovanni & Levchenko (2008)). These statements imply that emerging countries are weak to the exposure of external shocks. Therefore, the change in the economic structure such as the degree of exchange rate pass-through, trade openness and the source of shocks could be matter in determining the performance of monetary policy in these countries. Due to this condition, this chapter highlights the above aspects/ factors in evaluating the performances of various policy rules.

4.2 The model

For some exceptions, the model follows Lindé, Nessén & Söderström (2004). This model exhibits the habit formation in consumption, imperfect integration in financial market and gradual pass-through in exchange rate. Habit formation in consumption generates inertia in consumption and output and imperfect financial integration implies that there is a premium on foreign exchange.

The model assumes imperfect pass-through in the short-run where import price is sticky and producer faces quadratic adjustment cost when re-optimizing the price. However, deviations from the law of one price disappear and the pass-through is complete in the long-run. The model assumes a subset of firms re-optimizes prices while the others follow a rule of thumb in setting their prices.

The model applies here is a hybrid New Keynesian/ NOEM model. The basic blocks of the model consist of the aggregate demand/ IS curve, aggregate supply/ Phillips curve (domestic inflation, imported inflation and CPI inflation), UIP (uncovered interest parity) condition, net foreign assets and real profits equations, terms of trade equations (foreign and domestic), foreign sector equations, nominal and real exchange rate equations, exogenous shocks equations and monetary policy rule equations. The model is log-linearized around the steady state. All equations mentioned here are in log deviations from the steady state (with the exception of interest rate) and are denoted in lower case letters. All notations and equations mentioned below here are as indicated in Lindé, Nessén & Söderström (2004), otherwise it will be indicated.

4.2.1 Imperfect pass-through, terms of trade and real exchange rate

This model assumes the domestic residents consume both domestically produced goods and imported goods. Exchange rate pass-through is not perfect in the short run, implying deviations from the law of one price in the short run. The wedge between the two price levels can be captured in two different terms of trade, i.e. the domestic and foreign terms of trade.

Domestic terms of trade (τ_t) show the log-linearized relative price between imported (p_t^m) and domestic goods (p_t^d):

$$\tau_t \equiv p_t^m - p_t^d$$

Foreign terms of trade (τ_t^f) show the logarithmic relative price between the domestically produced good and the imported good on the world market denoted in domestic currency:

$$\tau_t^f \equiv p_t^d - e_t - p_t^f,$$

where e_t is the log nominal exchange rate and p_t^f is the log foreign currency price of imported good. Due to imperfect pass-through, the law of one price does not hold i.e. $p_t^m \neq p_t^f + e_t$ and the deviation from the law of one price (δ_t) is:

$$\delta_t = p_t^m - p_t^f - e_t = \tau_t + \tau_t^f$$

Given that the non-logarithmized CPI is a product of weighted log domestic and log imported price, the log terms of trade is correlated with the log real exchange rate (q_t):

$$p_t^c = (1 - \omega_m) p_t^d + \omega_m p_t^m$$

$$q_t \equiv e_t + p_t^f - p_t^c = -\tau_t^f - \omega_m \tau_t$$

where ω_m denotes the import share in consumption and also the weight on imported inflation. The degree of exchange rate pass-through determines the movements in terms of trade. This effect later is transmitted to the real exchange rate and other economic variables.

4.2.2 Aggregate supply and Phillips curve

The inflation dynamic in this model is described by the hybrid Phillips curves or inflation equations which captures the forward- and backward-looking components. The forward- and backward-looking behaviors may reflect the learning effects, staggered contracts or other institutional arrangements (Garresten, Moons & Aarle (2005)).

There are two sets of firms in this model, i.e. the imported goods and the domestic goods sectors. Firms of imported goods sector import goods from the foreign market at given world prices. The goods are transformed into differentiated goods and are sold to be used for domestic consumption or as an input in production. Combining both domestic and imported inputs, firms in domestic sector produce differentiated goods to be sold to the domestic and foreign market.

The price setting behavior of firms when facing the quadratic adjustment cost (γ_j) is modeled as the minimization of the deviation of the expected log-linearized price set (\hat{p}_{t+s}^j) from the optimal flexible price ($p_{t+s}^{opt,j}$):

$$\min_{p_t^{opt,j}} E_t \sum_{s=0}^{\infty} \beta^s \left\{ (p_{t+s}^{opt,j} - \hat{p}_{t+s}^j)^2 + \gamma_j (p_{t+s}^{opt,j} - p_{t+s-1}^{opt,j})^2 \right\} \quad j=d, m$$

(d denotes domestic sector and m denotes import sector)

where the optimal flexible price is derived from the profit maximization process under the absence of adjustment costs. Only $(1 - \alpha_j)$ fraction of firms re-optimizes prices. A fraction of α_j from domestic and import sectors are rule of thumb price setters by setting prices ($p_t^{rule,j}$) based on the aggregate price in previous period adjusted for its previous inflation rate.

$$p_t^{rule,j} = p_{t-1}^j + \pi_{t-1}^j, \quad j=d, m$$

Both price setting behaviors determine the aggregate price and inflation for the domestic economy:

$$p_t^j = (1 - \alpha_j) p_t^{opt,j} + \alpha_j p_t^{rule,j}, \quad j=d, m$$

After some substitutions and solving procedures, the log-linearized version of Phillips curves/ inflation equations for the domestic economy can be written as:

$$\pi_t^d = b_{\pi 1} E_t \pi_{t+1}^d + b_{\pi 2} \pi_{t-1}^d + b_{\pi 3} \pi_{t-2}^d + b_y y_t + b_\tau \tau_t + u_t^\pi$$

$$\pi_t^m = c_{\pi 1} E_t \pi_{t+1}^m + c_{\pi 2} \pi_{t-1}^m + c_{\pi 3} \pi_{t-2}^m + c_\tau [\tau_t + \tau_t^f]$$

where π_t^d and π_t^m are domestic and imported inflation (both in log deviation from steady state) respectively. The composite parameters are given by:

$$b_{\pi 1} = \beta \gamma_d \Psi_d$$

$$b_{\pi 2} = \alpha_d (1 + 2\gamma_d + \beta \gamma_d) \Psi_d$$

$$b_{\pi 3} = -\alpha_d \gamma_d \Psi_d$$

$$b_y = \frac{\theta(1 - \alpha_d)}{1 - \theta} \Psi_d$$

$$c_{\pi 2} = \alpha_m (1 + 2\gamma_m + \beta \gamma_m) \Psi_m$$

$$c_{\pi 3} = -\alpha_m \gamma_m \Psi_m$$

$$c_\tau = -(1 - \alpha_m) \Psi_m$$

$$\begin{aligned}
b_\tau &= \kappa(1 - \alpha_d)\Psi_d \\
c_{\pi_1} &= \beta\gamma_m\Psi_m \\
\Psi_j &= [\alpha_j + \gamma_j(1 + 2\beta\alpha_j)]^{-1}; j=d, m
\end{aligned}$$

where the notations for parameters are summarized in **Table III-A(3) in Appendix III-A** as in Lindé, Nessén & Söderström (2004).

The domestic inflation π_t^d depends on the expected future and previous domestic inflation rates, current output, terms of trades and inflation shock. On the other hand, the imported inflation π_t^m is determined by both future and previous imported inflation rate and the short-run price deviation i.e. $\delta = \tau_t + \tau_t^f \neq 0$. This hybrid Phillips curve captures the imperfect pass-through feature of East-Asian countries. The presence of import price stickiness c_τ implies that the domestic currency price cannot be fully adjusted under the exchange rate changes. This creates short-run deviations from the law of one price i.e. $\delta_t = \tau_t + \tau_t^f$. The price stickiness parameter (c_τ) depends on the adjustment cost (γ_j) and the fraction of rule of thumb price setters (α_j). When both parameters are relatively small, the price stickiness is weaker and thus exchange rate pass-through is higher or faster. The CPI inflation equation is a combination of domestic inflation and imported inflation.

$$\pi_t^c = (1 - \omega_m)\pi_t^d + \omega_m\pi_t^m$$

The Phillips curves in this model are in hybrid form. Empirical studies show that hybrid Phillips curve matches the data better compared to the purely forward-looking and purely backward-looking Phillips curve. For instance, Christiano et al. (1998) in their VAR studies find that the purely forward-looking Phillips curve is unable to replicate the hump-shaped of impulse response functions. A backward-looking component is introduced to the forward-looking New Keynesian Phillips curve to create the persistence of inflation rate. For example, Altig et al. (2002) introduce the rule of thumb behavior of price setters in the New Keynesian model.

4.2.3 Aggregate demand and IS curve

As shown in Lindé, Nessén & Söderström (2004), this model assumes that households consume both bundles of domestic and import goods. The households' consumption today is affected by the past aggregate consumption behavior which is denoted by the habit preference parameter (h) where $0 \leq h \leq 1$ and intertemporal elasticity of substitution, $\sigma > 0$:

$$u(C_t^j) = \frac{(C_t^j - hC_{t-1}^j)^{1-\sigma}}{1-\sigma}$$

Household j maximizes her intertemporal utility by choosing the level of consumption, domestic bond holdings and foreign bond holdings.

$$\max_{C_t^j, B_t^j, B_t^{f,j}} E \sum_{k=0}^{\infty} \beta^k u(C_{t+k}^j) \quad \text{s.t}$$

$$C_t^j + \frac{B_t^j}{(1+i_t)P_t^c} + \frac{\Xi_t B_t^{f,j}}{(1+i_t^f)\Phi(A_t)P_t^c} = \frac{B_{t-1}^j}{P_t^c} + \frac{\Xi_t B_{t-1}^{f,j}}{P_t^c} + \bar{X}_t^j$$

where B_t^j and $B_t^{f,j}$ are bonds denominated in the domestic and foreign currency respectively; i_t and i_t^f are the domestic and foreign interest rate respectively; P_t^c is the consumer price level; Ξ_t the nominal exchange rate and \bar{X}_t^j the aggregate real profits of household j ; $\Phi(A_t) = e^{-\phi A_t}$ is the premium to hold foreign bond which depends on the real aggregate net foreign asset in domestic economy $A_t = \frac{\Xi_t B_t^f}{P_t^c}$ (see (Lindé, Nessén & Söderström (2004)) for more details).

The utility maximization problem yields the Euler equation for consumption. After imposing some equilibrium conditions to the log-linearized Euler equation, the IS curve can be expressed as (Lindé, Nessén & Söderström (2004)):

$$y_t = (1-a_y)y_{t-1} + a_y E_t y_{t+1} + a_r [i_t - E_t \pi_{t+1}^d] + a_{\tau 1} \tau_{t-1} + a_{\tau 2} \tau_t + a_{\tau 3} E_t \tau_{t+1} \\ + a_{\tau f 1} \tau_{t-1}^f + a_{\tau f 2} \tau_t^f + a_{\tau f 3} E_t \tau_{t+1}^f + a_{y f 1} y_{t-1}^f + a_{y f 2} y_t^f + a_{y f 3} E_t y_{t+1}^f + u_t^y$$

where lower case letters denote log deviation from the steady state. The composite parameters are given by:

$$a_y = \frac{1}{1+h} \qquad a_{\tau f 1} = \frac{h\omega_x \eta}{1+h}$$

$$a_r = -\frac{(1-h)(1-\omega_x)}{(1+h)\sigma} \qquad a_{\tau f 2} = -\omega_x \eta$$

$$a_{\tau 1} = -\frac{h\eta\omega_m(1-\omega_x)}{1+h} \qquad a_{\tau f 3} = \frac{\omega_x \eta}{1+h}$$

$$a_{\tau 2} = -\frac{\omega_m(1-\omega_x)(1-h-\eta\sigma-h\eta\sigma)}{(1+h)\sigma} \qquad a_{y f 1} = -\frac{h\omega_x \chi_f}{1+h}$$

$$a_{\tau 3} = \frac{\omega_m(1-h-\eta\sigma)(1-\omega_x)}{(1+h)\sigma} \qquad a_{y f 2} = \omega_x \chi_f$$

$$a_{y f 3} = -\frac{\omega_x \chi_f}{1+h}$$

where the notations for parameters are summarized in **Table III-A(3) in Appendix III-A**. The hybrid IS curve combines both the forward- and backward-looking components in representing the goods market equilibrium. y_t denotes the domestic output, τ_t the domestic terms of trade, τ_t^f the foreign terms of trade, i_t the domestic short term nominal interest rate, y_t^f the foreign output and u_t^y the demand shocks. All variables except the interest rate are in logarithms form and are given in the form of deviation from the initial steady state.

The hybrid IS curve shows that the domestic output depends on its past output, the expected future output, the real interest rate, its past, current and expected future terms of trade, the past, current and expected future foreign terms of trade and also the past, current and expected future foreign output. The backward-looking component is the results of the ‘habit formation’ of household consumption while the forward-

looking component is explained by the optimal consumption smoothing behavior of rational, intertemporally maximizing agents (Garrestsen, Moons & Aarle (2005)).

Literatures show that the hybrid IS curve matches the data better compare to the forward-looking IS curve (Mayer (2003) and Goodhart & Hofmann (2005)). Therefore, the backward-looking components are added to the forward-looking New Keynesian IS curve through two ways, i.e. through the rule of thumb consumption behavior (e.g. Galí & Gertler (1999)) and the habit formation in household's utility function (e.g. Ratto et al. (2005)). In this model, the backward-lookingness in IS curve is due to the habit formation of household.

4.2.4 Uncovered interest parity (UIP)

The uncovered interest parity (UIP) condition takes the following form as in Adolfson (2001):

$$E_t \Delta e_{t+1} = i_t - i_t^f + a_t \phi + u_t^e$$

where ϕ is the measurement for the intermediate cost in foreign bond market or risk premium; a_t as net foreign asset holdings in domestic market; u_t^e is the disturbance term. The UIP condition is derived from the household's maximization problem. It shows that the exchange rate adjustment depends on the relative difference rate of domestic interest rate and foreign interest rate, the impacts of risk premium (ϕ) on net foreign asset in domestic market (a_t) and the disturbance term or the exchange rate shock that follows the AR(1) process:

$$u_t^e = \rho_e u_{t-1}^e + v_t^e$$

4.2.5 Net foreign assets and real profits

The log-linearized version of the net foreign assets in the domestic market (a_t) is represented by the following equation:

$$a_t = d_a a_{t-1} + d_y y_t + d_x \bar{x}_t + d_\tau \tau_t + d_{\tau_f} \tau_t^f + d_{y_f} y_t^f$$

where \bar{x}_t and y_t^f are the log-linearized real profit and log-linearized foreign demand respectively given that

$$\begin{aligned} d_a &= \frac{1}{\beta} \\ d_y &= -\frac{\Gamma_1}{\beta(1-\omega_x)[1+(1-\omega_m)\Gamma_1]} \Gamma_2^{(\theta-1)/\theta} \\ d_x &= \frac{\Gamma_1}{\beta[1+(1-\omega_m)\Gamma_1]} \Gamma_2^{(\theta-1)/\theta} \\ d_\tau &= \frac{\eta\omega_m\Gamma_1}{\beta[1+(1-\omega_m)\Gamma_1]} \Gamma_2^{(\theta-1)/\theta} \\ d_{\tau_f} &= -\frac{\eta\omega_x\Gamma_1}{\beta(1-\omega_x)[1+(1-\omega_m)\Gamma_1]} \Gamma_2^{(\theta-1)/\theta} \end{aligned}$$

$$d_{yf} = \frac{\chi_f \omega_x \Gamma_1}{\beta(1-\omega_x)[1+(1-\omega_m)\Gamma_1]} \Gamma_2^{(\theta-1)/\theta}$$

and

$$\Gamma_1 \equiv \frac{\eta_m(1-\theta+\eta_d\theta)}{\eta_d\eta_m - \eta_m(1-\theta+\eta_d\theta)(1-\omega_m) - \omega_m\eta_d}$$

$$\Gamma_2 \equiv \frac{\eta_d}{(\eta_d-1)(1-\theta)(1-\kappa)^{1-\kappa} \kappa^\kappa}$$

where the notations for parameters are summarized in **Table III-A(3) in Appendix III-A**.

This equation shows that the net foreign asset hold by the domestic households depends on its last period value a_{t-1} , the foreign and domestic output or demand level, the foreign and domestic terms of trades and the real profit earned, \bar{x}_t .

As shown in Lindé, Nessén & Söderström (2004), the real profits equation \bar{x}_t takes the following form:

$$\bar{x}_t = e_y y_t + e_\tau \tau_t + e_{\tau f} \tau_t^f + e_{yf} y_t^f$$

where

$$e_y = \frac{\eta_m - (\eta_m - 1)\omega_m}{\eta_m(1-\omega_x)} - \frac{\eta_d - 1}{\eta_d} \left[1 - \omega_m + \frac{1}{\Gamma_1} \right]$$

$$e_\tau = -\frac{\eta\omega_m}{\eta_m} - \frac{\kappa(\eta_d - 1)(1-\theta)}{\eta_d} \left[1 - \omega_m + \frac{1}{\Gamma_1} \right]$$

$$e_{\tau f} = \frac{(\eta_m - 1)\omega_m}{\eta_m} + \frac{\eta\omega_x [\eta_m - (\eta_m - 1)\omega_m]}{\eta_m(1-\omega_x)} - \frac{\eta}{\Gamma_1}$$

$$e_{yf} = -\frac{\chi_f \omega_x [\eta_m - (\eta_m - 1)\omega_m]}{\eta_m(1-\omega_x)} + \frac{\chi_f}{\Gamma_1}$$

The real profits of holding assets depend on both the foreign and domestic output level and terms of trades in both markets.

4.2.6 Foreign sector and exogenous shocks

In order to close the model, the behavioral equations for the foreign economy have to be specified. As East-Asian countries are small and open economies, they receive the impacts of shocks from the foreign economy exogenously. It is assumed that the foreign sector can be represented by AR(1) processes as in Adolfson (2001):

$$\begin{pmatrix} y_t^f \\ \pi_t^f \end{pmatrix} = \begin{pmatrix} \rho_y^f & 0 \\ 0 & \rho_\pi^f \end{pmatrix} \begin{pmatrix} y_{t-1}^f \\ \pi_{t-1}^f \end{pmatrix} + \begin{pmatrix} \sigma_{yf} & 0 \\ 0 & \sigma_{\pi f} \end{pmatrix} \begin{pmatrix} u_t^{yf} \\ u_t^{\pi f} \end{pmatrix}$$

$$(u_t^{yf}, u_t^{\pi f}) \sim N(0, I)$$

The shocks are uncorrelated zero mean i.i.d. disturbances with variance σ_{yf}^2 and $\sigma_{\pi f}^2$ respectively. The foreign interest rate is assumed to follow a simple Taylor rule:

$$i_t^f = \lambda_{\pi}^f \pi_t^f + \lambda_y^f y_t^f + u_t^{if}$$

where u_t^{if} is the foreign monetary policy shock with zero mean and variance σ_{if}^2 .

There are six shocks in this model: three domestic shocks (demand shock, exchange rate shock and cost-push/ inflation shock) and three foreign shocks (foreign demand shock, foreign cost-push shock and foreign monetary policy shock). The domestic shocks are assumed to follow AR(1) processes as in Adolfson (2001) where $u_t^j = \rho_j u_{t-1}^j + v_t^j$ with $0 \leq \rho_j < 1$, $j = y, \pi, e$ and v_t^j is white noise, $v_t^j \sim N(0, \sigma_j^2)$. The AR(1) processes for the domestic output, domestic cost-push and exchange rate shocks are as follows:

$$u_t^y = \rho_y u_{t-1}^y + v_t^y$$

$$u_t^{\pi} = \rho_{\pi} u_{t-1}^{\pi} + v_t^{\pi}$$

$$u_t^e = \rho_e u_{t-1}^e + v_t^e$$

4.3 Monetary policy rules

This section discusses the optimal simple rules and optimal rules with exchange rate and interest rate smoothing terms.

4.3.1 Optimal and simple rules

According to Rudebusch & Svensson (1998), there are two classes of policy rules: instrument and targeting rules. Optimal policy or the targeting rule determines the optimal policy responses given a set of objectives. It minimizes the objective loss function that deviates from a target variable.

The (unrestricted) optimal policy can be distinguished between discretion and commitment strategies (Garrestsen, Moons & Aarle (2005)). Under the commitment rule, the central bank is credible to set an optimal policy and the agents form expectations according to this rule. Under the discretion rule however, the central bank takes private expectations as given and re-optimizes the policy each period (Söderström (1999)).

As defined by Rudebusch & Svensson (1998), a simple rule or an explicit instrument rule is a monetary policy instrument based rule that reacts explicitly to available information. As this rule shows higher transparency and better communication to the public, it serves as a baseline rule for the comparison of actual policy. (Garrestsen, Moons & Aarle (2005)).

The (restricted) optimal simple rule is a sub-optimal rule which is subject to a conditional or restricted state variable set. Using the sub-optimal information set, this rule serves as a comparison to examine the optimal state-contingent rule's performance (Dennis (2000)). This chapter focuses on the analysis of (restricted) optimal simple rules.

4.3.2 The formation/ setting of optimal simple rules

The model is closed by assuming a linear interest rate rule for the domestic small open economy. As in Wollmershäuser (2006), the simple rules take the constrained optimization. The minimization of the policy maker's intertemporal loss function on a restricted state variable set can be written as:

$$\min_{\{i_t\}_{t=0}^{\infty}} E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\gamma_{\pi} (\pi_t^{CB})^2 + \gamma_y y_t^2 \right) \right]$$

subject to the state and evolution of the economy. Restrictions are imposed on the response coefficients to short-term interest rate. The weights on inflation and output are assumed to be γ_{π} and γ_y respectively. By normalizing γ_{π} to one, γ_y is the relative weight on output stabilization to inflation assigned by the society or central bank. The central bank can target on consumer/ CPI inflation or domestic inflation, i.e. $\pi_t^{CB} = \{\pi_t^c, \pi_t^d\}$. However in the real world, most of the central bank target on core CPI inflation or headline CPI inflation.

As shown in Svensson (2003), the scaled intertemporal loss function can be written in the following way when the discount factor β is approaching unity.

$$\lim_{\beta \rightarrow 1} (1-\beta) E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\gamma_{\pi} (\pi_t^{CB})^2 + \gamma_y y_t^2 \right) \right] = \gamma_{\pi} Var[\pi_t^{CB}] + \gamma_y Var[y_t]$$

A short-run interest rate rule is used by the central bank as a policy instrument in order to minimize the loss function. Meanwhile, the domestic economy is assumed to follow a Taylor simple rule. This policy rule can be regarded as a closed economy rule as it does not react directly to the exchange rate movements.

TR: Taylor rule

$$i_t = \lambda_{\pi} \pi_t^{CB} + \lambda_y y_t$$

where λ_{π} is the weight for CPI or domestic inflation, i.e. $\pi_t^{CB} = \{\pi_t^c, \pi_t^d\}$ and λ_y is the policy reaction's weight on output (y_t). The policy maker is concerned about both inflation (CPI or domestic) and output stability.

This rule is used as a baseline rule for comparisons. This rule is compared with (i) simple rules with exchange rate terms (rule TRE1 and TRE2); (ii) history dependent rules (TRH) including the interest rate smoothing rule (TRS), interest rate smoothing rule with exchange rate term (TRSE) and history dependent with exchange rate term (TRHE); (iii) forecast based inflation targeting rules (FBT), i.e. Taylor rule with forward-looking term (TRF) and with exchange rate term (TRFE) and (iv) strict inflation targeting rule (SIT). These rules take the following forms:

TRE1: TR with the change in nominal exchange rate

$$i_t = \lambda_{\pi 1} \pi_t^{CB} + \lambda_{y 1} y_t + \lambda_{\Delta e} \Delta e_t$$

TRE2: TR with the change in real exchange rate

$$i_t = \lambda_{\pi 1} \pi_t^{CB} + \lambda_{y 1} y_t + \lambda_{\Delta q} \Delta q_t$$

TRS: TR with smoothing term

$$i_t = (1 - \rho_i)(\lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t) + \rho_i i_{t-1}$$

TRSE: TRS with exchange rate term

$$i_t = (1 - \rho_i)(\lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\Delta q}\Delta q_t) + \rho_i i_{t-1}$$

TRH: TR with history dependent term (backward term in inflation)

$$i_t = \lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\pi_2}\pi_{t-1}^{CB}$$

TRHE: TRH with exchange rate term

$$i_t = \lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\pi_2}\pi_{t-1}^{CB} + \lambda_{\Delta q}\Delta q_t$$

TRF: TR with forward-looking term in inflation

$$i_t = \lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\pi_2}E_t\pi_{t+1}^{CB}$$

TRFE: TRF with exchange rate term

$$i_t = \lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\pi_2}E_t\pi_{t+1}^{CB} + \lambda_{\Delta q}\Delta q_t$$

TRHI: Hybrid TR (forward and backward term in inflation)

$$i_t = \lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\pi_2}E_t\pi_{t+1}^{CB} + \lambda_{\pi_3}\pi_{t-1}^{CB}$$

TRHIE: TRHI with exchange rate term

$$i_t = \lambda_{\pi_1}\pi_t^{CB} + \lambda_{y_1}y_t + \lambda_{\pi_2}E_t\pi_{t+1}^{CB} + \lambda_{\pi_3}\pi_{t-1}^{CB} + \lambda_{\Delta q}\Delta q_t$$

SIT: Strict inflation targeting rule

$$i_t = \lambda_{\pi_1}\pi_t^{CB}$$

where $\lambda_{\Delta e}$ or $\lambda_{\Delta q}$ are the weights for exchange rate (the change in nominal exchange and the change in real exchange rate); λ_{π_1} , λ_{π_2} and λ_{π_3} are the weights on inflation (CPI or domestic) and λ_{y_1} is the weight on output. ρ_i is the coefficient for the interest rate smoothing term.

Since the introduction of Taylor rule, many studies have proposed different modifications to the structure of this rule in order to improve the performance of this rule when applying it to the open economy context. However, the results are quite controversial. The augmented Taylor rules with exchange rate terms are included in this analysis as many studies show that adding the exchange rate terms to the simple rules help to improve the performances of the rules (for example Ball (1999), Senay (2001) and Wollmershäuser (2006)). A number of empirical studies also show that the short-run interest rate in some countries reacts to the exchange rate terms (for example Brischetto and Voss (1999) and Mohanty & Klau (2005)). On the other hand, other studies show the opposite or mixed outcomes (for example Côté et. al. (2002) and Taylor (1999)).

Besides comparing the simple Taylor rule with the rules that react to the exchange rate terms, this chapter also includes comparison of the policy rules with smoothing term. Literatures show that interest rate smoothing term is preferred in the analysis of monetary policy rules for several reasons. For instant, Mayer (2004) and Sack & Wieland (1999) claim that the interest rate smoothing term should include in the Taylor rule as it reflects the real or observable fact that the policy maker adjusts the interest rate gradually to the desired level. The preference to gradual adjustment behavior can be explained by three types of uncertainties faced by the policy maker, i.e. the model uncertainty, parameter uncertainty and data uncertainty. On the other

hand, Woodford (2002) claims that interest rate smoothing rule outperforms the other rules in stabilizing inflation and output gap without requiring variation of interest rate. Other studies, for example Côté & Lam (2001) compare various simple rules using the vector error correction forecasting model for the Canadian economy. Their results show that the interest rate smoothing rule dominates the other rules by minimizing the volatility of output, inflation and interest rate. The reason for a better performance of this rule as explained in Levin, Wieland & Williams (1998) is that this rule enables policy makers to have greater control over the long term interest rate and thereby it has greater influence over the aggregate demand and inflation. On the other hand, Côté et al. (2002) show that interest rate smoothing rules perform poorly in most models. The reason is exchange rate acts as a stabilizer and shock absorber. Smoothing the fluctuations in exchange rate interferes with the adjustment process, hence causing more volatility in output and inflation.

The history dependent rules and the rules with forecast term are also included in this analysis as previous studies show that these rules outperform the standard Taylor rule. For example, many studies show that the restricted history dependent rules outperform the standard Taylor rule (for instance Levin, Wieland & Williams (1998), Kimura & Kurozumi (2002) and Wohltmann & Winkler (2008)). On the other hand, the rules with forecast terms only perform slightly better relative to the standard rules (Levin, Wieland & Williams (1998)).

Monetary policy literatures show that flexible inflation targeting is preferable over the strict inflation targeting as flexible inflation targeting allows the monetary authorities maintain stability in both inflation and output. In contrast, strict inflation targeting lead to larger output volatility. According to Svensson (1998), strict inflation targeting requires activism in monetary, i.e. achieving inflation stabilization at a relatively short horizon. This generates higher variability in macro variables other than inflation.

4.3.3 Highlighted issues

Previous studies show that the economic structure and the country specific factors matter in determining the effectiveness of monetary policy (see the discussion in **Section 4.1.2**). Do these factors matter in the performances of policy rules/ regimes in East-Asia? In answering this question, the analysis on the performances of policy rules have considered four main factors, i.e. the degree of exchange rate pass-through, the degree of trade openness, the policy targeting rule (CPI versus domestic inflation targeting rules) and the nature and persistency of shocks.

In order to generate different degrees of exchange rate pass-through and trade openness, the values of parameters are adjusted accordingly. These parameters include the adjustment cost in import sector (γ_m), fraction of producer in import sector that are rule of thumb price setters (α_m), share of imports in inputs (κ), share of imports in consumption (ω_m) and share of exports in domestic production (ω_x). Following the idea of Adolfson (2001), the first two parameters are adjusted to

generate different degrees of exchange rate pass-through while the remaining three parameters are adjusted for the degrees of trade openness⁹.

The increase in the adjustment cost and fraction of rule of thumb price setters in import sector induces higher price stickiness in import sector and hence lower pass-through of exchange rate into domestic economy. The intuition is higher adjustment cost discourages (imported sector) firms to re-optimize prices or re-optimize prices less often. On the other hand, higher fraction of firms set prices based on the rule of thumb means prices are more sticky as more and more firms set prices to the previous price level and hence pass-through is lower. Both parameters determine the degree of exchange rate pass-through in the domestic economy. The analysis of the effects of exchange rate pass-through in this study is based on the percentage change in import price caused by an unidentified shock to the exchange rate. The degree of exchange rate pass-through can be due to a ‘genuine’ exchange rate or by other economic disturbances (Adolfson (2001)). In this model, it is assumed that the incomplete pass-through is caused by the nominal rigidities and the related structural parameter that determine the price stickiness. Following Adolfson (2001), the degree of exchange rate pass-through is constructed through the partial derivative of import price equation with respect to the exchange rate, assuming that the expected future inflation is zero.

$$\begin{aligned}\pi_t^m &= c_{\pi 1} E_t \pi_{t+1}^m + c_{\pi 2} \pi_{t-1}^m + c_{\pi 3} \pi_{t-2}^m + c_{\tau} [\tau_t + \tau_t^f] \\ p_t^m - p_{t-1}^m &= c_{\pi 2} \pi_{t-1}^m + c_{\pi 3} \pi_{t-2}^m + c_{\tau} [p_t^m - p_t^f - e_t] \\ p_t^m (1 - c_{\tau}) &= c_{\pi 2} \pi_{t-1}^m + c_{\pi 3} \pi_{t-2}^m + c_{\tau} [-p_t^f - e_t] + p_{t-1}^m \\ p_t^m &= \frac{1}{1 - c_{\tau}} [c_{\pi 2} \pi_{t-1}^m + c_{\pi 3} \pi_{t-2}^m + c_{\tau} [-p_t^f - e_t] + p_{t-1}^m] \\ \frac{\partial p_t^m}{\partial e_t} &= \frac{-c_{\tau}}{1 - c_{\tau}} = \frac{c_{\tau}}{c_{\tau} - 1} \quad (\text{exchange rate pass-through})\end{aligned}$$

where

$$c_{\tau} = -(1 - \alpha_m) \Psi_m$$

$$\text{with } \Psi_m = [\alpha_m + \gamma_m (1 + 2\beta\alpha_m)]^{-1}$$

In order to investigate the effects of different degrees of exchange rate pass-through and trade openness, the values of parameters are adjusted as below:

Table B.1: Degrees of exchange rate pass-through (ERPT)

	γ_m	α_m	ERPT = $\frac{c_{\tau}}{c_{\tau} - 1}$
Case I: low PT	0.7	0.7	0.1123
Case II: medium PT	0.3	0.3	0.4735
Case III: high PT	0.1	0.1	0.8037

Notes: Exchange rate pass-through (ERPT) is constructed from the Philips curve equation through the partial derivative of import price goods with respect to the exchange rate, assuming that the expectations of the future inflation are zero and discount rate $\beta = 0.99$

Table B.1 displays three different degrees of exchange rate pass-through by setting different values for γ_m and α_m . For simplicity, both parameters assume to take the

⁹ In Adolfson (2001), the exchange rate pass-through is determined by one parameter only, i.e. the adjustment cost in import sector as her model does not exhibit the rule of thumb price setting behavior.

same value and change at the same rate. However in reality, both parameters may have different values and do not necessarily increase or decrease at the same rate. This analysis only considers the case where both parameters increase or decrease simultaneously but does not consider the case where both parameters move at the opposite directions. It is reasonable to assume both parameters to move at the same direction as it is likely that the increase in the adjustment cost (γ_m) may induce more firms to change their price setting behavior to rule of thumb price setters in order to avoid the drop of production due to the increase of price and to maintain the market competitiveness.

Countries specific dataset (refer **Chapter Two**) show that East-Asian countries have different degrees of trade openness. Malaysia and Singapore have higher trade openness (which exceeds one) while the other countries such as Indonesia, Korea and Philippines have lower trade openness (below one)¹⁰. To see if trade openness matters in determining the economics achievement and the policy performance, the values of parameters for κ (the fraction of imported intermediate goods for production), ω_m (the fraction of imported goods for consumption) and ω_x (the fraction of domestic production goods that export to foreign market) are adjusted accordingly. These three parameters determine the degree of trade openness. Countries specific data show that the value for ω_m is very low, consistent to the low imported goods for consumption in East-Asia. The value for κ is higher relative to the other two parameters as East-Asian countries import relatively high fraction of intermediate goods for production (see **Appendix III-A, Table III-A(1, 2a and 2b)**). This study considers two cases of trade openness. **Table B.2** shows that in the first case, the domestic economy has lower trade openness (as indication for pre-crisis period condition or for those countries with lower trade openness). In the second case, the domestic economy is very open (could be the possible condition for the post-crisis period or for countries that are more open)¹¹.

Table B.2: Degrees of trade openness

	κ	ω_m	ω_x
Case (A): low openness	0.45	0.10	0.25
Case (B): high openness	0.60	0.30	0.40

The nature of shocks could be matter in determining the performance of a policy rule / regime as well. In order to investigate if the nature of shocks matters in determining the performance of a policy regime, the analysis is focused on five simple rules to represent different exchange rate regimes. Shocks are classified into nominal, real, foreign and domestic shocks. The performances of the policy rules are compared by considering different persistencies and variations of isolated and simultaneously shocks (see **Section 4.7**).

¹⁰ Trade openness is defined as the total import and export of goods over the total GDP (see Table I-A(5) In Appendix I-A, Chapter Two).

¹¹ The degree of trade openness indicated here is for general condition for East-Asia but it may not able to represent the trade openness condition for all individual countries. The fraction of imported goods for consumption is very low (about 10%) for both pre- and post-crisis periods. It is set to be 0.30 in case B in order to capture the effects of larger degree of openness in simulations.

4.4 Methodology and parameterization

There is no close way to solve the model. The model has to be solved using the numerical simulations. The optimization procedure is based on the generalized Schur decomposition proposed by Sims (1995) and Klein (1997) as summarized in **Appendix III-B**. For further details of this method, see Söderlind (1999).

Before running the simulations, all the relevant equations are listed. In sum, this model consists of 18 equations and can be summarized as follows:

- (1) $\pi_t^d = b_{\pi 1} E_t \pi_{t+1}^d + b_{\pi 2} \pi_{t-1}^d + b_{\pi 3} \pi_{t-2}^d + b_y y_t + b_\tau \tau_t + u_t^\pi$
- (2) $\pi_t^m = c_{\pi 1} E_t \pi_{t+1}^m + c_{\pi 2} \pi_{t-1}^m + c_{\pi 3} \pi_{t-2}^m + c_\tau [\tau_t + \tau_t^f]$
- (3) $\pi_t^c = (1 - \omega_m) \pi_t^d + \omega_m \pi_t^m$
- (4) $y_t = (1 - a_y) y_{t-1} + a_y E_t y_{t+1} + a_r [i_t - E_t \pi_{t+1}^d] + a_{\tau 1} \tau_{t-1} + a_{\tau 2} \tau_t + a_{\tau 3} E_t \tau_{t+1} + a_{\tau f 1} \tau_{t-1}^f + a_{\tau f 2} \tau_t^f + a_{\tau f 3} E_t \tau_{t+1}^f + a_{y f 1} y_{t-1}^f + a_{y f 2} y_t^f + a_{y f 3} E_t y_{t+1}^f + u_t^y$
- (5) $E_t \Delta e_{t+1} = i_t - i_t^f + a_\phi \phi - u_t^e$
- (6) $a_t = d_a a_{t-1} + d_y y_t + d_x \bar{x}_t + d_\tau \tau_t + d_{\tau f} \tau_t^f + d_{y f} y_t^f$
- (7) $\bar{x}_t = e_y y_t + e_\tau \tau_t + e_{\tau f} \tau_t^f + e_{y f} y_t^f$
- (8) $i_t = \lambda_\pi \pi_t^c + \lambda_y y_t$
- (9) $i_t^f = \lambda_\pi^f \pi_t^f + \lambda_y^f y_t^f + u_t^{if}$
- (10) $y_t^f = \rho_y^f y_{t-1}^f + u_t^{yf}$
- (11) $\pi_t^f = \rho_\pi^f \pi_{t-1}^f + u_t^{\pi f}$
- (12) $u_t^y = \rho_y u_{t-1}^y + v_t^y$
- (13) $u_t^\pi = \rho_\pi u_{t-1}^\pi + v_t^\pi$
- (14) $u_t^e = \rho_e u_{t-1}^e + v_t^e$
- (15) $\tau_t = p_t^m - p_t^d$
- (16) $\tau_t^f \equiv p_t^d - e_t - p_t^f$
- (17) $\Delta q_t = q_t - q_{t-1}$
- (18) $q_t = -\tau_t^f - \omega_m \tau_t$

The model is written in a state space representation form and is solved numerically (see **Appendix III-B**). Before running the simulations, we need to give values to the parameters, either through calibration or estimation. In this chapter, there is no attempt to estimate parameters but the values of parameters are determined through calibrations and observations on dataset of East-Asian countries. The parameterizations applied in previous studies in the small open economy are quite different, depending on the belief and interpretation of researchers based on a general or specified economy's condition. The parameterizations applied in this chapter are based on the general case for the crisis-hit East-Asian countries as a whole. Therefore, the parameterizations may not fully represent the economic conditions for the individual East-Asian countries. The values of parameters can also change over time, i.e. during the pre- and post-crisis periods. Besides, some parameters are

unobservable, e.g. the persistency of shocks. Due to these uncertainties, the analysis considers different parameterizations (see **Section 4.6**). Different parameterizations can be interpreted to represent different individual East-Asian economies and the change in the economic structures in the pre- and post-crisis periods.

Three parameters are set based on the data of East-Asian economies. These parameters include κ (share of imports in inputs), ω_m (share of imports in consumption) and ω_x (share of exports in domestic production). Following the idea of Lindé, Nessén & Söderström (2004), the value for κ is set by observing the data on imported inputs as percentage of total inputs in the producer and import stages. The value for ω_m is referred to the data of average share of imported inflation in core inflation and ω_x is referred to the data of average export share in GDP. In this study, the value of ω_x is defined as in Lindé, Nessén & Söderström (2004), and the data is obtained from the Asian Development Bank (ADB), 1989-2006, (see **Appendix III-A, Table III-A(1)**). The value for ω_x is set to be 0.25 as the approximately value of ω_x for majority of the East-Asian countries (with Malaysia and Singapore as exceptions) for the periods of 1989-1996 (before crisis). The value of ω_x has increased in the post-crisis period. The data for κ and ω_m are referred to the report of RIETI-TID (2005) on the component of imports for Asian (see **Appendix III-A, Table III-A(2a & 2b)**). The values for κ and ω_m are approximately set to be 0.45 and 0.10 respectively. Later, these values are adjusted to generate higher degree of trade openness as discussed in **section 4.3.3** (see **Table B.2**).

The remaining values of parameters are unobservable and the calibrations are based on the assumption and interpretation of authors. The calibrations applied here are based on the literature of small open economies. The value of import price stickiness (γ_m) and the fraction of producer in import sector that uses the rule of thumb as the pricing strategy (α_m) are essential in the determination on the degree of exchange rate pass-through. Empirical studies show that the degree of exchange rate pass-through differs across countries and over time. The results of Chapter Two show that East-Asian countries exhibit different degrees of exchange rate pass-through and pass-through does not decline in all countries. In order to consider different degree of exchange rate pass-through condition for East-Asian countries, these values are adjusted to generate three different degrees of exchange rate pass-through: the low, medium and high degrees of exchange rate pass-through (see **Table B.1**). As empirical studies show that pass-through into import price is the highest but that of the producer and consumer prices are low, the domestic price stickiness γ_d is assumed to be 5 which is higher than the price stickiness in the import sector¹². The fraction of producer in the domestic sector that applies the rule of thumb in their pricing strategy is assumed to be 0.5, the value that assigned for the small open economy context (for example Flamini (2005) and Justiniano & Preston (2004)). Focusing the analysis in the case of South Korea, Elekdag et al. (2005) set the prior value for this parameter to be 0.6 and report the posterior value of 0.51. Following

¹² Adolfson (2001) assigns this parameter to be 10 in her simulations.

Cook & Devereux (2006b) who focus the study in crisis-hit East-Asian countries, the discount factor β is set to be 0.99, implying an annualized real interest rate of 4%.

Previous studies report different values for the parameter of elasticity of substitution in multi-goods sectors. Cook and Devereux (2006a) assign the elasticity of substitution between traded and non-traded goods to be 0.66, between imported materials and domestic value added as 0.7 and between domestic goods and imports to be 0.6 in their studies in three East-Asian countries. Cook & Devereux (2006b) set the elasticity of substitution between individual retail goods to be 7.666 to capture the steady state mark-up of 1.15 for the case of East-Asian countries. Elekdag et al. (2005) normalize the elasticity of substitution between domestic and imported goods to be unity in the case study of South Korea. Devereux et al. (2005) assign the value of unity to the elasticity of substitution between traded and non-traded in the analysis of emerging economies.

Taking the value between 0.7 (as in Cook & Devereux (2006a)) and 1 (as in Elekdag et al. (2005)), the value for η or the elasticity of substitution between home and foreign goods is set equal to 0.9. A high value of η implies that the domestic output gap is very sensitive to terms of trade movements. Gali & Monacelli (2005) set this parameter to unity. Reducing the value for this parameter does not affect the main findings of analysis (see **section 4.6.1**). The values for η_m and η_d indicate the mark-up in the domestic and import sectors. These parameters take different values, depending on the model structure and assumptions of authors. Focusing the analysis in Thailand, Tanboon (2008) sets 1.20 to the mark-up for domestic sector. Sutthasri (2007) empirically calculates and shows that the range for this parameter is within 1.13 to 1.32 for Thailand. In this chapter, both η_m and η_d are assumed to share the same value of 5 which implies the mark-up for imported and domestic sectors ($\frac{\eta_m}{1-\eta_m}$ and $\frac{\eta_d}{1-\eta_d}$) of 1.25 which is slightly higher than 1.2, the mark-up in OECD countries in the literature (Choudhri (2005)). Reducing the mark-up for both sectors (i.e. increasing the value of η_m and η_d) does not change the main results of analysis (see **section 4.6.1**).

Following Lindé, Nessén & Söderström (2004), the relative risk aversion, σ takes the value of 1.2. The same value also assigned in Justiniano & Preston (2004) for the small open economy analysis. Elekdag et al. (2005) report the posterior value of 1.67 for this parameter in the case of South Korea when setting the prior value 3 to this parameter. This value is consistent to the results of Eichenbaum et al. (1988) who found the values of 0.5-3 for this parameter. Barsky et al. (1987) and Hall (1988), on the other hand, suggest the values greater than 5. Testing with different values, Choudhri (2005) finds that this parameter does not generate large variations in the outcomes.

The parameter for technology θ is set equal to 0.46, the values set for the small open economy (for example Lindé, Nessén & Söderström (2004) and Adolfson (2001)). The habit formation parameter, h is assumed to be 0.8 as in Flamini (2004). This

value is consistent to the value assigned in Tanboon (2008) of 0.85 for the case of Thailand. Based on the data of 1994 to 2006, GMM estimation indicates the value of 0.84 to 0.88 for this parameter for Thailand (Tanboon, 2008). ϕ measures the cost of intermediation in the foreign bond market. It indicates the degree of vulnerability of domestic financial economy to shocks. If this parameter takes the value away from zero, the domestic financial accelerator and balance sheet are weak (Elekdag et al. (2005)). Elekdag et al. (2005) show that the implied annually risk premium for South Korea take the value of 11-13% when testing with different prior values (0.2 versus 0.07). In this chapter, this parameter is set to be 0.10. The same value also applied in Merola (2006). Testing with a very low value for this parameter does not change the main results of analysis. Lindé, Nessén & Söderström (2004) find that this parameter takes the reasonable range of 0 to 0.115 in the case of small open economy (Sweden). The parameter χ_f is the income elasticity of foreign consumption and is assumed to be 0.9 as in Flamini (2005) and Adolfson (2001). The domestic economy is assumed to follow a Taylor policy rule. The central bank's loss function preference on inflation target is 1.0 and the relative preference for output is 0.5.

Most of the empirical studies on the business cycles and policy regimes or optimum currency area (OCA) for Asia investigate the relative importance of domestic and foreign shocks from the forecast error variance decompositions without giving information on the persistency of shocks. Although some of the Asian or East-Asian countries show certain level of symmetry in shocks, in general most of these countries are driven by country specific shocks and that foreign shocks play a relatively small role in the economic of East-Asia (for example, Sun & An (2008), Chow & Kim (2003) and Hoffmaister & Roldós (1997) as discussed in **Chapter Two**. Due to the lack of information for the persistency of shocks in East-Asia and that shocks are idiosyncratic and asymmetric, it is hard to make a general assumption on the persistency of shocks for the whole East-Asian countries in this study. Following the step of some studies, this chapter conducts the simulations by assuming all the shocks share the same persistency of 0.7 and standard error of 0.3¹³. The robustness of the results are checked by repeating the simulations for different persistencies and standard errors of shocks, alternative parameterization, different policy weightings and different policy targeting (see **Section 4.6**). The parameterization is summarized in **Table B.3**.

Table B.3: Parameterization

Policy preference	Supply relation	Demand relation	Foreign Taylor rule	Shock persistence	Standard error of shocks
$\gamma_y=0.5$	$\gamma_m=0.1, 0.3, 0.7$	$\eta=0.9$	$\lambda_\pi^f=1.5$	$\rho_\pi=0.7$	$\sigma_\pi=0.3$
$\gamma_\pi=1.0$	$\alpha_d=0.5$	$\eta_m=5$	$\lambda_y^f=0.5$	$\rho_y=0.7$	$\sigma_y=0.3$
	$\alpha_m=0.1, 0.3, 0.7$	$\eta_d=5$		$\rho_i^f=0.7$	$\sigma_{yf}=0.3$
	$\gamma_d=5$	$\sigma=1.2$		$\rho_y^f=0.7$	$\sigma_{\pi f}=0.3$
	$\omega_m=0.10, 0.3$	$\beta=0.99$		$\rho_\pi^f=0.7$	$\sigma_{yf}=0.3$
	$\kappa=0.45, 0.60$	$\omega_x=0.25, 0.4$		$\rho_e=0.7$	$\sigma_e=0.3$
	$\theta=0.46$	$h=0.8$			
		$\chi_f=0.9$			
		$\phi=0.10$			

¹³ Among the papers that conduct simulations by assuming same persistency or /and standard error for all shocks in their calibrations are Adolfson (2001), Parrado (2004); as priors parameters such as Juillard et. al (2006).

4.5 Results

4.5.1 The degree of exchange rate pass-through

The performances of the optimized restricted simple rules are evaluated in terms of the policy absolute loss and relative loss of the each rule to the unrestricted optimized rule and restricted optimized baseline Taylor rule. Assuming that the domestic economy is hit by six shocks simultaneously with the same persistency of shocks, various restricted optimized simple rules under different degrees of exchange rate pass-through are compared. All simulations are based on the CPI inflation targeting rules with the exception of **Section 4.5.4** where simulations are based on domestic inflation targeting rules.

Table B.4 displays the results of policy reaction coefficients for various rules under three cases of exchange rate pass-through. By observing the coefficients of the baseline Taylor rule (rule TR), one may find that the optimized coefficient of the policy rule to inflation impulse becomes larger when the pass-through rate is higher. This is because higher pass-through induces greater external shocks which require greater policy reaction and hence higher coefficient for inflation in the policy rule. The same result also holds for the optimized coefficient of interest rate smoothing term. The optimized coefficient for the smoothing term is relatively smaller for the low pass-through case in compare to the higher pass-through case (see rule TRS). This implies higher weight on interest rate stabilization for the high pass-through case in compared to the low pass-through case. However, as mentioned in Adolfson (2001), the smoothing coefficient may not necessary larger in the full pass-through case. For instance under low exchange rate pass-through case, the exchange rate disturbance on import price is small but persistent as it takes longer time to reach the steady state due to the low pass-through. Hence, the interest rate can be more persistent in the low pass-through case which induces higher coefficient of smoothing term for the low pass-through case.

The optimized coefficient to exchange rate is increasing in the degree of exchange rate pass-through. This result indicates that exchange rate plays a more important role in transmitting the inflation disturbances when the pass-through is higher. Hence, augmenting the policy with exchange rate term induces larger improvement in term of lower welfare loss in the high pass-through case. For the augmented Taylor rule that include the exchange rate term, the coefficients of the policy reaction to inflation and smoothing term are decreasing in contrast to the coefficient to exchange rate. This implies higher role of exchange rate relative to these variables in absorbing shock under the higher pass-through case.

The optimized coefficient for the current inflation term is negative but the optimized coefficient for the lagged inflation term is positive in the rules that react to the lagged inflation term (rule TRH, TRHE, TRHI and TRHIE). Or equivalently, the optimized coefficient for the current inflation is positive but the coefficient for the expectation term is negative. This is due to the mean reverting behavior of inflation. Assuming that shocks to inflation induce temporary deviation from the steady state, the central bank will raise the interest rate to control the current inflation but reduces the rate for the next period.

The policy absolute loss and relative loss provide comparisons on the performances of various rules. Relative loss (1) indicates the relative loss of each rule to the loss of unrestricted optimized rule that reacts to output and inflation (in this case, CPI inflation). Relative loss (2) is the relative loss of each rule to the loss of restricted optimized Taylor rule, i.e. rule TR. The results show that the unrestricted optimized rule always performs better than the restricted optimized rule. However, the restricted optimized rule can perform nearly well as the unrestricted optimized rule depending on the policy weight/ objective and economic conditions (for example the degree of trade openness and exchange rate pass-through). The restricted optimized rule could perform closely to the loss of unrestricted optimized rule when the pass-through is very low (see **Table B.4**) and the relative weight of output to inflation is very small (see **Table III-A(6) in Appendix III-A**). Due to its simple structure, the instrument rule is always served as the baseline rule for comparisons and policy evaluations.

Comparing the results of both absolute loss and relative loss, it is observed that exchange rate is welfare enhancing. Including the exchange rate term in the baseline Taylor rule reduces the welfare loss and the size of improvement is increasing in the degree of exchange rate pass-through. For instance, adding the exchange rate term in the baseline rule (rule TRE1) when the pass-through rate is high generates lower relative loss of about 8% under the unrestricted case and 6% under the restricted case. Adding the backward-looking components to the baseline rule such as the smoothing term (rule TRS and TRSE) and history dependent term (rule TRH and TRHE) also induces lower welfare loss. These history dependent rules (with and without exchange rate terms) perform better than the baseline rule with exchange rate term (rule TRE1 and TRE2). These rules allow gradual adjustment in prices and provide additional information to the policy maker which helps to reduce the variances or biases in the policy decisions. Similarly, the rules with forward-looking component with and without exchange rate term (rule TRF and TRFE) are welfare enhancing as well. In line with previous studies, the strict inflation targeting rule performs badly in all cases. This rule generates higher welfare loss and variance in output although the variance in consumer and domestic inflation are relatively low.

Apart from these results, the hybrid rules with and without exchange rate term (rule TRHI and TRHIE) outperform the other rules. The hybrid rule with exchange rate term (rule TRHIE) is superior to all rules under three cases of exchange rate pass-through as it incorporates both inertia and expectation on inflation in forming the policy reaction function. Similar to the other rules, this rule performs the best under the high pass-through case. The results show that exchange rate plays an improving role in the setups of policy rules in the open economy counterpart and suggest that the superior rule should react to the exchange rate term and is in hybrid form at least in the model applied in this chapter. The role of exchange rate in the design of monetary policy becomes more important as it generates higher improvement in term of lower welfare loss under the high pass-through case.

Table B.4: Policy rules based on CPI inflation targeting

Policy rules	Structure of rules	Absolute loss	Relative loss (1)	Relative loss (2)	V(y)	V(pi_c)	V(pi_d)
	<u>(I) Low Pass-through (LPT)</u>						
TR	$i_t = 4.0672\pi_t^c + 0.7838y_t$	9.0475	1.1660	1.0000	14.6269	1.7341	2.1774
TRE1	$i_t = 3.3052\pi_t^c + 0.7388y_t + 0.6218\Delta e_t$	8.8836	1.1449	0.9819	14.4803	1.6434	2.1287
TRE2	$i_t = 3.8437\pi_t^c + 0.7155y_t + 0.6509\Delta q_t$	8.8708	1.1432	0.9804	14.4594	1.6411	2.1318
TRS	$i_t = 0.4097(6.9229\pi_t^c + 1.4811y_t) + 0.5903i_{t-1}$	8.8606	1.1419	0.9793	14.4449	1.6382	2.1429
TRSE	$i_t = 0.5260(5.7392\pi_t^c + 1.1856y_t + 0.2637\Delta q_t) + 0.4740i_{t-1}$	8.8596	1.1418	0.9792	14.4430	1.6381	2.1413
TRH	$i_t = -0.1344\pi_t^c + 1.3147y_t + 5.1208\pi_{t-1}^c$	8.5466	1.1014	0.9446	13.4515	1.8208	2.2544
TRHE	$i_t = -0.1046\pi_t^c + 1.3104y_t + 5.0800\pi_{t-1}^c + 0.0127\Delta q_t$	8.5465	1.1014	0.9446	13.4497	1.8217	2.2555
TRF	$i_t = 10.3116\pi_t^c + 1.3733y_t - 6.0511E_t\pi_{t+1}^c$	8.8784	1.1442	0.9813	14.0356	1.8607	2.2535
TRFE	$i_t = 7.3369\pi_t^c + 1.0307y_t - 3.5657E_t\pi_{t+1}^c + 0.5767\Delta q_t$	8.7977	1.1338	0.9724	14.0089	1.7932	2.2201
TRHI	$i_t = -12.3299\pi_t^c + 1.6414y_t + 10.4782E_t\pi_{t+1}^c + 10.5053\pi_{t-1}^c$	8.4250	1.0858	0.9312	13.2371	1.8065	2.3011
TRHIE	$i_t = -14.1222\pi_t^c + 1.7117y_t + 11.4474E_t\pi_{t+1}^c + 11.6714\pi_{t-1}^c - 0.2152\Delta q_t$	8.4092	1.0837	0.9294	13.2024	1.8080	2.2987
SIT	$i_t = 2.9495\pi_t^c$	9.7732	1.2595	1.0802	17.4570	1.0447	1.5232
	The absolute loss for the unrestricted optimal rule is 7.7595 (LPT)						

Policy rules	Structure of rules	Absolute loss	Relative loss (1)	Relative loss (2)	V(y)	V(pi_c)	V(pi_d)
	<u>(I) Medium Pass-through (MPT)</u>						
TR	$i_t = 4.3654\pi_t^c + 0.7574y_t$	9.4600	1.2720	1.0000	16.0062	1.4569	1.6466
TRE1	$i_t = 2.7248\pi_t^c + 0.5471y_t + 0.8852\Delta e_t$	9.0059	1.2109	0.9520	15.3979	1.3070	1.7681
TRE2	$i_t = 3.4403\pi_t^c + 0.5082y_t + 0.8975\Delta q_t$	8.9787	1.2073	0.9491	15.3322	1.3126	1.7859
TRS	$i_t = 0.2450(8.7878\pi_t^c + 1.6153y_t) + 0.7550i_{t-1}$	8.9949	1.2095	0.9508	15.3289	1.3305	1.7998
TRSE	$i_t = 0.7058(4.0961\pi_t^c + 0.6422y_t + 0.7928\Delta q_t) + 0.2942i_{t-1}$	8.9736	1.2066	0.9486	15.3071	1.3201	1.7980
TRH	$i_t = -2.1167\pi_t^c + 1.3426y_t + 7.2538\pi_{t-1}^c$	8.5018	1.1432	0.8987	13.8760	1.5635	1.9568
TRHE	$i_t = -1.4926\pi_t^c + 1.2633y_t + 6.4139\pi_{t-1}^c + 0.3461\Delta q_t$	8.4669	1.1385	0.8950	13.8081	1.5628	1.9994
TRF	$i_t = 48.1194\pi_t^c + 5.0276y_t - 38.2074E_t\pi_{t+1}^c$	8.8023	1.1836	0.9305	14.5677	1.5185	1.8389
TRFE	$i_t = 22.1188\pi_t^c + 2.3825y_t - 16.5192E_t\pi_{t+1}^c + 1.2801\Delta q_t$	8.7282	1.1736	0.9226	14.4444	1.5060	1.9173
TRHI	$i_t = -10.4521\pi_t^c + 0.8331y_t + 7.6111E_t\pi_{t+1}^c + 8.1704\pi_{t-1}^c$	8.3946	1.1287	0.8874	13.4491	1.6701	2.0877
TRHIE	$i_t = -10.8971\pi_t^c + 0.7962y_t + 8.5805E_t\pi_{t+1}^c + 8.0006\pi_{t-1}^c + 0.2168\Delta q_t$	8.3352	1.1208	0.8811	13.4214	1.6245	2.0816
SIT	$i_t = 2.9609\pi_t^c$	10.0483	1.3571	1.0622	18.3728	0.8619	1.0556
	The absolute loss for the unrestricted optimal rule is 7.4371 (MPT)						

Policy rules	Structure of rules	Absolute loss	Relative loss (1)	Relative loss (2)	V(y)	V(pi_c)	V(pi_d)
	<u>(III) High Pass-through (HPT)</u>						
TR	$i_t = 5.1006\pi_t^c + 0.9671y_t$	9.6447	1.2963	1.0000	16.3594	1.4650	1.5398
TRE1	$i_t = 2.6532\pi_t^c + 0.5285y_t + 0.9389\Delta e_t$	9.0578	1.2174	0.9391	15.5365	1.2895	1.7216
TRE2	$i_t = 3.4057\pi_t^c + 0.4869y_t + 0.9434\Delta q_t$	9.0276	1.2134	0.9360	15.4608	1.2972	1.7409
TRS	$i_t = 0.2097(9.8849\pi_t^c + 1.7955y_t) + 0.7903i_{t-1}$	9.0518	1.2166	0.9385	15.4613	1.3211	1.7529
TRSE	$i_t = 0.7338(3.9635\pi_t^c + 0.5979y_t + 0.8651\Delta q_t) + 0.2662_i i_{t-1}$	9.0234	1.2128	0.9356	15.4354	1.3057	1.7518
TRH	$i_t = -1.9050\pi_t^c + 1.2685y_t + 6.8399\pi_{t-1}^c$	8.5718	1.1521	0.8887	13.9502	1.5967	1.9402
TRHE	$i_t = -1.5849\pi_t^c + 1.2387y_t + 6.4270\pi_{t-1}^c + 0.4766\Delta q_t$	8.4827	1.1401	0.8795	13.8666	1.5494	1.9950
TRF	$i_t = 158.76\pi_t^c + 16.4361y_t - 130.94E_t\pi_{t+1}^c$	8.8406	1.1882	0.9166	14.6524	1.5145	1.8367
TRFE	$i_t = 22.6218\pi_t^c + 2.3939y_t - 17.0349E_t\pi_{t+1}^c + 1.3583\Delta q_t$	8.7871	1.1810	0.9111	14.8993	1.4820	1.8993
TRHI	$i_t = -1.4794\pi_t^c + 1.3237y_t - 0.4422E_t\pi_{t+1}^c + 6.9311\pi_{t-1}^c$	8.5713	1.1520	0.8887	13.9714	1.5856	1.9312
TRHIE	$i_t = -6.8162\pi_t^c + 0.8532y_t + 5.2333E_t\pi_{t+1}^c + 6.5886\pi_{t-1}^c + 0.4908\Delta q_t$	8.4147	1.1310	0.8724	13.5893	1.6200	2.0926
SIT	$i_t = 2.95\pi_t^c$	10.2797	1.3816	1.0658	18.6645	0.9475	0.9867
	The absolute loss for the unrestricted optimal rule is 7.4402 (HPT).						

Notes: Relative loss (1) refers to the ratio of absolute loss of each simply rule to the absolute loss of unrestricted optimized rule that reacts to output and inflation; relative loss (2) indicates the relative loss of each simple rule to the loss of restricted optimized rule that react to both output and inflation, i.e rule TR. The absolute loss for unrestricted rule are 7.7595 (LPT), 7.4371 (MPT) and 7.4402 (HPT).

4.5.2 The effects of trade openness

How does the trade openness of one economy affect the policies performances? Does trade openness matter in determining the exchange rate pass-through and hence, influences the conduct of monetary policies? Adolfson (2001) states that economy with higher trade openness implies that the economy is more open to external shocks, hence greater impacts of foreign shocks to that economy. Under such condition, the exchange rate channel plays a greater role in the monetary policy transmission similar to the case of high degree of exchange rate pass-through. However, this condition does not necessary hold (as can be seen in the results later).

On the other hand, Ho & McCauley (2003) on their study in several emerging economies show that openness per se is not significantly correlated with the exchange rate pass-through. They note that although Latin American countries have lower degree of trade openness than Asian countries have, the pass-through in Latin American countries is stronger than that of Asian countries. However, they find that low income and high inflation history are significantly correlated with the exchange rate pass-through.

Following Adolfson (2001), the degree of trade openness is represented by three parameters, the import and export shares (ω_m and ω_x) and the share of imported intermediate inputs in production κ . The higher the values of these parameters indicate the more open one economy is. In order to generate higher trade openness, κ , ω_m and ω_x take the values of 0.60, 0.30 and 0.40 respectively which are higher than the values set in the previous section¹⁴. The more open one economy is, the higher are the exposure of foreign disturbances to that economy and the greater responses of policy reaction function to such disturbances. The opposite condition holds if the economy has a low degree of trade openness.

Table B.5 shows the results of objective loss for different restricted optimized CPI inflation targeting simple rules under different degrees of trade openness and exchange rate pass-through. Comparing the results in **Table B.5** with the one in **Table B.4**, it is observed that the results summarized in both tables are consistent to each other. The augmented Taylor rules with history dependent terms with and without exchange rate terms outperform the baseline Taylor rule. The hybrid rule with exchange rate term is superior to all rules. These rules perform better under high pass-through case. In contrast, the strict inflation targeting rule and the forecast based inflation targeting perform badly in all cases.

Apart from these results, it is observed that the size of improvement is larger in **Table B.4** than in **Table B.5**. This means that the size of improvement is slightly smaller for the more open economy case. The reason is under more open economy case (which is analog to greater pass-through case), although the effect of foreign disturbances to the domestic economy is greater, the price distortion due to import price stickiness is smaller. The variability in exchange rate is relatively smaller in compare to the less open economy case (see **Table B.6**). Exchange rate plays a lower role in adjusting prices. Hence the size of improvement by including the exchange rate term in the baseline rule could be smaller under more open economy case.

¹⁴ The parameterizations for other parameters hold the same.

Table B.5: Effects of higher trade openness on performances of simple rules

Rules	LPT			MPT			HPT		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
TR	8.2443	1.2108	1.0000	8.6983	1.1935	1.0000	8.8591	1.2074	1.0000
TRE1	8.2137	1.2063	0.9963	8.5217	1.1693	0.9797	8.5901	1.1708	0.9697
TRE2	8.2074	1.2054	0.9955	8.4880	1.1646	0.9758	8.5486	1.1651	0.9649
TRS	8.1901	1.2029	0.9934	8.4538	1.1599	0.9719	8.5187	1.1610	0.9617
TRSE	8.1867	1.2024	0.9930	8.4519	1.1597	0.9717	8.5127	1.1602	0.9609
TRH	7.9597	1.1690	0.9655	8.1157	1.1136	0.9330	8.2788	1.1283	0.9345
TRHE	7.9593	1.1690	0.9654	8.0760	1.1081	0.9284	8.1536	1.1113	0.9203
TRF	8.1188	1.1924	0.9848	8.4714	1.1624	0.9739	8.3530	1.1384	0.9429
TRFE	8.1013	1.1898	0.9826	8.2497	1.1319	0.9484	8.3485	1.1378	0.9423
TRHI	7.8918	1.1590	0.9572	8.1151	1.1135	0.9329	8.1980	1.1173	0.9254
TRHIE	7.8844	1.1580	0.9563	8.0289	1.1016	0.9230	8.1517	1.1110	0.9201
SIT	9.1387	1.3422	1.1085	9.4402	1.2953	1.0853	9.6896	1.3206	1.0937

Notes: Relative loss (1) refers to the ratio of absolute loss of each simple rule to the absolute loss of unrestricted optimized rule that reacts to output and inflation; relative loss (2) indicates the relative loss of each simple rule to the loss of restricted optimized rule that react to both output and inflation, i.e. rule TR. The absolute loss for unrestricted rule are 6.8089 (LPT), 7.2881 (MPT) and 7.3372 (HPT).

Table B.6 summarizes the unconditional variances for several variables under different degrees of trade openness and exchange rate pass-through. The variances change as the degrees of openness change. As discussed in Adolfson (2001), a more open economy implies larger reactions of policy to foreign shocks but lower policy response to domestic shocks. When the economy is more open, foreign shocks have greater impacts or influences on the domestic variables, for example the price level. This in turn requires larger adjustments in output. Therefore, the domestic economy that is more open may experience greater variability in price level (domestic price) and output. On the other hand, the variability in nominal and real exchange rate becomes smaller the more open the economy is. The reason is exchange rate plays a lower role in adjusting price following greater impacts of foreign shocks on domestic price level. In other words, the stabilization or price adjustment is achieved through output rather than via exchange rate channel (Adolfson, 2001).

Table B.6: Effects of trade openness – comparisons of variances

(A1) Case I: Lower openness								
Rules	V(y)	V(pi_d)	V(pi_m)	V(pi_c)	V(de)	V(tau)	V(i)	V(q)
<u>TR</u>								
LPT	14.6269	2.1774	7.6463	1.7341	25.7702	67.6450	9.5303	56.7161
MPT	16.0063	1.6466	13.8713	1.4569	21.6085	72.4076	7.8970	61.8679
HPT	16.3594	1.5398	17.6913	1.4650	20.6722	76.8307	8.6851	63.8991
<u>TRHE</u>								
LPT	13.4497	2.2555	7.9478	1.8217	20.2646	68.4413	9.7099	57.7384
MPT	13.8081	1.9995	10.6336	1.5628	15.8241	68.5658	9.5814	57.9402
HPT	13.8666	1.9950	11.9329	1.5494	14.6092	69.4808	9.4330	57.5995
(B) Case II: Higher openness								
Rules	V(y)	V(pi_d)	V(pi_m)	V(pi_c)	V(de)	V(tau)	V(i)	V(q)
<u>TR</u>								
LPT	14.1828	2.0803	3.0174	1.1529	9.3829	40.2751	4.4347	20.8452
MPT	15.4737	1.5397	4.4448	0.9615	5.8053	42.0751	3.7117	20.9507
HPT	15.9189	1.4120	4.8126	0.8996	5.1683	43.1282	4.2052	21.3067
<u>TRHE</u>								
LPT	13.4627	2.1588	3.0189	1.2280	8.48851	40.0783	4.2343	21.4773
MPT	13.8745	2.0437	3.4201	1.1388	5.5562	39.4153	3.8647	20.0845
HPT	13.9968	2.0848	3.4867	1.1552	4.3175	39.1804	3.6793	19.4907

4.5.3 Analyzing the effects of structural shocks

The impulse response function and variance decomposition are used to investigate the effects of shocks to the domestic economy. There are six shocks in this model: domestic inflation/ supply shocks, domestic output/ demand shocks, exchange rate shocks, foreign inflation shocks, foreign output shocks and foreign policy shocks. These shocks can be categorized as domestic shocks and foreign shocks. It is assumed that all shocks are equally persistent (0.7) with the standard error of 0.3. The domestic economy is assumed to follow an ad-hoc standard Taylor rule that reacts to output and CPI inflation. The parameter on output and inflation targeting are 0.5 and 1.5 respectively. The model is simulated by considering three different degrees of exchange rate pass-through, i.e. the low, medium and high pass-through. The results of impulse response functions on the effect of each single shock are summarized in **Appendix III-A(8)**¹⁵.

The foreign cost-push shock leads to the immediate rises in the domestic, imported and consumer inflation rates. As can be seen, the increase in inflation is larger for the medium and high pass-through cases but lower for the low pass-through case. The increase in the inflation level may lead to the decline in the demand, hence lower output and production. The holding of net foreign asset depends on the real profit, output, terms of trade, foreign output and foreign terms of trade. It is higher under the low pass-through case compare to the medium and high pass-through cases as the price distortion is smaller under the low pass-through case. The interest rate increases in response to the higher inflation rate. As the increase in import price is higher than the increase in domestic price, this means the terms of trade will increase where the domestic price is lower than the foreign price. Therefore, nominal exchange rate will appreciate but real exchange rate will depreciate.

When the foreign output shock hits the domestic economy, the domestic price level is relatively higher than the foreign price, hence higher domestic output. This is because the increase in the foreign production tends to press down the foreign price compare to the domestic price. Since domestic price is relatively higher than the foreign price, domestic trade balance is deteriorated. The interest rate is raised to control the price level and domestic currency appreciates. The higher price level also causes the consumption to fall. The fall in consumption and the initial appreciation of exchange rate reduces the demand for domestic goods, both effects offset the output effects of the foreign demand shock.

As in the case of foreign inflation shock, the real profit and net foreign asset holding is higher under the low pass-through case. The effect of lower price adjustment under the low pass-through case is due to the higher stickiness of price and the higher increase in productivity and output. The effects on the terms of trade depend on the relative price of imported and domestic goods. The results show that terms of trade increase but later smooth down as the effects of this shock dies out over time. The increase in foreign demand shock also leads to depreciation in real exchange rate.

¹⁵ Green line represents the high pass-through, red line represents the low pass-through and blue line represents the medium pass-through

The increase in the foreign interest rate implies lower foreign inflation rate and the domestic price level is relatively higher compare to the foreign price level. On the other hand, the import price will drop as the effect of the drop in the foreign inflation rate. For the case of low pass-through, the import price shows a small increase at the beginning before showing a small drop. The increase in import price is due to the effects of previous price level as the import price depends on its first and second lagged levels. The effect of the increase in domestic price on consumer price is larger than the effects of the decline in import price on consumer price due to the relatively low fraction of imported goods for consumption. This induces a small increase in consumer price. Due to the small increase in import price for the low pass-through case, the increase in consumer price for low pass-through case is higher than the high and medium pass-through cases.

When the domestic price is relatively high compare to the foreign price, the demand for domestic goods will fall. The drop in output for low pass-through case is slightly higher than the other two cases due to the higher increase in consumer price. The drops in output and the higher level in prices lead to a drop in real profit. The depreciation in domestic currency leads to the increase in the nominal and real exchange rate. Net foreign asset holding increases as it is more attractive and valuable for the domestic households to hold foreign asset.

Under the domestic inflation or cost-push shock, the domestic and CPI inflation rates will increase. This negative effect will induce lower demand, hence a drop in output. As the output and inflation move in the opposite way in the Taylor rule but the inflation rate dominates the move in output, therefore the interest rate will increase. Consumption will drop which leads to the drop in output.

The increase in inflation rate means the domestic currency depreciates, therefore the nominal exchange rate rises. This raises the demand for domestic goods. On the other hand, the real exchange rate drops in the case of medium and high exchange rate pass-through but fluctuates in the case of low pass-through depending on how large the change in output and price level. When the domestic currency depreciates, it is more expensive for the domestic agents to import foreign goods, hence higher import price. The total effects lead to the drop in the terms of trade. The real profit drops under the medium and high pass-through cases because higher inflation causes to the shrink in demand. On the other hand, real profit is quite fluctuate and shows a 's' curve under the low pass-through case. This can be explained by the effect of low pass-through that transmits to different degrees of changes in terms of trade which later has different influences on the aggregate demand.

When the same magnitude of inflation shock hits the economy, the domestic and consumer inflation rates will increase at the same magnitude at the beginning for all pass-through cases. Later, the domestic and consumer inflation rates under the low pass-through case drop faster, taking into account the effect of low increment in imported inflation on terms of trade as compare to the medium and high pass-through cases. The change in the inflation rate and the terms of trade affect the real profit. Causing by the immediate drop in the domestic and consumer inflation rates, the real profit drops immediately for all pass-through cases. This negative effect declines slowly to the initial level in the case of medium and high pass-through. On the other hand, real profit tends to be positive under the low pass-through case due to the effect of low increment in the import price on terms of trade. The continue increase in the

inflation rate for domestic and import sector and CPI leads to the drop in real profit under the low pass-through case before the effect dies out in the long-run.

A one percent increase in the domestic demand/ output shock leads to an increase in domestic productivity and price level. However, the rise in prices does not take place immediately. Indeed, the price levels show a certain level of decline in the beginning followed by a rise. This trend is observed in the domestic, CPI and import inflation rates. The reason for the decline in prices is due to the immediate rise in production which reduces the marginal cost of production. The continue decline in the domestic and CPI inflation rates is due to the backward-looking behavior of producer (see the equation for domestic and CPI inflation). Later, further increase in the demand leads to the increase in domestic and CPI inflation rates. The import price increases as well because higher demand induces higher production, hence higher demand for foreign goods for consumption and production. However, the increase in import price is relatively lower than the increase in domestic price and the terms of trade will drop. The real profit under the low pass-through case increases slightly and then drops with lower magnitude as compare to the other two cases. This is due to the effect of higher increment in output but lower increment in price for the lower pass-through case. When the domestic price increases, the interest rate increases as well. The total effect of a domestic demand shock is the increase in the nominal exchange rate but a decline in the real exchange rate. However, nominal exchange rate appreciates in the beginning before depreciates. The appreciation is due to the decline in the domestic and CPI inflation.

The increase in exchange rate shock or depreciation in exchange rate leads to the increase in domestic, CPI and import inflation rates. This is because the value of domestic currency is devaluated and consumer needs to pay high amount of money to buy the same goods before the devaluation of the currency. This leads to lower demand, hence lower production and output. The decline in output is even large for the low pass-through case. This is because although the increase in prices is smaller for the low pass-through case, the inertia is larger and longer time is needed for price adjustments. When the domestic currency devaluates, there is a tendency to hold more foreign asset. Net foreign asset increases.

On the other hand, depreciation in exchange rate means domestic goods is relatively cheaper compare to the foreign goods, the terms of trade increases, and the foreign demand for domestic produced goods increases. Hence, domestic output declines in the beginning followed by a small rise. However, the increment is very small. Domestic producer faces a small increase in real profit. For the low pass-through case, there is a higher increment in real profit followed by a decline before rising back to its steady state. This is because although exchange rate shock is smaller for the low pass-through case, it is more persistent. The higher increment is due to the lower increase in prices but equally size drop in demand in the other two cases and the decline followed is contributed by the higher persistency of exchange rate shock on prices and demand. The rise in inflation rate induces the authorities to tighten the policy.

4.5.4 CPI versus domestic inflation targeting

So far the simulations on the simple rules are based on the CPI or consumer inflation targeting. This section conducts simulations based on the domestic inflation targeting and compares the results of domestic inflation targeting with CPI inflation targeting.

According to Svensson (1998), CPI inflation is different from domestic inflation targeting as it offers a more prominent direct exchange rate channel compare to that of domestic inflation targeting. Some studies show that domestic inflation targeting is preferable over CPI inflation targeting. The reason is as explained in Parrado (2004), domestic inflation targeting allows exchange rate to react more to disturbances. Hence, it generates lower variability in inflation and output and with lower loss. Kirsanova, Leith and Wren-Lewis (2006) claim that the monetary authorities in the open economy should not target on CPI inflation as it induces instability. Flamini (2004) claims that when the pass-through is partial, it is more beneficial to target on domestic inflation. This is because incomplete pass-through tends to reduce volatility and trade-off of targeted variables in economy with domestic inflation targeting compare to that of CPI inflation targeting.

On the other hand, some studies show that CPI inflation targeting is favored over domestic inflation targeting. Svensson (1998) demonstrates that flexible CPI inflation targeting rules generate lower variability in variables and can be an attractive alternative rules for the context of open economy. Using the standard Taylor rule coefficients and optimized policy rule, Adolfson (2007) shows that monetary policy rule based on CPI inflation targeting yields lower welfare loss compare to that of domestic inflation targeting rule. As mentioned in Adolfson (2001), it is more preferable to target on CPI inflation. By targeting on CPI inflation, the policy maker indirectly influences the domestic inflation by reacting to exchange rate. The exchange rate volatility is smaller under CPI inflation targeting. This helps to stabilize the domestic inflation through lower variance trade-off between the domestic inflation and output.

Comparing various restricted optimized simple rules based on CPI inflation and domestic inflation targeting, the results of this chapter are consistent to the results in Adolfson (2007). Monetary policy rule based on CPI inflation targeting generates lower loss regardless the degree of exchange rate pass-through in compare to that of the domestic inflation targeting (see **Table B.4 (in Section 4.5.1)** and **Table B.7**). CPI inflation targeting also generates smaller variances, for example variances for output and inflation (domestic and CPI inflation) as shown in **Table B.4**.

Comparing the policy reaction coefficient of exchange rate for both targeting (**Table B.4 and Table B.7**), one may observe that the results from both tables are consistent to each other, i.e. the coefficient for exchange rate becomes larger the higher the pass-through is. This implies greater role of exchange rate in adjusting prices under higher pass-through case. In general, the coefficient for exchange rate is larger under domestic inflation targeting than under CPI inflation targeting¹⁶. This is because the direct effect of exchange rate on import price entered in CPI inflation targeting is removed under domestic inflation targeting. Hence, if exchange rate is welfare improving and it is included in the policy reaction function, the optimized weight on exchange rate under the domestic inflation targeting should be larger than that in the CPI inflation targeting rule (Adolfson (2001)).

¹⁶ With the exception of hybrid rule (TRHIE). The reason is the domestic and CPI inflation equations are in hybrid form. Targeting on domestic inflation may filter out the hybrid component from import inflation entered in CPI inflation. Therefore, the policy reaction under domestic inflation targeting may respond stronger to both forward- and backward-looking variables relative to exchange rate. The coefficient for exchange rate by targeting on domestic inflation is smaller than CPI inflation targeting.

Observing the relative loss from both tables, one can see that the augmented rules under the domestic inflation targeting generate larger welfare improvement compare to the case under the CPI inflation targeting as exchange rate plays a more prominent direct role under the domestic inflation targeting. The size of improvement is larger, the higher the degree of exchange rate pass-through is.

The results indicate that although CPI inflation targeting rules are preferable in term of lower variances and the policy maker can indirectly influence the domestic inflation, the augmented domestic inflation targeting rules induce higher improvement on its baseline rule compare to the one under the CPI inflation targeting.

Table B.7: Policy rules – domestic inflation targeting

Policy rules	Structure of rules	Absolute loss	Relative loss (1)	Relative loss (2)	V(y)	V(pi_c)	V(pi_d)
	<u>(I) Low Pass-through (LPT)</u>						
TR	$i_t = 3.7890\pi_t^d + 0.7474y_t$	9.7768	1.1735	1.0000	14.9843	1.9465	2.2847
TRE1	$i_t = 2.8449\pi_t^d + 0.6739y_t + 0.7445\Delta e_t$	9.4623	1.1358	0.9678	14.6829	1.7086	2.1208
TRE2	$i_t = 3.4107\pi_t^d + 0.6270y_t + 0.7734\Delta q_t$	9.4807	1.1380	0.9697	14.7226	1.7240	2.1194
TRS	$i_t = 0.3121(7.7678\pi_t^d + 1.7363y_t) + 0.68793i_{t-1}$	9.4298	1.1319	0.9645	14.6270	1.6769	2.1163
TRSE	$i_t = 0.2585(9.1380\pi_t^d + 2.0879y_t - 0.2657\Delta q_t) + 0.4740i_{t-1}$	9.4294	1.1318	0.9644	14.6255	1.6754	2.1166
TRH	$i_t = -0.0366\pi_t^d + 1.2112y_t + 4.4820\pi_{t-1}^d$	9.1809	1.1020	0.9390	13.7387	1.9895	2.3116
TRHE	$i_t = 0.1082\pi_t^d + 1.1846y_t + 4.2732\pi_{t-1}^d + 0.0631\Delta q_t$	9.1799	1.1019	0.9389	13.7293	1.9922	2.3152
TRF	$i_t = 7.8945\pi_t^d + 1.1604y_t - 4.1379E_t\pi_{t+1}^d$	9.6325	1.1562	0.9852	14.4937	2.1065	2.3857
TRFE	$i_t = 4.5654\pi_t^d + 0.7356y_t - 1.2674E_t\pi_{t+1}^d + 0.7238\Delta q_t$	9.4628	1.1358	0.9679	14.5108	1.8549	2.2074
TRHI	$i_t = -15.3659\pi_t^d + 1.6398y_t + 13.0527E_t\pi_{t+1}^d + 11.6325\pi_{t-1}^d$	8.9325	1.0722	0.9136	13.3532	1.8235	2.2559
TRHIE	$i_t = -16.1410\pi_t^d + 1.6821y_t + 13.2773E_t\pi_{t+1}^d + 12.2400\pi_{t-1}^d - 0.1683\Delta q_t$	8.9237	1.0711	0.9127	13.3195	1.8379	2.2639
SIT	$i_t = 2.8460\pi_t^d$	10.5433	1.2655	1.0784	18.0051	1.1676	1.5407
	The absolute loss for unrestricted optimal rule is 8.3312 (LPT)						

Policy rules	Structure of rules	Absolute loss	Relative loss (1)	Relative loss (2)	V(y)	V(pi_c)	V(pi_d)
	<u>(I) Medium Pass-through (MPT)</u>						
TR	$i_t = 3.9739\pi_t^d + 0.7121y_t$	10.1075	1.2955	1.0000	16.2137	1.9833	2.0007
TRE1	$i_t = 2.6175\pi_t^d + 0.5570y_t + 0.9294\Delta e_t$	9.4544	1.2118	0.9354	15.4701	1.3367	1.7194
TRE2	$i_t = 3.3544\pi_t^d + 0.5121y_t + 1.0343\Delta q_t$	9.4294	1.2086	0.9329	15.4071	1.3306	1.7259
TRS	$i_t = 0.2024(10.6156\pi_t^d + 2.0699y_t) + 0.7976i_{t-1}$	9.4512	1.2114	0.9307	15.4237	1.3485	1.7393
TRSE	$i_t = 0.7115(4.0401\pi_t^d + 0.6567y_t + 0.9436\Delta q_t) + 0.2885i_{t-1}$	9.4235	1.2079	0.9323	15.3854	1.3299	1.7309
TRH	$i_t = -1.3861\pi_t^d + 1.2025y_t + 5.9059\pi_{t-1}^d$	9.0840	1.1643	0.8987	14.1561	1.7592	2.0060
TRHE	$i_t = -0.3285\pi_t^d + 1.0361y_t + 4.4660\pi_{t-1}^d + 0.4659\Delta q_t$	9.0317	1.1576	0.8935	14.0639	1.6797	1.9998
TRF	$i_t = 15.7608\pi_t^d + 1.8693y_t - 11.3461E_t\pi_{t+1}^d$	9.5502	1.2241	0.9448	14.9478	1.9708	2.0764
TRFE	$i_t = 8.5183\pi_t^d + 1.0362y_t - 5.1357E_t\pi_{t+1}^d + 1.1329\Delta q_t$	9.2696	1.1881	0.9171	14.7210	1.5737	1.9091
TRHI	$i_t = -13.8483\pi_t^d + 0.6928y_t + 11.1690E_t\pi_{t+1}^d + 8.8818\pi_{t-1}^d$	8.8146	1.1298	0.8721	13.5601	1.6773	2.0345
TRHIE	$i_t = -14.3475\pi_t^d + 0.7039y_t + 11.5041E_t\pi_{t+1}^d + 9.1443\pi_{t-1}^d + 0.0463\Delta q_t$	8.8132	1.1296	0.8719	13.5532	1.6873	2.0366
SIT	$i_t = 2.9\pi_t^d$	10.7378	1.3763	1.0623	18.8493	1.2931	1.3132
	The absolute loss for unrestricted optimal rule is 7.8018 (MPT)						

Policy rules	Structure of rules	Absolute loss	Relative loss (1)	Relative loss (2)	V(y)	V(pi_c)	V(pi_d)
	<u>(III) High Pass-through (HPT)</u>						
TR	$i_t = 4.1001\pi_t^d + 0.7461y_t$	10.2006	1.3110	1.0000	16.4435	2.1371	1.9788
TRE1	$i_t = 2.6053\pi_t^d + 0.5415y_t + 0.9495\Delta e_t$	9.4577	1.2155	0.9272	15.5956	1.3258	1.6599
TRE2	$i_t = 3.3905\pi_t^d + 0.5026y_t + 1.0575\Delta q_t$	9.4273	1.2116	0.9242	15.5233	1.3176	1.6656
TRS	$i_t = 0.1878(11.3750\pi_t^d + 2.1643y_t) + 0.8122i_{t-1}$	9.4604	1.2159	0.9274	15.5545	1.3491	1.6832
TRSE	$i_t = 0.7922(3.8293\pi_t^d + 0.5921y_t + 1.0025\Delta q_t) + 0.2078i_{t-1}$	9.4246	1.2113	0.9239	15.5084	1.3196	1.6704
TRH	$i_t = -1.6157\pi_t^d + 1.1971y_t + 6.1651\pi_{t-1}^d$	9.0769	1.1666	0.8898	14.2798	1.7494	1.9371
TRHE	$i_t = -0.4666\pi_t^d + 1.0329y_t + 4.6449\pi_{t-1}^d + 0.5277\Delta q_t$	8.9998	1.1567	0.8823	14.1528	1.6137	1.9235
TRF	$i_t = 18.3160\pi_t^d + 2.0981y_t - 13.5779E_t\pi_{t+1}^d$	9.5234	1.2240	0.9336	15.0863	1.9541	1.9803
TRFE	$i_t = 9.7847\pi_t^d + 1.1466y_t - 16.2574E_t\pi_{t+1}^d + 1.2051\Delta q_t$	9.2391	1.1874	0.9057	14.8059	1.5217	1.8361
TRHI	$i_t = -14.7166\pi_t^d + 0.7109y_t - 11.7348E_t\pi_{t+1}^d + 9.3883\pi_{t-1}^d$	8.7900	1.1297	0.8617	13.6395	1.6944	1.9703
TRHIE	$i_t = -13.9284\pi_t^d + 0.6736y_t + 11.2549E_t\pi_{t+1}^d + 8.9198\pi_{t-1}^d + 0.0829\Delta q_t$	8.7838	1.1289	0.8611	13.6444	1.6628	1.9617
SIT	$i_t = 2.9029\pi_t^d$	10.8355	1.3926	1.0622	19.0415	1.4982	1.3147
	The absolute loss for unrestricted optimal rule is 7.7807 (HPT)						

Notes: Relative loss (1) refers to the ratio of absolute loss of each simply rule to the absolute loss of unrestricted optimized rule that reacts to output and inflation; relative loss (2) indicates the relative loss of each simple rule to the loss of restricted optimized rule that react to both output and inflation, i.e. rule TR. The absolute loss for unrestricted rule are 8.3312 (LPT), 7.8018 (MPT) and 7.7807 (HPT).

4.6 Robustness issue

One of the problems that the monetary authorities face when setting the monetary policy is the problem of uncertainty, for example uncertainties about the structure of economy and the types of shocks hitting the economy. According to Apel et al. (1999), the presence of uncertainty means the central bank has a limited knowledge of economic functions and it cannot formulate monetary policy in the optimal manner. One of the solutions to this problem is to search policy rules that are robust under all uncertainties and that are implementable, transparent and sufficiently sophisticated to include the factors that should be considered in the monetary policy decisions.

Previous studies on the robustness of policy rules show that simple rules are more robust to model uncertainty than the complicated one. Levin, Wieland & Williams (1998) find that Taylor type rules with high degree of interest rate smoothing term perform closely well as more complicated rules under four different models for the U.S. economy. More complicated rules are not very robust because they are fine-tuned for the specific dynamics of a given model. Focusing on the Canadian economy, Côté et al. (2002) demonstrate that simple policy rules are not robust to model uncertainty. In particular, interest rate smoothing rules perform poorly in most models especially in the backward-looking models.

Focusing on the exchange rate uncertainty, Wollmershäuser (2006) and Leitemo & Söderström (2005) seek to compare the performances of various simple rules. Their results are conflicting. While Leitemo & Söderström (2005) find that Taylor-type rules are sufficient to stabilize a small open economy under exchange rate uncertainty, Wollmershäuser (2006) finds open economy rules outperform the Taylor-type rules by increasing the degree of exchange rate uncertainty. This result implies that the degree of exchange rate uncertainty can change the ranking of policy rules for robustness. Apart from these results, previous studies show that the response of policy to uncertainty may depend on the type of parameters. Uncertainty about the effects of policy leads to the more aggressive policy behavior (Brainard (1967), Orphanides (1998), Apel et al. (1999) and Leitemo & Söderström (2004)). Others show that this result may not hold (Söderström (2000) and Leitemo & Söderström (2005)).

This section investigates the robustness of various restricted optimized simple rules from four main aspects namely the robustness under different parameterizations, uncertainty about persistency of shocks, robustness under different policy weightings and robustness under different targeting/ objectives. The investigations are conducted by focusing on CPI inflation targeting rules.

4.6.1 Robustness under alternative parameterization

Due to the lack of information and that not all parameters are observable; the parameterization assigned may not represent very well the economic condition for the East-Asian economies. Besides, the analysis does not focus on one individual country but it is based on a case of East-Asia as a whole. Each of the East-Asian countries may exhibit some country specific characters which differentiate one country to the other countries. Due to these reasons, it is necessary to consider alternative parameterizations in the analysis.

In checking the robustness results of analysis, several parameters are assumed to take different values. The risk premium parameter assumes to take a very small value that close to zero, i.e. 0.005. The elasticity of substitution between the domestic and import goods takes a lower value of 0.66 as Cook and Devereux (2006b) in the case of East-Asian countries. The mark-up for the domestic and import sectors also take a small value, i.e. 1.14 implying a value of 8 for both η_m and η_d . The parameterizations for the remaining parameters remain no change as stated in **Table B.3**. The results are summarized in **Table III-A(4), Appendix III-A**. The robustness test is based on the consumer/ CPI inflation targeting rules.

Using alternative parameterization in the simulation does not change the main findings. The more complicated rules such as the rule with history dependent term, augmented exchange rate rules and hybrid rules perform better than the baseline Taylor rule. The best rule is the hybrid rule with exchange rate term (rule TRHIE). The size of improvement is greater under the higher pass-through case. On the other hand, the strict inflation targeting rule induces higher loss in all cases. The results indicate that these more complicated rules are robust under different parameterizations.

4.6.2 Uncertainty about persistency of shocks

The nature and the inertia of shocks are crucial in affecting the monetary policy decision-making. This is because the emerging markets are very open in trade and vulnerable to the hits of external shocks. In the previous sections, all shocks are assumed to share the same persistency of 0.7 and standard error of 0.3. However in reality, different types of shocks may have different persistency and the persistency could be higher or lower than 0.7. Since the persistency of shocks may change over time and vary across countries, it is very difficult to know the persistency for different shocks. In order to investigate if the policy rules are robust under different persistency of shocks, robustness tests are conducted by adjusting different persistency for shocks. In the first case, all shocks share the same and higher inertia of 0.8 with the standard error of 0.4. In the second case, the domestic shocks are more persistent than the foreign shocks with the inertia of 0.7 versus 0.4 and standard error of 0.3 versus 0.2. The third case assumes that the foreign shocks are more persistent than the domestic shocks. The persistency for the foreign shocks (foreign policy shock, foreign demand and supply shocks) is 0.9 with the standard error of 0.4. The persistency for the domestic shocks (exchange rate shock, domestic demand and supply shocks) is 0.6 with the standard error of 0.3. The analysis is based on the CPI inflation targeting rules. The results are summarized in **Table III-A(5a-c), Appendix III-A**.

Table B.8a: Specifications for shocks (1)

Case I: Same persistency and variation of all shocks	Persistency: 0.8 Standard error: 0.4
Case II: Higher persistency and variation of domestic shocks	Persistency: 0.7 versus 0.4 Standard error: 0.3 versus 0.2
Case III: Higher persistency and variation of foreign shocks	Persistency: 0.9 versus 0.4 Standard error: 0.6 versus 0.3

The results indicate that the augmented more complicated Taylor rules are robust under uncertainty about persistency of shocks. The welfare loss is higher for higher pass-through case. Augmenting the baseline rule with exchange rate, history

dependent term and hybrid form are able to reduce the welfare loss of the baseline rule. These rules perform better under higher pass-through case. The hybrid rule with exchange rate term is superior to the other rules. The forecast based inflation targeting and strict inflation targeting rules perform badly. These results hold by changing the persistency of shocks. However, changing the persistency of shocks may change the ranking of these rules. The ranking for the hybrid rule with and without the exchange rate term does not change. This type of rule performs the best under different persistency of shocks.

4.6.3 Robustness under different policy weightings

How does the performance of a policy rule change by asserting different weightings on the targeted variables in the policy loss function? This section checks the robustness of policy rules by assuming different weightings on the policy loss function. In the previous section, the results are based on the simulations of policy loss function with the weightings of 1.0 and 0.5 for both inflation and output variables respectively. The results from the previous section are compared with the two different cases of weightings here. The first case assumes both the weightings on inflation and output variables are 1.0. The second case assumes the weightings on output is 0.1 compared to 1.0 on inflation variable. The analysis is focused on the CPI inflation targeting rules. The results are summarized in **Table III-A(6), Appendix III-A**.

The results show that it is more welfare beneficial to give higher weight to the inflation but a smaller weight to the output variable because giving higher weight to the output variable may generate higher welfare loss. This implies that stabilizing inflation is less costly compared to output as the public know and expect the future inflation will be lower. The conservative central banker tends to be more inflation averse by asserting higher weight on inflation. As in the case of different persistency of shocks, the more complicated rules perform better than the baseline rule under different weightings and exchange rate pass-through. However, changing the weightings in the loss function may change the ranking on the performances of these rules. On the other hand, the hybrid rule with and without the exchange rate term outperforms all the other rules irrespective the degree of exchange rate pass-through and weightings. The size of improvement for these rules becomes larger under higher degree of exchange rate pass-through with the exception of the case where the weight on output is 0.1. Under the very low weight on output variable case, the size of improvement for the high pass-through case is lower than the medium pass-through case. The reason is analog to the case of the very open economy. When the pass-through is very high, the effects of external shocks are very large but the distortion on domestic and consumer prices due to stickiness on import price is very low. Exchange rate plays a small role in adjusting prices. Hence, lower improvement induced by exchange rate under the very high pass-through case. Moreover, output is more volatile and needs larger adjustment under higher pass-through case. Stabilization is realized more through output adjustment. Assigning a very small weight on output stabilization (for instance 0.1) given that the pass-through is very high may affect the efficiency on the performances of the policy rules.

4.6.4 Robustness under different targeting policy

This section examines the robustness of the optimized simple rules under different policy objectives. So far, all the analyses are based on the assumption that the central bank's loss function responds to both inflation (domestic or consumer) and output variables. Using the short-term interest rate as its instrument, the central bank seeks to achieve its objectives/ targets by minimizing its intertemporal loss function.

$$V_1 = \min_{\{i_t\}_{t=0}^{\infty}} E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\gamma_{\pi} (\pi_t^{CB})^2 + \gamma_y y_t^2 \right) \right]$$

In order to examine the robustness aspect of various simple rules, simulations are repeated by assuming different targets/ objectives of central bank. Suppose now that besides aiming to stabilize both inflation and output as indicated by the loss function V_1 , the central bank also concerns about the interest rate movements.

$$V_2 = \min_{\{i_t\}_{t=0}^{\infty}} E_0 \left[\sum_{t=0}^{\infty} \beta^t \left(\gamma_{\pi} (\pi_t^{CB})^2 + \gamma_y y_t^2 + \gamma_i i_t^2 \right) \right]$$

where $\gamma_i > 0$ is the relative weight on interest rate smoothing. By targeting on interest rate, the central bank gradually adjusts the instrument to bring the inflation back to its targeted level after hitting by shocks. In other words, the interest rate term in the loss function plays a role to smooth out the economic fluctuations. Besides the smoothing role, the interest rate is targeted by the central bank to influence the public expectations about its future policies. Here, the interest rate is used as a way to bring the discretionary outcome closer to the outcome under commitment (Adolfson, 2001).

Assuming the central bank's loss function is V_2 , given that $\gamma_{\pi} = 1.0$, $\gamma_y = 0.5$ and $\gamma_i = 0.1$, the results of simulations are summarized in **Table III-A(7), Appendix III-A**. The analysis is based on the consumer inflation targeting rules. The results indicate that the restricted optimized simple rules with exchange rate terms perform well and outperform the baseline Taylor rule under three cases of exchange rate pass-through. The rules with history dependent term and hybrid rules also perform better than the baseline Taylor rule. The size of improvement is larger under higher pass-through case. The hybrid rule with exchange rate term (rule TRHIE) performs the best but the strict inflation targeting rule performs badly. Comparisons on the results obtained by assuming the loss function without and with interest rate target (loss function V_1 versus V_2) show that the augmented or more complicated rules are robust under different objectives/ targets irrespective the degree of exchange rate pass-through.

4.7 Evaluating the exchange rate regimes based on the nature of shocks

This section takes a different approach in evaluating the performances of policy rules by defining the policy rules to represent different exchange rate regimes (free floating, managed floating and fixed exchange rate regimes). Emphasizing on the effects of the nature of shocks and exchange rate pass-through, this chapter seeks to answer the following questions: (1) which monetary policy rule or regime works better for the emerging East-Asian economies before and after the financial crisis of 1997-98? (2) To what extent the performances of monetary policy rules

are affected by the nature and persistency of shocks, taking into account the economic conditions (trade openness and degree of exchange rate pass-through)? The analysis is focused on the CPI inflation targeting rules. For the purpose of evaluations, five simple rules are considered:

$$R1) i_t = \lambda_\pi \pi_t^c + \lambda_y y_t$$

$$R2) i_t = \lambda_\pi \pi_t^c + \lambda_y y_t + \lambda_{\Delta e} \Delta e_t$$

$$R3) i_t = \lambda_\pi \pi_t^c + \lambda_y y_t + \lambda_{\Delta q} \Delta q_t$$

$$R4) i_t = \lambda_\pi \pi_t^c + \lambda_y y_t + \lambda_q q_t$$

$$R5) i_t = \lambda_{\Delta e} \Delta e_t$$

where λ_π , λ_y and $\lambda_{\Delta e}$ are the weights on CPI inflation π_t^c , output y_t and exchange rate (the change in nominal exchange rate, the change in real exchange rate and the level of real exchange rate) respectively. In this study, the central bank's loss function shows higher preference on CPI inflation to output target i.e. 1.0 versus 0.5. Rule R1 is the standard Taylor rule. Rules R2 to R4 are the policy reaction functions with different exchange rate terms and rule R5 is the strict exchange rate targeting rule¹⁷. Following Parrado (2004), rule R1 can be interpreted as the free floating exchange rate regime/ flexible inflation targeting regime, rules R2 to R4 as the managed exchange rate regime and rule R5 as the fixed exchange rate regime.

There is no attempt to estimate the values of parameters for the East-Asian countries before and after the financial crisis of 1997-98. The analysis is focused on the effect of the source and persistency of shocks. The welfare loss of the simple rules is computed based on the single effect of each shock and also the simultaneously effects of all shocks. First, the welfare loss is computed based on the separately effect of each shock by allowing the effect of a single shock while the other shocks are restricted to have zero effect on the economy. In order to have a closer analysis on the effect of an individual shock, each shock is simulated separately from the other shocks. Each shock is assumed to have the same persistency and standard error of 0.8 and 0.4 respectively for the purpose of comparative analysis. The simulation is repeated by increasing the degree of trade openness for robustness checking.

Second, the welfare loss of various rules is computed as the simultaneously effect of all six shocks, i.e. the simulation is conducted by allowing the effects of six shocks at the same time. For better comparisons, shocks are categorized into nominal shocks (exchange rate shock, domestic and foreign inflation shocks, foreign monetary policy shocks); real shocks (domestic and foreign output shocks); domestic shocks (domestic inflation and output shocks and exchange rate shock) and foreign shocks (foreign inflation, output and monetary policy shocks). The specifications of shocks are summarized in **Table B.8b** below.

This study assumes that the parameterizations for the pre- and post-crisis periods hold the same. The only parameterizations that differentiate the two-period simulations are the degree of trade openness, the degree of exchange rate pass-through and the persistency and variation of shocks. These aspects are of country specific and may vary across countries. To undertake these country specific economics conditions and

¹⁷ Rule R1 is labeled as rule TR, while rule R2 and R3 are labeled as rule TRE1 and TRE2 respectively as mentioned and include in the analysis in section 4.3.2

the change in economic conditions in the pre- and post-crisis periods in East-Asia, this section conducts simulations covering three different degrees of exchange rate pass-through (as mentioned before in **Section 4.3.3**), four cases of different persistency and variation of shocks and two cases of trade openness. Comparisons on the results obtained under these different cases shed light on the robustness conditions of these rules. All simulations are based on the consumer inflation targeting rules.

Table B.8b: Specifications for shocks (2)

Case	Specifications
Case I(a): Same persistency and variation of all shocks	Persistency: 0.7 Standard error: 0.3
Case I(b): Same and higher persistency and variation of all shocks	Persistency: 0.8 Standard error: 0.4
Case II: Higher persistency and variation of foreign shocks	Persistency: 0.9 versus 0.4 Standard error: 0.6 versus 0.3
Case III: Higher persistency and variation of real shocks	Persistency: 0.8 versus 0.4 Standard error: 0.4 versus 0.3
Case IV: Higher persistency and variation of nominal shocks	Persistency: 0.8 versus 0.4 Standard error: 0.4 versus 0.3

4.7.1 Results

This section discusses the results of simulations based on the performances of several optimized simple policy rules. **Table B.9a** summarizes the results on the effect of individual shock. The results indicate that the domestic demand and supply shocks are the main source to the policy loss. This implies that the structure of this model exhibits the economic condition of East-Asia where the main shock to the economic fluctuations is domestic shock, in particular domestic demand and supply shocks. External shocks only explain a relatively small fraction of the business cycle fluctuations in East-Asia. The same results are reported by the empirical studies in East-Asian countries such as Sun and An (2008) and Hoffmaister and Roldós (1997).

Comparing the performance of various rules and policy regimes under separated shocks, it is observed that the source of shocks and the degree of exchange rate pass-through matter in determining the performance of policy rules/ regimes. In general, reacting to exchange rate or managed floating regime (rule R2, R3 and R4) induces greater improvement in term of lower welfare loss when the pass-through rate is higher. Besides, the size of improvement by reacting to exchange rate is larger when the economy is hitting by nominal shocks especially the domestic cost-push shock. Purely pegged regime is not favorable as it generates higher loss in most cases. This regime is favorable only under very prominent nominal shock (domestic cost-push shock). The results are robust or hold under higher trade openness case (as shown in **Table B.9b**). Together, the results imply favorable results to manage the exchange rate movements (managed floating and pegged regimes) when nominal shocks (monetary and inflationary shocks) are prominent and exchange rate pass-through is relatively high. These results are also hold in the case of simultaneously effects of all shocks¹⁸.

Table B.10a summarizes the results on the simultaneously effects of shocks under three different cases of exchange rate pass-through. There are six shocks faced by the

¹⁸ As shown in Section 4.5

domestic economy: domestic cost-push shock, domestic output shock, exchange rate shock, foreign policy shock, foreign cost-push shock and foreign output shock. **Table B.10a** summarizes the results of relative welfare loss for five optimized simple rules under different degrees of exchange rate pass-through and specifications of shocks.

Based on the results reported in **Table B.10a**, several main conclusions can be drawn. The main finding is the effectiveness of the policy rules that react to the exchange rate terms is impacted by the degree of exchange rate pass-through, the source and persistency of shocks. The size of improvements of the policy rules with exchange rate terms is higher when the degree of exchange rate pass-through is higher. This is because exchange rate plays a relatively more important role in predicting the variation in inflation given higher degree of exchange rate pass-through. The same results also find in previous studies (for example Adolfson (2007)).

The source of shocks together with the relative persistency and variation of shocks also affect the performances of the policy rules. Comparing the relative persistency and variation of domestic and foreign shocks (case I and case II), the results indicate that exchange rate plays an effective improving role in the performance of policy rules under all shocks (foreign and domestic shocks) when the pass-through rate is relatively high irrespective the relative persistency and variation of shocks. Moreover, the rule with real exchange rate term (rule R4) is more welfare enhancing under higher persistency and variation of foreign shocks (as shown in case II). This is because this rule is targeting at the deviation from PPP (the real exchange rate is defined as $q_t = -\tau_t^f - \omega_m \tau_t = e_t + p_t^f - p_t^c$ which is the deviation from PPP condition). PPP captures better the price distortions condition due to the price stickiness (Adolfson (2007)). Therefore, this rule performs better than the other rules under higher persistency and variation in foreign shocks. This rule shows insignificant improvement in term of welfare loss when the effect of foreign shocks is relatively smaller than the effect of domestic shocks.

Table B.9a: The effect of individual shock in the performance of policy rules (lower openness)

Rules	v^{π}		v^y		v^e		$u^{\pi f}$		u^{yf}		u^{if}	
	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss
<u>R1</u>												
LPT	15.8247	1.0000	16.5044	1.0000	0.07957	1.0000	0.03899	1.0000	0.01645	1.0000	0.0003121	1.0000
MPT	19.8094	1.0000	14.6365	1.0000	0.06685	1.0000	0.03276	1.0000	0.01504	1.0000	0.0003630	1.0000
HPT	19.8019	1.0000	16.5044	1.0000	0.06631	1.0000	0.03249	1.0000	0.01503	1.0000	0.0003702	1.0000
<u>R2</u>												
LPT	15.7923	0.9979	16.5028	0.9999	0.07900	0.9928	0.03883	0.9959	0.01629	0.9903	0.0003065	0.9820
MPT	16.1438	0.8149	14.1552	0.9671	0.06685	1.0000	0.03105	0.9478	0.01491	0.9913	0.0003282	0.9041
HPT	16.1704	0.8166	13.9241	0.9594	0.06628	0.9995	0.03101	0.9544	0.01475	0.9814	0.0003558	0.9611
<u>R3</u>												
LPT	15.7923	0.9979	16.5028	0.9999	0.07900	0.9928	0.03871	0.9928	0.01629	0.9903	0.0003065	0.9820
MPT	16.1438	0.8149	14.1552	0.9671	0.06685	1.0000	0.03276	1.0000	0.01491	0.9913	0.0003282	0.9041
HPT	16.1704	0.8166	13.9241	0.9594	0.06628	0.9995	0.03248	0.9997	0.01475	0.9814	0.0003558	0.9611
<u>R4</u>												
LPT	15.7955	0.9981	16.4854	0.9988	0.07860	0.9878	0.03851	0.9877	0.01622	0.9860	0.0003121	1.0000
MPT	18.8281	0.9504	14.4934	0.9902	0.06624	0.9908	0.03246	0.9908	0.01426	0.9481	0.0003102	0.8545
HPT	18.8919	0.9540	14.2338	0.9807	0.06289	0.9484	0.03081	0.9483	0.01425	0.9481	0.0003621	0.9781
<u>R5</u>												
LPT	17.9763	1.1359	29.3636	1.7791	0.1212	1.5232	0.5199	13.3342	0.01846	1.1256	0.001241	3.9763
MPT	17.9763	0.9074	29.3727	2.0068	0.1209	1.8085	0.3714	1.1392	0.01909	1.2693	0.001030	2.8374
HPT	17.9763	0.9078	29.8454	2.0563	0.1214	1.8308	0.3666	1.1283	0.01912	1.2721	0.001007	2.7201

Relative loss refers to the relative loss of each rule to the loss of baseline rule R1

Table B.9b: The effect of individual shock in the performance of policy rules (higher openness)

Rules	v^π		v^y		v^e		$u^{\pi,f}$		$u^{y,f}$		$u^{e,f}$	
	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss	Absolute loss	Relative loss
<u>R1</u>												
LPT	11.7991	1.0000	19.5067	1.0000	0.06020	1.0000	0.02950	1.0000	0.01274	1.0000	0.0002501	1.0000
MPT	14.8625	1.0000	19.0884	1.0000	0.05626	1.0000	0.02756	1.0000	0.01395	1.0000	0.0003679	1.0000
HPT	14.9448	1.0000	19.0375	1.0000	0.05614	1.0000	0.02751	1.0000	0.01435	1.0000	0.0004089	1.0000
<u>R2</u>												
LPT	11.7955	0.9997	19.4672	0.9979	0.05980	0.9933	0.02948	0.9993	0.01274	1.0000	0.0002458	0.9828
MPT	12.9384	0.8705	18.4922	0.9687	0.05626	1.0000	0.02634	0.9557	0.01373	0.9842	0.0003444	0.9361
HPT	12.9554	0.8669	18.1061	0.9511	0.05576	0.9932	0.02636	0.9582	0.01432	0.9979	0.0004050	0.9904
<u>R3</u>												
LPT	11.7955	0.9997	19.4672	0.9979	0.05980	0.9933	0.02944	0.9979	0.01274	1.0000	0.0002501	1.0000
MPT	12.9384	0.8705	18.4922	0.9687	0.05626	1.0000	0.02756	1.0000	0.01373	0.9842	0.0003444	0.9361
HPT	12.9554	0.8669	18.1061	0.9511	0.05576	0.9932	0.02732	0.9931	0.01382	0.9630	0.0004050	0.9904
<u>R4</u>												
LPT	11.7861	0.9989	19.4099	0.9950	0.05931	0.9852	0.02906	0.9851	0.01274	1.0000	0.0002501	1.0000
MPT	14.8625	1.0000	18.2469	0.9559	0.05363	0.9532	0.02628	0.9535	0.01327	0.9512	0.0003296	0.8959
HPT	14.9407	0.9997	18.1772	0.9548	0.05341	0.9514	0.02611	0.9491	0.01332	0.9282	0.0004031	0.9858
<u>R5</u>												
LPT	13.2784	1.1254	27.8862	1.4296	0.07406	1.2302	0.6375	21.6101	0.01599	1.2552	0.0006971	2.7873
MPT	13.2784	0.8934	27.4000	1.4354	0.07350	1.3064	0.3932	14.2670	0.01606	1.1512	0.0005519	1.5001
HPT	13.2784	0.8885	27.3892	1.4387	0.07366	1.3121	0.3841	13.9622	0.01606	1.1191	0.0005442	1.3309

Relative loss refers to the relative loss of each rule to the loss of baseline rule R1

Table B.10a: Simultaneously effect of shocks on the performance of policy rules (lower trade openness)

Case	Rules	Relative loss		
		LPT	MPT	HPT
Case I(a) Same persistency and variation for all shocks	R1	9.0475	9.4600	9.6447
	R2	0.9819	0.9520	0.9391
	R3	0.9805	0.9491	0.9360
	R4	0.9989	1.0000	0.9929
	R5	1.3729	1.3114	1.2859
Case I(b) Same and higher persistency and variation for all shocks	R1	35.5258	34.8595	35.2320
	R2	0.9858	0.9813	0.9748
	R3	0.9851	0.9800	0.9732
	R4	0.9973	0.9993	0.9999
	R5	1.3717	1.3886	1.3735
Case II Higher persistency and variation for foreign shocks	R1	2.6273	2.7678	2.8178
	R2	1.0000	0.9669	0.9542
	R3	0.9831	0.9304	0.9173
	R4	0.9612	0.9518	0.9497
	R5	1.8545	1.7434	1.7095
Case III Higher persistency and variation for real shocks	R1	17.6703	16.5574	16.5248
	R2	0.9978	0.9876	0.9885
	R3	0.9978	0.9877	0.9886
	R4	0.9974	0.9993	0.9992
	R5	1.7732	1.8861	1.8891
Case IV Higher persistency and variation for nominal shocks	R1	18.3699	20.2660	20.2863
	R2	0.9457	0.8523	0.8512
	R3	0.9332	0.8434	0.8430
	R4	0.9985	0.9804	0.9826
	R5	1.0610	0.9604	0.9592

Notes:

All rules are given in the values of relative loss (i.e. the policy loss relative to that of rule R1) except rule R1 is given in absolute loss.

Comparing the outcomes for different persistency and variation of real and nominal shocks (case III and IV), it is observed that exchange rate does not play a significant improving role in the performances of policy rules when real shocks are more persistent and volatile relative to that of nominal shocks (case III). Conversely, the rules that react to the exchange rate terms perform relatively well when nominal shocks are more persistent and volatile than the real shocks (case IV). Apart from these results, the strict exchange rate rule (pegged regime) performs badly in all cases except in the case where nominal shocks are more prevail. The results of this model are able to replicate the results of Mundell-Fleming model that favors floating regime if real shocks are more prevail but it prefers the pegged regime if nominal shocks are larger. The size of improvement is smaller, implying lower efficiency of exchange rate in adjusting shocks under more prominent of foreign shocks (case II). These results are consistent with the results found in Parrado (2004) that favor the floating regimes in the presence of foreign and real shocks.

For the purpose of robustness checking, simulations are repeated by increasing the degree of trade openness. The results are summarized in **Table B.10b**. In general, the results in **Table B.10b** (with higher trade openness specifications) are consistent to the results in **Table B.10a** (with lower trade openness specifications). The effectiveness of the monetary policy rules (especially the rules with exchange rate terms) is impacted by the degree of exchange rate pass-through, the source of shocks and the relative persistency and variation of shocks. The rules that react to the exchange rate work well for all shocks (domestic and foreign shocks). However, the

results favor the rule without exchange rate term (floating regime) if domestic economy faces greater real shocks but the results prefer the rules that react to the exchange rate (pegged or managed floating regime) in case of greater nominal shocks.

Table B.10b: Simultaneously effect of shocks on the performance of policy rules (higher trade openness)

Case	Rules	Relative loss		
		LPT	MPT	HPT
Case I(a) Same persistency and variation for all shocks	R1	8.2443	8.6983	8.8591
	R2	0.9963	0.9797	0.9696
	R3	0.9955	0.9758	0.9650
	R4	0.9999	0.9995	0.9982
	R5	1.2526	1.1847	1.1626
Case I(b) Same and higher persistency and variation for all shocks	R1	33.1175	34.4478	34.8214
	R2	0.9952	0.9951	0.9904
	R3	0.9949	0.9940	0.9888
	R4	0.9888	0.9998	0.9994
	R5	1.2669	1.2068	1.1933
Case II Higher persistency and variation for foreign shocks	R1	2.1219	2.2758	2.3238
	R2	0.9999	0.9919	0.9868
	R3	0.9926	0.9610	0.9487
	R4	0.9696	0.9792	0.9805
	R5	2.0235	1.8408	1.7941
Case III Higher persistency and variation for real shocks	R1	21.0928	20.6005	20.6450
	R2	0.9992	0.9844	0.9842
	R3	0.9992	0.9847	0.9845
	R4	0.9967	0.9901	0.9879
	R5	1.3722	1.3990	1.3952
Case IV Higher persistency and variation for nominal shocks	R1	14.3838	15.4397	15.5532
	R2	0.9698	0.9040	0.8980
	R3	0.9544	0.8934	0.8880
	R4	0.9959	0.9992	0.9985
	R5	1.0205	0.9478	0.9403

Notes:

All rules are given in the values of relative loss (i.e. the policy loss relative to that of rule R1) except rule R1 is given in absolute loss.

4.8 Conclusions

The role of exchange rate in the formation of monetary policy for the small open economy is always a topic of interest among economists and researchers. Previous studies have proposed various modifications on the Taylor rule to be implemented in the open economy context. However, as these studies report controversial results, it is not clear if the augmented more complicated rules perform better than the closed economy rule.

This chapter seeks to investigate this issue in the context of small open economy of East-Asia, focusing on the impacts of exchange rate pass-through, trade openness, policy target, the source and persistency of shocks. This chapter can be divided into two main parts. In the first part of analysis, simulations are carried out to compare various simple rules in term of welfare loss and variability. The results suggest the inclusion of exchange rate term in the policy reaction function as this type of rule generates lower loss. Adding the history dependent term in the baseline policy rule also helps to reduce the welfare loss. The hybrid rule with exchange rate term is superior to the other rules. These more complicated rules work more efficient under

high degree of pass-through as the size of improvement is higher under higher pass-through case. Besides determined by the degree of exchange rate pass-through, the performances of policy rules also depend on the trade openness, weighting of policy reaction function and persistency of shocks. These factors can influence the size of improvement and the ranking on the performances of policy rules. However, these more complicated rules are robust in the sense that they always show improvements irrespective these factors. The strict inflation targeting rule performs badly in all cases. CPI inflation targeting rules are preferable over the domestic inflation targeting rules. Targeting on CPI inflation generates lower welfare loss and variability compare to target on domestic inflation. Moreover, the policy maker can influence the domestic inflation indirectly by reacting to the exchange rate movements. On the other hand, exchange rate plays a more prominent role in price adjustments under domestic inflation targeting. Including the exchange rate term in the domestic inflation targeting rule induces larger improvement compare to that of CPI inflation targeting rules.

In the second part, this chapter uses different approach to evaluate the exchange rate regimes. Several simple rules are considered to represent different exchange rate regimes. Evaluations are based on the source, persistency and variation of shocks by considering different cases of exchange rate pass-through. The results show that the effectiveness of the monetary policy regimes depends crucially on the nature and variation of shocks. The results suggest for the opt of floating regime under greater real shocks but in favor of exchange rate pegged or managed floating regime when nominal shocks are more prevail. Depending on the country specific factors, different countries may experience different economic conditions and the effectiveness of policy rules to react to the exchange rate terms can be different across countries and changes over time. However, exchange rate targeting rules work well under very high degree of exchange rate pass-through and they deal effectively with domestic and nominal shocks.

To summarize the total results, including the exchange rate term in the monetary policy could be welfare enhancing. However, the effectiveness role of exchange rate depends crucially on the economic structures and features such as the degree of exchange rate pass-through, the source of shocks and trade openness which are of country specific. These factors should be highlighted in the formation of monetary policy rules and decisions.

When it comes to the choice of the best policy regime, there is no single best regime fits for all countries and forever. Rather, it is conditional on the economic circumstances and policy preferences which differ across countries and change over time. Perhaps, the choice of appropriate monetary policy/ regime should allow flexibility and stability elements (for example implementing a flexible inflation targeting or giving a weight to exchange rate in the policy rule) rather than defend on a particular rate as mentioned in Cavoli & Rajan (2003). The flexibility strategies allow the authority to react to various shocks in order to meet other goals when the inflation target is consistent with the target and relinquish other goals to meet the inflation target when the inflation level is far from the target.

References

- Adolfson,M., Laseen,S, Lindé,J. & Villani,M. 2005. Bayesian estimation of an open economy DSGE model with incomplete pass-through. Sveriges riksbank working paper series no. 179.
- Adolfson,M., Lindé,J. & Villani,M. 2006. Forecasting performance of an open economy dynamic stochastic general equilibrium model. Working paper. Sveriges Riksbank.
- Adolfson,M. 2001. Monetary policy and exchange rates-breakthrough of pass-through. The Economic Research Institute, University of Stockholm.
- Adolfson,M. 2007. Incomplete exchange rate pass-through and simple monetary policy rules. *Journal of International Money and Finance* 26: 468-494.
- Alfaro,L. 2002. Inflation, openness and exchange rate regimes. The quest for short-term commitment. Harvard Business school.
- Altig,D. et al. 2002. Technology shocks and aggregate fluctuations. Manuscript, Sveriges Riksbank.
- An,S. & Schorfheide,F. 2006. Bayesian analysis of DSGE models. Singapore Management University & University of Pennsylvania. CEPR & NBER.
- Apel,M., Nessen,M., Soderstrom,U. & Vredin,A. 1999. Different ways of conducting inflation targeting – theory and practice. *Quarterly review* 4/1999.
- Artis,M. & Ehrmann,M. 2006. The exchange rate – a shock absorber or source of shocks? A study of four open economies. *Journal of International Money and Finance* 25: 874-893.
- Ball,L. 1998. Policy rules for open economies. NBER working paper series 6760.
- Ball,L. 1999. Policy rules for open economies. In: Taylor,J.B (Ed.). *Monetary policy rules*. The University of Chicago Press: 127-156.
- Ball,L. 2000. Policy rules and external shocks. NBER working paper series 7910.
- Barsky,R.F., Thomas,J., Miles,S. K. & Matthew,D. S.1987. Preference Parameters and Behavioral Heterogeneity: An Experimental approach in the Health and Retirement Study,” *Quarterly Journal of Economics*,112, 537-579.
- Batini,N. & Haldane,A. 1998. Forward-looking rules for monetary policy. Bank of England.
- Batini,N., Harrison,R. & Millard,S.P. 2001. Monetary policy rules for an open economy. Bank of England.
- Benigno,P. 2001. Price stability with imperfect financial integration. New York University and CEPR.

-
- Brainard, W. 1967. Uncertainty and the effectiveness of policy. *American Economic Review*, 57(2): 411-425.
- Brischetto, A. & Voss, G. 1999. A structural vector auto regression model of monetary policy in Australia. Bank of Australia Research Discussion paper 1999-11.
- Bussière, M & Peltonen, T. 2008. Exchange rate pass-through in the global economy: the role of emerging market economies. ECB working paper no. 951/October 2008.
- Calvo, G.A. & Mishkin, F.S. 2003. The mirage of exchange rate regimes for emerging market countries. NBER working paper 9808.
- Campa, J.M., Golberg, L.S. & González-Mínguez, J.M. 2005. Exchange rate pass-through to import prices in the Euro area. NBER working paper.
- Campa, J.M. & Goldberg, L.S. 2002a. Exchange rate pass-through into import prices. NBER working paper.
- Campa, J.M. & Goldberg, L.S. 2002b. Exchange rate pass-through into import prices: a macro or micro phenomenon? NBER working paper.
- Campa, J.M. & González-Mínguez, J.M. 2002. Differences in exchange rate pass-through in Euro area. Universidad de Navarra.
- Cavoli, T. and Rajan, R. 2003. Designing appropriate exchange rate regimes for East Asia: inflation targeting and monetary policy rules. University of Adelaide. Discussion paper no. 0309.
- Choudhri, E.U. 2005. Monetary policy in a small emerging economy: exploring desirable interest rate rules. Carleton University.
- Choudhri, E.U. & Hakura, D.S. 2006. Exchange rate pass-through to domestic prices: Does the inflationary environment matter? *Journal of International Money and Finance* 25: 614-639.
- Chow, H.K. & Kim Y. 2003. A common currency peg in East Asia? Perspectives from Western Europe. *Journal of Macroeconomics* 25: 331-350.
- Christiano, L.J., Eichenbaum, M. & Evans, C.L. 1998. Monetary policy shocks: what have we learned and to what end? NBER working paper 6400.
- Christiano, L.J., Eichenbaum, M. & Evans, C.L. 2001. Nominal rigidities and the dynamics effects of a shock to monetary policy. Federal Reserve Bank of Cleveland. Working paper 01-07.
- Clarida, R.H., Gali, J. & Gertler, M. 2001. Optimal monetary policy in closed versus open economies: An integrated approach. NBER no 8604.

-
- Cook,D. & Devereux,M.B. 2006a. Accounting for the East Asian crisis: a quantitative model of capital outflows in small open economies. *Journal of Money, Credit and Banking*. Vol. 38 (3): 721-749.
- Cook,D. & Deveruex,M.B. 2006b. External currency pricing and the East Asian crisis. *Journal of International Economics* 69: 37-63.
- Corsetti,G. 2005. Openness and the case for flexible exchange rates. European University Institute. Working papers no. 2005/21.
- Côté,D. & Lam, J. 2001. Simple rules in the M1-VECM. Bank of Canada.
- Côté,D et. al. 2002. The performance and robustness of simple monetary policy rules in models of the Canadian economy. Manuscript, Bank of Canada.
- Côté,D, Kuszczak,J, Lam,J.P, Liu,Y & St-Amant,P. 2002. The performance and robustness simple monetary policy rules in models of the Canadian economy. Bank of Canada. Technical report no. 92.
- De Fiore,F. & Liu,Z. 2002. Openness and equilibrium determinacy under interest rate rules. European Central Bank. Working paper no. 173.
- DeJong,D.N., Ingram,B.F. & Whiteman,C.H. 1997. A Bayesian approach to dynamic macroeconomics. Then University of Pittsburgh & The University of Iowa.
- Dennis,R. 2000. Optimal simple targeting rules for small open economies. Federal Reserve Bank of San Francisco.
- Dennis,R. 2001. Solving for optimal simple rules in rational expectations models. Federal Reserve Bank of San Francisco.
- Dennis,R. 2003. New Keynesian optimal-policy models: an empirical assessment. Federal Reserve Bank of San Francisco.
- Desroches,B. 2004. The transmission of world shocks to emerging market countries: an empirical analysis. Bank of Canada working paper 2004-44.
- Devereux, M.B., Lane,P.R. & Xu,J. 2005. Exchange rate and monetary policy in emerging market economies. The Institute for International Integration Studies Discussion paper series.
- Devereux,M.B. & Lane,P.R. 2003. Understanding bilateral exchange rate volatility. *Journal of International Economics* 60: 109-132.
- Devereux,M.B. & Poon,D. 2004. A simple model of optimal monetary policy with financial constraints. The University of British Columbia.
- Devereux,M.B., Lane, P.R. & Xu,J. 2006. Exchange rate and monetary policy in emerging market economies. *The Economic Journal* 116: 478-506.

-
- Devereux M.B. & Yetman,J. 2009.Price adjustment and exchange rate pass-through. *Journal of International Money and Finance* xxx: 1-20.
- Dobrynskaya,U. 2008. The monetary and exchange rate policy of the Central Bank of Russia under asymmetrical price rigidity. *Journal of Innovations Economics*. 1(1): 29-62.
- Edwards,S. 2006. The relationship between exchange rates and inflation targeting revisited. NBER working paper series no. 12163.
- Eichenbaum,M,S., Hansen,L.P. & Singleton,K.J. 1988. A Time series analysis of representative agent models of consumption and leisure choice under uncertainty. *Quarterly Journal of Economics*, 103, 51-78.
- Elekdag,S., Justiniano,A. & Tchakarov,I. 2005. An estimated small open economy model of the financial accelerator. IMF working paper Wp/05/44.
- Flamini,A. 2005. Inflation targeting and exchange rate pass-through. Graduate Institute of International Studies. Working paper no. 04/2004.
- Fraga,A. et al. 2003. Inflation targeting in emerging market economies. In: Getler, Mark & Keneth Rogoff, orgs. NBER Macroeconomics Annual 18. MIT Press: 365-400.
- Frankel,J.A. & Rose,A.K. 1998. The endogeneity of the optimum currency area criteria. *The Economic Journal* 108: 1009-1025.
- Fuhrer, J.C. 2000b. Habit Formation in consumption and its implications for monetary policy models. *American Economic Review*, 90, No. 3 :367–90.
- Fuhrer,J.C. 1998. An optimizing model for monetary policy analysis: can habit formation help? Federal Reserve Bank of Boston.
- Fuhrer,J.C. 2000a. Optimal monetary policy in a model with habit formation. Federal Reserve Bank of Boston.
- Gagnon,J.E. & Ihrig,J. 2004. Monetary policy and exchange rate pass-through. Board of Governors of Federal Reserve System.
- Gali,J. & Gertler,M. 1999. Inflation dynamics: a structural econometric analysis. *Journal of Monetary Economics*. 44: 195-222.
- Gali,J. & Monacelli,T. 2005. Monetary policy and exchange rate volatility in a small open economy. *The Review of Economic Studies*: 72(3).
- Garretsen,H., Moons.G. & Aarle,B. 2005. Monetary policy in the Euro area: an analysis using a stylized New Keynesian model. Utrecht University, University of Antwerp & University of Maastricht.
- Gerlach,S. & Smets,F. 2000. MCIs and monetary policy. *European Economic Review* 44: 1677-1700.

-
- Giannoni, M.P. & Woodford, M. 2003. Notes on model for 'optimal inflation targeting rules'. Columbia University and Princeton University.
- Giovanni, J. & Levchenko, A.A. 2008. Trade openness and volatility. IMF working paper WP/08/146.
- Giuliodori, M. 2004. Nominal shocks and the current account: a structural VAR analysis of 14 OECD countries. *Review of World Economics* vol. 140(4): 569-592.
- Goodhart, C. & Hofmann, B. 2005. The Phillips curve, the IS curve and monetary transmission: evidence for the US and the Euro area. *CESifo Economic Studies*, vol. 51: 757-775.
- Hall, R.E. 1988. Intertemporal substitution in consumption. *The Journal of Political Economy*. Vol. 96(2): 339-357.
- Hausmann, R., Panizza, U. & Stein, E. 1999. Why do countries float the way they float? *Journal of Development Economics* 66: 387-414.
- Ho, C. & McCauley, R.N. 2003. Living with flexible exchange rates: issues and recent experience in inflation targeting emerging market economies. BIS working papers no. 130.
- Hoffmaister, A.W. & Roldós, J.E. 1997. Are business cycles different in Asia and Latin America? IMF working paper WP/97/9.
- Hoffmann, M. 2005. Fixed versus flexible exchange rate: evidence from developing countries. University of Cologne.
- Ito, T., Sasaki, Y.N. & Sato, K. 2005. Pass-through of exchange rate changes and macroeconomic shocks to domestic inflation in East Asian countries. RIETI discussion paper series 05-E-020.
- Jeanfils, P. 2001. A guided tour of the world of rational expectations models and optimal policies. National Bank of Belgium.
- Juillard, M. et al. 2005. Welfare-based monetary rules in an estimated DSGE model of the US economy. GEPREMAP.
- Juillard, M. et al. 2006. Welfare-based monetary rules in an estimated DSGE model of the US economy. ECB working paper no. 613.
- Justiniano, A. & Preston, B. 2004. Small open economy DSGE models: specification, estimation and model fit. IMF and Columbia University.
- Kimura, T. & Kurozumi, T. 2002. Effectiveness of history-dependent monetary policy. Bank of Japan.
- Kirsanova, T., Leith, C. & Wren-Lewis, S. 2006. Should central banks target consumer prices or the exchange rate? *The Economic Journal*, 116:F208-F231.

-
- Kollman,R. 2004. Welfare effects of a Monetary Union: the role of trade openness. *Journal of the European Economic Association*. 2(2-3): 289-301.
- Leitemo,K. & Soderstrom,U. 2004. Robust monetary policy in the New Keynesian framework. Discussion paper no. 4805. Centre for Economic Policy Research.
- Leitemo,K. & Söderström,U. 2005. Simple monetary policy rules and exchange rate uncertainty. *Journal of International Money and Finance* 24: 481-507.
- Levin,A., Wieland,V. & Williams,J.1998. Robustness of simple monetary policy rules under model uncertainty. National Bureau of Economic Research. Working paper 6570.
- Lindé,J, Nessén,M. & Söderström,U. 2004. Monetary policy in an estimated open economy model with imperfect pass-through. Sveriges Riksbank. Working paper no. 167.
- Lubik,T. & Schorfheide,F. 2005. A Bayesian look at New Open Economy Macroeconomics. Johns Hopkins University & University of Pennsylvania.
- Maih,J. 2005. A symmetric trade and nominal rigidities in a DSGE perspective: implications for the transmission of shocks and real exchange rate dynamics. Dissertation for the PhD degree. University of Oslo.
- Mayer,E. 2003. The mechanics of a reasonably fitted quarterly New Keynesian macro model. Universität Würzburg Economic papers. No.41.
- Mayer,E. 2004. The mechanics of a reasonably fitted quarterly New Keynesian macro model. University of Würzburg.
- Merola,R. 2006. A small open economy model with financial accelerator. Université Catholique de Louvain la neuve.
- Minella,A. et. al. 2003. Inflation targeting in Brazil. Constructing credibility under exchange rate volatility. *Journal of International Money and Finance*. 22: 1015-1040.
- Ministry of Economy, Trade and Industry. Trade structure underlying East Asian growth – advancement of triangular trade in: White paper on International Economy and trade 2005. METI.
- Mishkin,F. S. 2000. Inflation targeting in emerging market countries. NBER working paper series no. 7618.
- Moessner,R. 2005. Optimal discretionary policy and uncertainty about inflation persistence. European Central Bank. Working paper no. 540.
- Mohamed,D. 2006. Hybrid inflation and price level targeting in small open economy. MRPA.

-
- Mohanty,M.S. & Klau,M. 2004. Monetary policy rules in emerging market economies: issues and evidence. BIS working papers no. 149.
- Mohanty,M.S. & Klau,M. 2005. Monetary policy rules in emerging market economies: Issues and evidence in: Monetary policy and macroeconomic stabilization in Latin America, eds. Rolf J. Langhammer and Lucio Vinhas de Souza. The Kiel Institute.
- Monacelli,T. 2003. Monetary policy in a low pass-through environment. ECB working paper no. 227.
- Nogueira Junior,R.P. 2007. Inflation targeting and the role of exchange rate pass-through. University of Kent.
- Orphanides,A. 1998. Monetary policy evaluation with noisy information. Finance and Economics Discussion paper no 1998-50. Board of Governors of the Federal Reserve System.
- Osawa,N. 2006. Monetary policy responses to the exchange rate: empirical evidence from three East Asian inflation-targeting countries. Bank of Japan working paper series no. 06-E-14.
- Parrado,E. 2004. Inflation targeting and exchange rate rules in an open economy. IMF working paper WP/04/21.
- Pytlarczyk,E. 2005. An estimated DSGE model for the German economy within the Euro area. Universität Hamburg.
- Ratto,M., Röger,W., Veld,J. & Girardi,R. 2005. An estimated new Keynesian dynamic stochastic general equilibrium model of the Euro area. European Economy. Economic paper no. 220. European Commission.
- Rudebusch,G.D. & Svensson,L.E.O. 1998. Policy rules for inflation targeting, in Taylor,J (ed.), Monetary policy rules. University of Chicago Press. 203-253.
- Ruge-Murcia,F.J. 2003. Methods to estimate dynamic stochastic general equilibrium models. Universite de Montreal.
- Sack,B. & Wieland,V. 1999. Interest rate smoothing and optimal monetary policy: a review of recent empirical evidence. Board of Governors of the Federal Reserve System.
- Schmidt-Hebbel,K. & Werner,A. 2002. Inflation targeting in Brazil, Chile and Mexico: performance, credibility and the exchange rate. *Economia*. 2(2): 31-89.
- Senay,O. 2001. The role of the exchange rate in monetary policy rules. Middle East Technical University and University of York.
- Smets,F. & Wouters,R. 2002a. Openness, imperfect exchange rate pass-through and monetary policy. NBB working paper no. 19.

-
- Smets,F. & Wouters,R. 2002b. An estimated dynamic stochastic general equilibrium model of the Euro area. National Bank of Belgium working papers-research series.
- Smets,F. & Wouters,R. 2004. Forecasting with a Bayesian DSGE model: an applications to the Euro area. National Bank of Belgium working papers-research series no. 60.
- Söderlind,P. 1999. Solution and estimation of RE macromodel with optimal policy. *European Economic Review* 43: 813-823.
- Söderlind,P. 2003. Lecture notes for monetary policy (PhD course at UNISG). University of St. Gallen and CEPR.
- Söderström,U. 2000. Monetary policy with uncertain parameters. European Central Bank. Working paper no. 13.
- Sun,W. & An,L. 2008. Asymmetric shocks and exchange rate regimes in East Asia. *International Research Journal of Finance and Economics* 22: 38-48.
- Sutthasri,P. 2007. Parameter calibration for the Bank of Thailand DSGE model (in Thai). In: Tanboon,S. 2008. The Bank of Thailand structural model for policy analysis. Bank of Thailand.
- Svensson,L.E.O & Woodford,M. 2000. Indicator variables for optimal policy. NBER working paper No. 7953.
- Svensson,L.E.O. 1997. Inflation targeting: some extensions. NBER working paper No. 5962.
- Svensson,L.E.O. 1998. Inflation targeting as a monetary policy rule. CEPR and NBER.
- Svensson,L.E.O & Woodford,M. 2003. Implementing optimal policy through inflation forecast targeting. Princeton University.
- Svensson,L.E.O. 2003. What is wrong with Taylor rules? Using judgment in monetary policy through targeting rules. *Journal of Economic Literature* 41: 426-477.
- Svensson,L.E.O. 2007. Optimization under commitment and discretion, the recursive saddle point method, and targeting rules and instrument rules: Lecture notes. Princeton University.
- Tanboon,S. 2007. Stylized facts of the Thai economy. In: Tanboon,S. 2008. The Bank of Thailand structural model for policy analysis. Bank of Thailand.
- Tanboon,S. 2008. The Bank of Thailand structural model for policy analysis. Bank of Thailand.

-
- Taylor,J.B. 1999. The robustness and efficiency of monetary policy rules as guidelines for interest rate setting by the European Central Bank. *Journal of Monetary Economics* 43: 655-679.
- Taylor,J.B. 2001. The role of the exchange rate in monetary policy rules. *American Economic Review* 91(2): 263-267.
- Taylor,J.B. 2000. Low inflation, pass-through, and the pricing power of firms. *European Economic Review*. 44(7): 1389-1408.
- Villani,M. & Warne,A. 2003. Monetary policy analysis in a small open economy using Bayesian cointegrated structural VARs. Sveriges Riksbank working paper series no. 156.
- Wang,L. 2005. Degree of openness and the choice of exchange rate regimes – a re-evaluation with value-added based openness measures. Dissertation. Universität Hohenheim.
- Welz,P. 2005. Quantitative New Keynesian macroeconomics and monetary policy. Uppsala Universitet.
- Welz,P. 2006. Assessing predetermined expectations in the standard sticky-price model: a Bayesian approach. ECB working paper series no. 621.
- Wohltmann,H-W. & Winkler,R. 2008. Anticipated and unanticipated oil price shocks and optimal monetary policy. Christian-Albrechts-Universität Kiel. Economic working paper no. 2008-05.
- Wollmershäuser,T. 2006. Should central banks react to exchange rate movements? An analysis of the robustness of simple rules under exchange rate uncertainty. *Journal of Macroeconomics* 28: 493-519.
- Woodford,M. 2001. The Taylor rule and optimal monetary policy. Princeton University.
- Woodford,M. 2002. Optimal interest rate smoothing. Princeton University.

APPENDIX III-A

Table III-A(1): Share of exports in domestic production (ω_x)

Countries	1980-96	1999-2006
Indonesia	24.05	31.48
Korea	28.46	33.16
Malaysia	60.82	99.43
Philippines	18.19	45.78
Singapore	138.33	164.42
Thailand	24.64	56.93
Average1	49.08	71.87
Average2	23.84	41.84

Source: the original series for annually export and GDP are obtained from IMF.

ω_x is calculated as total export over GDP (in percent).

Average1 is the average values of all countries

Average2 is the average values of all countries but exclude Malaysia and Singapore

Table III-A(2a): Components of imported goods

Countries	Year	Components of imported goods (%)					
		Raw material	Parts	Capital	Manufacturing/material	Consumption ω_m	Intermediate κ
Indonesia	1980	23.7	8.5	17.9	42.4	7.4	74.6
	1990	12.2	28.4	28.4	37.2	7.1	77.8
	2003	20.3	13.5	13.5	46.1	7.6	79.9
Korea	1980	48.0	8.5	14.3	26.6	2.6	83.1
	1990	19.6	16.6	25.4	32.5	5.9	68.7
	2003	19.5	23.0	15.3	33.0	9.2	75.5
Malaysia	1980	15.1	18.0	15.6	34.8	16.4	67.9
	1990	4.7	26.0	27.5	30.4	11.4	61.1
	2003	5.2	47.9	15.0	23.9	7.9	77.0
Philippines	1980	34.6	10.5	15.4	34.5	5.1	79.6
	1990	20.7	15.6	14.4	38.7	10.6	75.0
	2003	9.9	48.8	7.9	25.8	7.7	84.5
Thailand	1980	30.5	11.8	9.7	40.1	8.0	82.4
	1990	10.1	21.6	21.7	37.1	9.5	68.8
	2003	14.5	26.0	18.1	33.1	8.3	73.6

Source: Research Institute of Economy, Trade and Industry, RIETI-TID (2005)

Intermediate goods = total % of the raw, parts and manufacturing/ material.

Table III-A(2b): Intermediate goods and consumption goods

Countries	Average % consumption goods on total imports		Average % intermediate goods on total imports	
	1980-1996	1999-2005	1980-1996	1999-2005
	Indonesia	6.58	7.10	57.03
Korea	4.82	8.19	45.39	54.83
Malaysia	12.64	7.75	59.62	71.71
Philippines	8.41	8.00	53.31	72.13
Singapore	13.97	11.41	46.89	62.82
Thailand	8.61	7.77	58.95	60.64
Average1	9.17	8.37	53.53	63.86
Average2	7.11	7.77	53.67	62.15

Source: the original series for annually imported intermediate and consumption goods are obtained from Research Institute of Economy, Trade and Industry, RIETI-TID.

The values in the table are calculated by the author.

Average1 is the average values of all countries

Average2 is the average values of all countries but exclude Malaysia and Singapore

Table III-A(3): Notations for the parameters

Parameter	Notation
θ	technology parameter
β	discount factor
γ_m	adjustment cost of production in import sector
γ_d	adjustment cost of production in domestic sector
α_m	fraction of rule of thumb price setters in import sector
α_d	fraction of rule of thumb price setters in domestic sector
κ	share of imported inputs for production
h	habit formation parameter
ω_x	share of exports in domestic production
ω_m	share of imports in domestic consumption
σ	risk aversion parameter
η	elasticity of substitution between home and foreign goods income elasticity of foreign consumption
χ_f	
η_m	elasticity of substitution across goods in import sector
η_d	elasticity of substitution across goods in domestic sector
ϕ	risk premium in foreign bond market

Table III-A(4): Alternative parameterization

Rules	LPT			MPT			HPT		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
TR	12.1428	1.1202	1.0000	12.6176	1.2577	1.0000	12.8326	1.2810	1.0000
TRE1	12.0973	1.1160	0.9963	12.4067	1.2367	0.9833	12.4982	1.2476	0.9739
TRE2	12.0937	1.1156	0.9960	12.3908	1.2351	0.9820	12.4782	1.2456	0.9724
TRS	12.0811	1.1145	0.9949	12.3701	1.2331	0.9804	12.4557	1.2434	0.9706
TRSE	12.0687	1.1133	0.9939	12.3689	1.2329	0.9803	12.4552	1.2433	0.9706
TRH	11.8036	1.0889	0.9721	11.4139	1.1377	0.9046	11.5339	1.1514	0.8988
TRHE	11.7976	1.0883	0.9716	11.3988	1.1362	0.9034	11.4470	1.1427	0.8920
TRF	12.1101	1.1172	0.9973	12.0395	1.2001	0.9542	12.1294	1.2108	0.9452
TRFE	12.0831	1.1147	0.9951	12.0228	1.1984	0.9529	12.1170	1.2096	0.9442
TRHI	11.4248	1.0539	0.9409	11.2598	1.1224	0.8924	11.5339	1.1514	0.8988
TRHIE	11.4202	1.0535	0.9405	11.2342	1.1198	0.8904	11.3920	1.1372	0.8877
SIT	14.3068	1.3198	1.1782	13.1711	1.3129	1.0439	13.3898	1.3366	1.0434

Notes: Relative loss (1) refers to the ratio of absolute loss of each simply rule to the absolute loss of unrestricted optimized rule that reacts to output and inflation; relative loss (2) indicates the relative loss of each simple rule to the loss of restricted optimized rule that react to both output and inflation, i.e. rule TR. The absolute losses for the unrestricted rule are 10.8401 (LPT), 10.0320 (MPT) and 10.0175 (HPT).

Table III-A(5a): Performances of simple rules, persistency =0.8 and std. error=0.4

Rules	Low PT			Medium PT			High PT		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
TR	34.5265	1.0879	1.0000	34.8595	1.2106	1.0000	35.2320	1.2248	1.0000
TRE1	34.2197	1.0783	0.9911	34.2090	1.1880	0.9813	34.3432	1.1939	0.9748
TRE2	34.1981	1.0776	0.9905	34.1633	1.1864	0.9800	34.2893	1.1920	0.9732
TRS	34.1233	1.0752	0.9883	34.0904	1.1839	0.9779	34.2220	1.1897	0.9713
TRSE	34.1154	1.0750	0.9881	34.0888	1.1838	0.9779	34.2162	1.1895	0.9711
TRH	33.1053	1.0432	0.9588	32.5297	1.1297	0.9331	32.7649	1.1390	0.9300
TRHE	33.1044	1.0431	0.9588	32.4423	1.1266	0.9306	32.5221	1.1306	0.9231
TRF	34.1071	1.0747	0.9878	33.3702	1.1588	0.9508	33.5002	1.1646	0.9573
TRFE	33.9232	1.0689	0.9825	33.3264	1.1573	0.9560	33.4999	1.1645	0.9508
TRHI	32.7564	1.0322	0.9487	32.2080	1.1185	0.9239	32.7480	1.1384	0.9295
TRHIE	32.7564	1.0322	0.9487	32.2080	1.1185	0.9239	32.7480	1.1384	0.9295
SIT	36.6007	1.1533	1.0601	36.4347	1.2653	1.0452	36.8484	1.2810	1.0459

Notes: Relative loss (1) refers to the ratio of absolute loss of each simple rule to the absolute loss of unrestricted optimized rule that reacts to output and inflation; relative loss (2) indicates the relative loss of each simple rule to the loss of restricted optimized rule that react to both output and inflation, i.e. rule TR. The absolute losses for the unrestricted rule are 31.7354 (LPT), 28.7961 (MPT) and 28.7664 (HPT).

Table III-A(5b): Higher persistency and std. error of domestic shocks

Rules	Low PT			Medium PT			High PT		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
TR	9.0317	1.1656	1.0000	9.4459	1.2717	1.0000	9.6316	1.2961	1.0000
TRE1	8.8568	1.1430	0.9806	8.9661	1.2071	0.9492	9.0154	1.2132	0.9360
TRE2	8.8541	1.1427	0.9803	8.9607	1.2064	0.9486	9.0094	1.2124	0.9354
TRS	8.8480	1.1419	0.9797	8.9837	1.2095	0.9511	9.0404	1.2166	0.9386
TRSE	8.8465	1.1417	0.9795	8.9589	1.2061	0.9484	9.0081	1.2122	0.9353
TRH	8.5308	1.1010	0.9445	8.4866	1.1425	0.8984	8.5555	1.1513	0.8883
TRHE	8.5307	1.1009	0.9445	8.4522	1.1397	0.8948	8.4680	1.1395	0.8792
TRF	8.8632	1.1439	0.9813	8.7908	1.1835	0.9306	8.8290	1.1881	0.9167
TRFE	8.7814	1.1333	0.9723	8.7161	1.1734	0.9227	8.7751	1.1809	0.9111
TRHI	8.4119	1.0856	0.9314	8.3719	1.1271	0.8863	8.5555	1.1513	0.8883
TRHIE	8.3956	1.0835	0.9296	8.3148	1.1194	0.8803	8.3946	1.1297	0.8716
SIT	9.7550	1.2590	1.0801	10.0302	1.3503	1.0619	10.2611	1.3808	1.0654

Notes: Definition of relative loss (1) and (2) are as footnote of Table II(2a). The absolute loss for the unrestricted optimized rule are 7.7485 (LPT), 7.4279 (MPT) and 7.4311 (HPT).

Table III-A(5c): Higher persistency and std. error of foreign shocks

Rules	Low PT			Medium PT			High PT		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
TR	2.6273	1.2415	1.0000	2.7678	1.3162	1.0000	2.8178	1.3357	1.0000
TRE1	2.6273	1.2415	1.0000	2.6761	1.2726	0.9668	2.6888	1.2746	0.9542
TRE2	2.5828	1.2204	0.9830	2.5752	1.2247	0.9304	2.5847	1.2252	0.9173
TRS	2.4988	1.1807	0.9511	2.4999	1.1888	0.9032	2.5149	1.1921	0.8925
TRSE	2.4899	1.1765	0.9477	2.4998	1.1888	0.9032	2.5139	1.1916	0.8921
TRH	2.4928	1.1779	0.9488	2.4684	1.1739	0.8918	2.4859	1.1784	0.8822
TRHE	2.4922	1.1776	0.9486	2.4568	1.1683	0.8876	2.4553	1.1639	0.8713
TRF	2.6258	1.2408	0.9994	2.6441	1.2574	0.9553	2.6567	1.1593	0.9428
TRFE	2.5712	1.2150	0.9786	2.5704	1.2224	0.9287	2.5784	1.2222	0.9150
TRHI	2.3258	1.0990	0.8852	2.3772	1.1305	0.8589	2.4803	1.1757	0.8802
TRHIE	2.3230	1.0977	0.8842	2.3589	1.1218	0.8522	2.3885	1.1322	0.8476
SIT	2.7997	1.3229	1.0656	2.9373	1.3969	1.0612	2.7997	1.3271	0.9936

Notes: Definition of relative loss (1) and (2) are as footnote of Table II(2a). The absolute losses for the unrestricted optimized rule are 2.1163 (LPT), 2.1028 (MPT) and 2.1096 (HPT).

Table III-A(6): Policy rules under different weightings

Rules	Case I $\gamma_\pi=1.0, \gamma_y=1.0$			Case II $\gamma_\pi=1.0, \gamma_y=0.5$			Case III $\gamma_\pi=1.0, \gamma_y=0.1$		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
<u>Low PT</u>									
TR	15.5689	1.3187	1.0000	9.0475	1.1660	1.0000	3.0710	1.0939	1.0000
TRE1	15.3728	1.3021	0.9874	8.8836	1.1449	0.9819	2.9453	1.0491	0.9591
TRE2	15.3544	1.3005	0.9862	8.8708	1.1432	0.9804	2.9423	1.0480	0.9581
TRS	15.3369	1.2990	0.9851	8.8606	1.1419	0.9793	2.9315	1.0442	0.9546
TRSE	15.3363	1.2990	0.9850	8.8596	1.1418	0.9792	2.9303	1.0427	0.9542
TRH	14.4913	1.2274	0.9308	8.5466	1.1014	0.9446	2.9157	1.0385	0.9494
TRHE	14.4829	1.2267	0.9302	8.5465	1.1014	0.9446	2.9157	1.0385	0.9494
TRF	15.0703	1.2765	0.9860	8.8784	1.1442	0.9813	2.9989	1.0682	0.9765
TRFE	14.9596	1.2672	0.9608	8.7977	1.1338	0.9724	2.9422	1.0480	0.9581
TRHI	14.2633	1.2081	0.9161	8.4250	1.0858	0.9312	2.8864	1.0281	0.9399
TRHIE	14.2406	1.2062	0.9147	8.4092	1.0837	0.9294	2.8847	1.0275	0.9393
SIT	18.2446	1.5464	1.1718	9.7732	1.2595	1.0802	3.2325	1.1514	1.0526
<u>Medium PT</u>									
TR	16.4610	1.3695	1.0000	9.4600	1.2720	1.0000	2.1807	1.1047	1.0000
TRE1	15.8760	1.3208	0.9644	9.0059	1.2109	0.9520	2.1011	1.0644	0.9635
TRE2	15.8255	1.3166	0.9614	8.9787	1.2073	0.9491	2.0987	1.0632	0.9624
TRS	15.8098	1.3153	0.9604	8.9949	1.2095	0.9508	2.1008	1.0642	0.9633
TRSE	15.7963	1.3142	0.9596	8.9736	1.2066	0.9486	2.0985	1.0631	0.9623
TRH	14.5968	1.2144	0.8867	8.5018	1.1432	0.8987	2.0740	1.0517	0.9511
TRHE	14.5291	1.2087	0.8826	8.4669	1.1385	0.8950	2.0655	1.0464	0.9472
TRF	15.2297	1.2670	0.9252	8.8023	1.1836	0.9305	2.1109	1.0694	0.9680
TRFE	15.1043	1.2566	0.9176	8.7282	1.1736	0.9226	2.0910	1.0593	0.9588
TRHI	14.2371	1.1845	0.8649	8.3946	1.1287	0.8874	2.0739	1.0506	0.9510
TRHIE	14.1731	1.1791	0.8610	8.3352	1.1208	0.8811	2.0538	1.0404	0.9418
SIT	18.8280	1.5664	1.1438	10.0483	1.3571	1.0622	2.2114	1.1203	1.0459
<u>High PT</u>									
TR	16.7359	1.3918	1.0000	9.6447	1.2963	1.0000	2.1637	1.0988	1.0000
TRE1	15.9864	1.3294	0.9552	9.0578	1.2174	0.9391	2.0971	1.0650	0.9692
TRE2	15.9288	1.3247	0.9518	9.0276	1.2134	0.9360	2.0947	1.0638	0.9681
TRS	15.9169	1.3237	0.9510	9.0518	1.2166	0.9385	2.0989	1.0659	0.9700
TRSE	15.8984	1.3221	0.9499	9.0234	1.2128	0.9356	2.0947	1.0638	0.9681
TRH	14.6955	1.2221	0.8781	8.5718	1.1521	0.8887	2.1009	1.0669	0.9710
TRHE	14.5706	1.2117	0.8706	8.4827	1.1401	0.8795	2.0578	1.0450	0.9510
TRF	15.2986	1.2722	0.9141	8.8406	1.1882	0.9166	2.1019	1.0674	0.9714
TRFE	15.2282	1.2664	0.9099	8.7871	1.1810	0.9111	2.0848	1.0588	0.9635
TRHI	14.6494	1.2183	0.8753	8.5713	1.1520	0.8887	2.0726	1.0526	0.9579
TRHIE	14.3226	1.1911	0.8558	8.4147	1.1310	0.8724	2.0572	1.0447	0.9508
SIT	19.1541	1.5929	1.1445	10.2797	1.3816	1.0658	2.2386	1.1369	1.1204

Notes: Definition of relative loss (1) and (2) are as footnote of Table II(2a). The absolute losses for the unrestricted optimized rules are as follows:

Case I: 11.8064 (LPT), 12.0300 (MPT) and 12.0249 (HPT)

Case II: 7.7595 (LPT), 7.4371 (MPT) and 7.4402 (HPT)

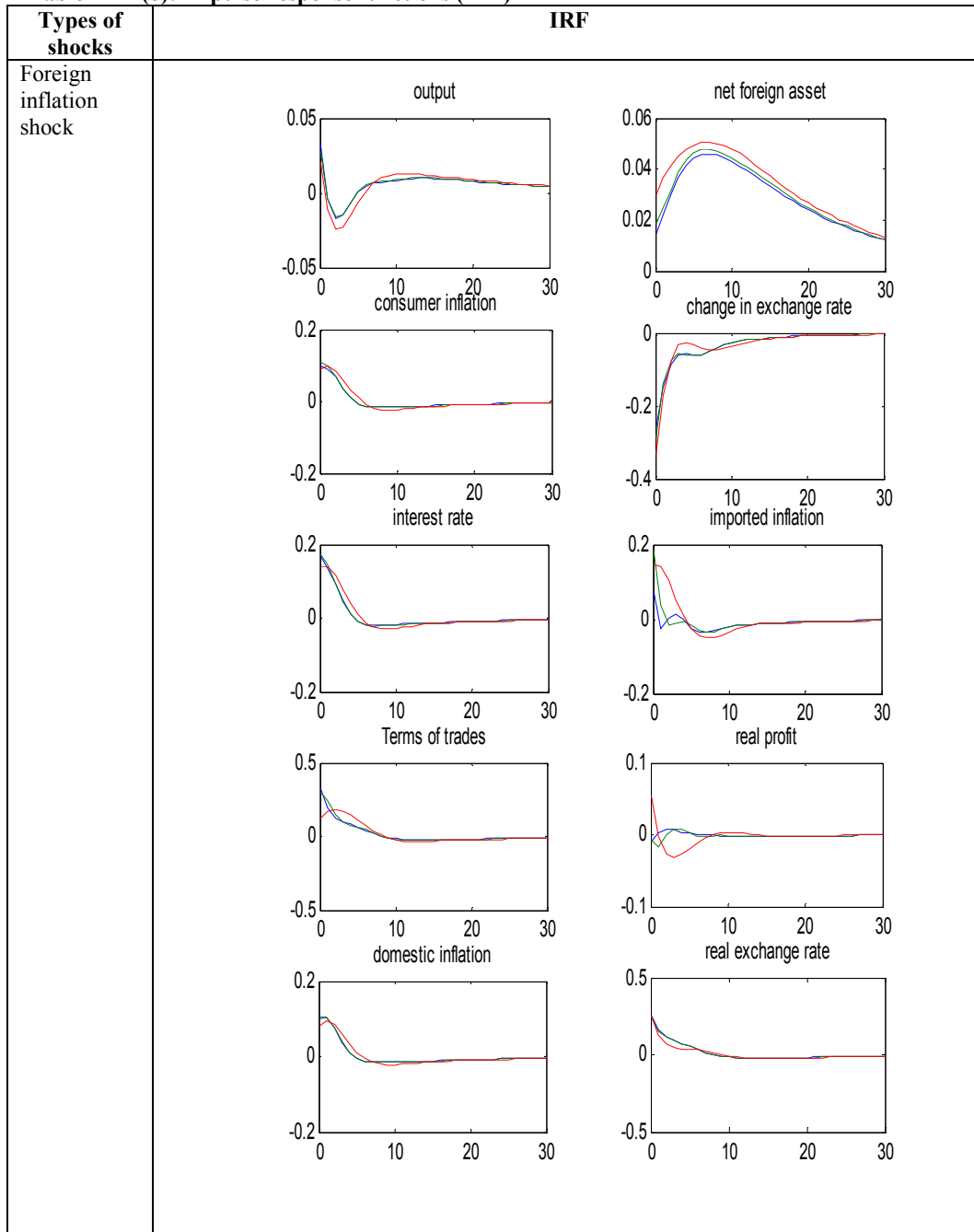
Case III: 2.8075 (LPT), 1.9740 (MPT) and 1.9691 (HPT)

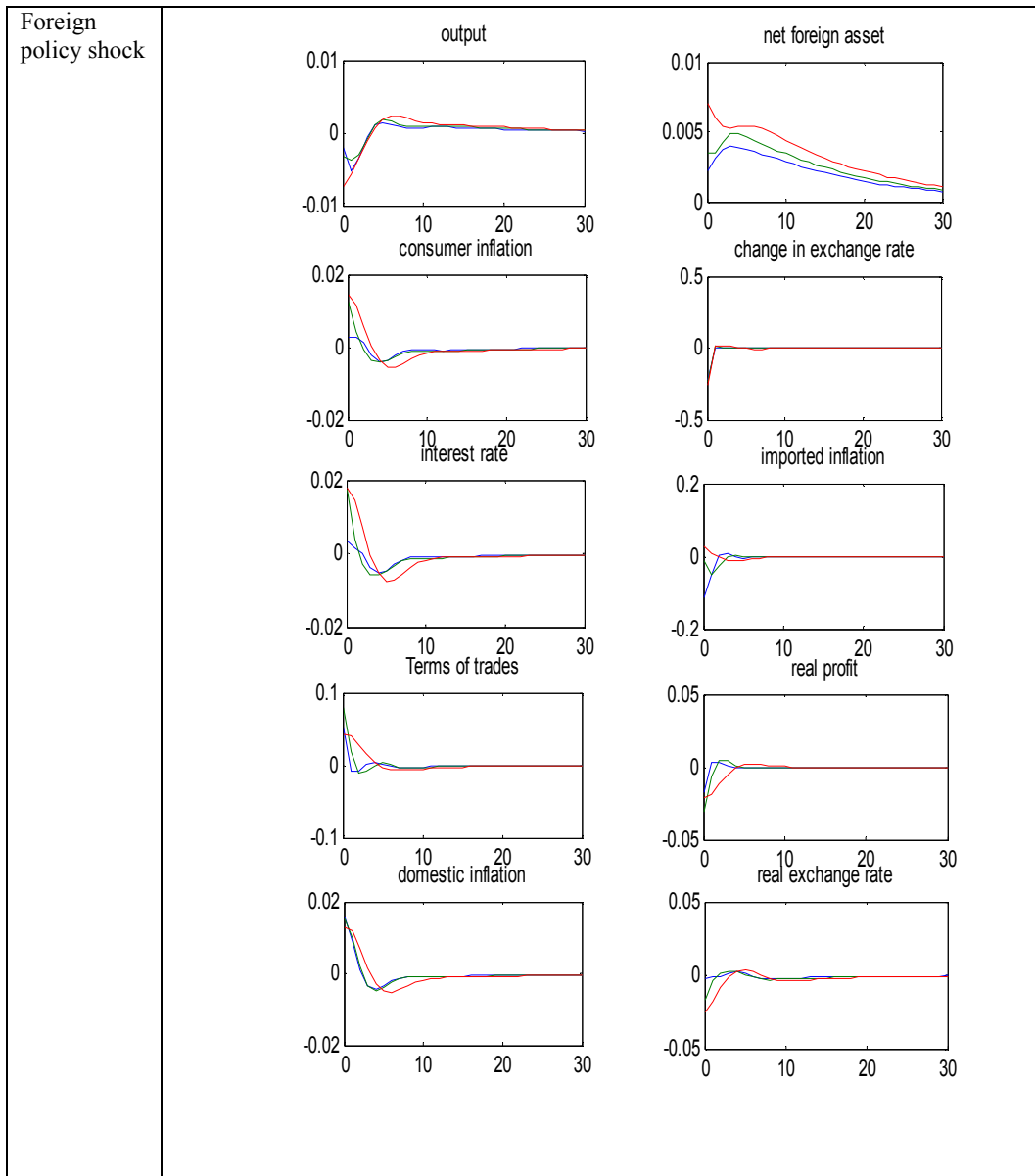
Table III-A(7): Relative loss of policy rules by targeting at interest rate

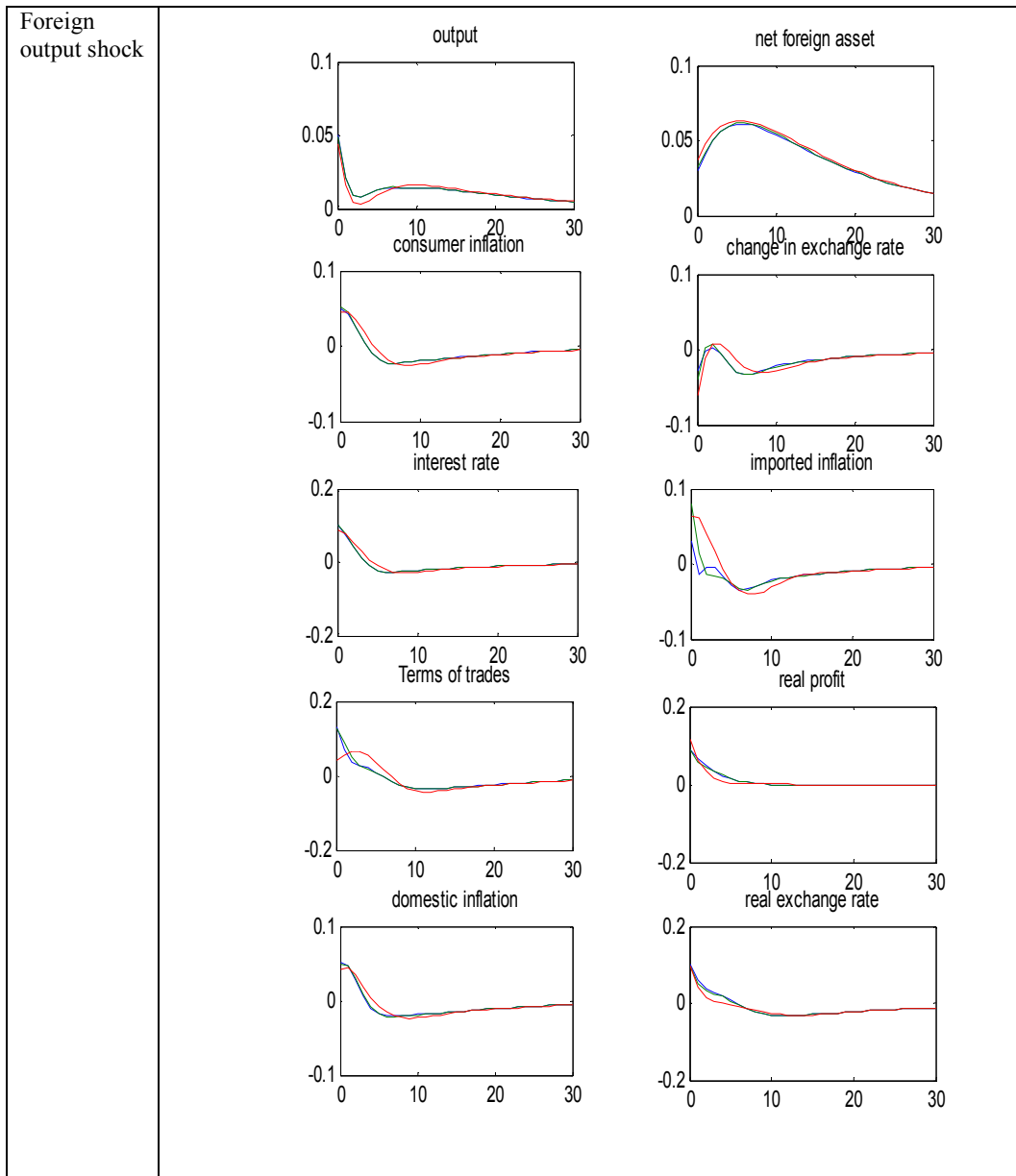
Rules	Low PT			Medium PT			High PT		
	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)	Absolute loss	Relative loss (1)	Relative loss (2)
TR	9.9915	1.2235	1.0000	10.2280	1.3194	1.0000	10.5020	1.3507	1.0000
TRE1	9.5889	1.1742	0.9597	9.5864	1.2366	0.9373	9.6502	1.2411	0.9189
TRE2	9.5578	1.1704	0.9566	9.5451	1.2313	0.9332	9.6032	1.2351	0.9144
TRS	9.4824	1.1611	0.9490	9.5191	1.2279	0.9307	9.5826	1.2324	0.9125
TRSE	9.4823	1.1611	0.9490	9.5068	1.2263	0.9295	9.5651	1.2302	0.9108
TRH	9.3940	1.1503	0.9402	9.3390	1.2047	0.9131	9.4447	1.2147	0.8993
TRHE	9.3809	1.1487	0.9389	9.2588	1.1943	0.9052	9.2850	1.1942	0.8841
TRF	9.8692	1.2085	0.9878	9.7305	1.2552	0.9514	9.9070	1.2741	0.9433
TRFE	9.5562	1.1702	0.9564	9.5047	1.2260	0.9293	9.5675	1.2305	0.9110
TRHI	8.8843	1.0879	0.8892	9.0775	1.1709	0.8875	9.4346	1.2134	0.8984
TRHIE	8.8832	1.0877	0.8891	8.8401	1.1403	0.8643	8.9394	1.1497	0.8512
SIT	10.6769	1.3074	1.0686	10.7876	1.3915	1.0547	11.0903	1.4263	1.0560

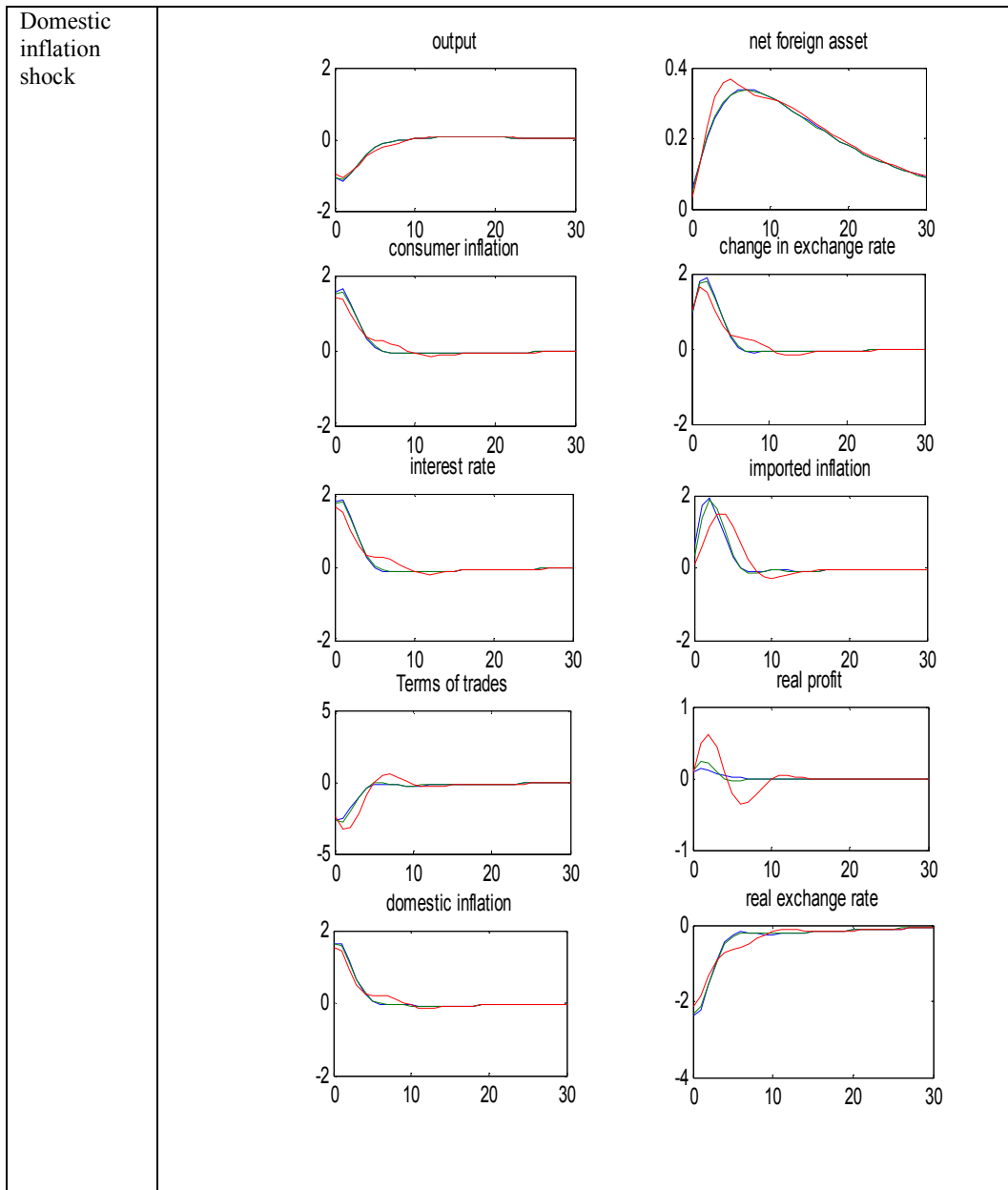
Note: Definition of relative loss (1) and (2) are as footnote of Table II(2a). The absolute losses for unrestricted optimized rule are 8.1666 (LPT), 7.7523 (MPT) and 7.7754 (HPT).

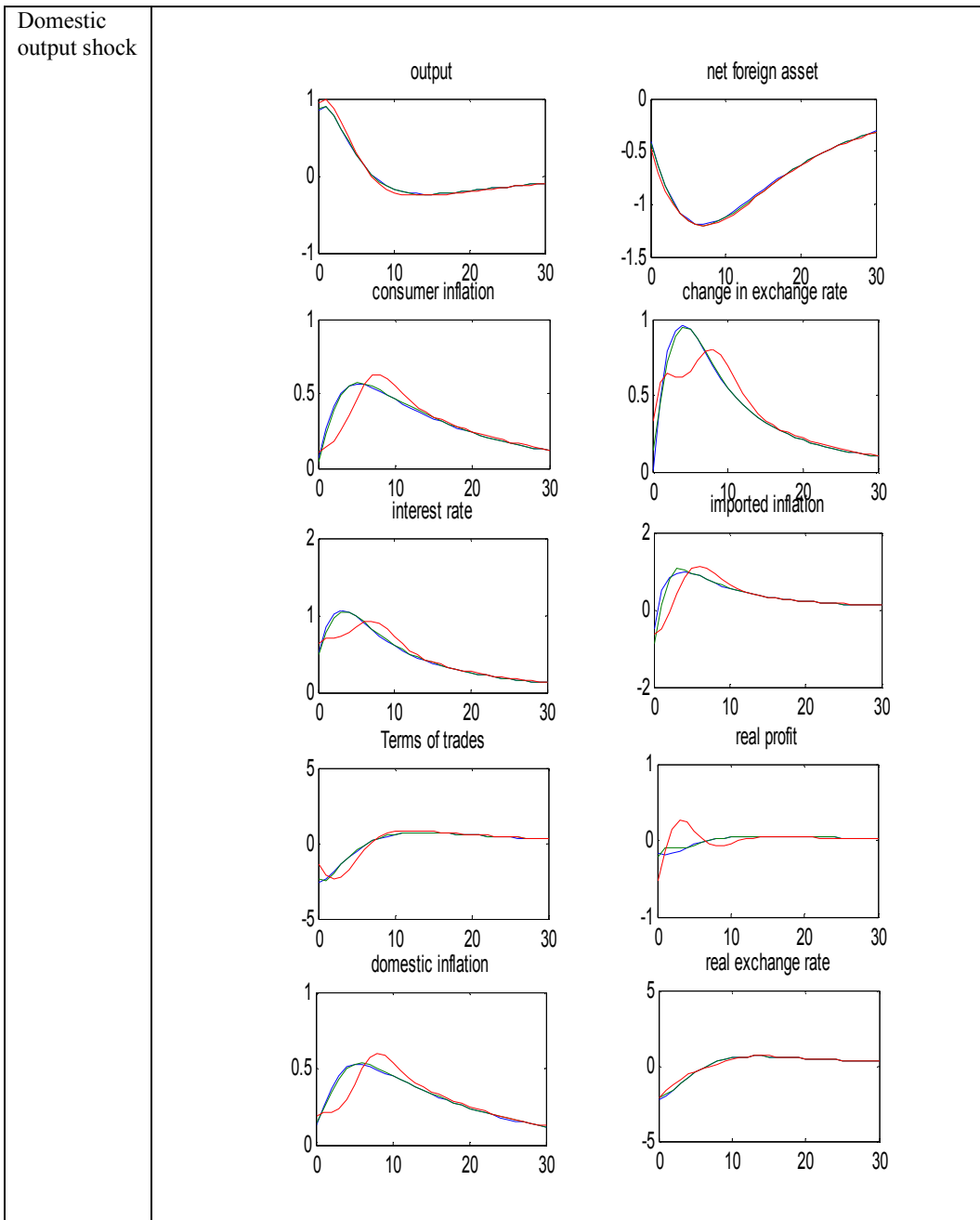
Table III-A(8): Impulse response functions (IRF)

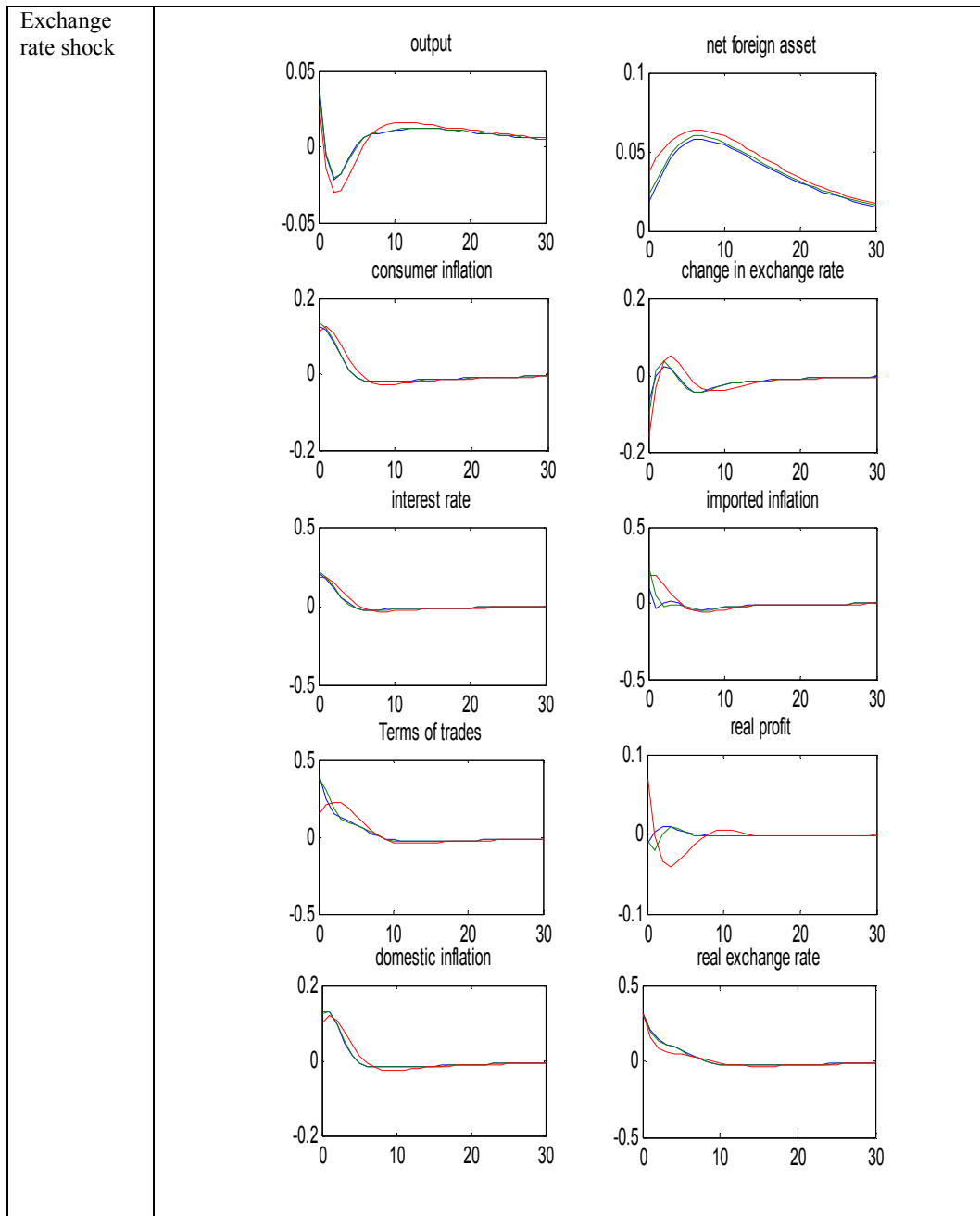












Remarks:

Green line represents the high pass-through case, red line represents the low pass-through case and blue line represents the medium pass-through case. The impulse response functions are simulated by assuming the domestic economy is represented by an ad-hoc standard Taylor-rule.

APPENDIX III-B

Solution and estimation of rational expectation model

This appendix summarizes the solution and estimation of the rational expectation model discussed in Söderlind (1999), Adolfson (2001) and Söderlind (2003).

The complete model of equations (1) to (18) can be written in a state space representation form:

$$\begin{bmatrix} x_{1,t+1} \\ E_t x_{2,t+1} \end{bmatrix} = A \begin{bmatrix} x_{1,t} \\ x_{2,t} \end{bmatrix} + B i_t + \begin{bmatrix} \varepsilon_{t+1} \\ 0_{n_2 \times 2} \end{bmatrix} \quad (1)$$

or $x_{t+1} = Ax_t + Bi_t + \xi_{t+1}$

where $x_{1,t}$ is a $(n_1 \times 1)$ vector of predetermined variables with the initial value $x_{1,0}$ is given. The $(n_2 \times 1)$ vector of non-predetermined or forward-looking variables is denoted as $x_{2,t}$. i_t is a $(k \times 1)$ vector of policy instruments and ε_{t+1} represents a $(n_1 \times 1)$ vector of innovations to $x_{1,t}$.

In this chapter, the predetermined, non-predetermined variables and the shocks are:

$x_{1,t} = [i_{t-1} \ y_t^f \ i_t^f \ \pi_t^f \ u_t^y \ u_t^\pi \ u_t^e \ \tau_t^f \ a_t \ \bar{x}_t \ \tau_t]$ with (11×1) dimensions

$x_{2,t} = [y_t \ \pi_t^d \ \pi_t^m \ \pi_t^c \ q_t \ \Delta q_t \ \Delta e_t]$ with (7×1) dimensions

$\varepsilon_t = [0 \ u_t^{yf} \ u_t^{if} \ u_t^{\pi f} \ v_t^y \ v_t^\pi \ v_t^e \ 0 \ 0 \ 0 \ 0]$ with (11×1) dimensions

Optimal policy with commitment rule

The problem of optimal unrestricted policy under commitment is to minimize the following loss function subject to the constraint in equation (1):

$$J_0 = E_0 \sum_{t=0}^{\infty} \beta^t [x_t' Q x_t + 2x_t' U i_t + i_t' R i_t]$$

s.t $x_{t+1} = Ax_t + Bi_t + \xi_{t+1}$ where $\xi_{t+1} = (\varepsilon_{t+1}, x_{2,t+1} - E_t x_{2,t+1})$

The problem is solved by forming the Lagrangian function:

$$L_0 = \min_{i_t} E_0 \sum_{t=0}^{\infty} \beta^t [x_t' Q x_t + 2x_t' U i_t + i_t' R i_t + 2\rho_{t+1}' (Ax_t + Bi_t + \xi_{t+1} - x_{t+1})] \quad (2)$$

The first order condition with costate vector ρ_{t+1} with respect to i_t and x_t are:

$$-B' E_t \rho_{t+1} = U' x_t + R i_t$$

$$\beta A' E_t \rho_{t+1} = \rho_t - \beta Q x_t - \beta U i_t$$

Q , U and R are matrices mapping the targeting variables in the loss function to the state variables (see Adolfson (2001) for more details).

By grouping $x_t = (x_{1,t}, x_{2,t})$ and $\rho_t = (\rho_{1,t}, \rho_{2,t})$ and reorder the rows where $x_{1,t}$ is placing before $\rho_{2,t}$, the result can be written in the following form:

$$GE_t \begin{bmatrix} k_{t+1} \\ \lambda_{t+1} \end{bmatrix} = D \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \quad (3)$$

$$\text{where } k_t = \begin{bmatrix} x_{1,t} \\ \rho_{2,t} \end{bmatrix} \text{ and } \lambda_t = \begin{bmatrix} x_{2,t} \\ i_t \\ \rho_{1,t} \end{bmatrix}$$

Generalized Schur Decomposition

Since matrix G is singular, generalized Schur decomposition is applied here. The square matrices G and D satisfy the following generalized Schur decomposition given that Q and Z are unitary, S and T are upper triangular (Söderlind (1999)).

$$G = QSZ^H \quad (4a)$$

$$D = QTZ^H \quad (4b)$$

The decomposition is reordered to allow the stable generalized eigenvalues to come first. Define the auxiliary variables θ and δ as:

$$\begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} = Z^H \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \quad (5)$$

By applying the generalized Schur decomposition of (4a) and (4b) and premultiply (5) by the non-singular matrix Q^H give the following:

$$Q^H QSZ^H E_t \begin{bmatrix} k_{t+1} \\ \lambda_{t+1} \end{bmatrix} = Q^H QTZ^H \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} \quad (6)$$

$$SZ^H E_t \begin{bmatrix} k_{t+1} \\ \lambda_{t+1} \end{bmatrix} = TZ^H \begin{bmatrix} k_t \\ \lambda_t \end{bmatrix}$$

$$SE_t \begin{bmatrix} \theta_{t+1} \\ \delta_{t+1} \end{bmatrix} = T \begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix}$$

$$\begin{bmatrix} S_{\theta\theta} & S_{\theta\delta} \\ 0 & S_{\delta\delta} \end{bmatrix} E_t \begin{bmatrix} \theta_{t+1} \\ \delta_{t+1} \end{bmatrix} = \begin{bmatrix} T_{\theta\theta} & T_{\theta\delta} \\ 0 & T_{\delta\delta} \end{bmatrix} \begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix}$$

In order to get a stable solution, we must have $\delta_t = 0$ for all t and the solution is:

$$E_t \theta_{t+1} = S_{\theta\theta}^{-1} T_{\theta\theta} \theta_t \quad (7)$$

given that $S_{\theta\theta}$ is invertible.

Invert (5) and partition:

$$\begin{bmatrix} k_t \\ \lambda_t \end{bmatrix} = \begin{bmatrix} Z_{k\theta} & Z_{k\delta} \\ Z_{\lambda\theta} & Z_{\lambda\delta} \end{bmatrix} \begin{bmatrix} \theta_t \\ \delta_t \end{bmatrix} = \begin{bmatrix} Z_{k\theta} \\ Z_{\lambda\theta} \end{bmatrix} \theta_t \quad (8)$$

Since $\delta_t = 0$, we get the solution $k_0 = \begin{bmatrix} x_{1,0} \\ 0 \end{bmatrix} = Z_{k\theta} \theta_0$ and $\theta_0 = Z_{k\theta}^{-1} k_0$ if $Z_{k\theta}$ is invertible.

The solutions for the other variables are (see Söderlind, 1999 for more details):

$$\begin{bmatrix} x_{2,t} \\ i_t \\ \rho_{1,t} \end{bmatrix} = Z_{\lambda\theta} Z_{k\theta}^{-1} \begin{bmatrix} x_{1,t} \\ \rho_{2,t} \end{bmatrix} \quad (9)$$

Optimal simple rule

Assume that the policy maker could commit to a simple decision rule:

$$i_t = -F \begin{bmatrix} x_{1,t} \\ x_{2,t} \end{bmatrix} \quad (10)$$

Substituting (10) into (1):

$$\begin{bmatrix} x_{1,t+1} \\ E_t x_{2,t+1} \end{bmatrix} = (A - BF) \begin{bmatrix} x_{1,t} \\ x_{2,t} \end{bmatrix} + B i_t + \varepsilon_{t+1} \quad (11)$$

A necessary condition for a unique equilibrium solution for the expectation difference equations (11) is $(A - BF)$ should have the number of stable roots equal to the number of predetermined variables (Söderlind (1999)). Given that F implies a unique equilibrium, the solution to the dynamic of the model is:

$$x_{1,t+1} = M x_{1,t} \quad (12)$$

$$x_{2,t} = C x_{1,t} \quad (13)$$

where $M = Z_{k\theta} T_{\theta\theta} Z_{k\theta}^{-1}$ and $C = Z_{\lambda\theta} Z_{k\theta}^{-1}$ are obtained using a Schur Decomposition of $(A - BF)$.

The loss function value is:

$$J_0 = x'_{1,0} V x_{1,0} + \frac{\beta}{1 - \beta} \text{tr}(V \Sigma) \quad (14)$$

$$\text{where } V = P' \begin{bmatrix} Q & U \\ U' & R \end{bmatrix} P + \beta M' V M$$

$$\text{and } P = \begin{bmatrix} I_{n1} \\ C \\ -F \begin{bmatrix} I_{n1} \\ C \end{bmatrix} \end{bmatrix}$$

Under an optimal simple rule, the loss function (14) is minimized subject to the restriction on the decision rule F with $x_{1,0}$ is given. This rule depends on the covariance matrix Σ and the initial state vector $x_{1,0}$.

CHAPTER FIVE**AN EMPIRICAL STUDY ON THE MONETARY POLICY AND EXCHANGE RATE REGIME: THE CASE OF EAST-ASIAN COUNTRIES****Abstract**

Focusing the study on several East-Asian countries, this chapter conducts an empirical investigation on the policy reaction function for these countries between the pre- and post-crisis periods of 1997-98. The main objective is to investigate the change in the policy reaction function, in particular the reaction of the short-term interest rate to the exchange rate movements between the two sub-periods. Two indicators are also constructed to study the change in the flexibility in exchange rate in these countries over time in compare to the exchange rate floaters in the developed countries. Applying the Generalized Method of Moments technique, the results show some evidences that the monetary authority in East-Asia reacts to the exchange rate movements in both sub-periods. The analysis using the two indicators shows that the emerging East-Asian countries hold very large ratio of reserves in compare to the developed countries. The flexibility in exchange rate in these countries has increased after the shift of exchange rate regimes to the more flexible regime aftermath the crisis. However, the degree of flexibility still considerably very low compare to that of free floaters in the developed countries. The results demonstrate some degrees of intervention in the foreign exchange market and short-term interest rate adjustments which limit the flexibility of exchange rate in these countries in compare to the pure floating regime in the developed countries aftermath the crisis or the move to the more flexible exchange rate regimes in East-Asia.

5.1 Introduction

Following the Asian financial crisis of 1997-98 and the switch of monetary policies and exchange rate regimes in East-Asian countries, there are growing studies on the topic about the design and evaluation of monetary policy in these countries. Two of the main hot debates are the merits of fixed versus flexible exchange rate and the role of exchange rate in the design of monetary policy rules.

It was argued that the small open economies should float their currencies as the floating regimes give greater insulations to the excessive volatility of real exchange rate overshooting and misalignments (Devereux (2003)). On the other hand, there are arguments that favor the fixed exchange rate regime as floating regime generates instability in the macroeconomics and thus causing the economy vulnerable to a currency crisis (Devereux (2001)). Focusing on the role of balance sheet effects, Eichengreen and Hausmann (2003) point out that emerging countries are fear to float their currencies due to the problem of 'liability dollarization' as interest rate and exchange rate fluctuations have great effects on the financial and balance sheet stability. In other words, when the foreign currency debt increases, the central bank tends to choose less flexible regime (Hausmann et al. (2004)).

The main purpose of this chapter is not to compare the performances of a battery of monetary policy rules as done in **Chapter Four** but it seeks to analyze the flexibility of exchange rate regimes in several crisis-hit East-Asian countries in compare to the flexibility of free floaters in the developed countries. In particular, comparisons are made between the two sub-periods (the pre- and post-crisis or after the switch to the floating regime) in these countries to reveal how significant the increase in the exchange rate flexibility and policy reaction function changes aftermath the switch of exchange rate regimes/ monetary policies and if the central banks follow what they have declared officially as free floaters.

This chapter conducts two different approaches of analysis. First, the Generalized Method of Moments (GMM) technique is applied to estimate the policy reaction function for the two sub-periods separately for each country in order to uncover how far the policy reaction function changes over time in response to the inflation and output gap. Specifically, the main focus of this analysis is to find out if the central banks in these countries react significantly to the exchange rate movements as they claimed not in the period aftermath the switch to the flexible exchange rate regime or inflation targeting regime. Second, two indicators are constructed (as in Hausmann et al. (2001)) to compare the flexibility of exchange rate in East- Asia in compare to the case of free floaters in the advanced countries. The first indicator measures the attempt of the policy maker to influence the movements in exchange rate through intervention in the foreign exchange market. The second indicator measures the intention of the policy maker to stabilize the exchange rate via interest rate adjustments. The main purpose of this analysis is to investigate the willingness of central banks to float the exchange rate or their 'fear' to float the exchange rate by influencing the exchange rate movements through interventions in the foreign exchange market and short-term interest rate adjustments.

The results from the estimated policy reaction functions show that the central banks in East-Asian countries react differently to inflation, output gap and exchange rate

between the two sub-periods. There are some evidences that the policy reaction function reacts significantly to the exchange rate terms in both sub-periods. The analysis using the two indicators shows that the emerging East-Asian countries hold very large ratio of reserves in compare to the developed countries. Although the flexibility in exchange rate has increased after the shift of exchange rate regimes to the flexible one in these countries, the degree of flexibility is still considerably very low compare to that of free floaters in the developed countries. The results demonstrate some degrees of intervention in the foreign exchange market and short-term interest rate adjustments in emerging countries which limit the flexibility of exchange rate in compare to the case of pure floating regime in the developed countries aftermath the crisis or the move to more flexible exchange rate regimes in East-Asia.

The chapter is organized as follows. Section two reviews the economics and monetary policies of several East Asian countries for the periods of pre- and post-crisis. Section three discusses the data, methodology and results in estimating the policy reaction functions. Section four constructs indicators to measure the flexibility of exchange rate regime in East-Asia followed by some discussions on the results. Section five concludes.

5.2 Economics and policy regimes in East-Asia

5.2.1 Some debates on the choice of regimes

Which exchange rate regime should be opted by the emerging economies? Does exchange rate act as a shock absorber in these countries? Why do emerging countries fear to float the exchange rate? These are the main issues and debates on the exchange rate regimes for emerging countries. Although these issues have long been debated, economists and researchers still have not reach the same view and agreement on the right exchange rate regime for emerging countries.

According to Maliszewska & Maliszewski (2004), the literature on the choice of exchange rate regimes can be divided into three main groups. The first group evaluates the exchange rate regimes by looking at the insulating properties of the regimes. For instance the Mundell-Fleming model shows that fixed exchange rate regime is preferred on face of large nominal shocks. This is because under the monetary shock (nominal shock) given that the exchange rate is flexible, nominal exchange rate will depreciate which later leads to the depreciation in the real exchange rate and higher volatility in output compare to the fixed regime. On the other hand, if real shocks are more prominent, the domestic economy should opt for the flexible regime as this regime allow quick adjustments in economy through relative prices which offsets the negative impact of real shocks in domestic economy.

The second group focuses on the possibility of forming the fixed regime or currency union and if such regime leads to greater economic integration. It refers to the literature of optimum currency area (OCA). The results favor the formation of OCA or fixed regime if the countries considered face the symmetry shocks. The choice on the regimes is based on the relative cost of giving up the exchange rate flexibility and the gains or benefits of fixed regime.

The third group analyses this topic from the aspect of credibility of monetary policy. In other words, how credible the peg exchange rate regime helps the central bank to achieve and maintain low inflation target.

Previous studies show that the source of shocks matters in determining the choice of exchange rate regimes. As discussed in Christl & Just (2004), the significant role of flexible exchange rate to act as a shock absorber crucially depends on the type/ source of shocks hitting the economy and exchange rate. Flexible exchange rate regime is more effective to absorb real shocks as this regime provides rapid adjustments through relative prices by inducing expenditure switching effects. On the other hand, the ability of exchange rate to absorb shocks could be very low if the exchange rate pass-through into import price is low. Besides, this regime is not desired under asymmetric monetary or financial shocks. This is because negative financial shocks induce higher interest rate which leads to appreciation in exchange rate, amplifying the negative effects on output. Therefore under negative financial shocks, the economy should opt for the fixed regime.

Focusing on the utility-based evaluation, Devereux (2003) shows that fixed exchange rate regime is more efficient to deal with shocks under imperfect financial market and rigidity in wage. Fixing the exchange rate induces deviation of output from the natural rate and hence leads to higher efficiency responses of output to demand shocks. On the other hand, empirical studies based on the OCA criteria do not favor the fixed regime or the formation of OCA for the emerging Asian countries as majority of these countries show asymmetric shocks (for examples, Sun and An (2008) and Hoffmaister & Roldós (1997)). According to Kwack (2005), a currency peg system is a better choice if the country is subject to systematic shocks. However, in case of unsystematic shocks, flexibility is preferred. The author suggests greater flexibility in exchange rate regime with intervention and flexible inflation targeting for the region of East-Asia as these emerging countries experience more unsystematic shocks.

Apart from these results, many papers show that emerging countries are fear to float their currencies. It is argued that although these countries officially announce their exchange rate regime to be freely floating, most of the central banks in these countries do not float their exchange rate freely. Hausmann et al. (2004) show that emerging countries tend to hold large ratio of reserve and there are some evidences of the central banks in these countries to control and limit the movements in exchange rate. Cavoli & Rajan (2003) discussed the reasons for the 'fear of floating' behavior of the central banks in emerging countries. One of the main reasons for the 'fear of floating' behavior is flexible regime induces excessive volatility or speculative bubbles which can lead to extreme currency fluctuations. Flexible regime also exhibits higher volatility in exchange rate. Excessive volatility is unfavored as it has negative effects on the composition of production and investment. Besides, exchange rate volatility could have a detrimental effect on trade and FDI compare to the institutionally fixed regimes which stimulates trade.

Besides these reasons, many studies link the 'fear of floating' behavior of emerging countries to the problem of 'liability dollarization' or 'original sins' and collateral financial constraints (Eichengreen & Hausmann (2003), Hausmann et al. (2004), Christl & Just (2004) and Devereux & Poon (2004)). Due to the undeveloped economic structures and unstable financial market, the debts for these countries are

denominated in the U.S. dollar or foreign currencies. Interest rate and exchange rate fluctuations have great effects on the financial and balance sheet stability. Emerging countries that hold large ratio of foreign currency debt tends to peg their currencies. Consistent to this explanation, Devereux and Lane (2003) find that the bilateral exchange rate volatility in emerging market is negatively correlated to the stock of external debt.

5.2.2 Middle solutions/ intermediate regimes

The exchange rate regimes literatures favor the choice of corner regimes (either fixed or floating regime) as these extreme solutions are more viable. The middle solutions are viewed as unstable and crisis-prone under the concept/ theory of ‘Impossible Trinity’. This trilogy states that a country cannot achieve completely capital flows and independent monetary policy simultaneously under the fixed exchange rate regime (Cavoli & Rajan (2003)). The middle solutions that does not permit fully flexible or fixed regime will be compelled. However, how far this theory holds in the real world?

The historical experiences and financial crisis demonstrate that hard peg induces speculative attacks and higher risk of contagions collapse. This option is not credible for the liberalized small open economies like East-Asia (Kwack (2005)). Floating regime is also undesirable as excessive volatility in exchange rate imposes negative effects on trade. Since none of the two corner solutions provide favorable outcomes, the intermediate regimes appear to be better choices (Eichengreen (1999)). As mentioned in Cavoli & Rajan (2003), the choice on the appropriate exchange rate regime is not an issue of black or white but choices on variety of regimes. The design of policy regime should not be done separately but it should be made conditional on the economic circumstances and policy preferences.

In the era of globalization and high capital mobility, emerging economies should not only concern about the exchange rate stability but also the flexibility in exchange rate. Both aspects are important as stability permits insulation on the adverse effect of uncertainty on real economy and flexibility allows immediate adjustments to deal with shocks and speculative attacks (Aminian (2005)). Due to the error in policy rules, uncertainty and inflation forecasting, Cavoli & Rajan (2003) suggest flexibility in the monetary policy strategies, for example to allow positive weight on exchange rate in the policy rule. Higher flexibility in inflation target implies higher discretion for the authority to respond to various shocks in order to meet other goals. On the other hand, Christl & Just (2004) also suggest the options for the intermediate regimes with small weights on exchange rate targeting. Aminian (2005) even suggests for the monetary integration and regional cooperation. According to him, forming the monetary integration enhances regional cooperation and more accurately defined of policy regimes which can increase the effectiveness and robustness of the intermediate regimes.

5.2.3 East-Asia in the pre- and post-crisis – some reviews

The financial crisis of 1997-98 in Asia induced many changes in the crisis-hit Asian countries, both the economics and monetary policy counterparts. The financial crisis has totally deteriorated the economics in Asia. The GDP growth has dropped to the negative level and the inflation rate jumped up dramatically (see **Table I-A(5)**,

Chapter Two). For example, the GDP annual growth rate in Thailand dropped from 9.2% in 1995 (pre-crisis) to -10.5% in 1998 (during the crisis) and recovered to 4.5% in 2005 (post-crisis). The annual inflation rate in Indonesia jumped wildly from 9.5% in 1995 to 58.5% in 1998 and dropped in 2005 to 10.9%.

The painful experiences caused by the crisis have induced the monetary authorities in these countries to evaluate and adopt the new monetary policy regimes. According to Zhu (2005), the price stability and financial stability were the main policy objectives for most of the central banks in these East-Asian countries before the crisis besides the exchange rate against the U.S. dollar. After the crisis, the central banks are more concerned on price stability and some of these countries have adopted the inflation targeting regime. However, output stability still remains as the policy objective under the flexible inflation targeting regime although it is given a lower weight.

Most of the crisis-hit East-Asian countries have switched from the more rigid exchange rate regime to the flexible one and inflation targeting after the crisis. According to Fung (2002), there is a tendency for the central banks in these countries to shift from the exchange rate stability to price stability. According to the International Monetary Financial (IMF) classifications, Korea and Philippines have moved from the managed floating to independently floating regime after the crisis. Thailand on the other hand, has moved from the pegged exchange rate regime to managed floating regime while Philippines remains the same regime as independently floating after the crisis. At the same time, these four countries have also altered their monetary policy to adopt the inflation targeting regime after the financial crisis of 1997-98, i.e. Korea in April 1998, Thailand in May 2000, Indonesia in 2000 and later Philippines in January 2002 (Osawa (2006)). On the other hand, Malaysia moved from the managed floating regime to pegged exchange rate from September 1998 to July 2005 but has moved back to managed floating after that. Singapore has moved from the De facto moving band to managed floating since November 1998 (see **Table I-A(8), Chapter Two**).

Before the crisis, most of the East-Asian countries used monetary base as a policy instrument. After the crisis, interest rate has used as the policy instrument. For example in Indonesia, the BI rate is used as a policy instrument. The call money rate is used in the case of Korea, the 14-day repurchase rate is used in Thailand and the over night rate and reverse repurchase rate are used in the case of Philippines (see **Table IV-(1), Appendix IV**). These countries target on headline or core CPI for a short or medium term horizon (refer **Table IV-(2), Appendix IV**).

Although these countries have abandoned the pegging exchange rate regime, exchange rate stability still remains as one of the objectives concerned by the central banks through interventions in the foreign exchange market. The central bank's reports and discussion papers show that sterilized intervention appears to be a common tool that used by the central banks to influence and adjust the movements of exchange rate in these countries. On the other hand, the central banks in these countries claim that they do not give a direct role to exchange rate in their policy reaction functions, for example:¹⁹

¹⁹ See BIS papers no. 31. Monetary policy in Asia: approaches and implementation. Proceedings of a BIS/HKIMR Conference held in Hong Kong SAR on 21-22 November 2005

*“The **Bank of Korea** steadfastly insists that it is not in the exchange rate targeting business. It justifies foreign exchange market “smoothing” by the need to control excessive exchange rate volatility, which, if they were to allow it, could unsettle inflation expectations” (p. 166).....Broadly speaking, the BOT (**Bank of Thailand**) does not attempt to influence the exchange rate level, for that should be left to the market based on the true fundamentals of the economy” (p. 199)..... However, this does not mean that the authorities (BNM, **Bank Negara Malaysia**) actually try to determine a time path for the exchange rate” (p. 206)..... Generally speaking, however, the BSP (**Central Bank of Philippines**) supports a market-determined level for the exchange rate and does not target a specific spot exchange rate against the US dollar. On a day-to-day basis, intervention in the spot market is done only to smooth out sharp fluctuations in the exchange rate and ensure orderly conditions in the foreign exchange market at all times” (p. 214)..... In this respect, BI (**Bank of Indonesia**) excludes the exchange rate from its monetary policy response, but regards the exchange rate as one variable in the information set to monitor and evaluate before decisions are made on the required interest rate response” (p. 222).*

Officially, the central banks do not consider a direct role for exchange rate in the policy reaction functions as shown in the central bank reports. However, do the central banks correspond to what they claim? Assuming the policy reaction function can be represented by a short term interest rate of Taylor type rule, previous empirical studies focused on emerging markets report mixed results. As summarized in **Table IV-(3), Appendix IV**, using different periods, model specifications and methodologies of estimation produce quite different results. Some studies show some significant responses of policy reaction function to exchange rate terms (for example Mohanty & Klau (2004), Eichengreen (2004) and McCallum (2007)) but some show the contrasting results (for example Osawa (2006) and Affandi (2004)). Therefore, it is not clear if the central banks in East-Asia consider a direct role for exchange rate in the policy reaction function empirically.

5.3 Do the central banks in East-Asia react directly to exchange rate?

This section conducts empirical analysis in estimating the policy reaction function in several East-Asian countries, examining the changes in the policy reaction in the pre- and post-crisis/ the change in the monetary policy regimes in these countries. This analysis may reveal the condition if these central banks really follow what they claim by not reacting directly to the exchange rate movements in their policy reaction functions under the flexible regime.

5.3.1 Approximating monetary policy reaction function

As discussed in Ramayandi (2007), it is difficult to measure the monetary policy stance as the operating targets of central banks vary across countries and change over time. There are three main operating targets, namely the monetary aggregate (quantity targeting), short-term interest rate (price targeting) and exchange rate targeting.

Short-term interest rate is widely used to proxy the monetary policy as empirical studies show that interest rate rule fits the real data well. Besides, there are arguments that the implementation of the actual monetary policy of one country can be traced through its short-term interest rate regardless the policy regime that the authority announced (Goodfriend (1991) and Goodhart (1995)). Other instrument, for example changes in monetary aggregate is less adequate to represent the monetary policy stance as this instrument is subject to non-monetary policy influences (Ramayandi (2007)). Due to these reasons, the Taylor type interest rate rule is used to proxy the monetary policy stance in this chapter. This rule assumes the authority adjusts the short-term interest rate by responding to the deviation of inflation from its target and output gap. The estimation on the interest rate rule involves the backward-looking specification (Taylor type rule) and forward-looking assumption (Ramayandi (2007)). Some studies demonstrate that the forward-looking specification works better than the backward-looking specification (Batini & Haldane (1999) and Salas (2004)).

The baseline policy rule is as in Clarida et al. (1998) and Ramayandi (2007) and can be formulated as:

$$\tilde{i}_t = \bar{i} + \alpha \left[E_t(\pi_{t+p1} | z_t) - \pi^* \right] + \beta E_t(\bar{y}_{t+p2} | z_t) + \gamma E_t(w_{t+p3} | z_t) \quad (1)$$

This rule indicates that the short-term interest rate is set based on the expected inflation around its target, i.e. $\left[E_t(\pi_{t+p1} | z_t) - \pi^* \right]$, output gap \bar{y}_t and other variables w_t (for example exchange rate). \bar{i} is the long-run equilibrium nominal rate and z_t is the information set. The monetary authority is assumed to smooth the movements in interest rate in the following form:

$$i_t = (1 - \rho_i) \tilde{i}_t + \rho_i i_{t-1} + \varepsilon_t \quad (2)$$

This equation indicates that the authority only impose partial adjustment on the actual interest rate, i.e. the actual interest rate i_t is adjusted partially to its desired current target \tilde{i} and its own past value movements i_{t-1} . ρ_i is the degree of interest rate smoothing. Substituting equation (1) into equation (2) gives the following policy reaction function:

$$\begin{aligned} i_t &= (1 - \rho_i) \left[\bar{i} + \alpha \left[E_t(\pi_{t+p1} | z_t) - \pi^* \right] + \beta E_t(\bar{y}_{t+p2} | z_t) + \gamma E_t(w_{t+p3} | z_t) \right] + \rho_i i_{t-1} + \varepsilon_t \\ i_t &= (1 - \rho_i) \left[\bar{i} + \alpha \left[E_t(\pi_{t+p1} | z_t) - \pi^* - \pi_{t+p1} + \pi_{t+p1} \right] + \beta \left[E_t(\bar{y}_{t+p2} | z_t) - \bar{y}_{t+p2} + \bar{y}_{t+p2} \right] \right. \\ &\quad \left. + \gamma \left[E_t(w_{t+k} | z_t) - w_{t+p3} + w_{t+p3} \right] + \rho_i i_{t-1} + \varepsilon_t \right] \\ i_t &= (1 - \rho_i) \left[\bar{i} + \alpha \left[E_t(\pi_{t+p1} | z_t) - \pi^* \right] + \beta E_t(\bar{y}_{t+p2} | z_t) + \gamma E_t(w_{t+p3} | z_t) \right] + \rho_i i_{t-1} + \xi_t \end{aligned}$$

Eliminating the unobserved forecast terms gives:

$$\begin{aligned} i_t &= (1 - \rho_i) (\bar{i} - \alpha \pi^*) + (1 - \rho_i) \alpha \pi_{t+p1} + (1 - \rho_i) \beta \bar{y}_{t+p2} + (1 - \rho_i) \gamma w_{t+p3} + \rho_i i_{t-1} + \xi_t \\ i_t &= a_0 + a_1 \pi_{t+p1} + a_2 \bar{y}_{t+p2} + a_3 w_{t+p3} + a_4 i_{t-1} + \xi_t \end{aligned} \quad (3)$$

where

$$a_0 = (1 - \rho_i) (\bar{i} - \alpha \pi^*); \quad a_1 = (1 - \rho_i) \alpha; \quad a_2 = (1 - \rho_i) \beta; \quad a_3 = (1 - \rho_i) \gamma \quad \text{and} \quad a_4 = \rho_i$$

$$\xi_t = -(1-\rho_i) \left\{ \left[\alpha \pi_{t+p1} - E_t(\pi_{t+p1} | z_t) \right] + \beta \left[\bar{y}_{t+p2} - E_t(\bar{y}_{t+p2} | z_t) \right] + \gamma \left[w_{t+p3} - E_t(w_{t+p3} | z_t) \right] \right\} + \varepsilon_t$$

$E_t(\xi_t) = 0$ and $p1, p2, p3 \geq 0$ are the number of leads include in the model.

a_1, a_2 and a_3 are the short-run coefficients for inflation, output gap and exchange rate term respectively. The long-run coefficient can be constructed by dividing each of the short-run coefficients with the term $(1-a_4)$.

The nominal short-term interest rate rule (equation 1) implies the real interest rate target (Clarida et al. (1998)):

$$r_t^* = \bar{r} + (1-\alpha) \left[E_t(\pi_{t+p1} | z_t) - \pi^* \right] + \beta E_t(\bar{y}_{t+p2} | z_t) + \gamma E_t(w_{t+k} | z_t) \quad (4)$$

where

$$r_t^* = \tilde{i}_t - E_t(\pi_{t+p} | z_t)$$

$$\bar{r} = \bar{i}_t - \pi^*$$

Equation (4) illustrates that when $\alpha > 1$, the Taylor Principle is fulfilled i.e. the real interest rate is adjusted to stabilize inflation. On the other hand, it only accommodates the inflation if $\alpha \leq 1$. $\alpha \leq 1$ is consistent to the self-fulfillment of fluctuations in inflation and output. According to Favero (2001), it is discriminating to evaluate the behavior of central bank based on the value of α .

Based on equation (3), the Taylor principle is fulfilled when the short-run inflation coefficient $a_1 > 1$ and the long-run inflation coefficient $\left(\frac{a_1}{1-a_4} \right) > 1$ where the response of nominal interest rate to inflation target induces increase in real interest rate (Frömmel & Schobert (2006)). The output gains stability when the coefficient of policy reaction function responds to output gap is positive. In case it is negative, the output is in instability. The coefficient of exchange rate term, a_3 supposes to be positive using the bilateral exchange rate data (or negative using the nominal and real effective exchange rate data), i.e. the central bank might implement a tight monetary policy when the domestic currency depreciates. This chapter seeks to investigate the responses of policy reaction to exchange rate terms by imposing three types of exchange rate terms/ definitions (the monthly change in exchange rate, the annually change in exchange rate and the exchange rate gap).

Alternatively, if the time series are non-stationary, one can conduct the estimation approach that resembles the error correction formulation proposed by Judd and Rudebusch (1998).

$$\Delta i_t = \omega \left[i_{t-1} - \tilde{i}_t \right] + \kappa \Delta i_{t-1} + \eta_t \quad (5)$$

Substituting equation (1) into equation (5) gives:

$$\Delta i_t = b_0 + b_1 \pi_{t+p1} + b_2 \bar{y}_{t+p2} + b_3 w_{t+p3} + b_4 i_{t-1} + b_5 \Delta i_{t-1} + \eta_t \quad (6)$$

where

$$b_0 = \omega (\pi^* - \bar{i}); \quad b_1 = -\omega \alpha; \quad b_2 = -\omega \beta; \quad b_4 = \omega; \quad b_5 = \kappa$$

$$E_t(\eta_t) = 0$$

The short-run coefficients for inflation, output gap and exchange rate terms are b_1, b_2 and b_3 respectively. The long-run coefficients are calculated by dividing each of the short-run coefficients with b_4 .

The policy reaction functions (3) and (6) can be estimated using the Generalized Method of Moments (GMM). The vector of instrumental variables/ information set should not correlate with the disturbance term ε_t and $E_t(\xi_t | u_t) = 0$.

5.3.2 Methodologies

In general, the empirical studies apply two econometric approaches in estimating the policy reaction function: the single equation techniques (such as the Least Square method and Instrument Variable estimation) and the system equation approach (the VAR model). Each method has its advantages and shortcomings. This chapter focuses on the single equation technique/ model in estimating the Taylor type interest rate rule.

Empirical studies apply different single equation methods to estimate the Taylor type interest rate rule. These methods include the Ordinary Least Square estimation or OLS (for example McClauley & Klau (2004) and Mohanty and Klau (2004)), Two Stage Least Square or TSLS (Osawa (2006) and Ullrich (2003)) and Generalized Method of Moments or GMM (such as Ramayandi (2007), Eichengreen (2004) and Affandi (2004)). The main issue that one has to be cautious in estimating the policy reaction function is the endogeneity problem. As claimed in Osawa (2006), Ordinary Least Square (OLS) estimation may generate biased results due to the endogeneity problem and that including the crisis periods may generate excessive responses of policy reaction function to exchange rate due to the crisis effects. According to Jondeau & Le Bihan (2002), OLS method may generate biased estimators for two reasons. First, the error term is likely to be correlated with the future inflation rate given that the expected future inflation is not observable and it is replaced with the actual leaded inflation. Second, the current interest rate shock is likely to affect the future inflation. The Generalized Method of Moments (GMM) technique can provide more robust results as this technique solves the endogeneity problem that arises under the least square method.

Following the step of previous studies, this chapter applies GMM in estimating the monetary policy reaction functions for several East-Asian countries. Before conducting the estimation, all the series are tested with the Augmented Dicky-Fuller unit-root test. Later, Wald test is used to test the hypothesis to reveal how significant the policy reaction function reacts to the exchange rate movements. The following section discusses some econometric concepts for GMM and statistical tests.

5.3.2.1 Generalized Method of Moments (GMM)

Assume a single equation model:

$$y_t = x_t \beta + \varepsilon_t \quad (7)$$

where β is a $(p \times 1)$ vector of unknown parameters, y_t is a $(d \times 1)$ vector of dependent variables and x_t is a $(d \times p)$ vector of independent variables that observed

at date t ; $t=1, 2, \dots, T$. Assume also that $H = (h'_t, h'_{t-1}, \dots, h'_1)'$ is a $(Td \times 1)$ vector that contains all the observations in a T size sample given that $H = (y_T, X_T, Z_T)$ and $h = (y_t, x_t, z_t)$.

As discussed in **Chapter Three** the main idea of GMM is to choose a set of parameter estimates in order to match the theoretical relation as closely as possible:

$$E[m(\beta_0, y_t, x_t, z_t)] = 0$$

where β_0 is the true $(p \times 1)$ vector of unknown parameters, z_t is a $(n \times 1)$ vector of instrument variables or information set that orthogonal to the theoretical moment $m(\beta_0, y_t, x_t, z_t)$. The theoretical moment is replaced by the sample moment of T

$$\text{observations: } \bar{m}(\beta, y_T, X_T, Z_T) = \sum_{t=1}^T [m(\beta, y_t, x_t, z_t)] / T = 0$$

In this chapter, the monetary policy reaction function takes two different approaches of modeling as indicated in equation (3) and (6):

$$i_t = a_0 + a_1 \pi_{t+p1} + a_2 \bar{y}_{t+p2} + a_3 w_{t+p3} + a_4 i_{t-1} + \xi_t$$

$$\Delta i_t = b_0 + b_1 \pi_{t+p1} + b_2 \bar{y}_{t+p2} + b_3 w_{t+p3} + b_4 i_{t-1} + b_5 \Delta i_{t-1} + \eta_t$$

Each equation is a single equation and is estimated separately using different countries data. Both equations are estimated separately using the GMM technique. Here, y_t represents the observable interest rate for the first policy reaction function equation (3) but it stands for the observable of the change in interest rate for the second policy reaction function equation (6). x_t consists of all the independent variables, i.e. $\pi_{t+p}, \bar{y}_{t+q}, w_{t+k}$ and i_{t-1} where $p1, p2, p3=0, 1, 2, \dots$ for the first equation and also the second equation (plus Δi_{t-1} in the second equation). The vector of unknown parameters to be estimated consists of all the coefficients of the independent variables and the constant term. The instrument variables set z_t is chosen by referring to the previous studies such that $\text{cov}(\varepsilon_t, z_t) = 0$.

As the number of instrument variables exceeds the number of parameters, there are more moment and orthogonality conditions than the unknown parameters i.e. $n > p$. Under this over-identification case, the distance of i -th element in the sample moment to zero depends on the weight of i -th orthogonality condition. The problem is solved by minimizing the weighted sum squares of the violation of moment conditions in the data with respect to β . In other word, we minimize the weighted distance between the theoretical and actual values by considering p linear combinations of the n moment conditions²⁰:

$$\min_{\beta} \bar{m}'[(\beta, y_T, X_T, Z_T)]' A [(\beta, y_T, X_T, Z_T)] \bar{m}[(\beta, y_T, X_T, Z_T)] \quad (8)$$

A is a $(n \times n)$ weighting matrix. Any positive definite matrix of A will yield a consistent estimator of β . According to Hansen (1982), a necessary (but not

²⁰ see Chapter Three for more discussions

sufficient) condition to obtain an (asymptotically) efficient estimate of β is to set A as the inverse of the covariance matrix of the sample moments (Favero (2001)). If the optimal weighting matrix is $\Psi = \lim_{T \rightarrow \infty} T.E \left\{ \left[\bar{m}(\beta_0, y_T, X_T, Z_T) \right] \left[\bar{m}(\beta_0, y_T, X_T, Z_T) \right]' \right\}$, the minimization problem for the GMM estimates (8) becomes:

$$\min_{\beta} \bar{m}(\beta, y_T, X_T, Z_T)' \Psi^{-1} \bar{m}(\beta, y_T, X_T, Z_T) \quad (9)$$

This chapter applies the White's Heteroskedasticity Consistent Covariance Matrix estimation method in GMM in constructing the weighting matrix. This option uses a weighting matrix that is robust to heteroskedasticity and contemporaneous correlation of unknown form. Applying the concept of White (1980) to GMM estimator, the weighting matrix can be consistently estimated when $m(\beta, y, x_t, z_t)$ is conditionally heteroskedastic. The optimal weighting matrix Ψ can be consistently estimated (see Hamilton (1994)) by:

$$\hat{\Psi}_T \equiv \frac{1}{T} \sum_{t=1}^T \left[m(\hat{\beta}_T, y_t, x_t, z_t) \right] \left[m(\hat{\beta}_T, y_t, x_t, z_t) \right]' \xrightarrow{p} \Psi$$

where $\hat{\beta}_T$ is consistent estimate of β_0 .

5.3.2.2 Hypothesis tests

As mentioned in **Chapter Three**, one should consider three main tests when applying the GMM technique, namely the endogeneity test of regressors, the exogeneity test for instruments and the test for the relevance of instruments.

The test for endogeneity is used to check the heteroskedasticity condition of the disturbance in the model and it is called the Hausman test. Based on the monetary policy reaction function of equation (3), the null hypothesis is there is no correlation between the regressor $x_t = (\pi_{t+p}, \bar{y}_{t+q}, w_{t+k}, i_{t-1})$ and the disturbance term ξ_t :

$$\text{cov}(\xi_t, x_t) = 0$$

In case this condition is violated, i.e. $\text{cov}(\xi_t, x_t) \neq 0$, then at least one of the regressors are correlated with the error term. OLS is no longer consistent and one should call for the instrument variable (IV) method or GMM.

The main idea of Hausman test is to compare two sets of estimates, where the first estimator $\hat{\beta}_c$ is the consistent and efficient estimator of β under both the null and alternative hypotheses whereas the second estimator $\hat{\beta}_e$ is only consistent and efficient under the null hypothesis. The Hausman statistic can be written as:

$$H = \hat{q}' \left[\text{var}(\hat{q}) \right]^{-1} \hat{q} \quad (10)$$

which is asymptotically χ_K^2 distributed under the null hypothesis. K is the dimension of β . The difference between these two estimators and the difference in variance are defined as:

$$\hat{q} = \hat{\beta}_c - \hat{\beta}_e$$

$$\text{var}(\hat{q}) = \text{var}(\hat{\beta}_c) - \text{var}(\hat{\beta}_e)$$

There are different ways to conduct the Hausman test. One of the approaches is to estimate the auxiliary regression (Baltagi (2002) and Baum et al. (2003)). Under the auxiliary regression strategy, the Hausman test is carried out by running two OLS regressions (equations (12) and (13)) where the structural equation is based on the difference between OLS and IV estimation in the following matrix form (Baum et al. (2003)):

$$y_t = x_{1t}\beta_1 + x_{2t}\beta_2 + \xi_t = x_t\beta + \xi_t \quad (11)$$

$$x_{1t} = z_{1t}\Gamma_1 + x_{2t}\Gamma_2 + \nu_t = z_t\Gamma + \nu_t \quad (12)$$

such that the regressors $x_t = [x_{1t} \ x_{2t}] = [x_{1t} \ z_{2t}]$ where x_{1t} and x_{2t} are the endogenous and exogenous regressors respectively. The instrument variable set z_t is partitioned as the excluded z_{1t} and included instruments z_{2t} respectively or $z_t = [z_{1t} \ z_{2t} \equiv x_{2t}]$ (see Baum et. al (2003)). Based on the monetary policy reaction function of equation (3), $y_t = i_t$ as the left hand side endogenous variable, $x_{1t} = \pi_{t+p}$ represents the right hand side endogenous variable and $x_{2t} = (\bar{y}_{t+q}, w_{t+k}, i_{t-1})$ as the exogenous variables. It is assumed that z_t is the instrument set that is correlated with x_{1t} but uncorrelated with ξ_t . Under this assumption, estimating on (12) is equivalent to test the correlation of ν_t and ξ_t . Exogeneity of z_t implies that $\hat{\nu}_t$ is a consistent estimate of ν_t under the OLS estimation on (12). The endogeneity test is simply based on the t-test of the significant of $\hat{\nu}_t$ in the following auxiliary regression:

$$y_t = \beta_1 x_{1t} + x_{2t}\beta_2 + \phi \hat{\nu}_t + \vartheta_t \quad (13)$$

The null hypothesis is OLS is consistent estimates or $\phi=0$. The rejection of the null hypothesis means $\text{cov}(\xi_t, x_t) \neq 0$ and one should choose IV or GMM technique.

The second and third tests are the tests to check the suitability of the instrument variables, i.e. the tests for the relevance and validity of instruments. The relevance of instruments means that the endogenous variable should have strong correlation with the instruments. The relevance test is conducted by examining the fit of the first stage regression, i.e. the reduced form regression of the suspected endogenous variable on the instrument and exogenous variables. A rule of thumb for a single endogenous regressor is the joint significant of the instrument F-statistic should be greater than 10 in order to satisfy the relevance condition (Baum et. al. (2003)).

In this chapter, the suspected endogenous variable is π_{t+p} . As the expected inflation data (for $p>0$) is not observable, the expected inflation is obtained by using the lead of the current inflation data. Hence, the construction of the expected inflation series is highly correlated with and determined by the previous and current inflation and other variables. The first stage regression is carried out by regressing π_{t+p} on the exogenous variables and the instrument set, i.e. the one to four lagged terms of inflation, output gap, the change in exchange rate and interest rate.

The overidentifying restriction test is carried out to check the orthogonality conditions and correct model specification under the overidentification case. As discussed in

Favero (2001), the minimization problem in GMM can be used to construct the J-statistic to test the validity of over-identifying restriction.

$$T \cdot \left\{ \bar{m} \left[\left(\hat{\beta}, y_T, X_T, Z_T \right) \right]' \hat{\Psi}^{-1} \bar{m} \left[\left(\hat{\beta}, y_T, X_T, Z_T \right) \right] \right\}_{H_0} \stackrel{a}{\sim} \chi_{n-p}^2 \quad (14)$$

The J-statistic multiplied by the number of observation/ sample T is an asymptotically χ_{n-p}^2 distribution with $(n-p)$ degrees of freedom where $n \geq p$ (as a necessary condition of restriction/ identification on parameters). The validity of restrictions is satisfied when one cannot reject the null hypothesis of valid over-identification. The rejection of the null hypothesis implies the failure in the orthogonality conditions which may due to the incorrectly instrument or untruly exogeneity condition of instruments. For more details about the method of GMM and hypothesis tests, see **Chapter Three**.

5.3.2.3 Augmented Dicky-Fuller Test and Wald test

Augmented Dicky-Fuller Test (ADF) is used to test the unit-root in a time series sample. In order to test the unit-root condition of a series, we assume an AR(1) process:

$$y_t = c + \hat{\rho} y_{t-1} + \varepsilon_t \quad (15)$$

In case $-1 < \hat{\rho} < 1$, y_t is a stationary series. At the other end, y_t exhibits an unit-root or non-stationary if $\hat{\rho} = 1$. The series is explosive if $\hat{\rho} > 1$. The null hypothesis is to assume an unit-root in the series.

$$H_0 : \hat{\rho} = 1 \text{ versus } H_1 : \hat{\rho} < 1$$

The test is carried by subtracting both sides of the equation with y_{t-1} :

$$\Delta y_t = c + \gamma y_{t-1} + \varepsilon_t \text{ with } \gamma = \hat{\rho} - 1 \quad (16)$$

The lagged term in Δy_t is added into the equation to control higher-order correlation:

$$\Delta y_t = c + \gamma y_{t-1} + \delta_1 \Delta y_{t-1} + \dots + \delta_p \Delta y_{t-p} + \varepsilon_t \quad (17)$$

$$\text{and } H_0 : \gamma = 0 \text{ versus } H_1 : \gamma < 0$$

The test is carried out by applying the t-statistic, i.e. $t = \frac{\gamma}{SE(\gamma)}$. The null hypothesis of unit-root is rejected if the t-statistic is greater than the absolute critical value.

Wald Test is a test that used to investigate how statistically significant the relationship between the independent and dependent variables or how close the unrestricted estimates compare to the restrictions under the null hypothesis. In case the restrictions are true, the unrestricted estimates should come close to the value of the restricted estimates. In this case, the main focus is to test if the coefficient of exchange rate is zero.

$$H_0 : \hat{a}_3 = 0 \quad (\text{for equation (3)})$$

$$\text{or } H_0 : \hat{b}_3 = 0 \quad (\text{for equation (6)})$$

The Wald statistic is: $w = \frac{(\hat{a}_3 - 0)^2}{\text{var}(\hat{a}_3)}$ or $w = \frac{(\hat{b}_3 - 0)^2}{\text{var}(\hat{b}_3)}$ which is an asymptotically chi-

square distribution. If the test rejects the null hypothesis, the alternative hypothesis holds which implies a non-zero response of interest rate to exchange rate.

5.3.3 Data and estimations

The data are in monthly and are obtained from the IMF, spanning from 1990M1-1997M6 (period I, the pre-crisis) and 1999M1-2008M6 (period II, the post-crisis)²¹. These data include the consumer price index or CPI, industrial production index, interest rate and three data of exchange rate. For the policy interest rate, Indonesia uses the call money rate and the other countries use the money market rate. In order to check if the policy reaction functions of these countries respond to the exchange rate movements, this chapter uses three different data as the proxies for exchange rate namely the bilateral exchange rate of domestic currency to USD (EX), real effective (REER) and nominal effective (NEER) exchange rate (which are obtained from the BIS and IMF).

The inflation is in annual rate which is constructed as the log current CPI deviates from the log 12th lagged of CPI using the monthly data. The output gap is defined as the log difference between the industrial production index and its HP filtered trend series. There are three definitions for changes in exchange rate, i.e. the monthly change in exchange rate (DEX, DNEER and DREER, using three exchange rate data), annually change in exchange rate (DEX12, using the EX data) and exchange rate gap (GAPEX, using the EX data). The monthly change in exchange rate is constructed as the log difference of exchange rate series deviates from its one lagged term while the annually change in exchange rate is defined as the log difference of the current exchange rate series deviates from its 12th lagged term. On the other hand, the exchange rate gap uses the same definition of output gap, i.e. the log difference of exchange rate series deviates from its HP filtered trend series. Due to the data availability problem, only four countries are considered in the analysis namely Indonesia, Korea, Philippines and Thailand²².

In order to overcome the problem of endogeneity and excessive effect of crisis, this study conducts the analysis of monetary policy reaction function using the two sub-periods data which excludes the crisis periods in the estimation and applies the Generalized Method of Moments (GMM) technique to estimate equation (3). Previous studies apply different specifications of estimation. For example Ramayandi (2007) assumes p_2 and $p_3=0$ and imposes different leads for the inflation target, i.e. $p_1=0, \dots, 4$. Ullrich (2003) assumes contemporaneous term for both inflation and output gap as this specification generates more reasonable results. Clarida et al. (1998) assume contemporaneous in output gap and lead 12 months in inflation. This chapter assumes that the inflation rate is in forward-looking term but the output gap and exchange rate terms are in contemporaneous. Ramayandi (2007) demonstrates that the target forecast horizon for inflation differs across countries and the results

²¹ Period II for Korea starts from 1999M7 to exclude large volatility of interest rate in the beginning of 1999

²² The estimation of policy reaction function in Indonesia only covers for the post-crisis period due to the data availability problem.

favor the shorter horizon because when the longer forecast horizon is included, inflation shows a low power of forecast to track the interest rate policy reaction function. Ullrich (2003) even finds that the contemporaneous inflation in the policy reaction function fits the data the best for Euro. This chapter compares different lead lengths for inflation and finds that when the inflation is very forward-looking, the policy reaction function shows a worsen fit. The result is consistent to the results reported in Ramayandi (2007) that favor the shorter forecast horizon for inflation. For simplicity, this chapter only summarizes the results of estimation for three specification cases. In the first case, the model is in contemporaneous form ($p1=p2=p3=0$). In the second and third cases, the output gap and exchange rate term are in contemporaneous but inflation is in lead, i.e. inflation leads three months in the second case and leads six months in the third case ($p1=3, 6$ and $p2=p3=0$). The result based on the level equation (3) is compared with the result of alternative approach of equation (6) for robustness checking.

Previous studies apply different instrument variables as the information set. In general, these studies treat the past information or lagged terms of explanatory variables in the interest rate rule as the instrument variables. For example, Affandi (2004) includes six lags of interest rate, inflation, exchange rate, money and manufacturing index in the instrument set; Cavoli (2007) uses one to six lagged, the nine and twelve lagged of regressors as instrument variables; Ramayandi (2007) uses different lagged term of interest rate, inflation, output gap and annually change in exchange rate as instrument variables for different countries and Salas (2004) applies one to six lagged, the nine and twelve lagged of interest rate, inflation, output gap, foreign interest rate, the change in import price, real effective exchange rate and monetary base as instrument variables. This chapter includes one to four lagged terms of all explanatory variables in the policy rule as instrument variables (instrument set 1). In Korea (period I) that uses the exchange rate gap (GAPEX) in the estimation, DEX is added as the instrument variable as this generate better result with higher R-square. Testing for the relevance condition of instruments reveals the possibility of weak instruments for the forward-looking inflation term in the case where $p1=3, 6$ and $p2=p3=0$. Therefore, the number of instruments is increased by adding the leaded term of inflation which indicated as instrument set 2. Applying different instruments does not generate significant differences in the results. The policy reaction functions of equation (3) and (6) with different specifications are estimated using EViews 3.0. The GMM estimations apply the White covariance weighting matrix.

5.3.4 Results – econometrics counterpart

5.3.4.1 Statistical tests

The property of the time series is examined before conducting the estimation. The Augmented Dicky-Fuller (ADF) unit-root test is applied to check the stationarity condition of all variables. The unit-root test shows mixed results (see **Table C.1**). Not all variables are stationary in their levels as assumed to be stationary in the empirical analysis of monetary policy. ADF test fails to reject the unit-root/ non-stationarity in interest rate, inflation and annually change in exchange rate (DEX12) for each country considered in the analysis. According to Favero (2001), non-stationarity of time series might generate a spurious regression. From the aspect of economic view, non-stationarity means persistency in shock and this does not permit the study on

cyclical fluctuations separately from the long-run growth components. Since stationarity condition does not hold for all variables in each country, estimation through alternative error-correction approach could provide more consistent and robust results. Nevertheless, Ullrich (2003) indicates that estimation on the interest rate rule in level when stationarity does not hold for all variables does not change significantly the long-run coefficients. This chapter firstly conducts the estimation of interest rate rule in level (equation 3), followed by the estimation in differenced form (equation 6) for robustness comparisons.

Table C.1: Augmented Dicky-Fuller (ADF) Unit-root test

Variable	Indonesia	Korea		Philippines		Thailand	
	Period II	Period I	Period II	Period I	Period II	Period I	Period II
Interest rate	-1.8731	-2.5258	-3.4938***	-4.2224***	-2.8345*	-2.7779*	-8.3485***
Output gap	-2.9982**	-2.7717*	-3.3429**	-4.3456***	-4.4974***	-3.1214**	-4.1095***
Inflation	-4.8438***	-1.2888	-3.0492**	-2.1591	-2.7039*	-2.1039	-1.2717
DEX	-6.9786***	-3.7004***	-5.8545***	-5.1415***	-4.7841***	-4.6814***	-5.5306***
DEX12	-4.9261***	-2.2005	-2.8376*	-2.5575	-1.8063	-2.3832	-3.1922***
GAPEX	-3.6718***	0.5117	-2.5286	-1.4068	-3.0744**	-2.6186	-3.2493**
DNEER	-6.7483***	-4.9037***	-6.0864***	-4.3945***	-5.3749***	-4.7419***	-5.7336***
DREER	-6.1753***	-4.9310***	-6.4557***	-4.4532***	-5.5592***	-5.1559***	-5.7701***

Notes: * denotes a 10% significant level; ** denotes a 5% significant level and *** denotes a 1% significant level
The specification for the test includes a constant term with 2 lagged terms

As claimed by many empirical studies on monetary policy reaction function, OLS is not a good choice in estimating the policy reaction function due to the endogeneity problem. In order to decide the estimation technique (OLS versus GMM), the endogeneity test is conducted. The rule of thumb is the rejection of the Hausman statistic favors the application of GMM and the non-rejection implies the consistent estimates of OLS. **Table C.2** summarizes the results of Hausman test based on three different cases of specification, i.e. $p1=0, 3, 6$ and $p2=p3=0$ using the DEX data for exchange rate. The results demonstrate that when the policy reaction function targets on current inflation ($p1=0$ given that $p2=p3=0$), the condition $cov(\varepsilon_t, x_t) = 0$ holds. However, when the policy reaction function is in forward-looking form ($p1=3$ and 6 given $p2=p3=0$), this condition is violated. Attempting to compare the results of estimation under the same method with different specifications and structures (compare the case $p1=0, 3, 6$ and $p2=p3=0$ and different modeling structure of equation (3) and (6)), all the estimations applied to the same econometric technique of GMM. Since endogeneity problem is detected in many cases, it is reasonable to apply the GMM method.

After deciding on GMM technique, the next step is to check the fulfillment of the requirements for instruments, i.e. the relevance and validity of instruments. The test on the relevance of the instruments is based on the first stage regression, i.e. by regressing the endogenous regressor (inflation/ expected inflation) on the instrument set and exogenous variables. The relevance of instrument condition is satisfied if the F-statistic is greater than 10 (Baum et al. (2003)). The results of this test are summarized in **Table C.3a**. Testing with the instrument set of one to four lagged terms of all explanatory or exogenous variables in the policy reaction function (instrument set 1), F-statistic reveals the satisfactory of the relevance instrument when $p1=0$ but not in each case when $p1=3$ and 6 by controlling $p2=p3=0$. The results imply the decline in the correlation between the instruments and the endogenous variable (inflation or expected inflation) when the inflation is more forward-looking. Since the instruments are not strong enough, the number of instruments should be increased to sufficiently achieve the relevance condition for the case $p1=3, 6$;

$p2=p3=0$. Increasing the instrument variables i.e. the previous instrument variables plus the current and one to two leaded inflation terms for the case $p1=3$ or plus the three to five leaded terms in inflation (instrument set 2) helps to achieve the relevance condition. The results are summarized in **Table C.3b**.

Table C.2: Endogeneity test ($p1=0, 3, 6$ and $p2=p3=0$)

Coeff.	Indonesia	Korea		Philippines		Thailand	
	II	I	II	I	II	I	II
$P1=0$							
C	-0.0039	0.0214***	0.0019***	0.0954***	0.0090***	0.0147	0.0001
I(-1)	0.8156***	0.7202***	0.9749***	0.1659	0.9140***	0.7269***	0.9437***
YBAR	0.0828**	0.0080	0.0076***	-0.0262	0.0292***	-0.0351	0.0036
PIE	0.2199***	0.2539***	-0.0281***	0.2366*	-0.0599***	0.2318	0.0518***
DEX	-0.0306	0.2399	0.0046	-0.2070	0.0757***	-1.3540***	0.0079
RESID	0.0696	-0.0064	0.0147	0.1108	-0.0086	-0.3635	-0.0022
R-SQ	0.8158	0.7363	0.9808	0.0940	0.9507	0.6159	0.9652
SE	0.0173	0.0116	0.0009	0.0440	0.0042	0.0206	0.0022
DW	2.5322	1.7617	1.3286	1.9799	1.3081	1.9293	1.8190
$P1=3$							
C	-0.0048	0.0181**	0.0018**	0.0911***	0.0102***	-0.0005	-0.0004
I(-1)	0.8385***	0.7401***	0.9879***	0.1840*	0.8990***	0.6649***	0.9513***
YBAR	0.0701**	0.0214	0.0069**	-0.0315	0.0340***	-0.0145	-0.0020
PIE	0.2086**	0.2678***	-0.0433***	0.2623*	-0.0574**	0.6573*	0.0662***
DEX	-0.0584	0.2039	0.0060	-0.2577	0.0912***	-1.4425***	0.0155
RESID	-0.0882	-0.2980*	0.0416**	-0.1840	0.0619*	-0.3747	-0.0528**
R-SQ	0.8052	0.7339	0.9802	0.0942	0.9452	0.6321	0.9659
SE	0.0177	0.0117	0.0009	0.0440	0.0044	0.0201	0.0022
DW	2.6614	1.8367	1.3755	1.9841	1.2375	1.9065	1.9164
$P1=6$							
C	-0.0019	0.0139*	0.0015**	0.0841***	0.0102***	-0.0199	-0.0011*
I(-1)	0.9006***	0.7860***	0.9833***	0.1996*	0.8897***	0.5815***	0.9572***
YBAR	0.0620*	0.0196	0.0099***	-0.0253	0.0321***	-0.0488	-0.0084
PIE	0.1134	0.2371***	-0.0261	0.3221*	-0.0390	1.2055**	0.0871***
DEX	-0.0413	0.2370	0.0049	-0.3458	0.0913***	-1.5635***	0.0144
RESID	-0.0074	-0.3775**	0.0397*	-0.5067*	0.0561	-0.8944*	-0.0848***
R-SQ	0.7979	0.7327	0.9785	0.1077	0.9405	0.6479	0.9653
SE	0.0181	0.0117	0.0009	0.0437	0.0045	0.0197	0.0022
DW	2.6388	1.7928	1.2456	1.9559	1.2153	1.8499	1.9437

Notes:

The explanations for the notations are: C = a_0 ; I(-1) = a_4 ; YBAR = a_2 ; PIE = a_1 ; DEX = a_3

RESID = residual or error term; R-SQ= R square; SE = standard error of regression and DW = Durbin-Watson statistic; I indicates the use of sub-sample pre-crisis data and II the post-crisis data

*** denotes the 1% significant level; ** the 5% significant level and * the 10% significant level

The exchange rate is represented by the monthly change in exchange rate (DEX). The instrument variables are one to four lagged of explanatory variables.

Table C.3a: Testing for relevance of instruments – instrument set 1

Case	First stage regression	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
$P1=0$	F-stat	10.6778	96.4064	29.1990	276.6360	164.0300	35.1713	101.7400
$P2=p3=0$	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
$P1=3$	F-stat	4.6441	9.5071	7.4654	23.2734	13.7932	3.7030	13.6861
$P2=p3=0$	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
$P1=6$	F-stat	2.6119	9.8167	5.5436	10.6413	6.7076	0.8279	5.5498
$P2=p3=0$	Prob.	0.0029	0.0000	0.0000	0.0000	0.0000	0.6440	0.0000

Notes: The instrument set includes one to four lagged term of all explanatory variables in the policy reaction function. The first stage regression gives the information on the F-statistic and the significant probability.

Table C.3b: Testing for relevance of instruments – instrument set 2

Case	First stage regression	Indonesia		Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II	
$p1=3$	F	146.2010	13.5621	23.2338	238.9880	121.5380	24.8493	106.6660	
$p2=p3=0$	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	
$p1=6$	F	89.2865	16.3878	20.9349	186.3210	215.907	19.5463	76.7185	
$p2=p3=0$	Prob.	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	

Notes: The instrument set includes one to four lagged of all explanatory variables in the policy reaction function plus the current and one to two lead terms in inflation for $p1=3$, $p2=p3=0$ or plus three to five lead terms in inflation for $p1=6$, $p2=p3=0$.

Table C.4a: Overidentifying test – instrument set 1

	Equation (3)						Equation (6)	
	Case I: $p1=p2=p3=0$		Case II: $p1=3$, $p2=p3=0$		Case III: $p1=6$, $p2=p3=0$		Case I: $p1=p2=p3=0$	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
Indonesia								
(A) DEX		7.9785		8.2701		8.1360		6.7797
(B) DEX12		8.9019		8.8047		7.5920		9.6390
(C) DNEER		9.3636		9.2826		8.7520		7.8246
(D) DREER		8.6589		8.5860		7.9520		7.3305
(E) GAPEX		14.5557		14.6934		11.0960		12.3525
Korea								
(A) DEX	7.2990	14.1804	7.4970	18.1965	8.7210	17.1666	7.2270	11.8368
(B) DEX12	10.5570	12.1716	13.4910	13.4400	14.2200	13.5048	10.7910	11.1780
(C) DNEER	9.1800	14.5260	7.8930	14.4900	9.8910	13.9230	9.2700	10.6164
(D) DREER	10.1070	14.1804	8.4330	14.2590	10.6830	13.4538	10.7910	10.9080
(E) GAPEX	13.8150*	12.0096	13.311*	12.5895	13.0590*	12.7908	11.9160**	9.2340
Philippines								
(A) DEX	8.4510	14.5806	8.7030	9.3129	8.3700	6.4692	8.0910	16.0170
(B) DEX12	7.1550	9.9066	7.4070	9.7791	7.1010	7.3872	6.8310	12.0612
(C) DNEER	6.3180	10.7274	6.3630	9.5127	6.1020	6.0696	6.1830	10.7046
(D) DREER	6.6240	12.1524	6.5970	11.5884	6.2010	7.4628	6.4440	13.8738
(E) GAPEX	7.5690	11.9586	7.6050	17.6157	7.4610	15.2280	7.3350	20.5428
Thailand								
(A) DEX	12.1770	12.9732	12.4200	14.3967	11.3580	14.1912	12.1230	13.4634
(B) DEX12	15.8040	15.5952	16.9110	15.4623	16.7940	14.5800	15.4350	15.5724
(C) DNEER	9.9990	14.1930	8.4575	15.8286	9.6730	11.9772	9.9990	14.3184
(D) DREER	10.9710	12.9048	9.1885	14.5965	11.3475	11.0592	10.9800	12.5058
(E) GAPEX	15.3720	18.3312	14.4810	17.8599	15.5790	15.8760	15.1110	15.5838
Chi-square	19.7	19.7	19.7	19.7	19.7	19.7	21.0	21.0
No. of overid. Restr.	11	11	11	11	11	11	12	12

Notes: The numerical values in the table are obtained by multiplying sample size (T) with J-statistic obtained from GMM estimation. These values are compared with chi-square statistic at 5% level given the number of overidentifying restriction. * indicates the chi-square is 25.0 as there are 15 overidentification restrictions and ** indicates the chi-square is 23.7 as there are 14 overidentification restrictions

Before conducting the estimation, the validity of the instrument variables is checked by applying the overidentifying restriction test, i.e. the J-test. J-test is the test used to check the validity of moment restrictions when the number of instrument variables exceeds the number of unknown parameters. Overidentifying restriction is valid when one cannot reject the null hypothesis of valid over-identification. The results of J-test are summarized in **Table C.4(a & b)**. The values of $(T \times J)$ are compared with the chi-square statistic at 5% level at given numbers of overidentifying restriction, i.e. the number of restrictions or the number of instrument variables minus the number of parameters to be estimated. Testing with one to four lagged terms of all exogenous variables as the instruments (instrument set 1), overidentifying test reveals the qualified or validity of the overidentification conditions for $p1=0$, 3 and 6 given $p2=p3=0$. The instrument set 2 with additional lead term variables also satisfies the validity condition of overidentification.

Table C.4b: Overidentifying test – instrument set 2

	Equation (3)			
	Case II: $p1=3, p2=p3=0$		Case III: $p1=6, p2=p3=0$	
	Period I	Period II	Period I	Period II
<u>Indonesia</u>				
(A) DEX		12.2958		8.7600
(B) DEX12		10.4166		11.0960
(C) DNEER		14.1102		11.2320
(D) DREER		12.1095		9.0880
(E) GAPEX		15.3333		14.1040
<u>Korea</u>				
(A) DEX	10.1250	10.5117	9.8010	17.2476
(B) DEX12	8.3520	14.7186	9.1260	17.5392
(C) DNEER	11.6640	12.0324	9.8730	15.6060
(D) DREER	11.4660	13.2423	10.0530	17.9388
(E) GAPEX	9.0000	20.3796	9.0720	17.6904
<u>Philippines</u>				
(A) DEX	18.0360	19.1205	13.4550	18.0336
(B) DEX12	18.0540	14.3535	18.8370	14.8512
(C) DNEER	15.0750	15.2145	14.8950	14.5350
(D) DREER	15.2370	14.5845	14.9040	14.1066
(E) GAPEX	9.5220	16.8525	7.8840	15.5856
<u>Thailand</u>				
(A) DEX	14.7780	21.6783 ⁺	12.4650	22.7988
(B) DEX12	18.8010	17.9931 ⁺	17.7300 ⁺	19.0404
(C) DNEER	9.9960	21.2343 ⁺	10.0470 ⁺	21.2220
(D) DREER	9.9365	22.1667 ⁺	11.4325 ⁺	21.8268
(E) GAPEX	15.7410	21.5118 ⁺	15.6420 ⁺	21.7728
Chi-square	23.7	23.7	23.7	23.7
No. of overid. Restr.	14	14	14	14

Notes:

The numerical values in the table are obtained by multiplying sample size (T) with J-statistic obtained from GMM estimation. These values are compared with chi-square statistic at 5% level given the number of overidentifying restriction. ⁺ indicates the chi-square is 22.4 as there are 13 overidentification restrictions

5.3.4.2 Estimation results

Next, we turn to the estimation results. As the relevance instrument test indicates the value of F-statistic below 10 when $p1=3$ and 6 given $p2=p3=0$ for instrument set 1, instrument set 1 may not sufficiently strong to explain the endogenous regressor in the case when $p1=3$ and 6, $p2=p3=0$. In order to obtain more robust estimation, this chapter conducts the estimation of GMM using both instrument set 1 and 2. Consider first the results of equation (3) under three specifications ($p1=0, 3$ and 6 given $p2=p3=0$) and using different definition for the change in exchange rate proxy for different exchange rate data by applying the instrument set 1. The results are summarized in **Table C.5(a, b & c)**. The results indicate that the policy reaction function (3) fits the data very well in the post-crisis period with very high R-square. It fits the data badly in Philippines in the pre-crisis period. One of the explanations for the good fit of data for the policy reaction function in the post-crisis period is the setup of the short-term interest rate as the policy instrument after the crisis in East-Asian countries. There was no clear policy instrument in these countries in the pre-crisis period.

Comparing the results under different specifications ($p1=0, 3$ and 6, $p2=p3=0$), it is observed that the policy reaction functions in East-Asia react strongly to the interest rate smoothing term, indicating the gradual adjustments in the short-term interest rate by the authorities in these countries. In general, the policy reaction functions in East-Asia also react significantly to the output gap and inflation, indicating the concern of

the authorities on output gap and inflation stability. The results do not show significant differences under different model specification ($p1=0, 3$ and $6, p2=p3=0$). Comparing the results between the two sub-periods, significant changes are observed in the policy reactions in these countries. The policy reaction functions in these countries tend to react stronger to the interest rate smoothing term but react weaker to the output gap and inflation. In some cases, the coefficients of inflation have declined closely to zero or non-significant in the post-crisis period.

Table C.5a: Policy reaction function
Case I: ($p1=p2=p3=0$), equation (3) – instrument set 1

Coefficient	Indonesia	Korea		Philippines		Thailand	
	Period II	Period I	Period II	Period I	Period II	Period I	Period II
(A) with DEX							
C	0.0034	0.0212***	0.0012*	0.0728***	0.0097***	0.0116	-0.0002
I(-1)	0.8669***	0.7072***	0.9899***	0.3046**	0.8862***	0.6659***	0.9589***
YBAR	0.0692*	0.0762	0.0016	0.0301	0.0235*	0.0593	0.0046
PIE	0.1069*	0.2509***	-0.0231**	0.2321*	-0.0311**	0.3454*	0.0556***
DEX	-0.0851	0.5536	0.0086	-0.3240	0.0343	-1.1350	0.0594
R-SQ	0.8035	0.7118	0.9787	0.0578	0.9452	0.5846	0.9580
DW	2.6290	1.7000	1.2037	2.2071	1.1260	1.8222	1.6900
J-stat	0.0985	0.0811	0.1313	0.0939	0.1279	0.1353	0.1138
(B) with DEX12							
C	-0.0100	0.0277***	0.0016*	0.0740***	0.0095***	0.0064	-0.0001
I(-1)	0.9614***	0.6691***	0.9777***	0.3215***	0.8701***	0.6561***	0.9414***
YBAR	0.1665***	0.1160**	0.0105***	0.0954	-0.0119	-0.0406	0.0081
PIE	0.1678**	0.2547***	-0.0212*	0.2057	-0.0040	0.4862**	0.0553***
DEX12	-0.0019	0.0130	0.0015	-0.0194	0.0099**	-0.0793	-0.0028
R-SQ	0.7902	0.7053	0.9792	0.0457	0.9307	0.5536	0.9643
DW	2.4368	1.7537	1.2481	2.2790	1.0404	1.7056	1.8287
J-stat	0.1099	0.1173	0.1127	0.0795	0.0869	0.1756	0.1368
(C) with DNEER							
C	0.0017	0.0282***	0.0013**	0.0625***	0.0082***	0.0115	-0.0004
I(-1)	0.8919***	0.6538***	0.9840***	0.4258***	0.8915***	0.6660***	0.9538***
YBAR	0.0705*	0.1438**	0.0048	0.1562	0.0108	0.0642	0.0012
PIE	0.1037*	0.2714***	-0.0205**	0.1890	-0.0181	0.3733*	0.0643***
DNEER	0.0959	-0.0634	-0.0072	-0.4642	-0.1368***	-0.5705	-0.0549**
R-SQ	0.7977	0.6871	0.9797	-0.0295	0.9374	0.5299	0.9615
DW	2.7083	1.7455	1.2517	2.4324	1.3151	1.7818	1.7577
J-stat	0.1156	0.1020	0.1345	0.0702	0.0941	0.1111	0.1245
(D) with DREER							
C	0.0015	0.0281***	0.0014**	0.0654***	0.0090***	0.0108	-0.0004
I(-1)	0.9964***	0.6617***	0.9831***	0.3990***	0.8813***	0.6799***	0.9536
YBAR	0.0680	0.1183**	0.0054	0.1668	0.0140	0.0323	-0.0013
PIE	0.1076*	0.2629***	-0.0203**	0.2097*	-0.0112	0.3675*	0.0654***
DREER	0.0644	-0.0203	-0.0087	-0.5170	-0.1148**	-0.2922	-0.0591**
R-SQ	0.8024	0.7030	0.9797	-0.0255	0.9361	0.5616	0.9615
DW	2.6911	1.7501	1.2476	2.4106	1.2679	1.7721	1.7727
J-stat	0.1069	0.1123	0.1313	0.0736	0.1066	0.1219	0.1132
(E) with GAPEX							
C	-0.0032	0.0314***	0.0007	0.0696***	0.0095***	0.0146	0.0000
I(-1)	0.8704***	0.6909***	0.9926***	0.3939***	0.8763***	0.6500***	0.9504***
YBAR	0.1178**	0.2299***	0.0038	0.0641	0.0288*	-0.0228	0.0087
PIE	0.1699***	0.1800***	-0.0131	0.1411	-0.0155	0.3341*	0.0524***
GAPEX	0.0090	0.1015***	-0.0019	0.0348	-0.0224	-0.0569	0.0000
R-SQ	0.8090	0.6662	0.9797	0.0375	0.9314	0.5777	0.9648
DW	2.5117	1.9265	1.2376	2.4341	1.0421	1.8041	1.8750
J-stat	0.1797	0.1535	0.1112	0.0841	0.1049	0.1708	0.1608

Notes:

The explanations for the notations are as under **Table C.2**; a_3 as coefficient for different exchange rate representations. The instrument variables are one to four lagged of explanatory variables. DEX (one to four lagged term) are added as instrument variables in Korea (period I) in the estimation of case (E) as this gives better results.

Table C.5b: Forward-looking reaction function
Case II ($p1=3, p2=p3=0$), equation (3) – instrument set 1

Coefficient	Indonesia		Korea		Philippines		Thailand	
	Period II	Period I	Period I	Period II	Period I	Period II	Period I	Period II
(A) with DEX								
C	0.0046	0.0169**	0.0005	0.0678***	0.0144***	0.0058	-0.0005	
I(-1)	0.8635***	0.7211***	1.0020***	0.3903***	0.8348***	0.6581***	0.9651***	
YBAR	0.0435	0.1187*	0.0050	0.0910	0.0316**	0.0740	0.0000	
PIE	0.1004	0.2929***	-0.0155	0.1750	-0.0443**	0.4838*	0.0592***	
DEX	-0.1021	0.5326	0.0018	-0.2706	0.1271**	-1.3358**	0.0663	
R-SQ	0.7956	0.6789	0.9778	0.0332	0.9370	0.6059	0.9573	
DW	2.7058	1.6463	1.1672	2.3649	1.2157	1.8603	1.7517	
J-stat	0.1021	0.0833	0.1733	0.0967	0.0857	0.1380	0.1297	
(B) with DEX12								
C	-0.0137	0.0247***	0.0009	0.0678***	0.0103***	0.0006	-0.0003	
I(-1)	0.9058***	0.7106***	0.9902***	0.3798***	0.8637***	0.6512***	0.9597***	
YBAR	0.1601**	0.1282**	0.0120***	0.1165	-0.0063	-0.0346	0.0058	
PIE	0.2645***	0.2148***	-0.0200	0.1973	-0.0083	0.6148**	0.0536***	
DEX12	-0.0228	0.0149	-0.0004	-0.0260	0.0094**	-0.1832	0.0024	
R-SQ	0.7819	0.6907	0.9787	0.0261	0.9274	0.5747	0.9633	
DW	2.3459	1.7819	1.3195	2.3744	1.0259	1.7311	1.8274	
J-stat	0.1087	0.1499	0.1280	0.0823	0.0881	0.1879	0.1393	
(C) with DNEER								
C	0.0017	0.0238***	0.0016***	0.0568***	0.0115***	0.0009	-0.0008*	
I(-1)	0.8852***	0.6803***	0.9863***	0.4826***	0.8654***	0.6444***	0.9590***	
YBAR	0.0539	0.2018***	0.0103**	0.1742	0.0329*	0.0831	-0.0032	
PIE	0.1112	0.2878***	-0.0335**	0.1796	-0.0380*	0.6404**	0.0753***	
DNEER	0.1282	-0.0504	-0.0063	-0.4467	-0.1364***	-0.8051	-0.0531	
R-SQ	0.7895	0.6433	0.9786	-0.0592	0.9352	0.5342	0.9607	
DW	2.7742	1.7429	1.2971	2.4978	1.3481	1.8043	1.7389	
J-stat	0.1146	0.0877	0.1380	0.0707	0.0857	0.0995	0.1426	
(D) with DREER								
C	0.0018	0.0228***	0.0017***	0.0588***	0.0149***	-0.0014	-0.0009*	
I(-1)	0.8762***	0.6972***	0.9849***	0.4562***	0.8428***	0.6636***	0.9595***	
YBAR	0.0475	0.1804***	0.0103**	0.1783	0.0471***	0.0528	-0.0071	
PIE	0.1128*	0.2738***	-0.0347**	0.2081	-0.0658***	0.6619**	0.0813***	
DREER	0.0929	0.0101	-0.0109	-0.4843	-0.0782*	-0.5508	-0.0684**	
R-SQ	0.7947	0.6632	0.9784	-0.0464	0.9306	0.5726	0.9593	
DW	2.7497	1.7644	1.2982	2.4857	1.1759	1.7998	1.7404	
J-stat	0.1060	0.0937	0.1358	0.0733	0.1044	0.1081	0.1315	
(E) with GAPEX								
C	-0.0010	0.0333***	0.0008	0.0671***	0.0110***	0.0042	-0.0003	
I(-1)	0.8445***	0.7129***	0.9872***	0.4443***	0.8674***	0.6274***	0.9543***	
YBAR	0.0576	0.2716***	0.0052	0.0966	0.0246	-0.0090	0.0082	
PIE	0.1723**	0.0931	-0.0074	0.1026	-0.0278	0.6077*	0.0556***	
GAPEX	0.0128	0.1217***	-0.0049*	0.0363	-0.0069	-0.0527	0.0066	
R-SQ	0.7995	0.6344	0.9793	0.0126	0.9288	0.5858	0.9632	
DW	2.6276	1.9598	1.2630	2.5060	1.0318	1.7653	1.8241	
J-stat	0.1814	0.1479	0.1199	0.0845	0.1587	0.1609	0.1609	

Notes:

The explanations for the notations are as under **Table C.2**; a_3 as coefficient for different exchange rate representations. The instrument variables are one to four lagged of explanatory variables. DEX (one to four lagged term) are added as instrument variables in Korea (period I) in the estimation of case (E) as this gives better results.

Table C.5c: Forward-looking reaction function
Case III ($p1=6, p2=p3=0$), equation (3) – instrument set 1

Coefficient	Indonesia		Korea		Philippines		Thailand	
	Period II	Period I	Period II	Period I	Period II	Period I	Period II	
(A) with DEX								
C	0.0027	0.0107	0.0004	0.0635***	0.0144***	-0.0069	-0.0014**	
I(-1)	0.8873***	0.7705***	0.9925***	0.4178***	0.8295***	0.6130***	0.9680***	
YBAR	0.0240	0.1389**	0.0084**	0.1099	0.0229	0.0441	-0.0086	
PIE	0.1012	0.2884***	-0.0005	0.1928	-0.0311	0.8567**	0.0841***	
DEX	-0.0564	0.5479	0.0058	-0.3233	0.1815***	-1.3924*	0.0627	
R-SQ	0.7893	0.6489	0.9767	0.0074	0.9238	0.6010	0.9502	
DW	2.7063	1.6556	1.1529	2.3620	1.3862	1.6984	1.4743	
J-stat	0.1017	0.0969	0.1683	0.0930	0.0599	0.1262	0.1314	
(B) with DEX12								
C	-0.01322*	0.0216***	0.0007	0.584**	0.0086***	-0.0076	-0.0012***	
I(-1)	0.9291***	0.7439***	0.9911***	0.4336***	0.8706***	0.6613***	0.9731***	
YBAR	0.0988**	0.1436**	0.0139***	0.1376	-0.0219	-0.0697	-0.0030	
PIE	0.2381***	0.1972**	-0.0135	0.2294	0.0168	0.8384*	0.0739***	
DEX12	-0.0247	0.0137	-0.0009	-0.0269	0.0061	0.0099	0.0054	
R-SQ	0.7848	0.6673	0.9771	-0.0172	0.9143	0.5612	0.9573	
DW	2.4171	1.7760	1.3038	2.3978	1.0289	1.6729	1.5822	
J-stat	0.0949	0.1580	0.1324	0.0789	0.0684	0.1866	0.1350	
(C) with DNEER								
C	0.0001	0.0171**	0.0016**	0.0496**	0.0119***	0.0025	-0.0016***	
I(-1)	0.9135***	0.7479***	0.9767***	0.5223***	0.8532***	0.5891***	0.9551***	
YBAR	0.0288	0.2100***	0.0137***	0.2003	0.0277	0.0335	-0.0141	
PIE	0.2005	0.2586***	-0.0191	0.2112	-0.0224	0.7342	0.2043***	
DNEER	0.0818	0.0284	-0.0152	-0.4020	-	-0.0157	-0.0347	
R-SQ	0.7846	0.6238	0.9757	-0.1117	0.1563***	0.5070	0.9502	
DW	2.7805	1.7635	1.2902	2.4666	0.9273	1.6828	1.3362	
J-stat	0.1094	0.1099	0.1365	0.0678	1.3236	0.1138	0.1109	
(D) with DREER								
C	-0.0004	0.0164**	0.0017**	0.0484**	0.0129***	0.0041	-0.0016***	
I(-1)	0.9034***	0.7648***	0.9732***	0.5109***	0.8446***	0.6208***	0.9536***	
YBAR	0.0243	0.1843***	0.0147***	0.2065	0.0308*	-0.0021	-0.0178	
PIE	0.1144*	0.2318***	-0.0193	0.2541	-0.0240	0.6442	0.1068***	
DREER	0.0473	0.1073	-0.0184*	-0.4183	-	-0.5306	-0.0398	
R-SQ	0.7879	0.6466	0.9753	-0.1105	0.1252***	0.5712	0.9494	
DW	2.7576	1.7787	1.3008	2.4553	0.9254	1.6959	1.3333	
J-stat	0.0994	0.1187	0.1319	0.0689	1.2358	0.1335	0.1024	
(E) with GAPEX								
C	-0.0114	0.0340***	0.0007	0.0652**	0.0127***	0.0110	-0.0011**	
I(-1)	0.9077***	0.7271***	0.9855***	0.4663***	0.8509***	0.5929***	0.9542***	
YBAR	0.0674**	0.2876***	0.0064	0.1138	0.0300*	-0.0613	-0.0052	
PIE	0.2393***	0.0521	-0.0019	0.0967	-0.0351	0.5361	0.0822***	
GAPEX	-0.0480	0.1328***	-0.0048*	0.0423	-0.0096	-0.0718	0.0114	
R-SQ	0.7843	0.6157	0.9783	-0.0067	0.9214	0.5929	0.9560	
DW	2.4715	1.9533	1.2485	2.5136	0.9601	1.6851	1.4858	
J-stat	0.1387	0.1451	0.1254	0.0829	0.1401	0.1731	0.1470	

Notes:

The explanations for the notations are as under **Table C.2**; a_3 as coefficient for different exchange rate representations. The instrument variables are one to four lagged of explanatory variables. DEX (one to four lagged term) are added as instrument variables in Korea (period I) in the estimation of case (E) as this gives better results.

The response of short-term interest rate policy reaction function to the exchange rate movements is captured by the coefficients of exchange rate for DEX, DEX12, DNEER, DREER and GAPEX or a_3 . GMM estimation reports mixed results as the interest rate policy reaction functions react differently to the exchange rate movements using different exchange rate data, period and countries. In order to investigate how significant the responses of interest rate policy reaction functions to

the exchange rate movements and how far the GMM estimation holds, a hypothesis test is conducted to test if $a_3=0$ which is called the Wald Test. The rejection of the hypothesis implies significant response of interest rate to the exchange rate movements or $a_3 \neq 0$. The results of Wald Test are summarized in **Table C.6**. The results of Wald Test are consistent to the results of GMM estimation which indicates some evidences on the significant responses of interest rate to the exchange rate movements in Korea, Philippines and Thailand. The responses of interest rate to the exchange rate movements are more pronounced in the post-crisis period in Philippines and Thailand as Wald Test rejects the null hypothesis $a_3=0$ in these two countries for the post-crisis period under different exchange rate definitions. The policy reaction function in Indonesia does not show any significant reaction to the exchange rate movements.

Table C.6: Wald Test – equation (3), instrument set 1

Case I: $p1=p2=p3=0$								
Exchange rate	Wald test	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
DEX	Chi-stat Prob.	1.3516 0.2450	0.8801 0.3481	2.2360 0.1348	0.5346 0.4646	0.6787 0.4100	2.5024 0.1136	2.6800 0.1016
DEX12	Chi-stat Prob.	0.0085 0.9263	0.5884 0.4430	0.3232 0.5696	0.1208 0.7281	5.0816 0.0242	0.2352 0.6277	0.6416 0.4231
DNEER	Chi-stat Prob.	1.0033 0.3165	0.6996 0.4029	0.1765 0.6796	1.9895 0.1584	8.4584 0.0036	0.5306 0.4663	4.6579 0.0309
DREER	Chi-stat Prob.	0.7240 0.3948	1.2114 0.2710	0.0199 0.8878	2.2253 0.1357	5.5543 0.0184	0.1147 0.7348	6.1388 0.0132
GAPEX	Chi-stat Prob.	0.0622 0.8030	0.5420 0.4616	8.6737 0.0032	0.2186 0.6401	1.8815 0.1716	1.4408 0.2300	0.0000 0.9963
Case II: $p1=3, p2=p3=0$								
Exchange rate	Wald test	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
DEX	Chi-stat Prob.	2.1146 0.1459	0.0406 0.8402	1.8294 0.1762	0.3291 0.5662	6.7139 0.0095	4.0203 0.0449	2.7144 0.0994
DEX12	Chi-stat Prob.	0.6985 0.4033	0.0661 0.7969	0.3297 0.5658	0.1239 0.7248	4.7126 0.0299	1.1912 0.2750	0.3988 0.5277
DNEER	Chi-stat Prob.	1.7778 0.1824	0.4726 0.4918	0.0931 0.7602	1.7702 0.1833	9.1931 0.0024	1.1663 0.2801	2.7107 0.0997
DREER	Chi-stat Prob.	1.4446 0.2294	1.3526 0.2448	0.0043 0.9474	1.8155 0.1778	4.0178 0.0450	0.3900 0.5302	5.0370 0.0248
GAPEX	Chi-stat Prob.	0.1178 0.7314	3.6615 0.0557	9.0127 0.0027	0.2088 0.6477	0.1968 0.6573	1.2871 0.2566	0.9234 0.3366
Case III: $p1=6, p2=p3=0$								
Exchange rate	Wald test	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
DEX	Chi-stat Prob.	0.5316 0.4659	1.6884 0.1938	0.4495 0.5025	0.4041 0.5250	12.5385 0.0004	3.7433 0.0530	1.8439 0.1745
DEX12	Chi-stat Prob.	0.9882 0.3202	0.2640 0.6074	0.3948 0.5298	0.1126 0.7372	2.0957 0.1477	6.0040 0.9492	1.6580 0.1979
DNEER	Chi-stat Prob.	0.8385 0.3598	0.0261 0.8716	1.9958 0.1577	1.4729 0.2249	9.5081 0.0020	1.4275 0.2322	0.8012 0.3707
DREER	Chi-stat Prob.	0.4162 0.5188	0.4566 0.4992	2.9969 0.0834	1.3706 0.2417	7.1298 0.0076	0.3506 0.5537	1.0885 0.2968
GAPEX	Chi-stat Prob.	1.2812 0.2576	10.3713 0.0013	3.5883 0.0582	0.2912 0.5894	0.3557 0.5509	2.3103 0.1285	2.5884 0.1076

5.3.4.3 Robustness checking

Section 5.3.2.2 discusses the results of GMM estimation based on the instrument set 1 for $p1=0, 3$ and 6 given $p2=p3=0$. As the test for the relevance of instruments reveals that the instruments are of less relevance for the case $p1=3$ and 6 , one should pay caution on the estimation results based on the instrument set 1 for the case $p1=3$ and 6 given $p2=p3=0$. For the robustness comparison, the policy reaction equation (3) for $p1=3$ and 6 , $p2=p3=0$ is re-estimated using the second instrument set, i.e. the instrument set 2 which fulfills the tests for the relevance and overidentification of instruments. The results are summarized in **Table IV-(5a & b) in Appendix IV**. The estimation results using the second instrument set are very similar to the results reported in the previous section based on the first instrument set. The policy reaction functions in East-Asia react strongly to the interest rate smoothing term but the reactions to the output gap and inflation have declined substantially in the post-crisis period. The policy reaction functions in four East-Asian countries react differently to the exchange rate movements. As reported in **Section 5.3.2.2**, there are evidences that the policy reaction functions in Korea, Philippines and Thailand react to the exchange rate terms in the pre- and/ or post-crisis periods. Although instrument set 1 does not fulfill the relevance test for instruments in certain cases, it is valid in identifying the restrictions and generates results that are consistent to the results using the relevant and valid instrument set 2.

Turning to the issue of stationarity, as the unit-root test shows that some of the variables are not stationary in their levels, it is necessary to check the robustness of the regression of equation (3) with the results obtained using the other modeling approach. For the comparison purpose, the policy reaction function is estimated in the differenced form (equation (6)) as in Judd & Rudebusch (1998)) with the model specification of $p1=p2=p3=0$. Attempting to investigate how the estimation results vary under different modeling structure using the same econometric technique (i.e. modeling the policy reaction function in the level versus in the differenced term), both equation (3) and (6) should be estimated under the same estimation technique and instrument set. For the purpose of comparison, equation (6) is estimated using the same GMM technique and instrument set 1. The estimation results are summarized in **Table C.7**. The results of Wald Test are summarized in **Table C.8** while the results of overidentifying test are summarized in **Table C.4a**. Again, J-test shows that the instrument variables fulfill the overidentifying restrictions.

Table C.7 shows that the estimation results of equation (6) are very close to the results of equation (3) using the same specification (see **Table C.3**). The estimated coefficients of equation (6) are quite similar to the coefficients estimated using equation (3) in **Table C.3**. The signs of coefficients in **Table C.3** also hold in **Table C.7**, indicating that GMM estimation is robust²³.

²³ The very similar results also found using different specifications of $p1=3, 6, p2=p3=0$.

Table C.7: Robustness checking
Case I: ($p1=p2=p3=0$), equation (6) – instrument set 1

Coefficient	Indonesia		Korea		Philippines		Thailand	
	Period II	Period I	Period I	Period II	Period I	Period II	Period I	Period II
(A) with DEX								
C	-0.0016	0.0248***	0.0013**	0.0737***	0.0054***	0.0115	0.0000	
I(-1)	-0.1354***	-0.3224***	-0.0184	-0.6884***	-0.0622***	-0.3218***	-0.0380*	
PIE	0.1505**	0.2602***	-0.0158*	0.2102*	-0.0192	0.3220*	0.0488***	
YBAR	0.0775*	0.0706	0.0034	0.0137	0.0101	0.0671	0.0036	
DI	-0.3445***	0.0938	0.2664***	-0.0502	0.4483***	-0.0401	0.1059	
DEX	-0.1516*	0.4996	0.0070	-0.3793	0.0907**	-1.3543	0.0584	
R-SQ	0.2759	0.1528	0.2797	0.3984	0.4316	0.1665	-0.0126	
DW	2.0586	1.8246	1.8151	2.1141	2.0478	1.7829	1.8392	
J-stat	0.0837	0.0803	0.1096	0.0899	0.1405	0.1347	0.1181	
(B) with DEX12								
C	-0.0070	0.0326***	0.0010	0.0727***	0.0063***	0.0067	-0.0001	
I(-1)	-0.0526	-0.3701***	-0.0159	-0.6513***	-0.0976***	-0.3563***	-0.0581***	
PIE	0.1378**	0.2603***	-0.0109	0.1776	0.0142	0.5002**	0.0558***	
YBAR	0.0715	0.1004*	0.0081**	0.0905	-0.0345**	-0.0315	0.0083	
DI	-0.4206***	0.1234	0.1889**	-0.0788	0.3961***	0.0639	-0.0156	
DEX12	0.0254	0.0135	0.0000	-0.0287	0.0116***	-0.0667	-0.0025	
R-SQ	0.3104	0.1328	0.2618	0.3912	0.0829	0.1001	0.1289	
DW	2.0898	1.8843	1.6622	2.1678	1.6272	1.7991	1.8097	
J-stat	0.1190	0.1199	0.1035	0.0759	0.0626	0.1715	0.1366	
(C) with DNEER								
C	-0.0039	0.0341***	0.0011**	0.0627***	0.0052***	0.0115	-0.0003	
I(-1)	-0.1249***	-0.3968***	-0.0155	-0.0627***	-0.0667***	-0.3358***	-0.0439***	
PIE	0.1681***	0.2829***	-0.0164**	0.1971	-0.0167	0.3771*	0.0610***	
YBAR	0.0923*	0.1277**	0.0038	0.1621	0.0138	0.0644	-0.0006	
DI	-0.4232***	0.1360	0.2122***	0.0232	0.2316***	0.0113	0.0855	
DNEER	0.1515	-0.1178	-0.0010	-0.4799	-0.1143**	-0.5440	-0.0589**	
R-SQ	0.2678	0.0632	0.2662	0.3306	0.3054	0.0014	0.0538	
DW	1.9748	1.8720	1.7041	2.4557	1.7187	1.7960	1.8692	
J-stat	0.0966	0.1030	0.0983	0.0687	0.0939	0.1111	0.1256	
(D) with DREER								
C	-0.0044	0.0342***	0.0012**	0.0658***	0.0053***	0.0108	-0.0004	
I(-1)	-0.1249***	-0.3883***	-0.0165	-0.6112***	-0.0691***	-0.3206***	-0.0434***	
PIE	0.1682***	0.2734***	-0.0169**	0.2213*	-0.0081	0.3688*	0.0621***	
YBAR	0.0893**	0.1034*	0.0039	0.1772	0.0146	0.0323	-0.0037	
DI	-0.4055***	0.1218	0.2049***	0.0286	0.2677***	0.0027	0.1081	
DREER	0.1137	-0.0259	-0.0027	-0.5412	-0.0816*	-0.2781	-0.0665***	
R-SQ	0.2876	0.1195	0.2646	0.3311	0.3176	0.0655	0.0406	
DW	1.9776	1.8489	1.6848	2.4356	1.7303	1.7756	1.9139	
J-stat	0.0905	0.1199	0.1010	0.0716	0.1217	0.1220	0.1097	
(E) with GAPEX								
C	-0.0094*	0.0389***	0.0007	0.0675***	0.0052***	0.0154	0.0002	
I(-1)	-0.1228***	-0.3524***	-0.0111	-0.5855***	-0.0614***	-0.3660***	-0.0458***	
PIE	0.2180***	0.1457**	-0.0096	0.1245	-0.0167	0.3455*	0.0392***	
YBAR	0.0991**	0.2322***	0.0038	0.0515	0.0033	-0.0219	0.0054	
DI	-0.3288***	0.1562	0.1991***	-0.0734	0.3808***	0.0792	0.2494**	
GAPEX	0.0287	0.1054***	-0.0015	0.0129	0.0088	-0.0714	-0.0020	
R-SQ	0.3185	0	0.2573	0.3896	0.3118	0.1559	0.1035	
DW	2.0971	2.0987	1.6746	2.3155	1.7928	1.9298	2.2355	
J-stat	0.1525	0.1324	0.0855	0.0815	0.1802	0.1679	0.1367	

Notes:

The explanations for the notations are: C = b_0 ; I(-1) = b_4 ; YBAR = b_2 ; PIE = b_1 ; DEX, DE12, DNEER,

DREER, GAPEX = b_3 ; DI = b_5 ; R-SQ = R square; SE = standard error of regression and DW = Durbin-Watson

statistic. I indicates the use of sub-sample pre-crisis data and II the post-crisis data

*** denotes the 1% significant level; ** the 5% significant level and * the 10% significant level

The exchange rate is represented by the monthly change in exchange rate (DEX). The instrument variables are one to four lagged of explanatory variables.

Table C.8: Wald Test – equation (6): $p1=p2=p3=0$, instrument set 1

Exchange rate	Wald test	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
DEX	Chi-stat	3.2445	1.8525	0.5865	0.7827	6.1088	2.6362	2.1964
	Prob.	0.0716	0.1735	0.4437	0.3727	0.0134	0.1044	0.1383
DEX12	Chi-stat	1.4179	0.2336	0.0015	0.2808	12.2471	0.1669	0.4271
	Prob.	0.2337	0.5571	0.9684	0.5961	0.0004	0.6829	0.5134
DNEER	Chi-stat	1.7310	0.5639	0.0180	2.1155	6.4295	0.4479	5.1921
	Prob.	0.2337	0.4526	0.8931	0.1458	0.0112	0.5033	0.0227
DREER	Chi-stat	1.6942	0.0330	0.1565	2.3752	3.5400	0.0852	7.2286
	Prob.	0.1930	0.8557	0.6924	0.1233	0.0599	0.7704	0.0072
GAPEX	Chi-stat	0.8047	8.5020	0.3665	0.0252	0.4797	2.2833	0.0851
	Prob.	0.3697	0.0035	0.5449	0.8738	0.4885	0.1308	0.7704

Comparisons on the results also can be made by observing the actual and fitted policy reaction function. As shown in **Table IV-(7)**, **Appendix IV**, the actual and fitted dependent variable or interest rate policy reaction function exhibits the stochastic trend or non-stationary feature under equation (3). **Table IV-(8)**, **Appendix IV** shows the actual and fitted dependent variable under regression on equation (6). Since the dependent variable is stationary (ADF test shows that all variables are stationary in the differenced term), the actual and fitted dependent variable under the regression on equation (6) exhibits no trend/ stationary feature. Regression on equation (6) is more robust. On the other hand, comparisons on the results based on equation (3) and (6) show very similar results, indicating robust results using GMM technique.

5.3.5 Results – economic interpretations

Table C.5 (a, b & c) summarize the results of GMM estimations for equation (3) using different specifications (backward-looking/ forward-looking policy reaction function) using different exchange rate data (DEX, DEX12, DNEER, DREER and GAPEX) based on instrument set 1. Applying different specifications (backward-looking/ contemporaneous and forward-looking specifications with different leads) generate quite similar and consistent results. The values of coefficients and R-square also do not change much under different specifications. However, the value of R-square tends to be smaller when the policy reaction function is more forward-looking. The same result also reported in Ramayandi (2007). This is because when the inflation horizon is more forward-looking, inflation has lower forecast ability to explain the movements in interest rate.

In general the results show that the interest rate policy reaction function fits and explains the data of East-Asian countries very well in the post-crisis period. However, it explains poorly the data of Philippines in the pre-crisis period with very low value of R-square. This is because the short-term interest rate is only used as the policy instrument in most of the East-Asian countries aftermath the crisis period.

Comparing the results across four emerging East-Asian countries between the two sub-periods, it is observed that the coefficients for inflation, output gap and exchange rate become smaller whereas the smoothing coefficient is larger in the post-crisis period. The result implies lower volatility in interest rate in the post-crisis period since the degree of smoothing in interest rate is larger. The result also demonstrates that the monetary authorities in these countries do not have full influences or only impose partial adjustments on the short-term interest rate.

The low reactions to inflation, output gap and exchange rate do not necessarily reflect the low response of interest rate to these variables aftermath the crisis. The decline in the coefficients for these variables could be due to lower fluctuations or stability achieved in these variables in the post-crisis period.

Comparing the results across countries, it is observed that the policy rule in each country reacts differently to inflation, output gap and exchange in the two sub-periods. The policy reaction function in Indonesia reacts significantly to inflation in the post-crisis period. In Korea, the monetary authority is concerned about inflation in the pre-crisis period. However, the coefficient of the interest rate to react to inflation is either non significant or very small (close to zero or slightly negative) in the post-crisis period. The result for the post-crisis period indicates that Korea tends to pay higher concern on output gap targeting than inflation targeting in the post-crisis period. These results are consistent to the results reported in Osawa (2006). According to Osawa (2006), the non-significant reaction of monetary policy to inflation in Korea does not necessarily mean the failure of the inflation targeting policy but it could be due to the achievement of price stability and low inflation variations in Korea. The policy reaction function in Philippines does not show significant response to inflation and output gap in the pre- and post-crisis periods. Although these four countries have implemented the inflation targeting regime after the financial crisis of 1997-98, the results show that Indonesia and Thailand are the only countries which the policy reaction function still reacts significantly to inflation in the post-crisis period. The policy reaction function in these two countries also fulfills the Taylor principle where the long-run coefficient for inflation is larger than unity.

Apart from these results, the responses of policy reaction functions to exchange rate term differ across countries. The short-term interest rate in Korea reacts significantly to the exchange rate gap in the pre- and post-crisis period (as shown in the short-term interest rate rule with three and six leads in inflation). The short-term interest rate in Korea reacts significantly to the monthly change in exchange rate (DEX) using the pre-crisis period (as indicated in the interest rate rule with three and six leads in inflation). Besides, there are evidences that the monetary authority in Philippines and Thailand concern about the exchange rate stability in the post-crisis period. The policy reaction function in Philippines reacts significantly to the monthly and annually change in exchange rate (DEX, DEX12, DNEER and DREER) and Thailand to monthly change in exchange rate (DNEER and DREER) aftermath the crisis. The results indicate that the monetary authorities in these countries do not follow the official policy regime that they have declared. On the other hand, the monetary policy in Indonesia does not react significantly to the exchange rate movements aftermath the crisis.

5.4 How flexible the exchange rate regimes in East-Asia?

Many studies claim that emerging countries are vulnerable to shocks and fear to float the exchange rate. Emerging countries tend to hold larger amount of reserves and they are said to be floating with 'lifejacket' (Hausmann et al. (2001)). There are also arguments that the exchange rate floaters in emerging countries do not float their exchange rate in practice (Calvo & Reinhart (2002)). This section seeks to investigate how true these arguments apply to East-Asian countries.

According to Hausmann et al. (2001), the policy maker can influence the movements of exchange rate through intervention in the foreign exchange market and by adjusting the policy reaction function. Following the idea of Hausmann et al. (2001), two indicators are constructed to compare the willingness of the policy maker to float the exchange rate for the periods of pre- and post-crisis or after the change of policy regimes in several East-Asian countries. Four developed countries (Canada, Japan, U.K. and U.S.) are included as control cases for comparisons.

The first indicator measures the attempt of the policy maker to influence the movements of exchange rate through intervention in the foreign exchange market. It is constructed as the relative volatilities of exchange rate to that of reserves. The volatility of exchange rate is indicated as the standard deviation of growth rate in exchange rate and the volatility in reserves is the standard deviation of reserves normalized by the average broad money (M2) valued in USD. The first indicator or RVER can be written as $RVER = sdev(VE) / sdev(RES / \bar{M}2)$. The second indicator measures the intention of the policy maker to stabilize the exchange rate via interest rate adjustments. It is constructed as the relative volatilities of exchange rate to that of interest rate. The volatility in interest rate is defined as the change in interest rate. The second indicator is defined as $RVEI = sdev(VE) / sdev(IR)$. Under a fixed regime, both indicators give the value of zero. On the other hand, the value is infinity or very large for the case of purely floating.

The data are in monthly spanning from 1990M1-1997M6 (pre-crisis) and 1999M1-2008M6 (post-crisis). The data are obtained from the IMF and consist of the international reserves, interest rate, M2 and bilateral nominal exchange rate of national currencies over USD. All countries use the bilateral exchange rate of national currencies over USD to represent the exchange rate data except U.S. uses the nominal effective exchange rate. For the interest rate data, Korea, Philippines and Thailand uses the money market rate; Indonesia and Japan use the call money rate; Malaysia and U.K. use the interbank overnight rate; Canada uses the interbank money market rate; Singapore uses the 3-month interbank rate and U.S. uses the federal funds rate.

The results are summarized in **Table C.9**. The ratio of reserves over M2 in East-Asian countries is very high compare to that of developed countries and has increased over time, implying the condition where emerging countries tend to be floating with ‘lifejacket’ (Hausmann et al. (2001)). Singapore shows the highest ratio of reserves of 63% (period I) and 57% (period II). The developed countries hold a very small amount of reserves (in one digit percent). Comparisons of the first indicator (RVER) show that the values of this indicator for East-Asian countries are very small in compare to that of the developed countries. The values of RVER have increased in majority of the East-Asian countries after the shift of exchange rate regime to the more flexible one in these countries, implying higher flexibility of exchange rate regime and lower intervention from the authorities. However, the values of this indicator in the emerging countries still considerably very low compare to that of the developed countries. The results demonstrate some degrees of intervention in the foreign exchange market in these emerging countries which limit the flexibility of exchange rate in compare to the pure floating regime in the developed countries.

As in the case of the first indicator, the values of the second indicator in the emerging East-Asia are very small while that of the developed countries are very large. In

general, the values of RVEI have increased in these emerging countries after the crisis or after the shift of exchange rate regimes to the flexible one. However, the values of RVEI are still very low relative to that in the developed countries, implying no pure floating regimes or some degrees of intervention from the authorities in the emerging East-Asia to limit the movements in exchange rate.

TableC.9: Indicators for exchange rate flexibility

Countries	Ratio of reserve over M2		Volatility of exchange rate over reserves		Volatility of exchange rate over interest rate	
	Period I	Period II	Period I	Period II	Period I	Period II
Indonesia	0.1028	0.2273	0.0968	1.1789	0.1225	0.8840
Korea	0.0477	0.1253	0.5154	0.4607	0.6301	1.9927
Malaysia	0.2525	0.2728	0.1242	0.0543	2.0716	1.0175
Philippines	0.2496	0.4393	0.0545	0.1710	0.3974	0.5051
Singapore	0.6346	0.5732	0.0488	0.0995	2.0771	2.2878
Thailand	0.1789	0.2066	0.0825	0.2478	0.2228	1.0935
Canada	0.0345	0.0598	1.8553	3.5716	2.2323	5.4778
Japan	0.0183	0.0695	6.2045	0.9952	15.3270	18.3687
U.K.	0.0361	0.0138	20.3600	15.5517	5.2477	3.4804
U.S.	0.0161	0.0091	19.8267	21.0463	8.4054	8.2370

5.5 Conclusions

How flexible the exchange rate regime in emerging countries relative to the case of developed countries? Do the monetary authorities in emerging countries concern about the exchange rate stability under the floating exchange rate regime? To what extent the monetary authorities in these countries follow what they have claimed in the monetary policy assessment? There are arguments that emerging countries are fear to float their exchange rate by holding large amount of reserves. Although officially moving to the flexible regimes, many emerging countries are reluctant to float the exchange rate. This chapter seeks to answer the above questions and arguments by conducting two approaches of analysis based on the dataset of several East-Asian countries.

First, empirical analysis is carried out to estimate the policy reaction function in four East-Asian countries for the periods of pre- and post-crisis. Second, two indicators are constructed to compare the flexibility of exchange rate regimes in these countries for the two sub-periods as compare to the case of free floaters in the developed countries. The results reveal that the monetary authorities in East-Asian countries are concerned about the exchange rate stability. There are evidences that the central banks/ monetary authorities in East-Asia adjust interest rate to influence the exchange rate movements in the period aftermath the implementation of the flexible exchange rate regimes as they claimed not. Evidences of intervention in the foreign exchange market are also found. Although the flexibility in exchange rate has increased after moving to the flexible exchange rate regimes, the degree of flexibility is far smaller compare to the case of free floaters in the developed countries. The results imply some degrees of intervention from the authorities in East-Asia to limit the movements of exchange rate. Emerging East-Asian countries do not float freely as the free floaters in the developed countries in both the pre- and post-crisis periods of 1997-98.

References

- Adolfson,M. 2001. Monetary policy and exchange rates-breakthrough of pass-through. The Economic Research Institute, University of Stockholm.
- Adolfson,M. 2007. Incomplete exchange rate pass-through and simple monetary policy rules. *Journal of International Money and Finance* 26: 468-494.
- Affandi,Y. 2004. Estimating monetary policy rule in post crisis Indonesia. University of Cambridge and Bank Indonesia.
- Aminian,N. 2005. Economic integration and prospects for regional monetary cooperation in East Asia. *Structural Change and Economic Dynamics* 16: 91-110.
- An,S. & Schorfheide,F. 2006. Bayesian analysis of DSGE models. Singapore Management University & University of Pennsylvania. CEPR & NBER.
- Ball,L. 1999. Policy rules for open economies. In: Taylor,J.(Ed.), *Monetary policy rules*. University of Chicago Press, Chicago.
- Ball,L. 2000. Policy rules and external shocks. NBER working paper series 7910.
- Baltagi,B.H. 2002. *Econometrics*. Springer. Third edition.
- Batini,N. & Haldane,A. 1999. Forward-looking rules for monetary policy. In: Taylor,J.B ed. *Monetary policy rules*. NBER.
- Baum,G.F., Schaffer,M.E. & Stillman,S. 2003. Instrumental variables and GMM: estimation and testing. Boston college. Working paper no. 545.
- Ca'Zorzi,M., Hahn,E. & Sanchez,M. 2007. Exchange rate pass-through in emerging markets. European Central Bank. Working paper no. 739.
- Calvo,G.A. & Reinhart,C.M. 2002. Fear of floating. *Quarterly Journal of Economics*, 117(2): 379-408.
- Cavoli,T. and Rajan,R. 2003. Designing appropriate exchange rate regimes for East Asia: inflation targeting and monetary policy rules. University of Adelaide. Discussion paper no. 0309.
- Cavoli,T. and Rajan,R.S. 2007. Do monetary policy rules work for Asia? Queensland University of Technology.
- Cavoli,T. and Rajan,R.S. 2008. Open economy inflation targeting arrangements and monetary policy rules. *Indian Growth and Development Review* vol.1(2): 237-251.
- Choudhri,E.U. 2005. Monetary policy in a small emerging economy: exploring desirable interest rate rules. Carleton University.

-
- Christl,J. & Just,C. 2004. Regional monetary arrangements – Are currency unions the way forward? Proceedings of ONB workshops: 60 years of Bretton Woods – the governance of the international financial system – looking ahead. Oesterreichische National Bank.
- Clarida,R., Gali,J. & Gertler,M. 1998. Monetary policy rules in practice: some international evidence. *European Economic Review* 42(6): 1033-1067.
- Condon,T. 2006. Comments on: Inflation targeting in Korea: a model of success? In: *Monetary policy in Asia: approaches and implementation*. BIS papers no. 31. 165-167.
- Dennis,R. 2000. Optimal simple targeting rules for small open economies. Federal Reserve Bank of San Francisco.
- Devereux,M.B. 2001. Monetary policy, exchange rate flexibility and exchange rate pass-through. In: *Revisiting the case for flexible exchange rates*, 47-82. Proceeding of a conference held by the Bank of Canada. November 2000.
- Devereux,M.B. 2003. Exchange rate policy and endogenous price flexibility. University of British Columbia and CEPR.
- Devereux,M.B. & Lane,P.R. 2001. Exchange rate and monetary policy in emerging market economics. CEPR.
- Devereux, M.B., Lane, P.R. and Xu,J. 2005. Exchange rate and monetary policy in emerging market economies. The Institute for International Integration Studies Discussion paper series.
- Devereux,M.B. & Poon,D. 2004. A simple model of optimal monetary policy with financial constraints. The University of British Columbia.
- Davis,G.C. & Kim,S.Y. 2002. Measuring instrument relevance in the single endogenous regressor - multiple instrument case: a simplifying procedure. *Economics Letters* 74: 321-325.
- Edwards,S. 2006. The relationship between exchange rates and inflation targeting revisited. NBER working paper series no. 12163.
- Edwards,S. & Levy-Yeyati,E. 2005. Flexible exchange rates as shock absorbers. *European Economic Review* 49(8): 2079-105.
- Eichengreen,B.J. & Hausmann,R. 2003. Debt denomination and financial instability in emerging market economies. Manuscript, UC Berkeley.
- Eichengreen,B. 1999. *Toward a new international financial architecture: a practical post-Asia agenda*. Institute for International Economics.
- Eichengreen,B. 2004. Monetary and exchange rate policy in Korea: assessments and policy issues. University of California.

-
- Favero,C.A. 2001. Applied macroeconometrics. Oxford University Press.
- Florens,C., Jondeau,E. & Le Bihan,H. 2001. Assessing GMM estimates of the federal reserve reaction function. Banque de France. No. 83.
- Fraga,A. et al. 2003. Inflation targeting in emerging market economies. In: Getler, Mark & Keneth Rogoff, orgs. NBER Macroeconomics Annual 18. MIT Press: 365-400.
- Frömmel,M. & Schobert,F. 2006. Monetary policy rules in Central and Eastern Europe. Universität Hannover and Deutsche Bundesbank. Discussion paper no. 341.
- Fung,B.S.C. 2002. A VAR analysis of the effects of monetary policy in East Asia. BIS working papers no. 119.
- Gan, P.T. & Kwek,K.T. 2008. Estimating monetary policy rules: an optimal monetary conditions index for Malaysia. International Research Journal of Finance and Economics. Issue 14: 196-211.
- Garretsen,H., Moons,G. & Aarle,B. 2005. Monetary policy in the Euro area: an analysis using a stylized New Keynesian model. Utrecht University, University of Antwerp & University of Maastricht.
- Gerlach,S. & Kristen,P.G. 2006. Monetary policy regimes and macroeconomics outcomes: Hong Kong and Singapore. In: Monetary policy in Asia: approaches and implementation. BIS papers no. 31. 40-64.
- Goodfriend,M. 1991. Interest rates and the conduct of monetary policy. Carnegie-Rochester Conference Series on Public Policy 34: 7-30.
- Goodhart,C.A.E. 1995. The central bank and the financial system. The MIT Press.
- Greene,W.H. 2000. Econometric analysis. Prentice Hall International Inc. Fourth edition.
- Greene,W.H. 2003. Econometric analysis. Pearson Education International. Inc. Fifth edition.
- Hamilton,J.D. 1994. Time series analysis. Princeton University Press.
- Hansen,L.P. 1982. Large sample properties of Generalized Method of Moments estimators. Econometrica 50: 1029-54.
- Hausmann,R., Panizza,U. & Stein,E. 1999. Why do countries float the way they float? Journal of Development Economics 66: 387-414.
- Hausmann,R., Panizza,U. & Stein,E. 2001. Original sin, pass-through and fear of floating. Inter-American Development Bank.

-
- Hausmann,R., Panizza,U. & Rigobon,R. 2004. The long run volatility puzzle of the real exchange rate. NBER working paper no. 10751.
- Hoffmaister,A.W. & Roldós,J.E. 1997. Are business cycles different in Asia and Latin America? IMF working paper WP/97/9.
- Hochreiter,E. & Siklos,P.L. 2002. Alternative exchange rate regimes: the options for Latin America. *The North American Journal of Economics and Finance* 13: 195-211.
- Hsing,Y. & Lee,S.H. 2004. Estimating the Bank of Korea's monetary policy reaction function: new evidence and implications. *The Journal of the Korean Economy*. Vol 5, no.1: 1-16.
- Ito,T. & Sato,K. 2007. Exchange rate pass-through and domestic inflation: a comparison between East Asia and Latin American countries. RIETI discussion paper series 07-E-040.
- Ito,T., Sasaki,Y.N. & Sato,K. 2005. Pass-through of exchange rate changes and macroeconomic shocks to domestic inflation in East Asian countries. RIETI Discussion paper series 05-E-020.
- Jondeau,E. & Le Bihan,H. 2002. Evaluating monetary policy rules in estimated forward-looking models. A comparison of US and German monetary policies. *Annales D'Economie Et de Statistique*. No. 67/68.
- Judd,J.P. & Rudebusch,G.D. 1998. Taylor's rule and the Fed: 1970-1997. *FRBSF Economic Review* no. 3: 3-16.
- Kim,S. & Park,Y.C. 2006. Inflation targeting in Korea: a model of success? In: *Monetary policy in Asia: approaches and implementation*. BIS papers no. 31. 140-164.
- Kwack,S.Y. 2005. Exchange rate and monetary regime options for regional cooperation in East Asia. *Journal of Asian Economics* 16: 57-75.
- Levin,A., Wieland,V. & Williams,J.1998. Robustness of simple monetary policy rules under model uncertainty. National Bureau of Economic Research. Working paper 6570.
- Lindé,J., Nessén,M. & Söderström,U. 2004. Monetary policy in an estimated open economy model with imperfect pass-through. Sveriges Riksbank. Working paper no. 167.
- Maliszewska,M. & Maliszewski,W. 2004. Exchange rate: shock generator or shock absorber? Center for Social and Economic Research.
- Mariano,R.S. & Villanueva,D.P. 2006. Monetary policy approaches and implementation in Asia: the Philippines and Indonesia. In: *Monetary policy in Asia: approaches and implementation*. BIS papers no. 31. 207-226.

-
- McCallum,B.T. 2007. Monetary policy in East Asia: the case of Singapore. IMES discussion paper series 2007-E-10.
- McCauley,R.N. & Klau,M. 2006. Estimating a Taylor rule for Thailand (in) Understanding monetary policy in Malaysia and Thailand: objectives, instruments and independence.
- McClauley,R.N. 2006. Understanding monetary policy in Malaysia and Thailand: objectives, instruments and independence. In: Monetary policy in Asia: approaches and implementation. BIS papers no. 31. 172-198.
- Minella,A. et. al. 2003. Inflation targeting in Brazil. Constructing credibility under exchange rate volatility. *Journal of International Money and Finance*. 22: 1015-1040.
- Mohanty,M.S. & Klau,M. 2004. Monetary policy rules in emerging market economies: issues and evidence. BIS working papers no. 149.
- Mohanty,M.S. & Klau,M. 2004. Monetary policy rules in emerging market economies: issues and evidence. BIS working papers no. 149.
- Monetary Authority of Singapore. 2000. Kicking the habit and turning over a new leaf: monetary policy in East Asia after the currency crisis. Occasional paper no. 21.
- Nogueira Junior,R.P. 2007. Inflation targeting and the role of exchange rate pass-through. University of Kent.
- Osawa,N. 2006. Monetary policy responses to the exchange rate: empirical evidence from three East Asian inflation-targeting countries. Bank of Japan working paper series no. 06-E-14.
- Parrado,E. 2004. Inflation targeting and exchange rate rules in an open economy. IMF working paper WP/04/21.
- Ramayandi,A. 2007. Approximating monetary policy: Case study for the ASEAN-5. Padjadjaran University. Working paper no. 200707.
- Rudebusch,G.D. & Svensson,L.E.O. 1998. Policy rules for inflation targeting, in Taylor,J (ed.), *Monetary policy rules*. University of Chicago Press. 203-253.
- Sahminan. 2002. Exchange rate pass-through into import prices: empirical evidences from some Southeast Asian countries. The University of North Carolina at Chapel Hill. Incomplete draft.
- Salas,J.M. 2004. The Philippine Central Bank's monetary policy reaction function from 1992 to 2003. University of the Philippines.
- Sun,W. & An,L. 2008. Asymmetric shocks and exchange rate regimes in East Asia. *International Research Journal of Finance and Economics* 22: 38-48.

-
- Svensson,L.E.O. 2003. What is wrong with Taylor rules? Using judgment in monetary policy through targeting rules. *Journal of Economic Literature* 41: 426-477.
- Ullrich,K. 2003. A comparison between the Fed and the ECB: Taylor rules. Centre for European Economic Research. Discussion paper no. 03-19.
- Webber,A.G. 1999. Dynamic and long run responses of import prices to the exchange rate in the Asia-Pacific. University of Wollongong. Working paper series WP99-11.
- Welz,P. 2005. Quantitative New Keynesian macroeconomics and monetary policy. Uppsala Universitet.
- White,H. 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity. *Econometrica* 48: 817-38.
- Wollmershäuser,T. 2006. Should central banks react to exchange rate movements? An analysis of the robustness of simple rules under exchange rate uncertainty. *Journal of Macroeconomics* 28: 493-519.
- Zhu,Q. 2005. Does monetary policy matter for East Asian countries? An empirical study about policy efficiency and macroeconomic performance in pre-crisis and post-crisis eras. Emory University.

APPENDIX IV
Table IV-(1): Monetary policy in East-Asia after the crisis

No	Countries	Inflation Targeting	Policy rate	Objectives
1	Indonesia	Yes Explicit CPI targeting	Base money (before July 05) BI rate (since July 05)	Low and stable inflation and exchange rate
2	Korea	Yes 2-pillar system (CPI and M3, 1997-2000) Core CPI targeting (since 2001)	Call money rate since 1998 Bank of Korea rate (May 2008)	Price and output stability
3	Malaysia	No	Before 2004: 3-month intervention rate Since April 04: overnight interbank rate	Low price and sustainable economic growth
4	Philippines	Yes Core CPI targeting	Overnight rate (RP) and reverse repurchase rate (RRP)	Price stability and economic growth
5	Singapore	No	NEER since 1981	Price stability and economic growth
6	Thailand	Yes Core CPI targeting	14-day repurchase rate since 2000 1-day repo rate since Jan 2007	Low price and economic growth

Source: Bank for International Settlements, BIS (2006)

Table IV-(2): Highlights of inflation targeting arrangements in selected Asian economies (as of June 2008)

Country	Date of initiation of IT arrangement	Target price index	Target rate	Target horizon	Escape clauses	Accountability	Target set by	Publication
Indonesia	May 1999	Headline CPI	4 – 6% (for 2008)	3 years	None	None, but parliament can request reports at any time	Government in consultation Central Bank	Quarterly inflation report, annual report to public
Korea	Jan 1998	Core CPI (excluding non-cereal agricultural products and petroleum products).	2.5 – 3.5% (average over 2007-2009)	Indefinite (medium term target)	Changes caused by major force	None	Central Bank in consultation with government	Inflation report and submission to parliament, publication of monetary policy meetings
Philippines	December 2001	Headline CPI. Also monitors core CPI (excluding agricultural products and petroleum products)	3 – 5% (for 2008)	2 years	Yes, in the event of oil price shocks, food supply shocks	Public explanation of the nature of the breach and steps to address it	Government in consultation Central Bank	Quarterly inflation report, publication of monetary policy meetings
Thailand	April 2000	Core CPI (excluding fresh food and energy)	0 – 3.5%	Indefinite	None	Public explanation of breach and steps taken to address it	Central Bank in consultation with government	Inflation report, inflation forecasts and publication of models used

Source: Cavoli & Rajan (2008)

Table IV-(3): Empirical results on monetary policy in Asia

Name	Countries	Periods	Methods	Exchange rate	Specifications	Findings
Osawa (2006)	Korea Philippines Thailand	1998M4-2006M2 2002M1-2006M1 2000M5-2006M2	TSLS	EX	Taylor rule with the change in current and lagged in exchange rate terms and interest rate smoothing term	The policy reaction function in all three countries does not react to exchange rate.
Mohanty and Klau (2004)	Asia (Korea, Philippines, Thailand, Taiwan & India), Latin America, Central Europe and South Africa	1990's-2002 (quarterly data)	OLS, GMM	REER	Taylor rule with the change in current and lagged in exchange rate terms and interest rate smoothing term	The policy reaction function reacts to exchange rate significantly in most cases. The response of short term interest rate to inflation is higher in Asia and Latin America compare to Central Europe. The response of short term interest rate to output gap in Asia is lower than Latin America and Central Europe.
Gan & Kwek (2008)	Malaysia	1995Q1-2006Q4	OLS	REER	MCI (monetary conditions index)	The change in interest rate and the change in exchange rate influence output gap. Excluding the exchange rate term in monetary policy leads to high volatility in monetary conditions.
Affandi (2004)	Indonesia	Pre-crisis: 1993M1-1997M6 post-crisis: 1997M7-2003M9 1999M5-2003M9	GMM	EX	Traded and non-traded goods, policy reaction function responses to forward looking inflation, output gap, interest rate smoothing and exchange rate deviates from the target	The policy reaction function in Indonesia reacts stronger to domestic inflation (non-traded) than CPI inflation (traded). The reaction to expected inflation is higher after the crisis. The coefficient of interest rate react to exchange rate is very low, suggesting no significant effect of exchange rate on the adjustment of interest rate movements.
McClauley & Klau (2006)	Thailand	1993Q3-2005Q2 2000Q2-2005Q2	OLS	REER, EX, NEER	As in Mohanty and Klau (2004)	Extending the data series of Mohanty and Klau (2004) to 2005 gives different results: the responses of interest rate to inflation and exchange rate decline, when using data of inflation targeting periods (2000-2005), interest rate does not react significantly to exchange rate.
Hsing & Lee (2004)	Korea	1978Q1-2003Q2	VAR	EX	Interest rate is a function of output gap, inflation gap, exchange rate gap and stock price gap (deviation from the trend).	Interest rate reacts positively to inflation, output gap, exchange rate gap and stock market price gap. Inflation and exchange rate are more influential in the short run while output gap and stock price explain more the variation of interest rate in the long run.

Eichengreen (2004)	Korea	1998M1-2003M5	GMM	EX	Interest rate is a function of output gap, forward looking in both inflation and exchange rate and interest rate smoothing term	The policy reaction function in Korea reacts to output gap, inflation and real exchange rate. Exchange rate matters in determining the movements of interest rate.
McCallum (2007)	Singapore	1981Q1-2005Q4	OLS, IV	EX	The change in exchange rate is a function of inflation, output gap and exchange rate terms; exchange rate as the policy reaction function rather than interest rate	Monetary policy in Singapore does not give an independent role to real exchange rate (the policy reaction function does not react significantly to exchange rate terms). The policy in Singapore takes the form of periodical exchange rate adjustment rather than interest rate; it can be regarded as a variant of inflation targeting but not a exchange rate targeting.
MAS (2000)	Indonesia, Korea, Malaysia and Thailand	1990M1-1997M6 1990M1-2000M4	GMM	EX	Interest rate reacts to smoothing term, forward looking deviation inflation from trend, forward looking output gap and deviation of exchange rate from its trend	Using the first sample periods of pre-crisis, only the policy reaction function in Korea reacts significantly to exchange rate; using the second sample periods that include the crisis periods, 3 out of 4 policy reaction functions reacts significantly to exchange rate
Cavoli and Rajan (2007)	Indonesia, Korea and Thailand	1985M1-2006M12	GMM	EX, NEER	(1) interest rate policy rule reacts to expected/ current inflation, current output gap, expected/current exchange rate gap and smoothing term (2) the exchange rate gap policy rule reacts to its lagged term, expected/ current inflation and current output gap	The interest rate policy function reacts stronger to inflation but reacts weakly to exchange rate. The exchange rate policy reaction function fit the data better for pre-crisis periods than post-crisis periods, implying changes in regimes.

Table IV-(4): Definition of variable for policy reaction function

Variable	Definition	Data
Short-term interest rate (i)	In level	Money market rate/ call money rate
Annually inflation (π)	$\log CPI_t - \log CPI_{t-12}$	Consumer price index (CPI)
Output gap (y)	$\log IP_t - \log IP_t^{HP}$	Industrial production index (IP)
Monthly change in exchange rate DEX DNEER DREER	$\log EX_t - \log EX_{t-1}$ $\log NEER_t - \log NEER_{t-1}$ $\log REER_t - \log REER_{t-1}$	Bilateral exchange rate per USD (EX) Nominal effective exchange rate (NEER) Real effective exchange rate (REER)
Annually change in exchange rate (DEX12)	$\log EX_t - \log EX_{t-12}$	Bilateral exchange rate per USD (EX)
Exchange rate gap (GAPEX)	$\log EX_t - \log EX_t^{HP}$	Bilateral exchange rate per USD (EX)

Table IV-(5a): Forward-looking reaction function
Case II: ($p1=3, p2=p3=0$), equation (3) – instrument set 2

Coefficient	Indonesia	Korea		Philippines		Thailand	
	Period II	Period I	Period II	Period I	Period II	Period I	Period II
(A) with DEX							
C	0.0012	0.0231***	0.0006	0.0736***	0.0152***	0.0158*	-0.0006
I(-1)	0.8412***	0.7166***	1.0074***	0.3564***	0.8317***	0.6670**	0.9588***
YBAR	0.0565	0.1287**	0.0039	0.1135	0.0380***	0.0535	0.0054
PIE	0.1626***	0.1972***	-0.0268***	0.1613	-0.0575***	0.2595	0.0525***
DEX	-0.1032	0.3895	0.0014	-0.4109	0.1151***	-1.0604*	0.0121
R-SQ	0.7982	0.6869	0.9777	0.0261	0.9366	0.5998	0.9633
DW	2.6343	1.6897	1.1774	2.2709	1.1696	1.8437	1.7769
J-stat	0.1518	0.2004	0.1821	0.1125	0.0947	0.1642	0.1953
(B) with DEX12							
C	-0.0121	0.0272***	0.0011	0.0713***	0.0081***	0.0087	-0.0003
I(-1)	0.1091***	0.7008***	0.9862***	0.3684***	0.9077***	0.6889***	0.9658***
YBAR	0.1563***	0.1508***	0.0130***	0.1229	0.0202*	-0.0239	0.0071
PIE	0.2488***	0.1902***	-0.0203**	0.1747	-0.0306***	0.3750*	0.0454***
DEX12	-0.0153	0.0240	-0.0003	-0.0259	0.0080**	-0.0745	0.0037
R-SQ	0.7821	0.6769	0.9785	0.0279	0.9366	0.5780	0.9630
DW	2.3503	1.7530	1.3296	2.3510	1.1449	1.8376	1.8373
J-stat	0.1286	0.2006	0.1367	0.0928	0.1326	0.2089	0.1621
(C) with DNEER							
C	-0.0027	0.0257***	0.0015***	0.0575***	0.0130***	0.0092	-0.0004
I(-1)	0.8828***	0.7168***	0.9849***	0.4716***	0.8611***	0.6596***	0.9555***
YBAR	0.0842**	0.1659***	0.0105**	0.1309	0.0503***	0.0666	0.0001
PIE	0.1683***	0.1803***	-0.0303***	0.1683	-0.0625***	0.4379**	0.0508***
DNEER	0.1497	0.0244	-0.0063	-0.1611	0.1025***	-0.7234	-0.0112
R-SQ	0.7879	0.6709	0.9787	-0.0144	0.9351	0.5458	0.9635
DW	2.6710	1.7806	1.3015	2.5283	1.2956	1.8311	1.8028
J-stat	0.1742	0.1675	0.1449	0.1296	0.1084	0.1176	0.1913
(D) with DREER							
C	-0.0011	0.0237***	0.0017***	0.0573***	0.0137***	0.0048	-0.0008*
I(-1)	0.8801***	0.7395***	0.9834***	0.4533***	0.8535***	0.6719***	0.9633***
YBAR	0.0698*	0.1543***	0.0106**	0.1145	0.0493***	0.0552	-0.0073
PIE	0.1435***	0.1655***	-0.0329***	0.2017	-0.0584***	0.5140**	0.0598***
DREER	0.1110	0.1044	-0.0113	-0.0848	-0.0964**	-0.5323	-0.0503*
R-SQ	0.7941	0.6784	0.9785	0.0001	0.9318	0.5739	0.9615
DW	2.6879	1.7861	1.3078	2.5078	1.2638	1.8285	1.7730
J-stat	0.1495	0.1693	0.1389	0.1274	0.1193	0.1169	0.1997
(E) with GAPEX							
C	-0.0013	0.0428***	0.0010**	0.0727***	0.0111***	0.0159*	-0.0003
I(-1)	0.8225***	0.6633***	0.9936***	0.4157***	0.8831***	0.6468***	0.9589***
YBAR	0.0599	0.3763***	0.0048	0.0945	0.0254**	-0.0240	0.0097
PIE	0.1988***	0.0437	-0.0236**	0.0768	-0.0516***	0.3094	0.0440***
GAPEX	0.0202	0.1504***	0.0030	0.0363	0.0084	-0.0698	0.0089
R-SQ	0.7968	0.5403	0.9792	0.0235	0.9336	0.5935	0.9630
DW	2.5396	1.9138	1.2591	2.4548	1.0932	1.8300	1.8282
J-stat	0.1893	0.1058	0.1605	0.1000	0.1836	0.1749	0.1938

Notes:

The explanations for the notations are as under **Table C.2**; a_3 as coefficient for different exchange rate representations

The instrument variables are one to four lagged of explanatory variables. DEX (one to four lagged term) are added as instrument variables in Korea (period I) in the estimation of case (E) as this gives better results.

Table IV-(5b): Forward-looking reaction function
Case III ($p1=6, p2=p3=0$), equation (3) – instrument set 2

Coefficient	Indonesia	Korea		Philippines		Thailand	
	Period II	Period I	Period II	Period I	Period II	Period I	Period II
(A) with DEX							
C	0.0024	0.0157**	0.0003	0.0703***	0.0118***	0.0031	-0.004
I(-1)	0.8815***	0.7684***	0.9988***	0.3874***	0.8502***	0.6337***	0.9827***
YBAR	0.0227	0.0999	0.0079**	0.1453	0.0066	0.0521	-0.0003
PIE	0.1143***	0.2025***	-0.0060	0.1625	-0.0176	0.6021***	0.0282**
DEX	-0.0411	0.6597*	0.0031	-0.5462	0.0307	-1.2245*	0.0565
R-SQ	0.7883	0.6658	0.9767	-0.0168	0.9249	0.6120	0.9563
DW	2.6784	1.6705	1.1543	2.2693	0.9371	1.8051	1.6600
J-stat	0.1095	0.1495	0.1768	0.1089	0.1597	0.1385	0.2111
(B) with DEX12							
C	-0.0022	0.0205***	0.0007	0.0736***	0.0185***	-0.0010	-0.0008**
I(-1)	0.9499***	0.7723***	0.9883***	0.4651***	0.7821***	0.6746***	0.9817***
YBAR	0.0638	0.0878*	0.0131***	0.2501*	0.0140	-0.0739	0.0010***
PIE	0.1017**	0.1589**	-0.0107	0.0041	-0.0499***	0.6671***	0.0537
DEX12	0.0086	0.0152	-0.0011	0.0110	0.0103***	0.0282	0.0056
R-SQ	0.7888	0.6919	0.9777	-0.0547	0.9125	0.5765	0.9598
DW	2.6406	1.8155	1.3058	2.4598	0.7660	1.7521	1.7073
J-stat	0.1387	0.2093	0.1456	0.1014	0.1624	0.1970	0.1763
(C) with DNEER							
C	0.0011	0.0205***	0.0015**	0.0677***	0.0113***	0.0062	-0.0008
I(-1)	0.9039***	0.7700***	0.9775***	0.4947***	0.8647***	0.6023***	0.9716***
YBAR	0.0324	0.1522**	0.0135***	0.2781**	0.0272*	0.0336	-0.0008
PIE	0.1064**	0.1592**	-0.0191*	0.0326	-0.0260*	0.6297***	0.0546***
DNEER	0.0678	0.1082	-0.0144	-0.2671	-0.1259	-0.9548	0.0035
R-SQ	0.7856	0.6676	0.9759	-0.0863	0.9317	0.5194	0.9601
DW	2.7224	1.7923	1.2875	2.4872	1.2659	1.7177	1.6852
J-stat	0.1404	0.1655	0.1425	0.1097	0.1445	0.1182	0.1965
(D) with DREER							
C	0.0009	0.0197***	0.0017**	0.0674***	0.0157***	0.0049	-0.0010**
I(-1)	0.8987***	0.7801***	0.9756***	0.4865***	0.8177***	0.6233***	0.9769***
YBAR	0.0284	0.1375**	0.0143***	0.2874**	0.0296**	-0.0038	-0.0039
PIE	0.1084**	0.1458*	-0.0206*	0.0557	-0.0424***	0.6216***	0.0567***
DREER	0.0480	0.1439	-0.0171*	-0.2448	-0.0282	-0.5358	-0.0144
R-SQ	0.7879	0.6749	0.9756	-0.0827	0.9205	0.5725	0.9598
DW	2.7187	1.7889	1.2900	2.4842	0.8897	1.7033	1.6760
J-stat	0.1136	0.1656	0.1383	0.1117	0.1661	0.1345	0.2021
(E) with GAPEX							
C	-0.0010	0.0386***	0.0009*	0.0713***	0.0119***	0.0099	-0.0007
I(-1)	0.8923***	0.6802***	0.9853***	0.4795***	0.8492***	0.5922***	0.9739***
YBAR	0.0487	0.3925***	0.0043	0.2711*	0.0112	-0.0510	0.0079
PIE	0.1384***	0.0862	-0.0118	0.0089	-0.0199	0.5603***	0.0479***
GAPEX	0.0038	0.1580***	-0.0048**	0.0095	-0.0072	-0.0675	0.0113
R-SQ	0.7919	0.5239	0.9780	-0.0731	0.9182	0.5901	0.9603
DW	2.6019	1.9412	1.2348	2.4671	0.9261	1.6840	1.7350
J-stat	0.1763	0.0876	0.1528	0.1008	0.1638	0.1738	0.2016

Notes:

The explanations for the notations are as under **Table C.2**; a_3 as coefficient for different exchange rate representations

The instrument variables are one to four lagged of explanatory variables. DEX (one to four lagged term) are added as instrument variables in Korea (period I) in the estimation of case (E) as this gives better results.

Table IV-(6): Wald Test – equation (3), instrument set 2

Case II: $p1=3, p2=p3=0$								
Exchange rate	Wald test	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
DEX	Chi-stat Prob.	2.3079 0.1287	1.5330 0.2156	0.0321 0.8577	0.9027 0.3420	7.8708 0.0050	2.9187 0.0875	0.1435 0.7048
DEX12	Chi-stat Prob.	0.5636 0.4528	0.8076 0.3688	0.0466 0.8290	0.2404 0.6539	4.5273 0.0333	0.2258 0.6346	1.0230 0.3118
DNEER	Chi-stat Prob.	2.2529 0.1333	0.0241 0.8765	0.4461 0.5042	0.2929 0.5883	9.0138 0.0027	0.9932 0.3189	0.1639 0.6856
DREER	Chi-stat Prob.	2.1847 0.1394	0.5480 0.4591	1.6255 0.2023	0.0746 0.7847	5.8492 0.0156	0.9298 0.3349	3.4808 0.0621
GAPEX	Chi-stat Prob.	0.3675 0.5443	10.1377 0.0014	1.4466 0.2291	0.2069 0.6492	0.4694 0.4932	2.4759 0.1156	1.8226 0.1770
Case III: $p1=6, p2=p3=0$								
Exchange rate	Wald test	Indonesia	Korea		Philippines		Thailand	
		Period II	Period I	Period II	Period I	Period II	Period I	Period II
DEX	Chi-stat Prob.	0.3740 0.5408	2.9875 0.0839	0.1523 0.6963	1.2737 0.2590	0.6096 0.4349	3.8682 0.0492	0.7050 0.4011
DEX12	Chi-stat Prob.	0.2366 0.6266	0.3691 0.5435	0.5814 0.4457	0.0433 0.8351	7.5419 0.0060	0.0354 0.8507	1.9512 0.1624
DNEER	Chi-stat Prob.	0.6326 0.4264	0.4936 0.4823	2.2352 0.1349	0.9612 0.3269	7.7682 0.0053	0.7443 0.3883	0.0103 0.9192
DREER	Chi-stat Prob.	0.4366 0.5087	1.0496 0.3056	3.1412 0.0763	0.7136 0.3982	0.5304 0.4664	0.3664 0.5449	0.1824 0.6693
GAPEX	Chi-stat Prob.	0.0144 0.9044	12.2949 0.0004	4.0496 0.0442	0.0169 0.8966	0.2462 0.6197	2.4649 0.1164	2.6485 0.1036

Table IV-(7): Residual, Actual and fitted policy reaction function – equation (3)

Country	Period I	Period II
Indonesia		
Korea		
Philippines		
Thailand		

Specification: $p1=p2=p3=0$; exchange rate: DEX

Table IV-(8): Residual, Actual and fitted policy reaction function – equation (6)

Country	Period I	Period II
Indonesia		
Korea		
Philippines		
Thailand		

Specification: $p1=p2=p3=0$; exchange rate: DEX

CHAPTER SIX**ECONOMIC STRUCTURE, THE SOURCE OF SHOCKS AND THE
EFFECTIVENESS MONETARY POLICY IN THE EMERGING COUNTRIES
OF EAST-ASIA****Abstract**

This chapter analyzes the dynamic and the change in the structure of shocks in East-Asia between the pre- and post-crisis of 1997-98 in evaluating the performance of the monetary policy/ regime. In particular, the change in the structure of shocks is related to the change in the policy regime between the two sub-periods. The inter-relationship between the source of shocks and the change in the policy regime could be captured in the impulse response function and forecast error variance decomposition. The results indicate that the domestic economies of East-Asia are driven mainly by domestic shocks, in particular the supply. The effect of external shocks in East-Asia is relatively low in the pre-crisis period but it has increased significantly in the post-crisis period. Besides, East-Asian countries are subject to asymmetric country specific shocks where the relative importance of shocks differs across countries and the economic variables in these countries react differently to shocks. Exchange rate is a source of shock to itself but the variability of exchange rate shock has declined significantly in the post-crisis period. There are evidences on greater role of exchange rate to act as a shock absorber in two of the East-Asian countries aftermath the crisis. The monetary authorities in East-Asia are still concerned about the exchange rate stability in the post-crisis period. The results also indicate that the shift in the policy regime induces some changes on the behavior and structure of the economic variables, for example lower inflation and higher volatility in exchange rate. Overall, the results imply more influential and effective monetary policy of East-Asia in the post-crisis period.

6.1 Introduction

Does exchange rate play a better role as a shock absorber in the emerging East-Asian countries under the flexible exchange rate regime aftermath the crisis of 1997-98? Does the role of exchange rate in the monetary policy stance in these countries dependent on the structure of shocks and exchange rate regime? What are the main determinant to the economic fluctuations in East-Asia and if the structure of shocks change over time in these countries? These are the main questions addressed in this chapter.

The change in the business cycle fluctuations and the structure of shocks are important in the design of effective monetary policy and also for the evaluations of policy regimes. Previous studies show that the nature of shocks or the source of business cycle fluctuations is closely linked to the policy regimes. Economic theory tells us that floating regimes are more feasible in dealing with large external or real shocks as this regime provides less costly adjustments through relative prices. On the other hand, fixed regime is preferred under more prominent domestic or nominal shocks (Cavoli & Rajan (2003)). Besides, the source of shocks also matters in determining the real exchange rate changes and the effectiveness role of exchange rate as a shock absorber under the flexible exchange rate regime. Exchange rate has a room for stabilizing and can act as a shock absorber only when an economy experiences asymmetric shock compare to its trading partner (Artis & Ehrmann (2006)). Both theoretical and empirical analyses imply that the nature of shocks is crucial in determining the effectiveness and the choice of policy regimes. At the other end, policy regimes could be matter in determining the transmission and impact of shocks to the domestic economy (Desroches (2004) and Hoffmaister et al. (1997)).

For the purpose of analysis, a structural VAR model is applied to the data of several crisis-hit East-Asian countries and it has three main objectives. First, it seeks to reveal the main source of shocks for the business cycle fluctuations in these emerging countries. In particular, comparisons of the results are made to reveal if the relative importance of shocks changes between the pre- and post-crisis of 1997-98 and if shocks are symmetric across countries. Second, it seeks to investigate the role of exchange rate and the inter-relationship between exchange rate and policy regimes in these countries before and after the switch to the flexible regime. In particular, it seeks to reveal if exchange rate acts as a shock absorber or a source of shock to the domestic economy and if the change in policy regime entails different transmission mechanisms and impacts of shocks. Third, this chapter examines the effectiveness of monetary policy by investigating to what extent the short-term interest rate can influence movements in domestic supply and demand. The intuitions behind the analysis are two fold, i.e. the understanding on the source of business cycle fluctuations provides information for a proper policy design on one hand, and it improves policy assessments via evaluations on the policy regimes on the other hand.

The results indicate that the domestic economies of East-Asia are driven mainly by domestic shocks, in particular the supply or real shock in the pre- and post-crisis periods. External shocks although only explain a relatively low fraction in the economic fluctuations of this region in the pre-crisis period, its effect on the domestic economies has increased substantially in the post-crisis period. Besides, shocks are

asymmetric across East-Asian countries. Although exchange rate is a source of shock to itself, it is not destabilizing as the impact of exchange rate shock that has transmitted to the real economy has declined significantly in the post-crisis period. The results also reveal some evidences on greater or a better role in exchange rate to act as a shock absorber in two of the East-Asian countries in the post-crisis period. Comparing the results in the pre- and post-crisis periods, it is observed that the monetary authorities in these countries are concerned about output and exchange rate movements besides the stability in inflation after the shift to the flexible exchange rate regime and inflation targeting in the post-crisis period. Since exchange rate reacts to monetary policy shock, adjustment through exchange rate is possible to achieve stabilization. The results also indicate that the shift in the policy regime induces some changes on the behavior and structure of the economic variables, for example lower inflation and higher volatility in exchange rate. Overall, the results imply more effective monetary policy of East-Asia in the post-crisis period.

The remainder of this chapter proceeds as follows. Section two reviews the empirical literature on the relationship between monetary policy and the nature of shocks in emerging countries. Section three discusses the methodology and data. Section four reports the econometric results. Section five discusses the main findings based on economic interpretations. Section six concludes.

6.2 The source of shocks in East-Asia – some empirical reviews

Recent studies are interested to investigate the business cycle in emerging countries of East Asia aftermath the financial crisis and following greater integration in trade and financial in these countries. Most of these studies intend to investigate the similarity in economic structures, finance and politic aspects in several East-Asian countries as the criteria to form the optimum currency area (OCA) in this region. From the aspect of economic structure, the results indicate higher possibility to form the OCA if the business cycles or macroeconomics in these countries exhibit some similarities and shocks are symmetric.

Most studies report results that do not favor the formation of OCA for East-Asia as majority of these countries exhibit idiosyncratic and country specific shocks ((Chow & Kim (2003), Zhang et al. (2004), Sun and An (2008), Hoffmaister and Roldós (1997)). Sun and An (2008) and Hoffmaister and Roldós (1997) find that domestic supply shock leads to the main fluctuations of these economies. External shocks only explain a small part of the economic fluctuations in these countries. On the other hand, a number of studies find significant correlations of shocks in a subset of East-Asian countries ((Kwan (1994)), Eichengreen & Bayoumi (1996), Bayoumi et al. (2000) and Zhang et al. (2004)). For example, Bayoumi et al. (2000) find correlation of shocks in a subset of East-Asian countries. According to them, although these countries exhibit differences in their economic and financial conditions, the region is not far away from Europe in satisfying certain criteria of OCA. In compare to the Europe countries, this region exhibit more pronounced differences in the degree of financial development and the lack of political commitment. As the preconditions for the sustainable and durable regional arrangement is dependent on the political criteria, the results do not favor the formation of OCA in Asia. On the other hand, Saucier

(2002) reports two groups of Asian countries fulfill the factor mobility and trade criteria for OCA. The first group is Japan and Asian NIEs (Newly Industrialized Economies, i.e. Hong Kong, Korea, Singapore and Taiwan) and the second group is China and ASEAN4 (Indonesia, Malaysia, Philippines and Thailand). Focusing the analysis in five ASEAN countries, Ramayandi (2005) reveals weak correlation in aggregate supply shock in the region using the data from 1960 to 1996 but significant correlation in this shock using the extended data to 2002. However, aggregate demand shock exhibits higher correlation in both samples. Based on these results, he concludes that although ASEAN countries satisfy some preconditions of OCA, they may need a lot of process and longer time to realize the idea.

The drastic changes in the monetary policy and exchange rate regime in East-Asia in 1997-98 has induced many studies and analyses regarding the merits of policy regimes in East-Asia. These studies analyze the link between the structure of shocks or economic fluctuations and policy regime in East-Asia. For example, Desroches (2004) investigate the source of macroeconomic fluctuations in 22 emerging countries. Her analysis intends to find out if the exchange rate regime matters in determining the differences in the transmission mechanism of shocks across emerging countries. The results indicate that the exchange rate regime is a critical factor. Other studies are interested in comparing the business cycle in Asia with other regions. Kim, Kose and Plummer (2000) compare the business cycle features in Asian with the G7 countries. They find that Asian economies are more open in trade than G7 economies. These economies also exhibit higher diversification in their export over time. These countries experience significant increase in their investment, export and import ratio to output over time in contrast to the share in agricultural which is diminishing over time. The trade in total export within the Asian region has increased over time as well. The results reveal that the main factors to the macroeconomic fluctuations in Asian countries are investment, government spending and consumption.

6.2.1 Is exchange rate a shock absorber or a source of shock?

The choice of exchange rate regime and its merit is crucially dependent on to what extent exchange rate can act as a shock absorber under the independently floating regime. The floating regime is effective when exchange rate adjusts to external shocks and plays a role as a shock absorber. However, exchange rate does not always act as a shock absorber. In some circumstances, it even generates larger shocks due to excessive fluctuations in exchange rate.

According to Edwards (2006), the precondition for the exchange rate to act as a shock absorber is changes in nominal exchange rate should be transmitted into real exchange rate changes or more precisely it should result in real exchange rate depreciation. Previous studies show that real exchange rate changes and the effectiveness role of exchange rate as a shock absorber is crucially determined by the source of shocks. Exchange rate has a room for stabilizing and can act as a shock absorber only when an economy experiences asymmetry shocks compare to its trading partner (Artis & Ehrmann (2006)). Therefore, under the existence of asymmetry shocks, the cost of relinquish the exchange rate will be high.

The analysis on the source of shocks is conducted through identifications on the structure of shocks in the SVAR model. The results reveal asymmetry shocks if both output and exchange rate are caused by the same shocks (Thomas (1997), Alexius & Post (2008) and Bjørnland (2004)). In other case, shocks are also categorized as asymmetric (symmetric) when the domestic and foreign interest rates react differently (similarly) to real shocks (Artis & Ehrmann (2006)). Exchange rate plays a significant role as a shock absorber in case it reacts strongly to asymmetric shocks. Exchange rate is said to be a shock generator if it reacts mainly to its own shock. However, if the disturbance does not transmit to the real economy, exchange rate is not destabilizing (Alexius & Post (2008) and Artis & Ehrmann (2006)).

Most of the studies investigating the role of exchange rate as a shock absorber intend to examine the cost of joining European Monetary Unification (EMU) which focus on small economies in Europe (for instance Thomas (1997) and Bjørnland (2004)). Other studies are focused on the role of exchange rate and the source of shocks in the small open economies (Drine & Rault (2004), Artis & Ehrmann (2006) and Alexius & Post (2008)).

These studies report mixed results. Artis & Ehrmann (2006) find that U.K. is subject to asymmetric shocks while the other three countries (Canada, Sweden and Denmark) are driven by symmetric shocks. Alexius & Post (2008) find stabilizing effects of exchange rate in two out of five countries considered in their studies. Focusing on the economy of Sweden, Thomas (1997) seeks to examine the potential cost for Sweden to give up the independently role for exchange rate as a requirement to participate the EMU. The results indicate that real exchange rate in Sweden is determined by higher fraction of demand shocks than other EMU countries. Since the shocks are controllable, Sweden may not face higher cost than other EMU countries to relinquish the exchange rate. Using a sample of 38 developing countries, Hoffmann (2005) seeks to compare to what extent the exchange rate regime matters in utilizing the role of exchange rate as a shock absorber. His results indicate that economies with floating exchange rate regimes tend to experience real exchange rate depreciation, hence more prominent role for the exchange rate to act as a shock absorber under the floating regimes.

6.3 Methodology and data

6.3.1 Model setup

Following the step of previous studies in analyzing the structure of shocks, a structural vector autoregressive (SVAR) modeling is applied here. This system equation model enables identifications on the structure of shocks and provides analysis on the transmission of shocks through impulse response function and forecast error variance decomposition. The model consists of seven endogenous variables which explain the domestic economy of East-Asia. These variables are foreign output/supply (y_t^*), foreign monetary policy (i_t^*), foreign price/ demand (p_t^*), domestic monetary policy (i_t), domestic output/ supply (y_t), real exchange rate (r_t) and domestic demand (p_t). The foreign variables are included in the system equation as

they affect the domestic variables. All the variables are in the first differenced logs term.

$$X_t = \left[\Delta y_t^* \quad \Delta i_t^* \quad \Delta p_t^* \quad \Delta y_t \quad \Delta i_t \quad \Delta r_t \quad \Delta p_t \right]'$$

For simplicity, the domestic economy can be represented by a VAR representation in the structural form as²⁴:

$$\begin{aligned} A_0 X_t &= A_1 X_{t-1} + \dots + A_q X_{t-q} + B \varepsilon_t \\ A_0 X_t &= \sum_{i=1}^q A_i X_{t-i} + B \varepsilon_t \quad i=1, \dots, q \end{aligned} \quad (1)$$

where X_t is a $(K \times 1)$; $K=7$ vector of endogenous variables; A_0 and B are the $(K \times K)$ matrices which indicate instantaneous relationship of variables in X_t and ε_t respectively; A_i 's are $(K \times K)$ coefficient matrices given $(i=1, \dots, q)$ and ε_t is the $(K \times 1)$ vector of structural shocks. ε_t consists of seven shocks, i.e. foreign supply shocks, foreign policy shocks, foreign demand shocks, domestic supply shocks, domestic monetary policy, exchange rate and domestic demand shocks. Both the foreign and domestic monetary policy and the exchange rate shocks are referred as nominal shocks.

$$\varepsilon_t = \left[\varepsilon_t^{s*} \quad \varepsilon_t^{i*} \quad \varepsilon_t^{d*} \quad \varepsilon_t^s \quad \varepsilon_t^i \quad \varepsilon_t^r \quad \varepsilon_t^d \right]'$$

Under the distributional assumptions, the structural disturbance term, ε_t is independently multivariate normal (IMN) distributed with mean zero, it is mutually uncorrelated and stable or positive definite, i.e.:

$$\begin{aligned} E[\varepsilon_t] &= 0, \\ \varepsilon_t &\sim IMN(0, \Sigma) \\ E[\varepsilon_t \varepsilon_t'] &= I_K \text{ and } \det(\Sigma) \neq 0 \end{aligned}$$

The structural form of equation (1) can be transformed into reduced form by pre-multiplying both sides of variables with A_0^{-1} (see Breitung et al. (2004)):

$$X_t = \bar{A}_1 X_{t-1} + \dots + \bar{A}_q X_{t-q} + e_t \quad (2)$$

where $\bar{A}_j = A_0^{-1} A_j$; $(j=1, \dots, q)$ and $e_t = A_0^{-1} B \varepsilon_t$ denotes the link between the reduced form of disturbances e_t (observable) and the structural shocks ε_t (unobservable) from which the variance-covariance can be derived:

$$E[e_t e_t'] = A_0^{-1} B E(\varepsilon_t \varepsilon_t') B' A_0^{-1} \quad (3)$$

or in sample moment:

$$\hat{\Sigma}_e = \hat{A}_0^{-1} \hat{B} \hat{B}' \hat{A}_0^{-1}$$

²⁴ For simplicity of explanation, the deterministic term does not show in the VAR (q) system equation. One can simply add the deterministic term to the VAR(q). This chapter includes a constant term, seasonal dummies and impulse dummies in the system equation.

$\hat{\Sigma}_e$ consists of $K(K+1)/2$ nonredundant elements which indicates the maximum number of identifiable parameters of the structural form matrices of A_0 and B . In order to identify the structural parameters, we need to impose restrictions on the parameter matrices either through contemporaneous restrictions on the parameter matrices of A_0 and B or long-run restrictions on the total effects of structural shocks. There are three possible cases with contemporaneous restrictions, i.e. (1) A model (by setting B matrix to an identity matrix such that $A_0 e_t = \varepsilon_t$ and impose restrictions on matrix A_0 to orthogonalize the shocks), (2) B model (by setting A_0 matrix to be an identity matrix such that $e_t = B\varepsilon_t$ and impose restrictions on matrix B to orthogonalize the shocks) and (3) AB model (combines the restrictions for A_0 and B so that $A_0 e_t = B\varepsilon_t$ and imposes additional restrictions on both A_0 and B in order to identify the shocks). $K(K-1)/2$ restrictions are required to identify the structural shocks in model A and B as there are $K(K-1)/2$ different instantaneous covariances. There are $K^2 + K(K-1)/2$ restrictions to be imposed on the full model (Breitung et al. (2004)).

The long-run restrictions model is the one proposed by Blanchard and Quah (1989). The long-run restrictions model sets A_0 as an identity matrix, i.e. $A_0 = I_K$ and imposes no restriction on B matrix such that $e_t = B\varepsilon_t$. The restrictions are based on the long-run restrictions that imposed on the cumulative impulse response function. In order to allow $[A_0 - A(L)]$ matrix to be invertible, all variables in the VAR should be in stationary condition (Favero (2001)). The details of the model are discussed in the following sections.

6.3.2 Impulse response function and forecast error variance decomposition

As mentioned in Favero, (2001), equation (1) can be written in a generic form as:

$$[I_K - A(L)]X_t = B\varepsilon_t \quad (4)$$

where $A(L) = \sum_{i=1}^q A_i L^i$ and $A_0 = I_K$ in order to be invertible

By inverting the term $[I_K - A(L)]$, we get the Wold moving average representation of structural form VAR process:

$$\begin{aligned} X_t &= C(L)\varepsilon_t \\ X_t &= C(L)\varepsilon_t = C_0\varepsilon_t + C_1\varepsilon_{t-1} + \dots + C_s\varepsilon_{t-s} \end{aligned} \quad (5)$$

where $C(L) = [I_K - A(L)]^{-1} B$ and $C_0 = B$

From equation (2), we know that $e_t = A_0^{-1} B\varepsilon_t = B\varepsilon$ given that A_0 is an identity matrix. Then, $\varepsilon_t = B^{-1}e_t$. Substitute this relationship into equation (5):

$$X_t = C(L)\varepsilon_t = C(L)B^{-1}e_t \quad (6)$$

Equation (6) can be written in a Wold representation of the reduced form VAR process:

$$X_t = D_0 e_t + D_1 e_{t-1} + \dots + D_s e_{t-s} \quad (7)$$

where $D_i = C_i B^{-1}$, $D_0 = I_K$ and $i=0, 1, \dots$

The (forecast error) impulse response function can be interpreted through the reduced form coefficients of equation (7):

$$D_s = \frac{\partial X_{t+s}}{\partial e_t} = \sum_{j=1}^s D_{s-j} A_j \quad s=1, 2, \dots \quad (8)$$

The elements $\{i, j\}$ of matrix D_s reflect the expected response of $X_{i,t+s}$ to an impulse or a unit change in X_{jt} . As the impulse response of X_{it} is measured in e_{it} , the impulse response of X_{it} to the change in e_t is called the impulse response function and it is captured by matrix D_s . On the other hand, the accumulated impulse response function is the product of the summation of D_s matrices or the long-run effects (see Breitung et al. (2004)):

$$D = \sum_{s=0}^{\infty} D_s = (I_K - A_1 - \dots - A_q)^{-1} \quad (9)$$

As the effect of the impulse vanishes over time i.e. $D_s \rightarrow 0$ as $s \rightarrow \infty$ (in a stationary case), it is called a transitory shock. The impulse responses are called the forecast error impulse responses. There are critics against the forecast error impulse responses to give the isolated effect of shock as e_t could be correlated. Therefore, orthogonal innovations based on the structural shock ε_t are preferred. In order to get orthogonalized shocks, i.e. when ε_t shocks are instantaneously uncorrelated, B is written in a lower triangular matrix such that $\Sigma_\varepsilon = BB'$. The orthogonalized shocks are captured by $\varepsilon_t = B^{-1}e_t$. The impulse responses to orthogonalized shocks is obtained from equation (5) where $C_i = D_i B$ for $i=0, 1, 2, \dots$. For the accumulated long-run effects of orthogonalized shocks, they are replaced by $C(1) = DB$.

The bootstrap methods are used to construct confidence intervals for impulse responses since this method is more reliable for small sample inference. This chapter applies the standard percentile interval bootstrap method (with 2000 replications) where the confidence interval for impulse responses is constructed as (see Breitung et al. (2004)):

$$CI = [s_{\alpha/2}^*, s_{1-\alpha/2}^*]$$

where $s_{\alpha/2}^*$ and $s_{1-\alpha/2}^*$ are the $\alpha/2$ and $1-\alpha/2$ quantiles respectively of the corresponding bootstrap estimator.

Another tool used to interpret the VAR model is the forecast error variance decomposition (FEVD). This tool is constructed as the h -step forecast error from the structural innovations (Breitung et al. (2004)):

$$X_{T+h} - X_{T+h|T} = C_0 \varepsilon_{T+h} + C_1 \varepsilon_{T+h-1} + \dots + C_{h-1} \varepsilon_{T+1} \quad (10)$$

Denoting the ij -th element of C_n as $c_{ij,n}$, the k -th element of the forecast error vector can be written as:

$$X_{k,T+h} - X_{k,T+h|T} = \sum_{n=0}^{h-1} c_{k1,n} \varepsilon_{1,T+h-n} + \dots + c_{kK,n} \varepsilon_{K,T+h-n} \quad (11)$$

Then, the forecast error variance is constructed as the following with the pre-condition that the structural disturbances are not contemporaneously and serially correlated:

$$\sigma_k^2(h) = \sum_{n=0}^{h-1} (c_{k1,n}^2 + \dots + c_{kK,n}^2) = \sum_{j=1}^K (c_{kj,0}^2 + \dots + c_{kj,h-1}^2) \quad (12)$$

The term in bracket on the right hand side of equation (12) indicates the contribution of variable j to the forecast error variance of variable k for h -step horizon. The contribution in percentage can be obtained in the following way:

$$\varpi_{kj}(h) = (c_{kj,0}^2 + \dots + c_{kj,h-1}^2) / \sigma_k^2(h) \quad (13)$$

6.3.3 Identifications

In order to get the impulse response of the effect of an isolated shock, the variance covariance matrix should be diagonal, i.e. shocks are orthogonal. One way to get to this condition is to apply the choleski decomposition. Under the Blanchard & Quah (1989) identification, the long-run impact matrix is in lower triangular choleski decomposition. This means that the first ε_t shock may have an instantaneous effect on all variables, the second shock has no impact on the first variable but it can have influences on the variables below it. This rule applies to all subsequent variables. Therefore, under the lower triangular choleski decomposition, the ordering of the variables in the system equation matters in generating different effects of shocks. The restrictions are imposed in such a way that some shocks do not have long-run effects, i.e. $C(1) = C_0 + C_1 + \dots$ equal to zero.

The long-run impact matrix can be written in the following form:

$$e_t = C(1)\varepsilon_t$$

$$\begin{pmatrix} e_t^{y^*} \\ e_t^{i^*} \\ e_t^{p^*} \\ e_t^y \\ e_t^i \\ e_t^r \\ e_t^p \end{pmatrix} = \begin{pmatrix} C(1)_{11} & 0 & 0 & 0 & 0 & 0 & 0 \\ C(1)_{21} & C(1)_{22} & 0 & 0 & 0 & 0 & 0 \\ C(1)_{31} & C(1)_{32} & C(1)_{33} & 0 & 0 & 0 & 0 \\ C(1)_{41} & C(1)_{42} & C(1)_{43} & C(1)_{44} & 0 & 0 & 0 \\ C(1)_{51} & C(1)_{52} & C(1)_{53} & C(1)_{54} & C(1)_{55} & 0 & 0 \\ C(1)_{61} & C(1)_{62} & C(1)_{63} & C(1)_{64} & C(1)_{65} & C(1)_{66} & 0 \\ C(1)_{71} & C(1)_{72} & C(1)_{73} & C(1)_{74} & C(1)_{75} & C(1)_{76} & C(1)_{77} \end{pmatrix} \begin{pmatrix} \varepsilon_t^{y^*} \\ \varepsilon_t^{i^*} \\ \varepsilon_t^{d^*} \\ \varepsilon_t^s \\ \varepsilon_t^i \\ \varepsilon_t^r \\ \varepsilon_t^d \end{pmatrix}$$

where $C(1) = \sum_{i=0}^{\infty} C_i$ and $C(1)$ is the long-run matrix of $C(L)$.

Totally $K(K-1)/2 = 7(6)/2 = 21$ long-run restrictions are imposed on the triangular matrix in order to identify the structural shocks where some of the structural shocks do not have long-run impacts on other variables. The ordering of the variables determines the structure of the shocks. The foreign variables are ordered before the domestic variables by assuming domestic economy is relatively small. Therefore the domestic variables have no impact on the foreign economy but receive the foreign shocks exogenously. The orderings among foreign and domestic variables are based on the standard macroeconomic theory as in Sun and An (2008). The output variable is ordered first as this variable is likely to influence the other variables in the system. The price variable is ordered after the real exchange rate variable as the price is determined by the exchange rate movements. Changes in the exchange rate can lead to changes in the domestic prices which is referred as exchange rate pass-through. In addition, the interest rate variable which represents the monetary policy is included in the system to provide evaluation on the monetary policy. It is ordered before the real exchange rate and pricing variables by assuming the monetary policy/ regime is able to determine the fluctuations in exchange rate and transmissions of shocks to the domestic economy. This ordering is named as the first ordering.

$$X_t = [\Delta y_t^* \quad \Delta i_t^* \quad \Delta p_t^* \quad \Delta y_t \quad \Delta i_t \quad \Delta r_t \quad \Delta p_t]' \text{ - first ordering}$$

Later, the estimation of the VAR model is repeated based on the alternative ordering of variables for robustness checking (see **Section 6.4.5**).

$$X_t = [\Delta y_t^* \quad \Delta i_t^* \quad \Delta p_t^* \quad \Delta y_t \quad \Delta i_t \quad \Delta p_t \quad \Delta r_t]' \text{ - alternative ordering}$$

6.3.4 Estimations

This section discusses how the identified structure of the long-run impact matrix can be estimated by means of feasible information maximum likelihood (FIML). For the purpose of explanation, equation (2) is written in a compact form:

$$Y = \Pi X + V \tag{14}$$

where

$$Y = [x_1, \dots, x_T] \text{ with } (K \times T) \text{ dimension}$$

$$\Pi = [\bar{A}_1, \dots, \bar{A}_q] \text{ with } (K \times Kq) \text{ dimension}$$

$$V = [e_1, \dots, e_T] \text{ with } (K \times T) \text{ dimension}$$

$$X = [x_{1-i}, \dots, x_{T-i}]' \text{ with } (Kq \times T) \text{ dimension}$$

The elements of Y , X and V are as mentioned in **Section 6.3.1**; $q=6$ and $K=7$. If no restriction is imposed on Π , both the least squares estimation and maximum likelihood estimation formulae coincide:

$$\hat{\Pi} = Y'X (XX')^{-1}$$

The same thing holds for the variance covariance matrix of unrestricted reduced form:

$$\hat{\Sigma}_e = T^{-1} \hat{V} \hat{V}'$$

However, this chapter implements a subset restriction on Π matrix to improve the estimation through sequential elimination algorithm with top-down procedure. Assumes that the right hand side variables/ term is represented by \bar{X}_{kt} , then:

$$Y = \Pi X + V = \bar{X}_{kt}$$

This procedure searches the optimal set of regressors by minimizing the following criteria:

$$CR(i_1, \dots, i_n) = \log[SSE(i_1, \dots, i_n)/T] + d_T n/T$$

where $SSE(i_1, \dots, i_n)$ is the sum square errors by including $(x_{i_1,t}, \dots, x_{i_n,t})$ in the model and c_T denotes the quantity of the specific criterion where $d_T = 2$ corresponding to the Akaike Information Criterion (AIC).

This procedure starts from the last regressor by checking if eliminate the last regressor improve the criteria value. If yes, the regressor is eliminated. Otherwise, it is maintained. The procedure is repeated by checking the second last regressor and so on. As restrictions are imposed on Π , the estimation is based on GLS method which has the same asymptotic properties as the ML estimator rather than OLS (Breitung et al. (2004)).

The identification and FIML estimation of the parameters can be based on the log-likelihood function:

$$\ell = \bar{c} - \frac{T}{2} \log |\Sigma_e| - \frac{T}{2} tr(\Sigma_e^{-1} \hat{\Sigma}_e) \quad (15)$$

$$\ell = \bar{c} - \frac{T}{2} \log |B|^2 - \frac{T}{2} tr\left[(B')^{-1} B \hat{\Sigma}_e\right]$$

where $\Sigma_e = BB'$ and $\Sigma_e^{-1} = [BB']^{-1}$ and $\hat{\Sigma}_e = T^{-1} \hat{V} \hat{V}'$ and \bar{c} is a constant or

$$\bar{c} = -\frac{KT}{2} \log 2\pi$$

Under the Blanchard and Quah (1989) restrictions, the long-run restrictions are imposed based on the structural matrix of total multipliers of observable variables $C(1) = A(1)^{-1} = (I_K - A_1 - \dots - A_q)^{-1}$ such that $C(1)$ is a long-run impact matrix and is in lower triangular. The lower triangular of $C(1)$ denotes a non-constrained value and the upper triangular is identified to be zero. According to Breitung et al. (2004), the long-run impact matrix of shocks $C(1)$ is linked to the reduced shocks by the contemporaneous matrix B .

$$C(1) = DB$$

$$C(1)C(1)' = D\Sigma_e D'$$

$$C(1)C(1)' = (I_K - A_1 - \dots - A_q)^{-1} \Sigma_e \left[(I_K - A_1' - \dots - A_q') \right]^{-1}$$

In order to impose non-linear restrictions on the long-run impact matrix, the following implicitly restrictions condition should be satisfied (Amisano & Giannini (1997)):

$$RvecB = d \quad (16)$$

where R is a $(r \times K^2)$ full row rank matrix and d is a non-zero $(r \times 1)$ vector. However, as this constraint introduces cross restrictions between the parameters in Π

and B matrices, the asymptotic information matrix is no more block-diagonal. Thus, one should consider an inexact system constraint (Amisano & Giannini (1997)):

$$\hat{R}vecB = d$$

where $\underset{T \rightarrow \infty}{plim} \hat{R} = R$, given that \hat{R} is consistent estimate of R in the limit. Or explicitly,

$$vecB = S\gamma + s \quad (17)$$

where S is a $(K^2 \times L)$ full column rank matrix, $L = K^2 - r$, s is a $(K^2 \times 1)$ vector and

$$\hat{R}S = [0] \text{ is a } (r \times L) \text{ matrix}$$

$$\hat{R}s = d \text{ is a } (r \times 1) \text{ matrix}$$

The chain rule of matrix differentiation is:

$$\frac{\partial \ell}{\partial \gamma} = \frac{\partial \ell}{\partial vecB} \cdot \frac{\partial vecB}{\partial \gamma} = \frac{\partial \ell}{\partial vecB} \cdot S$$

The chain rule of matrix differentiation using the definitions of the information matrix is (see Amisano & Giannini (1997) for further explanation):

$$I_T(vecB) = E[f'(vecB) \cdot f'(vecB)']$$

The score vector of long-likelihood with respect to $vec(B^{-1})$ is:

$$\frac{\partial \ell(B)}{\partial vecB} = \frac{\partial \ell(B)}{\partial vec(B^{-1})} \cdot \frac{\partial vec(B^{-1})}{\partial vecB} \quad (18)$$

After some manipulations and applying the chain rule of differentiation, the score vector for the vector of 'free' elements γ can be written as (Amisano & Giannini (1997)):

$$f'(\gamma) = \frac{\partial \ell}{\partial vecB^{-1}} \cdot \frac{\partial vecB^{-1}}{\partial vecB} \cdot \frac{\partial vecB}{\partial \gamma} \quad (19)$$

$$f'(\gamma) = -f'(vecB^{-1}) \left[(B')^{-1} \otimes B^{-1} \right] S = f'(vecB) S$$

Taking the first order condition to maximize the log-likelihood function with respect to γ gives:

$$f'(\gamma) = f'[vecB] S = [0] \text{ in } (1 \times L) \text{ row form}$$

$$f(\gamma) = S' f[vecB] = [0] \text{ in } (L \times 1) \text{ column form}$$

The informational matrix $I_T(\gamma)$ is defined as:

$$I_T(\gamma) = E[f(\gamma) \cdot f'(\gamma)] = S' [f'(vecB) \cdot f'(vecB)] S \quad (20)$$

$$I_T(\gamma) = S' [I_T(vecB)] S$$

Based on the informational matrix $I_T(\gamma)$ and the score vector $f(\gamma)$, the score algorithm is implemented to find the FIML estimator of γ (i.e. $\tilde{\gamma}$) using the following updating formulae:

$$\gamma_{k+1} = \gamma_k + [I_T(\gamma_k)]^{-1} f(\gamma_k) \quad (21)$$

Once $\tilde{\gamma}$ is obtained, we can estimate $vec(B)$, i.e.:

$$vec\tilde{B} = S\tilde{\gamma} + s$$

After obtaining $vec(\tilde{B})$, we can re-arrange the vector in matrix form to arrive at \tilde{B} .

From here, we can reach at the FIML estimate of restricted variance covariance matrix:

$$\tilde{\Sigma}_e = \tilde{B}\tilde{B}'$$

$\tilde{\Sigma}_e$ is corresponding to $\hat{\Sigma}_e$ under the exact identification case. Under the over-identification case, likelihood ratio (LR) test is performed to check the plausible of the over restrictions. The LR statistic is a chi-square distribution with the degree of freedom equals to the number of over-identification.

$$LR = T \left(\log |\tilde{\Sigma}_e| - \log |\hat{\Sigma}_e| \right)$$

This test is not relevant here as the long-run restrictions applied here is an exact identification case.

6.3.5 Diagnostic tests

This chapter conducts two diagnostic tests, namely the Portmanteau test for residual autocorrelation and the multivariate ARCH-LM test for heteroskedasticity.

Denoting $\hat{G}_i = \frac{1}{T} \sum_{t=i+1}^T \hat{e}_t \hat{e}'_{t-i}$ as the autocovariance of the residual series, Portmanteau

test checks the following null hypothesis:

$$H_0 : E(e_t e'_{t-i}) = 0 \text{ for } i=1, \dots, h > q$$

The test statistic is:

$$Q_h = \frac{1}{T} \sum_{j=1}^h tr(\hat{G}_j' \hat{G}_0^{-1} \hat{G}_j \hat{G}_0^{-1}) \quad (22)$$

where h is the number of autocorrelations (which is assumed to be 16 here), K is the number of variables in the VAR model i.e. seven in this chapter and q is the number of lagged term in the VAR model, i.e. six in this chapter. The test statistic has an approximately chi-square distribution with $K^2(h-q)$ or the difference between the autocorrelations and the number of estimated VAR coefficients degrees of freedom (see Lütkepohl (2004)). The test indicates no autocorrelation in the residuals when the test statistic is smaller than the chi-square value for example at 5% significant level.

The multivariate ARCH-LM test is constructed based on the following multivariate regression model:

$$vech(\hat{e}_t \hat{e}_t') = \beta_0 + B_1 vech(\hat{e}_{t-1} \hat{e}_{t-1}') + \dots + B_p (\hat{e}_{t-p} \hat{e}_{t-p}') + error_t \quad (23)$$

'vech' is the column-stacking operator for symmetric matrices. This operator transforms an $(K \times K)$ matrix into an $([K(K+1)/2] \times 1)$ vector by stacking the elements by columns of the matrices from the main diagonal vertically (Hamilton (1994)). β_0 and B_j (for $j=1, \dots, p$) are $\frac{1}{2}K(K+1)$ and $[\frac{1}{2}K(K+1)]^2$ coefficient matrices respectively. The test is based on the null hypothesis of:

$$H_0 : B_1 = \dots = B_p = 0$$

$$H_1 : B_1 \neq 0, \text{ or } \dots \text{ or } \dots B_p \neq 0$$

The test statistic is given by:

$$MARCH_{LM}(p) = \frac{1}{2}TK(K+1)R_m^2 \quad \text{where}$$

$$R_m^2 = 1 - \frac{2}{K(K+1)} tr(\hat{\Omega} \hat{\Omega}_0^{-1})$$

where $\hat{\Omega}$ is the residual covariance matrix with $\frac{1}{2}K(K+1)$ dimension from regression (23) and $\hat{\Omega}_0$ is the corresponding covariance matrix with $p=0$ (see Lütkepohl (2004)). The test statistic has a chi-square distribution with $(pK^2(K+1)^2/4)$ degrees of freedom. In this chapter, p is assumed to be 3. The test indicates no heteroskedasticity in the errors when one fails to reject the null hypothesis at a given significant level.

6.3.6 Data and empirical analyses

The analysis is focused on the emerging crisis-hit East-Asian countries in the pre- and post-crisis of 1997-98. Most of these countries have shifted the exchange rate regime to the flexible one following the financial crisis of 1997-98. The shift in the policy regime, the change in the structure of economic and shocks could be matter in determining the role of exchange rate between the two sub-periods in East-Asia. In order to analyze the link in these factors, this chapter conducts the analysis based on the data of pre- and post-crisis periods.

This chapter applies the data two sets of data: the foreign country and domestic country data. The foreign country is referred to U.S. and the domestic country refers to individual East-Asian country. The industrial production index (seasonally adjusted) is used as the proxy for output variable as most of the East-Asian countries do not have long enough data for GDP. The interest rate data is used to represent the monetary policy variable. The interest rate data could be different across countries. Malaysia uses the interbank overnight money rate while the other East-Asian countries use the money market rate. The foreign interest rate (foreign monetary policy) is represented by the Federal Fund Rate (FFR). The real exchange rate is constructed based on the definition of real exchange rate in Desroches (2004) and Hoffmaister & Roldós (1997), i.e. the relative price of non-traded goods (CPI) in

terms of traded goods (PPI). It is proxied by the ratio of domestic CPI over foreign PPI (in term of domestic currency):

$$r_t = \frac{CPI_t}{ex_t.PPI_t^*}$$

where ex_t is the nominal bilateral exchange rate of domestic currency per USD. The increase in real exchange rate is interpreted as appreciation while the decline in it means exchange rate depreciation. All the data are in monthly and are obtained from the International Financial Statistics (IFS), IMF. In order to give the outcomes in percentage change, all variables are measured in the natural logs form except the interest rate variables. Due to the difficulty in obtaining the complete data, only four East-Asian countries are able to be included in this study. These countries are Korea, Malaysia, Philippines and Thailand. The data span from 1981M1-2008M4 in the case of Korea and Malaysia. It spans from 1985M1-2008M4 and 1987M1-2008M4 in the case of Philippines and Thailand respectively.

The main objective of this chapter is to investigate the economic fluctuations and the effects of the shift of monetary policy regimes in East-Asia in the pre- and post-crisis periods. For the purpose of this study, empirical analysis using the structural VAR model can be conducted in two ways, i.e. either to estimate the model using the full sample with the inclusion of structural shift dummy or estimating the model by breaking the data into two sub-periods. This chapter applies the second option by dividing the data of East-Asian countries into two sub-periods, i.e. before 1997M7 (as the pre-crisis) and from 1999M7-2008M4 (as the post-crisis or aftermath the shift of policy regimes). The reasons to favor the second option are: (1) this option allows comparisons on the results (impulse response functions and forecast error variance decomposition) of the two separated sub-periods; (2) dividing the sample into two sub-periods and excludes the crisis period in the analysis avoid excessive effects of shocks or fluctuations due to the effects of crisis and (3) the main focus is to investigate the change in the results between the two sub-periods but not to investigate the effects of financial crisis in these countries.

The first option does not permit comparisons on the results (long-run impact matrix, impulse response function and forecast error variance decomposition) for the two sub-periods. Inclusion of the crisis period data in the analysis generates turmoil and excessive volatility in the sample. This problem is detected through the diagnostic checking. Using a full sample of data (1980s to 2008M4) for four East-Asian countries, the structural VAR model (first ordering) is estimated with the inclusion of dummy for the crisis break (1998M1)²⁵. The results of diagnostic tests for autocorrelation (Portmanteau test) and heteroskedasticity (multivariate ARCH-LM) are summarized in **Table V-A(2a) in Appendix V**. Portmanteau test shows no evidence of autocorrelation but multivariate ARCH-LM test detects heteroskedasticity when testing with 3 lags of error term in equation (23). Including more lags of error term helps to remove the heteroskedasticity. Including 11 lags of error term helps to remove the heteroskedasticity problem in Korea and Malaysia while in Philippines

²⁵ The crisis started at different date across East-Asian countries. Based on the line graph of the four domestic variables in level used in the estimation in these countries, significant and large fluctuations were shown started 1998M1. Therefore, 1998M1 is used as the indication of the crisis date. Changing the dummy to 1997M7 does not generate much difference in the results.

and Thailand, at least 9 and 8 lags respectively can solve the problem. However, multivariate ARCH-LM shows no evidence of heteroskedasticity under low lag (3 lags) error term when the crisis period (1997M7-1999M6) is excluded in the second option analysis (see **Table D.1**).

This chapter conducts the empirical analysis of structural VAR model in three different cases. First, estimations are based on the first ordering variables of VAR system equation using the two sub-period data for each East-Asian country. The results are compared with the results obtained under the second and third cases for robustness checking. In the second case, the same estimation procedure of case one is repeated by applying to the full set data for each East-Asian country. In the third case, estimation is based on the alternative ordering of variables using the two sub-periods data.

All the analyses are conducted using JMulTi version 4.15, a software for analyzing multiple time series. The subset restriction of top-down searching procedure is applied to improve the VAR estimation. The structural VAR model is just identified by applying the Blanchard Quah identification scheme.

6.4 Results – econometrics counterpart

6.4.1 Statistical and diagnostic checking

Before conducting the estimation, the property of data is checked through the unit-root test. All variables take the natural logs form (except the interest rate series) in order to capture the percentage change in the variables. Applying the unit-root test of Augmented Dicky Fuller (ADF) to the two sub-periods sample shows that in most cases, these variables are not stationary in their logged levels but stationary in the log-differenced terms (see **Table V-A(1)**, **Appendix V-A**). As discussed in Ramaswamy and Sloek (1997), there are three ways to specify the non-stationary series in a VAR system, i.e. either to specify the series in differenced form, specify them in levels or consider the cointegration relationships among the variables under consideration by applying the vector error correction model (VECM). VECM is considered when the cointegration relationship is known. However, if the relationship is unknown, VECM can be biased and it could be more appropriate to consider the VAR in levels. This paper follows the step of many studies in analyzing shocks, i.e. estimate the identified structural VAR model in differenced form in order to generate efficient estimators.²⁶ The long-run relationship of variables is identified using the Blanchard & Quah technique. Akaike Info Criterion, Final Prediction Error and Schwarz Criterion suggest different length of lags to be included in the analysis of each country. As in previous studies (for example Bayoumi & Eichengreen (1994), Kim & Roubini (2000), Goo (2008) and Artis & Ehrmann (2006)), this paper includes the same length of lags (six lags) in the model for all countries in order to preserve symmetry of

²⁶ The estimation applies top-down subset restrictions to improve the outcome, i.e. using an elimination algorithm to conduct a checking procedure from the last regressor to see if exclude this term in the equation improves the criterion value. If yes, the regressor will be eliminate and the process is continue to check the second last regressor and so on

specifications²⁷. The constant term and seasonal dummies are assumed in each case. Impulse dummy is considered in case significant impulse or break of series is detected/ suggested by the unit-root with structural break test²⁸. The estimation is followed by diagnostic checking, i.e. Portmanteau test for autocorrelation and multivariate ARCH-LM test for heteroskedasticity.

Table D.1 summarizes the results of diagnostic tests for case I estimation. Both diagnostic tests show that the estimation does not exhibit autocorrelation and heteroskedasticity problems as the results indicate the non-rejection of hypothesis null at 5% critical level in all cases. The same result also hold in case II and case III (see **Table V-A(2a & 2b), Appendix V**) by applying the same diagnostic tests for autocorrelation and heteroskedasticity.

Table D.1: Diagnostic test – case I

	Korea		Malaysia		Philippines		Thailand	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
<u>Autocorrelation test</u> (Portmanteau Test)								
t-statistic	670.3587	647.5425	648.3306	626.4618	619.0209	661.5591	657.9620	674.3021
p-value	0.6582	0.4866	0.8643	0.9092	0.9542	0.3172	0.4274	0.3115
<u>Heterokedasticity test</u> (Multivariate ARCH-LM Test)								
t-statistic	2374.6047	2345.9280	4821.2264	2384.4020	2396.2102	2388.4100	2376.5476	2372.9760
p-value	0.3676	0.5314	0.1326	0.3156	0.2577	0.2953	0.3570	0.3765

Notes: All MARCH-LM tests assume 3 lags or error term except Malaysia uses 6 lags in period I. Portmanteau test includes 16 lags of AR term

6.4.2 Estimation results and robustness comparisons

In order to check how far the results hold under different model specifications, the results of the first ordering using the two sub-period data that excludes the crisis period (case I) are compared with the results of case II using the full sample with structural shift dummy under the first ordering specification and case III under alternative ordering of the variables (applies to two-sub periods data). Case II and case III apply the same specification as applied in case I i.e. include six lags of the endogenous variables, a constant term and seasonal dummies, impulse dummies are included in the case of Malaysia and Philippines as mentioned before. For the full sample analysis, a structural shift dummy of 1998M1 is added in the model.

The following discussions are based on the results of structural VAR (long-run impact matrix, forecast variance decomposition (FEVD) and accumulated impulse response function (IRF) for orthogonalized shocks) and correlation of shocks among East-Asian countries. The long-run impact matrix shows the coefficients of reaction of each variable in the system equation to each single shock in the long-run based on the identification imposed. On the other hand, the (accumulated) impulse response function shows the responses of each variable in the system equation to a positive one standard deviation of each orthogonalized shock at different time horizons. The forecast error variance decomposition (FEVD) shows the percentage relative

²⁷ Applying different number of lags in the model does not change the main results.

²⁸ Impulse dummies are assumed for the following cases: Philippines, period II (2000M10) and Malaysia, period I (1984M3 and 1988M4)

contribution of each single shock to the variation of each variable in the system equation at different time horizons. As observed, the results reported from these three tools are consistent to each other. For example, the sign and size of accumulated impulse response for each variable under each single shock are consistent to the sign (direction of reaction) and size of each coefficient in the long-run impact matrix. Although the results vary across countries and over time, some general findings are reported.

First, consider the result of estimation for case I. The long-run impact matrix shows that the domestic variables tend to react significantly to the domestic shocks than to that of the external shocks (see **Table D.2**). Despite the detection of price puzzle, the sign of reaction to each domestic shock is consistent to the prediction of economic theory. For example, an increase in the domestic supply shock leads to a decline in the domestic price. A contractionary monetary policy leads to a decline in the domestic price and an appreciation in the exchange rate. The same results also reported in the FEVD where the relative contribution of external shocks to domestic variables is small compare to the contribution of domestic shocks especially in the pre-crisis period (see **Table D.3**). Besides, the FEVD, accumulated IRF and long-run impact matrix also show that exchange rate reacts strongly to its own shock in both sub-periods. In some cases, the size of reaction is larger in the second sub-period. In contrast, the domestic price does not exhibit large fluctuations to shocks. It reacts significantly to the demand shock and the effect of demand shock on the domestic price has declined in the post-crisis period. The results capture the change in the economic variables after the shift of monetary policy to the flexible exchange rate regime and inflation targeting in these countries aftermath the crisis. The details of the results are discussed in the following sub-sections for economic interpretations.

Next, we turn to compare the result of case I with the results obtained under case II and case III. The result of case II based on the estimation on the full sample are summarized in **Appendix V**. The results of the long-run impact matrix (**Table V-A(3a), Appendix V**) show that exchange rate is a source of shock to itself. Inflation is mainly determined by domestic demand shock. External shocks have significant impacts on inflation in Korea but not in the other countries. External shocks have some significant impacts on the movements of domestic variables contemporaneously. However in the long-run, the impacts are not significant in the countries that are less open such as Philippines and Thailand. FEVD also reports quite similar results (**Table V-A(4a), Appendix V**). FEVD shows that variations in domestic variables are mainly determined by domestic shocks. External shocks contribute to relatively low variations in domestic variables. Besides, real exchange rate reacts strongly to its own shock, revealing the evidence that exchange rate generate shocks. Exchange rate shock has no significant effect on the real economy or supply but its effect on inflation rate or demand side is considerably large. Supply shock appears to be a main source of real economic or output fluctuations in these countries. The quite similar results also reported in case I that apply to the two sub-periods data, indicating the robustness of the results using the full sample data and sub-sample data. On the other hand, estimation using the full sample data does not permit comparisons of the results for the pre- and post-crisis periods.

Table D.2: Long-run impact matrix – case I

Country	Long-run impact matrix													
	Period I							Period II						
Korea	121	0	0	0	0	0	0	60	0	0	0	0	0	0

	41	41	0	0	0	0	0	7	46	0	0	0	0	0
	***	***						***	***					
	-17	1	34	0	0	0	0	16	6	18	0	0	0	0
	***		***					***		***				
	21	56	1	158	0	0	0	-34	-59	15	79	0	0	0
		**		***							***			
19	25	-7	11	56	0	0	9	4	1	3	10	0	0	
	***			***						***				
-21	82	7	32	32	115	0	80	114	-63	21	2	152	0	
	***			*	***				*			***		
-32	-18	31	-9	13	21	33	-5	-15	4	-11	-9	-7	9	
	***	*	***	*	***	***				***	**	***	***	
Malaysia	107	0	0	0	0	0	0	81	0	0	0	0	0	0
	***							***						
	32	37	0	0	0	0	0	40	40	0	0	0	0	0
	***	***						***	***					
	-13	-8	36	0	0	0	0	9	10	18	0	0	0	0
			***					*	***					
	181	78	-50	286	0	0	0	41	8	-60	97	0	0	0
	***	***		***				**		***	***			
3	0	-34	31	72	0	0	3	3	-2	-2	5	0	0	
		*	***	***						*	***			
10	-24	36	-15	-20	138	0	3	-38	-33	-58	37	57	0	
					***					***	***	***		
-3	-11	39	3	5	27	36	17	4	9	-12	5	6	9	
		***			***	***			*	***	**	***	***	
Philippines	82	0	0	0	0	0	0	189	0	0	0	0	0	0
	***							***						
	28	45	0	0	0	0	0	191	30	0	0	0	0	0
	*	***						***	***					
	-9	13	27	0	0	0	0	44	5	18	0	0	0	0
			***							***				
	14	41	64	154	0	0	0	93	20	81	109	0	0	0
			**	***						***	***			
34	8	94	16	132	0	0	152	27	-3	2	17	0	0	
		***		***				***			***			
89	-6	-1	8	-8	159	0	-105	-106	53	-117	-123	118	0	
*					***					**	***	***		
-79	14	97	12	37	14	60	-13	-8	37	-6	-51	32	43	
	*		***		***	***			*		**	***	***	
Thailand	87	0	0	0	0	0	0	61	0	0	0	0	0	0
	**													
	17	56	0	0	0	0	0	56	29	0	0	0	0	0
		***							***					
	-28	9	18	0	0	0	0	15	1	15	0	0	0	0
	*		***							***				
	-45	-63	85	234	0	0	0	27	-10	-23	58	0	0	0
				***						*	***			
-11	65	42	-27	72	0	0	15	16	6	-6	18	0	0	
	*	**		***				*		***	***			
-10	-14	-13	-14	-4	48	0	-62	-165	-11	-39	92	173	0	
					***			**		**	***	***		
1	-8	3	0	2	1	23	26	0	28	-13	15	12	14	
						***			***	**	***	***	***	

Notes:

The values are in ($\times 10^{-4}$)

*** below the coefficient indicates a 1% significant level; ** as the indication of 5% significant level and * as the indication of 10% significant level

Table D.3: Forecast error variance decomposition (FEVD) – case I

	Period I FEVD for the change in output									Period II FEVD for the change in output								
	ε_t^{s*}	ε_t^{i*}	ε_t^{d*}	ε_t^s	ε_t^i	ε_t^r	ε_t^d	Total (f)	Total (d)	ε_t^{s*}	ε_t^{i*}	ε_t^{d*}	ε_t^s	ε_t^i	ε_t^r	ε_t^d	Total (f)	Total (d)
Kor	0.02 0.03	0.00 0.02	0.01 0.05	0.90 0.80	0.02 0.04	0.04 0.05	0.02 0.02	0.03 0.10	0.98 0.89	0.00 0.03	0.01 0.24	0.01 0.10	0.60 0.21	0.00 0.04	0.00 0.06	0.38 0.32	0.02 0.37	0.98 0.63
Mal	0.00 0.06	0.07 0.06	0.01 0.02	0.87 0.75	0.05 0.09	0.00 0.02	0.00 0.01	0.08 0.14	0.92 0.87	0.01 0.14	0.29 0.26	0.14 0.14	0.44 0.26	0.04 0.03	0.01 0.04	0.07 0.12	0.44 0.54	0.56 0.45
Phi	0.01 0.04	0.02 0.05	0.07 0.08	0.83 0.65	0.00 0.02	0.06 0.12	0.01 0.04	0.10 0.17	0.90 0.83	0.03 0.09	0.00 0.07	0.15 0.12	0.38 0.20	0.00 0.10	0.27 0.23	0.17 0.20	0.18 0.28	0.82 0.73
Thai	0.03 0.05	0.03 0.07	0.00 0.02	0.91 0.50	0.00 0.03	0.02 0.07	0.00 0.16	0.06 0.14	0.93 0.76	0.00 0.13	0.14 0.14	0.00 0.01	0.72 0.44	0.10 0.15	0.01 0.09	0.01 0.04	0.14 0.28	0.84 0.72
	FEVD for the change in interest rate									FEVD for the change in interest rate								
Kor	0.02 0.04	0.01 0.02	0.01 0.02	0.04 0.07	0.82 0.74	0.10 0.10	0.00 0.01	0.04 0.08	0.96 0.92	0.07 0.14	0.02 0.08	0.00 0.04	0.06 0.14	0.78 0.46	0.03 0.05	0.04 0.09	0.09 0.26	0.91 0.74
Mal	0.01 0.03	0.06 0.14	0.12 0.11	0.13 0.12	0.63 0.51	0.00 0.03	0.06 0.07	0.19 0.28	0.82 0.73	0.00 0.09	0.24 0.24	0.21 0.17	0.02 0.07	0.50 0.30	0.03 0.09	0.00 0.05	0.45 0.50	0.55 0.51
Phi	0.00 0.05	0.01 0.02	0.02 0.11	0.00 0.02	0.82 0.55	0.05 0.12	0.10 0.14	0.03 0.18	0.97 0.83	0.13 0.34	0.05 0.11	0.01 0.07	0.06 0.11	0.18 0.09	0.28 0.11	0.28 0.16	0.19 0.52	0.80 0.47
Thai	0.10 0.08	0.01 0.08	0.00 0.05	0.03 0.09	0.83 0.52	0.00 0.06	0.02 0.11	0.11 0.21	0.88 0.78	0.00 0.10	0.39 0.21	0.02 0.10	0.02 0.17	0.32 0.22	0.01 0.05	0.24 0.15	0.41 0.41	0.59 0.59
	FEVD for the change in real exchange rate									FEVD for the change in real exchange rate								
Kor	0.01 0.03	0.03 0.09	0.00 0.01	0.03 0.07	0.11 0.09	0.82 0.71	0.00 0.02	0.04 0.13	0.96 0.89	0.18 0.24	0.00 0.11	0.19 0.15	0.00 0.06	0.00 0.10	0.62 0.27	0.01 0.07	0.37 0.50	0.63 0.50
Mal	0.04 0.04	0.00 0.02	0.02 0.05	0.01 0.02	0.00 0.03	0.84 0.74	0.09 0.09	0.06 0.11	0.94 0.88	0.13 0.13	0.08 0.11	0.01 0.09	0.00 0.05	0.05 0.07	0.63 0.43	0.09 0.11	0.22 0.33	0.77 0.66
Phi	0.34 0.29	0.07 0.11	0.07 0.09	0.00 0.03	0.02 0.02	0.49 0.43	0.01 0.02	0.48 0.49	0.52 0.50	0.03 0.12	0.20 0.16	0.09 0.10	0.30 0.24	0.20 0.14	0.09 0.12	0.09 0.11	0.32 0.38	0.68 0.61
Thai	0.00 0.04	0.00 0.02	0.01 0.03	0.12 0.14	0.02 0.02	0.83 0.69	0.02 0.05	0.01 0.09	0.99 0.90	0.14 0.15	0.13 0.09	0.19 0.23	0.01 0.09	0.11 0.13	0.42 0.24	0.00 0.06	0.46 0.47	0.54 0.52
	FEVD for the change in price									FEVD for the change in price								
Kor	0.09 0.10	0.09 0.09	0.07 0.08	0.06 0.08	0.14 0.12	0.16 0.17	0.40 0.36	0.25 0.33	0.76 0.68	0.04 0.08	0.00 0.10	0.02 0.07	0.42 0.29	0.19 0.13	0.02 0.08	0.30 0.25	0.06 0.25	0.93 0.75
Mal	0.00 0.02	0.00 0.02	0.11 0.20	0.00 0.02	0.02 0.03	0.20 0.21	0.67 0.50	0.11 0.24	0.89 0.76	0.23 0.17	0.08 0.14	0.06 0.13	0.18 0.13	0.00 0.04	0.05 0.08	0.40 0.31	0.37 0.44	0.63 0.56
Phi	0.08 0.18	0.00 0.02	0.03 0.23	0.01 0.02	0.05 0.08	0.31 0.18	0.52 0.30	0.12 0.43	0.89 0.58	0.09 0.16	0.04 0.06	0.01 0.08	0.03 0.05	0.43 0.28	0.08 0.09	0.33 0.27	0.14 0.30	0.87 0.69
Thai	0.01 0.02	0.10 0.09	0.01 0.02	0.00 0.04	0.08 0.10	0.22 0.28	0.60 0.45	0.12 0.13	0.90 0.87	0.37 0.26	0.01 0.02	0.33 0.30	0.01 0.09	0.10 0.09	0.18 0.17	0.00 0.07	0.71 0.58	0.29 0.42

The numerical figures show the 1st and 20th periods of variance decompositions

The column total (f) indicates the total FEVD for foreign shocks while total (d) as total FEVD for domestic shocks

The estimation also considers the alternative ordering of variables in the system equation using the two sub-periods data (case III). The estimation is repeated by changing the order of the 6th and 7th variables in the system equation while the ordering of the other variables remain the same. The results of the long-run impacts matrix reports the similar results as reported in the previous section using the first ordering of variables. In general, it is observed that the exchange rate is a source of shock to itself. The coefficient of exchange rate shock reacts to real exchange rate becomes larger in the post-crisis period in two out of four countries (Korea and Thailand) considered in the analysis. In contrast, the coefficient reaction of demand shock to inflation is smaller in the post-crisis period in all countries. The results indicate that the shift in the monetary policy to the flexible exchange rate regime and inflation targeting leads to higher fluctuations in exchange rate but at the same time, it leads to lower and more stable price level. The results of FEVD show some differences (see **Table V-A(4b)**, **Appendix V-A**). In the first ordering scheme, real exchange rate in Thailand does not show significant changes in response to inflation or demand shock whereas in the alternative ordering here, it reacts strongly to demand shock in the post-crisis period. Real exchange rate shock also shows higher impact on domestic demand in Korea in period II under the new ordering in contrast to the result reported in the first ordering. Monetary policy in Philippines shows lower response to real exchange rate in the post-crisis period under the alternative ordering. Besides these differences, the main results still hold, i.e. external shocks have very low effects on the domestic economy in the pre-crisis period but the effects increase significantly in the post-crisis period; exchange rate is a source of shock to itself but the impact of shock has declined substantially in the post-crisis period. There are evidences indicating that monetary policy in some East-Asian countries reacts stronger to inflation or demand shock aftermath the crisis. Monetary policy also shows greater impacts on domestic supply and demand. Real exchange rate in Philippines reacts stronger to domestic supply and demand shocks, implying greater role of exchange rate to absorb shocks in this country compare to the other countries.

As the main estimation results obtained from case I, II and III are robust and consistent to each other, further discussion on the interpretations of the result is focused on the result of case I for simplicity (see **Section 6.5**).

6.5 Results – economic interpretations

Before discussing the results, the data for each country are studied. As observed from the statistic for domestic variables (see **Table D.4**), all countries considered in the analysis experience declines in the change in price or inflation, lower volatility in interest rate and output growth rate in the post-crisis period.²⁹ The data reveal the trade-off between output growth and inflation. Although these countries have improved the inflation rate, they face the trade-off in term of lower output growth. On the other hand, these countries are moving from appreciation in real exchange rate to real depreciation (with the exception of Korea). As discussed later, the move from appreciation to depreciation indicates a positive outcome, i.e. exchange rate plays a more effective role as a shock absorber (see **Section 6.5.2**).

²⁹ However, Thailand experiences a small increase in growth rate.

Table D.4: Descriptive statistics

	Korea		Malaysia		Philippines		Thailand	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
\bar{p}_t								
mean	0.0044	0.0026	0.0027	0.0017	0.0093	0.0039	0.0036	0.0024
std. dev.	0.0053	0.0041	0.0040	0.0026	0.0123	0.0056	0.0051	0.0042
\bar{y}_t								
mean	0.0082	0.0063	0.0079	0.0051	0.0105	0.0052	0.0071	0.0073
std. dev.	0.0348	0.0403	0.0630	0.0354	0.0501	0.0517	0.0381	0.0308
\bar{r}_t								
mean	0.0014	0.0000	0.0005	-0.0005	0.0014	-0.0010	0.0010	-0.0001
std. dev.	0.0103	0.0243	0.0127	0.0123	0.0331	0.0236	0.0166	0.0211
\bar{i}_t								
mean	0.1264	0.0430	0.0606	0.0290	0.1504	0.0794	0.1063	0.0238
std. dev.	0.0274	0.0061	0.0197	0.0034	0.0597	0.0167	0.0369	0.0179

The variables are in first differenced log form. The data are in monthly and spanning from 1981M1-1997M6 (period I) and 1999M1-2008M4 (period II). A one percentage is equivalent to 0.01.

Previous section has discussed the general results of long-run impact matrix, FEVD and accumulated IRF of three different cases. The following sub-sections discuss in detail the economic interpretation of the results based on these three tools (long-run impact matrix, FEVD and accumulated IRF). The following discussion is based on the result of case I.

6.5.1 The source and structure of shocks

The forecast error variance decomposition (FEVD) reveals the source of economic fluctuations at different time horizons. It gives us the relative importance of shocks on determining the variations in domestic variables. In line with the results reported in previous studies, the business cycle fluctuation in East-Asia is driven by domestic shocks. External shocks explain relatively low economic fluctuations in these countries (see **Table D.3**). Domestic output is driven mainly by supply (real) shock while the domestic price is driven by demand shock. On the other hand, the monetary policy and real exchange rate are mainly determined by nominal domestic shocks. The same results also reported in the long-run impact matrix, i.e. domestic variables react strongly and significantly to domestic shocks but react insignificantly to external shocks.

However, this result does not necessarily hold in the post-crisis period as the impacts of external shocks increase substantially in the post-crisis period. The total impact of external shocks on inflation in Thailand even exceeds the total effect of domestic shocks on inflation. In some cases, foreign supply and foreign demand shocks can explain more the variations in monetary policy and inflation. The explanations for this phenomenon include higher trade openness of East-Asian countries, integration in international trades and the move to the more flexible exchange rate regimes which permit greater foreign effects on domestic economy.

Comparing the results across countries, it is observed that the relative importance of shocks (domestic versus external shocks) on domestic variables differs across countries and variables. For example in the post-crisis period, the inflation in Thailand is more determined by external supply and external demand shocks whereas that in Korea is mainly determined by domestic supply and domestic demand shocks. In Philippines, the variation

in inflation (period II) is more impacted by domestic monetary policy and demand shocks. The results imply that each country exhibits different structure and country specific shocks.

In order to investigate if shocks are symmetric across countries, the analysis on the correlations of shocks is conducted by constructing the reduced disturbances of shocks in the structural VAR system equation. The shocks in East-Asian countries are symmetric if the correlation of shocks among countries is positive but they are asymmetric if the correlation is negative or insignificant (Zhang, Sato & McAleer (2004)). This analysis provides information on the degree of linkage and similarity in the structure of shocks that faced by the domestic economies of East-Asia. **Table D.5** displays the correlation of domestic shocks among East-Asian countries. As observed, the correlation of domestic shocks (domestic supply, real exchange rate and domestic demand shocks) is very low among East-Asian countries. The results indicate that shocks are of country specific or shocks are asymmetric across these countries. However, the correlation in nominal or exchange rate shock among these countries shows the tendency to increase in the post-crisis period. This may be explained by higher regional trade and cooperation among these countries and the move to the same direction in the policy regime, i.e. flexible exchange rate and inflation targeting regimes aftermath the crisis.

Following the step in Artis & Ehrmann (2006), the analysis in the structure of shocks can also be done based on the impulse response function. Shocks are symmetric if both the foreign and domestic monetary policy variables exhibit the same pattern of responses to the demand and supply shocks (or real shock)³⁰. **Table V-B(1), Appendix V** shows the response of foreign monetary policy to different shocks (the first row of the table) and also the response of domestic monetary policy to shocks (the second row of the table). In all cases, different responses are shown by both foreign and domestic monetary policy variables. This confirms the results that shocks are asymmetric in these countries.

As shocks in East-Asia are asymmetric, there is a role for exchange rate to act as a shock absorber. The statistic table (see **Table D.4**) shows that real exchange rate in these countries tend to experience depreciation in the post-crisis period (except Korea). This implies that exchange rate play a more effective role as a shock absorber under more flexible regime.

³⁰ The definition or interpretation of real versus nominal shocks in VAR model is arbitrary. It depends on the interpretation of the author and the plausibility of the underlying economic model and orthogonality of the shocks which can be different under different models specifications and identification schemes (Jeselius, 2006). This chapter follows the interpretation of Goo (2008) and Artis & Ehrmann (2006): real shocks are supply and demand shocks and the exchange rate and monetary policy shocks are nominal shocks.

Table D.5: Correlations of structural shocks

	Period I					Period II			
	e_t^s Supply shock					e_t^s Supply shock			
	Korea	Malaysia	Philippines	Thailand		Korea	Malaysia	Philippines	Thailand
Korea	1.0000				Korea	1.0000			
Malaysia	-0.0848	1.0000			Malaysia	0.0406	1.0000		
Philippines	0.1498	-0.0820	1.0000		Philippines	-0.1703	0.0615	1.0000	
Thailand	0.2526	0.0509	-0.0399	1.0000	Thailand	0.2289	0.2968	0.3716	1.0000
	e_t^i Monetary policy shock					e_t^i Monetary policy shock			
Korea	1.0000				Korea	1.0000			
Malaysia	0.0341	1.0000			Malaysia	-0.0834	1.0000		
Philippines	0.0553	0.0468	1.0000		Philippines	-0.0088	-0.0912	1.0000	
Thailand	-0.1012	0.0362	-0.1043	1.0000	Thailand	0.0270	0.0622	0.0976	1.0000
	e_t^r Exchange rate shock					e_t^r Exchange rate shock			
Korea	1.0000				Korea	1.0000			
Malaysia	-0.0137	1.0000			Malaysia	0.3791	1.0000		
Philippines	0.1505	0.1043	1.0000		Philippines	0.4142	0.3696	1.0000	
Thailand	0.2372	0.3036	0.1355	1.0000	Thailand	0.5000	0.2674	0.3495	1.0000
	e_t^d Demand shock					e_t^d Demand shock			
Korea	1.0000				Korea	1.0000			
Malaysia	0.0231	1.0000			Malaysia	-0.2130	1.0000		
Philippines	0.0454	0.1066	1.0000		Philippines	0.0272	0.0930	1.0000	
Thailand	0.0254	-0.0349	0.1440	1.0000	Thailand	0.1455	0.1093	0.0298	1.0000

6.5.2 The role of exchange rate: absorber or source of shocks?

The role of exchange rate is captured through the responses of exchange rate to supply and demand shocks. Exchange rate may play a significant role as a shock absorber if it reacts strongly to the supply and demand shocks (Artis & Ehrmann (2006)). However, exchange rate can be a source of shock if it reacts strongly to its own shock. Previous studies find that exchange rate is a source of shock to itself and could be destabilizing (Artis & Ehrmann (2006) and Bjørnland (2004)). The same result also holds here. The three tools, i.e. FEVD, IRF and long-run impact matrix show that in all cases, nominal shock (exchange rate shock) is the main source of real exchange rate fluctuations especially in the case of Korea and Malaysia in the pre-crisis period. However, the relative effect of this shock on real exchange rate movements has declined significantly in the post-crisis period especially in the case of Philippines. Although exchange rate is a source of shock to itself, the effects of exchange rate shock that has transmitted to the real economy or output is small in both periods with the exception of Philippines. The relative contribution of exchange rate shock on the variations of domestic inflation is relatively larger in the pre-crisis period but it has declined drastically in the post-crisis period.

Comparing the relative impacts of shocks on real exchange rate movements from FEVD, it is observed that there is a significant increase in the reactions of real exchange rate to domestic supply and demand shocks in Philippines or real shocks have higher impacts on real exchange rate movements. The responses of real exchange rate to both shocks do not change much in the other countries between the two sub-periods. Besides, accumulated IRF of real exchange rate also tends to show depreciation in response to external shocks in the post-crisis period in Philippines. These results imply that exchange rate plays a greater role as a shock absorber in Philippines aftermath the crisis compare to the other three countries.

6.5.3 Exchange rate regimes and the shock transmission mechanisms

Desroches (2004) finds that exchange rate regime matters in determining the differences in the transmission mechanism of shocks across emerging countries where the economies with floating exchange rate regimes tend to experience real exchange rate depreciation. Hoffmann (2005) also finds the same results. How far their results hold in the case of East-Asian countries? Does the shift in the policy regime induce different reactions of domestic variables under various shocks between the two sub-periods or policy regimes?

The (accumulated) impulse response function provides us the information on the size and the dynamic of shocks, i.e. how shocks induce different reactions/ changes of economic variables over time (see **Table V-B (1), Appendix V**). The negative sign for the response of the change in real exchange rate implies depreciation whereas the negative sign in the response of other variables indicates a decline in that variable. The results of accumulated IRF are consistent to the results reported in the long-run impact matrix. The size and sign of impulse responses are similar to the one reported in the long-run impact matrix. The following discusses theoretically the prediction on the responses of domestic variables to different shocks under accumulated IRF.

Theoretically under the floating regime, when there is an increase in the foreign supply such as higher foreign production, the foreign price tends to be lower. Since domestic price is relatively higher than the foreign price, this induces a rise in domestic interest rate. The outcome is domestic currency appreciates, domestic price declines and output declines. The opposite outcome is possible if the authority controls the movements in exchange rate. The public will revise the expectation on future interest rate to be lower as they expect the authority to keep the exchange rate target. This leads to the decline in interest rate and price. Output increases and domestic currency depreciates.

The increase in the foreign interest rate means lower foreign price. This generates two effects on domestic output and price level. The domestic economy tends to follow the step of foreign countries by increasing the domestic interest rate not only because the foreign country is large and has large effect on the small country but also to avoid inflationary effect. This leads to lower money supply and domestic currency depreciates relative to the foreign currency. These changes lead to two possible outcomes on output. First, depreciation leads to higher price and stimulates higher output or production. Second, higher interest rate tends to dampen the demand, domestic price declines and this leads to the decline in output. A small economy tends to experience the second outcome (Kim & Roubini (2000)).

A one percent increase in the foreign demand shock, i.e. the increase in foreign price implies lower domestic price relative to the foreign price. Lower domestic price is associated with lower domestic interest rate and domestic currency depreciates. This later leads to higher domestic price and output. On the other hand, under the exchange rate targeting regime, the public anticipate a rise in the future interest rate as they expect the authority will increase the interest rate in the future to maintain the exchange rate target. The expectation on higher interest rate leads to higher price and domestic currency appreciates.

Domestic supply shock, for example the increase in productivity leads to higher output or production and lower domestic price. This causes to lower interest rate and domestic currency is expected to depreciate (Goo (2008)). On the other hand, a positive supply shock also may lead to higher interest rate if the increase in the aggregate demand is greater than increase in aggregate supply. The price tends to be higher and exchange rate appreciates. In the pre-crisis period with exchange rate targeting regime, domestic economy tends to experience appreciation as the public anticipate the increase in the expected interest rate for the authority to maintain the exchange rate target. The increase in the expected interest rate is associated with higher price and exchange rate appreciates.

When there is an increase in the demand on domestic goods, domestic price tends to be higher. This induces higher production (higher output). Higher demand also leads to higher interest rate and in domestic currency appreciates. However, a positive demand shock can also lead to depreciation in the domestic currency, especially in the pre-crisis period. This is due to the anticipation of the market participants that revise expectation on the future interest rate for the authority to maintain the exchange rate target. The decline in the expected interest rate is associated with lower price (Goo (2008)).

A negative exchange rate shock may lead to the depreciation in exchange rate. Depreciation in exchange rate improves the trade balance as domestic goods are cheaper than the foreign goods. This is followed by the increase in output. According to Goo (2008), it is possible that depreciation in exchange rate leads to lower output in the short-run if the export and import prices adjust faster than their quantities counterpart. Depreciation in exchange rate also induces higher price and interest rate is expected to be raised up to control the inflationary impulse. A contractionary monetary policy, i.e. the increase in the domestic interest rate leads to a decline in domestic output and price and the domestic currency is expected to appreciate. However, the price can also increase (known as price puzzle) if the monetary contraction responds to higher expected domestic inflation (Goo (2008)). According to Kim & Roubini (2000), it is possible that the contractionary monetary policy leads to a currency nominal depreciation (exchange rate puzzle) due to the Fisher effect where the increase in interest rate is associated with higher expectation in inflation. However, the contractionary monetary policy can lead to different outcomes in real exchange rate depending on the ratio of $r_t = \frac{CPI_t}{ex_t \cdot PPI_t^*}$. Assuming that the foreign price

level does not change, the economy will experience real depreciation if the nominal appreciation is smaller than the decline in the domestic price level. The other way holds if nominal appreciation is greater than the decline in price level. Both the price and exchange rate puzzles are common or are always detected in the empirical studies. Previous studies that exhibit such puzzles include Fung (2002), Cushman & Zha (1997), Artis & Ehrmann (2006) and Goo (2008). Sims (1992) shows that the price puzzle problem can be resolved by including the commodity price in the VAR system equation. However, the inclusion of commodity price may not solve the price puzzle problem in the case of emerging market economies as shown in Fung (2002).

Despite the evidence of price puzzle, the impulse responses in general are as predicted by economic theory. The size and sign of accumulated IRF are similar to the size and sign shown in the long-run impact matrix. The effect of external shocks on domestic variables tends to be insignificant as shown by the long-run impact matrix.

The results also show that the shift in the policy regimes induces changes in the behavior and structure of the economic variables. The output growth and the change in real exchange rate are more sensitive to shocks in compare to the domestic inflation. Both variables are more volatile. The domestic output growth is mainly determined by the domestic supply shock. However, the effect of domestic supply shock on output growth is declining aftermath the crisis in East-Asia. The change in real exchange rate seems to be more volatile in period II in response to various shocks. The increase in the volatility of real exchange rate reflects the abandon of fixed exchange rate regime and the adoption of flexible exchange rate and inflation targeting regimes in most of the East-Asian countries aftermath the crisis. The shift of policy regimes and greater concern of the authorities on price stability aftermath the crisis also help to maintain the low and stable inflation rate. These changes are demonstrated in the results here where the responses of inflation variable to shocks have declined in period II. The inflation impulse is small and less persistent aftermath the implementation of the inflation targeting and more flexible regime in these countries.

For the exchange rate to act as a shock absorber, changes in nominal exchange rate must be translated into real exchange rate depreciation to generate expenditure switching effects (Edwards (2006)). Impulse response function shows that changes in the nominal exchange rate do not transmit to real depreciation in all cases in response to external shocks. However, accumulated IRF shows that Malaysia and Thailand tend to experience larger real exchange rate depreciation hitting by external shocks in the post-crisis period.

6.5.4 The effectiveness of monetary policy

As the results indicate greater influences of external shocks on the domestic economy under the more flexible regime and that real economy reacts to the exchange rate shock, excessive volatility of exchange rate and a sudden shift/ change in the foreign economic could impose certain negative effects on the domestic economy. An investigation is conducted to find out if the independently monetary policy is able to impose stabilization against external shocks and exchange rate fluctuations. The examination also seeks to reveal how influential the monetary policy shock induces changes in the real economy and if stabilization is possible through exchange rate adjustments.

First of all, observing the response of monetary policy to demand, supply and exchange rate shocks through FEVD (see **Table D.3**) sheds light on the change in the monetary policy in East-Asia between the two sub-periods. The results differ across countries. In Philippines, the monetary policy shows higher response to these three shocks. In Thailand, the monetary policy shows higher and stronger response to demand or inflation shock after moving to the flexible regime and inflation targeting framework. The results reveal higher concern of the authorities on price stability after the implementation of the inflation targeting regime in these two countries. At the same time, the authority in Philippines shows greater concern on the exchange rate stability than the other East-Asian countries aftermath the crisis. The monetary policy reaction functions in Korea and Malaysia do not show significant change in responses to domestic supply and demand shocks.

The effects of monetary policy shock on output, inflation and exchange rate indicate the influential of monetary policy on these variables. Turning to the effects of monetary policy shock on output, inflation and exchange rate, it is observed that monetary policy shock has

greater impacts on the movements of domestic output, domestic inflation and real exchange rate in Philippines and Thailand aftermath the crisis. The results of FEVD imply greater influential and effectiveness of monetary policy in these two countries after the shift to the flexible exchange rate and inflation targeting regimes. FEVD, accumulated IRF and the long-run impact matrix show that real exchange rate in all countries (except Korea) reacts stronger to monetary policy shock in the post-crisis period. As real exchange rate shows higher response to monetary policy shock in the post-crisis period, monetary policy is able to influence changes in exchange rate and entails stabilization under the flexible regime. The results imply higher possibility for the monetary policy in some East-Asian countries to induce stabilization through exchange rate adjustments in the post-crisis period or under the more flexible exchange rate regime.

Overall, there are evidences of more effective and better functioning of monetary policy in some East-Asian countries considered in the analysis aftermath the crisis. In these countries, the monetary policy reacts stronger to inflation and shows higher impacts on inflation and output. Exchange rate also reacts stronger to monetary policy shock in the post-crisis period, indicating higher possibility for the monetary policy to restore equilibrium through exchange rate adjustments.

6.6 Conclusions

This paper conducts a structural VAR model analysis to examine the source of business cycle fluctuations in several East-Asian countries. The main focus of this analysis is to compare the relative importance of various shocks, the real exchange rate fluctuations and the structure and transmission of shocks in determining the policy performance in East-Asian countries in the pre- and post-crisis periods/ after the shift of policy regimes. The results provide information for the selection of more appropriate policy regimes and also for the evaluations of monetary policy.

The results indicate that the main source of economic fluctuations in East-Asia is domestic shocks, in particular the supply or real shocks. External shocks explain a relatively low fraction in the economic fluctuations of this region in the pre-crisis period. However, the effects have increased substantially in the post-crisis period. Besides, East-Asian countries are subject to asymmetric country specific shocks and differ in the transmissions of shocks. The relative importance of shocks differs across countries and the economic variables in these countries react differently to shocks. Exchange rate is a source of shock to itself but its has declined significantly in the post-crisis period. It is not destabilizing in the post-crisis period since its effect on real economy has declined and stays low in the post-crisis period. On the other hand, evidences show that exchange rate play a greater role as a shock absorber in the post-crisis period in two East-Asian countries. Monetary policy reacts stronger to real shocks and has greater influence on real economy and exchange rate. Besides targeting on inflation, the monetary authorities in these countries also concern on output and exchange rate stability (as shown in Philippines). Stabilization through exchange rate adjustment is possible since exchange rate reacts to monetary policy shock. At the same time, inflation targeting regime maintains stability in price with lower volatility in inflation. These changes imply more effective monetary policy and greater role of exchange rate to act as a shock absorber in these countries after the shift of monetary policy to the flexible exchange rate and inflation targeting regimes.

Exchange rate may play a conflicting role. It can act as a shock absorber under the flexible regime, but at the same time it may generate shocks to itself. Excessive volatility in exchange rate could be harmful to the real economy especially for the emerging market. In order to minimize the negative effects of flexible exchange rate, previous studies have suggested different solutions and regimes for the emerging countries. As emphasized in Aminian (2005), the policy maker in emerging economy should concern on both stability and flexibility in exchange rate. Both aspects are important as stability permits insulation on the adverse effect of uncertainty on real economy and flexibility allows immediate adjustments to deal with shocks and speculative attacks (Aminian (2005)). Others suggest the flexibility in exchange rate regime with intervention under the flexible inflation targeting (Kwack (2005)) or the opt for the intermediate regimes with small weight on exchange rate targeting (Christl & Just (2004)).

Although the analysis on the structure and the source of shocks indicate greater role of exchange rate to act as a shock absorber under the flexible regime in East-Asia, the effectiveness of the policy regime may vary across countries and change over time. For instance, countries that hold large foreign currency denominated liabilities may experience higher debt when the currency depreciates. This may lead to bankruptcies and the reduction in the economic growth (Eichengreen and Hausmann (1999)). Besides, Devereux (2004) also suggests the opt for the peg regime for emerging countries given that the international financial market is imperfect. Under the imperfect international financial market, the floating regime does not generate welfare maximization as this regime does not entail output to react efficiently to external demand shock.

As a conclusion, the results of this chapter indicate that the source of shocks and the policy regime are closely linked to each other. The increasingly relative effect of external shocks in East-Asia is one of the aspects that should not be ignored in the monetary policy setup for (the East-Asia) emerging countries. Apart from the source of shocks, the policy maker should also consider other aspects (for example the structure of financial market and exchange rate pass-through) in making the choice of policy regime.

References

- Alexius,A. & Post,E. 2008. Exchange rates and asymmetric shocks in small open economies. *Empirical Economics* 35: 527-541
- Aminian,N. 2005. Economic integration and prospects for regional monetary cooperation in East Asia. *Structural Change and Economic Dynamics* 16: 91-110.
- Amisano,G. & Giannini,C. 1997. *Topics in structural VAR econometrics*. Springer. Second, revised and enlarged edition.
- Artis,M. & Ehrmann,M. 2006. The exchange rate – a shock absorber or source of shocks? A study of four open economies. *Journal of International Money and Finance* 25: 874-893.

-
- Bayoumi, T. & Eichengreen, B. 1994. One money or many? Analyzing the prospects for monetary unification in various parts of the world. Princeton Studies in International Finance, no. 76. Princeton University.
- Bayoumi, T., Eichengreen, B. & Mauro, P. 2000. On regional monetary arrangements for ASEAN. *Journal of the Japanese and International Economics* 14: 121-148.
- Bjørnland, H.C. 2004. The role of the exchange rate as a shock absorber in a small open economy. *Open Economies Review* 15: 23-43.
- Breitung, J. et al. 2004. Structural vector autoregressive modeling and impulse responses. In *Applied time series econometrics*. Cambridge University Press.
- Cavoli, T. and Rajan, R. 2003. Designing appropriate exchange rate regimes for East Asia: inflation targeting and monetary policy rules. University of Adelaide. Discussion paper no. 0309.
- Chow, H.K. and Kim, Y. 2003. A common currency peg in East Asia? Perspectives from Western Europe. *Journal of Macroeconomics* 25: 331-350.
- Cushman, D.O. & Zha, T. 1997. Identifying monetary policy in a small open economy under flexible exchange rates. *Journal of Monetary Economics*. 39(3): 433-448.
- Desroches, B. 2004. The transmission of world shocks to emerging market countries: an empirical analysis. Bank of Canada working paper 2004-44.
- Drine, I. & Rault, C. 2004. The sources of real exchange fluctuations in developing countries: an econometric investigation. The William Davidson Institute. Working paper no. 653.
- Edwards, S. 2006. The relationship between exchange rates and inflation targeting revisited. NBER working paper series no. 12163.
- Edwards, S. & Yeyati, E.L. 2003. Flexible exchange rates as shock absorbers. NBER working paper no. 9867.
- Eichengreen, B. & Bayoumi, T. 1996. Is Asia an optimum currency area? Can it become one? Regional, global and historical perspectives on Asian monetary relations. Center for International and Development Economics Research. University of California, Berkeley.
- Favero, C.A. 2001. *Applied macroeconometrics*. Oxford University Press.
- Fung, B.S.C. 2002. A VAR analysis of the effects of monetary policy in East Asia. BIS working papers no. 119.
- Goo, S.W. 2008. The role of exchange rate and inflation targeting policy on economic performances: a SVAR approach. In: *Exchange rate and monetary policy: selected*

-
- comparative experiences during the pre- and post 1997 Asian financial crisis. University of Adelaide. Dissertation.
- Hamilton, J.D. 1994. Time series analysis. Princeton University Press.
- Hoffmaister, A.W. & Roldós, J.E. 1997. Are business cycles different in Asia and Latin America? IMF working paper WP/97/9.
- Hoffmann, M. 2005. Fixed versus flexible exchange rate: evidence from developing countries. University of Cologne.
- Jeselius, K. 2006. The cointegrated VAR model. Methodology and applications – Advanced texts in econometrics. Oxford University Press.
- Kim, S., Kose, M.A. & Plummer, M.G. 2000. Dynamics of business cycles in Asia: differences and similarities. Brandeis University. Working paper series vol. 2000-15.
- Kim, S., Kose, M.A. & Plummer, M.G. 2003. Dynamics of business cycles in Asia: differences and similarities. Review of Development Economics. Vol. 7: 462-477.
- Kim, S. & Roubini, N. 2000. Exchange rate anomalies in the industrial countries: a solution with structural VAR approach. Journal of Monetary Economics 45: 561-586.
- Kwack, S.Y. 1999. Capital inflows and monetary policy in Asia before the financial crisis. KIEP working paper 99-12. Korea Institute for International Economics Policy.
- Kwack, S.Y. 2005. Exchange rate and monetary regime options for regional cooperation in East Asia. Journal of Asian Economics 16: 57-75.
- Kwan, C.H. 1994. Economic interdependence in the Asia-Pacific region: towards a Yen bloc. Routledge, London.
- Lütkepohl, H. 2004. Vector autoregressive and vector error correction models. In Applied time series econometrics. Cambridge University Press.
- Ramaswamy, R. & Sloek, T. 1997. The real effects of monetary policy in the European Union: what are the differences? IMF working paper no. 160.
- Ramayandi, A. 2005. ASEAN monetary cooperation: Issues and prospects. Pacific Economic papers no. 349. Australia-Japan Research Centre. The Australian National University.
- Sims, C.A. 1992. Interpreting the macroeconomic time series facts: the effects of monetary policy. European Economic Review. 36(5): 975-1011.
- Saucier, P. 2002. The case for an Asian exchange rate mechanism In: Proceedings of the International Conference Towards regional currency areas. Santiago, Chile.

- Sun,W. & An,L. 2008. Asymmetric shocks and exchange rate regimes in East Asia. *International Research Journal of Finance and Economics* 22: 38-48.
- Thomas,A. 1997. Is the exchange rate as shock absorber? The case of Sweden. *International Monetary Fund. IMF working paper WP/97/176.*
- Zhang,Z. et al. 2004. Is a monetary union feasible for East Asia? *Applied Economics* 36: 1031-1043.
- Zhang,Z., Sato,K. & McAleer,M. 2004. Asian monetary integration: a structural VAR approach. *Mathematics and Computers in Simulation* 42: 447-458.

APPENDIX V-A

Table V-A(1): Augmented Dicky-Fuller Unit-root test

Variable	Korea		Malaysia		Philippines		Thailand		U.S.	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
y_t^*									-2.7714	-1.3563
Δy_t^*									-5.0909***	-10.2099***
i_t^*									-2.0925	-2.2555
Δi_t^*									-3.6192***	-4.0626***
p_t^*									-1.8934	-1.0385
Δp_t^*									-6.7386***	-8.3846***
y_t	-2.1331	-2.9024	-2.3829	-3.0644	-2.0635	-2.3585	-1.2068	-2.8266		
Δy_t	-21.8048***	-11.3376***	-21.8043***	-3.1213**	-9.5618***	-10.3091***	-12.9193***	-3.5089***		
r_t	-0.5716	-1.7684	-0.8499	-1.8481	0.1314	-2.2342	0.0096	-1.8858		
Δr_t	-9.7418***	-8.8441***	-12.7499***	-9.2141***	-13.7909***	-9.4211***	-8.8962***	-9.5392***		
p_t	-1.1804	-2.3446	-1.3682	-1.2103	-2.2560	-2.9167	-1.9543	-0.4798		
Δp_t	-9.3978	-9.4481***	-11.4576***	-11.0321***	-6.9011***	-7.3767***	-9.3439***	-6.5900***		
i_t	-2.9654**	-1.1043	-2.9699**	-0.8369	-8.5715***	-1.5547	-3.6020***	-1.5114		
Δi_t	-15.1680***	-6.2607***	-13.4372***	-4.6293***	-10.8927***	-6.9194***	-12.1459***	-4.6830***		

Notes:

All the series are in log form except the series for interest rate.

 Δ denotes the first differenced operator.

*** denotes the significant statistic at 1% level; ** the significant statistic at 5% level and * the significant statistic at 10% level.

Table V-A(2a): Diagnostic tests – case II

	Korea	Malaysia	Philippines	Thailand
<u>Autocorrelation test</u> <u>(Portmanteau Test)</u>				
t-statistic	682.4269	703.4796	658.2003	682.5330
p-value	0.6362	0.5409	0.8748	0.6147
<u>Heteroskedasticity test</u> <u>(Multivariate ARCH-LM Test)</u>				
t-statistic	2989.4003 (3)	3560.9170 (3)	2984.1213 (3)	2832.0903 (3)
p-value	0.0000	0.0000	0.0000	0.0000
	8664.1280 (11)	8678.4239 (11)	7151.9319 (9)	6397.4850 (8)
	0.3782	0.3378	0.2091	0.1316

Notes: The number in bracket indicates the number of lagged error term include in the multivariate ARCH-LM test. Portmanteau test includes 16 autocorrelation terms in the test

Table V-A(2b): Diagnostic test – case III

	Korea		Malaysia		Philippines		Thailand	
	Period I	Period II	Period I	Period II	Period I	Period II	Period I	Period II
<u>Autocorrelation test</u> <u>(Portmanteau Test)</u>								
t-statistic	676.0193	640.2099	640.9384	609.4457	618.0708	672.3365	658.8120	670.3510
p-value	0.5787	0.5896	0.9091	0.9662	0.9568	0.1895	0.4290	0.3710
<u>Heteroskedasticity test</u> <u>(Multivariate ARCH-LM Test)</u>								
t-statistic	2382.2390	2320.6576	4805.4571	2401.7816	2415.3633	2427.8778	2377.2742	2363.6188
p-value	0.3268	0.6734	0.1479	0.2325	0.1774	0.1347	0.3531	0.4290

All MARCH-LM tests assume 3 lags or error term except Malaysia uses 6 lags in period I. Portmanteau test includes 16 lags of AR term

Table V-A(3a): Long-run impact matrix – case II

Country	Long-run impact matrix							Country	Long-run impact matrix							
Korea	87 ***	0	0	0	0	0	0	Philippines	78 ***	0	0	0	0	0	0	0
	31 ***	35 **	0	0	0	0	0		37 ***	44 ***	0	0	0	0	0	0
	-9 ***	0	27 ***	0	0	0	0		-10	16 ***	29 **	0	0	0	0	0
	40 *	18	3	171 ***	0	0	0		4	24	62 ***	180 ***	0	0	0	0
	11	7	-1	-26 *	94 ***	0	0		11	12	6	6	118 ***	0	0	0
	28	48	39	122 ***	-75 *	247 ***	0		-6	40	47	-69 ***	31	262 ***	0	0
	-16 ***	-16 ***	11 ***	-17 ***	14 ***	-3 ***	41 ***		-46 *	19	76	1	21 *	2	90 ***	0
Malaysia	91 ***	0	0	0	0	0	0	Thailand	7 ***	0	0	0	0	0	0	0
	29 ***	34 ***	0	0	0	0	0		56 ***	47 ***	0	0	0	0	0	0
	-9 ***	0	29 ***	0	0	0	0		-15 ***	4	20 ***	0	0	0	0	0
	120 ***	63 ***	10	255 ***	0	0	0		-80	35	59 ***	226 ***	0	0	0	0
	-19 *	4	-9	13 **	61 ***	0	0		26	35 ***	-9	-16	109 ***	0	0	0
	67 ***	-16	4	10	-59 ***	197 ***	0		-101 *	-17	-24	48	-127 ***	264 ***	0	0
	1	-6 *	14 ***	1	7 *	2	37 **		10	-5	5	-13 ***	9 **	2	33 ***	0

Notes:

The values are in ($\times 10^{-4}$)

*** below the coefficient indicates a 1% significant level; ** as the indication of 5% significant level and * as the indication of 10% significant level

Table V-A(3b): Long-run impact matrix – case III

Country	Long-run impact matrix													
	Period I							Period II						
Korea	123 ***	0	0	0	0	0	0	61 *	0	0	0	0	0	0
	42 ***	40 ***	0	0	0	0	0	72 *	47 ***	0	0	0	0	0
	-17 **	8	34 ***	0	0	0	0	15	5	17 ***	0	0	0	0
	8	67	29	166 ***	0	0	0	-39	-74	20	69 ***	0	0	0
	17	25 *	-11	13	58 ***	0	0	9	3	2	2	10 ***	0	0
	-34 **	-15	18	-14	17 ***	47 ***	0	-6	-12	2	-7 **	-8 ***	11 ***	0
	-37 ***	109 ***	22	58 ***	38 ***	59 ***	120 ***	92	116	-65 **	0	-11 **	-89 ***	125 ***
Malaysia	107 ***	0	0	0	0	0	0	83 ***	0	0	0	0	0	0
	32 ***	37 ***	0	0	0	0	0	41 *	38 ***	0	0	0	0	0
	-13	-8	36 ***	0	0	0	0	10	11 *	21 ***	0	0	0	0
	180 ***	79 ***	-49	286 ***	0	0	0	41	-15	-104 ***	100 ***	0	0	0
	2	0	-34 **	32 ***	73 *	0	0	4	3 *	-1	-2 **	5 ***	0	0
	-3	-10	38 ***	3	6	44 *	0	19 *	4	9 *	-9 **	6 *	15 ***	0
	13	-24	29	-14	-21 **	70 ***	113 ***	6	-33	23	-59 ***	39 ***	31 ***	51 ***
Philippines	78 ***	0	0	0	0	0	0	327	0	0	0	0	0	0
	27 *	46 ***	0	0	0	0	0	308	29 ***	0	0	0	0	0
	-6	12	27 ***	0	0	0	0	65	5	18 ***	0	0	0	0
	22	41	60 ***	153 ***	0	0	0	26	33	91 ***	116 ***	0	0	0
	46	5	88 ***	14	131 ***	0	0	245	29 ***	-4	3	17 ***	0	0
	-61	114	91 ***	10	35 ***	62 ***	0	-104	-24	50 *	-3	-58 ***	61 ***	0
	65	4	10	14	1 ***	60 ***	142 ***	-53	-124	55	-127 **	-123 **	77 **	89 ***
Thailand	85	0	0	0	0	0	0	61 ***	0	0	0	0	0	0
	29	51 ***	0	0	0	0	0	53 **	28 ***	0	0	0	0	0
	-22	3	19 ***	0	0	0	0	13 *	-3	16 ***	0	0	0	0
	-43	-41	89	249 ***	0	0	0	28	-8	-29 **	57 ***	0	0	0
	11	41 *	49 ***	-33 ***	71 ***	0	0	14	3 *	11	-8 *	19 ***	0	0
	-4	-5	5	-1	2	26 ***	0	24	-1	34 ***	-11 **	17 ***	18 ***	0
	-10	-22	-16 *	-8	0	2	41 ***	-34 *	-114 **	-7	-20	87 **	81 ***	120 ***

Notes:

The values are in ($\times 10^{-4}$)

*** below the coefficient indicates a 1% significant level; ** as the indication of 5% significant level and * as the indication of 10% significant level

Table V-A(4a): FEVD – case II

	Period I								Total (f)	Total (d)
	FEVD for the change in output									
	\mathcal{E}_t^{s*}	\mathcal{E}_t^{i*}	\mathcal{E}_t^{d*}	\mathcal{E}_t^s	\mathcal{E}_t^i	\mathcal{E}_t^r	\mathcal{E}_t^d			
Kor	0.02 0.02	0.00 0.01	0.00 0.00	0.88 0.83	0.08 0.10	0.01 0.03	0.01 0.01	0.00 0.03	0.98 0.87	
Mal	0.00 0.04	0.06 0.05	0.02 0.03	0.92 0.85	0.01 0.03	0.00 0.00	0.00 0.00	0.08 0.12	0.93 0.88	
Phi	0.00 0.04	0.00 0.04	0.05 0.05	0.92 0.79	0.00 0.00	0.02 0.05	0.00 0.02	0.05 0.13	0.94 0.86	
Thai	0.01 0.03	0.11 0.12	0.00 0.03	0.86 0.76	0.00 0.01	0.01 0.01	0.01 0.04	0.12 0.18	0.88 0.82	
	FEVD for the change in interest rate									
Kor	0.00 0.03	0.02 0.02	0.00 0.01	0.13 0.16	0.80 0.65	0.04 0.10	0.01 0.02	0.02 0.06	0.97 0.93	
Mal	0.02 0.05	0.03 0.07	0.01 0.02	0.05 0.05	0.84 0.74	0.03 0.04	0.01 0.02	0.06 0.14	0.93 0.85	
Phi	0.00 0.05	0.10 0.09	0.01 0.06	0.01 0.01	0.88 0.75	0.00 0.02	0.00 0.02	0.11 0.20	0.89 0.80	
Thai	0.01 0.04	0.06 0.06	0.02 0.03	0.01 0.04	0.80 0.68	0.05 0.09	0.05 0.07	0.09 0.13	0.91 0.88	
	FEVD for the change in real exchange rate									
Kor	0.06 0.08	0.04 0.04	0.01 0.01	0.14 0.16	0.11 0.11	0.61 0.58	0.02 0.02	0.11 0.13	0.96 0.87	
Mal	0.07 0.07	0.00 0.01	0.03 0.06	0.01 0.02	0.00 0.03	0.87 0.74	0.05 0.08	0.10 0.14	0.93 0.87	
Phi	0.06 0.08	0.01 0.01	0.00 0.01	0.05 0.05	0.00 0.02	0.82 0.77	0.05 0.06	0.07 0.10	0.92 0.90	
Thai	0.00 0.02	0.00 0.00	0.01 0.02	0.06 0.06	0.15 0.15	0.75 0.67	0.03 0.07	0.01 0.04	0.99 0.95	
	FEVD for the change in price									
Kor	0.06 0.06	0.09 0.10	0.01 0.02	0.02 0.05	0.03 0.04	0.11 0.15	0.69 0.59	0.16 0.18	0.85 0.83	
Mal	0.00 0.01	0.00 0.02	0.05 0.07	0.00 0.02	0.00 0.02	0.09 0.14	0.85 0.73	0.05 0.10	0.94 0.91	
Phi	0.00 0.02	0.02 0.03	0.05 0.15	0.00 0.01	0.01 0.02	0.18 0.15	0.74 0.62	0.07 0.20	0.93 0.80	
Thai	0.06 0.10	0.00 0.05	0.02 0.04	0.00 0.03	0.07 0.12	0.03 0.03	0.81 0.63	0.08 0.19	0.91 0.81	

Table V-A(4b): Forecast error variance decomposition (FEVD) – case III

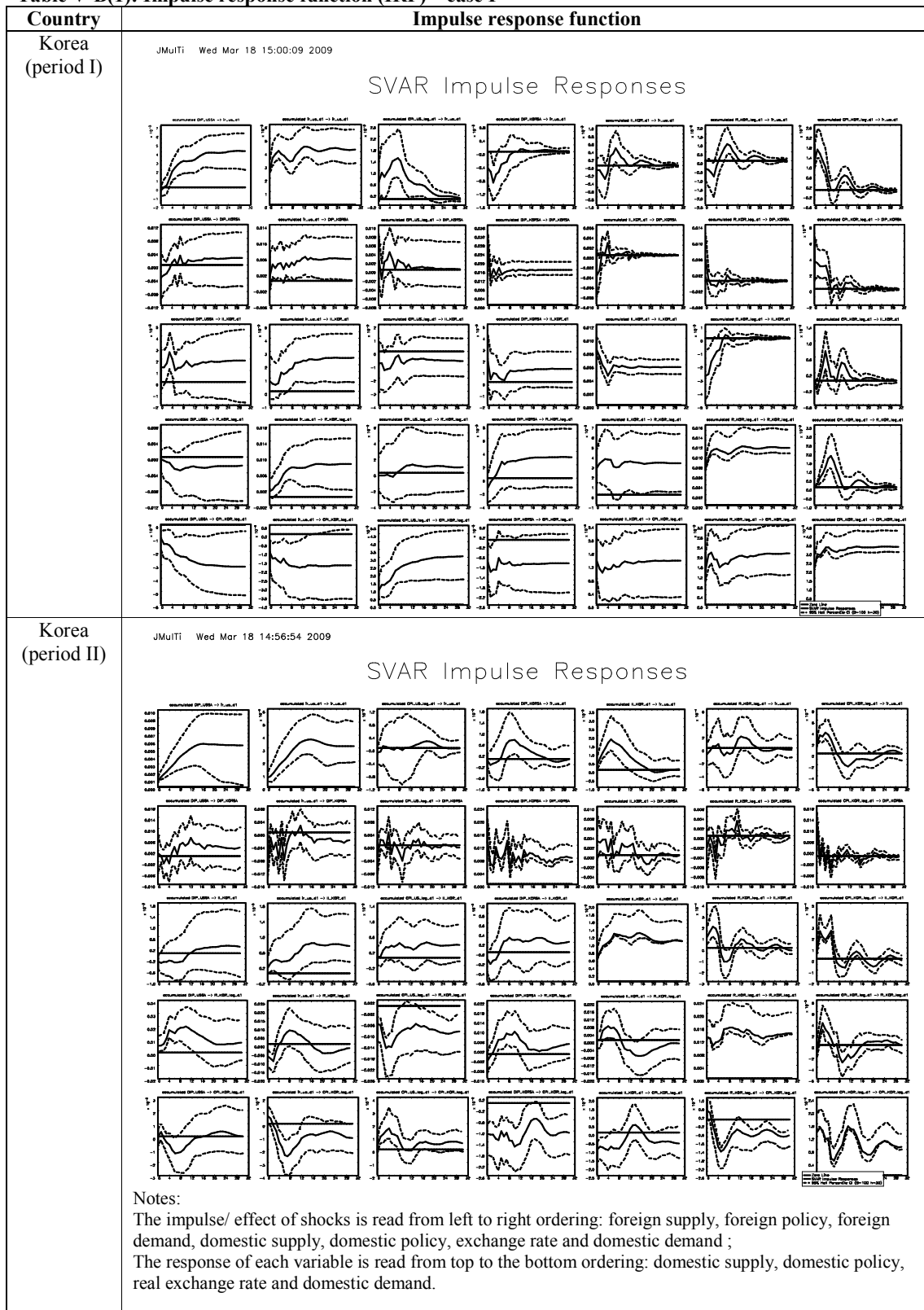
	Period I FEVD for the change in output									Period II FEVD for the change in output								
	ε_t^{s*}	ε_t^{i*}	ε_t^{d*}	ε_t^s	ε_t^i	ε_t^r	ε_t^d	Total (f)	Total (d)	ε_t^{s*}	ε_t^{i*}	ε_t^{d*}	ε_t^s	ε_t^i	ε_t^r	ε_t^d	Total (f)	Total (d)
Kor	0.03 0.04	0.00 0.02	0.03 0.09	0.89 0.79	0.02 0.03	0.00 0.01	0.03 0.03	0.06 0.15	0.94 0.86	0.00 0.03	0.01 0.17	0.03 0.11	0.55 0.23	0.00 0.05	0.24 0.21	0.17 0.19	0.04 0.31	0.96 0.68
Mal	0.00 0.06	0.07 0.06	0.01 0.02	0.87 0.75	0.05 0.09	0.00 0.02	0.00 0.01	0.08 0.14	0.92 0.87	0.01 0.08	0.20 0.17	0.17 0.10	0.55 0.30	0.02 0.03	0.01 0.09	0.03 0.22	0.38 0.35	0.61 0.64
Phi	0.01 0.04	0.02 0.05	0.07 0.07	0.85 0.66	0.00 0.02	0.06 0.10	0.00 0.05	0.10 0.16	0.91 0.83	0.05 0.10	0.03 0.06	0.13 0.12	0.40 0.21	0.00 0.13	0.38 0.23	0.00 0.15	0.21 0.28	0.78 0.72
Thai	0.01 0.04	0.00 0.05	0.01 0.03	0.97 0.50	0.00 0.04	0.01 0.19	0.00 0.15	0.02 0.12	0.98 0.88	0.01 0.14	0.15 0.16	0.00 0.02	0.74 0.46	0.11 0.16	0.00 0.05	0.00 0.02	0.16 0.32	0.85 0.69
	FEVD for the change in interest rate									FEVD for the change in interest rate								
Kor	0.01 0.04	0.01 0.02	0.01 0.01	0.03 0.05	0.83 0.75	0.10 0.10	0.02 0.03	0.03 0.07	0.98 0.93	0.08 0.14	0.02 0.08	0.00 0.04	0.07 0.15	0.74 0.45	0.08 0.08	0.00 0.06	0.10 0.26	0.89 0.74
Mal	0.01 0.03	0.06 0.14	0.11 0.11	0.13 0.12	0.63 0.51	0.02 0.04	0.04 0.05	0.18 0.28	0.82 0.72	0.00 0.11	0.24 0.25	0.22 0.16	0.02 0.06	0.49 0.30	0.02 0.10	0.00 0.03	0.46 0.52	0.53 0.49
Phi	0.00 0.05	0.01 0.02	0.02 0.11	0.00 0.02	0.85 0.57	0.07 0.14	0.04 0.10	0.03 0.18	0.96 0.83	0.08 0.35	0.08 0.11	0.03 0.08	0.04 0.09	0.14 0.09	0.01 0.04	0.62 0.25	0.19 0.54	0.81 0.47
Thai	0.11 0.11	0.01 0.05	0.02 0.06	0.01 0.08	0.82 0.52	0.00 0.07	0.02 0.11	0.14 0.22	0.85 0.78	0.00 0.12	0.39 0.19	0.02 0.12	0.04 0.19	0.23 0.19	0.05 0.06	0.26 0.13	0.41 0.43	0.58 0.57
	FEVD for the change in real exchange rate									FEVD for the change in real exchange rate								
Kor	0.01 0.04	0.02 0.11	0.00 0.01	0.00 0.05	0.12 0.10	0.68 0.54	0.16 0.15	0.03 0.16	0.96 0.84	0.21 0.26	0.00 0.10	0.18 0.15	0.01 0.08	0.00 0.09	0.31 0.17	0.28 0.15	0.39 0.51	0.60 0.49
Mal	0.05 0.05	0.00 0.02	0.03 0.06	0.01 0.02	0.00 0.03	0.87 0.74	0.05 0.08	0.08 0.13	0.93 0.87	0.13 0.13	0.08 0.10	0.00 0.08	0.02 0.07	0.05 0.07	0.72 0.49	0.00 0.06	0.21 0.31	0.79 0.69
Phi	0.29 0.23	0.06 0.09	0.06 0.08	0.00 0.03	0.02 0.04	0.57 0.49	0.00 0.03	0.41 0.40	0.59 0.59	0.02 0.07	0.27 0.20	0.05 0.09	0.21 0.18	0.22 0.17	0.23 0.21	0.00 0.07	0.34 0.36	0.66 0.63
Thai	0.01 0.04	0.00 0.02	0.02 0.03	0.08 0.09	0.00 0.03	0.87 0.75	0.02 0.03	0.03 0.09	0.97 0.90	0.09 0.12	0.09 0.07	0.11 0.21	0.01 0.08	0.17 0.16	0.32 0.22	0.22 0.15	0.29 0.40	0.72 0.61
	FEVD for the change in price									FEVD for the change in price								
Kor	0.09 0.11	0.07 0.08	0.06 0.06	0.06 0.08	0.14 0.12	0.01 0.02	0.57 0.53	0.22 0.25	0.78 0.75	0.05 0.11	0.02 0.10	0.05 0.05	0.43 0.32	0.16 0.13	0.11 0.11	0.19 0.17	0.12 0.26	0.89 0.73
Mal	0.00 0.02	0.00 0.03	0.11 0.19	0.00 0.02	0.02 0.03	0.00 0.05	0.87 0.67	0.11 0.24	0.89 0.77	0.27 0.21	0.03 0.06	0.02 0.08	0.10 0.09	0.00 0.04	0.01 0.07	0.57 0.44	0.32 0.35	0.68 0.64
Phi	0.05 0.14	0.01 0.02	0.02 0.22	0.01 0.02	0.05 0.07	0.12 0.08	0.75 0.44	0.08 0.38	0.93 0.61	0.15 0.17	0.01 0.08	0.03 0.10	0.01 0.02	0.46 0.30	0.02 0.04	0.32 0.28	0.19 0.35	0.81 0.64
Thai	0.02 0.04	0.14 0.13	0.05 0.05	0.00 0.03	0.07 0.08	0.15 0.24	0.57 0.42	0.21 0.22	0.79 0.77	0.32 0.23	0.02 0.03	0.44 0.38	0.00 0.09	0.10 0.08	0.08 0.11	0.05 0.09	0.78 0.64	0.23 0.37

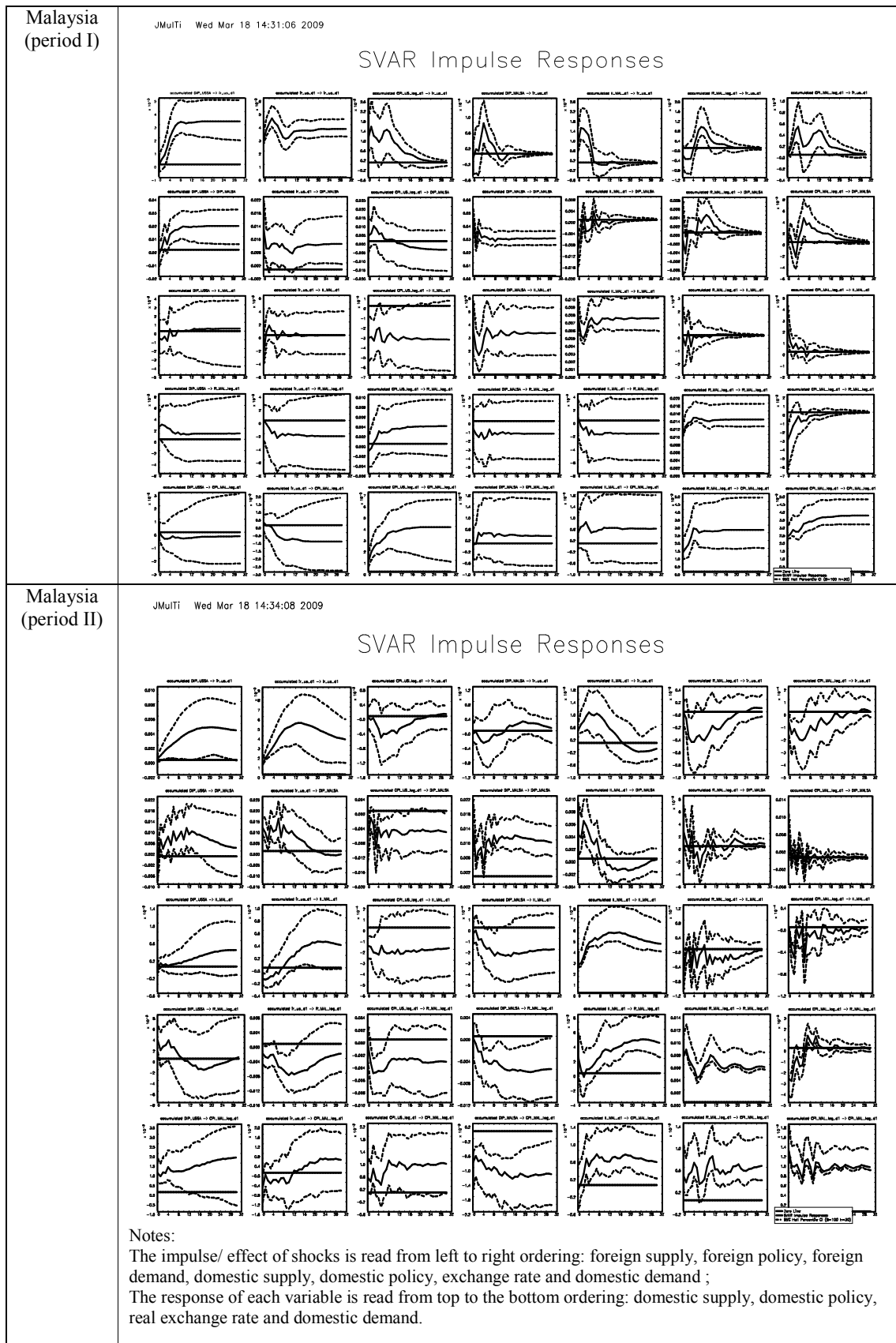
The numerical figures show the 1st and 20th periods of variance decompositions

The column total (f) indicates the total FEVD for foreign shocks while total (d) as total FEVD for domestic shocks

APPENDIX V-B

Table V-B(1): Impulse response function (IRF) – case I

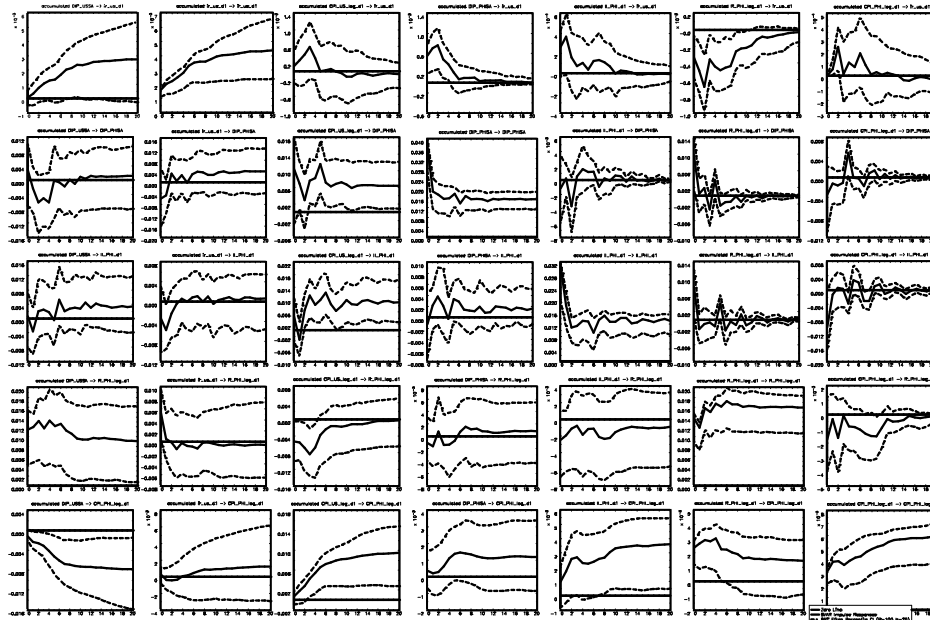




Philippines
(period I)

JMulti Thu Mar 19 03:54:19 2009

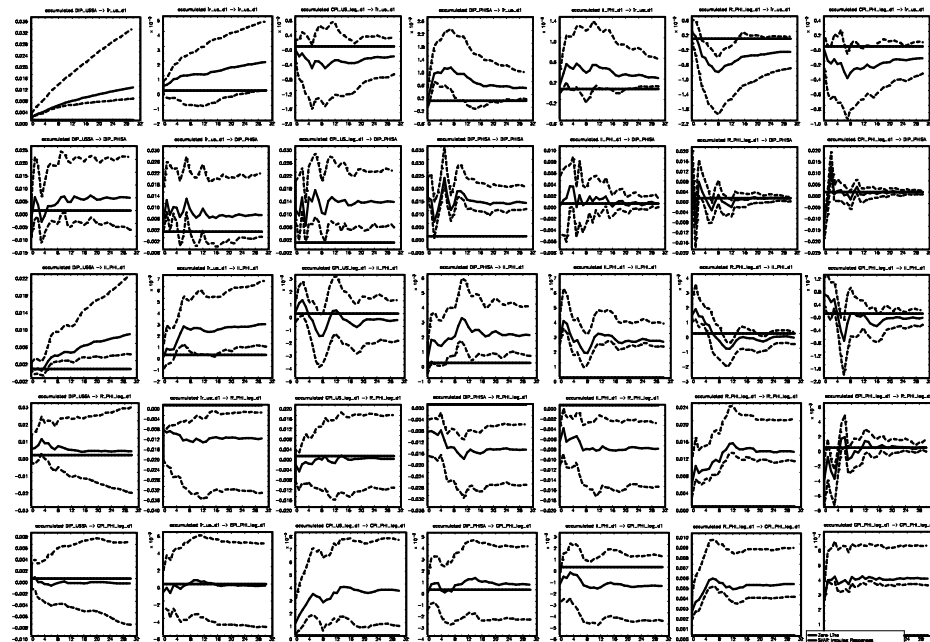
SVAR Impulse Responses



Philippines
(period II)

JMulti Sun Mar 22 10:07:02 2009

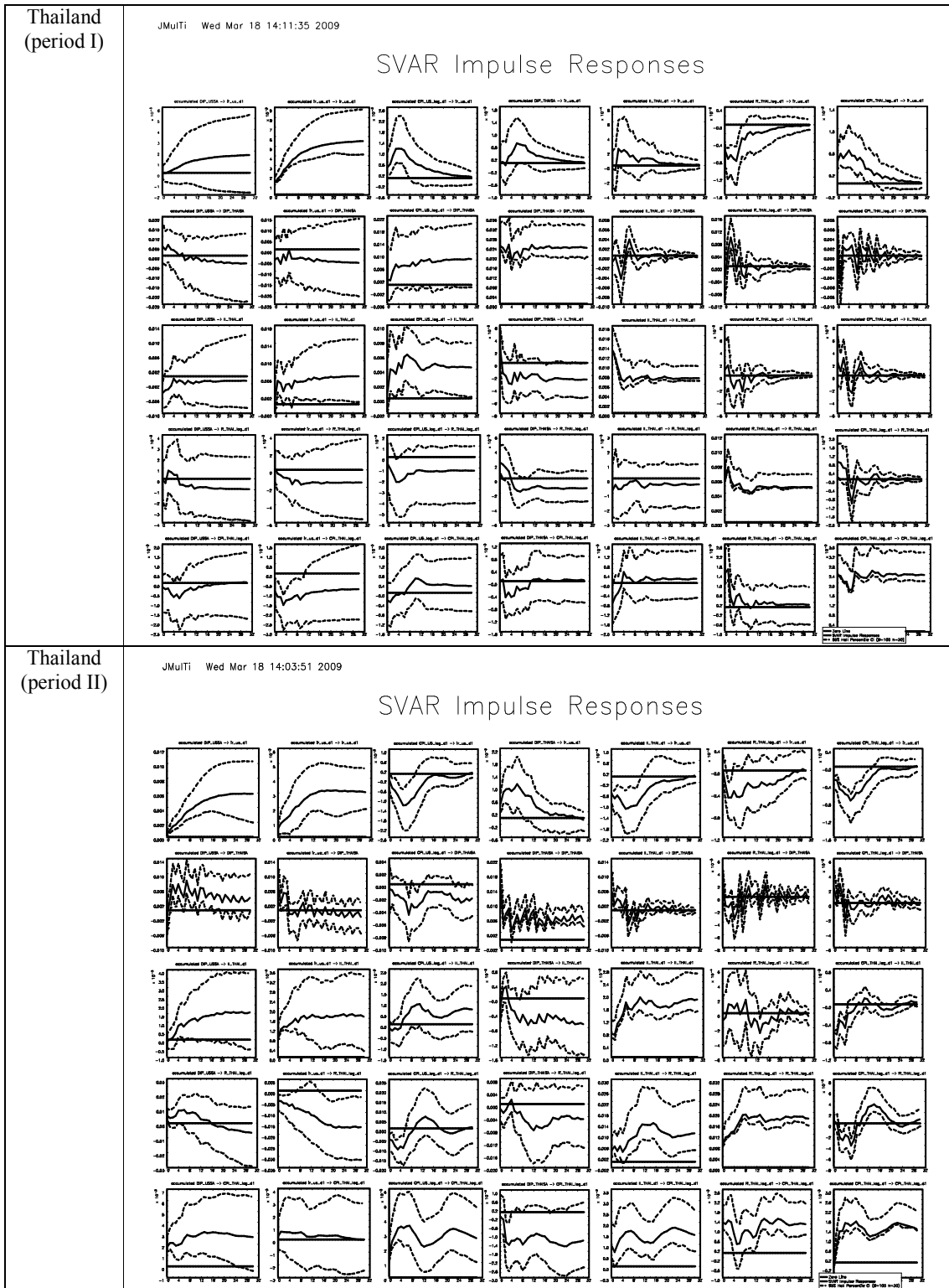
SVAR Impulse Responses



Notes:

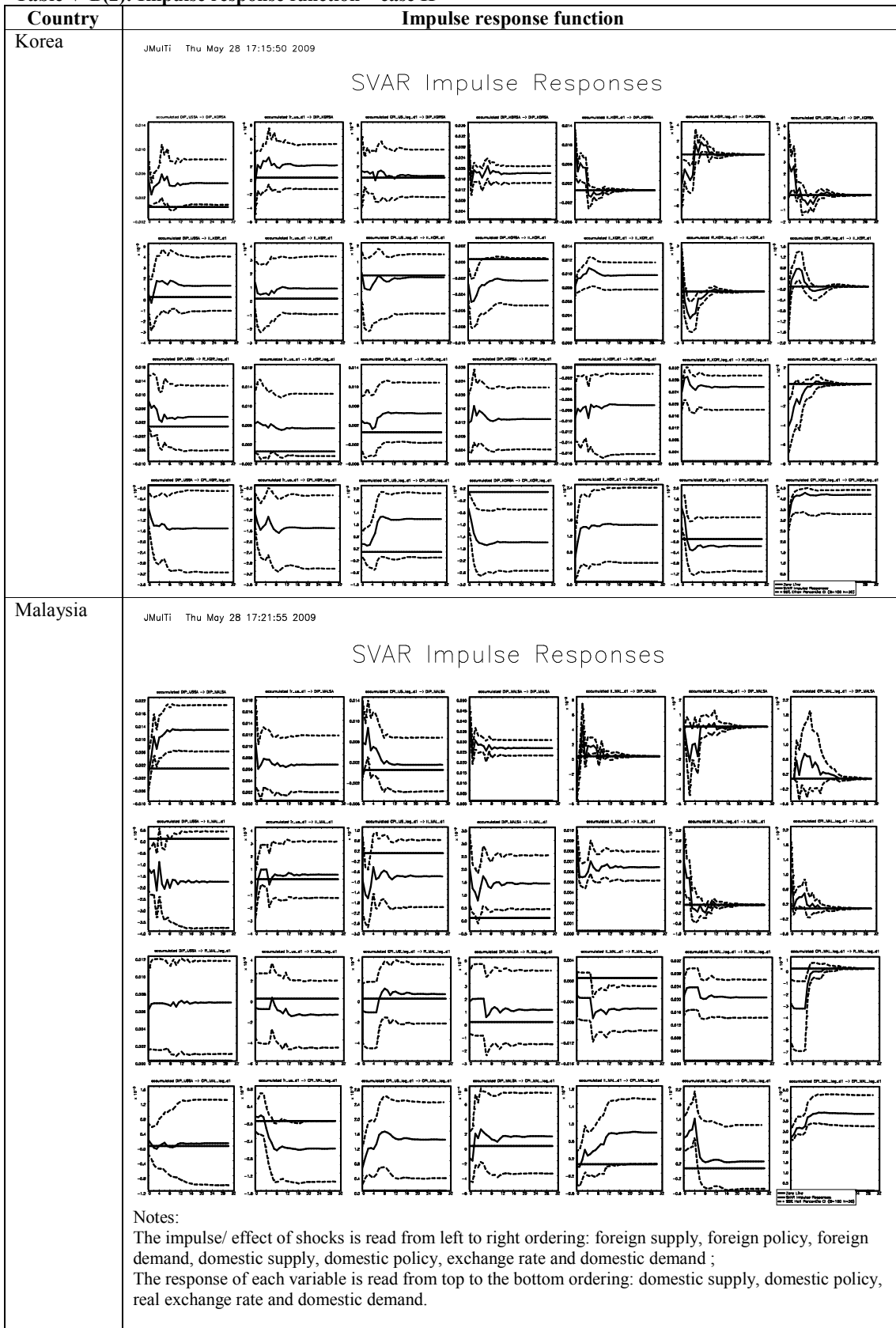
The impulse/ effect of shocks is read from left to right ordering: foreign supply, foreign policy, foreign demand, domestic supply, domestic policy, exchange rate and domestic demand ;

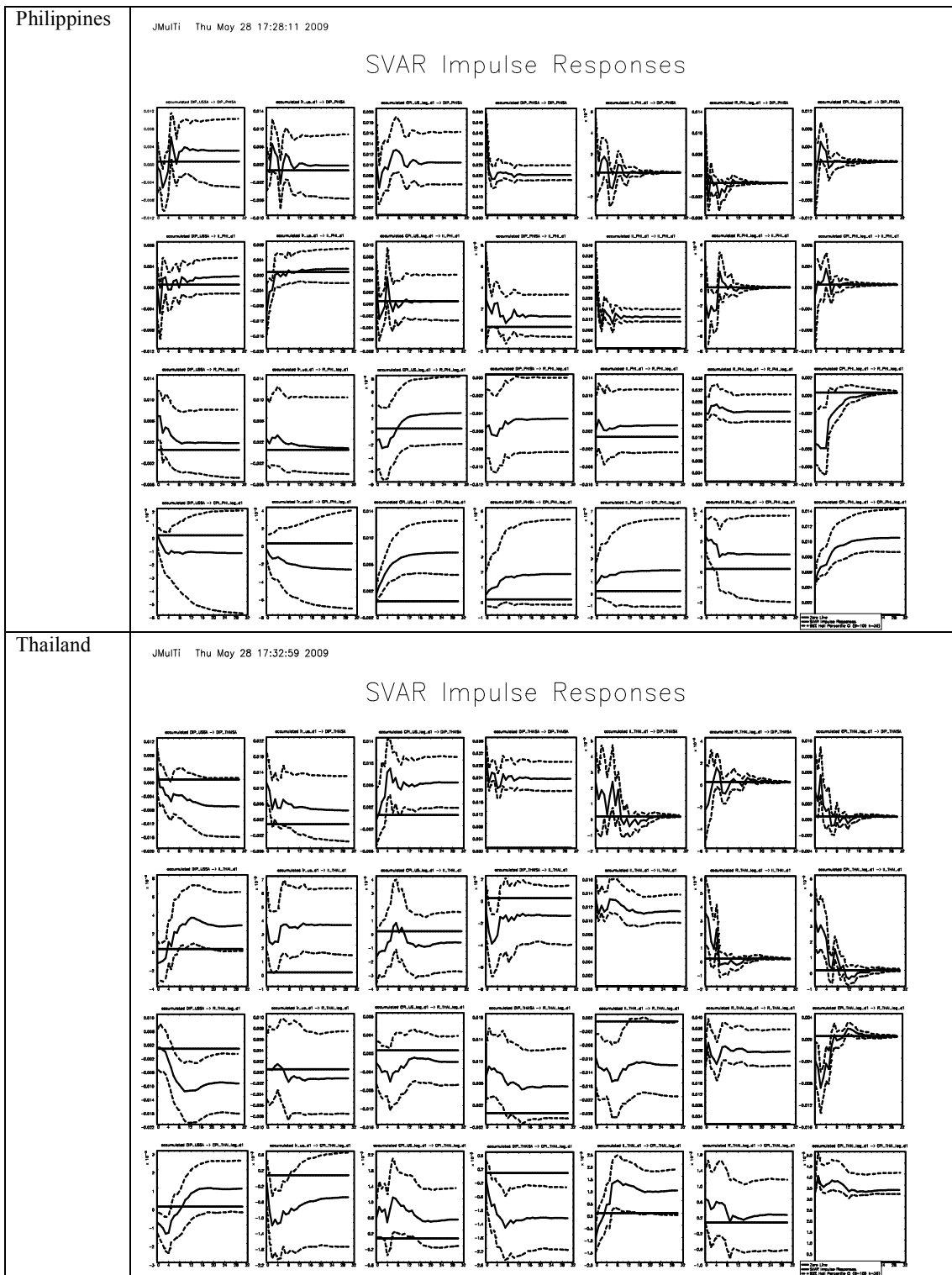
The response of each variable is read from top to the bottom ordering: domestic supply, domestic policy, real exchange rate and domestic demand.



Notes:
 The impulse/ effect of shocks is read from left to right ordering: foreign supply, foreign policy, foreign demand, domestic supply, domestic policy, exchange rate and domestic demand ;
 The response of each variable is read from top to the bottom ordering: foreign policy, domestic supply, domestic policy, real exchange rate and domestic demand.

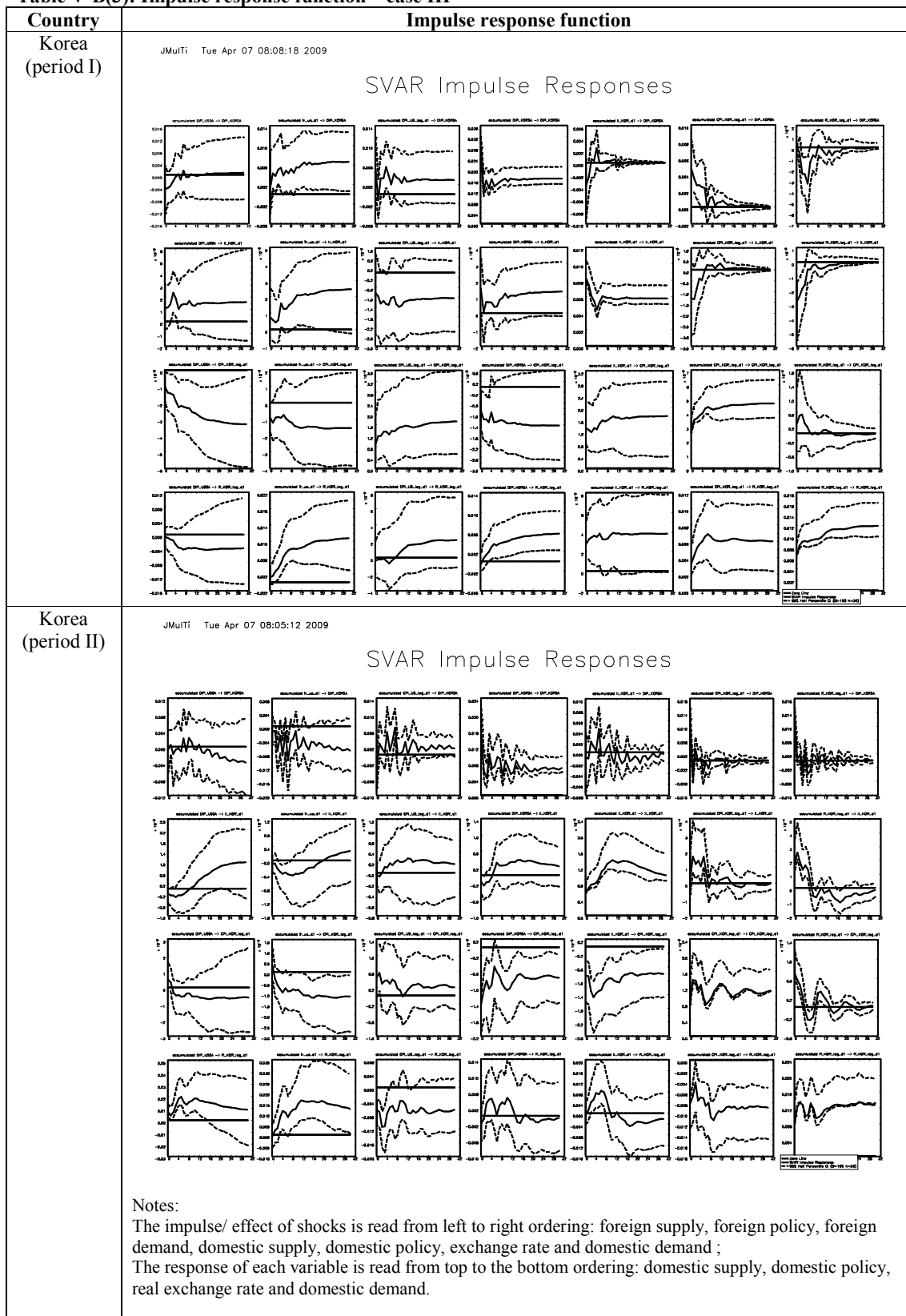
Table V-B(2): Impulse response function – case II

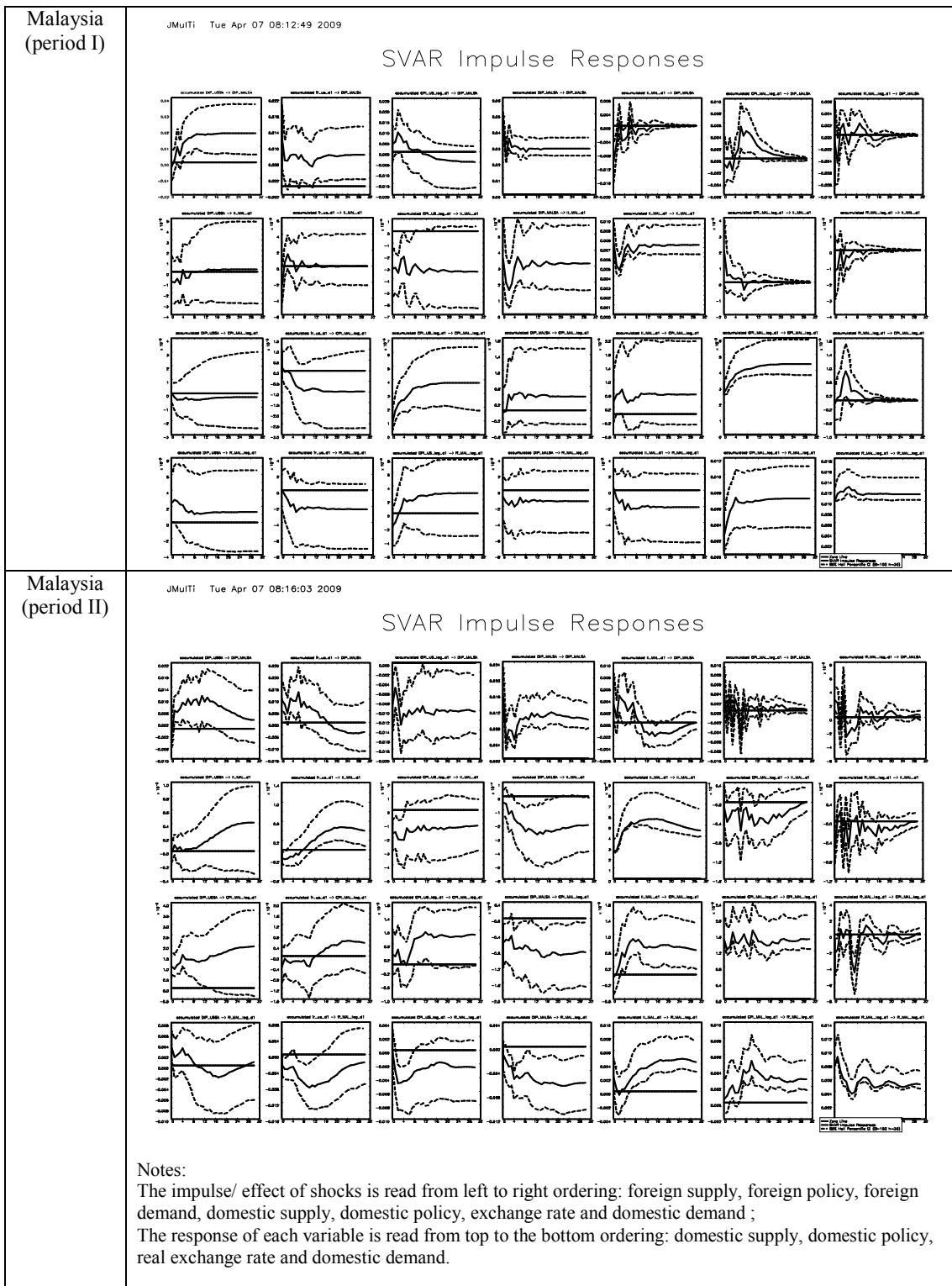




Notes:
 The impulse/ effect of shocks is read from left to right ordering: foreign supply, foreign policy, foreign demand, domestic supply, domestic policy, exchange rate and domestic demand ;
 The response of each variable is read from top to the bottom ordering: domestic supply, domestic policy, real exchange rate and domestic demand.

Table V-B(3): Impulse response function – case III

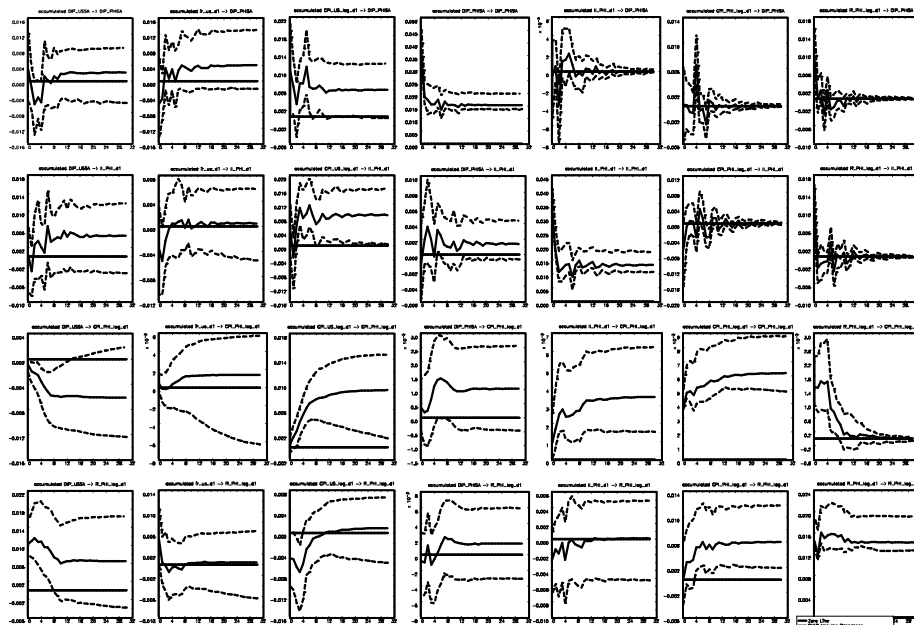




Philippines
(period I)

JMulti Tue Apr 07 07:52:24 2009

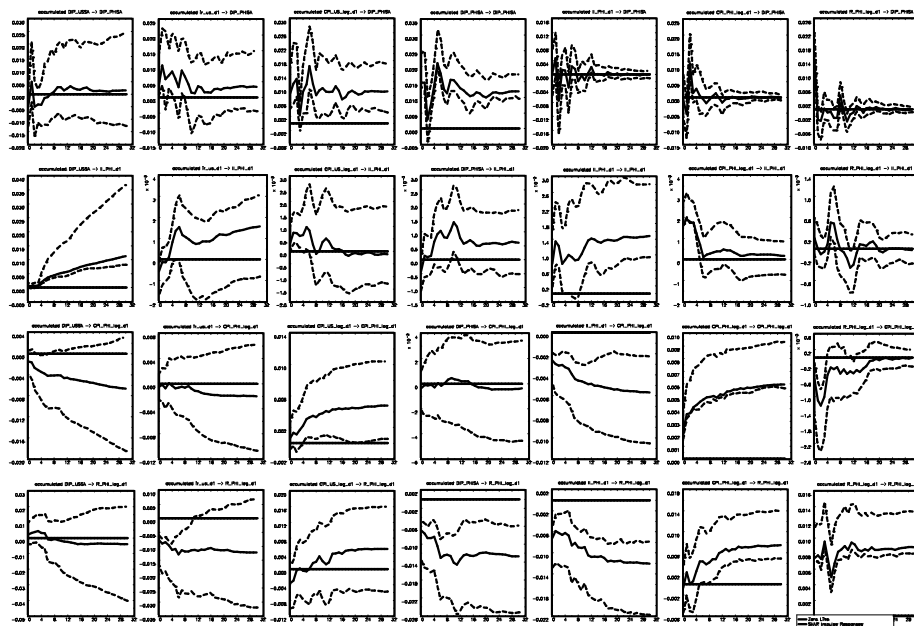
SVAR Impulse Responses



Philippines
(period II)

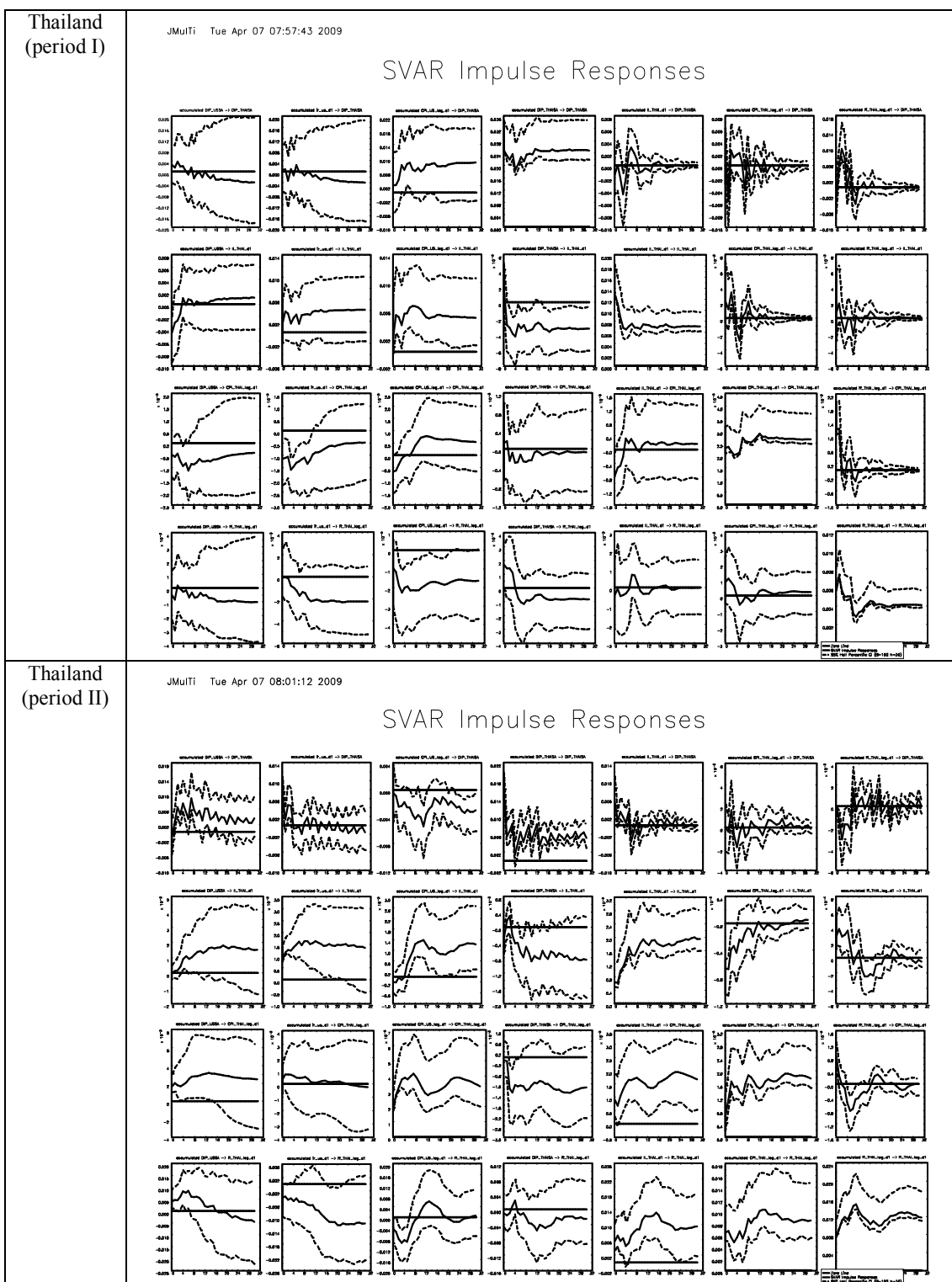
JMulti Tue Apr 07 07:47:08 2009

SVAR Impulse Responses



Notes:

The impulse/ effect of shocks is read from left to right ordering: foreign supply, foreign policy, foreign demand, domestic supply, domestic policy, exchange rate and domestic demand ;
The response of each variable is read from top to the bottom ordering: domestic supply, domestic policy, real exchange rate and domestic demand.



Notes:
 The impulse/ effect of shocks is read from left to right ordering: foreign supply, foreign policy, foreign demand, domestic supply, domestic policy, exchange rate and domestic demand ;
 The response of each variable is read from top to the bottom ordering: domestic supply, domestic policy, real exchange rate and domestic demand.

SIOK KUN, SEK

Olshausenstr. 66A-007
24118 Kiel,
Germany.

Phone: +49(0)431-8886969
Email: siokksek@economics.uni-kiel.de

PERSONAL PROFILE

Date of Birth: 14th January, 1976 in Malacca, Malaysia
Nationality: Malaysian
Status: Single

EDUCATION

1997-2000 Bachelor Degree in Economics, National University of Malaysia
2000-2001 Master in Economics, National University of Malaysia
2001-2002 Master in Science (Quality & Productivity Improvement), National University of Malaysia
2005-2009 Ph.D in "Quantitative Economics", Christian-Albrechts-Universität zu Kiel
2008 Advanced Studies Program, the Kiel Institute for the World Economy

EMPLOYMENT

July 2000- Sept 2000 Population Census for the State of Malacca, Statistic Department of Malacca
Sept 2001- May 2002 Research Assistant, National University of Malaysia
June 2002- Mac 2003 Tutor, UCMAS Mental Arithmetic Centre, Kajang , Selangor
May 2003- Sept 2005 Admin. Officer, Taiyu Furniture Corp (M) Sdn. Bhd., Malacca

PERSONAL SKILLS

Languages: Chinese (Mandarin, Teochew, Hokkian), English, Malay
Computer skills: SPSS, Eviews, Jmulti, Matlab, Dynare, Stata

WORKING PAPERS

“Exchange rate pass-through and volatility: impacts on domestic prices in four Asian countries” (2008). MPRA paper no. 11130.

“Interactions between monetary policy and exchange rate in inflation targeting emerging countries: the case of three East-Asian countries” 2008. MPRA paper no. 12034.

PUBLICATIONS

“Nominal shocks and current account dynamics: a structural VAR analysis in the Southeast Asian countries” (2007). International Economic Conference on Trade and Industry, proceedings.

“Pass-through of exchange rate into domestic prices: the case of four East-Asian countries” (2008). The International Journal of Economic Policy Studies, vol. 3(3): 45-72 – with Zhanna Kapsalyamova.

“Interactions between monetary policy and exchange rate in inflation targeting emerging countries: the case of three East-Asian countries” (2009). International Journal of Economics and Finance, vol. 1(2): 27-44.

“The source of shocks and the role of exchange rate as a shock absorber: a comparative study in the crisis-hit East-Asian countries” (forthcoming). Journal of Mathematics Research.

CONFERENCES/ COURSES

July 2007	Dynare Summer School – Paris, France
December 2007	The Japanese Economic Policy Association 2007 Conference – Tokyo, Japan
December 2007	The International Economic Conference on Trade and Industry – Pinang, Malaysia
January & May 2008	Advanced Studies Program Term Paper Conferences – Kiel, Germany
April 2008	The course in “Global Sensitivity Analysis of Macroeconomics Models” – Ispra, Italy
June 2009	Asian Mathematical Conference – Kuala Lumpur, Malaysia

Affirmation

I hereby affirm that I have completed my doctoral thesis entitled “Economic structures, the nature of shocks and the role of exchange rate in the monetary policy formation in the emerging countries of East-Asia” entirely on my own and unassisted, and that I have specially marked all of the quotes I have used from other authors as well as those passages in my work that are extremely close to the thoughts presented by other authors, and listed the sources in accordance with the regulations I have been given.

18th September, 2009, Kiel

(Siok Kun, Sek)

