



UNIVERSITI PUTRA MALAYSIA

MACROECONOMICS OF VERTICALLY GLOBALIZED PRODUCTION

WONG CHIN YOONG

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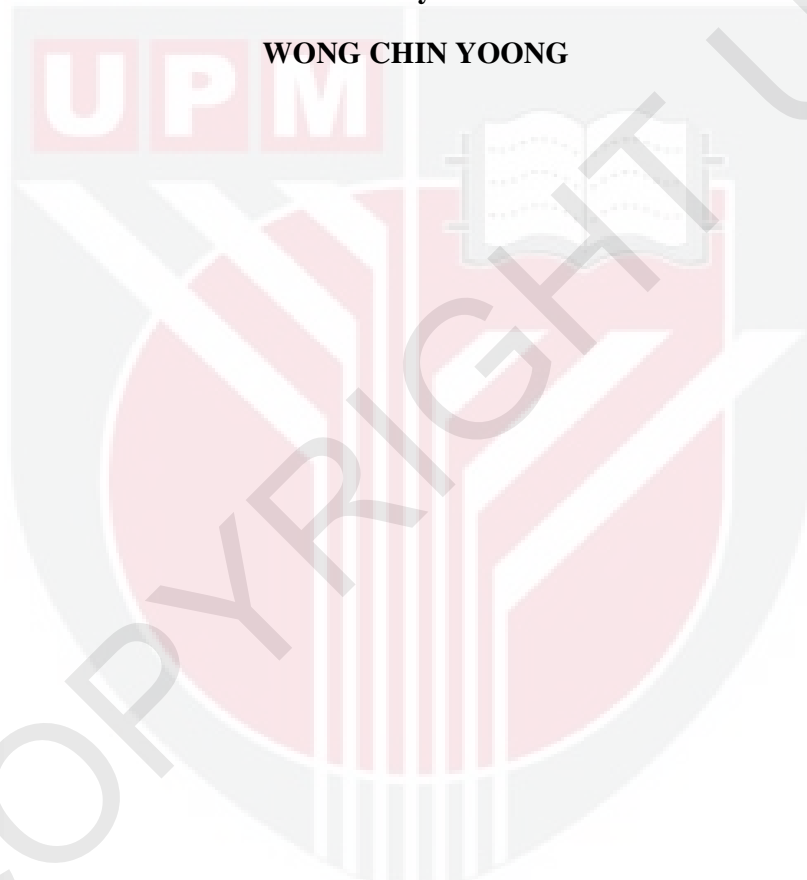
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**MACROECONOMICS OF VERTICALLY GLOBALIZED
PRODUCTION**

By

WONG CHIN YOONG



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**MACROECONOMICS OF VERTICALLY GLOBALIZED
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December 2012

Chairman: Professor Dr. Muzafar Shah Habibullah, Ph.D

Faculty: Economics and Management

This thesis investigates the macroeconomic implications of vertically fragmented production by shedding light on three long-standing issues in international macroeconomics: trade-comovement puzzle, China's syndrome, and international monetary policy coordination. Chapter 3 revisits the trade-comovement puzzle. Existing models of international business cycle, ranging from two-country real business cycle model to simple vertical-specialization model, are known for the inability to reproduce the empirical regularities that economies linked with bilateral trade in intermediate inputs tend to comove more closely. Such modeling-empirics mismatch casts doubt on the role of international trade as transmission mechanism.

This thesis contributes to the literature by laying out a medium-scale two-country New Keynesian model with three processing stages fragmented across borders. Doing so allows us to capture the essence of vertical specialization in the form of

vertical and processing trade. The model is then estimated using Bayesian method on trade-weighted East and Southeast Asian time series. The estimated model has convincingly demonstrated its ability to replicate neatly the business cycle comovement over a large set of macroeconomic variables. As such, the thesis delivers a message that proper modeling of production fragmentation is a rewarding exercise for solving trade-comovement puzzle.

Turning our attention to contemporary issues, the anxiety with respect to the influence of rising China on Asian neighbors has been mounting. Whether China's rise is benign or malign to Asian neighboring economies remains empirically indecisive. By taking the model into the data of China and East/Southeast Asia, Chapter 4 shows that vertical trade in intermediate inputs between China and East Asia has substantially arisen alongside processing trade in the aftermath of China's WTO accession. East Asia, as the story goes, specializes at midstream production to produce intermediate goods traded vertically with China which specializes at downstream production for processing export.

Nonetheless, vertical trade between China and the developing Southeast Asia is trivial over the same time span. Both regions vertically specialize at downstream production, competing in processing trade against each other. Unsurprisingly then, the impulse response analysis indicates that China's integration into regional production network has been benign to the advanced East Asian economies through vertical trade, but malign to the developing Southeast Asian economies that have to compete in processing trade. The thesis thus puts forward

an argument that macroeconomic interdependence is hugely influenced by the nature of production and trade linkage.

For open economies that are vertically and sequentially linked through production fragmentation and network-driven trade, an important question is if there is welfare gain from international monetary policy coordination. Drawn on the model estimated on China, East and Southeast Asia, Chapter 5 revisits this classic issue by proposing two novel views of optimal monetary policy coordination. Firstly, economies with strong trade link are not necessarily the natural candidates for policy coordination. The pattern of trade linkage does matter. Welfare gains from policy coordination can be sizeable only when the member economies vertically specialize at different chains of production and thus complement each other through vertical and processing trade.

Another equally if not more important contribution of this thesis is to develop a view of optimal monetary policy coordination as competing objectives of optimal input allocation due to production fragmentation and optimal consumption allocation with home bias. The former has disinflationary bias while the latter has expansionary bias. Were intratemporal elasticity of substitution between home and foreign final goods not equivalent to that between home and foreign intermediate goods, two biases are not counterbalanced. Either way will lead to currency misalignment, ending in inefficient price dispersion of identical goods across borders. Such effect occurs regardless of the genre of trade links. This has reinstated a strong case for international monetary policy coordination.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

**MAKROEKONOMI GLOBALISASI PENGELUARAN SECARA
MENEGAK**

Oleh

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Tesis ini mengkaji implikasi makroekonomi bagi globalisasi pengeluaran secara menegak dengan memberikan tumpuan kepada tiga isu yang penting dalam makroekonomi antarabangsa, iaitu masalah ketidakselarasan antara perdagangan antarabangsa dan kitaran ekonomi, sindrom China, dan penyelarasan antarabangsa dasar monetari. Bab 3 mengkaji semula masalah ketidakselarasan antara perdagangan dan kitaran ekonomi. Sebagaimana yang diketahui, baik model dua negara kitaran ekonomi sebenar ataupun model pengkhususan menegak mudah, model-model kitaran ekonomi antarabangsa yang sedia ada ini tidak berkeupaya untuk menghasilkan semula kenyataan empirikal berikut: ekonomi bagi negara-negara yang dihubungkan dengan perdagangan dua hala dalam barang perantaraan berkecenderungan untuk berkisar bersama dengan lebih rapat. Ketidaksepadanan antara model ekonomi dan bukti empirikal ini telah mencetuskan keraguan tentang peranan perdagangan antarabangsa sebagai mekanisme saluran kejutan.

Tesis ini menyumbang kepada karya yang sedia ada dengan membina model dua negara Keynesian Baru yang dilengkapi dengan tiga peringkat pemprosesan yang berpecah merentasi sempadan negara. Pemodelan sedemikian menyenangkan penghayatan intipati pengkhususan menegak dalam bentuk perdagangan menegak dan perdagangan pemprosesan. Model ini kemudiannya dianggarkan dengan kaedah Bayesian berdasarkan siri masa Asia Timur dan Asia Tenggara. Model tersebut telah menunjukkan keupayaan yang memberangsangkan dalam penghasilan semula kitaran ekonomi sebenar yang mengrakumi set pembolehkan makroekonomi yang luas. Oleh itu, tesis ini telah menyampaikan mesej yang penting bahawa pemodelan fragmentasi pengeluaran yang merentasi sempadan negara adalah satu usaha untuk menyelesaikan masalah ketidaksepadanan antara perdagangan dan kitaran ekonomi yang amat bernilai.

Apabila kita mengalihkan tumpuan kepada isu-isu semasa, kebimbangan terhadap pengaruh negara China yang semakin berkembang dalam negara-negara jiran di rantau Asia memang tidak dapat diabaikan. Walaubagaimanapun, bukti-bukti tentang sama ada kebangkitan negara China memanfaatkan atau menyusahkan negara jirandi rantau Asia masih dicari-cari. Apabila model tersebut dianggar dengan siri masa China dan Asia Timur/Tenggara, Bab 4 menunjukkan bahawa perdagangan menegak dalam barang pengantaraan antara China dan Asia Timur telah berkembang pesat di samping perdagangan pemprosesan selepas penyertaan negara China dalam Organisasi Perdagangan Dunia (WTO). Khususnya, negara-negara Asia Timur mengkhusus pada pengeluaran aliran tengah untuk menghasilkan barang-barang pengantaraan yang

diperdagangkan secara menegak dengan China yang mengkhusus pada pengeluaran hiran bagi tujuan eksport pemprosesan.

Sebaliknya, perdagangan menegak antara China dan Asia Tenggara tidak begitu ketara dalam jangka masa yang sama. Sebaliknya, kedua-dua rantau ini mengkhusus pada pengeluaran hiran, and bersaing antara satu sama lain dalam perdagangan pemprosesan. Maka tidaklah hairan apabila analisis tindak balas impuls menunjukkan bahawa integrasi negara China dalam rangkaian pengeluaran serantau telah memanfaatkan ekonomi Asia Timur yang maju melalui perdagangan menegak. Sebaliknya, kebangkitan negara China merupakan cabaran hebat kepada ekonomi Asia Tenggara yang sedang membangun akibat daripada persaingan dalam perdagangan pemprosesan. Secara kesimpulannya, tesis ini telah mengemukakan hujah bahawa kesalingbergantungan ekonomi makro amat dipengaruhi oleh corak rangkaian pengeluaran dan perdagangan.

Bagi ekonomi-ekonomi terbuka yang dihubungkan melalui pemecahan pengeluaran dan perdagangan menegak yang berurutan, satu persoalan yang penting sekali ialah sama ada penyelarasan antarabangsa dasar-dasar monetari membawa keuntungan kebajikan. Berdasarkan model yang dianggarkan pada China, Asia Timur dan Asia Tenggara, Bab 5 mengkaji semula isu klasik ini dengan mencadangkan dua pandangan yang asli berkenaan dengan penyelarasan antarabangsa dasar monetari yang optimum. Yang pertama, ekonomi-ekonomi dengan pautan perdagangan yang kukuh tidak semestinya sesuai untuk penyelarasan dasar monetari. Corak rantaian perdagangan yang menjadi penentu.

Keuntungan kebajikan daripada penyelarasan dasar monetari menonjol hanya apabila ekonomi-ekonomi anggota mengkhusus pada rantaian pengeluaran menegak yang berbeza dan saling melengkapi antara satu sama lain melalui perdagangan menegak dan pemprosesan.

Yang kedua, buat pertama kali dalam karya-karya berkenaan tesis ini mengusulkan konsep penyelarasan dasar monetari yang optimum dari segi objektif-objectif yang bertentangan akibat peruntukan input optimum yang disebabkan oleh pemecahan pengeluaran dan peruntukan penggunaan optimum yang disebabkan oleh keutamaan terhadap barangan tempatan. Objektif terdahulu bersifat menguncup manakala objektif yang kemudian bersifat mengembang. Sekiranya keanjalan penggantian antara barangan akhir tempatan dan asing tidak bersamaan dengan keanjalan penggantian antara barangan perantaraan tempatan dan asing, kedua-dua objektif yang bertentangan ini tidak dapat diimbangi. Hasilnya, ketidakselarasan dalam kadar pertukaran mata wang akan berlaku. Ia akan mengakibatkan dispersi harga barangan akhir yang tidak efisien merentasi sempadan negara. Kesan ini akan terjadi tanpa mengira corak hubungan perdagangan. Oleh hal yang demikian, faktor ini telah mengukuhkan seruan bagi penyelarasan antarabangsa dasar monetari.

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This thesis is the culmination of many years of thoughts and efforts, and along the way I have accumulated a great deal of practical support and intellectual debt. My greatest debt goes to Prof. Dr. Muzafar Shah Habibullah for his relentless trust and tolerance on my work. His willingness to accept me as his supervisee is deeply appreciated till date. Sincere gratitude also goes to Associate Professor Dr. Law Siong Hook for his invaluable assistance throughout the studies. Their humbleness and academic enthusiasm, despite the outstanding academic achievements, has always been a role model for me.

I would like to express my gratefulness to three individuals who have indirectly influenced my attitude as an academic economist. I first met Jomo K.S during a public talk in Melaka in 1997 when currency and financial crises started landing on Malaysia. Since then I never miss his lectures during my undergraduate and master studies. His academic integrity and uncompromising concern about the relevance of economics for understanding the economic world, till date, has constantly reminded me not to give up practical relevance simply for the sake of analytical rigor in my intellectual pursuit.

My first article related to this topic has been published in a special issue on Phillips curve in the *North American Journal of Economics and Finance*. And the guest editor is Kenneth Kuttner. I can still remember his advice that “you have to bridge your work to existing literature, not just cite them, to show appreciation on others’ work on the one hand and to demonstrate your novelty on

the other hand". This has been the principle of writing ever since then that I attempt to hold every time I have my ink poured, although more often than not I fail miserably.

I always have great enthusiasm on theoretical modeling. Revealing the mechanism underlying an economic phenomenon through the lens of self-constructed economic model is intellectually fascinating. But in an academic environment which I stay that weighs heavily on empirical not theoretical analysis, the learning process becomes extremely taxing and demotivating. I nearly lost my enthusiasm until I attended ZEW summer workshop for young economist last year in Mainheim, Germany and met Fabio Ghironi. His enthusiastic presentation on the integration of firm heterogeneity into macroeconomic model has been especially inspiring. I regain the long lost interest and confidence when my work has been invited and accepted for publication in *International Review of Economics and Finance*.

Lastly and most importantly, I owe my deepest gratitude to Yoke Kee, my frequent coauthor and life companion. It is indeed an understatement to claim that without her this thesis can never be completed. She appeared when I was in the trough of my life; she brought me to my current supervising committee who treats me as researcher not student when I found dead end with the previous one; she shares my thoughts and opinions when no one cares; she keeps the confidence and trust on me when I myself have lost. She fixes me. I thus dedicate this thesis to her.

I certify that a Thesis Examination Committee has met on 6 December 2012 to conduct the final examination of Wong Chin Yoong on his thesis entitled "Macroeconomics of Vertically Globalized Production" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the degree of Doctor of Philosophy.

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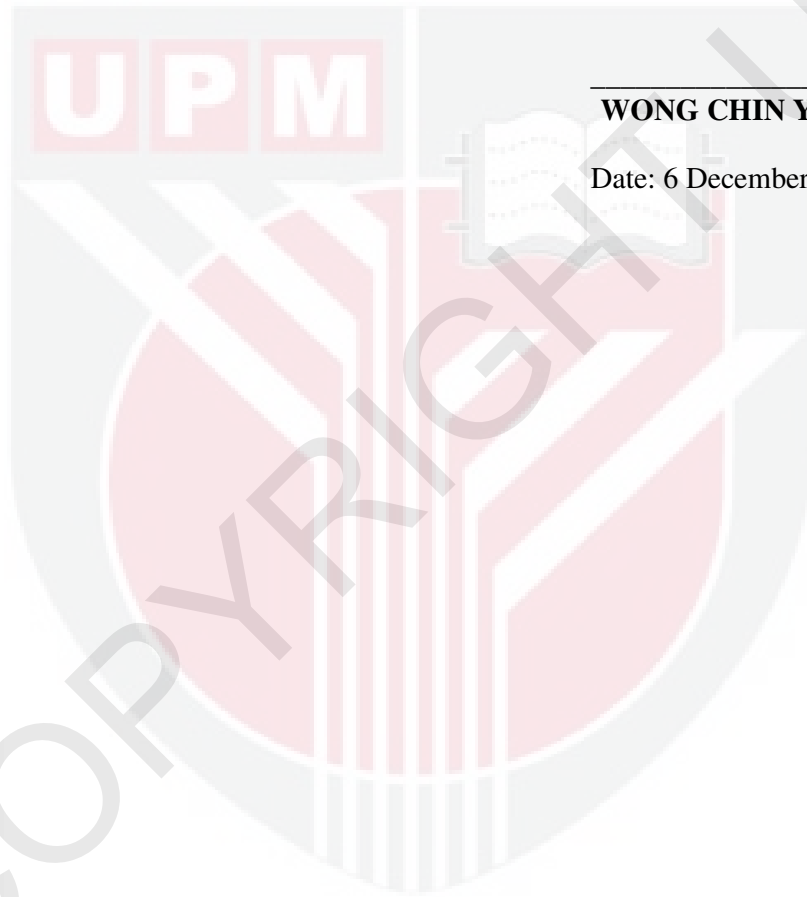
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Date: 26 February 2013

DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is no summated for any other degree at Universiti Putra Malaysia or other institution.



WONG CHIN YOONG

Date: 6 December 2012

LIST OF TABLES

Table	Page
1.1 Share of intermediate goods in total exports and imports, 2004	3
1.2 Geographic profile of world trade in parts and components	4
1.3 Share of value added component in total gross exports, 2004	5
3.1 Prior and posterior distributions for international real business cycle model	48
3.2 International real business cycle model and simple vertical-specialization model: cross-region correlations	50
3.3 Prior and posterior distributions for simple vertical-Specialization model	52
3.4 Prior and posterior distributions for New Keynesian model with vertical and processing trade	72
3.5 Measuring vertical specialization of total export	77
3.6 NKVPT model: contemporaneous cross-region correlations	79
4.1 Calibrated steady states, 1987Q1-2008Q4	113
4.2 Priors and posteriors for full sample 1987Q1 – 2008Q4	115
4.3 Vertical specialization index	121
4.4 Priors and posteriors for subsample 2001Q1 – 2008Q4	126
4.5 Forecast error variance decomposition in post Chinese WTO accession	141
5.1 Parameters and shocks, 1987Q1-2008Q4	161
5.2 Some stylized facts, 1987Q1-2008Q4	162
5.3 Measure of vertical specialization in total export	164
5.4 Definition of parameters in the unconditional welfare measure	166
5.5 Unconditional welfare cost of policy noncoordination	174

LIST OF FIGURES

Figure	Page
1.1 Taxonomy of vertical specializations	2
3.1 Trade-weighted macroeconomic data of advanced East Asian and developing Southeast Asian economies	69
3.2 Cross correlations	80
3.3 Autocorrelations for developing Southeast Asia	81
3.4 Effects of EA5 total factor productivity shock	87
3.5 Effects of EA5 investment-specific technology shock	88
3.6 Effects of EA5 monetary policy shock	89
4.1 Rising trade of Asia with China alongside falling trade with the United States	94
4.2 Forecast error variance decomposition, GDP: (a) China; (b) East Asia	132
4.3 Forecast error variance decomposition, PPI inflation: (a) China; (b) East Asia	133
4.4 Forecast error variance decomposition, CPI inflation: (a) China; (b) East Asia	134
4.5 Forecast error variance decomposition, interest rate: (a) China; (b) East Asia	135
4.6 Forecast error variance decomposition, GDP: (a) China; (b) Southeast Asia	136
4.7 Forecast error variance decomposition, PPI inflation: (a) China; (b) Southeast Asia	137
4.8 Forecast error variance decomposition, CPI inflation: (a) China; (b) Southeast Asia	138
4.9 Forecast error variance decomposition, interest rate: (a) China; (b) Southeast Asia	139
4.10 Dynamic responses of East and Southeast Asia to Chinese TFP shock	145
4.11 Dynamic responses of East and Southeast Asia to Chinese	

	TFP shock post Chinese WTO-accession	146
5.1	Welfare cost of noncoordination under vertical-processing trade structure	179
5.2	Welfare cost of noncoordination under vertical-vertical trade structure	180
5.3	Welfare cost of noncoordination under processing-processing trade structure	181
5.4	Welfare cost of noncoordination and home bias	186
5.5	Welfare cost of noncoordination and correlation of productivity	187

LIST OF ABBREVIATIONS

Introduction

This notation guide and symbol glossary provides a brief summary of the chapters' basic notation conventions. Symbol usage is generally covered by the self-contained discussion within each chapter. For the sake of convenience, a listing of symbol conventions is included here.

Label conventions

(i) *Parameters*

- μ : Share of consumption in non-separable utility
 σ : Constant relative risk aversion
 χ_M : Reciprocal of interest elasticity of money demand
 α : Share of capital in Cobb-Douglass production function
 δ : Depreciation rate
 ω : Share of imported intermediate inputs in production (two-production stage model)
 ϑ : Intratemporal elasticity of substitution between home and imported intermediate inputs
 φ : Intratemporal elasticity of substitution between home and imported final goods
 ϵ : Elasticity of substitution between varieties
 γ : Home bias
 b : Indicator for habit formation
 Λ : Parameter governing the degree of forward-looking-ness of investment
 κ_2 : Share of imported intermediates in midstream production
 κ_3 : Share of imported intermediates in downstream production
 θ_p : Probability that firm j is not able to re-optimize price
 θ_w : Probability that worker l is not able to re-optimize nominal wage
 ψ : The degree of exchange rate pass-through into imported consumer price
 ρ_α : Persistence in AR(1) total factor productivity shock
 ρ_I : Persistence in AR(1) investment-specific technology shock
 ρ_R : Persistence in interest rate
 V_π : Central bank's responsiveness toward variability in CPI inflation
 V_Y : Central bank's responsiveness toward aggregate demand variability
 $V_{\Delta S}$: Central bank's responsiveness toward rate of change in nominal exchange rates between home currency and U.S. dollar

(ii) *Variables*

A	: AR(1) Hicks-neutral exogenous technology shock
C	: Consumption
C_H	: Downstream output for local consumption
C_F	: Imported final output at c.i.f
H	: Habit formation
I	: Investment
K	: Capital stock
M	: Money demand
M_{1F}	: Imported upstream output at c.i.f
M_{2F}	: Imported midstream output at c.i.f
N	: Labor service
P_{1H}	: Price of upstream output for local use
P_{1F}	: Domestic price of imported upstream output
P_{2H}	: Price of midstream output for local use
P_{2F}	: Domestic price of imported midstream output
P_{3H}	: Price of downstream output for local use
P_{3F}	: Domestic price of imported downstream output
P	: Consumer price index (CPI) inflation
r	: Opportunity cost of holding money/short-term interest rate.
r_K	: Common real return to capital stock
r^n	: The natural rate of interest
S_{HD}	: Nominal exchange rate between home currency and U.S dollar
S_{FD}	: Nominal exchange rate between foreign currency and U.S dollar
Y_1	: Upstream production
Y_2	: Midstream production
Y_3	: Downstream production
Y_{1H}	: Domestic upstream output
Y_{1H}^*	: Exported upstream output at f.o.b
Y_{2H}	: Domestic midstream output
Y_{2H}^*	: Exported midstream output at f.o.b
Y_{3H}^*	: Exported downstream output at f.o.b
τ	: Transportation cost
π_{2H}	: Producer price index (PPI) inflation
π_{3H}	: GDP deflator inflation
π_{2H}^*	: Intermediate export price inflation
π_{3H}^*	: Final export price inflation

(iii) *Abbreviations*

ASEAN	: Association of Southeast Asian Nations
CEE	: Central and East Europe

CPI	: Consumer Price Index
C.I.F	: Cost, insurance and freight
DP	: U.S dollar pricing
DSGE	: Dynamic stochastic general equilibrium
EA	: East Asia
EIU	: Economist Intelligence Unit
F.O.B	: Free on board
GDP	: Gross Domestic Product
IDE-JETRO	: Institute of Developing Economies-Japan External Trade Organization
IRBC	: International Real Business Cycle
IST	: Investment-specific Technology
LCP	: Local currency pricing
MCMC	: Markov Chan Monte Carlo
NAWM	: New Area-Wide Model
NKVPT	: New Keynesian model with vertical and processing trade
NOEM	: New open economy macroeconomics
PCP	: Producer currency pricing
PPI	: Producer Price Index
SEA	: South East Asia
TFP	: Total Factor productivity
TOT	: Terms of Trade
UIPC	: uncovered interest parity condition
VP	: Vertical Processing
VS	: Vertical Specialization
WTO	: World Trade Organization

TABLE OF CONTENTS

ABSTRACT	Page i
ABSTRAK	iv
ACKNOWLEDGEMENTS	viii
APPROVAL	x
DECLARATION	xi
LIST OF TABLES	xii
LIST OF FIGURES	xiii
LIST OF ABBREVIATIONS	xv

CHAPTER

1 INTRODUCTION	
1.1 Motivation of study	1
1.2 Problem statements	5
1.3 Objectives of study	7
1.3.1 General objective of the study	7
1.3.2 Specific objectives of the study	8
1.4 Overview of the study	9
1.5 Significance of the study	11
2 THE MACROECONOMICS IMPLICATIONS OF VERTICALLY PRODUCTION AND TRADE: WHAT'S OLD AND WHAT'S NEW?	
2.1 International business cycle comovement	13
2.1.1 What's old in modeling strategy?	15
2.1.2 What's new?	17
2.2 The China's syndrome	19
2.2.1 What's old in the empirical literature?	20
2.2.2 What's new?	21
2.3 Gain from international monetary policy coordination	22
2.3.1 What's old?	23
2.3.2 What's new?	29
3 INTERNATIONAL BUSINESS CYCLE COMOVEMENT AND VERTICAL SPECIALIZATION RECONSIDERED IN A MULTISTAGE BAYESIAN-DSGE MODEL	
3.1 Introduction	31
3.2 A Brief tour on two-country IRBC and VS model	35
3.2.1 International Real Business Cycle (IRBC) Model	35
3.2.2 A simple form of vertical-specialization (VS) model	37
3.3 Bayesian estimation	42
3.4 Estimating two-country IRBC and VS model	45
3.4.1 Data and priors for IRBC model	45
3.4.2 Quantitative performance of IRBC model	46

3.4.3	Data and priors for VS model	51
3.4.4	Quantitative performance of VS model	54
3.5	A two-country, three-processing stage New Keynesian Model	56
3.5.1	Upstream firms	57
3.5.2	Midstream firms	58
3.5.3	Downstream firms	60
3.5.4	Optimal pricing decision with U.S dollar pricing in export	61
3.5.5	Household	63
3.5.6	Trade balance, value added and monetary policy	65
3.5.7	Modeling trade cost	66
3.6	Evaluating New Keynesian Model with vertical and processing trade	66
3.6.1	Data, prior and posterior distribution for NKVPT model	67
3.6.2	Quantitative performance of NKVPT model	77
3.6.3	What can we learn from sensitivity analysis?	82
3.6.4	Inspecting the mechanism	84
3.7	Concluding Remark	90
4	RISING CHINA, ANXIOUS ASIA? AN ASSESSMENT IN BAYESIAN-DSGE MODEL WITH VERTICAL AND PROCESSING TRADE	
4.1	Introduction	92
4.2	A macroeconomic model of vertical and processing Trade	97
4.2.1	Firm's cost minimization problem	98
4.2.2	First order and market clearing conditions	101
4.2.3	Optimal symmetric pricing decision with U.S. dollar denominated trade	103
4.2.4	Household	106
4.3	Parameter Estimates	109
4.3.1	Data and calibration	110
4.3.2	Prior and posterior distribution	113
4.3.3	What can we learn from subsample estimates?	121
4.4	Evaluating macroeconomic interdependence between China and Asia	129
4.4.1	Source of shocks	129
4.4.2	A Reassessment when vertical trade arises	140
4.4.3	Shocks propagation	143
4.5	Concluding remarks	147
5	OPTIMAL MONETARY POLICY COORDINATION FOR OPEN ECONOMIES WITH PRODUCTION FRAGMENTATION AND TRADE	
5.1	Introduction	149
5.2	The linearized model of production fragmentation and trade	153

5.2.1	Value added	154
5.2.2	Chains of production	155
5.2.3	Time-dependent U.S dollar pricing	157
5.3	Bayesian estimation and some stylized facts	159
5.4	Characterizing the welfare criterion	164
5.5	Optimal Nash and coordinated monetary policy	171
5.6	Is monetary policy coordination always (sub)optimal?	176
5.6.1	The role of intertemporal and intratemporal elasticity of substitution	177
5.6.2	Disinflationary versus inflationary bias: recipe for currency misalignment	182
5.6.3	The role of home bias in consumption	185
5.6.4	Do the symmetries of shock matter? Yes and no	186
5.7	Conclusion	188
6	CONCLUSION	
6.1	What we already did?	190
6.2	What we need to do?	193
	REFERENCES	195
	APPENDIX 3.1	202
	APPENDIX 4.1	220
	APPENDIX 4.2	222
	APPENDIX 4.3	224
	APPENDIX 5.1	238
	BIODATA OF STUDENT	246
	LIST OF PUBLICATIONS	248