Essays on International Monetary Policy Coordination in the ASEAN-5+3 Countries: Analyses Using Dynamic Stochastics General Equilibrium (DSGE) Approach

ASEAN５ヶ国＋３ヶ国における金融政策の国際協調：

動学的確率的一般均衡アプローチを用いた分析

Dissertation

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Abstract

This research examines the feasibility of international monetary policy coordination among the ASEAN-5+3 countries. Three types of interaction regimes among these countries were explored: ”No Coordination”, ”Bilateral Coordination”, and ”Multilateral Coordination”. To examine the feasibility of policy coordination, this research uses the Dynamic Stochastic General Equilibrium (DSGE) approach. Two types of the DSGE New Open Economy Macroeconomic (NOEM) model were constructed: (1) the one-factor-production model; and (2) the two-production-factor model. Besides calculating welfare in each type of interaction among the ASEAN-5+3 countries, this research also estimates parameters that affect the welfare in each country.

This research finds that some schemes of international monetary policy coordination is feasible for the ASEAN-5+3 economies. For both the one-production-factor and two-production-factor models, the ASEAN-5+3 multilateral monetary policy coordination is the best feasible policy option for the ASEAN-5+3 countries. There is only one feasible bilateral coordination case in the one-production-factor, but there are 18 feasible cases in the two-production factor model.

Relative size of the participating countries is a dominant factor that determines the feasibility of policy coordination. Nonetheless, it is still possible to have feasible policy coordination when there is big gap in sizes among participating countries, if there is other factor(s) that has significant influence on the welfare of these countries, such as strong trade linkage.

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CHAPTER 1

INTRODUCTION

1.1. Background

Many researchers have interchangeably used the terms "international policy cooperation" and "international policy coordination" when referring to collective efforts by some countries to adjust their policies to achieve common objective(s). Meyer et.al. (2002) defines [international policy] "cooperation" to an agreement among policy makers in two or more nations that involves achieving a Pareto efficient outcome and is credibly enforced, for example, by a supranational authority. Meanwhile, "coordination" refers to an attempt to achieve one-particular equilibrium out of the set. Thus, "coordination" refers to the ***attempt***, while "cooperation" is the ***agreement*** resulted from that attempt. This dissertation uses the term "international policy coordination" to refer to join efforts by two or more economies (or countries) to pursue a common goal of achieving higher welfare.

Cárcamo-Díaz (2005) pointed out that the main idea behind international macroeconomic policy coordination is that countries can better-off if they take into account the welfare effects of their policy actions on their partners (i.e. spillovers), as well as the other's policy responses to those actions. It is possible for a player's strategy to alter gains or losses of the other of changing his own strategy. If an increase in a player's strategy increases the optimal strategy of the other player, then strategic complementarities presents. Cárcamo-Díaz summarized three reasons behind international macroeconomic policy coordination:

(1) Macroeconomic policy coordination may lead to a Pareto-Superior cooperative outcome than those of a non-cooperative Nash Equilibrium.
(2) Macroeconomic policy coordination can reduce the likelihood of countries to use protectionist trade policy instruments.
(3) Macroeconomic policy coordination can reduce volatility in macroeconomic variables (such as bilateral exchange rate between two partner countries).

According to Truman (2011), the common denominator in international policy coordination is an attempt to achieve objective or outcomes that maximize positive spillovers or externalities and minimize negative spillovers or externalities. Truman pointed out the broad spectrum of policy coordination, with four important points across the spectrum from one extreme to the other:

(1) Periodic exchanges on issues of common interest or concern (the most lenient form).
(2) Reviews on the economic and financial policies of the participating countries ("surveillance" type of coordination).
(3) Agreement upon joint or parallel policy actions through which countries cooperate to achieve a common agreed objective (generally on specific issue or on ad-hoc basis).
(4) Continued adjustment of policies to achieve a common objective or objectives (such as full employment and price stability).

Eichengreen (2011) suggested that international policy cooperation is most likely take place in four sets of circumstances:

(1) Cooperation is most likely when its centers on technical issues (such as central bank swaps and credits or prudential supervision and regulation), as distinct from high-profile and politicized monetary and fiscal policies.

(2) Coordination is most likely when it is institutionalized, i.e. when procedures and precedents create presumptions about the appropriate conduct of policy and reduce transaction costs of reaching an agreement.
(3) Cooperation is most likely when it is concerned with preserving an existing set of policies and behaviors (i.e. when it is concerned with preserving a "policy regime") rather than when it is directed at altering policies.
(4) Monetary, macroeconomic, and financial cooperation is most likely in the context of broad comity among nations. Conflict over other issues, whether economic or not, complicates efforts to reach agreement even on technical economic and financial policies.

There are two important concepts which this dissertation uses to analyze international monetary policy coordination: (i) externality; and (ii) international public goods. These two concepts will be further discussed in Chapter 2.

An externality (or spillover) is defined as the case where an action of one economic agent affects the utility or production possibilities of another in a way that is not reflected in the marketplace (Just et.al., 2004). An externality can be positive (i.e. positive externality) when it benefits or negative (negative externality) when it harms the other economic agent(s). International policy coordination is aimed to improve participating countries' welfare by internalizing externalities in coordinated policymaking. It can help to maintain regional or global macroeconomic stability in the case of negative externalities – where macroeconomic shock or policy (such as devaluation) in one country affects other countries' welfare. For instance, policy coordination among the G20 countries during the 2009 Global Recession helped to prevent global currency wars. Without policy coordination, competitive devaluations among the G20 countries might prolong and worsen the recession. In the case of positive externalities, international policy coordination may help to deepen economic relations and integration among countries involved.

Meanwhile, a pure public good is defined as a good which has non-excludable and non-rivalry characteristics. However, there are goods that only have part of these two characteristics, such as the club goods (excludable and partially rivalry), common goods (non-excludable and partially rivalry), and impure public goods (non-excludable and rivalry, or partially excludable and partially rivalry) (UNIDO, 2008). An international public good can be defined by its geographical scope: cross-border, regional, and global. Regional economic stability through policy coordination has mixed characteristics between club goods and pure public goods.

One crucial issue pertaining to international policy coordination is to what extent a country's economic authority (e.g. government and central bank) should sacrifice its independence in policymaking for a common goal with another country. The European sovereign debt crisis in 2009 was an evidence on how giving up monetary policy independence could prevent a country from taking necessary steps (e.g. hiking policy rate or imposing capital control) to save its economy in a crisis (as happened to Portugal, Italy, Ireland, Greece, and Spain – the EU peripheral countries). Some critics to the European Union (EU) integration said the inexistence of fiscal policy integration had prevented the EU from taking unified fiscal and economic policy to save ailing member countries; while other critics said that giving up fiscal independence making the EU peripheral countries even more difficult to save their economies during a crisis.

There have been many attempts by countries to coordinate economic policies at the global level. For instance, the establishment of the Bretton Woods system in 1944, along with its three proposed-institutional pillars: the International Monetary Fund (IMF), the International Bank for

Reconstruction and Development (IBRD) and the International Trade Organization (ITO). The Bretton Woods system was eventually abandoned in 1971. Nonetheless developed countries continue their attempts to coordinate policies. Initial informal meetings among finance ministers of seven developed nations were formalized to the Group of Seven (G7)[1] in 1976, where the G7 had led to the high-profile international agreements such as the Plaza Agreement (1985) and the Louvre Accord (1987). While the G7 remains as the main forum of meetings for these developed countries, other fora that involve larger number of participants are also held: the Group of Eight (G8)[2] in 1997 – which is the G7 plus Russia, and the Group of 20 (G20) in 1999 – which comprises several advanced and emerging market economies[3].

Attempts to coordinate macroeconomic policies also take place at the regional level, mostly in the international trade area. In Europe, it was started with the establishment of the European Coal and Steel Community (ECSC) in 1950. The ECSC later evolved to the European Economic Community (EEC) in 1957, and later became the European Union (EU) in 1999. Similar efforts to coordinate policies take place in other regions. African countries established the African Economic Community in 1981 to promote economic cooperation towards the creation of economic and monetary union (starting with the creation of free trade areas), while Latin Americas countries established the MERCOSUR in 1991 to promote free trade.

In Asia, the Association of Southeast Asian Nations (ASEAN) established the ASEAN Free Trade Area (AFTA) in 1992[4]. The main objectives of the AFTA are[5]: (i) to create a single market and an international production base; (ii) to attract foreign direct investments; and (iii) to expand intra-ASEAN trade and investments. The trade liberalization pillar of the AFTA was the Common Effective Preferential Tariff (CEPT) Scheme which aimed to eliminate tariffs on intra-AFTA trade. The CEPT was in effect since January 1993. By 2010, more than 99% of the tariff lines in the CEPT inclusion list had been eliminated in the six original AFTA members, while around 95 – 99% of the tariff lines had been cut to the 0 – 5% tariff range for the new members. As most of the targets in the CEPT had been achieved, the CEPT was replaced by the more comprehensive ASEAN Trade in Goods Agreement (ATIGA) in May 2010 (Okabe and Urata, 2013). Compared to the CEPT, the ATIGA comprises several new elements to ensure the realization of free flow of goods within ASEAN, including the following: tariff liberalization, removal of non-tariff barriers, rules of origin, trade facilitation, customs, standards and conformance, and sanitary and phytosanitary measures[6].

The Asia-Pacific countries also coordinate policies in international finance area. Kawai et.al (2015) saw financial cooperation in the region[7] has been pursued in three fronts: (i) regional economic surveillance; (ii) regional short-term liquidity support facility; and (iii) local currency market development. Pertaining to regional economic surveillance, the ASEAN + 3 countries introduced the Economic Review and Policy Dialogue (EPRD) in 2000 to promote macroeconomic and financial stability through early detection of irregularities, vulnerabilities, and systemic risks and the swift implementation of remedial policy actions. The EPRD was expected to compel its participating countries to implement prudent macroeconomic and fiscal policies at the national level as a result of peer pressures and pursue policy coordination if needed. However, the EPRD was not effective as it is only set as dialogue forum among finance ministers without a proper body to run day-to-day surveillance function. The EPRD also did not include central bank governors, where the latter met among themselves in the Executive Meeting of Asia-Pacific Central Banks (EMEAP). To address these two problems, the ASEAN + 3 countries established the ASEAN + 3

Macroeconomic Research Office (AMRO) in 2011 as a permanent institution to run regional macroeconomic surveillance and replaced the finance minister meetings with joint meeting of finance ministers and central banks from 2012.

The ASEAN + 3 countries set the Chiang Mai Initiative (CMI) in 2000, which was a short-term liquidity support facility intended to prevent and manage currency crises or crisis contagion. It started as a combination of (i) a network of bilateral swap agreements (BSAs) among the Plus Three Countries – and between one of these Plus Three Countries and selected ASEAN members; and (ii) the ASEAN Swap Arrangements (ASA). Monetary and fiscal authorities of the ASEAN+3 countries and the Monetary Authority of Hong Kong agreed to convert the bilateral schemes of the CMI into a multilateralized self-managed reserves pooling scheme, called the Chiang Mai Initiative Multilateralization (CMIM) in 2010. The size of the reserves pool expanded from USD 90 billion under the CMI to initially USD 120 billion in 2010 under the CMIM and later increased to USD 240 billion in 2012 (Kawai et.al., 2015).

Learning from the 1997–1998 Asian Financial Crisis, the ASEAN + 3 countries see the importance to develop Asian Bond Market to reduce the risk of "double mismatches" problem from cross-border bank borrowing. The "double mismatches" problem refers to currency mismatch and currency mismatch borne by commercial banks when they borrow foreign currency denominated short-term loans from overseas and lend long-term loans to domestic firms (that mostly earn their income in domestic currency). During the 1997-1998 Asian Financial Crisis, domestic banks in most of the ASEAN economies and South Korea were hit by the "double mismatches" problem: many of their borrowers defaulted their loan payments while at the same time the cost of borrowing from overseas lenders increased in domestic currency terms as these countries' currencies depreciated sharply. Facing the risk of loan payment default by banks in these countries, foreign lenders did not rollover their loans; which depreciated these countries' currencies further and worsened the currency crises.

An Asian Bond Market that issue local currency bonds will reduce the risk of financial system instability stemming from the "double mismatches" problem embedded in foreign currency denominated short-term cross-border bank loans. Kawai et.al. mentioned four other reasons behind the importance of an Asian Bond Market: (i) it supports rapid economic growth in Asian economies that requires large funding for corporate investment; (ii) it facilitates fundraising for Asian infrastructure projects; (iii) it helps multinational companies (particularly from Japan and South Korea) that set up their operations in emerging Asian economies to issue long-term bonds in these countries' currencies; and (iv) it provides venue for pension funds and insurance institutions to invest in secure long-term assets amid the expanding size of the middle income earners in Asia.

In 2002, the governments in the ASEAN + 3 countries introduced the Asian Bond Market Initiative (ABMI) to investigate concrete measures to promote domestic bond markets. Meanwhile, the EMEAP launched the Asian Bond Fund (ABF1) to develop US dollar denominated sovereign and quasi sovereign bond markets under the management of the Bank for International Settlements (BIS) in 2003. The EMEAP then introduced ABF2 to develop local currency denominated bond markets managed by private sector fund managers and administered by the BIS in 2004. As local currency denominated bonds were developed, the EMEAP decided to close the ABF1 and transferred the funds registered in ABF1 to ABF2 in 2016 (Shirai and Sugandi, 2019).

The Asia-Pacific countries are also seeking to foster international coordination in exchange rate and fiscal policies, although coordination in these two areas are not progressing as fast as those in trade and finance areas. In terms of exchange rate coordination, Asia-Pacific countries are still far from creating a single currency akin to the Euro. In the near future, exchange rate coordination may be still limited to the surveillance scope, such as the creation of Asian Currency Unit (ACU) index that serves as an indicator of whether a country's currency is undervalued or overvalued against the regional average Studies by Ogawa and Shimizu (2005), Gupta (2012), and Pontines (2013) showed a widening deviation of exchange rate movements of the Asia-Pacific countries due to different exchange rate regimes and diverse policy objectives (Kawai, 2009). The widening deviations of exchange rate movements is not conducive for creation of a single currency in the region. Moreover, policymakers in these countries may not see enough merit in stabilizing their mutual exchange rates and delegate a small part of monetary policy sovereignty to a regional institution (Kawai, 2015). Meanwhile, the scope for international fiscal policy coordination is even more limited, as the Asia-Pacific countries prefer to maintain their sovereignty in fiscal policymaking. While coordinating government budgetary matters are difficult to do, policy coordination can still be done in the creation of an Asian Bond Market and the Asian Infrastructure Investment Fund.

International policy coordination may facilitate regional and global economic integration, as it can create macroeconomic and financial stability. Economic integration has continued to progress in the Asia-Pacific region, particularly in the East Asia and Southeast Asia (sub) regions. The progress of economic integration tends to be faster in the Southeast Asia than in the East Asia, notably through the ASEAN framework. Based on the Asia-Pacific Regional Cooperation and Integration Index (ARCII) calculated by the Asian Development Bank, the Southeast Asia had the highest average score of integration among sub-regions in Asia-Pacific during the period 2006 – 2017, followed by the East Asia (Asian Development Bank, 2018). The Southeast Asian region also progressed more rapidly in international trade policy coordination by already establishing the AFTA, while as of today China, Japan, and South Korea are still negotiating their own free trade area in the East Asia region. Political factors and economic nationalism seem hindering institutionalized cooperation among China, Japan, and South Korea. In the case of AFTA Plus Three (APT) framework that the Chiang Mai Initiative, the three countries prefer to attach themselves the ASEAN cooperation framework rather than creating their own common pool of reserves for the East Asia region.

As the East Asia region has China (the world's second largest economy), Japan (the world's third largest), and South Korea (the world's eleventh largest), it has bigger economic size than the Southeast counterpart. Table 1 display the selected macroeconomic indicators in eight Asia-Pacific countries included in this dissertation: Indonesia, Malaysia, Singapore, Thailand, and the Philippines (the ASEAN-5 countries), China, Japan, and South Korea (the CJK or "plus three" countries). The eight economies are rather diverse in terms of economic size and structures, where the International Monetary Fund (IMF) classifies Japan, South Korea, and Singapore as advanced economies while the remaining five belong to emerging market economies. Among the eight economies, China, Indonesia, and Japan have the biggest number share of population, where Japan's population aging faster than the other two. The eight countries are gradually recovering from the 2008-2009 global financial crisis and recession, where higher average growth rates were seen in most countries (except in China, South Korea, and Thailand) in the period 2010 – 2018 than in 2000 – 2009. Among the eight countries, Indonesia has the highest inflation rate while Japan has the lowest. Indonesia also has the weakest currency (highest exchange rate per US Dollar) among the eight countries, while Singapore has the strongest.

Table 1-1. Summary of ASEAN + 3 Macroeconomic Indicators

	Population size (million people, as of 2018)	Nominal GDP (USD billion, as of 2018)	Real GDP growth (%)	Annual average inflation rate (%)	Exchange rate (per US Dollar)
Indonesia	264	1,022	*Avg. 2010 – 2018:* 5.5 *Avg. 2000 – 2009:* 5.3	*Avg. 2010 – 2018:* 4.9 *Avg. 2000 – 2009:* 8.5	*Avg. 2010 – 2018:* 11,543 *Avg. 2000 – 2009:* 9,360
Malaysia	32	354	*Avg. 2010 – 2018:* 5.4 *Avg. 2000 – 2009:* 4.7	*Avg. 2010 – 2018:* 2.3 *Avg. 2000 – 2009:* 2.2	*Avg. 2010 – 2018:* 3.58 *Avg. 2000 – 2009:* 3.68
Singapore	6	361	*Avg. 2010 – 2018:* 5.3 *Avg. 2000 – 2009:* 5.3	*Avg. 2010 – 2018:* 1.8 *Avg. 2000 – 2009:* 1.5	*Avg. 2010 – 2018:* 1.32 *Avg. 2000 – 2009:* 1.64
Thailand	68	487	*Avg. 2010 – 2018:* 3.8 *Avg. 2000 – 2009:* 4.3	*Avg. 2010 – 2018:* 1.7 *Avg. 2000 – 2009:* 2.5	*Avg. 2010 – 2018:* 32 *Avg. 2000 – 2009:* 39
The Philippines	107	331	*Avg. 2010 – 2018:* 6.3 *Avg. 2000 – 2009:* 4.5	*Avg. 2010 – 2018:* 3.1 *Avg. 2000 – 2009:* 5.2	*Avg. 2010 – 2018:* 46 *Avg. 2000 – 2009:* 50
China	1,395	13,407	*Avg. 2010 – 2018:* 7.8 *Avg. 2000 – 2009:* 10.3	*Avg. 2010 – 2018:* 2.6 *Avg. 2000 – 2009:* 1.9	*Avg. 2010 – 2018:* 6.46 *Avg. 2000 – 2009:* 7.89
Japan	126	4,972	*Avg. 2010 – 2018:* 1.4 *Avg. 2000 – 2009:* 0.5	*Avg. 2010 – 2018:* 0.5 *Avg. 2000 – 2009:* -0.3	*Avg. 2010 – 2018:* 100 *Avg. 2000 – 2009:* 112
South Korea	52	1,619	*Avg. 2010 – 2018:* 3.4 *Avg. 2000 – 2009:* 4.7	*Avg. 2010 – 2018:* 1.9 *Avg. 2000 – 2009:* 3.1	*Avg. 2010 – 2018:* 1,118 *Avg. 2000 – 2009:* 1,130

Source: IMF International Financial Statistics, author’s calculation

Observing the integration trend in Southeast Asian and East Asian economies, this research questions the feasibility of international monetary policy coordination among the ASEAN-5+3 countries. The benefit of international policy coordination is the improvement of welfare for the participating countries, where welfare is defined as macroeconomic stability. The cost of policy coordination is the loss of flexibility for the central bank of the participating to country to conduct monetary policy in the presence of shock, compared to if it does not coordinate policy. To be deemed as feasible, net benefits from an international coordination should be felt by all participating countries. If there is at least one (potential) participating country whose costs of joining international policy coordination exceeds its benefit, then such coordination is not feasible.

Various theoretical models on international policy coordination have been constructed, including those of Corsetti and Pesenti (2001), Obstfeld and Rogoff (2002), Sutherland (2004), Berger and Wagner (2006), Liu and Pappa (2007), and Coenen et.al, (2008). These models, which will be discussed in Chapter 2, share the same spirit: policy action in one country creates externalities in the other country. Canzoneri et.al. (2005) classify these models into two categories: (i) the first-generation models, which are based on the traditional Keynesian school and found that the gains from international policy coordination are small; and (ii) the second generation models, which are based on New Keynesian school and found that under certain conditions the gains from policy coordination can be significant.

There is rather limited number of literatures on international policy coordination in Asia. Among these studies are those of Branson and Healy (2005), Truman (2011), Gupta (2012), Majuca (2013), Majuca and Pagaduan (2015), Tan (2016), and Sugandi (2016, 2018). Most previous studies on international policy coordination took the United States and the Euro Area (or the European Union) in the standard two-country models since the two economies have similar sizes and characteristics; hence allowing the researchers to impose symmetrical assumption on parameters in their models. Symmetrical assumption for parameters in the model is not valid to use for the East Asian and Southeast Asian countries, since these countries are different in sizes and have more diverse characteristics.

This research includes only the ASEAN-5 + 3 countries, since other East Asian and Southeast Asian countries do not have sufficient quarterly time series data for all variables in the models. Three cases of international policy interactions among these countries are explored: (i) "no coordination" (Nash); (ii) bilateral coordination; and (iii) multilateral coordination. The scope of international policy coordination in this dissertation is limited to monetary policy coordination, to enable us to focus on the role of central banks in setting the optimum policy rules for the three cases of international policy interactions. Nonetheless, this dissertation also incorporates fiscal policy making, although it is assumed to have limited impact at country level only. The time period for this dissertation is set from the first quarter 2000 to the second quarter of 2018.

This research is based on a hypothetical assumption of the existence of a supranational planner exercising fiscal and monetary policy in a bilateral or multilateral coordination among the ASEAN-5+3 countries. Such an assumption is needed because as of today there is no governing institution for the ASEAN-5+3 countries that has authority to make policies for these countries. Despite this assumption and other assumptions in the models that make this research produce hypothetical results, it is useful for empirical purpose. By examining the feasibility of international policy coordination among the ASEAN-5+3 countries, this research can shed a light for policymakers in these countries whether it is worth it to coordinate monetary policies.

This dissertation uses the model from Liu and Pappa (2007) as theoretical model reference, as it is a simple but comprehensive non-stochastic model that incorporates both fiscal and monetary policies. This dissertation will also refer to the bilateral coordination model developed by Sugandi (2016) that modified and adjusted the Liu and Pappa's model for the ASEAN-5 countries.

1.2. Problem Formulation and Research Questions

The main problem in this research can be formulated as: "Will monetary policy coordination among the ASEAN-5 + 3 countries improve these countries' welfare?"

The research problem can be elaborated further to the following research questions:

1) Will a participating country obtain higher welfare from bilateral monetary policy coordination compared to when the respective country individually pursues its welfare objective?
2) Will a participating country obtain higher welfare from multilateral monetary policy coordination compared to when the respective country individually pursues its welfare objective?
3) Will a participating country obtain higher welfare from multilateral monetary policy coordination compared to from bilateral monetary policy coordination?
4) Is international monetary policy coordination feasible for the ASEAN-5+3 countries, i.e. are the benefits from policy coordination exceeds the costs for each of the participating country? If yes, what is the best scheme of policy coordination?

1.3. Research Objectives and Benefits

The main objective of this research is to examine whether international monetary policy coordination can really improve welfare of the ASEAN-5 + 3 countries. If policy coordination can really improve welfare of the participating countries, then there are possibilities for further monetary integration among the ASEAN-5 countries in the future.

This research will benefit policymakers in the ASEAN-5 + 3 countries as it offers a "policy map" to show the best to the worst cooperation partners that can improve these countries' welfare. This research will also contribute to academic literatures on international economic policy coordination in the Asia-Pacific region, particularly among the ASEAN-5 + 3 countries.

1.4. Research Contributions

There are two areas where this research seeks to contribute:

1) Model development

The main contribution of this dissertation is construct multicountry models that are suitable to the empirical conditions of the ASEAN-5 + 3 economies. The models in this dissertation depart from the Liu-Pappa (2007) and Sugandi (2016, 2018) models in the following areas:

(i) Types of government spending

In this research, the government is assumed to allocate its expenditure on purchases of non-traded and traded goods for households, fixed-rate coupon payment to households, cash transfers to households, and subsidies for firms in the non-traded and traded sectors. In Liu-Pappa model, the government expenditure is allocated only for cash transfers to households and subsidies for firms in the non-traded and traded sectors. The Sugandi model already included government purchases of goods, bond coupon payment, and cash transfers for households, as well as subsidies for firms in the non-traded and traded sectors.

(ii) Taxes

This research introduces consumption tax and labor tax imposed on households, where the tax revenues serve as part of government's total revenues. The Liu-Pappa model does not incorporate taxes, but the Sugandi models already incorporates taxes.

(iii) Type of bonds

This research assumes that the bonds are entirely issued by the government, and these bonds are conventional bonds that pay fixed coupon rate (nominal interest rate) at maturity rather than state-contingent-based as in Liu-Pappa model. The Liu-Pappa model assumes that the government does not issue bond; all bonds are issued by firms. The Sugandi model assumes that the government issued bonds and pay bond coupon, but the coupon payment is state-contingent-based rather than based on fixed-rate.

(iv) Introduction of multilateral coordination

The Liu-Pappa and Sugandi models are a two-country model with bilateral type of interactions. While also using a two-country model to examine bilateral coordination cases for the ASEAN-5 + 3 countries, this dissertation introduces multi-country models and multilateral interactions.

(v) *Welfare distribution for countries involved in international policy coordination*

In the bilateral coordination case, Liu-Pappa model assumes equal distribution of total welfare (half – half) between the two participating countries. The Sugandi model assumes that total welfare in bilateral coordination is distributed based on the relative economic size of the participating countries. In this dissertation, distribution of total welfare under the bilateral and multilateral regimes are based on the relative population size of the participating countries. The relative population size is chosen as the weight since some economies may have almost equal economic size but are very different in population size (such as Malaysia and Singapore). As the social welfare in this dissertation is derived from utility function of households, it is more appropriate to use population size rather than economic size to measure a country's welfare.

(vi) *Introduction of capital and money ("cash") in the two-production-factor model*

To make the model closer to the reality, this research introduces capital in firms' production functions and money in households' utility function. These two features did not present in the Liu-Pappa and Sugandi models.

2) Contribution to the Asia-Pacific economic studies

This research seeks to enrich literatures on empirical economic studies on the Asia-Pacific region, particularly international monetary policy coordination among the ASEAN-5+3 countries. Many previous studies on international policy coordination overlooked diverse characteristics of each economy involved in interactions and imposed symmetrical assumption on most characteristics in the Home and Foreign economies, such as time preference, marginal utility of labor, share of the non-tradable versus tradable goods in the economy, and share of domestically produced and imported tradable goods. While symmetrical assumption will simplify model construction and analysis at the theoretical level, it overlooks the impact of specific characteristics in each country on policymaking. Many previous studies on international policy coordination are also biased toward the United States and Euro Area (European Union). Therefore, this research incorporates different characteristics in the ASEAN + 3 countries to create more empirically suitable models.

1.5. Organization of Dissertation

This dissertation is divided into seven chapters, as follow:

Chapter 1: Introduction.

Chapter 2: Literature Review.

Chapter 3: Research Methodology.

Chapter 4: One-Production-Factor Model.

Chapter 5: Two-Production-Factor Model.

Chapter 6: Comparison Between the One-Production Factor and the Two-Production-Factor Models

Chapter 7: Conclusions

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[1] The G7 members are the United States, Japan, the United Kingdom, Germany, France, Italy, and Canada.

[2] The G8 is no longer active since 2014 because Russia is no longer invited by the G7 after the country's annexation of Crimea.

[3] The G20 members are Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, United Kingdom, United States, and the European Union.

[4] The ASEAN in 1992 comprised six countries: Indonesia, Malaysia, Singapore, Thailand, and Brunei Darussalam. Hence these six countries, ASEAN-6, are the initial members of the AFTA. The remaining four ASEAN countries joined the AFTA subsequently: Vietnam (1995), Laos and Myanmar (1997), and Cambodia (1999).

[5] See https://fta.miti.gov.my/index.php/pages/view/asean-afta

[6] See https://www.miti.gov.my/miti/resources/fileupload/Write-up%20on%20ASEAN%20Trade%20in%20Goods%20Agreement%20(ATIGA).pdf

[7] The term "East Asia" in Kawai et.al. (2015) refers to China (including Hong Kong), Japan, South Korea, Taiwan, and the ASEAN-10 countries.

CHAPTER 2

LITERATURE REVIEW

This section briefly explains the main concepts and definitions used in the dissertation, as well as related findings from previous studies on international policy coordination.

2.1. The New Open Economy Macro (NOEM) Models

As pointed out by Corsetti (2007), the first New Open Economy Macroeconomics (NOEM) model was introduced in 1995 by Obstfeld and Rogoff in their so-called "Redux" model". The Redux model was built to provide intuitive predictions about exchange rates, outputs, and current accounts, as their movements sometimes differ sharply from what are predicted by modern flexible intertemporal models or the traditional sticky-price Keynesian model (Obstfeld and Rogoff [1995]). The Redux model is a two-country model that combines global macroeconomic dynamics and a supply side framework based on the assumptions of monopolistic competition and sticky nominal prices. One important aspect of the Redux model is the recognition of international welfare spillovers due to monetary and fiscal policies, which affect individual countries' welfare.

Corsetti described that the NOEM model sought to provide a new theoretical framework for open economy analysis and policy design, overcoming limitations of the Mundell-Flemming model. The new framework incorporates choice-theoretic, general equilibrium models featuring nominal rigidities and imperfect competition in the markets for goods and/or labor. Corsetti noted two dimensions that differentiate the NOEM models from the Mundell-Flemming approach: (1) all agents in the NOEM are optimizing; and (2) NOEM's general equilibrium analysis paves the way towards a further integration of international economics as unified field by bridging traditional gap between open macro and trade theory.

There are basic features of the NOEM models build by Obstfeld-Rogoff, as summarized by Corsetti. The economy consists of two countries, Home and Foreign, specialized in the production of one type of tradable goods. Home consumption falls on both local goods and imports; the price level includes both local goods and imports prices in Home currency. Preferences over local and imported goods are Cobb-Douglas with identical weight across countries. Meanwhile, utility from consumption is assumed to be logarithmic, while disutility from labor is linear. The welfare criterion is mainly derived from the utility function of the representative household (consumer).

The NOEM literature continues to see development of newer models with distinct specifications. For instance, Corsetti and Pesenti (2001) developed their NOEM model that allows educated restrictions on preferences. Betts and Devereux (2000) modified the Redux model by assuming a fraction of s of firms can set different prices in home and foreign markets. Chari et.al. (2002) incorporated capital in their NOEM model, noting that the single-factor labor in the Redux model is not sufficient to capture the overall impact of monetary shock on the economy. Liu and Pappa (2007) modified the standard NOEM model by allowing the share of traded goods to total goods to be different across countries.

This dissertation employs the NOEM framework because of incorporation of international welfare spillover, the general equilibrium design of the model, as well as the simple features of economic agents, consumer utility function, and firms' technologies. Furthermore, this dissertation will mostly adopt and modify the NOEM model developed by Liu and Pappa (2007) to make it more suitable for the cases of ASEAN-5 countries.

2.2. Dynamic General Equilibrium (DGE) and Dynamic Stochastic General Equilibrium (DGSE) Models

The Dynamic General Equilibrium (DGE) model is developed to explain the aggregate macroeconomy based on strong microeconomic foundations. In the DGE model, economic agents are assumed as rational and make decisions that appear to be optimal for them by using available information. Agents' individual decisions are coordinated through markets to produce the macroeconomy (Wickens, 2008). The DGE model is a "dynamic" model as it involves time dimension, where agents make intertemporal decision based on their expectation about future – given available information at the time, and that their current decisions are also affected by their past decisions, other agents' past decisions, and system constraints set in the past.

The DGE model assumes that the economy is always in short-run equilibrium, while the long-run (or steady state) equilibrium is a mathematical property of the macroeconomic model that describes its path when all past shocks have fully worked through the system. The long-run equilibrium can be either a static equilibrium (where all variables are constant) or a growth equilibrium (where in the absence of shocks, there is no tendency for the economy to depart from a given path). The short-run equilibrium may differ from the long-run equilibrium but, if stable, the short-run equilibrium will be changing through time and will overtime approach the long-term equilibrium. The "general equilibrium" terms in the DGE implies that in an equilibrium (either short-run or long-run), all variables are simultaneously in equilibrium.

The DGE model assumes the existence of unique equilibrium. In the presence of stochastic growth stemming from technological shocks, the economy fluctuates about some stochastic steady state and will always returns to that steady state. After the disturbances by the stochastic shocks, neither the choice variables (e.g. consumption) nor the welfare function are significantly disturbed by the stochastic shocks; and the nearby equilibrium solutions are always approximately "good solutions". Fiscal and monetary policies can only be distortionary, and thus should be reduced to minimum.

As elaborated by Wickens, standard DGE model usually employs three economic agents: (1) households; (2) firms; and (3) social planner. A DGE model that incorporate monetary policy often breakdowns social planner further to the government (exercises fiscal policy) and the central bank (exercises monetary policy). Individual decisions of economic agents are assumed to be based on maximizing the discounted sum and future expected welfare subject to preferences and four constraints: (i) budget or resource constraints; (ii) endowments; (iii) the available technology; and (iv) information. Households' decisions are related to consumption, labor supply, and assets holdings. Firms' decisions are typically related to the supply of goods and services, labor demand, investment, productive and financial capital, and the use of profit. The government exercises fiscal policy by determining its expenditure, taxation, transfers, and the issuance of public debt; while the central bank exercises monetary policy by setting interest rate, money supply, or through other monetary policy instruments.

The DGE models can be differentiated between stochastic models and deterministic models. Stochastic DGE models incorporate stochastic (random) shocks and/or exogenous random variables, while the deterministic DGE models do not include such randomness. The Real Business Cycle (RBC) and the Dynamic Stochastic General Equilibrium (DSGE) models are the two predominant stochastic DGE models.

The RBC model is a New Classical DGE model introduced by Kydland and Prescott (1982), which emphasizes on the role of real shocks, particularly technology shocks, in driving business fluctuations. The RBC model assumes the existence of perfect insight among economic agents, the existence of perfect markets, and the flexibility of price and nominal wages in the economy.

With the assumptions of price and nominal wage flexibility, any change in the monetary policy instrument induced immediate changes in inflation, thus has little impact on real variables. In other words, monetary policy has no real effects on the real business cycles in the RBC model (Rebelo, 2005). This outcome contradicts empirical evidences that monetary policy can have significant impact on real variables. The outcome also makes the RBC less useful for policy analysis in central banks.

The DSGE model is a New Keynesian – New Classical synthesis, which combines the RBC model and the New Keynesian features, such as nominal rigidities of prices and wages. Goodfriend and King (1997) and Rotemberg and Woodford (1997) were the pioneers of the DSGE model, where they developed monetary business cycle models based on the common micro foundations used in the RBC model but introduced nominal rigidities and imperfect competition to models. There are two major assumptions that distinguish the DSGE from the RBC model: (i) fluctuations in nominal variables (such as money supply) can influence fluctuations in real variables (such as output and employment); and (ii) real market imperfections (such as imperfect competition or imperfect information) can also influence economic fluctuations (Schmidt and Wieland, 2012). These two assumptions were meant to address the weaknesses of the early RBC models when confronted with empirical evidences.

The DSGE modeling heavily lend various mathematical and computational methods to solve the model and estimate the parameters. The introduction of Dynare, a software platform that can be conveniently used to solve the DSGE models, helps to widespread the models to the economic community. This dissertation uses the Dynamic Programming method to solve the DSGE model and the Bayesian method for the parameter estimations. The Dynamic Programming method, which was introduced by Richard Bellman, is an optimization method that breaks complex optimization problem into sub-problems with recursive manner. The Bayesian estimation method combines subjective prior distribution information and the sample-based likelihood function of the parameters to obtain posterior distribution of the parameters. In the Bayesian econometrics, a parameter is considered as a random variable rather than a constant as in the classical econometrics.

2.3. International Monetary Policy Coordination Models

Although there are various international monetary policy coordination models developed by different researchers, these models share the same spirit: policy action in one country creates externalities on the other country. Hence, the key insight of these models is that coordination of policies among countries that takes into account these externalities may lead to higher welfare for all countries.

Canzoneri et al. (2005) classify international monetary policy coordination models based on their historical development into two categories:

1) The first-generation models

The first-generation models were old Keynesian models that provide theoretical rationale for international monetary policy coordination. The first-generation models were critical responses to the view of Chicago School that saw a flexible exchange rate as a way to insulate domestic employment from foreign economic disturbances, including foreign monetary policies. The Chicago School believes that there is no need for central banks to intervene the foreign exchange market or coordinating their policies to address macroeconomic shocks, as the exchange rate mechanism will automatically correct the imbalances in their economies.

Although the first-generation model proved that there were gains from international monetary policy coordination, such gains were quantitatively small. The first-generation models include game-theory-based models by Hamada (1976), Oudiz and Sachs (1985), and Canzoneri and Gray (1985).

2) The second-generation models

These are New-Keynesian-based models that incorporate optimizing households, monopolistic competition, and some sort of nominal inertias. Among the pioneers of the second-generation modelers are Corsetti and Pesenti (2001) and Obstfeld and Rogoff (2002). Canzoneri et.al. (2005) pointed out the four characteristics of assumptions used in the earlier version of the generation models: (i) a balanced current account; (ii) log utility of consumption; (iii) constant expenditure shares (on components of the composite consumption goods); and (iv) a log specification for the utility of money.

The need for international monetary policy coordination in the second-generation models is still an open question. Earlier version models tended to find that the gains from coordination were rather small, but later version models found that the gains can be substantial under particular conditions.

The following are some examples of international monetary policy coordination models.

2.3.1. Corsetti and Pesenti (2001)

Corsetti and Pesenti built a two-country DSGE - NOEM model to examine the transmission of fiscal and monetary policies in interdependent economies through terms of trade externalities. They used the assumptions of nominal rigidities and monopolistic competition in their model (which are common in the NOEM models) but moved further by assuming that the substitutability among domestically produced goods is higher than between domestic goods and foreign goods as a group. The latter assumption allows the model to examine the macroeconomic and welfare implications of terms of trade externalities.

The Corsetti - Pesenti model assumes the existence of two countries: Home and Foreign; where each economy is inhabited by a continuum of economic agents [i.e. households]. The lifetime utility of the representative agent is derived from its consumption basket of domestic and imported goods, labor supply, real money balance, and consumption of public goods. The agents hold two types of assets: national money and international bond. Firms in each economy produces goods using labor as the only production factor. There is no differentiation between firms producing intermediate goods and final goods. The labor and the good markets are assumed to be perfectly competitive; Corsetti and Pesenti stated that the introduction of price rigidity in the goods market do not alter the model solutions. There is a government in each economy that provide public goods, impose tax, and print money. The welfare criterion for each country is based on the lifetime utility of the representative agent. Corsetti and Pesenti assumed that preference over consumption goods both within and across countries are symmetric, but preferences towards liquidity, leisure, and public goods can be different.

Corsetti and Pesenti identified two sources of economic distortions that affect welfare effects of monetary and fiscal policies: monopolistic supply in production (the internal source) and monopoly power of a country in trade (the external source) and paid more attention to the interplay between the two. In an open economy with nominal rigidities, an unanticipated monetary expansion in the one hand can increase output towards its efficient level, but on the other hand reduces domestic consumer's purchasing power in the global market as domestic inflation accelerates. Hence in particular cases, monetary policy expansion can have a beggar-thyself impact on a country's welfare. Meanwhile, an unanticipated exchange rate depreciation of a country can be beggar-thyself rather than beggar-thy-neighbor, because gains in domestic output may be offset by deteriorating terms of trade. Fiscal policy expansions are generally beggar-thy-neighbor in the long-run. In the short run, a fiscal policy expansion raises inflation at unchanged terms of trade thus curbing welfare benefits from monetary expansion. Corsetti and Pesenti also found that smaller and more open economies are more likely to harmed by inflationary shocks. Larger economies benefit from moderate demand-led expansions but may be worst off if policymakers attempt to close the output gap.

2.3.2. Obstfeld and Rogoff (2002)

Obstfeld and Rogoff examined whether in a world with tightly linked goods and financial market, countries can obtain gains from macroeconomic stabilization by unilaterally setting their own monetary rules rather than coordinating policies together. Obstfeld and Rogoff adapt their previously built two-period two-country NOEM model (Obstfeld and Rogoff, 2000) that encompass incomplete international financial market. The model assumes the existence of international bond markets, but there is no trade in international equities.

In the Obstfeld-Rogoff model, the world is assumed to consist of two equally sized and identical countries. In each economy, there is a continuum of firms producing a continuum of differentiated nontraded and traded goods using a continuum labor. The model assumes nominal rigidity of wage, where workers set nominal wage a period in advance and, ex post, supply the amount of labor that firms demand at the posted nominal wage. Prices, however, are assumed to be flexible. While monopolistic firms can impose price discrimination across the Home and Foreign markets, prices are the same constant markup over wages in both countries due to the assumption of constant and identical elasticities of demand.

The individual country's welfare in the Obstfeld-Rogoff is formulated as a function of expected exchange rate and expected terms of trade, where the expected terms of trade incorporate expected consumption. In the case of cooperation, each country maximizes its individual welfare as their contribution to the collective welfare.

The main distinction between the Obstfeld-Rogoff model with the standard international monetary policy coordination models in the 1980s and 1990s lies on the assumption on how change in policy rule affects wages and prices. In the standard models of those time, changes in policy rule only affects the variances of wages and prices; while in the Obstfeld – Rogoff model changes in rules also affect the means of wages and prices. Consequently, it is possible in the Obstfeld-Rogoff model for countries to manipulate their policy rules to raise domestic expected welfare at the expense of foreigners' expense, e.g. by manipulating real exchange rate and terms of trade.

Obstfeld and Rogoff pointed out that the importance of international cooperation in setting monetary rules lies critically on how nominal rigidities interact with other distortions in the economy, e.g. distortions due to monopoly and imperfect capital markets. The smaller the cross effect of the monetary policy rule on "real distortions", the less the need for cooperation will be. In a special case where there are no distortions, cooperation in rule-setting can be enforcing. In more general cases where nominal rigidities interact with other distortions, the gains from international cooperation are an empirical question. Obstfeld and Rogoff found in their study that while international cooperation is beneficial in theory, it was unimportant empirically.

Obstfeld and Rogoff concluded that under plausible assumptions, it is possible for countries to gain from macroeconomic stabilization by unilaterally design their monetary policy rules. As domestic monetary policy rules improve, and as international assets market become more complete, there are plausible circumstances where the outcome of a Nash (non-cooperating) monetary rule-setting game begins to approximate the outcome of a cooperating system. Convergence occurs when globally optimal monetary policy rule seeks fully to offset nominal rigidities and are not forced to also carry the burden of counteracting capital market imperfections or other extra distortions.

2.3.3. Sutherland (2004)

Sutherland developed a NOEM model that focuses on the structure of international financial markets for the existence and welfare gains from international monetary policy coordination. The Sutherland model is a two-country two-period stochastic general equilibrium model. In his model, the Home and Foreign economies have identical economic structure. Each country is populated by a continuum of agents who consume a basket of goods containing all home and foreign produced goods. Each agent is also a monopoly producer of a single differentiated product. Monetary authority seeks to maximize social welfare, which is measured in terms of the aggregate utility of agents.

Sutherland introduces three types of international financial markets structure in his model: (a) financial autarky (where international financial market does not exist); (b) international financial markets where the asset markets open *before* policymakers set monetary policy rules; and (c) international financial markets where the asset markets open *after* policymakers set monetary policy rules. Sutherland also introduces two types of policy interaction regime between the two countries: (i) "No Coordination (Nash)" regime; and (ii) "Coordination" regime. Under the "No Coordination" regime, the Home and the Foreign monetary authorities chooses parameters of monetary policy rule to maximize welfare of their respective countries. Under the "Coordination" regime, a single world policymaker chooses coefficients in the Home and Foreign monetary policy rules to maximize the world aggregate welfare.

Combining the three types of international financial markets structure and the two types of policy interaction regimes, Sutherland examines welfare under the six following scenarios:

Table 2.1. Sutherland's six scenarios of international financial market structure and monetary policy interaction regimes

Financial autarky No coordination	Financial autarky Monetary policy coordination
Existence of international financial markets where the asset markets open *before* policymakers set monetary policy rules No coordination	Existence of international financial markets where the asset markets open *before* policymakers set monetary policy rules Monetary policy coordination
Existence of international financial markets where the asset markets open *after* policymakers set monetary policy rules No coordination	Existence of international financial markets where the asset markets open *after* policymakers set monetary policy rules Monetary policy coordination

The Sutherland model closely resembles the Obstfeld and Rogoff model (2002), but with the following differences. The Sutherland model allows the elasticity of substitution between the home and foreign goods to be different than unity. There are no non-traded goods (i.e. all goods are tradable), no "cost-push" or sector-specific shocks, and there is full exchange-rate pass through in the model. For cases of non-financial-autarky, the model also allows international trade of state-contingent assets.

Sutherland finds that welfare gains from policy coordination are the largest when: (1) the elasticity of substitutions between home and foreign goods differs from unity; (2) international markets in state-contingent assets allow full consumption risk sharing; and (3) asset trade takes place before monetary policy rules are determined. Welfare gains are found to be much smaller when there are no international financial markets.

The Sutherland model has the following strengths: (i) its simplicity; (ii) its stochastic nature that involves the element of probability; (iii) its assumption that household's utility is also determined by cash holding; and (iv) its flexibility that allows elasticity between home and foreign goods to differ from unity. Meanwhile, the model has the following limitations : (a) it is not a dynamic model, as it involves only one time period; (b) it does not differentiate households from firms, where the individual agent is treated both as a producer and a consumer; (c) it does not differentiate between the non-traded and the traded sectors and hence does not involve specific-sector shocks; and (d) it does not introduce the role of a government that exercise fiscal policy.

2.3.4. Carlberg (2005)

Carlberg develops theoretical mathematical models to study international monetary and fiscal policy coordination in the world economy. The Carlberg models are based on the Mundell-Flemming model. These models are not general equilibrium models, as they are not built upon microeconomic foundations. These models are also deterministic (non-stochastic) models as they do not involve probability.

Carlberg discusses the scenarios of international policy competition and of policy cooperation (coordination). He started with the static two-monetary-region model (taking Europe and the United States as samples) and expands the model to dynamic multi-monetary-region models. Carlberg also started his models with strict assumptions of perfect capital mobility and equal economic sizes of countries involved before relaxing these assumptions later.

Below are some key findings from the Carlberg models for the cases of monetary policy expansion or fiscal policy expansion:

- International policy cooperation is always superior to international policy competition, both in the case of monetary and fiscal policy.
- ***International monetary policy competition*** leads to full employment and price stability in all participating regions. Adjustment process of economic variables toward the steady state equilibrium is slow due the presence of large negative externalities from monetary policies.
- ***International monetary policy cooperation*** leads to full employment and price stability in all participating countries. Adjustment process of economic variables toward the steady state equilibrium is fast because participating regions internalize negative externalities from monetary policies. Thus, *international monetary policy cooperation is superior than international monetary policy competition.*
- In the case of ***imperfect capital mobility***, international ***fiscal policy competition*** may or may not lead to full employment in all participating regions. It is possible to achieve full employment when the capital mobility is sufficiently low. Adjustment process of economic variables toward the steady state equilibrium is slow due the presence of large negative externalities from fiscal policies.
- In the case of ***imperfect capital mobility***, international ***fiscal policy cooperation*** leads to full employment in all participating regions. Adjustment process of economic variables toward the steady state equilibrium is fast because participating regions internalize negative

externalities from monetary policies. Thus, ***international fiscal policy cooperation is superior than international fiscal policy competition.***

- In the case of ***perfect capital mobility***, international ***fiscal policy competition*** does not lead to full employment in every participating region due to the presence of large externalities. International fiscal competition cannot reduce unemployment in all participating countries.
- In the case of ***perfect capital mobility***, international ***fiscal policy cooperation*** does not lead to full employment in every participating region due to the presence of large externalities. However, fiscal cooperation helps to reduce unemployment of all participating regions to certain extent. Thus, ***international fiscal policy cooperation is superior than international fiscal policy competition.***
- Increasing number of participating regions in international policy competition or cooperation creates larger negative externalities.

2.3.5. Berger and Wagner (2006)

Berger and Wagner developed a theoretical model to seek the best policy rules that must be pursued by monetary authority in the presence of international monetary policy coordination. Berger and Wagner assume the existence of a world central bank that sets a targeting rule to maximize the world aggregate welfare, where the rule is affected by productivity and cost-push shocks. A targeting rule is defined as a rule that eliminates all fluctuations in the targeted variable. The world central bank is assumed to use money supply (rather than interest rate) as its policy instrument. Berger and Wegner examine four types of targeting rule: (1) nominal income targeting; (2) monetary targeting (i.e. setting target level of money supply); (3) producer price targeting; and (4) consumer price targeting.

The Berger-Wagner model is a two-country two-period model. In this model, the world is assumed to comprise of two equally sized countries with identical economic structure. Each economy is inhabited by a continuum of households whose consumption bundle includes domestically produced and imported goods from the other country. Each country has two types of consumption goods producers: (i) the "fixed-price agents", who are required to set prices before shocks occur and monetary policy is set; and (ii) the "flex-price agents", who operate in markets when prices are set after the realization of shocks and the setting of monetary policy. The model assumes that intermediate goods markets are characterized by full-flexibility, which implies that all intermediate goods producers are flex-price producers. The model also assumes the existence of full pass-through exchange rate changes into intermediate goods, but zero pass-through into the prices final consumption goods.

The Berger-Wagner model incorporates two types of shocks: (i) productivity shock; and (ii) cost-push shock. Productivity shock is defined as a stochastic shock to the labor supply, while cost-push shock is a random fluctuation in the (net) mark-up over marginal cost that monopolistically competitive final goods producer set.

Berger and Wagner use the welfare under producer-price-targeting as a benchmark and comparing the remaining types of targeting rules under different cases of shocks to examine the following nine scenarios:

Table 2.2. Berger and Wagner's nine scenarios of shocks and monetary policy targeting rule

Productivity and cost-push shock are equally important Consumer price targeting	Productivity and cost-push shock are equally important Nominal income targeting	Productivity and cost-push shock are equally important Monetary targeting
Productivity shock is more important than cost-push shock Consumer price targeting	Productivity shock is more important than cost-push shock Nominal income targeting	Productivity shock is more important than cost-push shock Monetary targeting
Cost-push shock is more important than productivity shock Consumer price targeting	Cost-push shock is more important than productivity shock Nominal income targeting	Cost-push shock is more important than productivity shock Monetary targeting

Berger and Wagner find that when cost push-shock and productivity shock are equally important, nominal income targeting or monetary targeting are fare better than consumer or producer price targeting. Nominal income targeting or monetary targeting are unambiguously preferable to consumer or producer price targeting when cost-push shock is more important than productivity shock. When productivity shock is more important than cost-push shock, consumer or producer price targeting is better than nominal income or monetary targeting. In all of the nine scenarios above, income targeting always dominates monetary targeting, while consumer price targeting tends to be slightly better than producer price targeting.

The Berger-Wagner model has the following strengths: (i) it is a stochastic model that involves the element of probability; (ii) it focuses on the impact of different monetary policy rules in each country on individual and collective welfare; and (iii) it introduce stickiness of consumption good prices. The limitations of the Berger-Wagner model are as follow: (a) it does not differentiate between the non-tradable and the tradable sector; and hence does not involve specific-sector shocks and (b) it does not introduce a government that exercises fiscal policy.

2.3.6. Liu and Pappa (2007)

Liu and Pappa developed a two-country model for international monetary policy coordination between the United States and the European Union. Their study focuses on the role of asymmetries in production sector across countries in generating gains from policy coordination.

The Liu-Pappa model assumes the existence of two economies with equal size populations: Home and Foreign. Each country has a continuum, identical, and infinitely lived households, which can be represented by a "representative household". The representative household consume a basket final goods that comprises non-traded and traded goods, while the traded goods consist of domestically produced and imported ones. Final consumption goods are assumed as composites of intermediate goods produced in the non-traded and traded sector.

There are two production sectors in each country: (i) the traded sector; and (ii) the non-traded sector. The traded sector produces traded goods that enter consumption basket in both countries, while the non-traded sector produces non-traded goods that are only domestically consumed. The Liu-Pappa departs from the standard NOEM models by allowing the share of traded goods in consumption basket to be different across countries to allow cross-country difference in production and trading structures.

The model assumes the existence of a continuum of intermediate-good-producing firms in the non-traded and traded sector in each country. These firms use constant-return-to-scale (CRS) technology, where labor is the only production factor used by firms. Labor is assumed to be mobile across sectors, but no across countries. The model implicitly assumes the existence of final-good-producing firms in each sector that transform intermediate goods to final consumption goods using the constant elasticity of substitution (CES) technology.

The welfare criterion in the Liu-Pappa model is formulated in a quadratic form based on the second order approximation of the households' utility function and private sector's equilibrium conditions. To show the gains from international monetary policy coordination, Liu and Pappa compared the level of welfare between the non-coordination (Nash) and coordination regimes. Under the non-coordination regime, each central bank seeks to maximize the welfare of its own households, subject to private sector's, taking foreign policy variables as given. Under the coordination regime, monetary policy decisions of the two countries are delegated to a supranational monetary institution, who seeks to maximize a weighted average of national welfare for both countries. The supranational monetary institution in the coordination regime considers macroeconomic variables in both countries.

Liu and Pappa concluded that although international policy coordination cannot replicate potential welfare in the natural rate allocations, it can increase welfare gains of participating countries compared to when each country pursuing its policy objectives independently. Under policy coordination, each country internalizes terms-of trade externalities. Liu and Pappa added that the benefits of policy coordination will be bigger in the case of asymmetric economies compared to the symmetric case.

The Liu and Pappa's model has the following strength: (i) its simplicity; (ii) it has a complete policymaker (a national or supranational planner) that exercises both fiscal and monetary policies; (iii) it is a dynamic and stochastic model; (iv) it allows for asymmetric structure of the non-tradable and tradable sectors between the Home and Foreign economy; and (v) it allows for price stickiness (staggered price setting ala Calvo model) in the non-tradable and tradable sector. The Liu and Pappa's model has some limitations, including the following: (a) it overlooks the role of capital in production as it assumes that labor is the only available production input; (b) it assumes that the national or supranational planner plays a passive role in fiscal policy, simply to provide subsidies for firms to reduce price mark-ups; and (c) it does not explain on how the government raise its revenue to finance its expenditure (there is no tax introduced in the model).

This dissertation follows and expands the Liu and Pappa's model due to its comprehensive nature: (1) the existence of complete monetary and fiscal authorities in each economy; (2) differentiation between tradable and non-tradable sectors in each economy; (3) differentiation between domestically-produced and imported tradable goods; and (4) the stochastic and dynamic elements in their model.

2.3.7. Coenen et.al. (2008)

Coenen et.al. develop a simplified version of the New Area-Wide Model (NAWM) of the European Central Bank (ECB) to quantify the gains from international monetary policy coordination between the Euro Area and the United States (US). The NAWM is a two-region Dynamic Stochastic General Equilibrium (DSGE) model that is calibrated to represent the Euro Area and US economy.

Their simplified NAWM model are based on the following assumptions: (i) prices and wages adjust at irregular interval of time to their efficient level although they are partially indexed to past inflation; (ii) import sector is unable to set price optimally in each period so that the model has less than full exchange rate passthrough; (iii) households and firms have persistent habits and thus react slowly to exogenous disturbances; (iv) international financial market is imperfect so that the net-asset positions are denominated in one currency only; (v) fiscal authorities in the Euro Area and the US run a balanced budget and use distortionary taxes and lump-sum taxes to finance their consumption; and (vi) monetary policies in the Euro Area and the US are described by an interest rule, which link the interest rate to inflation and output.

They examine three scenarios of policy interactions:

(1) Cooperation

Here, cooperation is defined as a case where the central banks' objective is to maximize the population-weighted sum of the Euro Area and the US aggregate of the utility function of each household living in the two countries.

(2) Non-cooperation without the announcement of policy rules

Each central bank maximizes the aggregate welfare country under the constraint that the other central bank can set the entire future path of its own instrument freely (being it either money supply or interest rate).

(3) Non-cooperation with the announcement of policy rules

Each central bank is assumed to announce a linear interest rate rule. Then, each central bank maximizes the aggregate welfare of its own country under the constraint that the other central bank can choose freely the coefficient of its policy rule.

Coenen et.al. found that given the existing degree of openness of the Euro Area and the US, the gains from international monetary policy coordination is very small, about 0.03% of the output that households would consume in an economy not subjected to stochastic fluctuations.

Coenen et.al. drew three conclusions from their study: (1) the gains from cooperation are very sensitive to the degree of openness, where higher degree of openness increases the gains; (2) higher markup shocks can increase gains from cooperation; (3) the gains from cooperation will be considerably larger when prices in the domestic intermediate good sector becomes less sticky.

The model built by Coenen et.al. has the following strengths: (i) it is a dynamic stochastic general equilibrium model that involves the elements intertemporal decision-making, probability; (ii) it assumes firms to use two-production-factor technology, i.e. labor and capital; (iii) it introduce stickiness of prices and wages; and (iv) it differentiates the fiscal and monetary authorities; and (v) it assumes active roles of the government (fiscal authority) in purchasing final goods, as well as imposing lump sum tax and discretionary taxes subsidies on households and firms. One among the limitations of the Coenen model is it does not differentiate between the non-tradable and the tradable sectors; and hence does not involve specific-sector shocks.

2.4. Empirical Studies on International Policy Coordination in the Asia-Pacific

Kamada and Takigawa (2005) developed a cross-country macro-econometric NOEM for nine Asia Pacific countries to address three policy issues: (1) the desirability of currency basket pegs in East Asia; (2) the anticipated effects of China's currency reform (i.e. CNY currency appreciation to reflect its fair value); and (3) the non-negativity constraint on the Japanese nominal interest rates. They concluded the following: (1) currency basket pegs for the East Asian countries seem superior to USD-only pegs; (2) China's currency reform benefits China itself but harms its neighbors when China is facing economic recession; however, China's currency reform harms China's own economy but benefits its neighbors in the case of US recession; and (3) the non-negativity constraint on the Japanese nominal interest rate has mixed effect on other East Asian countries when the Japanese domestic demand falls.

Branson and Healy (2005) examined potential gains from monetary and exchange rate coordination in the ASEAN and China (ASEAN+1). They analyzed the historical movement of these countries' real effective exchange rates (REERs). They concluded that potential gains from such coordination can come from three sources: (1) direct gains from stabilization with sustainable macro policies; (2) direct gains from by ruling out unintended competitive devaluation and cascading speculation from market to market; and (3) indirect gains in terms of importance of stabilization for the Chiang Mai Initiative and the ASEAN Bond Market (ABM) development. They also found out the ASEAN countries and China has quite similar trade patterns and their policies are already implicitly coordinated, with their REERs tend to move together. They believed that the ASEAN and China are already moving towards integration in practical effect .

Truman (2011) examined three aspects of the Asian economic coordination: (1) macroeconomic policies; (2) reserve management; and (3) crisis management. Truman saw differences in terms of degree of integration between the Asian group that include large economies [e.g. China and Japan] and the ASEAN group, where the earlier group exhibits greater unemployment and growth integration than later. He went on by stating that Asia is dominated by its large economies and supply chain relationship. He suggested that the purpose of Asian regional policy coordination should be to promote economic growth and financial stability in the region.

Gupta (2012) conducted a study on Asian exchange rate policy coordination using a hypothetical Asian Currency Unit. He found out that there is a widening deviation in exchange rate movements of the Asian currencies due to the adoption of different exchange rate regimes by the participating countries amid different policy objectives. Gupta pointed out that there are some institutions that can assist exchange rate coordination and financial and economic integration in Asia, including a multilateralized swap arrangement, a regional surveillance mechanism, and a bond fund.

Sui-Lay Tan (2014) conducted a study on the feasibility of policy coordination among the ASEAN-5 countries using global Vector Autoregression (VAR) model. She considers the global VAR model has an advantage of accounting for the relative importance of trade and financial flows in influencing the size of spillovers between countries. She found the evidence of symmetric responses to the common (global) shock of interest: a US monetary policy shock, a US output shock, a Chinese output shock, and an oil price shocks. She concluded that the cost of coordinating policies among the ASEAN-5 is not so onerous and is feasible.

Also using a VAR model, Majuca and Pagaduan (2015) shows that the intrinsic differences among the characteristics of the individual ASEAN economies pose a challenge for a regional macroeconomic coordination. There exists a wide variation in the impact of external shocks to the ASEAN countries. For instance, Singapore is more affected by the rest of the world, while Indonesia and the Philippines are mostly affected by domestic shocks.

Sugandi (2016) modified the Liu-Pappa model for empirical study on the feasibility of bilateral monetary and fiscal policy coordination among the ASEAN-5 countries. The modifications are: (i) the introduction of taxes in the model; (ii) the introduction of government spending for the provision of semi-public goods for households; and (iii) the introduction of the Game Theory framework to assess the feasibility of policy coordination. Under strict assumption that externalities in bilateral policy coordination will only fall upon the participating countries and that interest rate is the only available monetary policy instrument, Sugandi found that in general bilateral monetary and fiscal policy coordination is not feasible for the ASEAN-5 countries. The only feasible bilateral coordination is coordination between Indonesia and the Philippines. Sugandi (2018) modified model developed by Sugandi (2016) by extending the scope of externalities to all countries in the world economy and exploring the case of multilateral coordination among the ASEAN-5 countries. He found that both multilateral coordination is not feasible for the ASEAN-5 countries, and only one case of feasible bilateral coordination. His 2018 model has several shortcomings, including the small magnitude of shocks and rather short period of simulations. This study has addressed the shortcomings in Sugandi's 2018 model.

2.5. International Externalities and Public Goods

This section discusses externalities (or spillover) and public goods, which are different but closely related concepts. International monetary policy coordination discussed in this study is aimed to improve welfare by internalizing externalities into policy making, while macroeconomic stability stemming from such coordination is an international public goods. Both externalities and public goods are caused by market failures.

An externality is defined as the case where an action of one economic agent affects the utility or production possibilities of another in a way that is not reflected in the marketplace (Just et.al., 2004). Mankiw describes that an externality arises when a person engages in an activity that influence the well-being of a bystander and yet neither pays no receives any compensation for that effect (Mankiw, 2008). If the impact of such an externality is beneficial to the bystander, then it is called a positive externality. If the impact on the bystander is adverse, then it is a negative externality. Externalities is caused by market failure since the market cannot price-in of such benefits or harms, cannot provide appropriate information for all agents about these benefits or harms, and cannot provide mechanism to compensate the bystanders if harmed.

Varian defines public goods as goods that are not excludable and are non-rival, as opposed to the private goods which are excludable and rival (Varian, 1992). A good is excludable if people cannot be excluded from consuming it, while it is non-rival if one person's consumption does not reduce the amount available to other consumers. The United Nations Industrial Development Organization (UNIDO) differentiates between public goods and public bads (UNIDO, 2008). Public goods are goods that possess non-rival and non-excludable benefits (e.g. international financial stability or pollution control). Public bads are also non-rival and non-excludable but they harm the utility of agents or the society (e.g. haze from forest fire).

Public goods are caused by market failure since the market cannot recognize their existence in the pricing mechanism. Leaving public goods provision to the market will result in undersupply with respect to the socially desirable level. There are also embedded problems related to public goods provision due to their two characteristics. The non-excludable characteristic creates free-riding problem, as potential users may wait for the goods to be supplied and consume them for free without giving contribution to the provision of such goods. The non-rivalry characteristic implies zero marginal cost of use, which causes exclusion becomes inefficient as potential consumers with a positive marginal benefit are denied access to the goods (Varian, 1992).

The categorization of public goods versus private goods is not rigid, however. Besides the pure public goods and pure private goods, there are some goods with some degree of mixed characteristics between public goods and private goods (Table 2.5): (1) club goods (which is excludable and partially rival); (2) common goods (which is non-excludable and rival); and (3) impure public goods (which is partially excludable and rival or excludable and partially rival). Regional macroeconomic stability stemming from international monetary policy coordination can be classified as impure public goods, as it is non-rival but partially excludable to countries in the region and/or to other countries with trade and financial links to the region.

With respect to their geographical scopes, public goods can be differentiated between national public goods and international public goods (Table 2.6). National public goods are public goods whose spillover are effects limited to national borders. International public goods can be differentiated further between cross-border or regional public goods and global public goods.

In public economics, the way the supply of public goods is created by the individual efforts of different community members is known as public goods aggregation technologies. The UNIDO enlist six types of public goods aggregation technologies as follow (Table 2.7):

1) Simple summation

In this technology, contributions from each agent are summed up as an aggregate supply of the public goods. There is no weighting in the summation process. This technology is the most common aggregation technology. If used, the simple summation technology is efficient for the provision of club goods but can cause undersupply problem for pure public goods and undersupply or overuse problem for impure public goods.

2) Weighted sum

In this technology, the aggregated level of provision is determined by the weighted sum of individual contributions. The weight can be based on different factor(s), such countries' geographical proximity or development level. If used, the weighted sum technology is efficient for the provision of club goods but can cause undersupply problem for the provision of pure public goods and impure public goods.

3) Best shot

In this technology, the aggregated level provision of the public good is determined solely by the largest single contributor, who act as a leader. A strategic implication of the selection of the best-shot technology is the need for coordination to avoid wasting resources due to duplication of effort. The best-shot technology is efficient for the provision of club goods but can cause undersupply or oversupply problem for impure public goods. This technology can be efficient for pure public goods provision in some cases but can cause undersupply problem in other cases.

4) Better-shot

This technology is the less stringent version of the best-shot technology, where the existence of less extreme conditions for leadership. In this technology, the largest contributor has the greatest impact on supply, followed by the second largest contributor, and so on. The better-shot technology is efficient for the provision of club goods but can cause undersupply or oversupply problem for impure public goods. This technology can be efficient for pure public goods provision in some cases but can cause undersupply problem in other cases.

5) Weakest-link

In this technology, the smallest effort or contribution fixes the effective provision level. Contributions beyond this smallest level will not increase aggregate provision. Consequently, contributors will match the smallest contribution level. The weakest-link technology is efficient for the provision of pure public goods but can cause undersupply or overuse problem for impure public goods and external forced-based undersupply.

6) Weaker-link

This is the less stringent version of the weakest-link technology. In this technology, the smallest contributor has the greatest impact on the aggregate provision, followed by the second smallest contributor, and so on. The weaker-link technology is efficient for the provision of pure public goods but can cause undersupply or overuse problem for impure public goods and external forced-based undersupply.

Table 2.5. The Characteristics and Typology of Public Goods

Benefits	*Rival*	*Partially rival*	*Non-rival*
Excludable	**Pure private goods** - Food - Cars, fuel	**Club goods** - Intelsat - International Space Station - Canals, waterways	- Weather monitoring stations
Non-excludable	**Common goods** - Free access pasture - Open pathways - Hunting grounds - Air corridors	**Impure public goods** - Ocean fisheries - Pest control	**Pure public goods** - Pollution control - Disease-eradication program - Strategic weapons - Sound financial practices - Basic research
Partially excludable	**Impure public goods** - Financial market information dissemination - Agriculture service extension	**Impure public goods** - Rain forests	**Impure public goods** - Satellite-based weather forecast - Regional macroeconomic stability

Source: United Nations Industrial Development Organization, adapted from Sandler (2002) and Kaul (1999); with additional examples of impure public goods.

Table 2.6. Geographic Scopes of Public Goods

Kind of public goods		Definition	Example
National		Spillover effects limited to national borders	National healthcare system Ground water purification
International	Cross-border / Regional	Spillover effects reach a group of countries forming a region	Regional economic cooperation agreement Regional corridors
	Global	Spillover effects have worldwide scope	Climate change prevention

Source: United Nations Industrial Development Organization, adapted from Sandler (2002) and Kaul (1999); with additional examples of impure public goods.

Table 2.7. Supply Prognosis for International Public Goods and Role of Supranational Institutions

	Pure public goods	Impure public goods	Club goods
Simple summation	Undersupply	Overuse / undersupply.	Efficient supply.
Weighted sum	Undersupply dependent on the relative weight of agent-specific benefits and actions. A large weight means that individual agent will tend to contribute more to the supply.	Overuse / undersupply.	Efficient supply.
Best shot	Undersupply or efficient supply. Supply determined by the agents with the highest contribution. Leadership by a dominant nation or institution is needed. Requires coordination and pooling of resources based on comparative advantages.	Oversupply / some undersupply. Coordination and polling issues.	Efficient supply.
Better shot	Undersupply or efficient supply. The largest contributor has the greatest marginal impact. Coordination and pooling issues are lesser concern, as there are more suppliers.	Oversupply / some undersupply. Coordination and polling issues are less of concern.	Efficient supply.
Weakest link	For homogenous group, efficient supply is expected. For a less homogenous group, the better-endowed nations may have to bolster the capacity of those in the group that cannot meet the efficient supply level.	Overuse / some undersupply owing to crowding.	External forced-based undersupply. Additional externalities must be taken into account introducing tools.
Weaker link	For homogenous group, efficient supply is expected. The smallest contribution has the greatest supply impact; less a capacity issue. Suppliers can make up for undersupply. A better endowed country may be less interested in the capacity of less endowed. Need for coordination	Overuse / some undersupply owing to crowding.	Some external forced-based undersupply. Additional externalities must be taken into account introducing tools.

Source: UNIDO, based on Sandler (1999)

2.6. The Game Theory Framework

This section briefly discusses the Game Theory framework, as this study uses the framework to determine feasible bilateral and monetary policy coordination. When interacting each other, every country assesses their welfare pay-off matrix when choosing two options between coordinating policy or not coordinating.

Cárcamo-Díaz (2005) introduces four categories of the Game Theory framework to analyze international monetary policy coordination:

1) One-shot games with perfect information

It is a category game between two players who select their equilibrium actions once only. As a simplification, the players are often assumed to know their own payoffs and those of their competitors with any possible move they can take, and to know that other knows that they know, and so forth (known as "common knowledge). Among prominent games within this category are the "Prisonner's Dilemmma", the "Stag Hunt", and the "Battle of Sexes".

2) One-shot games with imperfect information

It is a category of one-shot games where each player does not know with certainty all of the relevant information about the other player. A frequent assumption to solve games of incomplete information is to assume that individual payoffs are drawn from a distribution function which is a common knowledge by all the players, and that these payoffs are "chosen" in a previous stage by one player called "Nature".

3) Repeated games with perfect information

It is a category of games where different countries are repeatedly interacting over a long horizon of uncertain duration, which can be modelled as an infinite horizon. Rasmussen pointed out that in repeated games the fundamental rules framing the decisions do not change from one repetition to the next, only the history of play increases (Cárcamo-Díaz, 2005). When the same one-shot game is played either: (i) an infinite number of times or (ii) a finite but initially uncertain number of times (there is a non-zero probability of the game ending in any stage), the equilibrium outcomes can be very different from the Nash equilibria observed in a single one-shot game.

4) Dynamic games with imperfect information

It is a category of game where country officials in the two countries never know the exact payoff function in their partner country. Players use information that become available to them by updating their beliefs after observing the actions taken by the other players at each stage. In these games, beliefs and strategies are closely linked and cannot be understood separately.

This study uses the one-shot with perfect information game framework. The steady state welfare values of the countries in interaction are known by all parties, and all parties are assumed to have perfect information on the payoffs of other country's strategy.

CHAPTER 3

RESEARCH METHODOLOGY

3.1. Basic Settings for the Models

This section only displays the Home economy side as the Foreign countries mirror the structure of the Home economy. Throughout this paper, subscripts "t" refers to time index, "n" to foreign country index, "i" to index for firms in the non-traded sector, and "j" to index for firms in the traded sector.

The model assumes the existence of eleven countries representing the world: Home country and ten Foreign countries, where similar economic agents live in each economy. The eleven countries are: (1) Indonesia; (2) Malaysia; (3) Singapore; (4) Thailand; (5) the Philippines; (6) the European Union; (7) the United States; (8) China; (9) Japan; (10) South Korea; and (11) Australia. When this study analyzes policy interactions among the ASEAN-5 countries, it treats the remaining six countries as external environment. Likewise, when this study analyzes the ASEAN-5 + China, ASEAN-5 + Japan, ASEAN-5 + South Korea, or ASEAN-5 + 3, it treats other countries outside the respective cluster as external environment.

Externalities are transmitted across countries through trade and financial channels. Traded goods in the eleven countries are from domestic production and imports. Non-traded goods are assumed to be produced and consumed domestically. Bond markets are connected across countries, and there is international risk-sharing among these countries.

3.1.1. Types of International Policy Interactions

This study assumes three types of policy interactions among countries:

(i) No Coordination (Nash) regime

Government and central bank in the Home country make policies without coordinating with other countries. Central bank seeks to optimize Home country's welfare by minimizing output gaps (which is the difference between the actual output of an economy and its potential output) and inflation rates in the traded and non-traded sectors while considering policies and outputs in other countries as given.

(ii) Bilateral Coordination regime

There is a hypothetical supranational planner that seeks to optimize welfare in two participating countries by setting fiscal and monetary policies in both countries while considering policies and outputs in the remaining nine countries as given. The supranational planner sets fiscal policies in each of the two countries independently. The monetary policies in the two countries are set interdependently: interest rate policy in each country is determined by considering output gaps and inflation rates in the traded and non-traded sectors of both countries.

(iii) Multilateral Coordination regime

The supranational planner seeks to optimize welfare of the participating countries by setting fiscal and monetary policies in these countries while considering policies and outputs in the non-participating countries as given. Fiscal policies in each of the participating countries are set independently, while the monetary policies in these five countries are set interdependently.

3.1.2. Economic Agents

This study assumes the existence of four economic agents in each economy: (i) households; (ii) firms; (iii) government or supranational planner exercising fiscal policy; and (iv) central bank or supranational planner exercising monetary policy.

3.1.2.1. Households

There is a continuum of identical, infinitely-lived households. The representative household in each country is endowed with one unit of time and derives utility from consuming a basket of final goods (C_t) given price level P_t and subjective discount factor β. Some portion of C_t is directly purchased by household $(\breve{C}_t)$, and the government provides the rest (G_t). $\breve{C}_t$ comprises non-traded goods $(\breve{C}_{Nt})$ and traded goods $(\breve{C}_{Tt})$. $\breve{C}_{Tt}$ comprises domestically produced traded goods $(\breve{C}_{Ht})$ and imported traded goods from foreign countries $(\sum_{n=1}^{10} \breve{C}_{Fnt})$.

Price level (P_t) is determined by the price index of non-traded goods $(\bar{P}_{Nt})$ and price index of traded goods $(\bar{P}_{Tt})$. $\bar{P}_{Tt}$ is determined by the price index of domestically produced traded goods $(\bar{P}_{Ht})$ and price index of imported traded goods from Foreign Country-n (n = 1, 2, …, 10) measured in domestic currency $(e_{nt}\, \bar{P}^*_{Fnt})$. e_{nt} is defined as the value of domestic currency per foreign currency n.

$$\breve{C}_t = \alpha^{-\alpha} (1 - \alpha)^{-(1-\alpha)}\, \breve{C}_{Tt}^{\alpha}\, \breve{C}_{Nt}^{1-\alpha} \quad \text{... (1)}$$

$$\breve{C}_{Tt} = \omega_0^{-\omega_0}\, \breve{C}_{Ht}^{\omega_0} \prod_{n=1}^{10} \omega_n^{-\omega_n}\, \breve{C}_{Fnt}^{\omega_n} \quad \text{... (2)}$$

$$P_t = \bar{P}_{Tt}^{\alpha}\, \bar{P}_{Nt}^{1-\alpha} \quad \text{... (3)}$$

$$\bar{P}_{Tt} = \bar{P}_{Ht}^{\omega_0} \prod_{n=1}^{10} (e_{nt}\, \bar{P}^*_{Fnt})^{\omega_n} \quad \text{... (4)}$$

where

α = share of traded goods in the total goods in the Home economy

ω_0 = share of domestically produced traded goods in the total traded goods in the Home economy

ω_n = share of imported traded goods from foreign country-n to the total imported traded goods

$\omega_0 + \sum_{n=1}^{10} \omega_n = 1$

In the **one-production-factor** model, household's assets are in the form of domestic government bonds (B_t), foreign government bonds $(\sum_{n=1}^{10} e_{nt}\, B^*_{nt})$, and cash money (M_t). Household's income in period t is in the form of wage (W_t), transfers from d government (TR_t), principal and interest payment from domestic government bonds purchased in period t-1 $\left((1 + R_{t-1})B_{t-1}\right)$, and principal and interest payment from foreign government bonds purchased in period t-1 $(\sum_{n=1}^{10}(1 + R^*_{nt-1})\, e_{nt-1}\, B^*_{nt-1})$. The **two-production-factor** model incorporates all types of assets and income in the one-production model, but adds investment $(K_t - (1 - \delta)\, K_{t-1})$ as another type of asset and income from leasing capital in period t-1 $\left(R^{kap}_{t-1}\, K_{t-1}\right)$ as another type of income in period t. In the household's budget constraint, carried over cash from the previous period (M_{t-1}) plus income in period t should equal to consumption and assets holding in period t.

In period t, household supplies labor (L_t) to earn wage. Some portion of the wage is deducted to pay income tax (t_{Lt}). By providing labor, household loses some part of its utility; this marginal loss is measured by the marginal disutility of labor (Ψ). Household purchases government bonds in period t to accumulate assets. Household pays consumption tax (t_{Ct}) when purchasing goods. To simplify the model, this study assumes that income tax rates are the same across time and economic sectors (t_L); likewise, for consumption tax rates (t_C).

The representative household in each economy faces three optimization problems:
(i) Utility maximization subject to budget constraint to obtain the optimum real wage equation and the Euler equation.
(ii) Cost minimization of non-traded and traded goods consumption to get demand functions for non-traded and traded goods.
(iii) Cost minimization of domestically produced and imported traded goods consumption to get demand functions for domestically produced and imported traded goods.

3.1.2.2. Firms

There are two sectors in the economy: the non-traded sector and traded sector. For each sector, this study differentiates between firms producing intermediate goods ($Y_{Nt}(i)$ and $Y_{Tt}(j)$, where i and j are index of firms in the non-traded and traded sector, respectively) and firms producing final goods (Y_{Nt} and Y_{Tt}). Home-produced traded intermediate goods $(Y_{Tt}(j))$ comprise those sold in the domestic market $(Y_{Ht}(j))$ and those sold to foreign countries $(\sum_{n=1}^{10} Y^*_{Hnt}(j))$.

In the **one-production-factor** model, all firms in the economy are assumed to use labor as the sole production factor. In the **two-production-factor** model, all firms are assumed to use labor and capital, where the composition of labor and capital in the production technology are different in the traded and non-traded sectors. Capital is considered as a final good used to conduct production process, and thus is different from intermediate goods (which are processed to produce final goods). Capital is assumed to be freely mobile across countries.

3.1.2.2.1 Firms Producing Intermediate Goods

In each sector, there is a continuum of firms producing differentiated intermediate goods indexed in the interval [0,1]. Each firm uses Constant Return to Scale (CRS) technology to produce intermediate goods using labor input. Firms producing intermediate goods are assumed as price takers in the input market but monopolistic competitors in the product market.

Following the Calvo's price setting, firms seek to adjust their selling price every period, but only some of them can do so. The probability of firms for being able to adjust their price in period t is $1-\gamma_N$ for firms in the non-traded sector and $1-\gamma_T$ for the traded sector. In other words, the probability to keep price unchanged in period t is γ_N for firms in the non-traded sector and γ_T for firms in the traded sector. By the Law of Large Numbers, a fraction $1-\gamma_N$ of firms in the non-traded sector can adjust prices, while γ_N cannot. Likewise, a fraction $1-\gamma_T$ of firms in the traded sector can adjust prices, while γ_T cannot.

The government provides subsidies to firms in the non-traded sector (τ_N) and the traded sector (τ_N) to reduce steady-state mark-up distortions.

The representative firms producing <u>**non-traded**</u> intermediate goods faces the following optimization problems:

(i) Cost minimization to derive optimum unit cost in the non-traded sector.
(ii) Profit maximization to derive optimum pricing rules for non-traded intermediate goods.

The representative firms producing **traded** intermediate goods faces the following optimization problems:
(i) Cost minimization to derive optimum unit cost in the traded sector.
(ii) Profit maximization to derive optimum pricing rules for traded intermediate goods.

3.1.2.2.2 Firms Producing Final Goods

Final goods in the non-traded sector (Y_{Nt}) are assumed to be produced using non-traded intermediate goods. Domestically produced final goods in the traded sector (Y_{Tt}) are assumed to comprise those using domestically produced intermediate goods (Y_{Ht}) and those using imported intermediate goods from Foreign Country-n (Y_{Fnt}). There is some degree of substitutability between similar domestically produced and imported traded intermediate goods.

This study assumes the existence of infinite number of identical firms in each sector that bundles intermediate goods to final goods according to the constant elasticity of substitution (CES) aggregation technology.

The representative firm producing **non-traded** final goods faces the following optimization problems:
(1) Cost minimization to derive optimum labor unit cost in the non-traded sector.
(2) Profit maximization to obtain Home demand function for non-traded final goods.

The representative firm producing **traded** final goods faces the following optimization problems:
(1) Cost minimization to derive optimum labor unit cost in the traded sector.
(2) Profit maximization to obtain Home demand function for traded final goods.

3.1.2.3. Government or Supranational Planner Exercising Fiscal Policy

The government (supranational planner) is assumed to have long-term horizon (i.e. focusing at steady state) in making fiscal policy, rather than responding to short-term shocks. The government (supranational planner) seeks to find optimum labor allocations at the steady state that help households maximizing utility. Besides pursuing this long-term objective, at every time period the government (supranational planner) purchases goods for households (G_t), transfers cash to households (TR_t), pays bond interests and principal to households $\left((1+R_{t-1})\,B_{t-1}\right)$, and provides subsidies for firms producing non-traded intermediate goods (τ_N) and traded goods (τ_T). When purchasing goods, the government (supranational planner) pays consumption tax.

To generate revenues for its expenditures, the government (supranational planner) collects consumption tax (t_C) and labor income tax (t_L), as well as issuing government bonds (B_t). Revenues generated by the supranational planner in a country can only be expensed in the respective country and cannot be used in other country.

In period t, G_t comprises government spending on non-traded goods (G_{Nt}) and traded goods (G_{Tt}), where G_{Tt} consists of government spending on domestically produced traded goods (G_{Ht}) and imported traded goods from Foreign Country-n (G_{Fnt}).

Relations among G_t, G_{Nt}, G_{Tt}, G_{Ht}, and G_{Ft} are described by the following equations:

$$G_t = \alpha^{-\alpha}\,(1-\alpha)^{-(1-\alpha)}\,G_{Tt}^{\alpha}\,G_{Nt}^{1-\alpha} \qquad \ldots (5)$$

$$G_{Tt} = \omega_0^{-\omega_0}\,G_{Ht}^{\omega_0}\prod_{n=1}^{10}\omega_n^{-\omega_n}\,G_{Fnt}^{\omega_n} \qquad \ldots (6)$$

The government (supranational planner) faces three optimization problems:

(i) Utility maximization (prepared for household) at steady state to obtain optimum labor allocations in the non-traded and traded sectors.

(ii) Cost minimization of government spending on non-traded and traded goods to get the government or supranational planner's demand functions for non-traded and traded goods in period t.

(iii) Cost minimization of domestically produced and imported traded goods consumption to obtain the government's or supranational planner's demand functions for domestically produced and imported traded goods in period t.

3.1.2.4. Central Bank or Supranational Planner Exercising Monetary Policy

Central bank (supranational planner in exercising monetary policy) is assumed to focus on managing short-term shocks in the economy rather than pursuing long-term objectives. The central bank (supranational planner) seeks to optimize welfare by minimizing a social objective function subject to private sector's (i.e. households' and firms') optimizing conditions.

The objective function includes a loss function that contains variables of output gaps in the non-traded and traded sectors ($\tilde{y}_N$ and $\tilde{y}_T$) and inflation in the two sectors (π_N and π_H), as well as parameters that measure elasticity of substitutions between differentiated products in the two sectors (θ_N and θ_T) and responsiveness of pricing decisions to variations in the real marginal cost gaps of the two sectors (κ_N and κ_T).

Nominal interest rate gap ($\hat{r}$), which is the gap between the short-term nominal interest rate from its natural rate, serves as a control variable in the model.

Under the "No Coordination" regime, the central bank optimizes welfare of the Home economy ($\mathbb{W}^{NC}$). Under the "Bilateral Coordination" or the "Multilateral Coordination" regime, the supranational planner seeks to optimize "welfare contribution" of each participating country based on their relative economic size as a part of "collective welfare". The collective welfare here can be defined as international macroeconomic stability, which is an international public goods that has non-rivalry and non-excludable characteristics.

3.1.3 Market Clearing Conditions

The market clearing conditions in the one-production-factor and the two-production-factor models are: (1) non-traded goods market clearing condition; (2) traded goods market clearing condition; (3) labor market clearing condition; (4) international bonds market clearing condition; (5) international risk-sharing condition; and (6) uncovered interest parity . In addition to these conditions, the two-production-factor-model imposes capital market clearing condition.

3.2. Steps to Solve the Model

As depicted in Figure 3.1., there are five stages to solve the DSGE models in this study and calculate welfare in this study, which are applicable for the "No Coordination", the "Bilateral Coordination", and the "Multilateral Coordination" cases, both in the one-production factor and two-production factor models:

1) Optimization by economic agents

In this stage, households maximize their utilities. Firms seek to find optimum pricing for their output, as well as finding their optimum output and optimum factor unit cost. The government or supranational planner seeks to help households maximizing their utilities through provision of some goods and cash transfers, as well as by allocating optimum labor for in the non-traded and traded sectors.

2) Aggregation of optimum solutions and market clearing conditions

Nominal aggregate supply and demand in the non-traded and traded sectors, real aggregate demand in the non-traded and traded sectors, aggregate consumption (in the one-production-factor mode) or aggregate domestic demand (in the two-production-factor), and aggregate demand for production factor(s) are derived using optimum solutions from stage 1.

To solve the model, market clearing conditions for goods, labor, and bonds markets (and the capital market for the two-production-factor model) as well as the international risk sharing condition that involve terms of trade between the Home and Foreign economies are all set in this stage.

3) Derivation of flexible price (natural-rate) equilibrium)

Using log-linearized aggregations of optimum solutions in stage 2 and market clearing conditions, the natural rate equilibrium system is derived. The system comprises: (a) natural rate of non-traded output; (b) natural rate of traded output; (c) natural rate terms of trade between the Home economy and Foreign Country-n; (d) natural rate of aggregate consumption or natural rate of aggregate domestic demand; (e) real interest rate in the flexible-price equilibrium; (f) the relative price of non-traded goods in terms of traded goods.

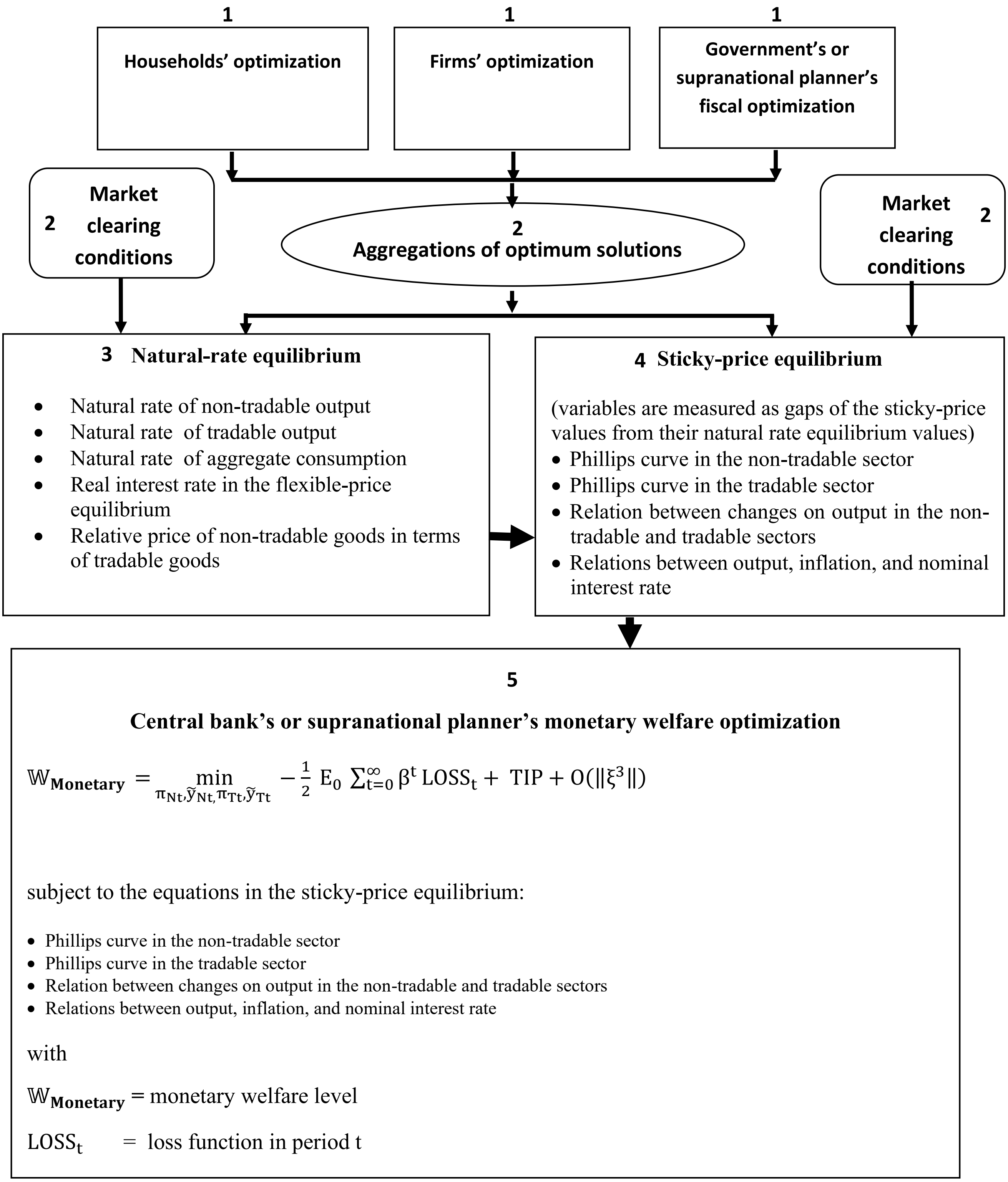
4) Derivation of sticky-price equilibrium

Using log-linearized aggregations of optimum solutions in stage 2, market clearing conditions, and gaps of variables from their natural rate equilibrium values in stage 3, we derive the sticky price equilibrium that comprises: (a) Phillips curves; (b) relation between changes on output in the non-traded and traded sectors; (c) relations between changes on output in the non-traded and traded sectors; and (d) relations between output, inflation, and nominal interest rate.

5) Welfare optimization by central bank or supranational planner

The central bank or the social planner optimizes the welfare objective function subject to households' and private sector's optimizing conditions (which are the equations in the sticky-price equilibrium). The monetary welfare optimization cannot be manually calculated. Thus, this study uses the linear quadratic (LQ) approximation solution technique as suggested by Díaz-Giménez (2004). There are three steps involved in this solution technique: (1) computation of the steady state; (2) construction of the quadratic approximation; and (3) computation of the optimal value.

Figure 3.1: The NOEM-DSGE Framework in This Study



3.3. Assessment of the Feasibility of Policy Coordination

This study ranks the best to the worst welfare from each type of policy interaction ("No Coordination" (NC), "Bilateral Coordination" (BC), and "Multilateral Coordination" (MC) regimes) for each of the ASEAN-5+3 economies. From the welfare ranking, the best to the worst "potential" coordination partner can be identified.

The Game Theory framework is used to create welfare pay-off matrixes for interaction between or among potential partners in the BC and MC cases. An international monetary policy coordination scheme is deemed as "feasible" when **all** countries in the coordination have higher welfare compared to when they follow the NC regime. If there is at least one country whose welfare is not "better-off" when joining a policy coordination scheme, the scheme is not feasible.

3.4. Variables, Parameters, Data, and Data Sources

There are five main variables used in the models developed for this study: (1) non-traded sector inflation; (2) traded sector inflation; (3) non-traded sector output gap; (4) traded sector output gap; and (5) nominal interest rate gap. The non-traded sector in this study is defined as a sector that comprises service activities (e.g. public services, wholesale and retail trade, transport and communication, business and financial services); while the traded sector comprises goods producing activities (e.g. as agriculture, manufacturing, mining and quarrying).

Output gap data are obtained from the constant price Gross Domestic Product (GDP) data after the rebasing, seasonal adjustment, the one-sided Hodrick-Prescott (HP) filtering, and calculation processes. Quarter on quarter inflation data is obtained from the Consumer Price Index (CPI) data after the rebasing, seasonal adjustment, and calculation processes. Nominal interest rate gap data is obtained from the yield of 10-Year government bond data after the HP filtering and calculation processes. Data processing and estimation in this study mostly following the methods suggested by Adjemian et al. (2011) and Johannes Pfeifer (2018) for the DSGE using the Dynare software.

GDP and CPI data with different base years need to be rebased (rescaled) to obtain a long and consistent time series. This study follows the GDP base year rescaling method as used by the World Bank. For example, Indonesia's GDP data using the 2000 base year is rebased to the 2010 base year by first creating an index dividing each year of the base year 2000 series by its 2010 value and then multiplying each year's index result by the corresponding 2010 value. This study uses the same rebasing method for the CPI. After rebasing, the time series data needs to be cleansed from the seasonal and cyclical components to allow us to focus on the long-term trends. Seasonal adjustment is used to remove seasonal components from the time series data, while the HP filter is used to extract the trend component of a time series from short-term fluctuations associated with business cycle.

The calculated parameters in this paper are parameters whose values are directly calculated using the available data, calibrated parameters are parameters whose values are obtained through trial and error to make the variables in the model converge to their steady-state values, and estimated parameters are parameters whose values are obtained by solving the model. The rest parameters are derived from the calibrated and estimated parameter values.

The calculated parameters in the one-production-factor and the two-production factor models are: (i) relative size of the Home economy to the World of 11 Countries (ρ); (ii) discount factor in the Home economy (β); (iii) share of traded goods to the total of goods in the Home economy (α); (iv) share of domestically produced traded goods to the total of traded goods in the Home economy (ω_0); (v) share of imported traded goods from Foreign Country-n to total imported traded goods (ω_n); and (vi) marginal disutility of labor (Ψ). There are two additional calibrated parameters in the two-production-factor model: (a) labor input share in the non-traded sector (φ_N); and (b) labor input share in the traded sector (φ_T). The long-run interest rate to calibrate the discount factor is calculated following Ramayandi (2008). The income elasticity of money demand (v) parameter is set to 1, following Sims (2017), Aruoba and Schorfheide (2008), and Leo (2009). Empirically, v is not always equal to 1 as shown by Kumar (2013). To simplify the models, however, this research assumes $v = 1$ .The shock parameters $ƀ_1, ƀ_2, \varrho_1, \varrho_2$ are calibrated through trial and error process to have the parameters in the model converged.

The estimated parameters are: (a) responsiveness of pricing decision to variations in the real marginal cost gap in the non-traded sector (κ_N); (b) responsiveness of pricing decision to variations in the real marginal cost gap in the traded sector (κ_T); (c) elasticity of substitution between differentiated products in the non-traded sector (θ_N); and (d) elasticity of substitution between differentiated products in the traded sector (θ_T).

Parameters derived from the calibrated and estimated parameters are: (1) probability for intermediate-good-producing firms to adjust prices in the non-traded sector (γ_N) ; (2) probability for intermediate-good-producing firms to adjust prices in the traded sector (γ_T); (3) steady-state price markup in the non-traded sector (μ_N); and (4) steady-state price markup in the traded sector (μ_T).

Table 3.1. display the variables, calibrated parameters, data, and data sources used in this study. The data range is from Q3-2003 to Q2-2018. Gross domestic product (GDP) and consumer price index (CPI) data used in the model are obtained from CEIC, while the yields of 10-year government bonds are from Bloomberg. Trade and nominal GDP data are obtained from the IMF Directions of Trade Statistics and World Economic Outlook Database, respectively. Other data used in this study are nominal GDP, fixed capital formation, labor input share, exchange rate, and average weekly working hours per worker.

The values of calibrated parameters in the one-production-factor and the two-production-factor models are shown in Tables 3.2 and Tables 3(3), respectively. The following are the formulas used for the calibration for the Home economy (which are symmetrical for other countries in the models):

- Relative economic size to the world of 11 economies

  $\rho_0 = average\ \left(\frac{nominal\ GDP\ of\ the\ Home\ economy}{to\ nominal\ GDP\ of\ the\ 11\ economies}\right)$ from Q3-2003 to Q2-2018 … (7)

- Parameter β

  $$\beta = (1 + \bar{\imath})^{-0.25} \quad \ldots (8)$$

  where

  $\bar{\imath}$ = long-run interest rate, approximated by the average yield of 10-year government bond from Q3-2003 to Q2-2018

- Parameter α

  $\alpha = average\ \left(\frac{nominal\ GDP\ of\ tradable\ sector}{total\ nominal\ GDP}\right)$ from Q3-2003 to Q2-2018 … (9)

- Parameter ω_0 for each country

  $\omega_0 = average\ \left(\frac{nominal\ GDP\ of\ traded\ sector}{nominal\ GDP\ of\ traded\ sector + nominal\ GDP\ of\ imports}\right)$ from Q3-2003 to Q2-2018

  … (10)

- Parameter ω_n for imported goods from Foreign Country-n

  $\omega_n = average \left(\frac{imports\ values\ from\ Country-n}{total\ import\ values}\right)$ from Q3-2003 to Q2-2018 … (11)

- Parameter v

  $v = 1$ … (12)

- Parameter Ψ

  - in the one-production factor model

  $\Psi = \frac{(1-\alpha) + \alpha\omega_0}{L}$ …. (13a)

  - in the two-production factor model

  $\Psi = \frac{(1-\varphi_N)(1-\alpha) + (1-\varphi_T)\ \alpha\omega_0}{L}$ … (13b)

  where

  $L = \frac{combined\ working\ hours\ per\ week\ in\ the\ nontradable\ and\ tradable\ sectors}{total\ hours\ per\ week}$

The joint parameter β in the "Bilateral Coordination" and "Multilateral Coordination" is calculated as weighted average of the β values of the participating countries in the monetary policy coordination. The weights are the relative size of each economy to the total size of economies of the participating countries.

$\beta^{\blacksquare} = \frac{\rho_0}{(\rho_0 + \rho_0)}\beta_0 + \frac{\rho_1}{(\rho_0 + \rho_0)}\beta_1$ … (14)

$\beta^{\blacklozenge} = \frac{1}{\sum_{n=0}^{k-1}\rho_n} \sum \rho_n\ \beta_n$ … (15)

where k = the number of participating countries

This study uses the Dynare version 4.4.3 and Matlab version R2015b software to solve the DSGE model, estimate main parameters in the model, and compute the welfare, and EViews 11 to run HP filtering and estimate parameters for some of exogenous variables.

Table 3.1. Variables, Calibrated Parameters, Data, and Data Source

Variable or Parameter	Data	Source
Non-traded sector output gap	Constant price Gross Domestic Product (GDP) of the ASEAN-5+3 countries, broken down by economic sector	CEIC
Traded sector output gap	Constant price Gross Domestic Product (GDP) of the ASEAN-5+3 countries, broken down by economic sector	CEIC
Non-traded sector inflation	Consumer Price Index (CPI) of the ASEAN-5+3 countries, broken down by economic sector	CEIC
Traded sector inflation	Consumer Price Index (CPI) of the ASEAN-5+3 countries, broken down by economic sector	CEIC
Interest rate gap	Yield of the 10-Year government bonds for the ASEAN-5+3 countries	Bloomberg
Exchange rate	Exchange rate of the ASEAN-5+3 currencies per US Dollar	Bloomberg
Relative economic size	Nominal Gross Domestic Products (GDP) of the ASEAN-5+3 countries	IMF World Economic Outlook
Share of non-traded sector	Constant Price Gross Domestic Products (GDP) of the ASEAN-5+3 countries, broken down by economic sector	CEIC
Share of traded sector	Constant price Gross Domestic Products (GDP) of the ASEAN-5+3 countries, broken down by economic sector	CEIC
Share of domestically produced traded goods	Constant price Gross Domestic Products (GDP) of the ASEAN-5+3 countries, , broken down by components of expenditures	CEIC
Share of imported traded goods by country	Imports values of the ASEAN-5+3 countries, broken down by country Nominal GDP, broken down by components of expenditures	IMF Directory of Trade Statistics CEIC
Capital gap	Gross fixed capital formation from constant price GDP, broken down by components of expenditures	CEIC
Labor input share in the economy	Labor input share in the economy of the ASEAN-5+3 countries, or labor income component of constant price GDP broken down by income flows to factor owners	Penn World Table (University of Groningen) CEIC
Labor supply	Average weekly working hours per worker	ILO and countries statistics office

Table 3.2(1). Calculated and Calibrated Parameter Values for the ASEAN-5 + 3 Countries in the One-Production-Factor Model

	ρ	β	α	ω	$ƀ_1$	$ƀ_2$	ϱ_1	ϱ_2
Indonesia	0.014	0.978	0.467	0.678	0.700	0.010	0.010	0.700
Malaysia	0.005	0.990	0.449	0.392	0.700	0.010	0.010	0.700
Singapore	0.005	0.994	0.191	0.100	0.700	0.010	0.010	0.700
Thailand	0.007	0.991	0.393	0.363	0.700	0.010	0.010	0.700
The Philippines	0.004	0.984	0.354	0.405	0.700	0.010	0.010	0.700
China	0.129	0.991	0.482	0.710	0.700	0.010	0.010	0.700
Japan	0.109	0.998	0.210	0.573	0.700	0.010	0.010	0.700
South Korea	0.024	0.990	0.328	0.390	0.700	0.010	0.010	0.700

Source: Author's calculation

Table 3.2(2). Joint Discount Factor ($\beta^{■}$) Values in Bilateral Monetary Policy Coordination among the ASEAN-5 + 3 Countries in the One-Production-Factor Model

$\beta^{■}$	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	S. Korea
Indonesia	---	0.981	0.982	0.982	0.979	0.990	0.996	0.986
Malaysia	0.981	---	0.992	0.991	0.987	0.991	0.998	0.990
Singapore	0.982	0.992	---	0.992	0.989	0.991	0.998	0.991
Thailand	0.982	0.991	0.992	---	0.988	0.991	0.998	0.990
Philippines	0.979	0.987	0.989	0.987	---	0.991	0.997	0.989
China	0.990	0.991	0.991	0.991	0.991	---	0.994	0.991
Japan	0.996	0.998	0.998	0.998	0.997	0.994	---	0.997
South Korea	0.986	0.990	0.991	0.990	0.989	0.991	0.997	---

Source: Author's calculation

Table 3.2(3). Joint Discount Factor ($\beta^{♦}$) Values in Multilateral Monetary Policy Coordination among the ASEAN-5, CJK, and ASEAN-5 + 3 Countries in the One-Production-Factor Model

	ASEAN-5	ASEAN-5 + China	ASEAN-5 + Japan	ASEAN-5 + South Korea	CJK	ASEAN-5 + 3
$\beta^{♦}$	0.985	0.990	0.995	0.987	0.994	0.993

Source: Author's calculation

Table 3.3(1). Calculated and Calibrated Parameter Values for the ASEAN-5 + 3 Countries in the Two-Production-Factor Model

Country	ρ	β	α	ω	φ_N	φ_T	ƀ_1	ƀ_2	ϱ_1	ϱ_2
Indonesia	0.014	0.978	0.467	0.678	0.507	0.499	0.700	0.010	0.010	0.700
Malaysia	0.005	0.990	0.449	0.392	0.304	0.617	0.700	0.010	0.010	0.700
Singapore	0.005	0.994	0.191	0.100	0.569	0.677	0.700	0.010	0.010	0.700
Thailand	0.007	0.991	0.393	0.363	0.592	0.622	0.700	0.010	0.010	0.700
Philippines	0.004	0.984	0.354	0.405	0.658	0.547	0.700	0.010	0.010	0.700
China	0.129	0.991	0.482	0.710	0.361	0.504	0.700	0.010	0.010	0.700
Japan	0.109	0.998	0.210	0.573	0.535	0.366	0.700	0.010	0.010	0.700
S. Korea	0.024	0.990	0.328	0.390	0.358	0.589	0.700	0.010	0.010	0.700

Source: Author's calculation

Table 3.3(2). Joint Discount Factor ($\beta^{■}$) Values in Bilateral Monetary Policy Coordination among the ASEAN-5 + 3 Countries in the Two-Production-Factor Model

$\beta^{■}$	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	S. Korea
Indonesia	---	0.981	0.982	0.982	0.979	0.990	0.996	0.986
Malaysia	0.981	---	0.992	0.991	0.987	0.991	0.998	0.990
Singapore	0.982	0.992	---	0.992	0.989	0.991	0.998	0.991
Thailand	0.982	0.991	0.992	---	0.988	0.991	0.998	0.990
Philippines	0.979	0.987	0.989	0.987	---	0.991	0.997	0.989
China	0.990	0.991	0.991	0.991	0.991	---	0.994	0.991
Japan	0.996	0.998	0.998	0.998	0.997	0.994	---	0.997
South Korea	0.986	0.990	0.991	0.990	0.989	0.991	0.997	---

Source: Author's calculation

Table 3.3(3). Joint Discount Factor ($\beta^{♦}$) Values in Multilateral Monetary Policy Coordination among the ASEAN-5 + 3 Countries in the Two-Production-Factor Model

	ASEAN-5	ASEAN-5 + China	ASEAN-5 + Japan	ASEAN-5 + South Korea	CJK	ASEAN-5 + 3
$\beta^{♦}$	0.985	0.990	0.995	0.987	0.994	0.993

Source: Author's calculation

CHAPTER 4

ONE-PRODUCTION-FACTOR MODEL

4.1. Model Specifications

This section elaborates the one-production-factor model. For the definitions of notations used in the model, please refer to Appendix 4.1. (page 81 – 86).

4.1.1. Agents' Optimization Problems

Below are the optimization problems faced by the economic agents.

4.1.1.1. Households

The representative household faces three optimization problems:

(1) Utility maximization subject to budget constraint to obtain the optimum real wage equation, the Euler equation, and optimum real money balance

$$\max_{\check{C}_t, L_t, B_t, B^*_{nt}, M_t} U_t = E_t \sum_{t=0}^{\infty} \beta^t \left[ln\, C_t - \Psi\, L_t + v\, ln\left(\frac{M_t}{P_t}\right)\right]$$

$$\equiv E_t \sum_{t=0}^{\infty} \beta^t \left[ln\left(\check{C}_t + G_t\right) - \Psi\, L_t + v\, ln\left(\frac{M_t}{P_t}\right)\right]$$

subject to

$$(1 + t_C)\, P_t\, C_t + B_t + \sum_{n=1}^{10} e_{nt}\, B^*_{nt} + M_t$$
$$= (1 - t_L)\, W_t\, L_t + TR_t + (1 + R_{t-1})B_{t-1} + \sum_{n=1}^{10}(1 + R^*_{nt-1})\, e_{nt-1}\, B^*_{nt-1} + M_{t-1} \quad \ldots (1)$$

where v is income elasticity of money demand.

(2) Cost minimization of non-traded and traded goods consumption to get demand functions for non-traded and traded goods

$$\min_{\check{C}_{Tt}, \check{C}_{Nt}} (1 + t_C)\, \bar{P}_{Tt}\, \check{C}_{Tt} + (1 + t_C)\, \bar{P}_{Nt}\, \check{C}_{Nt}$$

subject to

$$\check{C}_t = \alpha^{-\alpha}\, (1 - \alpha)^{-(1-\alpha)}\, \check{C}^{\alpha}_{Tt}\, \check{C}^{1-\alpha}_{Nt} \quad \ldots (2)$$

(3) Cost minimization of domestically produced and imported traded goods consumption to get demand functions for domestically produced and imported traded goods; setting consumption tax rate equal for domestically produced and imported traded goods

$$\min_{\check{C}_{Ht}, \check{C}_{Fnt}} (1 + t_C)\, \bar{P}_{Ht}\, \check{C}_{Ht} + (1 + t_C) \sum_{n=1}^{10} e_{nt}\, \bar{P}^*_{Fnt}\, \check{C}_{Fnt}$$

subject to

$$\check{C}_{Tt} = \omega_0^{-\omega_0}\, \check{C}^{\omega_0}_{Ht} \prod_{n=1}^{10} \omega_n^{-\omega_n}\, \check{C}^{\omega_n}_{Fnt} \quad \ldots (3)$$

4.1.1.2. Firms

4.1.1.2.1. Firms Producing Intermediate Goods

Production functions for firms producing intermediate goods in the non-traded and traded sector are formulated as follow, respectively:

$$Y_{Nt}(i) = A_{Nt} L_{NIt}(i) \quad ; \quad i \in [0,1] \quad \ldots (4)$$

$$Y_{Tt}(j) \equiv Y_{Ht}(j) + \sum_{n=1}^{10} Y_{Hnt}^{*}(j) = A_{Tt}L_{TIt}(j) \quad ; \quad j \in [0,1] \qquad \ldots (5)$$

where L_{NIt} and L_{TIt} are labor input for non-traded and traded intermediate good production, respectively; A_{Nt} and A_{Tt} are shocks in the non-traded and traded sectors, respectively.

The log-linearized form of productivity shocks in each sector are stated as:

$$\hat{a}_{Nt} = b_1\, \hat{a}_{Nt-1} + b_{12}\, \hat{a}_{Tt-1} + \varepsilon_{Nt} \quad ; \quad \varepsilon_{Nt} \sim i.i.d.(0, \sigma_{Nt}^2) \qquad \ldots (6)$$

$$\hat{a}_{Tt} = \varrho_1\, \hat{a}_{Nt-1} + \varrho_2\, \hat{a}_{Tt-1} + \varepsilon_{Tt} \quad ; \quad \varepsilon_{Tt} \sim i.i.d.(0, \sigma_{Tt}^2) \qquad \ldots (7)$$

where

b_1, b_2 , ϱ_1, ϱ_2 are shock parameters; ε_{Nt} and ε_{Tt} are error terms for non-traded and traded sector, respectively.

4.1.1.2.1.1. Firms Producing Non-traded Intermediate Goods

Firms producing non-traded intermediate goods face two optimization problems:

(i) Cost minimization to derive optimum unit cost of labor in the non-traded sector V_{NIt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{NIt}} W_t\, L_{NIt}(i)$$

subject to

$$A_{Nt}\, L_{NIt}(i) = Y_{Nt}(i) = \left(\frac{P_{Nt}(i)}{\overline{P}_{Nt}}\right)^{-\theta_N} Y_{Nt} \qquad \ldots (8)$$

(ii) Profit maximization to derive optimum pricing rules for non-traded intermediate goods

$$\max_{P_{Nt(i)}} E_t \sum_{ҁ=t}^{\infty} \gamma_N^{ҁ-t} \left[P_{Nt}(i)\,(1+\tau_N) - V_{Nҁ}\right] Y_{Nҁ}(i) \qquad \ldots (9)$$

4.1.1.2.1.2. Firms Producing Traded Intermediate Goods

Firms producing traded intermediate goods face two optimization problems:

(i) Cost minimization to derive optimum unit cost of labor in the traded sector V_{TIt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{TIt}} W_t\, L_{TIt}(j)$$

subject to

$$A_{Tt}\, L_{TIt}(j) = Y_{Tt}(j) = \left(\frac{P_{Ht}(j)}{\overline{P}_{Ht}}\right)^{-\theta_T} Y_{Tt} \qquad \ldots (10)$$

(ii) Profit maximization to derive optimum pricing rules for traded intermediate goods (Prices of intermediate goods to be sold in foreign countries are assumed to be benchmarked to domestic prices before converted to foreign market prices using the respective country's exchange rates)

$$\max_{P_{Ht(j)}} E_t \sum_{ҁ=t}^{\infty} {\gamma_T}^{ҁ-t} \left[P_{Ht}(j)(1+\tau_T) - V_{TIҁ}\right] Y_{Tҁ}(j) \qquad \ldots (11)$$

where

$$Y_{T\natural}(j) = Y_{H\natural}(j) + \sum_{n=1}^{10} Y^{*}_{Hn\natural}(j)$$

4.1.1.2.2. Firms Producing Final Goods

Aggregation of final goods in the non-traded and traded sectors are formulated as:

$$Y_{Nt} = \left[\int_0^1 Y_{Nt}(i)^{(\theta_N-1)/\theta_N}\ di\right]^{\theta_N/(\theta_N-1)} \quad \ldots (12)$$

$$Y_{Tt} = Y_{Ht} + \sum_{n=1}^{10} Y_{Fnt} \quad \ldots (13)$$

where

$$Y_{Ht} = \left[\int_0^1 Y_{Ht}(j)^{(\theta_T-1)/\theta_T}\ dj\right]^{\theta_T/(\theta_T-1)} \quad \ldots (13a)$$

$$Y_{Fnt} = \left[\int_0^1 Y_{Fnt}(j)^{(\theta_T-1)/\theta_T}\ dj\right]^{\theta_T/(\theta_T-1)} \quad \ldots (13b)$$

4.1.1.2.2.1. Firms Producing Non-traded Final Goods

The representative firm producing non-traded final goods faces the following optimization problems:

(i) Cost minimization to derive optimum labor unit cost in the non-traded sector V_{NCt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{Nt}} W_t\, L_{NCt}$$

subject to

$$A_{Nt}\, L_{NCt} = Y_{Nt} \quad \ldots (14)$$

(ii) Profit maximization to obtain demand function for non-traded intermediate goods

$$\max_{P_{Nt}(i)} \overline{P}_{Nt}\left[\int_0^1 Y_{Nt}(i)^{\frac{(\theta_N-1)}{\theta_N}}\ di\right]^{\frac{\theta_N}{(\theta_N-1)}} - \int_0^1 P_{Nt}(i)\, Y_{Nt}(i)\, di - V_{NCt} \quad \ldots (15)$$

4.1.1.2.2.2. Firms Producing Traded Final Goods

The representative firm producing traded final goods faces the following optimization problems:

(i) Cost minimization to derive optimum labor unit cost in the traded sector V_{TCt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{Tt}} W_t\, L_{TCt}$$

subject to

$$A_{Tt}\, L_{TCt} = Y_{Tt} \quad \ldots (16)$$

(ii) Profit maximization to obtain demand function for traded final goods
(Prices of final goods to be sold in foreign countries are assumed to be benchmarked to domestic prices before converted to foreign market prices using the respective country's exchange rates)

$$\max_{P_{Ht}(j)} \overline{P}_{Ht} \left[\int_0^1 Y_{Ht}(j)^{(\theta_T-1)/\theta_T}\, dj\right]^{\theta_T/(\theta_T-1)} - \int_0^1 P_{Ht}(j)\, Y_{Tt}(j)\, dj \; - V_{TCt} \qquad \ldots (17)$$

4.1.1.3. Government or Supranational Planner Exercising Fiscal Policy

The government (supranational planner's) fiscal balance at time t is formulated as:

$$\int_0^1 \left((1+t_C)\, G_t + TR_t + (1+R_{t-1})\, B_{t-1}\right) dx + \int_0^1 \tau_N\, P_{Nt}(i)\, Y_{Nt}^d(i)\; di + \int_0^1 \tau_T\, P_{Ht}(j)\, Y_{Tt}^d(j)\; dj$$

$$= \int_0^1 \left(t_C\left(\check{C}_t + G_t\right) + t_L\, W_t\, L_t + B_t\right) dx \qquad \ldots (18)$$

The government (supranational planner) faces three optimization problems:

(i) Utility maximization (prepared for household) at steady state to obtain optimum labor allocations in the non-traded and traded sectors

$$\max_{L_N, L_T} U = \; ln\, C - \Psi\, L \; + v\, ln\left(\frac{M}{P}\right)$$

subject to

$$C = \alpha^{-\alpha}\, (1-\alpha)^{-(1-\alpha)}\, Y_N^{1-\alpha} \left(Y_T^{\omega_0} \prod_{n=1}^{10} \left({Y_{Tn}^{*}}^{\omega_n}\right)\right)^{\alpha}$$

$$\equiv \alpha^{-\alpha}\, (1-\alpha)^{-(1-\alpha)}\, L_N^{1-\alpha}\, (L_T^{\omega_0} \; \prod_{n=1}^{10} ({Y_{Tn}^{*}}^{\omega_n}))^{\alpha}$$

$$L = L_N + L_T \qquad \ldots (19)$$

(ii) Cost minimization of government spending on non-traded and traded goods to get the government or supranational planner's demand functions for non-traded and traded goods at time t

$$\min_{G_{Tt}, G_{Nt}} (1+t_C)\, \overline{P}_{Tt}\, G_{Tt} + \; (1+t_C)\, \overline{P}_{Nt}\, G_{Nt}$$

subject to

$$G_t \; = \; \alpha^{-\alpha}\, (1-\; \alpha)^{-(1-\alpha)}\, G_{Tt}^{\alpha}\, G_{Nt}^{1-\alpha} \qquad \ldots (20)$$

(iii) Cost minimization of domestically produced and imported traded goods consumption to obtain the government's or supranational planner's demand functions for domestically produced and imported traded goods at time t

$$\min_{G_{Ht}, G_{Ft}} (1+\; t_C)\, \overline{P}_{Ht}\; G_{Ht} + \; (1+\; t_C)\, \sum_{n=1}^{10} e_{nt}\, \overline{P}_{Fnt}^{*}\, G_{Fnt}$$

subject to

$$G_{Tt} = \; \omega_0^{-\omega_0}\, G_{Ht}^{\omega_0} \prod_{n=1}^{10} \omega_n^{-\omega_n}\, G_{Fnt}^{\omega_n} \qquad \ldots (21)$$

4.1.1.4. Central Bank or Supranational Planner Exercising Monetary Policy

4.1.1.4.1. Welfare Optimization Under the "No Coordination" (Nash) Regime

Welfare optimization problem for the central bank under the "No Coordination" regime is formulated as:

$$\mathbb{W}^{NC} = \min_{\pi_{Nt}, \tilde{y}_{Nt}, \pi_{Ht}, \tilde{y}_{Tt}} \; -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left\{\text{LOSS}_t + \; TIP + O(\|\xi\|^3)\right\}$$

$$\equiv \min_{\pi_{Nt},\tilde{y}_{Nt,}\pi_{Ht},\tilde{y}_{Tt}} -\frac{1}{2}E_0 \sum_{t=0}^{\infty}\beta^t \left\{\begin{matrix} (1-\alpha)\left[\tilde{y}_{Nt}^2 + \frac{\theta_N}{\kappa_N}\pi_{Nt}^2\right] + \alpha\omega_0\left[\tilde{y}_{Tt}^2 + \frac{\theta_T}{\kappa_T}\pi_{Ht}^2\right] \\ + (1+v)\,\alpha\sum_{n=1}^{10}\omega_n\,\tilde{y}_{Tnt}^* + v\,(1-\alpha)\,\tilde{y}_{Nt} + v\,\alpha\,\omega_0\,\tilde{y}_{Tt} \\ + TIP + O(\|\xi\|^3) \end{matrix}\right\}$$

subject to

$$\pi_{Nt} = \beta\,E_t\,\pi_{Nt+1} + \kappa_N\,\tilde{y}_{Nt}$$

$$\pi_{Ht} = \beta\,E_t\,\pi_{Ht+1} + \kappa_T\,\tilde{y}_{Tt}$$

$$\Delta\,\tilde{y}_{Nt} + \pi_{Nt} + \Delta\,\hat{a}_{Nt} = \Delta\,\tilde{y}_{Tt} + \pi_{Ht} + \Delta\,\hat{a}_{Tt}$$

$$(1-\alpha)\,\tilde{y}_{Nt} + \alpha\,\tilde{y}_{Tt} = E_t\big[(1-\alpha)\,\tilde{y}_{Nt+1} + \alpha\,\tilde{y}_{Tt+1}\big] - \{\hat{r}_t - E_t[(1-\alpha)\,\pi_{Nt+1} + \alpha\,\pi_{Ht+1}]\}$$

… (22)

where

TIP = terms independent of policy and shocks

$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks

4.1.1.4.2. Welfare Optimization Under the "Bilateral Coordination" Regime

Welfare optimization problem for the supranational planner under the "Bilateral Coordination" regime is formulated as:

$$\mathbb{W}^{BC} = \min_{\pi_{Nt},\tilde{y}_{Nt,}\pi_{Ht},\tilde{y}_{Tt},\pi_{N1t}^*,\tilde{y}_{N1t}^*,\pi_{H1t}^*,y_{T1t}^*} -\frac{1}{2}\,E_0\,\sum_{t=0}^{\infty}\left\{\begin{matrix} \frac{(\rho_0+\rho_1)}{\rho_0}\left(\beta^{\blacksquare\,t} LOSS_t + TIP + O(\|\xi^3\|)\right) \\ + \frac{(\rho_0+\rho_1)}{\rho_1}\left(\beta^{\blacksquare\,t}\,LOSS_{1t}^* + TIP_{1t}^* + O_1^*\left(\left\|\xi_1^{*3}\right\|\right)\right) \end{matrix}\right\}$$

subject to

$$\pi_{Nt} = \beta^{\blacksquare} E_t\,\pi_{Nt+1} + \kappa_N\,\tilde{y}_{Nt}$$

$$\pi_{Ht} = \beta^{\blacksquare} E_t\,\pi_{Ht+1} + \kappa_T\,\tilde{y}_{Tt}$$

$$\Delta\,\tilde{y}_{Nt} + \pi_{Nt} + \Delta\,\hat{a}_{Nt} = \Delta\,\tilde{y}_{Tt} + \pi_{Ht} + \Delta\,\hat{a}_{Tt}$$

$$(1-\alpha)\,\tilde{y}_{Nt} + \alpha\,\tilde{y}_{Tt} = E_t[(1-\alpha)\,\tilde{y}_{Nt+1} + \alpha\,\tilde{y}_{Tt+1}] - \{\hat{r}_t - E_t[(1-\alpha)\,\pi_{Nt+1} + \alpha\,\pi_{Ht+1}]\}$$

$$\pi_{N1t}^* = \beta^{\blacksquare} E_t\,\pi_{N1t+1}^* + \kappa_{N1}^*\tilde{y}_{N1t}^*$$

$$\pi_{H1t}^* = \beta^{\blacksquare} E_t\,\pi_{H1t+1}^* + \kappa_{T1}^*\tilde{y}_{T1t}^*$$

$$\Delta\,\tilde{y}_{N1t}^* + \pi_{N1t}^* + \Delta\hat{a}_{N1t}^* = \Delta\,\tilde{y}_{T1t}^* + \pi_{H1t}^* + \Delta\hat{a}_{T1t}^*$$

$$(1-\alpha^*)\tilde{y}_{N1t}^* + \alpha\,\tilde{y}_{T1t}^* = E_t\left[(1-\alpha^*)\tilde{y}_{N1t+1}^* + \alpha^*\tilde{y}_{T1t+1}^*\right] - \{\hat{r}_{1t}^* - E_t[(1-\alpha^*)\pi_{N1t+1}^* + \alpha^*\pi_{H1t+1}^*]\}$$

… (23)

where

$$\beta^{\blacksquare} = \frac{\rho_0\,\beta + \rho_1\,\beta_1^*}{(\rho_0+\rho_1)}$$

$$LOSS_t = (1-\alpha)\left[\tilde{y}_{Nt}^2 + \frac{\theta_N}{\kappa_N}\pi_{Nt}^2\right] + \alpha\omega_0\left[\tilde{y}_{Tt}^2 + \frac{\theta_T}{\kappa_T}\pi_{Ht}^2\right] + (1+v)\,[\alpha\omega_1\,\tilde{y}_{T1t}^* + \alpha\sum_{n=2}^{10}\omega_n\,\tilde{y}_{Tnt}^*] + v\,(1-\alpha)\,\tilde{y}_{Nt} + v\,\alpha\omega_0\,\tilde{y}_{Tt}$$

$$LOSS_{1t}^{*} = (1-\alpha_1^{*})\left[\tilde{y}_{N1t}^{*}{}^{2} + \frac{\theta_{N1}^{*}}{\kappa_{N1}^{*}}\ \pi_{N1t}^{*}{}^{2}\right] + \alpha_1^{*}\omega_{1\cdot 1}^{*}\left[\tilde{y}_{T1t}^{*}{}^{2} + \frac{\theta_{T1}^{*}}{\kappa_{T1}^{*}}\ \pi_{H1t}^{*}{}^{2}\right]$$
$$+ (1+v_1^{*})\left[\alpha_1^{*}\,\omega_{1\cdot 0}^{*}\,\tilde{y}_{Tt} + \alpha_1^{*}\sum_{n=2}^{10}\omega_{1\cdot n}^{*}\,\tilde{y}_{Tnt}^{*}\right] + v_1^{*}(1-\alpha_1^{*})\,\tilde{y}_{N1t}^{*} + v_1^{*}\,\alpha_1^{*}\omega_{1\cdot 1}^{*}\,\tilde{y}_{T1t}^{*}$$

TIP = terms independent of policy and shocks for the Home economy
$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the home economy
TIP_{1t}^{*} = terms independent of policy and shocks for the Foreign Country
$O_1^{*}(\|\xi_1^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the Foreign Country

4.1.1.4.3. Welfare Optimization Under the "Multilateral Coordination" Regime

Welfare optimization problem for the supranational planner under the "Multilateral Coordination" regime is formulated as

$$\mathbb{W}^{MC} = \min_{\pi_{Nt},\tilde{y}_{Nt},\pi_{Ht},\tilde{y}_{Tt},\pi_{N1t}^{*},\tilde{y}_{N1t}^{*},\pi_{H1t}^{*},y_{T1t}^{*}\,\dots\,\pi_{Nkt}^{*},\tilde{y}_{Nkt}^{*},\pi_{Hkt}^{*},y_{Tkt}^{*}}$$
$$-\frac{1}{2}\ E_0\sum_{t=0}^{\infty}\beta^{\blacklozenge t}\left\{\begin{array}{c}\frac{(\rho_0+\rho_1+\dots+\rho_k)}{\rho_0}\left(LOSS_t + TIP + O(\|\xi^3\|)\right)\\ +\frac{(\rho_0+\rho_1+\dots+\rho_k)}{\rho_1}\left(LOSS_{1t}^{*} + TIP_{1t}^{*} + O_1^{*}(\|\xi_1^{*3}\|)\right)\\ +\ \dots\\ +\frac{(\rho_0+\rho_1+\dots+\rho_k)}{\rho_k}\left(LOSS_{kt}^{*} + TIP_{kt}^{*} + O_k^{*}(\|\xi_k^{*3}\|)\right)\end{array}\right\}$$

subject to

$$\pi_{Nt} = \beta^{\blacklozenge}E_t\,\pi_{Nt+1} + \kappa_N\,\tilde{y}_{Nt}$$
$$\pi_{Ht} = \beta^{\blacklozenge}E_t\,\pi_{Ht+1} + \kappa_T\,\tilde{y}_{Tt}$$
$$\Delta\,\tilde{y}_{Nt} + \pi_{Nt} + \Delta\,\hat{a}_{Nt} = \Delta\,\tilde{y}_{Tt} + \pi_{Ht} + \Delta\,\hat{a}_{Tt}$$
$$(1-\alpha)\,\tilde{y}_{Nt} + \alpha\,\tilde{y}_{Tt} = E_t\left[(1-\alpha)\,\tilde{y}_{Nt+1} + \alpha\,\tilde{y}_{Tt+1}\right] - \{\hat{r}_t - E_t[(1-\alpha)\,\pi_{Nt+1} + \alpha\,\pi_{Ht+1}]\}$$
$$\pi_{N1t}^{*} = \beta^{\blacklozenge}E_t\,\pi_{N1t+1}^{*} + \kappa_{N1}^{*}\tilde{y}_{N1t}^{*}$$
$$\pi_{H1t}^{*} = \beta^{\blacklozenge}E_t\,\pi_{H1t+1}^{*} + \kappa_{T1}^{*}\tilde{y}_{T1t}^{*}$$
$$\Delta\,\tilde{y}_{N1t}^{*} + \pi_{N1t}^{*} + \Delta\hat{a}_{N1t}^{*} = \Delta\,\tilde{y}_{T1t}^{*} + \pi_{H1t}^{*} + \Delta\hat{a}_{T1t}^{*}$$
$$(1-\alpha_1^{*})\tilde{y}_{N1t}^{*} + \alpha_1^{*}\,\tilde{y}_{T1t}^{*} = E_t\left[(1-\alpha_1^{*})\tilde{y}_{N1t+1}^{*} + \alpha_1^{*}\tilde{y}_{T1t+1}^{*}\right] - \{\hat{r}_{1t}^{*} - E_t[(1-\alpha_1^{*})\pi_{N1t+1}^{*} + \alpha_1^{*}\pi_{H1t+1}^{*}]\}$$

…

$$\pi_{Nkt}^{*} = \beta^{\blacklozenge}E_t\,\pi_{Nkt+1}^{*} + \kappa_{Nk}^{*}\tilde{y}_{Nkt}^{*}$$
$$\pi_{Hkt}^{*} = \beta^{\blacklozenge}E_t\,\pi_{Hkt+1}^{*} + \kappa_{Tk}^{*}\tilde{y}_{kt}^{*}$$
$$\Delta\,\tilde{y}_{Nkt}^{*} + \pi_{Nkt}^{*} + \Delta\hat{a}_{Nkt}^{*} = \Delta\,\tilde{y}_{Tkt}^{*} + \pi_{Hkt}^{*} + \Delta\hat{a}_{Tkt}^{*}$$
$$(1-\alpha_k^{*})\tilde{y}_{Nkt}^{*} + \alpha_k^{*}\,\tilde{y}_{Tkt}^{*} = E_t\left[(1-\alpha_k^{*})\tilde{y}_{Nkt+1}^{*} + \alpha_k^{*}\tilde{y}_{Tkt+1}^{*}\right] - \{\hat{r}_{kt}^{*} - E_t[(1-\alpha_k^{*})\pi_{Nkt+1}^{*} + \alpha_k^{*}\pi_{Hkt+1}^{*}]\}$$

… (24)

where

k = number of participating countries – 1

$$\beta^{\blacklozenge} = \frac{\rho_0\,\beta + \rho_1\,\beta_1^*}{(\rho_0 + \rho_1)}$$

$$LOSS_t = (1-\alpha)\left[\tilde{y}_{Nt}^2 + \frac{\theta_N}{\kappa_N}\,\pi_{Nt}^2\right] + \alpha\omega_0\left[\tilde{y}_{Tt}^2 + \frac{\theta_T}{\kappa_T}\pi_{Ht}^2\right]$$
$$+ (1+v)\,[\alpha\omega_1\,\tilde{y}_{T1t}^* + \alpha\textstyle\sum_{n=2}^{10}\omega_n\,\tilde{y}_{Tnt}^*] + v\,(1-\alpha)\,\tilde{y}_{Nt} + \alpha\omega_0\,\tilde{y}_{Tt}$$

$$LOSS_{1t}^* = (1-\alpha_1^*)\left[\tilde{y}_{N1t}^{*\,2} + \frac{\theta_{N1}^*}{\kappa_{N1}^*}\,\pi_{N1t}^{*\,2}\right] + \alpha_1^*\omega_{1\cdot 1}^*\left[\tilde{y}_{T1t}^{*\,2} + \frac{\theta_{T1}^*}{\kappa_{T1}^*}\,\pi_{H1t}^{*\,2}\right]$$
$$+ (1+v_1^*)\,[\alpha_1^*\,\omega_{1\cdot 0}^*\,\tilde{y}_{Tt} + \alpha_1^*\textstyle\sum_{n=2}^{10}\omega_{1\cdot n}^*\,\tilde{y}_{Tnt}^*] + v_1^*(1-\alpha_1^*)\,\tilde{y}_{N1t}^* + v_1^*\,\alpha_1^*\omega_{1\cdot 1}^*\,\tilde{y}_{T1t}^*$$

…

$$LOSS_{kt}^* = \frac{(1-\alpha_k^*)}{(1-\varphi_{Nk}^*)}\left[\tilde{y}_{Nkt}^{*\,2} + \frac{\theta_{Nk}^*}{\kappa_{Nk}^*}\,\pi_{Nkt}^{*\,2}\right] + \frac{\alpha_k^*\,\omega_{k\cdot k}^*}{(1-\varphi_{Tk}^*)}\left[\tilde{y}_{Tkt}^{*\,2} + \frac{\theta_{Tk}^*}{\kappa_{Tk}^*}\,\pi_{Hkt}^{*\,2}\right]$$
$$+(1+v_k^*)\left[\alpha_k^*\,\omega_{k\cdot 0}^*\,\tilde{y}_{Tt} + \alpha_k^*\,\omega_{k\cdot 1}^*\,\tilde{y}_{T1t}^* + \cdots + \alpha_k^*\textstyle\sum_{n=k-1}^{10}\omega_{k\cdot n}^*\,\tilde{y}_{Tnt}^*\right]$$
$$+v_k^*\,(1-\alpha_k^*)\,\tilde{y}_{Nkt}^* + v_k^*\,\alpha_k^*\omega_{k\cdot k}^*\,\tilde{y}_{Tkt}^*$$

TIP = terms independent of policy and shocks for the Home economy

$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the home economy

TIP_{1t}^* = terms independent of policy and shocks for Foreign Country-1

$O_1^*(\|\xi_1^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-1

…

TIP_{kt}^* = terms independent of policy and shocks for Foreign Country-k

$O_k^*(\|\xi_k^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-k

4.1.2. Optimum Solutions to Economic Agents' Problems

Below are solutions for agents' optimization problems. For the definitions of the notations, please refer back to Section 4.1.1.

4.1.2.1. Households

- **Utility maximization**

- Optimum real wage

$$\frac{W_t}{P_t} = \frac{(1+t_C)}{(1-t_L)}\,\Psi\,C_t \qquad \ldots (1)$$

- Euler equation

$$\frac{1}{1+R_t} = \beta\,E_t\left(\frac{P_t\,C_t}{P_{t+1}\,C_{t+1}}\right) \qquad \ldots (2)$$

- Optimum real money balance … (3)

$$\frac{M_t}{P_t} = \left(\frac{1+R_t}{R_t}\right) v\,(1+t_C)\,C_t$$

- **Cost minimization of non-traded and traded goods consumption**

- Demand function for non-traded goods

$$\check{C}_{Nt} = (1-\alpha)\,\frac{P_t\,\check{C}_t}{\bar{P}_{Nt}} \qquad \ldots (4)$$

- Demand function for traded goods

$$\breve{C}_{Tt} = \alpha \frac{P_t \breve{C}_t}{\bar{P}_{Tt}} \quad \ldots (5)$$

- **Cost minimization of domestically produced and imported traded goods consumption**

- Demand function for domestically produced traded goods

$$\breve{C}_{Ht} = \omega_0 \frac{\bar{P}_{Tt} \breve{C}_{Tt}}{\bar{P}_{Ht}} \quad \ldots (6)$$

- Demand function for imported traded goods from Foreign Country-n; n = 1, 2, …, 10

$$\breve{C}_{Fnt} = \omega_n \frac{\bar{P}_{Tnt} \breve{C}_{Tnt}}{\varepsilon_{Nt} \bar{P}_{Fnt}} \quad \ldots (7)$$

4.1.2.2. Firms

4.1.2.2.1. Firms Producing Intermediate Goods

4.1.2.2.1.1. Firms Producing Non-traded Intermediate Goods

- **Cost minimization**

  - Optimum labor unit cost

$$V_{NIt} = \frac{W_t}{A_{Nt}} \quad \ldots (8)$$

- **Profit maximization**

- Optimum pricing rule for non-traded intermediate good i

$$P_{Nt}(i) = \frac{\mu_N}{(1+\tau_N)} \frac{E_t \sum_{ϟ=t}^{\infty} \gamma_N^{ϟ-t} \, V_{NIϟ} \, Y_{Nϟ}(i)}{E_t \sum_{ϟ=t}^{\infty} \gamma_N^{ϟ-t} \, Y_{Nϟ}(i)} \quad \ldots (9)$$

with

$$\mu_N = \theta_N / (\theta_N - 1)$$

4.1.2.2.2. Firms Producing Traded Intermediate Goods

- **Cost minimization**

  - Optimum unit labor cost

$$V_{TIt} = \frac{W_t}{A_{Tt}} \quad \ldots (10)$$

- **Profit maximization**

- Optimum pricing rule for non-traded intermediate good i

$$P_{Ht}(j) = \frac{\mu_T}{(1+\tau_T)} \frac{E_t \sum_{ϟ=t}^{\infty} \gamma_T^{ϟ-t} V_{TIϟ} \left(Y_{Hϟ}(j) + \sum_{n=1}^{10} Y_{Hnϟ}^{*}(j)\right)}{E_t \sum_{ϟ=t}^{\infty} \gamma_T^{ϟ-t} \left(Y_{Hϟ}(j) + \sum_{n=1}^{10} Y_{Hnϟ}^{*}(j)\right)} \quad \ldots (11)$$

with

$$\mu_T = \theta_T / (\theta_T - 1)$$

4.1.2.2.2. Firms Producing Final Goods

4.1.2.2.2.1. Firms Producing Non-traded Final Goods

- **Cost minimization**

- Optimum labor unit cost

$$V_{NCt} = \frac{W_t}{A_{Nt}} \quad \text{… (12)}$$

- **Profit maximization**

- Demand function for non-traded intermediate good i

$$Y_{Nt}(i) = \left(\frac{P_{Nt}(i)}{\bar{P}_{Nt}}\right)^{-\theta_N} Y_{Nt} \quad \text{… (13)}$$

where

$$\bar{P}_{Nt} = \left[\int_0^1 P_{Nt}^{1-\theta_N}(i)\, di\right]^{1/(1-\theta_N)}$$

4.1.2.2.2.2. Firms Producing Traded Final Goods

- **Cost minimization**

- Optimum labor unit cost

$$V_{TCt} = \frac{W_t}{A_{Tt}} \quad \text{… (14)}$$

- **Profit maximization**

- Demand function for domestically produced traded intermediate good j

$$Y_{Ht}(j) = \left(\frac{P_{Ht}(j)}{\bar{P}_{Ht}}\right)^{-\theta_T} Y_{Ht} \quad \text{… (15)}$$

where

$$\bar{P}_{Ht} = \left[\int_0^1 P_{Ht}^{1-\theta_T}(j)\, dj\right]^{1/(1-\theta_T)}$$

- Demand function for imported traded intermediate good j from Foreign Country-n

$$Y_{Fnt}^{d}(j) = \left(\frac{P_{Fnt}(j)}{\bar{P}_{Fnt}}\right)^{-\theta_T} Y_{Fnt} \quad \text{… (16)}$$

where

$$\bar{P}_{Fnt} = \left[\int_0^1 P_{Fnt}^{1-\theta_T}(j)\, dj\right]^{1/(1-\theta_T)}$$

4.1.2.3. Government or Supranational Planner Exercising Fiscal Policy

- **Utility maximization**

- Optimum labor allocation in the non-traded sector

$$\Psi\, L_N = 1 - \alpha \quad \text{… (17)}$$

- Optimum labor allocation in the traded sector

$$\Psi\, L_T = \alpha\, \omega_0 \quad \text{… (18)}$$

- Optimum labor allocation in the Home economy

$$\Psi\, L \equiv \Psi\,(L_N + L_T) = 1 - \alpha\,(1 - \omega_0) \quad \text{… (19)}$$

- **Cost minimization of non-traded and traded goods consumption**

- Demand function for non-traded goods consumption

$$G_{Nt} = (1-\alpha)\frac{P_t G_t}{\bar{P}_{Nt}} \quad \ldots (20)$$

- Demand function for traded goods consumption

$$G_{Tt} = \alpha \frac{P_t G_t}{\bar{P}_{Tt}} \quad \ldots (21)$$

- **Cost minimization of domestically produced and imported traded goods consumption**

- Demand function for domestically produced traded goods

$$G_{Ht} = \omega_0 \frac{\bar{P}_{Tt} G_{Tt}}{\bar{P}_{Ht}} \quad \ldots (22)$$

- Demand function for imported traded goods consumption from Foreign Country-n

$$G_{Fnt} = \omega_n \frac{\bar{P}_{Tnt} G_{Tnt}}{e_{Nt} \bar{P}_{Fnt}} \quad \ldots (23)$$

4.1.3. Market Clearing Conditions, Aggregations, and Equilibria

Below are the market clearing conditions, aggregations of optimum solutions, and equilibria in the model. For the definitions of the notations, please refer back to Section 4.1.1.

4.1.3.1. Market Clearing Conditions

- Non-traded goods market clearing condition for each country in period t, where each country's aggregate supply of non-traded goods equals the respective country's aggregate demand for non-traded goods

  - For the Home economy

$$\bar{P}_{Nt} Y_{Nt} = (1-\alpha) P_t C_t$$

  - For each of the foreign countries (n = 1, 2, …, 10)

$$\bar{P}_{Nnt} Y_{Nnt} = (1-\alpha_n^*) \bar{P}_{nt}^* C_{nt}^* \quad \ldots (24)$$

- Traded goods market clearing condition in period t, where the global aggregate supply of traded goods equals the global aggregate demand for traded goods

$$\bar{P}_{Ht} Y_{Tt} + \sum_{i=0}^{10} \bar{P}_{Fnt}^* Y_{Tnt}^* = \alpha P_t C_t + \sum_{n=1}^{10} (\alpha_n^* \bar{P}_{nt}^* K_{nt}^*) \quad \ldots (25)$$

- Labor market clearing condition for each economy at time t, where the labor supply equals the market demand from the non-traded and traded sectors

  - For the Home economy

$$L_t = L_{Nt} + L_{Tt}$$

  - For each of the Foreign Countries (n = 1, 2, …, 10)

$$L_{nt}^* = L_{Nnt}^* + L_{Tnt}^* \equiv L_{NInt}^* + L_{NCnt}^* + L_{TInt}^* + L_{TCnt}^* \quad \ldots (26)$$

- •International bond market clearing condition at period t, where there is no excess supply or excess demand of bonds in the world economy (households in the other countries will absorb an excess supply of bonds in one country, while buying bonds from other countries can meet the excess demand for bonds in one country)

$$B_t + \sum_{n=1}^{10} e_{nt} B_{nt}^* = 0 \quad \ldots (27)$$

- International risk-sharing condition under the balanced-trade steady state, where real effective exchange rate of the Home economy (Ϙ_t) is determined by consumption in all economies in the world

  - For the Home economy

  $$\text{Ϙ}_t = \sum_{n=1}^{10} \left(\frac{\alpha}{\alpha_n} \frac{\omega_0}{(1-\omega_n^*)} \frac{C_t}{C_{nt}^*} \right)$$

  - For each of the Foreign Countries (n = 1, 2, …, 10)

  $$\text{Ϙ}_{nt}^* = \sum_{\substack{i=0,\\ n\neq i}}^{10} \left(\frac{\alpha_n^*}{\alpha_i} \frac{\omega_{n\cdot n}^*}{(1-\omega_{n\cdot i}^*)} \frac{C_{nt}^*}{C_{n\cdot it}^*} \right) \quad \dots (28)$$

- Uncovered interest parity between the Home economy and Foreign Country-n

  - For the Home economy

  $$R_t^{nat} - R_{nt}^{*\,nat} = E_t\, \hat{e}_{nt+1}^{nat} - \hat{e}_{nt}^{\,nat} + u_t \equiv E_t \hat{s}_{nt+1}^{nat} - \hat{s}_{nt}^{\,nat} + E_t\pi_{Ht+1} - E_t\pi_{Hnt+1}^* + u_t$$

  - For each of the Foreign Countries (n = 1, 2, ⋯, 10 ; I = 0, 1, ⋯ 10; $I \neq$ n

  $$R_{nt}^{*\,nat} - R_{it}^{*\,nat} = E_t \hat{e}_{n\cdot it+1}^{*\;\;nat} - \hat{e}_{n\cdot it}^{*\;\;nat} + u_t$$

  $$\equiv E_t \hat{s}_{n\cdot it+1}^{*\;\;nat} - \hat{s}_{n\cdot it}^{*\;\;nat} + E_t\pi_{Fnt+1}^* + E_t\pi_{Fit+1}^* + u_t \quad \dots (29)$$

  where u_t is a global exchange rate shock felt by all countries.

4.1.3.2. Aggregations of Optimum Solutions

- Terms of trade of Home economy with respect to Foreign Country-n at period t (S_{nt})

  $$S_{nt} = \frac{Y_{Tt}}{Y_{Tnt}^*} \quad \dots (30)$$

- Real aggregate demand for goods in the non-traded sector at period t (Y_{Nt})

  $$Y_{Nt} = (1-\alpha)\, C_t\, Q_{Nt}^{\;-\alpha} \quad \dots (31)$$

  where $Q_{Nt} = \frac{\bar{P}_{Nt}}{\bar{P}_{Tt}}$ is the relative price of non-traded goods to traded goods

- Real aggregate demand for goods in the traded sector at period t (Y_{Tt})

  $$Y_{Tt} = \alpha\, C_t\, Q_{Nt}^{\;1-\alpha} \prod_{n=1}^{10} S_{nt}^{\omega_n} \quad \dots (32)$$

- Aggregate consumption at period t (C_t^A)

  $$C_t^A = \alpha^{-\alpha}(1-\alpha)^{\alpha-1}\, Y_{Nt}^{\;1-\alpha}\, Y_{Tt}^{\omega_0} \prod_{n=1}^{10} {Y_{Tnt}^*}^{\omega_n \alpha} \quad \dots (33)$$

- Aggregate demand for labour in the non-traded sector at period t (L_{Nt})

  $$L_{Nt} = \frac{1}{A_{Nt}} \int_0^1 Y_{Nt}^d(i)\, di = \frac{\hat{\Sigma}_{Nt}}{A_{Nt}}\, Y_{Nt} \quad \dots (34)$$

  where $\hat{\Sigma}_{Nt} = \int_0^1 \left(\frac{P_N(i)}{\bar{P}_N}\right)^{-\theta_N} di$ measures price dispersion within non-traded sector

- Aggregate demand for labour in the traded sector at period t (L_{Tt})

  $$L_{Tt} = \frac{1}{A_{Tt}} \int_0^1 (Y_{Ht}(j) + Y_{Ht}^*(j))\, dj = \frac{\hat{\Sigma}_{Ht}}{A_{Tt}}\, Y_{Tt} \quad \dots (35)$$

  where $\hat{\Sigma}_{Ht} = \int_0^1 \left(\frac{P_H(i)}{\bar{P}_H}\right)^{-\theta_N} dj$ measures price dispersion within the traded sector

4.1.3.3. Natural Rate Equilibrium

- Natural rate of non-traded output ($\hat{y}_{Nt}^{nat}$)
  $\hat{y}_{Nt}^{nat} = \hat{a}_{Nt}$ … (36)
- Natural rate of traded output ($\hat{y}_{Tt}^{nat}$)
  $\hat{y}_{Tt}^{nat} = \hat{a}_{Tt}$ … (37)
- Natural rate of the terms of trade of Home economy with Foreign Country-n ($\hat{s}_{nt}^{nat}$)
  $\hat{s}_{nt}^{nat} = \hat{a}_{Tt} - \hat{a}_{Tnt}^{*}$ … (38)
- Natural rate of aggregate consumption $\left(\hat{c}_t^{A^{nat}}\right)$
  $\hat{c}_t^{A^{nat}} = (1-\alpha)\,\hat{a}_{Nt} + \alpha\omega_0\,\hat{a}_{Tt} - \alpha\,\sum_{n=1}^{10}\omega_n\,\hat{s}_t^{nat}$ … (39)
- Real interest rate ($\widehat{rr}_t^{nat}$) in the flexible-price equilibrium
  $\widehat{rr}_t^{nat} = E_t\,\Delta\,\hat{c}_{t+1}^{nat} = 0$ … (40)
- Relative price of non-traded goods in terms of traded goods ($\hat{q}_{Nt}^{nat}$)
  $\hat{q}_{Nt}^{nat} \equiv \hat{p}_{Nt}^{nat} - \hat{p}_{Tt}^{nat} = \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha\,\sum_{n=1}^{10}\omega_n\,\hat{s}_{nt}^{nat}$ … (41)

4.1.3.4. Sticky Price Equilibrium

- Phillips curve in the non-traded sector
  $\pi_{Nt} = \beta\,E_t\,\pi_{Nt+1} + \kappa_N\,\tilde{y}_{Nt}$ … (42)
  where
  $\kappa_N = \frac{(1-\beta\,\gamma_N)(1-\gamma_N)}{\gamma_N}$
  is a constant that measures the responsiveness of pricing decision to the variations in the real marginal cost gap in the non-traded sector

- Phillips curve in the traded sector
  $\pi_{Ht} = \beta\,E_t\,\pi_{Ht+1} + \kappa_T\,\tilde{y}_{Tt}$ … (43)
  where
  $\kappa_T = \frac{(1-\beta\,\gamma_T)(1-\gamma_T)}{\gamma_T}$
  is a constant that measures the responsiveness of pricing decision to the variations in the real marginal cost gap in the traded sector

- Relation between changes on output in the non-traded and traded sectors
  $\Delta\,\tilde{y}_{Nt} + \Delta\,\hat{a}_{Nt} + \pi_{Nt} = \Delta\,\tilde{y}_{Tt} + \Delta\,\hat{a}_{Tt} + \pi_{Ht}$ … (44)

- Relations between output, inflation, and nominal interest rate
  $(1-\alpha)\,\tilde{y}_{Nt} + \alpha\,\tilde{y}_{Tt}$
  $= E_t\,[(1-\alpha)\,\tilde{y}_{Nt+1} + \alpha\,\tilde{y}_{Tt+1}] - \{r_t - E_t\,[(1-\alpha)\,\pi_{Nt+1} + \alpha\,\pi_{Ht+1}]\}$ … (45)

4.1.4. Model Solution and Welfare Calculation

This study uses the linear quadratic (LQ) approximation solution technique as suggested by Díaz-Giménez (2004) to compute the welfare. There are three steps involved in the LQ approximation technique: (1) computation of the steady state values; (2) construction of the quadratic approximation (comprises the construction of Bellman equations and evaluation of welfare function around the steady state values); and (3) computation the optimal value. This dissertation does not display steps (2) and (3) as they are very technical.

The steady state values for the parameters are calculated by solving the following system of equations, derived from the central bank or supranational planner's monetary welfare optimization problems, shocks in the non-traded and traded sectors, and foreign countries' traded sector output gaps (which are exogenous variables and assumed to follow lag(1) autoregression function based on their past values).

The steady state values of $\hat{r}^{SS}$, $\tilde{y}_N^{SS}$, $\tilde{y}_T^{SS}$, π_N^{SS} , π_H^{SS} , $\hat{a}_N^{SS}$, $\hat{a}_T^{SS}$ are calculated using Dynare software. This study also uses Dynare to estimate the model's parameters θ_N , θ_T , κ_N , and κ_T for each regime by the Bayesian method.

Below are the steady state equation systems for each interaction regime among the ASEAN-5+3. For the definitions of notations, please see Appendix 4.1. (page 81 – 86).

- **For the "No Coordination" regime**

$$\hat{a}_{Nt} = ƅ_1\ \hat{a}_{Nt-1} + ƅ_2\ \hat{a}_{Tt-1} + \varepsilon_{Nt} \quad \dots (1)$$

$$\hat{a}_{Tt} = \varrho_1\ \hat{a}_{Nt-1} + \varrho_2\ \hat{a}_{Tt-1} + \varepsilon_{Tt} \quad \dots (2)$$

$$\hat{a}^*_{N1t} = ƅ^*_{1\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + ƅ^*_{1\cdot 2}\ \hat{a}^*_{T1t-1} + \varepsilon^*_{N1t} \quad \dots (3)$$

$$\hat{a}^*_{T1t} = \varrho^*_{1\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{1\cdot 2}\ \hat{a}^*_{T1t-1} + \varepsilon^*_{T1t} \quad \dots (4)$$

$$\hat{a}^*_{N2t} = ƅ^*_{2\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + ƅ^*_{2\cdot 2}\ \hat{a}^*_{T2t-1} + \varepsilon^*_{N2t} \quad \dots (5)$$

$$\hat{a}^*_{T2t} = \varrho^*_{2\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{2\cdot 2}\ \hat{a}^*_{T2t-1} + \varepsilon^*_{T2t} \quad \dots (6)$$

$$\hat{a}^*_{N3t} = ƅ^*_{3\cdot 1}\ \hat{a}^*_{N3t\cdot 1} + ƅ^*_{3\cdot 2}\ \hat{a}^*_{T3t-1} + \varepsilon^*_{N3t} \quad \dots (7)$$

$$\hat{a}^*_{T3t} = \varrho^*_{3\cdot 1}\ \hat{a}^*_{N3t-1} + \varrho^*_{3\cdot 2}\ \hat{a}^*_{T3t-1} + \varepsilon^*_{T3t} \quad \dots (8)$$

$$\hat{a}^*_{N4t} = ƅ^*_{4\cdot 1}\ \hat{a}^*_{N4t\cdot 1} + ƅ^*_{4\cdot 2}\ \hat{a}^*_{T4t-1} + \varepsilon^*_{N4t} \quad \dots (9)$$

$$\hat{a}^*_{T4t} = \varrho^*_{4\cdot 1}\ \hat{a}^*_{N4t\cdot 1} + \varrho^*_{4\cdot 2}\ \hat{a}^*_{T4t-1} + \varepsilon^*_{T4t} \quad \dots (10)$$

$$\hat{a}^*_{N5t} = ƅ^*_{5\cdot 1}\ \hat{a}^*_{N5t\cdot 1} + ƅ^*_{5\cdot 2}\ \hat{a}^*_{T5t-1} + \varepsilon^*_{N5t} \quad \dots (11)$$

$$\hat{a}^*_{T5t} = \varrho^*_{5\cdot 1}\ \hat{a}^*_{N5t\cdot 1} + \varrho^*_{5\cdot 2}\ \hat{a}^*_{T5t-1} + \varepsilon^*_{T5t} \quad \dots (12)$$

$$\hat{a}^*_{N6t} = ƅ^*_{6\cdot 1}\ \hat{a}^*_{N6t\cdot 1} + ƅ^*_{6\cdot 2}\ \hat{a}^*_{T6t-1} + \varepsilon^*_{N6t} \quad \dots (13)$$

$$\hat{a}^*_{T6t} = \varrho^*_{6\cdot 1}\ \hat{a}^*_{N6t\cdot 1} + \varrho^*_{6\cdot 2}\ \hat{a}^*_{T6t-1} + \varepsilon^*_{T6t} \quad \dots (14)$$

$$\hat{a}^*_{N7t} = ƅ^*_{7\cdot 1}\ \hat{a}^*_{N7t\cdot 1} + ƅ^*_{7\cdot 2}\ \hat{a}^*_{T7t-1} + \varepsilon^*_{N7t} \quad \dots (15)$$

$$\hat{a}^{*}_{T7t} = \varrho^{*}_{7\cdot 1}\ \hat{a}^{*}_{N7t\cdot 1} + \varrho^{*}_{7\cdot 2}\ \hat{a}^{*}_{T7t-1} + \varepsilon^{*}_{T7t} \quad \dots (16)$$

$$\hat{a}^{*}_{N8t} = ƀ^{*}_{8\cdot 1}\ \hat{a}^{*}_{N8t\cdot 1} + ƀ^{*}_{8\cdot 2}\ \hat{a}^{*}_{T8t-1} + \varepsilon^{*}_{N8t} \quad \dots (17)$$

$$\hat{a}^{*}_{T8t} = \varrho^{*}_{8\cdot 1}\ \hat{a}^{*}_{N8t\cdot 1} + \varrho^{*}_{8\cdot 2}\ \hat{a}^{*}_{T8t-1} + \varepsilon^{*}_{T8t} \quad \dots (18)$$

$$\hat{a}^{*}_{N9t} = ƀ^{*}_{9\cdot 1}\ \hat{a}^{*}_{N9t\cdot 1} + ƀ^{*}_{9\cdot 2}\ \hat{a}^{*}_{T9t-1} + \varepsilon^{*}_{N9t} \quad \dots (19)$$

$$\hat{a}^{*}_{T9t} = \varrho^{*}_{9\cdot 1}\ \hat{a}^{*}_{N9t\cdot 1} + \varrho^{*}_{9\cdot 2}\ \hat{a}^{*}_{T9t-1} + \varepsilon^{*}_{T9t} \quad \dots (20)$$

$$\hat{a}^{*}_{N10t} = ƀ^{*}_{10\cdot 1}\ \hat{a}^{*}_{N10t\cdot 1} + ƀ^{*}_{10\cdot 2}\ \hat{a}^{*}_{T10t-1} + \varepsilon^{*}_{N10t} \quad \dots (21)$$

$$\hat{a}^{*}_{T10t} = \varrho^{*}_{10\cdot 1}\ \hat{a}^{*}_{N10t\cdot 1} + \varrho^{*}_{10\cdot 2}\ \hat{a}^{*}_{T10t-1} + \varepsilon^{*}_{T10t} \quad \dots (22)$$

$$\hat{y}^{nat}_{Nt} = \hat{a}_{Nt} \quad \dots (23)$$

$$\hat{y}^{nat}_{Tt} = \hat{a}_{Tt} \quad \dots (24)$$

$$\hat{s}^{nat}_{1t} = \hat{a}_{Tt} - \hat{a}^{*}_{T1t} \quad \dots (25)$$

$$\hat{s}^{nat}_{2t} = \hat{a}_{Tt} - \hat{a}^{*}_{T2t} \quad \dots (26)$$

$$\hat{s}^{nat}_{3t} = \hat{a}_{Tt} - \hat{a}^{*}_{T3t} \quad \dots (27)$$

$$\hat{s}^{nat}_{4t} = \hat{a}_{Tt} - \hat{a}^{*}_{T4t} \quad \dots (28)$$

$$\hat{s}^{nat}_{5t} = \hat{a}_{Tt} - \hat{a}^{*}_{T5t} \quad \dots (29)$$

$$\hat{s}^{nat}_{6t} = \hat{a}_{Tt} - \hat{a}^{*}_{T6t} \quad \dots (30)$$

$$\hat{s}^{nat}_{7t} = \hat{a}_{Tt} - \hat{a}^{*}_{T7t} \quad \dots (31)$$

$$\hat{s}^{nat}_{8t} = \hat{a}_{Tt} - \hat{a}^{*}_{T8t} \quad \dots (32)$$

$$\hat{s}^{nat}_{9t} = \hat{a}_{Tt} - \hat{a}^{*}_{T9t} \quad \dots (33)$$

$$\hat{s}^{nat}_{10t} = \hat{a}_{Tt} - \hat{a}^{*}_{T10t} \quad \dots (34)$$

$$\hat{c}_t^{A^{nat}} = (1-\alpha)\,\hat{a}_{Nt} + \alpha\omega_0\,\hat{a}_{Tt} - \alpha \sum_{n=1}^{10} \omega_n\,\hat{s}^{nat}_{nt} \quad \dots (35)$$

$$\widehat{rr}^{nat}_t = E_t\,\Delta\hat{c}^{A}_{t+1}{}^{nat} = 0 \quad \dots (36)$$

$$\hat{q}^{nat}_{Nt} = \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha \sum_{n=1}^{10} \omega_n\,\hat{s}^{nat}_{nt} \quad \dots (37)$$

$$u_t = u_{t-1} + \varepsilon_{ut} \quad \dots (38)$$

$$\Delta_{R_t^{nat} R_{1t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{1t+1} - \hat{s}^{nat}_{1t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H1t+1} + u_t \quad \dots (39)$$

$$\Delta_{R_t^{nat} R_{2t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{2t+1} - \hat{s}^{nat}_{2t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H2t+1} + u_t \quad \dots (40)$$

$$\Delta_{R_t^{nat} R_{3t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{3t+1} - \hat{s}^{nat}_{3t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H3t+1} + u_t \quad \dots (41)$$

$$\Delta_{R_t^{nat} R_{4t}^{*}{}^{nat}} = E_t \hat{s}_{4t+1}^{nat} - \hat{s}_{4t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H4t+1}^{*} + u_t \quad \dots (42)$$

$$\Delta_{R_t^{nat} R_{5t}^{*}{}^{nat}} = E_t \hat{s}_{5t+1}^{nat} - \hat{s}_{5t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H5t+1}^{*} + u_t \quad \dots (43)$$

$$\Delta_{R_t^{nat} R_{6t}^{*}{}^{nat}} = E_t \hat{s}_{6t+1}^{nat} - \hat{s}_{6t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H6t+1}^{*} + u_t \quad \dots (44)$$

$$\Delta_{R_t^{nat} R_{7t}^{*}{}^{nat}} = E_t \hat{s}_{7t+1}^{nat} - \hat{s}_{7t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H7t+1}^{*} + u_t \quad \dots (45)$$

$$\Delta_{R_t^{nat} R_{8t}^{*}{}^{nat}} = E_t \hat{s}_{8t+1}^{nat} - \hat{s}_{8t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H8t+1}^{*} + u_t \quad \dots (46)$$

$$\Delta_{R_t^{nat} R_{9t}^{*}{}^{nat}} = E_t \hat{s}_{9t+1}^{nat} - \hat{s}_{9t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H9t+1}^{*} + u_t \quad \dots (47)$$

$$\Delta_{R_t^{nat} R_{10t}^{*}{}^{nat}} = E_t \hat{s}_{10t+1}^{nat} - \hat{s}_{10t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H10t+1}^{*} + u_t \quad \dots (48)$$

$$\tilde{y}_{T1t}^{*} = \beth_1^{*} \tilde{y}_{T1t-1}^{*} + \varepsilon_{T1t}^{*} \quad \dots (49)$$

$$\tilde{y}_{T2t}^{*} = \beth_2^{*} \tilde{y}_{T2t-1}^{*} + \varepsilon_{T2t}^{*} \quad \dots (50)$$

$$\tilde{y}_{T3t}^{*} = \beth_3^{*} \tilde{y}_{T3t-1}^{*} + \varepsilon_{T3t}^{*} \quad \dots (51)$$

$$\tilde{y}_{T4t}^{*} = \beth_4^{*} \tilde{y}_{T4t-1}^{*} + \varepsilon_{T4t}^{*} \quad \dots (52)$$

$$\tilde{y}_{T5t}^{*} = \beth_5^{*} \tilde{y}_{T5t-1}^{*} + \varepsilon_{T5t}^{*} \quad \dots (53)$$

$$\tilde{y}_{T6t}^{*} = \beth_6^{*} \tilde{y}_{T6t-1}^{*} + \varepsilon_{T6t}^{*} \quad \dots (54)$$

$$\tilde{y}_{T7t}^{*} = \beth_7^{*} \tilde{y}_{T7t-1}^{*} + \varepsilon_{T7t}^{*} \quad \dots (55)$$

$$\tilde{y}_{T8t}^{*} = \beth_8^{*} \tilde{y}_{T8t-1}^{*} + \varepsilon_{T8t}^{*} \quad \dots (56)$$

$$\tilde{y}_{T9t}^{*} = \beth_9^{*} \tilde{y}_{T9t-1}^{*} + \varepsilon_{T9t}^{*} \quad \dots (57)$$

$$\tilde{y}_{T10t}^{*} = \beth_{10}^{*} \tilde{y}_{T10t-1}^{*} + \varepsilon_{T10t}^{*} \quad \dots (58)$$

$$\tilde{y}_{Nt} = \frac{1}{\kappa_N} E_t[\pi_{Nt} - \beta\, \pi_{Nt+1}] \quad \dots (59)$$

$$\tilde{y}_{Tt} = \frac{1}{\kappa_T} E_t\, [\pi_{Ht} - \beta\, \pi_{Ht+1}] \quad \dots (60)$$

$$\pi_{Nt} = -\frac{(1+\kappa_N)}{(1+\kappa_N+\beta\,\theta_N)} \left(\tilde{y}_{Nt} - \hat{r}_{t-1} + \alpha\, (\hat{a}_{Nt} - \hat{a}_{Nt-1}) - \alpha\, (\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_N+\beta\,\theta_N)} \tilde{y}_{Nt-2} \quad \dots (61)$$

$$\pi_{Ht} = -\frac{(1+\kappa_T)}{(1+\kappa_T+\beta\,\theta_T)} \left(\tilde{y}_{Tt} - \hat{r}_{t-1} - (1-\alpha)\, (\hat{a}_{Nt} - \hat{a}_{Nt-1}) + (1-\alpha)\, (\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_T+\beta\,\theta_T)} \tilde{y}_{Tt-2} \quad \dots (62)$$

$$\hat{r}_t = \frac{1}{[1-\alpha(1-\omega_0)]} \begin{Bmatrix} (1-\alpha)\, E_t\big(\tilde{y}_{Nt+1} + \pi_{Nt+1} + \alpha\, (\hat{a}_{Nt+1} - \hat{a}_{Nt}) - \alpha\, (\hat{a}_{Tt+1} - \hat{a}_{Tt})\big) \\ +\alpha\omega_0\, E_t\big(\tilde{y}_{Tt+1} + \pi_{Ht+1} - (1-\alpha)(\hat{a}_{Nt+1} - \hat{a}_{Nt}) + (1-\alpha)(\hat{a}_{Tt+1} - \hat{a}_{Tt})\big) \end{Bmatrix} \quad \dots (63)$$

- **For the "Bilateral Coordination" regime**

$\hat{a}_{Nt} = \text{ƅ}_1 \ \hat{a}_{Nt-1} + \text{ƅ}_2 \ \hat{a}_{Tt-1} + \varepsilon_{Nt}$ … (1)

$\hat{a}_{Tt} = \varrho_1 \ \hat{a}_{Nt-1} + \varrho_2 \ \hat{a}_{Tt-1} + \varepsilon_{Tt}$ … (2)

$\hat{a}^*_{N1t} = \text{ƅ}^*_{1\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \text{ƅ}^*_{1\cdot 2} \ \hat{a}^*_{T1t-1} + \varepsilon^*_{N1t}$ … (3)

$\hat{a}^*_{T1t} = \varrho^*_{1\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{1\cdot 2} \ \hat{a}^*_{T1t-1} + \varepsilon^*_{T1t}$ … (4)

$\hat{a}^*_{N2t} = \text{ƅ}^*_{2\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \text{ƅ}^*_{2\cdot 2} \ \hat{a}^*_{T2t-1} + \varepsilon^*_{N2t}$ … (5)

$\hat{a}^*_{T2t} = \varrho^*_{2\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{2\cdot 2} \ \hat{a}^*_{T2t-1} + \varepsilon^*_{T2t}$ … (6)

$\hat{a}^*_{N3t} = \text{ƅ}^*_{3\cdot 1} \ \hat{a}^*_{N3t\cdot 1} + \text{ƅ}^*_{3\cdot 2} \ \hat{a}^*_{T3t-1} + \varepsilon^*_{N3t}$ … (7)

$\hat{a}^*_{T3t} = \varrho^*_{3\cdot 1} \ \hat{a}^*_{N3t-1} + \varrho^*_{3\cdot 2} \ \hat{a}^*_{T3t-1} + \varepsilon^*_{T3t}$ … (8)

$\hat{a}^*_{N4t} = \text{ƅ}^*_{4\cdot 1} \ \hat{a}^*_{N4t\cdot 1} + \text{ƅ}^*_{4\cdot 2} \ \hat{a}^*_{T4t-1} + \varepsilon^*_{N4t}$ … (9)

$\hat{a}^*_{T4t} = \varrho^*_{4\cdot 1} \ \hat{a}^*_{N4t\cdot 1} + \varrho^*_{4\cdot 2} \ \hat{a}^*_{T4t-1} + \varepsilon^*_{T4t}$ … (10)

$\hat{a}^*_{N5t} = \text{ƅ}^*_{5\cdot 1} \ \hat{a}^*_{N5t\cdot 1} + \text{ƅ}^*_{5\cdot 2} \ \hat{a}^*_{T5t-1} + \varepsilon^*_{N5t}$ … (11)

$\hat{a}^*_{T5t} = \varrho^*_{5\cdot 1} \ \hat{a}^*_{N5t\cdot 1} + \varrho^*_{5\cdot 2} \ \hat{a}^*_{T5t-1} + \varepsilon^*_{T5t}$ … (12)

$\hat{a}^*_{N6t} = \text{ƅ}^*_{6\cdot 1} \ \hat{a}^*_{N6t\cdot 1} + \text{ƅ}^*_{6\cdot 2} \ \hat{a}^*_{T6t-1} + \varepsilon^*_{N6t}$ … (13)

$\hat{a}^*_{T6t} = \varrho^*_{6\cdot 1} \ \hat{a}^*_{N6t\cdot 1} + \varrho^*_{6\cdot 2} \ \hat{a}^*_{T6t-1} + \varepsilon^*_{T6t}$ … (14)

$\hat{a}^*_{N7t} = \text{ƅ}^*_{7\cdot 1} \ \hat{a}^*_{N7t\cdot 1} + \text{ƅ}^*_{7\cdot 2} \ \hat{a}^*_{T7t-1} + \varepsilon^*_{N7t}$ … (15)

$\hat{a}^*_{T7t} = \varrho^*_{7\cdot 1} \ \hat{a}^*_{N7t\cdot 1} + \varrho^*_{7\cdot 2} \ \hat{a}^*_{T7t-1} + \varepsilon^*_{T7t}$ … (16)

$\hat{a}^*_{N8t} = \text{ƅ}^*_{8\cdot 1} \ \hat{a}^*_{N8t\cdot 1} + \text{ƅ}^*_{8\cdot 2} \ \hat{a}^*_{T8t-1} + \varepsilon^*_{N8t}$ … (17)

$\hat{a}^*_{T8t} = \varrho^*_{8\cdot 1} \ \hat{a}^*_{N8t\cdot 1} + \varrho^*_{8\cdot 2} \ \hat{a}^*_{T8t-1} + \varepsilon^*_{T8t}$ … (18)

$\hat{a}^*_{N9t} = \text{ƅ}^*_{9\cdot 1} \ \hat{a}^*_{N9t\cdot 1} + \text{ƅ}^*_{9\cdot 2} \ \hat{a}^*_{T9t-1} + \varepsilon^*_{N9t}$ … (19)

$\hat{a}^*_{T9t} = \varrho^*_{9\cdot 1} \ \hat{a}^*_{N9t\cdot 1} + \varrho^*_{9\cdot 2} \ \hat{a}^*_{T9t-1} + \varepsilon^*_{T9t}$ … (20)

$\hat{a}^*_{N10t} = \text{ƅ}^*_{10\cdot 1} \ \hat{a}^*_{N10t\cdot 1} + \text{ƅ}^*_{10\cdot 2} \ \hat{a}^*_{T10t-1} + \varepsilon^*_{N10t}$ … (21)

$\hat{a}^*_{T10t} = \varrho^*_{10\cdot 1} \ \hat{a}^*_{N10t\cdot 1} + \varrho^*_{10\cdot 2} \ \hat{a}^*_{T10t-1} + \varepsilon^*_{T10t}$ … (22)

$\hat{y}^{nat}_{Nt} = \hat{a}_{Nt}$ … (23)

$\hat{y}^{nat}_{Tt} = \hat{a}_{Tt}$ … (24)

${\hat{y}^*_{N1t}}^{nat} = \hat{a}^*_{N1t}$ … (25)

${\hat{y}^*_{T1t}}^{nat} = \hat{a}^*_{T1t}$ … (26)

$$\hat{s}_{1t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T1t}^{*} \quad \dots (27)$$

$$\hat{s}_{2t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T2t}^{*} \quad \dots (28)$$

$$\hat{s}_{3t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T3t}^{*} \quad \dots (29)$$

$$\hat{s}_{4t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T4t}^{*} \quad \dots (30)$$

$$\hat{s}_{5t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T5t}^{*} \quad \dots (31)$$

$$\hat{s}_{6t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T6t}^{*} \quad \dots (32)$$

$$\hat{s}_{7t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T7t}^{*} \quad \dots (33)$$

$$\hat{s}_{8t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T8t}^{*} \quad \dots (34)$$

$$\hat{s}_{9t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T9t}^{*} \quad \dots (35)$$

$$\hat{s}_{10t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T10t}^{*} \quad \dots (36)$$

$$\hat{c}_{t}^{A^{nat}} = (1-\alpha)\,\hat{a}_{Nt} + \alpha\omega_0\,\hat{a}_{Tt} - \alpha\,\textstyle\sum_{n=1}^{10}\omega_n\,\hat{s}_{nt}^{nat} \quad \dots (37)$$

$$\widehat{rr}_{t}^{nat} = E_t\,\Delta\hat{c}_{t+1}^{A^{nat}} = 0 \quad \dots (38)$$

$$\hat{q}_{Nt}^{nat} \equiv \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha\,\textstyle\sum_{n=1}^{10}\omega_n\,\hat{s}_{nt}^{nat} \quad \dots (39)$$

$$\hat{s}_{1\cdot 0_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{Tt} \quad \dots (40)$$

$$\hat{s}_{1\cdot 2_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T2t}^{*} \quad \dots (41)$$

$$\hat{s}_{1\cdot 3_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T3t}^{*} \quad \dots (42)$$

$$\hat{s}_{1\cdot 4_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T4t}^{*} \quad \dots (43)$$

$$\hat{s}_{1\cdot 5_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T5t}^{*} \quad \dots (44)$$

$$\hat{s}_{1\cdot 6_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T6t}^{*} \quad \dots (45)$$

$$\hat{s}_{1\cdot 7_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T7t}^{*} \quad \dots (46)$$

$$\hat{s}_{1\cdot 8_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T8t}^{*} \quad \dots (47)$$

$$\hat{s}_{1\cdot 9_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T9t}^{*} \quad \dots (48)$$

$$\hat{s}_{1\cdot 10_t}^{*\,nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T10t}^{*} \quad \dots (49)$$

$$\hat{c}_{1t}^{A*^{nat}} = (1-\alpha_1^{*})\,\hat{a}_{N1t}^{*} + \alpha_1^{*}\,\omega_1^{*}\,\hat{a}_{T1t}^{*} - \alpha_1^{*}\,\textstyle\sum_{n=0,n\neq 1}^{10}\omega_{1\cdot n}^{*}\,\hat{s}_{1\cdot n_t}^{*\,nat} \quad \dots (50)$$

$$\widehat{rr}_{1t}^{*\ nat} = E_t\, \Delta\hat{c}_{1t+1}^{A*\ \ nat} = 0 \qquad \dots (51)$$

$$\hat{q}_{N1t}^{*\ \ nat} = \hat{a}_{T1t}^{*} - \hat{a}_{N1t}^{*} - \alpha_1^{*} \sum_{n=0, n\neq 1}^{10} \omega_{1\cdot n}^{*}\, \hat{s}_{1\cdot n_t}^{*\ \ nat} \qquad \dots (52)$$

$$u_t = u_{t-1} + \varepsilon_{ut} \qquad \dots (53)$$

$$\Delta_{R_t^{nat} R_{1t}^{*\ nat}} = E_t\hat{s}_{1t+1}^{nat} - \hat{s}_{1t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H1t+1}^{*} + u_t \qquad \dots (54)$$

$$\Delta_{R_t^{nat} R_{2t}^{*\ nat}} = E_t\hat{s}_{2t+1}^{nat} - \hat{s}_{2t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H2t+1}^{*} + u_t \qquad \dots (55)$$

$$\Delta_{R_t^{nat} R_{3t}^{*\ nat}} = E_t\hat{s}_{3t+1}^{nat} - \hat{s}_{3t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H3t+1}^{*} + u_t \qquad \dots (56)$$

$$\Delta_{R_t^{nat} R_{4t}^{*\ nat}} = E_t\hat{s}_{4t+1}^{nat} - \hat{s}_{4t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H4t+1}^{*} + u_t \qquad \dots (57)$$

$$\Delta_{R_t^{nat} R_{5t}^{*\ nat}} = E_t\hat{s}_{5t+1}^{nat} - \hat{s}_{5t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H5t+1}^{*} + u_t \qquad \dots (58)$$

$$\Delta_{R_t^{nat} R_{6t}^{*\ nat}} = E_t\hat{s}_{6t+1}^{nat} - \hat{s}_{6t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H6t+1}^{*} + u_t \qquad \dots (59)$$

$$\Delta_{R_t^{nat} R_{7t}^{*\ nat}} = E_t\hat{s}_{7t+1}^{nat} - \hat{s}_{7t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H7t+1}^{*} + u_t \qquad \dots (60)$$

$$\Delta_{R_t^{nat} R_{8t}^{*\ nat}} = E_t\hat{s}_{8t+1}^{nat} - \hat{s}_{8t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H8t+1}^{*} + u_t \qquad \dots (61)$$

$$\Delta_{R_t^{nat} R_{9t}^{*\ nat}} = E_t\hat{s}_{9t+1}^{nat} - \hat{s}_{9t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H9t+1}^{*} + u_t \qquad \dots (62)$$

$$\Delta_{R_t^{nat} R_{10t}^{*\ nat}} = E_t\hat{s}_{10t+1}^{nat} - \hat{s}_{10t}^{nat} + E_t\pi_{Ht+1} - E_t\pi_{H10t+1}^{*} + u_t \qquad \dots (63)$$

$$\Delta_{R_{1t}^{*\ nat} R_t^{nat}} = \hat{s}_{1\cdot 0_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 0_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{Ht+1} + u_t \qquad \dots (64)$$

$$\Delta_{R_{1t}^{*\ nat} R_{2t}^{*\ nat}} = \hat{s}_{1\cdot 2_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 2_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H2t+1}^{*} + u_t \qquad \dots (65)$$

$$\Delta_{R_{1t}^{*\ nat} R_{3t}^{*\ nat}} = \hat{s}_{1\cdot 3_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 3_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H3t+1}^{*} + u_t \qquad \dots (66)$$

$$\Delta_{R_{1t}^{*\ nat} R_{4t}^{*\ nat}} = \hat{s}_{1\cdot 4_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 4_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H4t+1}^{*} + u_t \qquad \dots (67)$$

$$\Delta_{R_{1t}^{*\ nat} R_{5t}^{*\ nat}} = \hat{s}_{1\cdot 5_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 5_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H5t+1}^{*} + u_t \qquad \dots (68)$$

$$\Delta_{R_{1t}^{*\ nat} R_{6t}^{*\ nat}} = \hat{s}_{1\cdot 6_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 6_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H6t+1}^{*} + u_t \qquad \dots (69)$$

$$\Delta_{R_{1t}^{*\ nat} R_{7t}^{*\ nat}} = \hat{s}_{1\cdot 7_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 7_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H7t+1}^{*} + u_t \qquad \dots (70)$$

$$\Delta_{R_{1t}^{*\ nat} R_{8t}^{*\ nat}} = \hat{s}_{1\cdot 8_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 8_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H8t+1}^{*} + u_t \qquad \dots (71)$$

$$\Delta_{R_{1t}^{*\ nat} R_{9t}^{*\ nat}} = \hat{s}_{1\cdot 9_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 9_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H9t+1}^{*} + u_t \qquad \dots (72)$$

$$\Delta_{R_{1t}^{*\ nat} R_{10t}^{*\ nat}} = \hat{s}_{1\cdot 10_{t+1}}^{*\ \ nat} - \hat{s}_{1\cdot 10_t}^{*\ \ nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H10t+1}^{*} + u_t \qquad \dots (73)$$

$$\tilde{y}^*_{T2t} = \beth^*_2 \, \tilde{y}^*_{T2t-1} + \varepsilon^*_{T2t} \qquad \dots (74)$$

$$\tilde{y}^*_{T3t} = \beth^*_3 \, \tilde{y}^*_{T3t-1} + \varepsilon^*_{T3t} \qquad \dots (75)$$

$$\tilde{y}^*_{T4t} = \beth^*_4 \, \tilde{y}^*_{T4t-1} + \varepsilon^*_{T4t} \qquad \dots (76)$$

$$\tilde{y}^*_{T5t} = \beth^*_5 \, \tilde{y}^*_{T5t-1} + \varepsilon^*_{T5t} \qquad \dots (77)$$

$$\tilde{y}^*_{T6t} = \beth^*_6 \, \tilde{y}^*_{T6t-1} + \varepsilon^*_{T6t} \qquad \dots (78)$$

$$\tilde{y}^*_{T7t} = \beth^*_7 \, \tilde{y}^*_{T7t-1} + \varepsilon^*_{T7t} \qquad \dots (79)$$

$$\tilde{y}^*_{T8t} = \beth^*_8 \, \tilde{y}^*_{T8t-1} + \varepsilon^*_{T8t} \qquad \dots (80)$$

$$\tilde{y}^*_{T9t} = \beth^*_9 \, \tilde{y}^*_{T9t-1} + \varepsilon^*_{T9t} \qquad \dots (81)$$

$$\tilde{y}^*_{T10t} = \beth^*_{10} \, \tilde{y}^*_{T10t-1} + \varepsilon^*_{T10t} \qquad \dots (82)$$

$$\tilde{y}_{Nt} = \frac{1}{\kappa_N} E_t[\pi_{Nt} - \beta^{\blacksquare} \, \pi_{Nt+1}] \qquad \dots (83)$$

$$\tilde{y}_{Tt} = \frac{1}{\kappa_T} E_t[\pi_{Ht} - \beta^{\blacksquare} \, \pi_{Ht+1}] \qquad \dots (84)$$

$$\pi_{Nt} = -\frac{(1+\kappa_N)}{(1+\kappa_N+\beta^{\blacksquare}\,\theta_N)}\left(\tilde{y}_{Nt} - \hat{r}_{t-1} + \alpha\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) - \alpha\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_N+\beta^{\blacksquare}\,\theta_N)}\tilde{y}_{Nt-2} \qquad \dots (85)$$

$$\pi_{Ht} = -\frac{(1+\kappa_T)}{(1+\kappa_T+\beta^{\blacksquare}\,\theta_T)}\left(\tilde{y}_{Tt} - \hat{r}_{t-1} - (1-\alpha)\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) + (1-\alpha)\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_T+\beta^{\blacksquare}\,\theta_T)}\tilde{y}_{Tt-2} \qquad \dots (86)$$

$$\hat{r}_t = \frac{1}{[1-\alpha(1-\omega_0)]}\left\{\begin{array}{c}(1-\alpha)E_t\left(\tilde{y}_{Nt+1} + \pi_{Nt+1} + \alpha\,(\hat{a}_{Nt+1} - \hat{a}_{Nt}) - \alpha\,(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right)\\ +\alpha\omega_0\, E_t\left(\tilde{y}_{Tt+1} + \pi_{Ht+1} - (1-\alpha)(\hat{a}_{Nt+1} - \hat{a}_{Nt}) + (1-\alpha)(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right)\end{array}\right\} \qquad \dots (87)$$

$$\tilde{y}^*_{N1t} = \frac{1}{\kappa^*_{N1}} E_t[\pi^*_{N1t} - \beta^{\blacksquare} \, \pi^*_{N1t+1}] \qquad \dots (88)$$

$$\tilde{y}^*_{T1t} = \frac{1}{\kappa^*_{T1}} E_t[\pi^*_{H1t} - \beta^{\blacksquare} \, \pi^*_{H1t+1}] \qquad \dots (89)$$

$$\pi^*_{N1t} = -\frac{(1+\kappa^*_{N1})}{(1+\kappa^*_{N1}+\beta^{\blacksquare}\theta^*_{N1})}\left(\tilde{y}^*_{N1t} - \hat{r}^*_{1t-1} + \alpha^*_1(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) - \alpha^*_1\,(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right) - \frac{1}{(1+\kappa^*_{N1}+\beta^{\blacksquare}\theta^*_{N1})}\tilde{y}^*_{N1t-2} \qquad \dots (90)$$

$$\pi^*_{H1t} = -\frac{(1+\kappa^*_{T1})}{(1+\kappa^*_{T1}+\beta^{\blacksquare}\theta^*_{T1})}\left(\tilde{y}^*_{T1t} - \hat{r}^*_{1t-1} - (1-\alpha^*_1)\,(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) + (1-\alpha^*_1)\,(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right) - \frac{1}{(1+\kappa^*_{T1}+\beta^{\blacksquare}\theta^*_{T1})}\tilde{y}^*_{T1t-2} \qquad \dots (91)$$

$$\hat{r}^*_{1t} = \frac{1}{[1-\alpha^*_1(1-\omega^*_1)]}\left\{\begin{array}{c}(1-\alpha^*_1)\,E_t\left(\tilde{y}^*_{N1t+1} + \pi^*_{N1t+1} + \alpha^*_1\,(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) - \alpha^*_1\,(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\right)\\ +\alpha^*_1\omega^*_1\, E_t\left(\tilde{y}^*_{T1t+1} + \pi^*_{T1t+1} - (1-\alpha^*_1)(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) + (1-\alpha^*_1)(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\right)\end{array}\right\} \qquad \dots (92)$$

- **For the "Multilateral Coordination" regime**

$$\hat{a}_{Nt} = \text{ƀ}_1 \ \hat{a}_{Nt-1} + \text{ƀ}_2 \ \hat{a}_{Tt-1} + \varepsilon_{Nt} \quad \dots (1)$$

$$\hat{a}_{Tt} = \varrho_1 \ \hat{a}_{Nt-1} + \varrho_2 \ \hat{a}_{Tt-1} + \varepsilon_{Tt} \quad \dots (2)$$

$$\hat{a}^*_{N1t} = \text{ƀ}^*_{1\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \text{ƀ}^*_{1\cdot 2} \ \hat{a}^*_{T1t-1} + \varepsilon^*_{N1t} \quad \dots (3)$$

$$\hat{a}^*_{T1t} = \varrho^*_{1\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{1\cdot 2} \ \hat{a}^*_{T1t-1} + \varepsilon^*_{T1t} \quad \dots (4)$$

$$\hat{a}^*_{N2t} = \text{ƀ}^*_{2\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \text{ƀ}^*_{2\cdot 2} \ \hat{a}^*_{T2t-1} + \varepsilon^*_{N2t} \quad \dots (5)$$

$$\hat{a}^*_{T2t} = \varrho^*_{2\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{2\cdot 2} \ \hat{a}^*_{T2t-1} + \varepsilon^*_{T2t} \quad \dots (6)$$

$$\hat{a}^*_{N3t} = \text{ƀ}^*_{3\cdot 1} \ \hat{a}^*_{N3t\cdot 1} + \text{ƀ}^*_{3\cdot 2} \ \hat{a}^*_{T3t-1} + \varepsilon^*_{N3t} \quad \dots (7)$$

$$\hat{a}^*_{T3t} = \varrho^*_{3\cdot 1} \ \hat{a}^*_{N3t-1} + \varrho^*_{3\cdot 2} \ \hat{a}^*_{T3t-1} + \varepsilon^*_{T3t} \quad \dots (8)$$

$$\hat{a}^*_{N4t} = \text{ƀ}^*_{4\cdot 1} \ \hat{a}^*_{N4t\cdot 1} + \text{ƀ}^*_{4\cdot 2} \ \hat{a}^*_{T4t-1} + \varepsilon^*_{N4t} \quad \dots (9)$$

$$\hat{a}^*_{T4t} = \varrho^*_{4\cdot 1} \ \hat{a}^*_{N4t\cdot 1} + \varrho^*_{4\cdot 2} \ \hat{a}^*_{T4t-1} + \varepsilon^*_{T4t} \quad \dots (10)$$

$$\hat{a}^*_{N5t} = \text{ƀ}^*_{5\cdot 1} \ \hat{a}^*_{N5t\cdot 1} + \text{ƀ}^*_{5\cdot 2} \ \hat{a}^*_{T5t-1} + \varepsilon^*_{N5t} \quad \dots (11)$$

$$\hat{a}^*_{T5t} = \varrho^*_{5\cdot 1} \ \hat{a}^*_{N5t\cdot 1} + \varrho^*_{5\cdot 2} \ \hat{a}^*_{T5t-1} + \varepsilon^*_{T5t} \quad \dots (12)$$

$$\hat{a}^*_{N6t} = \text{ƀ}^*_{6\cdot 1} \ \hat{a}^*_{N6t\cdot 1} + \text{ƀ}^*_{6\cdot 2} \ \hat{a}^*_{T6t-1} + \varepsilon^*_{N6t} \quad \dots (13)$$

$$\hat{a}^*_{T6t} = \varrho^*_{6\cdot 1} \ \hat{a}^*_{N6t\cdot 1} + \varrho^*_{6\cdot 2} \ \hat{a}^*_{T6t-1} + \varepsilon^*_{T6t} \quad \dots (14)$$

$$\hat{a}^*_{N7t} = \text{ƀ}^*_{7\cdot 1} \ \hat{a}^*_{N7t\cdot 1} + \text{ƀ}^*_{7\cdot 2} \ \hat{a}^*_{T7t-1} + \varepsilon^*_{N7t} \quad \dots (15)$$

$$\hat{a}^*_{T7t} = \varrho^*_{7\cdot 1} \ \hat{a}^*_{N7t\cdot 1} + \varrho^*_{7\cdot 2} \ \hat{a}^*_{T7t-1} + \varepsilon^*_{T7t} \quad \dots (16)$$

$$\hat{a}^*_{N8t} = \text{ƀ}^*_{8\cdot 1} \ \hat{a}^*_{N8t\cdot 1} + \text{ƀ}^*_{8\cdot 2} \ \hat{a}^*_{T8t-1} + \varepsilon^*_{N8t} \quad \dots (17)$$

$$\hat{a}^*_{T8t} = \varrho^*_{8\cdot 1} \ \hat{a}^*_{N8t\cdot 1} + \varrho^*_{8\cdot 2} \ \hat{a}^*_{T8t-1} + \varepsilon^*_{T8t} \quad \dots (18)$$

$$\hat{a}^*_{N9t} = \text{ƀ}^*_{9\cdot 1} \ \hat{a}^*_{N9t\cdot 1} + \text{ƀ}^*_{9\cdot 2} \ \hat{a}^*_{T9t-1} + \varepsilon^*_{N9t} \quad \dots (19)$$

$$\hat{a}^*_{T9t} = \varrho^*_{9\cdot 1} \ \hat{a}^*_{N9t\cdot 1} + \varrho^*_{9\cdot 2} \ \hat{a}^*_{T9t-1} + \varepsilon^*_{T9t} \quad \dots (20)$$

$$\hat{a}^*_{N10t} = \text{ƀ}^*_{10\cdot 1} \ \hat{a}^*_{N10t\cdot 1} + \text{ƀ}^*_{10\cdot 2} \ \hat{a}^*_{T10t-1} + \varepsilon^*_{N10t} \quad \dots (21)$$

$$\hat{a}^*_{T10t} = \varrho^*_{10\cdot 1} \ \hat{a}^*_{N10t\cdot 1} + \varrho^*_{10\cdot 2} \ \hat{a}^*_{T10t-1} + \varepsilon^*_{T10t} \quad \dots (22)$$

$$\hat{y}^{nat}_{Nt} = \hat{a}_{Nt} \quad \dots (23)$$

$$\hat{y}^{nat}_{Tt} = \hat{a}_{Tt} \quad \dots (24)$$

$$\hat{y}_{N1t}^{*}{}^{nat} = \hat{a}_{N1t}^{*} \quad \ldots (25)$$

$$\hat{y}_{T1t}^{*}{}^{nat} = \hat{a}_{T1t}^{*} \quad \ldots (26)$$

$$\hat{y}_{N2t}^{*}{}^{nat} = \hat{a}_{N2t}^{*} \quad \ldots (27)$$

$$\hat{y}_{T2t}^{*}{}^{nat} = \hat{a}_{T2t}^{*} \quad \ldots (28)$$

$$\hat{y}_{N3t}^{*}{}^{nat} = \hat{a}_{N3t}^{*} \quad \ldots (29)$$

$$\hat{y}_{T3t}^{*}{}^{nat} = \hat{a}_{T3t}^{*} \quad \ldots (30)$$

$$\hat{y}_{N4t}^{*}{}^{nat} = \hat{a}_{N4t}^{*} \quad \ldots (31)$$

$$\hat{y}_{T4t}^{*}{}^{nat} = \hat{a}_{T4t}^{*} \quad \ldots (32)$$

$$\hat{y}_{N5t}^{*}{}^{nat} = \hat{a}_{N5t}^{*} \quad \ldots (33)$$

$$\hat{y}_{T5t}^{*}{}^{nat} = \hat{a}_{T5t}^{*} \quad \ldots (34)$$

$$\hat{y}_{N6t}^{*}{}^{nat} = \hat{a}_{N6t}^{*} \quad \ldots (35)$$

$$\hat{y}_{T6t}^{*}{}^{nat} = \hat{a}_{T6t}^{*} \quad \ldots (36)$$

$$\hat{y}_{N7t}^{*}{}^{nat} = \hat{a}_{N7t}^{*} \quad \ldots (37)$$

$$\hat{y}_{T7t}^{*}{}^{nat} = \hat{a}_{T7t}^{*} \quad \ldots (38)$$

$$\hat{y}_{N8t}^{*}{}^{nat} = \hat{a}_{N8t}^{*} \quad \ldots (39)$$

$$\hat{y}_{T8t}^{*}{}^{nat} = \hat{a}_{T8t}^{*} \quad \ldots (40)$$

$$\hat{y}_{N9t}^{*}{}^{nat} = \hat{a}_{N9t}^{*} \quad \ldots (41)$$

$$\hat{y}_{T9t}^{*}{}^{nat} = \hat{a}_{T9t}^{*} \quad \ldots (42)$$

$$\hat{y}_{N10t}^{*}{}^{nat} = \hat{a}_{N10t}^{*} \quad \ldots (43)$$

$$\hat{y}_{T10t}^{*}{}^{nat} = \hat{a}_{T10t}^{*} \quad \ldots (44)$$

$$\hat{s}_{1t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T1t}^{*} \quad \ldots (45)$$

$$\hat{s}_{2t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T2t}^{*} \quad \ldots (46)$$

$$\hat{s}_{3t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T3t}^{*} \quad \ldots (47)$$

$$\hat{s}_{4t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T4t}^{*} \quad \ldots (48)$$

$$\hat{s}_{5t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T5t}^{*} \quad \ldots (49)$$

$$\hat{s}_{6t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T6t}^{*} \quad \ldots (50)$$

$$\hat{s}_{7t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T7t}^{*} \quad \ldots (51)$$

$$\hat{s}_{8t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T8t}^{*} \quad \ldots (52)$$

$$\hat{s}_{9t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T9t}^{*} \quad \ldots (53)$$

$$\hat{s}_{10t}^{nat} = \hat{a}_{Tt} - \hat{a}_{T10t}^{*} \quad \ldots (54)$$

$$\hat{c}_{t}^{A^{nat}} = (1-\alpha)\, \hat{a}_{Nt} + \alpha\omega_0\, \hat{a}_{Tt} - \alpha \sum_{n=1}^{10} \omega_n\, \hat{s}_{t}^{nat} \quad \ldots (55)$$

$$\widehat{rr}_{t}^{nat} = E_t\, \Delta\, \hat{c}_{t+1}^{nat} = 0 \quad \ldots (56)$$

$$\hat{q}_{Nt}^{nat} \equiv \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha \sum_{n=1}^{10} \omega_n\, \hat{s}_{nt}^{nat} \quad \ldots (57)$$

$$\hat{s}_{1\cdot 0_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{Tt} \quad \ldots (58)$$

$$\hat{s}_{1\cdot 2_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T2t}^{*} \quad \ldots (59)$$

$$\hat{s}_{1\cdot 3_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T3t}^{*} \quad \ldots (60)$$

$$\hat{s}_{1\cdot 4_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T4t}^{*} \quad \ldots (61)$$

$$\hat{s}_{1\cdot 5_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T5t}^{*} \quad \ldots (62)$$

$$\hat{s}_{1\cdot 6_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T6t}^{*} \quad \ldots (63)$$

$$\hat{s}_{1\cdot 7_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T7t}^{*} \quad \ldots (64)$$

$$\hat{s}_{1\cdot 8_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T8t}^{*} \quad \ldots (65)$$

$$\hat{s}_{1\cdot 9_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T9t}^{*} \quad \ldots (66)$$

$$\hat{s}_{1\cdot 10_t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{T10t}^{*} \quad \ldots (67)$$

$$\hat{c}_{1t}^{A*^{nat}} = (1-\alpha_1^{*})\, \hat{a}_{N1t}^{*} + \alpha_1^{*}\, \omega_1^{*}\, \hat{a}_{T1t}^{*} - \alpha_1^{*} \sum_{n=0,n\neq 1}^{10} \omega_{1\cdot n}^{*}\, \hat{s}_{1\cdot n_t}^{*\;nat} \quad \ldots (68)$$

$$\widehat{rr}_{1t}^{*\;nat} = E_t\, \Delta \hat{c}_{1t+1}^{A*\;nat} = 0 \quad \ldots (69)$$

$$\hat{q}_{N1t}^{*\;nat} = \hat{a}_{T1t}^{*} - \hat{a}_{N1t}^{*} - \alpha_1^{*} \sum_{n=0,n\neq 1}^{10} \omega_{1\cdot n}^{*}\, \hat{s}_{1\cdot n_t}^{*\;nat} \quad \ldots (70)$$

…

$$\hat{s}^{*}_{k-0_t}{}^{nat} = \hat{a}^{*}_{Tkt} - \hat{a}_{Tt} \quad \dots (71)$$

$$\hat{s}^{*}_{k-1_t}{}^{nat} = \hat{a}^{*}_{Tkt} - \hat{a}^{*}_{Tkt} \quad \dots (72)$$

…

$$\hat{s}^{*}_{k\cdot n_t, n\neq k}{}^{nat} = \hat{a}^{*}_{Tkt} - \hat{a}^{*}_{Tnt} \quad \dots (73)$$

$$\hat{c}^{*}_{kt}{}^{nat} = (1-\alpha^{*}_{k})\, \hat{a}^{*}_{Nkt} + \alpha^{*}_{k}\, \omega^{*}_{k}\, \hat{a}^{*}_{Tkt} - \alpha^{*}_{k} \sum_{n=0, n\neq k}^{10} \omega^{*}_{k\cdot n}\, \hat{s}^{*}_{k\cdot n_t}{}^{nat} \quad \dots (74)$$

$$\widehat{rr}^{*}_{kt}{}^{nat} = E_t\, \Delta \hat{c}^{*}_{kt+1}{}^{nat} = 0 \quad \dots (75)$$

$$\hat{q}^{*}_{Nkt}{}^{nat} = \hat{a}^{*}_{Tkt} - \hat{a}^{*}_{Nkt} - \alpha^{*}_{k} \sum_{n=0, n\neq k}^{10} \omega^{*}_{k\cdot n}\, \hat{s}^{*}_{k\cdot n_t}{}^{nat} \quad \dots (76)$$

$$u_t = u_{t-1} + \varepsilon_{ut} \quad \dots (77)$$

$$\Delta_{R_t^{nat} R_{1t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{1t+1} - \hat{s}^{nat}_{1t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H1t+1} + u_t \quad \dots (78)$$

$$\Delta_{R_t^{nat} R_{2t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{2t+1} - \hat{s}^{nat}_{2t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H2t+1} + u_t \quad \dots (79)$$

$$\Delta_{R_t^{nat} R_{3t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{3t+1} - \hat{s}^{nat}_{3t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H3t+1} + u_t \quad \dots (80)$$

$$\Delta_{R_t^{nat} R_{4t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{4t+1} - \hat{s}^{nat}_{4t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H4t+1} + u_t \quad \dots (81)$$

$$\Delta_{R_t^{nat} R_{5t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{5t+1} - \hat{s}^{nat}_{5t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H5t+1} + u_t \quad \dots (82)$$

$$\Delta_{R_t^{nat} R_{6t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{6t+1} - \hat{s}^{nat}_{6t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H6t+1} + u_t \quad \dots (83)$$

$$\Delta_{R_t^{nat} R_{7t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{7t+1} - \hat{s}^{nat}_{7t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H7t+1} + u_t \quad \dots (84)$$

$$\Delta_{R_t^{nat} R_{8t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{8t+1} - \hat{s}^{nat}_{8t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H8t+1} + u_t \quad \dots (85)$$

$$\Delta_{R_t^{nat} R_{9t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{9t+1} - \hat{s}^{nat}_{9t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H9t+1} + u_t \quad \dots (86)$$

$$\Delta_{R_t^{nat} R_{10t}^{*}{}^{nat}} = E_t \hat{s}^{nat}_{10t+1} - \hat{s}^{nat}_{10t} + E_t \pi_{Ht+1} - E_t \pi^{*}_{H10t+1} + u_t \quad \dots (87)$$

$$\Delta_{R_{1t}^{*}{}^{nat} R_t^{nat}} = \hat{s}^{*}_{1\cdot 0_{t+1}}{}^{nat} - \hat{s}^{*}_{1\cdot 0_t}{}^{nat} + E_t \pi^{*}_{H1t+1} - E_t \pi_{Ht+1} + u_t \quad \dots (88)$$

$$\Delta_{R_{1t}^{*}{}^{nat} R_{2t}^{*}{}^{nat}} = \hat{s}^{*}_{1\cdot 2_{t+1}}{}^{nat} - \hat{s}^{*}_{1\cdot 2_t}{}^{nat} + E_t \pi^{*}_{H1t+1} - E_t \pi^{*}_{H2t+1} + u_t \quad \dots (89)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{3t}^{*}{}^{nat}} = \hat{s}_{1\cdot3_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot3_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H3t+1}^{*} + u_t \quad \dots (90)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{4t}^{*}{}^{nat}} = \hat{s}_{1\cdot4_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot4_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H4t+1}^{*} + u_t \quad \dots (91)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{5t}^{*}{}^{nat}} = \hat{s}_{1\cdot5_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot5_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H5t+1}^{*} + u_t \quad \dots (92)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{6t}^{*}{}^{nat}} = \hat{s}_{1\cdot6_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot6_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H6t+1}^{*} + u_t \quad \dots (93)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{7t}^{*}{}^{nat}} = \hat{s}_{1\cdot7_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot7_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H7t+1}^{*} + u_t \quad \dots (94)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{8t}^{*}{}^{nat}} = \hat{s}_{1\cdot8_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot8_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H8t+1}^{*} + u_t \quad \dots (95)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{9t}^{*}{}^{nat}} = \hat{s}_{1\cdot9_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot9_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H9t+1}^{*} + u_t \quad \dots (96)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{10t}^{*}{}^{nat}} = \hat{s}_{1\cdot10_{t+1}}^{*}{}^{nat} - \hat{s}_{1\cdot10_{t}}^{*}{}^{nat} + E_t\pi_{H1t+1}^{*} - E_t\pi_{H10t+1}^{*} + u_t \quad \dots (97)$$

…

$$\Delta_{R_{kt}^{*}{}^{nat}R_{t}^{nat}} = \hat{s}_{k\cdot0_{t+1}}^{*}{}^{nat} - \hat{s}_{k\cdot0_{t}}^{*}{}^{nat} + E_t\pi_{Hkt+1}^{*} - E_t\pi_{Ht+1} + u_t \quad \dots (98)$$

$$\Delta_{R_{kt}^{*}{}^{nat}R_{1t}^{*}{}^{nat}} = \hat{s}_{k\cdot1_{t+1}}^{*}{}^{nat} - \hat{s}_{k\cdot1_{t}}^{*}{}^{nat} + E_t\pi_{Hkt+1}^{*} - E_t\pi_{H1t+1}^{*} + u_t \quad \dots (99)$$

…

$$\Delta_{R_{kt}^{*}{}^{nat}R_{nt,n\neq k}^{*}{}^{nat}} = \hat{s}_{k\cdot n_{t+1},n\neq k}^{*}{}^{nat} - \hat{s}_{k\cdot n_{t},n}^{*}{}^{nat} + E_t\pi_{Hkt+1}^{*} - E_t\pi_{Hnt+1,n\neq k}^{*} + u_t \quad \dots (100)$$

$$\tilde{y}_{T(n-k)t}^{*} = \beth_{n-k}^{*}\, \tilde{y}_{T(n-k)t-1}^{*} + \varepsilon_{T(n-k)t}^{*} \quad \dots (101)$$

…

$$\tilde{y}_{Tnt}^{*} = \beth_{n}^{*}\, \tilde{y}_{Tnt-1}^{*} + \varepsilon_{Tnt}^{*} \quad \dots (102)$$

$$\tilde{y}_{Nt} = \frac{1}{\kappa_N} E_t[\pi_{Nt} - \beta^{\blacktriangle}\, \pi_{Nt+1}] \quad \dots (103)$$

$$\tilde{y}_{Tt} = \frac{1}{\kappa_T} E_t[\pi_{Ht} - \beta^{\blacktriangle}\, \pi_{Ht+1}] \quad \dots (104)$$

$$\pi_{Nt} = -\frac{(1+\kappa_N)}{(1+\kappa_N+\beta^{\blacktriangle}\,\theta_N)}\left(\tilde{y}_{Nt} - \hat{r}_{t-1} + \alpha\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) - \alpha\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_N+\beta^{\blacktriangle}\,\theta_N)}\tilde{y}_{Nt-2} \quad \dots (105)$$

$$\pi_{Ht} = -\frac{(1+\kappa_T)}{(1+\kappa_T+\beta^{\blacktriangle}\,\theta_T)}\left(\tilde{y}_{Tt} - \hat{r}_{t-1} - (1-\alpha)\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) + (1-\alpha)\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_T+\beta^{\blacktriangle}\,\theta_T)}\tilde{y}_{Tt-2}$$

… (106)

$$\hat{r}_t = \frac{1}{[1-\alpha(1-\omega_0)]}\begin{Bmatrix} (1-\alpha)E_t\left(\tilde{y}_{Nt+1} + \pi_{Nt+1} + \alpha\left(\hat{a}_{Nt+1} - \hat{a}_{Nt}\right) - \alpha\left(\hat{a}_{Tt+1} - \hat{a}_{Tt}\right)\right) \\ +\alpha\omega_0\, E_t\left(\tilde{y}_{Tt+1} + \pi_{Ht+1} - (1-\alpha)(\hat{a}_{Nt+1} - \hat{a}_{Nt}) + (1-\alpha)(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right)\end{Bmatrix} \quad \dots (107)$$

$$\tilde{y}^*_{N1t} = \frac{1}{\kappa^*_{N1}}\, E_t[\pi^*_{N1t} - \beta^{\blacktriangle}\, \pi^*_{N1t+1}] \quad \dots (108)$$

$$\tilde{y}^*_{T1t} = \frac{1}{\kappa^*_{T1}}\, E_t[\pi^*_{H1t} - \beta^{\blacktriangle}\, \pi^*_{H1t+1}] \quad \dots (109)$$

$$\pi^*_{N1t} = -\frac{(1+\kappa^*_{N1})}{(1+\kappa^*_{N1}+\beta^{\blacktriangle}\theta^*_{N1})}\left(\tilde{y}^*_{N1t} - \hat{r}^*_{1t-1} + \alpha^*_1(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) - \alpha^*_1\,(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right) - \frac{1}{(1+\kappa^*_{N1}+\beta^{\blacktriangle}\theta^*_{N1})}\tilde{y}^*_{N1t-2} \quad \dots (110)$$

$$\pi^*_{H1t} = -\frac{(1+\kappa^*_{T1})}{(1+\kappa^*_{T1}+\beta^{\blacktriangle}\theta^*_{T1})}\left(\tilde{y}^*_{T1t} - \hat{r}^*_{1t-1} - (1-\alpha^*_1)\;(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) + (1-\alpha^*_1)\,(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right) - \frac{1}{(1+\kappa^*_{T1}+\beta^{\blacktriangle}\theta^*_{T1})}\tilde{y}^*_{T1t-2} \quad \dots (111)$$

$$\hat{r}^*_{1t} = \frac{1}{[1-\alpha^*_1(1-\omega^*_1)]}\begin{Bmatrix} (1-\alpha^*_1)\, E_t\left(\tilde{y}^*_{N1t+1} + \pi^*_{N1t+1} + \alpha^*_1\,(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) - \alpha^*_1\,(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\right) \\ +\alpha^*_1\omega^*_1\, E_t\left(\tilde{y}^*_{T1t+1} + \pi^*_{T1t+1} - (1-\alpha^*_1)(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) + (1-\alpha^*_1)(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\right)\end{Bmatrix}$$

… (112)

…

$$\tilde{y}^*_{Nkt} = \frac{1}{\kappa^*_{Nk}}\, E_t[\pi^*_{Nkt} - \beta^{\blacktriangle}\, \pi^*_{Nkt+1}] \quad \dots (113)$$

$$\tilde{y}^*_{Tkt} = \frac{1}{\kappa^*_{Tk}}\, E_t[\pi^*_{Hkt} - \beta^{\blacktriangle}\, \pi^*_{Hkt+1}] \quad \dots (114)$$

$$\pi^*_{Nkt} = -\frac{(1+\kappa^*_{Nk})}{(1+\kappa^*_{Nk}+\beta^{\blacktriangle}\theta^*_{Nk})}\left(\tilde{y}^*_{Nkt} - \hat{r}^*_{kt-1} + \alpha^*_k(\hat{a}^*_{Nkt} - \hat{a}^*_{Nkt-1}) - \alpha^*_k\,(\hat{a}^*_{Tkt} - \hat{a}^*_{Tkt-1})\right) - \frac{1}{(1+\kappa^*_{Nk}+\beta^{\blacktriangle}\theta^*_{Nk})}\tilde{y}^*_{Nkt-k} \quad \dots (115)$$

$$\pi^*_{Hkt} = -\frac{(1+\kappa^*_{Tk})}{(1+\kappa^*_{Tk}+\beta^{\blacktriangle}\theta^*_{Tk})}\left(\tilde{y}^*_{Tkt} - \hat{r}^*_{kt-1} - (1-\alpha^*_k)\;(\hat{a}^*_{Nkt} - \hat{a}^*_{Nkt-1}) + (1-\alpha^*_k)\,(\hat{a}^*_{Tkt} - \hat{a}^*_{Tkt-1})\right) - \frac{1}{(1+\kappa^*_{Tk}+\beta^{\blacktriangle}\theta^*_{Tk})}\tilde{y}^*_{Tkt-k} \quad \dots (116)$$

$$\hat{r}^*_{kt} = \frac{1}{[1-\alpha^*_k(1-\omega^*_k)]}\begin{Bmatrix} (1-\alpha^*_k)\, E_t\left(\tilde{y}^*_{Nkt+1} + \pi^*_{Nkt+1} + \alpha^*_k\,(\hat{a}^*_{Nkt+1} - \hat{a}^*_{Nkt}) - \alpha^*_k\,(\hat{a}^*_{Tkt+1} - \hat{a}^*_{Tkt})\right) \\ +\alpha^*_k\omega^*_k\, E_t\left(\tilde{y}^*_{Tkt+1} + \pi^*_{Tkt+1} - (1-\alpha^*_k)(\hat{a}^*_{Nkt+1} - \hat{a}^*_{Nkt}) + (1-\alpha^*_k)(\hat{a}^*_{Tkt+1} - \hat{a}^*_{Tkt})\right)\end{Bmatrix}$$

… (117)

4.2. Results

4.2.1. Parameter Estimates and Derived Parameter Values

Appendix 4.2. displays the results of parameter estimation for the ASEAN-5+3 countries. Appendix 4.3. shows the results of Z-test to determine whether there are significant differences between parameter values under different interaction regimes: ”No Coordination” (NC), ”Bilateral Coordination” (BC), and ”Multilateral Coordination” (MC). Appendix 4.4. displays the values of derived parameters.

There is no clear pattern of value changes when a country moves from one regime to another. It implies that the parameter values are specifically determined by the economic structures of the interacting countries.

Parameter values of responsiveness of pricing decisions to variation in the real marginal cost gap in the traded sector (κ_T) are higher than the parameter values of responsiveness of pricing decisions to variation in the real marginal cost gap in the non-traded sector (κ_N). This finding applies for all the ASEAN-5+3 countries and in all types of interaction regimes.

The parameter estimates show rather diverse direction of inequalities signs between θ_N and θ_T across the ASEAN-5 countries. Under the NC regime, θ_T is greater than θ_N in the case of Indonesia, Singapore, Thailand, China, and South Korea; but θ_N is greater than θ_T in the case of Malaysia, the Philippines, and Japan. Under the BC regime, θ_T is greater than θ_N in the cases of Indonesia (with all partners), Singapore (with all partners), Thailand (with all partners), the Philippines (in BC with Singapore), China (with all partners), Japan (in BC with Singapore), and South Korea (with all partners); but θ_N is greater than θ_T in the cases of Malaysia (with all partners), the Philippines (in almost all cases, except in BC with Singapore), and Japan (in almost all cases, except in BC with Singapore). Under the MC regime, θ_T is greater than θ_N in the case of Indonesia (for all the 5 possible schemes), Singapore (for all the 5 possible schemes), Thailand (for all the 5 possible schemes), the Philippines (for almost all the 5 possible schemes, except for the ASEAN-5+3 scheme), China (for all the 3 possible schemes), Japan (for the ASEAN+3 scheme), and South Korea (for all the 3 possible schemes); but θ_N is greater than θ_T in the case of Malaysia (for all the 5 possible schemes), the Philippines (for the ASEAN-5+3 scheme), and Japan (for the CJK and the ASEAN-5 + Japan schemes).

The Z-test result shows that in most cases there are no significant differences between parameter values of non-traded sector (κ_N and θ_N) under the NC, BC, and MC regimes. This finding applies to all the ASEAN-5+3 countries. There are also no significant differences in most cases between parameter values of the traded sector (κ_T and θ_T) under the three interaction regimes – this finding applies to all the ASEAN-5+3 countries.

The values of derived parameter γ_N in almost all the ASEAN-5+3 (except for Malaysia) in most cases of NC and BC are higher than 50%, while for Malaysia the γ_N values are around 49% - 50%. These values imply that non-traded intermediate good producers in almost all the ASEAN-5 are likely to keep rather than changing their output prices in the presence of shock. In the ASEAN-5+3 MC scheme, the values of γ_N for Indonesia, Malaysia, and Thailand are lower than 10%; while the values of γ_N for Singapore, the Philippines, China, Japan, and South Korea are higher than 50%. In other MC schemes, the values of γ_N for almost all the ASEAN-5+3 countries tend to be higher than 50%, except for Malaysia's that lie around 49% - 50%. Meanwhile, the values of γ_T are less than 10% for all the ASEAN-5+3 countries in all interacting regimes, implying that traded intermediate good producers in these countries are more likely to change rather than keeping their outprices in the presence of shocks.

The direction of inequalities signs between μ_N and μ_T are rather diverse. Under the NC and BC regimes, θ_T is greater than θ_N in the case of Indonesia, Singapore, Thailand, and South Korea; θ_N is greater than θ_T in the case of Malaysia, the Philippines, and Japan; and θ_N is more or less equal to θ_T. Under the MC regime, θ_T is greater than θ_N in the case of Indonesia, Singapore, Thailand, the Philippines, South Korea, and China (except for the CJK MC scheme where θ_N is more or less equal to θ_T); while θ_N is greater than θ_T in the case of Malaysia and Japan.

4.2.2. Welfare

Tables 4.1. display the welfare values for each of the ASEAN-5+3 countries under the three interaction regimes: " No Coordination" (NC), "Bilateral Coordination" (BC), and "Multilateral Coordination" (MC). All variables in the model for each the ASEAN-5+3 economies have zero values in the steady state. It implies that the model has a unique solution for each country and for each interaction regime, and the all parameters of in the model converges.

The following are the findings with respect to the welfare of each of the ASEAN-5+3 countries:

(1) Indonesia

The highest welfare is achieved when Indonesia enters MC scheme with the ASEAN-5+3. The lowest welfare is when Indonesia bilaterally coordinates policy with Japan. Indonesia's welfare in the ASEAN-5 + China or ASEAN-5 + Japan is higher than its welfare under the NC regime and in any BC case. Indonesia's welfare in the ASEAN-5 MC is lower than its welfare under the NC regime. Indonesia's welfare under MC in the ASEAN-5 or the ASEAN-5 + South Korea scheme is lower than its welfare in BC with the Philippines, Malaysia, Singapore, or Thailand; but higher than in BC with South Korea, China, or Japan. Indonesia's welfare under the NC regime is higher than its welfare under any BC case.

(2) Malaysia

The highest welfare is achieved when Malaysia enters MC scheme with the ASEAN-5+3. The lowest welfare is when Malaysia bilaterally coordinates policy with Japan. Malaysia's welfare under MC in the ASEAN-5 + China or ASEAN-5 + Japan scheme is always higher than its welfare in the NC regime or any BC case. Malaysia's welfare in the MC with the ASEAN-5 or ASEAN-5 + South Korea scheme is higher than its welfare in the NC regime and in almost any BC case (except in BC with Indonesia). Meanwhile, Malaysia's welfare under the NC regime is higher than its welfare in almost any BC case, except BC with Indonesia and BC with the Philippines.

(3) Singapore

The highest welfare is achieved when Singapore enters MC scheme with the ASEAN-5+3. The lowest welfare is when Singapore bilaterally coordinates policy with Japan. Singapore's welfare under MC in the ASEAN + China or ASEAN-5 + Japan scheme is always higher than its welfare in the NC regime or any BC case. Singapore's welfare under MC in the ASEAN-5 or the ASEAN-5 + South Korea scheme is higher than its welfare in the NC regime or in almost any BC case (except in BC with Indonesia). Meanwhile, Singapore's welfare under the NC regime is lower than its welfare in almost any BC case, except BC with Japan.

(4) Thailand

The highest welfare is achieved when Thailand enters MC scheme with the ASEAN-5+3. The lowest welfare is when Thailand bilaterally coordinates policy with Japan. Thailand's welfare under MC in the ASEAN-5 + China or ASEAN-5 + Japan is always higher than its welfare in the NC regime or in any BC case. Thailand's welfare under MC in the ASEAN-5 or ASEAN-5 + South Korea scheme is higher than its welfare in the NC regime or in almost any BC case (except in BC with Indonesia). Meanwhile, Thailand's welfare under the NC regime is lower than its welfare in almost any BC case, except BC with Singapore and Japan.

(5) The Philippines

The highest welfare is achieved when the Philippines enters MC scheme with the ASEAN-5+3. The lowest welfare is when the Philippines bilaterally coordinates policy with Japan. The Philippines' welfare under MC in the ASEAN-5 + China or ASEAN-5 + Japan is always higher than its welfare in the NC regime or in any BC case. The Philippines' welfare under MC in the ASEAN-5 scheme is higher than its welfare in the NC regime or in almost any BC case (except in BC with Indonesia). The Philippines' welfare under MC in the ASEAN-5 + South Korea scheme is lower than its welfare in the NC regime, but higher than in almost any BC case (except in BC with Indonesia). Meanwhile, the Philippines welfare under the NC regime is higher than its welfare in almost any BC case, except BC with Indonesia.

(6) China

The highest welfare is achieved when China enters MC scheme with the ASEAN-5+3. The lowest welfare is when China enters the CJK MC scheme. China's welfare under MC in the ASEAN-5+3 scheme or ASEAN-5 + China is always higher than its welfare under the NC regime or in any BC case. China's welfare under the NC regime is lower than its welfare in almost any BC cases, except BC with Singapore and with Japan.

(7) Japan

The highest welfare is achieved when Japan enters MC scheme with the ASEAN-5+3. The lowest welfare is when Japan enters the CJK MC scheme. Japan's welfare under MC in the ASEAN-5+3 scheme or ASEAN-5 + Japan is always higher than its welfare under the NC regime or in any BC case. Japan's welfare under the NC regime is always lower than its welfare in any BC case with any other ASEAN-5+3 countries.

(8) South Korea

The highest welfare is achieved when South Korea enters MC scheme with the ASEAN-5+3. The lowest welfare is when Japan enters the CJK MC scheme. South Korea's welfare under MC in the ASEAN-5+3 scheme or ASEAN-5 + South Korea is always higher than its welfare under the NC regime or in any BC case. South Korea's welfare under the NC regime is higher than its welfare in BC cases with almost any other ASEAN-5+3 countries, except in BC with Indonesia and with the Philippines.

Table 4.2. displays the best to the worst ”potential” cooperation partners under the BC regime for each of the ASEAN-5+3 countries. Table 4.3. displays the best to worst ”potential” cooperation MC schemes for each of the ASEAN-5+3 countries. ”Potential” here means that while it may be beneficial for a country to enter a BC or an MC scheme to improve its welfare, policy coordination may or may not happen depending on whether such scheme also benefits the counterpart country (countries).

Indonesia is the best BC partner for almost all other ASEAN-5+3 countries, while Japan is the worst partner for all other countries in the group. Within the (sub)group of ASEAN-5 Indonesia is the best BC partner for other countries. Within the CJK (sub)group, China is the best BC partner for Japan and South Korea.

The ASEAN-5+3 scheme is the best MC scheme for all the ASEAN-5+3 countries. The ASEAN-5 + South Korea is the worst MC scheme for all the ASEAN-5 countries, while the CJK is the worst scheme for all the CJK countries.

Table 4.1. Welfare Values

- **No Coordination Cases**

	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	South Korea
Welfare	-0.08947	-0.09510	-0.09704	-0.09558	-0.09225	-0.09558	-0.09900	-0.09510

- **Bilateral Coordination Cases**

	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	South Korea
Indonesia	---	-0.09097	-0.09135	-0.09142	-0.09011	-0.09497	-0.09786	-0.09332
Malaysia	-0.09097	---	-0.09602	-0.09537	-0.09381	-0.09547	-0.09850	-0.09550
Singapore	-0.09135	-0.09602	---	-0.09618	-0.09476	-0.09562	-0.09891	-0.09582
Thailand	-0.09142	-0.09537	-0.09618	---	-0.09428	-0.09553	-0.09827	-0.09558
Philippines	-0.09011	-0.09381	-0.09476	-0.09428	---	-0.09542	-0.09840	-0.09508
China	-0.09497	-0.09547	-0.09562	-0.09553	-0.09542	---	-0.09713	-0.09557
Japan	-0.09786	-0.09850	-0.09891	-0.09827	-0.09840	-0.09713	---	-0.09833
South Korea	-0.09332	-0.09550	-0.09582	-0.09558	-0.09508	-0.09557	-0.09833	---

- **Multilateral Coordination Cases**

	CJK	ASEAN-5	ASEAN-5 + China	ASEAN-5 + Japan	ASEAN-5 + South Korea	ASEAN-5 + 3
Indonesia	---	-0.09221	-0.08864	-0.08221	-0.09285	1.76547
Malaysia	---	-0.09221	-0.08864	-0.08221	-0.09285	1.76547
Singapore	---	-0.09221	-0.08805	-0.08221	-0.09274	1.76547
Thailand	---	-0.09221	-0.08864	-0.08221	-0.09285	1.76547
Philippines	---	-0.09221	-0.08864	-0.08221	-0.09285	1.76547
China	-0.10827	---	-0.08864	---	---	1.76547
Japan	-0.10827	---	---	-0.08221	---	1.76547
South Korea	-0.10827	---	---	---	-0.09285	1.76547

Source: Author's calculation.

Table 4.2. Best to Worst "Potential" Bilateral Coordination Partners for the ASEAN-5+3 Countries

	1	2	3	4	5	6	7
Indonesia	Philippines	Malaysia	Singapore	Thailand	S. Korea	China	Japan
Malaysia	Indonesia	Philippines	Thailand	China	S. Korea	Singapore	Japan
Singapore	Indonesia	Philippines	China	S. Korea	Malaysia	Thailand	Japan
Thailand	Indonesia	Philippines	Malaysia	China	S. Korea	Singapore	Japan
Philippines	Indonesia	Malaysia	Thailand	Singapore	S. Korea	China	Japan
China	Indonesia	Philippines	Malaysia	Thailand	S. Korea	Singapore	Japan
Japan	China	Indonesia	Thailand	S. Korea	Philippines	Malaysia	Singapore
S. Korea	Indonesia	Philippines	Malaysia	China	Thailand	Singapore	Japan

(1) Within the ASEAN-5 Group

	1	2	3	4
Indonesia	Philippines	Malaysia	Singapore	Thailand
Malaysia	Indonesia	Philippines	Thailand	Singapore
Singapore	Indonesia	Philippines	Malaysia	Thailand
Thailand	Indonesia	Philippines	Malaysia	Singapore
Philippines	Indonesia	Malaysia	Thailand	Singapore

(2) Within the CJK Group

	1	2
China	South Korea	Japan
Japan	China	South Korea
South Korea	China	Japan

Source: Author's calculation

Table 4.3. Best to Worst "Potential" Multilateral Coordination Schemes for the ASEAN-5+3 Countries

	1	2	3	4	5
Indonesia	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5	ASEAN-5 + S. Korea
Malaysia	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5	ASEAN-5 + S. Korea
Singapore	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5	ASEAN-5 + S. Korea
Thailand	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5	ASEAN-5 + S. Korea
Philippines	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5	ASEAN-5 + S. Korea
China	ASEAN-5+3	ASEAN-5 + China	CJK	---	---
Japan	ASEAN-5+3	ASEAN-5 + Japan	CJK	---	---
S. Korea	ASEAN-5+3	ASEAN-5 + S. Korea	CJK	---	---

Source: Author's calculation

4.2.3. Coordination Pay-off Matrixes

This section displays payoff matrices based on the assumption of one-shot-game with perfect information to examine which bilateral coordination or multilateral monetary policy coordination schemes are feasible for each of the ASEAN-5+3 countries. When dealing with its potential partner(s), each country can opt to coordinate or not to coordinate its policy.

4.2.3.1. Bilateral Coordination vs. No Coordination

The following are the payoff matrices for each of the ASEAN-5+3 countries when they choose between not coordinating (No Coordination) or coordinating policies (Coordination):

- **Indonesia - Malaysia**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for Malaysia is to coordinate policy (welfare loss = -0.09097). Policy coordination is <u>not feasible</u> in this scenario.

		MALAYSIA	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09510)	(-0.08947 ; -0.09097)
	Coordination	(-0.09097 ; -0.09510)	(-0.09097 ; -0.09097)

- **Indonesia - Singapore**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for Singapore is to coordinate policy (welfare loss = -0.09135). Policy coordination is <u>not feasible</u> in this scenario.

		SINGAPORE	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09704)	(-0.08947 ; -0.09135)
	Coordination	(-0.09135 ; -0.09704)	(-0.09135 ; -0.09135)

- **Indonesia – Thailand**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for Thailand is to coordinate policy (welfare loss = -0.09142). Policy coordination is <u>not feasible</u> in this scenario.

		THAILAND	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09558)	(-0.08947 ; -0.09142)
	Coordination	(-0.09142 ; -0.09558)	(-0.09142 ; -0.09142)

- **Indonesia – The Philippines**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for the Philippines is to coordinate (welfare loss = -0.09011). Policy coordination is <u>not feasible</u> in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09225)	(-0.08947 ; -0.09011)
	Coordination	(-0.09011 ; -0.09225)	(-0.09011 ; -0.09011)

- **Indonesia – China**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for China is to coordinate policy (welfare loss = -0.09497). Policy coordination is not feasible in this scenario.

		CHINA	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09558)	(-0.08947 ; -0.09497)
	Coordination	(-0.09497 ; -0.09558)	(-0.09497 ; -0.09497)

- **Indonesia – Japan**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09786). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09900)	(-0.08947 ; -0.09786)
	Coordination	(-0.09786 ; -0.09900)	(-0.09786 ; -0.09786)

- **Indonesia – South Korea**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08947), while the best strategy for South Korea is to coordinate (welfare loss = -0.09332). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08947 ; -0.09510)	(-0.08947 ; -0.09332)
	Coordination	(-0.09332 ; -0.09510)	(-0.09332 ; -0.09332)

- **Malaysia – Singapore**

  The best strategy for Malaysia is not to coordinate policy (welfare loss = -0.09510), while the best strategy for Singapore is to coordinate policy (welfare loss = -0.09602). Policy coordination is not feasible in this scenario.

		SINGAPORE	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09510 ; -0.09704)	(-0.09510 ; -0.09602)
	Coordination	(-0.09602 ; -0.09704)	(-0.09602 ; -0.09602)

- **Malaysia – Thailand**

  The best strategy for Malaysia is not to coordinate policy (welfare loss = -0.09510), while the best strategy for Thailand is to coordinate policy (welfare loss = -0.09537). Policy coordination is not feasible in this scenario.

		THAILAND	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09510 ; -0.09558)	(-0.09510 ; -0.09537)
	Coordination	(-0.09537 ; -0.09558)	(-0.09537 ; -0.09537)

- **Malaysia – The Philippines**
  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.09381), while the best strategy for the Philippines is not to coordinate (welfare loss = -0.09381). Policy coordination is not feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09510 ; -0.09225)	(-0.09510 ; -0.09381)
	Coordination	(-0.09381 ; -0.09225)	(-0.09381 ; -0.09381)

- **Malaysia – China**
  The best strategy for Malaysia is not to coordinate policy (welfare loss = -0.09510), while the best strategy for China is to coordinate policy (welfare loss = -0.09547). Policy coordination is not feasible in this scenario.

		CHINA	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09510 ; -0.09558)	(-0.09510 ; -0.09547)
	Coordination	(-0.09547 ; -0.09558)	(-0.09547 ; -0.09547)

- **Malaysia – Japan**
  The best strategy for Malaysia is not to coordinate policy (welfare loss = -0.09510), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09850). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09510 ; -0.09900)	(-0.09510 ; -0.09850)
	Coordination	(-0.09850 ; -0.09900)	(-0.09850 ; -0.09850)

- **Malaysia – South Korea**
  The best strategy for Malaysia is not to coordinate policy (welfare loss = -0.09510), while the best strategy for South Korea is not to coordinate (welfare loss = -0.09510). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09510 ; -0.09510)	(-0.09510 ; -0.09550)
	Coordination	(-0.09550 ; -0.09510)	(-0.09550 ; -0.09550)

- **Singapore – Thailand**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09618), while the best strategy for Thailand is not to coordinate (welfare loss = -0.09558). Policy coordination is not feasible in this scenario.

		THAILAND	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09704 ; -0.09558)	(-0.09704 ; -0.09618)
	Coordination	(-0.09618 ; -0.09558)	(-0.09618 ; -0.09618)

- **Singapore – The Philippines**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09476), while the best strategy for Philippines is not to coordinate (welfare loss = -0.09225). Policy coordination is not feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09704 ; -0.09225)	(-0.09704 ; -0.09476)
	Coordination	(-0.09476 ; -0.09225)	(-0.09476 ; -0.09476)

- **Singapore – China**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09562), while the best strategy for China is not to coordinate (welfare loss = -0.09558). Policy coordination is not feasible in this scenario.

		CHINA	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09704 ; -0.09558)	(-0.09704 ; -0.09562)
	Coordination	(-0.09562 ; -0.09558)	(-0.09562 ; -0.09562)

- **Singapore – Japan**
  The best strategy for Singapore is not to coordinate policy (welfare loss = -0.09704), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09891). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09704 ; -0.09900)	(-0.09704 ; -0.09891)
	Coordination	(-0.09891 ; -0.09900)	(-0.09891 ; -0.09891)

- **Singapore – South Korea**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09582), while the best strategy for Korea is not to coordinate policy (welfare loss = -0.09510). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09704 ; -0.09510)	(-0.09704 ; -0.09582)
	Coordination	(-0.09582 ; -0.09510)	(-0.09582 ; -0.09582)

- **Thailand – The Philippines**
  The best strategy for Thailand is to coordinate policy (welfare loss = -0.09428), while the best strategy for the Philippines is not to coordinate (welfare loss = -0.09225). Policy coordination is not feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
THAILAND	**No Coordination**	(-0.09558 ; -0.09225)	(-0.09558 ; -0.09428)
	Coordination	(-0.09428 ; -0.09225)	(-0.09428 ; -0.09428)

- **Thailand – China**
  The best strategy for Thailand is to coordinate policy (welfare loss = -0.09553), while the best strategy for China is to coordinate policy (welfare loss = -0.09553). Policy coordination is feasible in this scenario.

		CHINA	
		No Coordination	Coordination
THAILAND	No Coordination	(-0.09558 ; -0.09558)	(-0.09558; -0.09553)
	Coordination	(-0.09553 ; -0.09558)	(-0.09553; -0.09553)*

- **Thailand – Japan**
  The best strategy for Thailand is not to coordinate policy (welfare loss = -0.09558), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09827). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	Coordination
THAILAND	No Coordination	(-0.09558 ; -0.09900)	(-0.09558 ; -0.09827)
	Coordination	(-0.09827 ; -0.09900)	(-0.09827 ; -0.09827)

- **Thailand – South Korea**
  Thailand can opt to coordinate or not to coordinate policy (welfare loss = -0.09558), while the best strategy for Korea is not to coordinate policy (welfare loss = -0.09510). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	Coordination
THAILAND	No Coordination	(-0.09558 ; -0.09510)	(-0.09558 ; -0.09558)
	Coordination	(-0.09558 ; -0.09510)	(-0.09558 ; -0.09558)

- **The Philippines – China**
  The best strategy for Philippines is not to coordinate policy (welfare loss = -0.09225), while the best strategy for China is to coordinate policy (welfare loss = -0.09542). Policy coordination is not feasible in this scenario.

		CHINA	
		No Coordination	Coordination
THE PHILIPPINES	No Coordination	(-0.09225 ; -0.09558)	(-0.09225 ; -0.09542)
	Coordination	(-0.09542 ; -0.09558)	(-0.09542 ; -0.09542)

- **The Philippines – Japan**
  The best strategy for Philippines is not to coordinate policy (welfare loss = -0.09225), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09840). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	Coordination
THE PHILIPPINES	No Coordination	(-0.09225 ; -0.09900)	(-0.09225 ; -0.09840)
	Coordination	(-0.09840 ; -0.09900)	(-0.09840 ; -0.09840)

- **The Philippines – South Korea**
  The best strategy for Philippines is not to coordinate policy (welfare loss = -0.09225), while the best strategy for Korea is to coordinate policy (welfare loss = -0.09508). Policy coordination is <u>not feasible</u> in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
THE PHILIPPINES	**No Coordination**	(-0.09225 ; -0.09510)	(-0.09225 ; -0.09508)
	Coordination	(-0.09508 ; -0.09510)	(-0.09508 ; -0.09508)

- **China – Japan**
  The best strategy for China is not to coordinate policy (welfare loss = -0.09558), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09713). Policy coordination is <u>not feasible</u> in this scenario.

		JAPAN	
		No Coordination	**Coordination**
CHINA	**No Coordination**	(-0.09558 ; -0.09900)	(-0.09558 ; -0.09713)
	Coordination	(-0.09713 ; -0.09900)	(-0.09713 ; -0.09713)

- **China – South Korea**
  The best strategy for China is to coordinate policy (welfare loss = -0.09557), while the best strategy for South Korea is not to coordinate policy (welfare loss = -0.09510). Policy coordination is <u>not feasible</u> in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
CHINA	**No Coordination**	(-0.09558 ; -0.09510)	(-0.09558 ; -0.09557)
	Coordination	(-0.09557 ; -0.09510)	(-0.09557 ; -0.09557)

- **Japan – South Korea**
  The best strategy for Japan is to coordinate policy (welfare loss = -0.09833), while the best strategy for South Korea is not to coordinate policy (welfare loss = -0.09510). Policy coordination is <u>not feasible</u> in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
JAPAN	**No Coordination**	(-0.09900 ; -0.09510)	(-0.09900 ; -0.09833)
	Coordination	(-0.09833 ; -0.09510)	(-0.09833 ; -0.09833)

To summarize, the only feasible bilateral coordination in the one-production-factor model is bilateral coordination between Thailand and China.

4.2.3.2. Multilateral Coordination vs. No Coordination

As depicted in Table 4.4., multilateral coordination under the scheme of ASEAN-5 + China, ASEAN-5 + Japan, and ASEAN-5+3 are feasible for the participating countries. In these three scenarios, welfare for each participating country under the Multilateral Policy Coordination regime is higher than welfare under the No Coordination regime. Meanwhile, multilateral policy coordination under the ASEAN-5 and the CJK schemes are not feasible as these schemes only produce lower welfare for each participating country than the welfare level under the No Coordination regime.

Table 4.4. Multilateral Coordination vs. No Coordination Pay-off Matrixes

	No Coordination	ASEAN-5	ASEAN-5 + China*	ASEAN-5 + Japan*	ASEAN-5 + Korea	CJK	ASEAN-5 + CJK*
Indonesia	-0.08947	-0.09221	-0.08864	-0.08221	-0.09285	---	1.76547
Malaysia	-0.09510	-0.09221	-0.08864	-0.08221	-0.09285	---	1.76547
Singapore	-0.09704	-0.09221	-0.08864	-0.08221	-0.09285	---	1.76547
Thailand	-0.09558	-0.09221	-0.08864	-0.08221	-0.09285	---	1.76547
Philippines	-0.09225	-0.09221	-0.08864	-0.08221	-0.09285	---	1.76547
China	-0.09558	---	-0.08864	---	---	-0.10827	1.76547
Japan	-0.09900	---	---	-0.08221	---	-0.10827	1.76547
South Korea	-0.09510	---	---	---	-0.09285	-0.10827	1.76547

4.3. Analysis

In the one-production-factor model, the values of estimated and derived parameters are rather diverse across the ASEAN-5+3 countries, implying that country-specific factors determine the values. The value κ_T is higher than κ_N for all the ASEAN-5+3 countries in any interaction regime; implying that traded intermediate good producers are more price-sensitive than non-traded intermediate good producers. In line with the finding for κ_T, traded intermediate good producers in the ASEAN-5+3 countries are more likely to change prices in the presence of labor productivity or exchange rate shock (as shown by γ_T that are lower than 10% for all of these countries) than non-traded good producers (where γ_N for almost all the ASEAN-5+3 countries are higher than 50%, except for Malaysia whose values between 49% - 50%). Non-traded intermediate good producers are not flexible in changing their output prices in the presence of economic shock since they can only sell their product domestically, while traded intermediate good producers are more flexible in changing prices since they have access both to the domestic and foreign countries' markets.

The benefit of international policy coordination is the improvement of welfare for the participating countries. Welfare is defined as macroeconomic stability, as reflected by the welfare objective function that seek to minimize inflations and output gaps in the non-traded sectors. Meanwhile, the cost of policy coordination is the loss of flexibility for the central bank of the participating to country to conduct monetary policy in the presence of shock, compared to if it does not coordinate policy. Participating central banks must be committed to maintain their natural interest rate gap targets as jointly set with their partner in coordination. As such, the central bank is no longer flexible in hiking the interest rate in the case of high inflation or to cut interest rate to spur economic growth.

There are many components that affect welfare which are included in the model's system of equations in the one-production-factor model: (1) relative size of the country (in the case of NC) or participating countries (ρ); (2) non-traded sector inflation in each country (π_N); (3) traded sector inflation in each country (π_T); (4) output gap in the non-traded sector of each country ($\tilde{y}_N$); (5) output gap in the traded sector of each country ; (5) discount factor (ρ); (6) share of traded sector in each country's economy (α); (7) share of imported goods to total traded goods in each country's economy (ω_0); (8) share of imported traded goods from Foreign Country-n (n = 1, … 10) to total traded goods (ω_0); (9) responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector (κ_N); (10) responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector (κ_T);(11) elasticity of substitution between differentiated products in the non-traded sector (θ_N); (12) elasticity of substitution between differentiated products in the non-traded sector; and (13) elasticity of substitution between differentiated products in the traded sector (θ_T). Among these components, it is relative sizes of the participating countries that affects welfare in most cases of monetary policy coordination.

In the one-production-factor model, the ASEAN-5+3 MC provides the highest "potential welfare" for all participants. The second-best "potential" welfare for the ASEAN-5 countries and for Japan is obtained through BC with Japan; for China through the ASEAN-5 + China MC; and for South Korea through the ASEAN-5 + South Korea. For all the ASEAN-5 countries, BC with Japan is the worst policy option. Meanwhile, for the CJK countries, CJK MC is the worst policy option.

Results from the welfare pay-off matrix show that in the one-production-factor model, the BC regime is not feasible for almost all the ASEAN-5+3 countries (the exception is BC between Thailand and China). For at least one country in the bilateral pair, the welfare in the bilateral coordination is smaller than the welfare in the NC regime. It implies that the costs for establishing BC exceeds the benefits, except in the case of Thailand – China BC. The large of disparity in economic size is the main reason behind the low rate of policy coordination feasibility among the ASEAN-5 countries. As the model uses the weighted sum aggregated technology for the supply of impure public good (which is the welfare in the form of macroeconomic stability), a country with higher weight (here: bigger relative economic size) must bear higher cost although it will receive higher benefit (in the case of positive welfare). Assuming that the European Union is a single economy, China and Japan are the third and the fourth largest economy in the 11-Country World (Table 4.5.)

Table 4.5. Relative Economic Size (ρ) of the ASEAN-5 + 3 Countries in the Model (%)*

	EU	US	CN	JP	SK	AU	ID	TH	MY	SG	PH	TOTAL
ρ	35.52	32.67	12.89	10.87	2.36	2.32	1.35	0.65	0.50	0.46	0.41	**100.00**

Note: EU = European Union US = United States CN = China JP = Japan
SK = South Korea ID = Indonesia TH = Thailand MY = Malaysia
SG = Singapore PH = the Philippines

Source: Author's calculation

Within the ASEAN-5 group, bilateral coordination with Indonesia gives the highest welfare for other member countries in the group. For Indonesia, however, its welfare under the NC regime is always higher than bilateral coordination with other ASEAN-5 countries. Difference in size is the main factor here. As the biggest economy in the ASEAN-5 group, Indonesia must pay the highest cost to provide the club good in bilateral coordination while its partner pays less. The size of Indonesia's economy is 2.7 times of Malaysia, 2.9 times of Singapore, 2.1 times of the Philippines, and 3.3 times of the Philippines. This cost is particularly related to inflation control, as Indonesia has the highest inflation rate in the non-traded and traded sectors in the ASEAN-5 group (Table 4.6.). Bank Indonesia (Indonesia's central bank) is adopting inflation rate targeting regime for its monetary policy. By bilaterally coordinating policy, Bank Indonesia will lose flexibility in controlling inflation through interest rate instrument (in this case: to hike) because it will have to maintain the jointly set interest rate gap target for Indonesia.

Within the CJK group, both China and Japan will be better-off if not bilaterally coordinating policy with South Korea due to huge differences in economic size. The size of China's economy is about 5.5 times of Korea's economy, while Japan's is about 4.6 times of Korea's. To the People's Bank of China (China's central bank), BC with Korea will reduce its flexibility in using interest rate instrument (in this case: to cut) to reduce its relatively big output gap. To the Bank of Japan (Japan's central bank), BC with South Korea will cost its flexibility to use interest rate instrument (in this case: to cut) to simultaneously increase inflation and promote growth.

Despite the huge economic size difference between Thailand and China, Thailand – China BC is feasible. One possible explanation is because the close trade link between two countries in the global supply chain. Thailand - China BC will increase the elasticity of substitution of differentiated product (θ_T) in both countries, thus allowing final goods producers in the two countries to have more choices of intermediate outputs. This condition weakens the bargaining position of intermediate-good-producing firms in the treaded sector to increase prices of their products and in turn help to curb traded sector inflation in both countries.

Table 4.6. Average Inflation Rates and Output Gaps in the ASEAN-5+3 Countries (%), Q3-2003 – Q2-2018

	ID	MY	SG	TH	PH	CN	JP	SK
π_N	1.350	0.449	0.449	0.277	0.835	0.675	0.017	0.463
π_T	1.831	0.757	0.550	0.906	1.233	0.642	0.118	0.848
$\tilde{y}_N$	0.508	0.571	-0.107	0.132	0.635	2.129	0.017	0.072
$\tilde{y}_T$	0.238	-0.001	-0.394	-0.287	0.494	0.715	-0.270	-0.265

Source: Author's calculation

To have a feasible MC scheme, the benefits for each participating country must exceed the costs they bear. If this condition does not apply to at least one country, then the MC scheme is not feasible. There are more feasible cases in the MC schemes: ASEAN-5 + China, ASEAN-5 + Japan, and ASEAN-5+3. This implies that as more countries enter policy coordination, the individual country's cost for establishing regional macroeconomic stability declines. It is noticeable that the welfare value for each participating country in the ASEAN-5+3 MC is positive (as opposed to the negative welfare values in all cases of NC and BC as well as in almost all cases of MC).

The ASEAN-5 policy coordination is not feasible because of the economic size disparity. Indonesia as the biggest country in the group must bear most of the costs that exceeds the benefits it receives although it benefits the other ASEAN-5 countries). The CJK MC is also not feasible because of the size issue, where China's and Japan's costs for joining this MC exceeds the benefits. Despite the increasing number of participants compared to in the ASEAN-5 MC and the CJK MC, the ASEAN-5 + South Korea MC is not feasible, as the costs for Indonesia and South Korea still exceed the benefits they receive.

The main finding from the one-production-factor model in this study that there are some cases where policy coordination among the ASEAN-5+3 countries is feasible partly supports conclusions from Branson dan Healy (2005), Gupta (2012), and Tan (2014) that see international monetary policy coordination in the ASEAN-5, ASEAN-5+1, or Asia as feasible. The model shows that MC cases are more prospective than the BC cases. For the BC cases, the finding in this study is in line with conclusion from Sugandi (2016, 2018) that in general bilateral policy coordination is not feasible for the ASEAN-5 countries.

APPENDIX 4.1.

Definitions of Notations

- **Indexes and Mathematical Operators**

t = time index

n = country index

k = number of participating countries in Multilateral Coordination – 1

i = index for firms in the non-traded sector

j = index for firms in the traded sector

E_t = expectation operator in period t

E_0 = expectation operator in period t = 0

- **Parameters**

- Calculated Parameters

β = subjective discount factor in the Home economy

$\beta^{\blacksquare}$ = weighted joint subjective discount factor in Bilateral Coordination

$\beta^{\blacklozenge}$ = weighted joint subjective discount factor in Multilateral Coordination

ρ_0 = relative size of the Home economy to the total size of the 11 economies in the model

ρ_1 = relative size of Foreign Country-1 to the total size of the 11 economies in the model

ρ_k = relative size of Foreign Country-k to the total size of the 11 economies in the model

α = share of traded goods in the total goods in the home economy

α_1^* = share of traded goods in the total goods in Foreign Country-1

α_k^* = share of traded goods in the total goods in Foreign Country-k

ω_0 = share of domestically-produced traded goods to total traded goods in the Home economy

$\omega_{1\cdot 1}^*$ = share of domestically-produced traded goods to total traded goods in Foreign Country-1

$\omega_{k\cdot k}^*$ = share of domestically-produced traded goods to total traded goods in Foreign Country-k

ω_n = share of imported traded goods from Foreign Country-n to the total imported traded goods

$\omega_{1\cdot n, n\neq 1}^*$ = share of imported traded goods from other Foreign Country-n to total traded goods in Foreign Country-1

$\omega_{k\cdot n, n\neq 1}^*$ = share of imported traded goods from other Foreign Country-n to total traded goods in Foreign Country-k

$\omega_0 + \sum_{n=1}^{10} \omega_n = 1$

$\omega_{1\cdot 1}^* + \sum_{n=0, n\neq 1}^{10} \omega_{1\cdot n}^* = 1$

$\omega_{k\cdot k}^* + \sum_{n=0, n\neq k}^{10} \omega_{k\cdot n}^* = 1$

$\Psi =$ marginal disutility of labor

v = income elasticity of money demand in the Home economy

v_1^* = income elasticity of money demand in Foreign Country-1

ν_k^* = income elasticity of money demand in Foreign Country-k

- Calibrated Parameters

$\text{ƀ}_1 =$ parameter for shock from the non-traded sector in the Home economy's non-traded sector equation

$\text{ƀ}_2 =$ parameter for shock from the traded sector in the Home economy's non-traded sector equation

$\varrho_1 =$ parameter for shock from the non-traded sector in the Home economy's traded sector equation

$\varrho_2 =$ parameter for shock from the traded sector in the Home economy's traded sector equation

- Estimated Parameters

θ_N = elasticity of substitution between differentiated products in the non-traded sector of the Home economy

θ_{N1}^* = elasticity of substitution between differentiated products in the non-traded sector of Foreign Country-1

θ_{Nk}^* = elasticity of substitution between differentiated products in the non-traded sector of Foreign Country-k

θ_T = elasticity of substitution between differentiated products in the traded sector

θ_{T1}^* = elasticity of substitution between differentiated products in the traded sector of the Foreign Country-1

θ_{Tk}^* = elasticity of substitution between differentiated products in the traded sector of the Foreign Country-k

κ_N = responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector

κ_{N1}^* = responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector of Foreign Country-1

κ_{Nk}^* = responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector of Foreign Country-k

κ_T = responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector

κ_{T1}^* = responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector of Foreign Country-1

κ_{Tk}^* = responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector of Foreign Country-k

- **Variables**

- Productivity and Exchange Rate Shocks

A_{Nt} = productivity shock in the non-traded sector in period t

A_{Tt} = productivity shocks in the traded sector in period t

$\hat{a}_{Nt}$ = log-linearized productivity shock in the non-traded sector of the Home economy in period t

$\hat{a}^*_{N1t}$ = log-linearized productivity shock in the non-traded sector of Foreign Country-1 in period t

…

$\hat{a}^*_{N10t}$= log-linearized productivity shock in the non-traded sector of Foreign Country-10 in period t

$\hat{a}_{Tt}$ = log-linearized productivity shock in the traded sector of the Home economy in period t

$\hat{a}^*_{T1t}$ = log-linearized productivity shock in the traded sector of Foreign Country-1 in period t

…

$\hat{a}^*_{T10t}$= log-linearized productivity shock in the traded sector of Foreign Country-10 in period t

ε_{Nt} = error term in the productivity shock equation for the non-traded sector of the Home economy in period t

ε^*_{N1t} = error term in the productivity shock equation for the non-traded sector of Foreign Country-1 in period t

…

ε^*_{N10t} = error term in the productivity shock equation for the non-traded sector of Foreign Country-10 in period t

ε_{Tt} = error term in the productivity shock equation for the traded sector of the Home economy in period t

ε^*_{T1t} = error term in the productivity shock equation for traded sector of Foreign Country-1 in period t

…

ε^*_{T10t} = error term in the productivity shock equation for traded sector of Foreign Country-10 in period t

u_t = log-linearized global exchange rate shock felt by all countries

- Representative Households in the Home Economy (Analogously for Foreign Countries)

C_t = household's consumption of final goods in period t

$\check{C}_t$ = self-purchased household's consumption in period t

$\check{C}_{Nt}$ = self-purchased household's consumption of non-traded goods

$\check{C}_{Tt}$ = self-purchased household's consumption of traded goods in period t

$\check{C}_{Ht}$ = self-purchased household's consumption of domestically-produced traded goods in period t

$\check{C}_{Fnt}$ = self-purchased household's consumption of imported traded goods from Foreign Country-n in period t $(\check{C}_{Fnt})$

G_t = household's consumption of government-provided-goods in period t

$\frac{M_t}{P_t}$ = real money demand in period t

W_t = nominal wage in period t

L_t = labor supply (in ratio of working hours to total hours per week) in period t

TR_t = transfers from the government in period t

B_t = nominal amount of domestic government bonds held by household in period t
B^*_{nt} = nominal amount of Foreign Country-n government bonds held household in period t
R_t = nominal interest rate of bond in period t
t_L = income tax
t_C = consumption tax
P_t = aggregate price level in period t
$\bar{P}_{Nt}$ = price index of non-traded goods in period t
$\bar{P}_{Tt}$ = price index of traded goods in period t
$\bar{P}_{Ht}$ = price index of domestically-produced traded goods in period t
e_{nt} = exchange rate of domestic currency per currency of Foreign Country-n in period t
$e_{nt}\ \bar{P}^*_{Fnt}$ = price index of imported traded goods from Foreign Country-n measured in domestic currency in period t

- ***Representative Firms***
(Analogously for Foreign Countries)

\+ *Intermediate Goods Producers*
$Y_{Nt}(i)$ = non-traded intermediate good i produced in the Home economy in period t
$Y_{Tt}(j)$ = traded intermediate goods j produced in the Home economy in period t
$Y_{Ht}(j)$ = domestically produced traded intermediate goods sold in the Home economy in period t
$Y^*_{Hnt}(j)$ = domestically produced traded intermediate goods exported to Foreign Country-n in period t
$L_{NIt}(i)$ = labor input for firm producing non-traded intermediate good i in period t
γ_N = probability of non-traded intermediate good i producer to keep output price unchanged
τ_N = government subsidy for firm producing non-traded intermediate good i
V_{NIt} = unit cost of firm producing non-traded intermediate good i in period t
$L_{TIt}(j)$ = labor input for firm producing traded intermediate good j in period t
γ_T = probability traded intermediate good j producer to keep output price unchanged
τ_T = government subsidy for firm producing traded intermediate good j
V_{TIt} = unit cost of firm producing traded intermediate good j in period t

\+ *Final Goods Producers*
Y_{Nt} = aggregate demand for non-traded final goods in the Home economy period t
Y_{Tt} = aggregate demand for traded final goods in the Home economy in period t
Y_{Ht} = demand for domestically produced traded final goods in the Home economy in period t
Y_{Fnt} = demand for imported traded final goods from Foreign Country-n sold in the Home economy in period t
L_{NCt} = labor input for firm producing non-traded final goods in period t
V_{NCt} = unit cost of firm producing non-traded final good in period t
L_{TCt} = labor input for firm producing traded final goods in period t
V_{TCt} = unit cost of firm producing traded final good in period t

- Government or Supranational Planner Exercising Fiscal Policy (Analogously for Foreign Countries)

L_N = labor supply in the non-traded sector of the Home economy at the steady state
L_T = labor supply in the traded sector of the Home economy at the steady state
L = total labor supply in the Home economy at the steady state

Y_N = traded sector output (final goods) in the Home at the steady state
Y_T = traded sector output (final goods) in the Home at the steady state
Y_{Tn}^* = traded sector output in Foreign Country-n at the steady state
$\frac{M}{P}$ = real money demand at the steady state

G_{Nt} = government spending to provide non-traded final goods for households in period t
= household's consumption of government-provided non-traded final goods in period t

G_{Tt} = government spending to provide traded final goods for households in period t
= household's consumption of government-provided traded final goods in period t

G_{Ht} = government spending on domestically produced final goods for households in period t

G_{Fnt} = government spending to import traded final goods from Foreign Country-n for households in period t

- Central Bank or Supranational Planner Exercising Fiscal Policy (Analogously for Foreign Countries)

$\tilde{y}_{Nt}$ = output gap in the non-traded sector of the Home economy in period t
$\tilde{y}_T$ = output gap in the traded sector of the Home economy in period t
π_{Nt} = inflation in the non-traded sector of the Home economy in period t
π_{Ht} = inflation in the traded sector of the Home economy in period t
$\hat{r}_t$ = nominal interest rate gap in the Home economy in period t
$LOSS_t$ = loss function of central bank (supranational planner) of the Home economy in period t
TIP = terms independent of policy and shocks for the Home economy
$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the home economy

$\tilde{y}_{N1t}^*$ = output gap in the non-traded sector of Foreign Country-1 in period t
$\tilde{y}_{T1t}^*$ = output gap in the traded sector of Foreign Country-1 in period t
π_{N1t}^* = inflation in the non-traded sector of Foreign Country-1 in period t
π_{H1t}^* = inflation in the traded sector of Foreign Country-1 in period t
$\hat{r}_{1t}^*$ = nominal interest rate gap in Foreign Country-1 in period t
$LOSS_{1t}^*$ = loss function of central bank (supranational planner) of Foreign Country-1 in period t
TIP_{1t}^* = terms independent of policy and shocks for Foreign Country-1
$O_1^*(\|\xi_1^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-1

$\tilde{y}_{Nkt}^*$ = output gap in the non-traded sector of Foreign Country-k in period t
$\tilde{y}_{Tkt}^*$ = output gap in the traded sector of Foreign Country-k in period t

π_{Nkt}^{*} = inflation in the non-traded sector of Foreign Country-k in period t
π_{Hkt}^{*} = inflation in the traded sector of Foreign Country-k in period t
$\hat{r}_{kt}^{*}$ = nominal interest rate gap in Foreign Country-k in period t
$LOSS_{kt}^{*}$ = loss function of central bank (supranational planner) of Foreign Country-k in period t
TIP_{kt}^{*} = terms independent of policy and shocks for Foreign Country-k
$O_{k}^{*}(\|\xi_{k}^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-k

- ***Market Clearing Conditions, Natural Rate Equilibrium, and Sticky Price Equilibrium***

R_{t}^{nat} = natural nominal interest rate of the Home economy in period t
$R_{nt}^{*\ nat}$ = natural nominal interest rate of Foreign Country-n in period t
$\hat{e}_{nt}^{\ nat}$ = natural exchange rate gap of the Home economy in period t
$E_{t}\ \hat{e}_{nt+1}^{nat}$ = expected natural exchange rate gap of the Home economy in period t+1
$\hat{s}_{nt}^{\ nat}$ = natural rate of the terms of trade of Home economy with Foreign Country-n ($\hat{s}_{nt}^{nat}$) in period t
$E_{t}\hat{s}_{nt+1}^{nat}$ = natural rate of the terms of trade of Home economy with Foreign Country-n ($\hat{s}_{nt}^{nat}$) in period t+1
Ϙ_{t} = real effective exchange rate of the Home economy in period t
$\hat{y}_{Nt}^{nat}$ = natural rate of non-traded output in period t
$\hat{y}_{Tt}^{nat}$ = natural rate of traded output in period t
$\hat{l}_{Nt}^{nat}$ = natural labor input gap in the non-traded sector in period t
$\hat{l}_{Tt}^{nat}$ = natural labor input gap in the traded sector in period t
$\hat{c}_{t}^{A\,nat}$ = natural rate of aggregate domestic demand in period t
$\widehat{rr}_{t}^{nat}$ = natural real interest rate gap in period t
$\hat{q}_{Nt}^{nat}$ = natural gap of relative price of non-traded goods in terms of traded goods in period t

APPENDIX 4.2.

Estimated Posterior Means and Standard Deviations of Parameters Under Different Policy Interaction Regimes

(1) Indonesia

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.415	72.441	21.221	27.097	0.069	11.195	1.798	5.950
Bilateral coordination								
with Malaysia	0.415	72.775	21.183	27.024	0.072	11.462	1.794	5.837
with Singapore	0.416	72.597	21.112	27.036	0.068	10.897	1.813	6.076
with Thailand	0.415	72.626	21.180	27.143	0.071	10.867	1.833	6.058
with the Philippines	0.417	72.795	21.158	27.131	0.069	11.518	1.732	5.934
with China	0.418	72.835	20.950	27.019	0.074	12.040	1.773	6.187
with Japan	0.417	73.016	20.862	26.945	0.067	11.599	1.810	5.914
with South Korea	0.417	72.543	21.083	27.014	0.069	11.307	1.755	5.852
Multilateral coordination								
in ASEAN-5	0.437	73.168	20.936	30.426	0.092	4.372	1.598	2.210
in ASEAN-5 + China	0.639	55.914	20.113	46.452	0.036	0.224	1.146	0.501
in ASEAN-5 + Japan	0.459	58.870	20.139	26.940	0.091	0.793	1.063	0.369
in ASEAN-5 + S. Korea	0.434	69.946	20.945	28.771	0.081	0.440	1.048	0.460
in ASEAN-5 + 3	0.296	139.123	11.294	59.109	0.073	20.014	2.691	9.889

Source: Author’s calculation

(2) Malaysia

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.523	50.227	52.555	49.747	0.140	9.960	5.533	9.815
Bilateral coordination								
with Indonesia	0.524	50.144	53.024	50.052	0.132	9.662	5.334	9.556
with Singapore	0.525	50.180	52.425	49.675	0.135	9.776	5.618	9.989
with Thailand	0.528	50.419	52.472	50.285	0.137	11.274	5.207	14.097
with the Philippines	0.524	50.189	52.755	49.784	0.141	10.196	5.391	10.239
with China	0.529	50.185	52.516	49.695	0.144	20.504	5.475	20.117
with Japan	0.525	50.105	52.068	49.799	0.133	20.353	5.349	19.856
with South Korea	0.528	50.166	52.611	49.723	0.141	19.702	5.387	19.611
Multilateral coordination								
in ASEAN-5	0.519	50.372	52.459	48.244	0.137	2.280	6.295	4.968
in ASEAN-5 + China	0.681	64.078	70.808	41.153	0.440	0.631	1.041	0.247
in ASEAN-5 + Japan	0.521	41.432	51.361	43.828	0.054	0.701	1.438	0.340
in ASEAN-5 + S. Korea	0.503	53.731	51.481	48.888	0.093	0.967	2.451	0.627
in ASEAN-5 + 3	2.802	1.985	119.612	7.289	0.630	14.397	18.938	11.731

Source: Author’s calculation

(3) Singapore

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.232	50.062	18.204	49.714	0.018	4.544	1.253	6.705
Bilateral coordination								
with Indonesia	0.207	50.256	20.455	49.273	0.016	4.554	0.992	6.528
with Malaysia	0.207	50.274	20.347	49.329	0.016	4.488	0.933	6.361
with Thailand	0.207	50.270	20.340	49.323	0.015	4.545	0.903	6.318
with the Philippines	0.207	50.214	20.365	49.817	0.010	2.813	0.965	6.283
with China	0.207	50.204	20.364	49.404	0.016	4.425	0.897	6.293
with Japan	0.206	50.276	20.278	49.343	0.015	4.434	0.883	6.558
with South Korea	0.207	50.170	20.351	49.493	0.017	1.777	0.813	2.048
Multilateral coordination								
in ASEAN-5	0.207	50.487	20.429	48.394	0.015	2.080	0.887	1.696
in ASEAN-5 + China	0.207	51.291	21.665	47.695	0.000	0.053	0.580	0.060
in ASEAN-5 + Japan	0.208	54.894	20.322	65.045	0.016	0.313	0.585	0.186
in ASEAN-5 + S. Korea	0.208	46.573	20.414	56.034	0.015	0.266	0.506	0.427
in ASEAN-5 + 3	0.222	59.878	17.969	69.575	0.008	3.144	0.971	6.925

Source: Author’s calculation

(4) Thailand

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.147	107.114	25.303	92.558	0.020	20.653	1.999	19.431
Bilateral coordination								
with Indonesia	0.146	105.476	25.505	92.826	0.021	18.736	2.021	17.425
with Malaysia	0.147	105.919	25.294	93.049	0.019	16.502	1.952	15.287
with Singapore	0.147	105.885	25.284	92.569	0.020	18.265	2.045	18.419
with the Philippines	0.147	107.161	25.350	93.760	0.018	16.090	2.008	10.771
with China	0.146	107.737	25.295	92.587	0.021	20.421	1.945	18.387
with Japan	0.147	107.859	25.069	92.695	0.020	20.777	2.015	19.580
with South Korea	0.146	107.481	25.352	92.761	0.021	21.112	2.030	18.802
Multilateral coordination								
in ASEAN-5	0.147	107.233	25.426	94.803	0.017	4.631	2.228	12.527
in ASEAN-5 + China	0.175	162.590	20.480	172.733	0.024	0.906	0.119	0.497
in ASEAN-5 + Japan	0.176	78.496	24.605	148.439	0.045	0.967	0.870	1.011
in ASEAN-5 + S. Korea	0.153	99.814	25.155	107.100	0.024	0.476	0.838	1.792
in ASEAN-5 + 3	0.162	49.177	19.827	27.475	0.011	24.473	1.927	33.392

Source: Author’s calculation

(5) The Philippines

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.254	81.287	37.217	16.930	0.043	23.332	3.450	8.018
Bilateral coordination								
with Indonesia	0.255	76.111	37.328	16.720	0.046	20.777	3.419	7.729
with Malaysia	0.254	75.707	37.097	16.308	0.046	20.954	3.465	7.397
with Singapore	0.290	127.010	36.028	67.341	0.051	10.494	3.331	25.386
with Thailand	0.255	75.635	37.047	16.579	0.049	9.530	3.644	10.361
with China	0.254	81.413	36.994	16.878	0.043	24.721	3.372	8.805
with Japan	0.254	81.236	36.632	16.992	0.044	24.106	3.335	7.806
with South Korea	0.254	81.058	36.991	16.982	0.044	25.380	3.330	7.939
Multilateral coordination								
in ASEAN-5	0.289	127.190	36.195	66.653	0.039	5.863	2.962	8.846
in ASEAN-5 + China	0.271	199.304	22.203	70.044	2.405	0.964	0.415	0.467
in ASEAN-5 + Japan	0.293	143.475	34.889	77.092	0.041	0.728	1.869	0.785
in ASEAN-5 + S. Korea	0.289	143.944	36.176	75.998	0.040	0.585	2.563	1.189
in ASEAN-5 + 3	0.256	40.144	42.540	11.395	0.017	42.631	4.494	28.194

Source: Author’s calculation

(6) China

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.373	142.557	55.649	56.958	0.074	21.864	4.515	12.444
Bilateral coordination								
with Indonesia	0.376	135.260	55.599	56.161	0.076	19.338	4.608	12.410
with Malaysia	0.375	135.302	55.491	55.904	0.074	19.684	4.600	12.104
with Singapore	0.365	134.984	53.110	56.443	0.083	19.918	4.674	12.370
with Thailand	0.372	142.879	55.723	57.007	0.079	22.742	4.651	12.734
with the Philippines	0.372	142.761	55.698	56.910	0.076	24.201	4.599	12.257
with Japan	0.377	135.456	55.387	55.770	0.080	20.575	4.624	12.895
with South Korea	0.376	135.619	55.538	55.886	0.081	20.449	4.705	12.996
Multilateral coordination								
in CJK	0.376	135.300	55.315	55.733	0.074	20.138	4.573	11.931
in ASEAN-5 + China	0.519	114.665	49.575	100.504	0.066	0.930	0.520	0.313
in ASEAN-5 + 3	0.399	7.474	10.905	117.257	0.044	39.354	13.338	21.599

Source: Author's calculation

(7) Japan

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.194	47.089	58.193	52.994	0.049	9.970	5.200	10.487
Bilateral coordination								
with Indonesia	0.194	46.754	58.346	53.261	0.048	9.927	5.193	10.611
with Malaysia	0.194	47.079	58.154	53.162	0.045	9.903	5.170	10.913
with Singapore	0.194	94.832	60.734	106.527	0.047	17.527	5.052	20.308
with Thailand	0.195	46.942	58.239	53.183	0.053	10.583	5.455	10.790
with the Philippines	0.194	46.765	58.234	53.261	0.048	9.814	5.162	10.525
with China	0.194	47.012	58.340	53.194	0.049	9.869	5.300	10.830
with South Korea	0.194	46.957	58.357	53.236	0.047	10.136	5.090	10.525
Multilateral coordination								
in CJK	0.194	47.055	58.483	52.987	0.047	9.161	5.369	10.163
in ASEAN-5 + Japan	0.180	50.030	55.129	43.464	0.036	0.392	1.021	0.734
in ASEAN-5 + 3	0.304	27.273	61.378	125.817	0.034	16.125	1.583	26.441

Source: Author’s calculation

(8) South Korea

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	0.160	125.608	41.387	74.223	0.026	21.841	3.289	16.632
Bilateral coordination								
with Indonesia	0.161	120.750	41.482	73.971	0.028	19.860	3.388	20.445
with Malaysia	0.160	125.425	41.425	74.252	0.027	22.844	3.381	15.839
with Singapore	0.163	119.876	39.219	74.505	0.027	7.370	3.232	7.044
with Thailand	0.160	125.006	41.370	74.265	0.026	21.920	3.312	15.926
with the Philippines	0.159	125.510	41.436	74.020	0.028	22.067	3.444	16.069
with China	0.161	121.141	41.266	73.601	0.027	18.286	3.205	16.036
with Japan	0.162	120.894	40.987	73.921	0.026	18.595	3.228	15.830
Multilateral coordination								
in CJK	0.161	121.001	41.065	73.671	0.028	18.242	3.144	15.986
in ASEAN-5 + S. Korea	0.163	110.499	41.022	68.980	0.032	1.303	0.273	2.538
in ASEAN-5 + 3	0.144	106.253	39.452	40.202	0.005	6.316	0.804	10.170

Source: Author's calculation

APPENDIX 4.3.
Z-test Results of Parameters Under Different Policy Regimes

(H0: No difference between means of the two populations; H1: otherwise. α = 5%)

(1) Indonesia

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
ID_NC vs. ID_MY*	ID_NC vs. ID_MY	ID_NC vs. ID_MY	ID_NC vs. ID_MY
ID_NC vs. ID_SG	ID_NC vs. ID_SG	ID_NC vs. ID_SG	ID_NC vs. ID_SG
ID_NC vs. ID_TH*	ID_NC vs. ID_TH	ID_NC vs. ID_TH	ID_NC vs. ID_TH*
ID_NC vs. ID_PH	ID_NC vs. ID_PH	ID_NC vs. ID_PH	ID_NC vs. ID_PH*
ID_NC vs. ID_CN	ID_NC vs. ID_CN	ID_NC vs. ID_CN	ID_NC vs. ID_CN
ID_NC vs. ID_JP	ID_NC vs. ID_JP	ID_NC vs. ID_JP	ID_NC vs. ID_JP
ID_NC vs. ID_SK	ID_NC vs. ID_SK	ID_NC vs. ID_SK	ID_NC vs. ID_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
ID_NC vs. ASEAN-5	ID_NC vs. ASEAN-5	ID_NC vs. ASEAN-5	ID_NC vs. ASEAN-5
ID_NC vs. ASEAN-5+CN	ID_NC vs. ASEAN-5+CN	ID_NC vs. ASEAN-5+CN	ID_NC vs. ASEAN-5+CN
ID_NC vs. ASEAN-5+JP	ID_NC vs. ASEAN-5+JP	ID_NC vs. ASEAN-5+JP	ID_NC vs. ASEAN-5+JP
ID_NC vs. ASEAN-5+SK	ID_NC vs. ASEAN-5+SK	ID_NC vs. ASEAN-5+SK	ID_NC vs. ASEAN-5+SK
ID_NC vs. ASEAN-5 + 3	ID_NC vs. ASEAN-5 + 3	ID_NC vs. ASEAN-5 + 3	ID_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
ID_MY vs. ASEAN-5	ID_MY vs. ASEAN-5	ID_MY vs. ASEAN-5	ID_MY vs. ASEAN-5
ID_SG vs. ASEAN-5	ID_SG vs. ASEAN-5	ID_SG vs. ASEAN-5	ID_SG vs. ASEAN-5
ID_TH vs. ASEAN-5	ID_TH vs. ASEAN-5	ID_TH vs. ASEAN-5	ID_TH vs. ASEAN-5
ID_PH vs. ASEAN-5	ID_PH vs. ASEAN-5	ID_PH vs. ASEAN-5	ID_PH vs. ASEAN-5
ID_CN vs. ASEAN-5	ID_CN vs. ASEAN-5	ID_CN vs. ASEAN-5	ID_CN vs. ASEAN-5
ID_JP vs. ASEAN-5	ID_JP vs. ASEAN-5	ID_JP vs. ASEAN-5	ID_JP vs. ASEAN-5
ID_SK vs. ASEAN-5	ID_SK vs. ASEAN-5	ID_SK vs. ASEAN-5	ID_SK vs. ASEAN-5
ID_MY vs. ASEAN-5+CN	ID_MY vs. ASEAN-5+CN	ID_MY vs. ASEAN-5+CN	ID_MY vs. ASEAN-5+CN
ID_SG vs. ASEAN-5+CN	ID_SG vs. ASEAN-5+CN	ID_SG vs. ASEAN-5+CN	ID_SG vs. ASEAN-5+CN
ID_TH vs. ASEAN-5+CN	ID_TH vs. ASEAN-5+CN	ID_TH vs. ASEAN-5+CN	ID_TH vs. ASEAN-5+CN
ID_PH vs. ASEAN-5+CN	ID_PH vs. ASEAN-5+CN	ID_PH vs. ASEAN-5+CN	ID_PH vs. ASEAN-5+CN
ID_CN vs. ASEAN-5+CN	ID_CN vs. ASEAN-5+CN	ID_CN vs. ASEAN-5+CN	ID_CN vs. ASEAN-5+CN
ID_JP vs. ASEAN-5+CN	ID_JP vs. ASEAN-5+CN	ID_JP vs. ASEAN-5+CN	ID_JP vs. ASEAN-5+CN
ID_SK vs. ASEAN-5+CN	ID_SK vs. ASEAN-5+CN	ID_SK vs. ASEAN-5+CN	ID_SK vs. ASEAN-5+CN
ID_MY vs. ASEAN-5+JP	ID_MY vs. ASEAN-5+JP	ID_MY vs. ASEAN-5+JP	ID_MY vs. ASEAN-5+JP
ID_SG vs. ASEAN-5+JP	ID_SG vs. ASEAN-5+JP	ID_SG vs. ASEAN-5+JP	ID_SG vs. ASEAN-5+JP
ID_TH vs. ASEAN-5+JP	ID_TH vs. ASEAN-5+JP	ID_TH vs. ASEAN-5+JP	ID_TH vs. ASEAN-5+JP
ID_PH vs. ASEAN-5+JP	ID_PH vs. ASEAN-5+JP	ID_PH vs. ASEAN-5+JP	ID_PH vs. ASEAN-5+JP
ID_CN vs. ASEAN-5+JP	ID_CN vs. ASEAN-5+JP	ID_CN vs. ASEAN-5+JP	ID_CN vs. ASEAN-5+JP
ID_JP vs. ASEAN-5+JP	ID_JP vs. ASEAN-5+JP	ID_JP vs. ASEAN-5+JP	ID_JP vs. ASEAN-5+JP*
ID_SK vs. ASEAN-5+JP	ID_SK vs. ASEAN-5+JP	ID_SK vs. ASEAN-5+JP	ID_SK vs. ASEAN-5+JP
ID_MY vs. ASEAN-5+SK	ID_MY vs. ASEAN-5+SK	ID_MY vs. ASEAN-5+SK	ID_MY vs. ASEAN-5+SK
ID_SG vs. ASEAN-5+SK	ID_SG vs. ASEAN-5+SK	ID_SG vs. ASEAN-5+SK	ID_SG vs. ASEAN-5+SK
ID_TH vs. ASEAN-5+SK	ID_TH vs. ASEAN-5+SK	ID_TH vs. ASEAN-5+SK	ID_TH vs. ASEAN-5+SK
ID_PH vs. ASEAN-5+SK	ID_PH vs. ASEAN-5+SK	ID_PH vs. ASEAN-5+SK	ID_PH vs. ASEAN-5+SK
ID_CN vs. ASEAN-5+SK	ID_CN vs. ASEAN-5+SK	ID_CN vs. ASEAN-5 + SK*	ID_CN vs. ASEAN-5+SK
ID_JP vs. ASEAN-5+SK	ID_JP vs. ASEAN-5+SK	ID_JP vs. ASEAN-5+SK	ID_JP vs. ASEAN-5+SK
ID_SK vs. ASEAN-5+SK	ID_SK vs. ASEAN-5+SK	ID_SK vs. ASEAN-5+SK	ID_SK vs. ASEAN-5+SK
ID_MY vs. ASEAN-5 + 3	ID_MY vs. ASEAN-5 + 3	ID_MY vs. ASEAN-5 + 3	ID_MY vs. ASEAN-5 + 3
ID_SG vs. ASEAN-5 + 3	ID_SG vs. ASEAN-5 + 3	ID_SG vs. ASEAN-5 + 3	ID_SG vs. ASEAN-5 + 3
ID_TH vs. ASEAN-5 + 3	ID_TH vs. ASEAN-5 + 3	ID_TH vs. ASEAN-5 + 3	ID_TH vs. ASEAN-5 + 3
ID_PH vs. ASEAN-5 + 3	ID_PH vs. ASEAN-5 + 3	ID_PH vs. ASEAN-5 + 3	ID_PH vs. ASEAN-5 + 3
ID_CN vs. ASEAN-5 + 3	ID_CN vs. ASEAN-5 + 3	ID_CN vs. ASEAN-5 + 3	ID_CN vs. ASEAN-5 + 3
ID_JP vs. ASEAN-5 + 3	ID_JP vs. ASEAN-5 + 3	ID_JP vs. ASEAN-5 + 3	ID_JP vs. ASEAN-5 + 3
ID_SK vs. ASEAN-5 + 3	ID_SK vs. ASEAN-5 + 3	ID_SK vs. ASEAN-5 + 3	ID_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at α = 5%.

(2) Malaysia

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
MY_NC vs. MY_ID	MY_NC vs. MY_ID*	MY_NC vs. MY_ID	MY_NC vs. MY_ID
MY_NC vs. MY_SG	MY_NC vs. MY_SG*	MY_NC vs. MY_SG	MY_NC vs. MY_SG*
MY_NC vs. MY_TH	MY_NC vs. MY_TH	MY_NC vs. MY_TH	MY_NC vs. MY_TH
MY_NC vs. MY_PH	MY_NC vs. MY_PH*	MY_NC vs. MY_PH	MY_NC vs. MY_PH*
MY_NC vs. MY_CN	MY_NC vs. MY_CN*	MY_NC vs. MY_CN	MY_NC vs. MY_CN*
MY_NC vs. MY_JP	MY_NC vs. MY_JP*	MY_NC vs. MY_JP	MY_NC vs. MY_JP*
MY_NC vs. MY_SK	MY_NC vs. MY_SK*	MY_NC vs. MY_SK	MY_NC vs. MY_SK*

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
MY_NC vs. ASEAN-5	MY_NC vs. ASEAN-5	MY_NC vs. ASEAN-5	MY_NC vs. ASEAN-5
MY_NC vs. ASEAN-5+CN	MY_NC vs. ASEAN-5+CN	MY_NC vs. ASEAN-5+CN	MY_NC vs. ASEAN-5+CN
MY_NC vs. ASEAN-5+JP	MY_NC vs. ASEAN-5+JP	MY_NC vs. ASEAN-5+JP	MY_NC vs. ASEAN-5+JP
MY_NC vs. ASEAN-5+ SK	MY_NC vs. ASEAN-5+ SK	MY_NC vs. ASEAN-5+ SK	MY_NC vs. ASEAN-5+ SK
MY_NC vs. ASEAN-5 + 3	MY_NC vs. ASEAN-5 + 3	MY_NC vs. ASEAN-5 + 3	MY_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
MY_ID vs. ASEAN-5	MY_ID vs. ASEAN-5	MY_ID vs. ASEAN-5	MY_ID vs. ASEAN-5
MY_SG vs. ASEAN-5	MY_SG vs. ASEAN-5	MY_SG vs. ASEAN-5*	MY_SG vs. ASEAN-5
MY_TH vs. ASEAN-5	MY_TH vs. ASEAN-5*	MY_TH vs. ASEAN-5*	MY_TH vs. ASEAN-5
MY_PH vs. ASEAN-5	MY_PH vs. ASEAN-5	MY_PH vs. ASEAN-5	MY_PH vs. ASEAN-5
MY_CN vs. ASEAN-5	MY_CN vs. ASEAN-5	MY_CN vs. ASEAN-5	MY_CN vs. ASEAN-5
MY_JP vs. ASEAN-5	MY_JP vs. ASEAN-5	MY_JP vs. ASEAN-5	MY_JP vs. ASEAN-5
MY_SK vs. ASEAN-5	MY_SK vs. ASEAN-5	MY_SK vs. ASEAN-5	MY_SK vs. ASEAN-5
MY_ID vs. ASEAN-5+CN	MY_ID vs. ASEAN-5+CN	MY_ID vs. ASEAN-5+CN	MY_ID vs. ASEAN-5+CN
MY_SG vs. ASEAN-5+CN	MY_SG vs. ASEAN-5+CN	MY_SG vs. ASEAN-5+CN	MY_SG vs. ASEAN-5+CN
MY_TH vs. ASEAN-5+CN	MY_TH vs. ASEAN-5+CN	MY_TH vs. ASEAN-5+CN	MY_TH vs. ASEAN-5+CN
MY_PH vs. ASEAN-5+CN	MY_PH vs. ASEAN-5+CN	MY_PH vs. ASEAN-5+CN	MY_PH vs. ASEAN-5+CN
MY_CN vs. ASEAN-5+CN	MY_CN vs. ASEAN-5+CN	MY_CN vs. ASEAN-5+CN	MY_CN vs. ASEAN-5+CN
MY_JP vs. ASEAN-5+CN	MY_JP vs. ASEAN-5+CN	MY_JP vs. ASEAN-5+CN	MY_JP vs. ASEAN-5+CN
MY_SK vs. ASEAN-5+CN	MY_SK vs. ASEAN-5+CN	MY_SK vs. ASEAN-5+CN	MY_SK vs. ASEAN-5+CN
MY_ID vs. ASEAN-5+JP	MY_ID vs. ASEAN-5+JP	MY_ID vs. ASEAN-5+JP	MY_ID vs. ASEAN-5+JP
MY_SG vs. ASEAN-5+JP	MY_SG vs. ASEAN-5+JP	MY_SG vs. ASEAN-5+JP	MY_SG vs. ASEAN-5+JP
MY_TH vs. ASEAN-5+JP	MY_TH vs. ASEAN-5+JP	MY_TH vs. ASEAN-5+JP	MY_TH vs. ASEAN-5+JP
MY_PH vs. ASEAN-5+JP	MY_PH vs. ASEAN-5+JP	MY_PH vs. ASEAN-5+JP	MY_PH vs. ASEAN-5+JP
MY_CN vs. ASEAN-5+JP	MY_CN vs. ASEAN-5+JP	MY_CN vs. ASEAN-5+JP	MY_CN vs. ASEAN-5+JP
MY_JP vs. ASEAN-5+JP	MY_JP vs. ASEAN-5+JP	MY_JP vs. ASEAN-5+JP	MY_JP vs. ASEAN-5+JP
MY_SK vs. ASEAN-5+JP	MY_SK vs. ASEAN-5+JP	MY_SK vs. ASEAN-5+JP	MY_SK vs. ASEAN-5+JP
MY_ID vs. ASEAN-5+SK	MY_ID vs. ASEAN-5+SK	MY_ID vs. ASEAN-5+SK	MY_ID vs. ASEAN-5+SK
MY_SG vs. ASEAN-5+SK	MY_SG vs. ASEAN-5+SK	MY_SG vs. ASEAN-5+SK	MY_SG vs. ASEAN-5+SK
MY_TH vs. ASEAN-5+SK	MY_TH vs. ASEAN-5+SK	MY_TH vs. ASEAN-5+SK	MY_TH vs. ASEAN-5+SK
MY_PH vs. ASEAN-5+SK	MY_PH vs. ASEAN-5+SK	MY_PH vs. ASEAN-5+SK	MY_PH vs. ASEAN-5+SK
MY_CN vs. ASEAN-5+SK	MY_CN vs. ASEAN-5+SK	MY_CN vs. ASEAN-5+SK	MY_CN vs. ASEAN-5+SK
MY_JP vs. ASEAN-5+SK	MY_JP vs. ASEAN-5+SK	MY_JP vs. ASEAN-5+SK	MY_JP vs. ASEAN-5+SK
MY_SK vs. ASEAN-5+SK	MY_SK vs. ASEAN-5+SK	MY_SK vs. ASEAN-5+SK	MY_SK vs. ASEAN-5+SK
MY_ID vs. ASEAN-5 + 3	MY_ID vs. ASEAN-5 + 3	MY_ID vs. ASEAN-5 + 3	MY_ID vs. ASEAN-5 + 3
MY_SG vs. ASEAN-5 + 3	MY_SG vs. ASEAN-5 + 3	MY_SG vs. ASEAN-5 + 3	MY_SG vs. ASEAN-5 + 3
MY_TH vs. ASEAN-5 + 3	MY_TH vs. ASEAN-5 + 3	MY_TH vs. ASEAN-5 + 3	MY_TH vs. ASEAN-5 + 3
MY_PH vs. ASEAN-5 + 3	MY_PH vs. ASEAN-5 + 3	MY_PH vs. ASEAN-5 + 3	MY_PH vs. ASEAN-5 + 3
MY_CN vs. ASEAN-5 + 3	MY_CN vs. ASEAN-5 + 3	MY_CN vs. ASEAN-5 + 3	MY_CN vs. ASEAN-5 + 3
MY_JP vs. ASEAN-5 + 3	MY_JP vs. ASEAN-5 + 3	MY_JP vs. ASEAN-5 + 3	MY_JP vs. ASEAN-5 + 3
MY_SK vs. ASEAN-5 + 3	MY_SK vs. ASEAN-5 + 3	MY_SK vs. ASEAN-5 + 3	MY_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(3) Singapore

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
SG_NC vs. SG_ID	SG_NC vs. SG_ID	SG_NC vs. SG_ID	SG_NC vs. SG_ID
SG_NC vs. SG_MY	SG_NC vs. SG_MY	SG_NC vs. SG_MY	SG_NC vs. SG_MY
SG_NC vs. SG_TH	SG_NC vs. SG_TH	SG_NC vs. SG_TH	SG_NC vs. SG_TH
SG_NC vs. SG_PH	SG_NC vs. SG_PH	SG_NC vs. SG_PH	SG_NC vs. SG_PH
SG_NC vs. SG_CN	SG_NC vs. SG_CN	SG_NC vs. SG_CN	SG_NC vs. SG_CN
SG_NC vs. SG_JP	SG_NC vs. SG_JP	SG_NC vs. SG_JP	SG_NC vs. SG_JP
SG_NC vs. SG_SK	SG_NC vs. SG_SK	SG_NC vs. SG_SK	SG_NC vs. SG_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SG_NC vs. ASEAN-5	SG_NC vs. ASEAN-5	SG_NC vs. ASEAN-5	SG_NC vs. ASEAN-5
SG_NC vs. ASEAN-5 + CN	SG_NC vs. ASEAN-5 + CN	SG_NC vs. ASEAN-5 + CN	SG_NC vs. ASEAN-5+CN
SG_NC vs. ASEAN-5 + JP	SG_NC vs. ASEAN-5 + JP	SG_NC vs. ASEAN-5 + JP	SG_NC vs. ASEAN-5+JP
SG_NC vs. ASEAN-5 + SK	SG_NC vs. ASEAN-5 + SK	SG_NC vs. ASEAN-5 + SK	SG_NC vs. ASEAN-5+ SK
SG_NC vs. ASEAN-5 + 3	SG_NC vs. ASEAN-5 + 3	SG_NC vs. ASEAN-5 + 3	SG_NC vs. ASEAN-5+3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SG_ID vs. ASEAN-5	SG_ID vs. ASEAN-5	SG_ID vs. ASEAN-5	SG_ID vs. ASEAN-5
SG_MY vs. ASEAN-5*	SG_MY vs. ASEAN-5	SG_MY vs. ASEAN-5	SG_MY vs. ASEAN-5
SG_TH vs. ASEAN-5	SG_TH vs. ASEAN-5	SG_TH vs. ASEAN-5	SG_TH vs. ASEAN-5
SG_PH vs. ASEAN-5	SG_PH vs. ASEAN-5	SG_PH vs. ASEAN-5	SG_PH vs. ASEAN-5
SG_CN vs. ASEAN-5*	SG_CN vs. ASEAN-5	SG_CN vs. ASEAN-5	SG_CN vs. ASEAN-5
SG_JP vs. ASEAN-5	SG_JP vs. ASEAN-5	SG_JP vs. ASEAN-5	SG_JP vs. ASEAN-5
SG_SK vs. ASEAN-5*	SG_SK vs. ASEAN-5	SG_SK vs. ASEAN-5	SG_SK vs. ASEAN-5
SG_ID vs. ASEAN-5+CN	SG_ID vs. ASEAN-5+CN	SG_ID vs. ASEAN-5+CN	SG_ID vs. ASEAN-5+CN
SG_MY vs. ASEAN-5+CN	SG_MY vs. ASEAN-5+CN	SG_MY vs. ASEAN-5+CN	SG_MY vs. ASEAN-5+CN
SG_TH vs. ASEAN-5+CN	SG_TH vs. ASEAN-5+CN	SG_TH vs. ASEAN-5+CN	SG_TH vs. ASEAN-5+CN
SG_PH vs. ASEAN-5+CN	SG_PH vs. ASEAN-5+CN	SG_PH vs. ASEAN-5+CN	SG_PH vs. ASEAN-5+CN
SG_CN vs. ASEAN-5+CN	SG_CN vs. ASEAN-5+CN	SG_CN vs. ASEAN-5+CN	SG_CN vs. ASEAN-5+CN
SG_JP vs. ASEAN-5+CN	SG_JP vs. ASEAN-5+CN	SG_JP vs. ASEAN-5+CN	SG_JP vs. ASEAN-5+CN
SG_SK vs. ASEAN-5+CN*	SG_SK vs. ASEAN-5+CN	SG_SK vs. ASEAN-5+CN	SG_SK vs. ASEAN-5+CN
SG_ID vs. ASEAN-5+JP	SG_ID vs. ASEAN-5+JP	SG_ID vs. ASEAN-5+JP	SG_ID vs. ASEAN-5+JP
SG_MY vs. ASEAN-5+JP	SG_MY vs. ASEAN-5+JP	SG_MY vs. ASEAN-5+JP	SG_MY vs. ASEAN-5+JP
SG_TH vs. ASEAN-5+JP	SG_TH vs. ASEAN-5+JP	SG_TH vs. ASEAN-5+JP	SG_TH vs. ASEAN-5+JP
SG_PH vs. ASEAN-5+JP	SG_PH vs. ASEAN-5+JP	SG_PH vs. ASEAN-5+JP	SG_PH vs. ASEAN-5+JP
SG_CN vs. ASEAN-5+JP	SG_CN vs. ASEAN-5+JP	SG_CN vs. ASEAN-5+JP	SG_CN vs. ASEAN-5+JP
SG_JP vs. ASEAN-5+JP	SG_JP vs. ASEAN-5+JP	SG_JP vs. ASEAN-5+JP	SG_JP vs. ASEAN-5+JP
SG_SK vs. ASEAN-5+JP	SG_SK vs. ASEAN-5+JP	SG_SK vs. ASEAN-5+JP	SG_SK vs. ASEAN-5+JP
SG_ID vs. ASEAN-5+SK	SG_ID vs. ASEAN-5+SK	SG_ID vs. ASEAN-5+SK	SG_ID vs. ASEAN-5+SK
SG_MY vs. ASEAN-5+SK	SG_MY vs. ASEAN-5+SK	SG_MY vs. ASEAN-5+SK	SG_MY vs. ASEAN-5+SK
SG_TH vs. ASEAN-5+SK	SG_TH vs. ASEAN-5+SK	SG_TH vs. ASEAN-5+SK	SG_TH vs. ASEAN-5+SK
SG_PH vs. ASEAN-5+SK	SG_PH vs. ASEAN-5+SK	SG_PH vs. ASEAN-5+SK	SG_PH vs. ASEAN-5+SK
SG_CN vs. ASEAN-5+SK	SG_CN vs. ASEAN-5+SK	SG_CN vs. ASEAN-5+SK	SG_CN vs. ASEAN-5+SK
SG_JP vs. ASEAN-5+SK	SG_JP vs. ASEAN-5+SK	SG_JP vs. ASEAN-5+SK	SG_JP vs. ASEAN-5+SK
SG_SK vs. ASEAN-5+SK	SG_SK vs. ASEAN-5+SK	SG_SK vs. ASEAN-5+SK	SG_SK vs. ASEAN-5+SK
SG_ID vs. ASEAN-5 + 3	SG_ID vs. ASEAN-5 + 3	SG_ID vs. ASEAN-5 + 3	SG_ID vs. ASEAN-5 + 3
SG_MY vs. ASEAN-5 + 3	SG_MY vs. ASEAN-5 + 3	SG_MY vs. ASEAN-5 + 3	SG_MY vs. ASEAN-5 + 3
SG_TH vs. ASEAN-5 + 3	SG_TH vs. ASEAN-5 + 3	SG_TH vs. ASEAN-5 + 3	SG_TH vs. ASEAN-5 + 3
SG_PH vs. ASEAN-5 + 3	SG_PH vs. ASEAN-5 + 3	SG_PH vs. ASEAN-5 + 3	SG_PH vs. ASEAN-5 + 3
SG_CN vs. ASEAN-5 + 3	SG_CN vs. ASEAN-5 + 3	SG_CN vs. ASEAN-5 + 3	SG_CN vs. ASEAN-5 + 3
SG_JP vs. ASEAN-5 + 3	SG_JP vs. ASEAN-5 + 3	SG_JP vs. ASEAN-5 + 3	SG_JP vs. ASEAN-5 + 3
SG_SK vs. ASEAN-5 + 3	SG_SK vs. ASEAN-5 + 3	SG_SK vs. ASEAN-5 + 3	SG_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(4) Thailand

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
TH_NC vs. TH_ID*	TH_NC vs. TH_ID	TH_NC vs. TH_ID	TH_NC vs. TH_ID
TH_NC vs. TH_MY*	TH_NC vs. TH_MY	TH_NC vs. TH_MY*	TH_NC vs. TH_MY
TH_NC vs. TH_SG*	TH_NC vs. TH_SG	TH_NC vs. TH_SG	TH_NC vs. TH_SG*
TH_NC vs. TH_PH	TH_NC vs. TH_PH*	TH_NC vs. TH_PH	TH_NC vs. TH_PH
TH_NC vs. TH_CN	TH_NC vs. TH_CN	TH_NC vs. TH_CN*	TH_NC vs. TH_CN*
TH_NC vs. TH_JP	TH_NC vs. TH_JP	TH_NC vs. TH_JP	TH_NC vs. TH_JP*
TH_NC vs. TH_SK	TH_NC vs. TH_SK	TH_NC vs. TH_SK	TH_NC vs. TH_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
TH_NC vs. ASEAN-5	TH_NC vs. ASEAN-5*	TH_NC vs. ASEAN-5	TH_NC vs. ASEAN-5
TH_NC vs. ASEAN-5+CN	TH_NC vs. ASEAN-5+CN	TH_NC vs. ASEAN-5+CN	TH_NC vs. ASEAN-5+CN
TH_NC vs. ASEAN-5+JP	TH_NC vs. ASEAN-5+JP	TH_NC vs. ASEAN-5+JP	TH_NC vs. ASEAN-5+JP
TH_NC vs. ASEAN-5+SK	TH_NC vs. ASEAN-5+SK	TH_NC vs. ASEAN-5+SK	TH_NC vs. ASEAN-5+SK
TH_NC vs. ASEAN-5 + 3	TH_NC vs. ASEAN-5 + 3	TH_NC vs. ASEAN-5 + 3	TH_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
TH_ID vs. ASEAN-5	TH_ID vs. ASEAN-5	TH_ID vs. ASEAN-5	TH_ID vs. ASEAN-5
TH_MY vs. ASEAN-5	TH_MY vs. ASEAN-5	TH_MY vs. ASEAN-5	TH_MY vs. ASEAN-5
TH_SG vs. ASEAN-5	TH_SG vs. ASEAN-5	TH_SG vs. ASEAN-5	TH_SG vs. ASEAN-5
TH_PH vs. ASEAN-5*	TH_PH vs. ASEAN-5*	TH_PH vs. ASEAN-5	TH_PH vs. ASEAN-5
TH_CN vs. ASEAN-5	TH_CN vs. ASEAN-5	TH_CN vs. ASEAN-5	TH_CN vs. ASEAN-5
TH_JP vs. ASEAN-5*	TH_JP vs. ASEAN-5	TH_JP vs. ASEAN-5	TH_JP vs. ASEAN-5
TH_SK vs. ASEAN-5	TH_SK vs. ASEAN-5	TH_SK vs. ASEAN-5	TH_SK vs. ASEAN-5
TH_ID vs. ASEAN-5+CN	TH_ID vs. ASEAN-5+CN	TH_ID vs. ASEAN-5+CN	TH_ID vs. ASEAN-5+CN
TH_MY vs. ASEAN-5+CN	TH_MY vs. ASEAN-5+CN	TH_MY vs. ASEAN-5+CN	TH_MY vs. ASEAN-5+CN
TH_SG vs. ASEAN-5+CN	TH_SG vs. ASEAN-5+CN	TH_SG vs. ASEAN-5+CN	TH_SG vs. ASEAN-5+CN
TH_PH vs. ASEAN-5+CN	TH_PH vs. ASEAN-5+CN	TH_PH vs. ASEAN-5+CN	TH_PH vs. ASEAN-5+CN
TH_CN vs. ASEAN-5+CN	TH_CN vs. ASEAN-5+CN	TH_CN vs. ASEAN-5+CN	TH_CN vs. ASEAN-5+CN
TH_JP vs. ASEAN-5+CN	TH_JP vs. ASEAN-5+CN	TH_JP vs. ASEAN-5+CN	TH_JP vs. ASEAN-5+CN
TH_SK vs. ASEAN-5+CN	TH_SK vs. ASEAN-5+CN	TH_SK vs. ASEAN-5+CN	TH_SK vs. ASEAN-5+CN
TH_ID vs. ASEAN-5+JP	TH_ID vs. ASEAN-5+JP	TH_ID vs. ASEAN-5+JP	TH_ID vs. ASEAN-5+JP
TH_MY vs. ASEAN-5+JP	TH_MY vs. ASEAN-5+JP	TH_MY vs. ASEAN-5+JP	TH_MY vs. ASEAN-5+JP
TH_SG vs. ASEAN-5+JP	TH_SG vs. ASEAN-5+JP	TH_SG vs. ASEAN-5+JP	TH_SG vs. ASEAN-5+JP
TH_PH vs. ASEAN-5+JP	TH_PH vs. ASEAN-5+JP	TH_PH vs. ASEAN-5+JP	TH_PH vs. ASEAN-5+JP
TH_CN vs. ASEAN-5+JP	TH_CN vs. ASEAN-5+JP	TH_CN vs. ASEAN-5+JP	TH_CN vs. ASEAN-5+JP
TH_JP vs. ASEAN-5+JP	TH_JP vs. ASEAN-5+JP	TH_JP vs. ASEAN-5+JP	TH_JP vs. ASEAN-5+JP
TH_SK vs. ASEAN-5+JP	TH_SK vs. ASEAN-5+JP	TH_SK vs. ASEAN-5+JP	TH_SK vs. ASEAN-5+JP
TH_ID vs. ASEAN-5+SK	TH_ID vs. ASEAN-5+SK	TH_ID vs. ASEAN-5+SK	TH_ID vs. ASEAN-5+SK
TH_MY vs. ASEAN-5+SK	TH_MY vs. ASEAN-5+SK	TH_MY vs. ASEAN-5+SK	TH_MY vs. ASEAN-5+SK
TH_SG vs. ASEAN-5+SK	TH_SG vs. ASEAN-5+SK	TH_SG vs. ASEAN-5+SK	TH_SG vs. ASEAN-5+SK
TH_PH vs. ASEAN-5+SK	TH_PH vs. ASEAN-5+SK	TH_PH vs. ASEAN-5+SK	TH_PH vs. ASEAN-5+SK
TH_CN vs. ASEAN-5+SK	TH_CN vs. ASEAN-5+SK	TH_CN vs. ASEAN-5+SK	TH_CN vs. ASEAN-5+SK
TH_JP vs. ASEAN-5+SK	TH_JP vs. ASEAN-5+SK	TH_JP vs. ASEAN-5+SK	TH_JP vs. ASEAN-5+SK
TH_SK vs. ASEAN-5+SK	TH_SK vs. ASEAN-5+SK	TH_SK vs. ASEAN-5+SK	TH_SK vs. ASEAN-5+SK
TH_ID vs. ASEAN-5 + 3	TH_ID vs. ASEAN-5 + 3	TH_ID vs. ASEAN-5 + 3	TH_ID vs. ASEAN-5 + 3
TH_MY vs. ASEAN-5 + 3	TH_MY vs. ASEAN-5 + 3	TH_MY vs. ASEAN-5 + 3	TH_MY vs. ASEAN-5 + 3
TH_SG vs. ASEAN-5 + 3	TH_SG vs. ASEAN-5 + 3	TH_SG vs. ASEAN-5 + 3	TH_SG vs. ASEAN-5 + 3
TH_PH vs. ASEAN-5 + 3	TH_PH vs. ASEAN-5 + 3	TH_PH vs. ASEAN-5 + 3	TH_PH vs. ASEAN-5 + 3
TH_CN vs. ASEAN-5 + 3	TH_CN vs. ASEAN-5 + 3	TH_CN vs. ASEAN-5 + 3	TH_CN vs. ASEAN-5 + 3
TH_JP vs. ASEAN-5 + 3	TH_JP vs. ASEAN-5 + 3	TH_JP vs. ASEAN-5 + 3	TH_JP vs. ASEAN-5 + 3
TH_SK vs. ASEAN-5 + 3	TH_SK vs. ASEAN-5 + 3	TH_SK vs. ASEAN-5 + 3	TH_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(5) Philippines

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
PH_NC vs. PH_ID	PH_NC vs. PH_ID	PH_NC vs. PH_ID	PH_NC vs. PH_ID
PH_NC vs. PH_MY*	PH_NC vs. PH_MY	PH_NC vs. PH_MY	PH_NC vs. PH_MY
PH_NC vs. PH_SG	PH_NC vs. PH_SG	PH_NC vs. PH_SG	PH_NC vs. PH_SG
PH_NC vs. PH_TH	PH_NC vs. PH_TH	PH_NC vs. PH_TH	PH_NC vs. PH_TH
PH_NC vs. PH_CN*	PH_NC vs. PH_CN*	PH_NC vs. PH_CN	PH_NC vs. PH_CN*
PH_NC vs. PH_JP*	PH_NC vs. PH_JP*	PH_NC vs. PH_JP	PH_NC vs. PH_JP*
PH_NC vs. PH_SK	PH_NC vs. PH_SK	PH_NC vs. PH_SK	PH_NC vs. PH_SK*

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
PH_NC vs. ASEAN-5	PH_NC vs. ASEAN-5	PH_NC vs. ASEAN-5	PH_NC vs. ASEAN-5
PH_NC vs. ASEAN-5+CN	PH_NC vs. ASEAN-5+CN	PH_NC vs. ASEAN-5+CN	PH_NC vs. ASEAN-5+CN
PH_NC vs. ASEAN-5+JP	PH_NC vs. ASEAN-5+JP	PH_NC vs. ASEAN-5+JP	PH_NC vs. ASEAN-5+JP
PH_NC vs. ASEAN-5+ SK	PH_NC vs. ASEAN-5+ SK	PH_NC vs. ASEAN-5+ SK	PH_NC vs. ASEAN-5+ SK
PH_NC vs. ASEAN-5 + 3	PH_NC vs. ASEAN-5 + 3	PH_NC vs. ASEAN-5 + 3	PH_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
PH_ID vs. ASEAN-5	PH_ID vs. ASEAN-5	PH_ID vs. ASEAN-5	PH_ID vs. ASEAN-5
PH_MY vs. ASEAN-5	PH_MY vs. ASEAN-5	PH_MY vs. ASEAN-5	PH_MY vs. ASEAN-5
PH_SG vs. ASEAN-5	PH_SG vs. ASEAN-5	PH_SG vs. ASEAN-5	PH_SG vs. ASEAN-5
PH_TH vs. ASEAN-5	PH_TH vs. ASEAN-5	PH_TH vs. ASEAN-5	PH_TH vs. ASEAN-5
PH_CN vs. ASEAN-5	PH_CN vs. ASEAN-5	PH_CN vs. ASEAN-5	PH_CN vs. ASEAN-5
PH_JP vs. ASEAN-5	PH_JP vs. ASEAN-5	PH_JP vs. ASEAN-5	PH_JP vs. ASEAN-5
PH_SK vs. ASEAN-5	PH_SK vs. ASEAN-5	PH_SK vs. ASEAN-5	PH_SK vs. ASEAN-5
PH_ID vs. ASEAN-5+CN	PH_ID vs. ASEAN-5+CN	PH_ID vs. ASEAN-5+CN	PH_ID vs. ASEAN-5+CN
PH_MY vs. ASEAN-5+CN	PH_MY vs. ASEAN-5+CN	PH_MY vs. ASEAN-5+CN	PH_MY vs. ASEAN-5+CN
PH_SG vs. ASEAN-5+CN	PH_SG vs. ASEAN-5+CN	PH_SG vs. ASEAN-5+CN	PH_SG vs. ASEAN-5+CN
PH_TH vs. ASEAN-5+CN	PH_TH vs. ASEAN-5+CN	PH_TH vs. ASEAN-5+CN	PH_TH vs. ASEAN-5+CN
PH_CN vs. ASEAN-5+CN	PH_CN vs. ASEAN-5+CN	PH_CN vs. ASEAN-5+CN	PH_CN vs. ASEAN-5+CN
PH_JP vs. ASEAN-5+CN	PH_JP vs. ASEAN-5+CN	PH_JP vs. ASEAN-5+CN	PH_JP vs. ASEAN-5+CN
PH_SK vs. ASEAN-5+CN	PH_SK vs. ASEAN-5+CN	PH_SK vs. ASEAN-5+CN	PH_SK vs. ASEAN-5+CN
PH_ID vs. ASEAN-5+JP	PH_ID vs. ASEAN-5+JP	PH_ID vs. ASEAN-5+JP	PH_ID vs. ASEAN-5+JP
PH_MY vs. ASEAN-5+JP	PH_MY vs. ASEAN-5+JP	PH_MY vs. ASEAN-5+JP	PH_MY vs. ASEAN-5+JP
PH_SG vs. ASEAN-5+JP	PH_SG vs. ASEAN-5+JP	PH_SG vs. ASEAN-5+JP	PH_SG vs. ASEAN-5+JP
PH_TH vs. ASEAN-5+JP	PH_TH vs. ASEAN-5+JP	PH_TH vs. ASEAN-5+JP	PH_TH vs. ASEAN-5+JP
PH_CN vs. ASEAN-5+JP	PH_CN vs. ASEAN-5+JP	PH_CN vs. ASEAN-5+JP	PH_CN vs. ASEAN-5+JP
PH_JP vs. ASEAN-5+JP	PH_JP vs. ASEAN-5+JP	PH_JP vs. ASEAN-5+JP	PH_JP vs. ASEAN-5+JP
PH_SK vs. ASEAN-5+JP	PH_SK vs. ASEAN-5+JP	PH_SK vs. ASEAN-5+JP	PH_SK vs. ASEAN-5+JP
PH_ID vs. ASEAN-5+SK	PH_ID vs. ASEAN-5+SK	PH_ID vs. ASEAN-5+SK	PH_ID vs. ASEAN-5+SK
PH_MY vs. ASEAN-5+SK	PH_MY vs. ASEAN-5+SK	PH_MY vs. ASEAN-5+SK	PH_MY vs. ASEAN-5+SK
PH_SG vs. ASEAN-5+SK	PH_SG vs. ASEAN-5+SK	PH_SG vs. ASEAN-5+SK	PH_SG vs. ASEAN-5+SK
PH_TH vs. ASEAN-5+SK	PH_TH vs. ASEAN-5+SK	PH_TH vs. ASEAN-5+SK	PH_TH vs. ASEAN-5+SK
PH_CN vs. ASEAN-5+SK	PH_CN vs. ASEAN-5+SK	PH_CN vs. ASEAN-5+SK	PH_CN vs. ASEAN-5+SK
PH_JP vs. ASEAN-5+SK	PH_JP vs. ASEAN-5+SK	PH_JP vs. ASEAN-5+SK	PH_JP vs. ASEAN-5+SK
PH_SK vs. ASEAN-5+SK	PH_SK vs. ASEAN-5+SK	PH_SK vs. ASEAN-5+SK	PH_SK vs. ASEAN-5+SK
PH_ID vs. ASEAN-5 + 3	PH_ID vs. ASEAN-5 + 3	PH_ID vs. ASEAN-5 + 3	PH_ID vs. ASEAN-5 + 3
PH_MY vs. ASEAN-5 + 3	PH_MY vs. ASEAN-5 + 3	PH_MY vs. ASEAN-5 + 3	PH_MY vs. ASEAN-5 + 3
PH_SG vs. ASEAN-5 + 3	PH_SG vs. ASEAN-5 + 3	PH_SG vs. ASEAN-5 + 3	PH_SG vs. ASEAN-5 + 3
PH_TH vs. ASEAN-5 + 3	PH_TH vs. ASEAN-5 + 3	PH_TH vs. ASEAN-5 + 3	PH_TH vs. ASEAN-5 + 3
PH_CN vs. ASEAN-5 + 3	PH_CN vs. ASEAN-5 + 3	PH_CN vs. ASEAN-5 + 3	PH_CN vs. ASEAN-5 + 3
PH_JP vs. ASEAN-5 + 3	PH_JP vs. ASEAN-5 + 3	PH_JP vs. ASEAN-5 + 3	PH_JP vs. ASEAN-5 + 3
PH_SK vs. ASEAN-5 + 3	PH_SK vs. ASEAN-5 + 3	PH_SK vs. ASEAN-5 + 3	PH_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(6) China

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
CN_NC vs. CN_ID	CN_NC vs. CN_ID	CN_NC vs. CN_ID	CN_NC vs. CN_ID
CN_NC vs. CN_MY	CN_NC vs. CN_MY	CN_NC vs. CN_MY	CN_NC vs. CN_MY
CN_NC vs. CN_SG	CN_NC vs. CN_SG	CN_NC vs. CN_SG	CN_NC vs. CN_SG
CN_NC vs. CN_TH	CN_NC vs. CN_TH	CN_NC vs. CN_TH	CN_NC vs. CN_TH*
CN_NC vs. CN_PH*	CN_NC vs. CN_PH	CN_NC vs. CN_PH	CN_NC vs. CN_PH*
CN_NC vs. CN_JP	CN_NC vs. CN_JP	CN_NC vs. CN_JP	CN_NC vs. CN_JP
CN_NC vs. CN_SK	CN_NC vs. CN_SK	CN_NC vs. CN_SK	CN_NC vs. CN_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
CN_NC vs. CJK	CN_NC vs. CJK	CN_NC vs. CJK	CN_NC vs. CJK
CN_NC vs. ASEAN-5+CN	CN_NC vs. ASEAN-5+CN	CN_NC vs. ASEAN-5+CN	CN_NC vs. ASEAN-5+CN
CN_NC vs. ASEAN-5 + 3	CN_NC vs. ASEAN-5 + 3	CN_NC vs. ASEAN-5+3	CN_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
CN_ID vs. CJK*	CN_ID vs. CJK*	CN_ID vs. CJK	CN_ID vs. CJK
CN_MY vs. CJK	CN_MY vs. CJK*	CN_MY vs. CJK	CN_MY vs. CJK
CN_SG vs. CJK	CN_SG vs. CJK	CN_SG vs. CJK	CN_SG vs. CJK
CN_TH vs. CJK	CN_TH vs. CJK	CN_TH vs. CJK	CN_TH vs. CJK
CN_PH vs. CJK	CN_PH vs. CJK	CN_PH vs. CJK	CN_PH vs. CJK
CN_JP vs. CJK*	CN_JP vs. CJK*	CN_JP vs. CJK	CN_JP vs. CJK*
CN_SK vs. CJK*	CN_SK vs. CJK	CN_SK vs. CJK	CN_SK vs. CJK
CN_ID vs. ASEAN-5+CN	CN_ID vs. ASEAN-5+CN	CN_ID vs. ASEAN-5+CN	CN_ID vs. ASEAN-5+CN
CN_MY vs. ASEAN-5+CN	CN_MY vs. ASEAN-5+CN	CN_MY vs. ASEAN-5+CN	CN_MY vs. ASEAN-5+CN
CN_SG vs. ASEAN-5+CN	CN_SG vs. ASEAN-5+CN	CN_SG vs. ASEAN-5+CN	CN_SG vs. ASEAN-5+CN
CN_TH vs. ASEAN-5+CN	CN_TH vs. ASEAN-5+CN	CN_TH vs. ASEAN-5+CN	CN_TH vs. ASEAN-5+CN
CN_PH vs. ASEAN-5+CN	CN_PH vs. ASEAN-5+CN	CN_PH vs. ASEAN-5+CN	CN_PH vs. ASEAN-5+CN
CN_JP vs. ASEAN-5+CN	CN_JP vs. ASEAN-5+CN	CN_JP vs. ASEAN-5+CN	CN_JP vs. ASEAN-5+CN
CN_SK vs. ASEAN-5+CN	CN_SK vs. ASEAN-5+CN	CN_SK vs. ASEAN-5+CN	CN_SK vs. ASEAN-5+CN
CN_ID vs. ASEAN-5 + 3	CN_ID vs. ASEAN-5 + 3	CN_ID vs. ASEAN-5 + 3	CN_ID vs. ASEAN-5 + 3
CN_MY vs. ASEAN-5 + 3	CN_MY vs. ASEAN-5 + 3	CN_MY vs. ASEAN-5 + 3	CN_MY vs. ASEAN-5 + 3
CN_SG vs. ASEAN-5 + 3	CN_SG vs. ASEAN-5 + 3	CN_SG vs. ASEAN-5 + 3	CN_SG vs. ASEAN-5 + 3
CN_TH vs. ASEAN-5 + 3	CN_TH vs. ASEAN-5 + 3	CN_TH vs. ASEAN-5 + 3	CN_TH vs. ASEAN-5 + 3
CN_PH vs. ASEAN-5 + 3	CN_PH vs. ASEAN-5 + 3	CN_PH vs. ASEAN-5 + 3	CN_PH vs. ASEAN-5 + 3
CN_JP vs. ASEAN-5 + 3	CN_JP vs. ASEAN-5 + 3	CN_JP vs. ASEAN-5 + 3	CN_JP vs. ASEAN-5 + 3
CN_SK vs. ASEAN-5 + 3	CN_SK vs. ASEAN-5 + 3	CN_SK vs. ASEAN-5 + 3	CN_SK vs. ASEAN-5 + 3

Source: Author's calculation.   Note: * = H_0 accepted at $\alpha = 5\%$.

(7) Japan

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
JP_NC vs. JP_ID	JP_NC vs. JP_ID	JP_NC vs. JP_ID	JP_NC vs. JP_ID
JP_NC vs. JP_MY	JP_NC vs. JP_MY*	JP_NC vs. JP_MY*	JP_NC vs. JP_MY
JP_NC vs. JP_SG*	JP_NC vs. JP_SG	JP_NC vs. JP_SG	JP_NC vs. JP_SG
JP_NC vs. JP_TH	JP_NC vs. JP_TH	JP_NC vs. JP_TH*	JP_NC vs. JP_TH
JP_NC vs. JP_PH	JP_NC vs. JP_PH	JP_NC vs. JP_PH*	JP_NC vs. JP_PH
JP_NC vs. JP_CN*	JP_NC vs. JP_CN*	JP_NC vs. JP_CN	JP_NC vs. JP_CN
JP_NC vs. JP_SK*	JP_NC vs. JP_SK	JP_NC vs. JP_SK	JP_NC vs. JP_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
JP_NC vs. CJK	JP_NC vs. CJK*	JP_NC vs. CJK	JP_NC vs. CJK*
JP_NC vs. ASEAN-5+JP	JP_NC vs. ASEAN-5+JP	JP_NC vs. ASEAN-5+JP	JP_NC vs. ASEAN-5+JP
JP_NC vs. ASEAN-5 + 3	JP_NC vs. ASEAN-5 + 3	JP_NC vs. ASEAN-5+3	JP_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
JP_ID vs. CJK*	JP_ID vs. CJK	JP_ID vs. CJK	JP_ID vs. CJK
JP_MY vs. CJK*	JP_MY vs. CJK*	JP_MY vs. CJK	JP_MY vs. CJK
JP_SG vs. CJK	JP_SG vs. CJK	JP_SG vs. CJK	JP_SG vs. CJK
JP_TH vs. CJK*	JP_TH vs. CJK	JP_TH vs. CJK	JP_TH vs. CJK
JP_PH vs. CJK*	JP_PH vs. CJK	JP_PH vs. CJK	JP_PH vs. CJK
JP_CN vs. CJK*	JP_CN vs. CJK*	JP_CN vs. CJK	JP_CN vs. CJK
JP_SK vs. CJK	JP_SK vs. CJK	JP_SK vs. CJK	JP_SK vs. CJK
JP_ID vs. ASEAN-5+JP	JP_ID vs. ASEAN-5+JP	JP_ID vs. ASEAN-5+JP	JP_ID vs. ASEAN-5+JP
JP_MY vs. ASEAN-5+JP	JP_MY vs. ASEAN-5+JP	JP_MY vs. ASEAN-5+JP	JP_MY vs. ASEAN-5+JP
JP_SG vs. ASEAN-5+JP	JP_SG vs. ASEAN-5+JP	JP_SG vs. ASEAN-5+JP	JP_SG vs. ASEAN-5+JP
JP_TH vs. ASEAN-5+JP	JP_TH vs. ASEAN-5+JP	JP_TH vs. ASEAN-5+JP	JP_TH vs. ASEAN-5+JP
JP_PH vs. ASEAN-5+JP	JP_PH vs. ASEAN-5+JP	JP_PH vs. ASEAN-5+JP	JP_PH vs. ASEAN-5+JP
JP_CN vs. ASEAN-5+JP	JP_CN vs. ASEAN-5+JP	JP_CN vs. ASEAN-5+JP	JP_CN vs. ASEAN-5+JP
JP_SK vs. ASEAN-5+JP	JP_SK vs. ASEAN-5+JP	JP_SK vs. ASEAN-5+JP	JP_SK vs. ASEAN-5+JP
JP_ID vs. ASEAN-5 + 3	JP_ID vs. ASEAN-5 + 3	JP_ID vs. ASEAN-5 + 3	JP_ID vs. ASEAN-5 + 3
JP_MY vs. ASEAN-5 + 3	JP_MY vs. ASEAN-5 + 3	JP_MY vs. ASEAN-5 + 3	JP_MY vs. ASEAN-5 + 3
JP_SG vs. ASEAN-5 + 3	JP_SG vs. ASEAN-5 + 3	JP_SG vs. ASEAN-5 + 3	JP_SG vs. ASEAN-5 + 3
JP_TH vs. ASEAN-5 + 3	JP_TH vs. ASEAN-5 + 3	JP_TH vs. ASEAN-5 + 3	JP_TH vs. ASEAN-5 + 3
JP_PH vs. ASEAN-5 + 3	JP_PH vs. ASEAN-5 + 3	JP_PH vs. ASEAN-5 + 3	JP_PH vs. ASEAN-5 + 3
JP_CN vs. ASEAN-5 + 3	JP_CN vs. ASEAN-5 + 3	JP_CN vs. ASEAN-5 + 3	JP_CN vs. ASEAN-5 + 3
JP_SK vs. ASEAN-5 + 3	JP_SK vs. ASEAN-5 + 3	JP_SK vs. ASEAN-5 + 3	JP_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(8) South Korea

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
SK_NC vs. SK_ID	SK_NC vs. SK_ID	SK_NC vs. SK_ID	SK_NC vs. SK_ID
SK_NC vs. SK_MY	SK_NC vs. SK_MY*	SK_NC vs. SK_MY	SK_NC vs. SK_MY*
SK_NC vs. SK_SG	SK_NC vs. SK_SG	SK_NC vs. SK_SG	SK_NC vs. SK_SG
SK_NC vs. SK_TH*	SK_NC vs. SK_TH	SK_NC vs. SK_TH*	SK_NC vs. SK_TH*
SK_NC vs. SK_PH	SK_NC vs. SK_PH*	SK_NC vs. SK_PH	SK_NC vs. SK_PH
SK_NC vs. SK_CN	SK_NC vs. SK_CN	SK_NC vs. SK_CN	SK_NC vs. SK_CN
SK_NC vs. SK_JP	SK_NC vs. SK_JP	SK_NC vs. SK_JP	SK_NC vs. SK_JP

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SK_NC vs. CJK	SK_NC vs. CJK	SK_NC vs. CJK	SK_NC vs. CJK
SK_NC vs. ASEAN-5+SK	SK_NC vs. ASEAN-5+SK	SK_NC vs. ASEAN-5+SK	SK_NC vs. ASEAN-5+SK
SK_NC vs. ASEAN-5 + 3	SK_NC vs. ASEAN-5 + 3	SK_NC vs. ASEAN-5+3	SK_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SK_ID vs. CJK	SK_ID vs. CJK	SK_ID vs. CJK	SK_ID vs. CJK
SK_MY vs. CJK	SK_MY vs. CJK	SK_MY vs. CJK	SK_MY vs. CJK
SK_SG vs. CJK	SK_SG vs. CJK	SK_SG vs. CJK	SK_SG vs. CJK
SK_TH vs. CJK	SK_TH vs. CJK	SK_TH vs. CJK	SK_TH vs. CJK
SK_PH vs. CJK	SK_PH vs. CJK	SK_PH vs. CJK	SK_PH vs. CJK
SK_CN vs. CJK*	SK_CN vs. CJK*	SK_CN vs. CJK	SK_CN vs. CJK*
SK_JP vs. CJK	SK_JP vs. CJK*	SK_JP vs. CJK	SK_JP vs. CJK
SK_ID vs. ASEAN-5+SK	SK_ID vs. ASEAN-5+SK	SK_ID vs. ASEAN-5+SK	SK_ID vs. ASEAN-5+SK
SK_MY vs. ASEAN-5+SK	SK_MY vs. ASEAN-5+SK	SK_MY vs. ASEAN-5+SK	SK_MY vs. ASEAN-5+SK
SK_SG vs. ASEAN-5+SK	SK_SG vs. ASEAN-5+SK	SK_SG vs. ASEAN-5+SK	SK_SG vs. ASEAN-5+SK
SK_TH vs. ASEAN-5+SK	SK_TH vs. ASEAN-5+SK	SK_TH vs. ASEAN-5+SK	SK_TH vs. ASEAN-5+SK
SK_PH vs. ASEAN-5+SK	SK_PH vs. ASEAN-5+SK	SK_PH vs. ASEAN-5+SK	SK_PH vs. ASEAN-5+SK
SK_CN vs. ASEAN-5+SK	SK_CN vs. ASEAN-5+SK	SK_CN vs. ASEAN-5+SK	SK_CN vs. ASEAN-5+SK
SK_JP vs. ASEAN-5+SK	SK_JP vs. ASEAN-5+SK	SK_JP vs. ASEAN-5+SK	SK_JP vs. ASEAN-5+SK
SK_ID vs. ASEAN-5 + 3	SK_ID vs. ASEAN-5 + 3	SK_ID vs. ASEAN-5 + 3	SK_ID vs. ASEAN-5 + 3
SK_MY vs. ASEAN-5 + 3	SK_MY vs. ASEAN-5 + 3	SK_MY vs. ASEAN-5 + 3	SK_MY vs. ASEAN-5 + 3
SK_SG vs. ASEAN-5 + 3	SK_SG vs. ASEAN-5 + 3	SK_SG vs. ASEAN-5 + 3	SK_SG vs. ASEAN-5 + 3
SK_TH vs. ASEAN-5 + 3	SK_TH vs. ASEAN-5 + 3	SK_TH vs. ASEAN-5 + 3	SK_TH vs. ASEAN-5 + 3
SK_PH vs. ASEAN-5 + 3	SK_PH vs. ASEAN-5 + 3	SK_PH vs. ASEAN-5 + 3	SK_PH vs. ASEAN-5 + 3
SK_CN vs. ASEAN-5 + 3	SK_CN vs. ASEAN-5 + 3	SK_CN vs. ASEAN-5 + 3	SK_CN vs. ASEAN-5 + 3
SK_JP vs. ASEAN-5 + 3	SK_JP vs. ASEAN-5 + 3	SK_JP vs. ASEAN-5 + 3	SK_JP vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

APPENDIX 4.4.

Values of Derived Parameters Under Different Policy Interaction Regimes

(1) Indonesia

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	53.468%	1.344%	1.049	1.038
Bilateral coordination				
with Malaysia	53.408%	1.338%	27.024	1.050
with Singapore	53.365%	1.341%	27.036	1.050
with Thailand	53.390%	1.341%	27.143	1.050
with the Philippines	53.391%	1.338%	27.131	1.050
with China	53.152%	1.337%	27.019	1.050
with Japan	53.073%	1.333%	26.945	1.050
with South Korea	53.260%	1.342%	27.014	1.050
Multilateral coordination				
in ASEAN-5	52.494%	1.331%	1.050	1.034
in ASEAN-5 + China	46.012%	1.728%	1.052	1.022
in ASEAN-5 + Japan	51.515%	1.643%	1.052	1.039
in ASEAN-5 + S. Korea	52.556%	1.390%	1.050	1.036
in ASEAN-5 + 3	1.426%	1.348%	1.014	1.017

Source: Author's calculation

(2) Malaysia

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	49.427%	1.916%	1.019	1.021
Bilateral coordination				
with Indonesia	49.519%	1.919%	1.019	1.020
with Singapore	49.329%	1.917%	1.019	1.021
with Thailand	49.245%	1.909%	1.019	1.020
with the Philippines	49.410%	1.917%	1.019	1.020
with China	49.219%	1.917%	1.019	1.021
with Japan	49.223%	1.920%	1.020	1.020
with South Korea	49.251%	1.918%	1.019	1.021
Multilateral coordination				
in ASEAN-5	49.607%	1.911%	1.019	1.021
in ASEAN-5 + China	44.910%	1.514%	1.014	1.025
in ASEAN-5 + Japan	49.402%	2.304%	1.020	1.023
in ASEAN-5 + S. Korea	50.131%	1.795%	1.020	1.021
in ASEAN-5 + 3	3.164%	1.530%	1.022	1.027

Source: Author's calculation

(3) Singapore

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	**Traded Sector (γ_T)**	**Non-traded Sector (μ_N)**	**Traded Sector (μ_T)**
No coordination	62.180%	1.922%	1.058	1.021
Bilateral coordination				
with Indonesia	64.121%	1.915%	1.051	1.021
with Malaysia	63.904%	1.914%	1.052	1.021
with Thailand	63.903%	1.914%	1.052	1.021
with the Philippines	63.942%	1.916%	1.052	1.020
with China	63.924%	1.917%	1.052	1.021
with Japan	63.792%	1.914%	1.052	1.021
with South Korea	63.929%	1.918%	1.052	1.021
Multilateral coordination				
in ASEAN-5	64.066%	1.906%	1.051	1.021
in ASEAN-5 + China	63.944%	1.878%	1.048	1.021
in ASEAN-5 + Japan	63.727%	1.758%	1.052	1.016
in ASEAN-5 + S. Korea	63.920%	2.060%	1.052	1.018
in ASEAN-5 + 3	65.507%	1.666%	1.030	1.022

Source: Author's calculation

(4) Thailand

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	**Traded Sector (γ_T)**	**Non-traded Sector (μ_N)**	**Traded Sector (μ_T)**
No coordination	68.605%	0.917%	1.041	1.011
Bilateral coordination				
with Indonesia	68.856%	0.931%	1.041	1.011
with Malaysia	68.608%	0.927%	1.041	1.011
with Singapore	68.561%	0.927%	1.041	1.011
with the Philippines	68.644%	0.916%	1.041	1.011
with China	68.640%	0.911%	1.041	1.011
with Japan	68.395%	0.910%	1.042	1.011
with South Korea	68.662%	0.914%	1.041	1.011
Multilateral coordination				
in ASEAN-5	68.732%	0.916%	1.041	1.011
in ASEAN-5 + China	66.280%	0.608%	1.051	1.006
in ASEAN-5 + Japan	66.067%	1.243%	1.042	1.007
in ASEAN-5 + S. Korea	68.128%	0.982%	1.041	1.009
in ASEAN-5 + 3	1.499%	1.251%	1.054	1.007

Source: Author’s calculation

(5) The Philippines

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	61.099%	1.201%	1.028	1.063
Bilateral coordination				
with Indonesia	61.140%	1.281%	1.028	1.064
with Malaysia	61.035%	1.287%	1.028	1.065
with Singapore	58.984%	0.775%	1.029	1.015
with Thailand	60.949%	1.289%	1.028	1.064
with China	60.961%	1.199%	1.028	1.063
with Japan	60.772%	1.202%	1.028	1.063
with South Korea	60.958%	1.204%	1.028	1.063
Multilateral coordination				
in ASEAN-5	59.123%	0.774%	1.028	1.015
in ASEAN-5 + China	59.998%	0.497%	1.047	1.014
in ASEAN-5 + Japan	58.704%	0.687%	1.030	1.013
in ASEAN-5 + S. Korea	59.084%	0.685%	1.028	1.013
in ASEAN-5 + 3	57.255%	0.735%	1.029	1.010

Source: Author’s calculation

(6) China

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	55.112%	0.692%	1.018	1.018
Bilateral coordination				
with Indonesia	54.857%	0.729%	1.019	1.018
with Malaysia	54.869%	0.728%	1.018	1.018
with Singapore	55.313%	0.730%	1.018	1.018
with Thailand	55.006%	0.690%	1.018	1.018
with the Philippines	54.997%	0.691%	1.018	1.018
with Japan	54.750%	0.728%	1.019	1.018
with South Korea	54.845%	0.727%	1.018	1.018
Multilateral coordination				
in CJK	54.775%	0.728%	1.018	1.018
in ASEAN-5 + China	49.557%	0.857%	1.021	1.010
in ASEAN-5 + 3	56.376%	0.548%	1.018	1.017

Source: Author's calculation

(7) Japan

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	65.019%	2.039%	1.017	1.019
Bilateral coordination				
with Indonesia	64.684%	2.052%	1.017	1.019
with Malaysia	64.637%	2.038%	1.017	1.019
with Singapore	64.675%	1.033%	1.017	1.009
with Thailand	64.603%	2.044%	1.017	1.019
with the Philippines	64.641%	2.052%	1.017	1.019
with China	64.739%	2.041%	1.017	1.019
with South Korea	64.693%	2.044%	1.017	1.019
Multilateral coordination				
in CJK	64.727%	2.040%	1.017	1.019
in ASEAN-5 + Japan	65.776%	1.923%	1.018	1.024
in ASEAN-5 + 3	64.467%	2.362%	1.015	1.017

Source: Author's calculation

(8) South Korea

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	67.656%	0.784%	1.025	1.014
Bilateral coordination				
with Indonesia	67.529%	0.815%	1.025	1.014
with Malaysia	67.519%	0.785%	1.025	1.014
with Singapore	67.180%	0.821%	1.026	1.014
with Thailand	67.480%	0.787%	1.025	1.014
with the Philippines	67.552%	0.784%	1.025	1.014
with China	67.372%	0.812%	1.025	1.014
with Japan	67.128%	0.814%	1.025	1.014
Multilateral coordination				
in CJK	67.300%	0.813%	1.025	1.014
in ASEAN-5 + S. Korea	67.324%	0.889%	1.025	1.015
in ASEAN-5 + 3	67.736%	0.813%	1.021	1.010

Source: Author’s calculation

CHAPTER 5

TWO-PRODUCTION-FACTOR MODEL

5.1. Model Specification

This section elaborates the two-production-factor model. For the definitions of notations used in the model, please refer to Appendix 5.1. (page 156 – 161).

5.1.1. Agents' Optimization Problems

Below are the optimization problems faced by the economic agents.

5.1.1.1. Households

The representative household faces three optimization problems:

(1) Utility maximization subject to budget constraint to obtain the optimum real wage equation, the Euler equation, the optimum real money balance, and optimum capital rent rate

$$\max_{\breve{C}_t,\, L_t,\, B_t, B^*_{nt}\, K_t,\, M_t} U_t = E_t \sum_{t=0}^{\infty} \beta^t \left[ln\, C_t - \Psi\, L_t + v\, ln\left(\frac{M_t}{P_t}\right)\right]$$

$$\equiv E_t \sum_{t=0}^{\infty} \beta^t \left[ln\left(\breve{C}_t + G_t\right) - \Psi\, L_t + v\, ln\left(\frac{M_t}{P_t}\right)\right]$$

subject to

$$(1+t_C)\, P_t\, C_t + [K_t - (1-\delta)\, K_{t-1}] + B_t + \sum_{n=1}^{10} e_{nt}\, B^*_{nt} + M_t$$
$$= (1-t_L)\, W_t\, L_t + TR_t + R^{kap}_{t-1}\, K_{t-1} + (1+R_{t-1})\, B_{t-1} + \sum_{n=1}^{10} (1+R^*_{nt-1})\, e_{nt-1}\, B^*_{nt-1} + M_{t-1} \quad \text{... (1)}$$

where v is income elasticity of money demand.

(2) Cost minimization of non-traded and traded goods consumption to get demand functions for non-traded and traded goods

$$\min_{\breve{C}_{Tt}, \breve{C}_{Nt}} (1+t_C)\, \overline{P}_{Tt}\, \breve{C}_{Tt} + (1+t_C)\, \overline{P}_{Nt}\, \breve{C}_{Nt}$$

subject to

$$\breve{C}_t = \alpha^{-\alpha}\, (1-\alpha)^{-(1-\alpha)}\, \breve{C}^{\alpha}_{Tt}\, \breve{C}^{1-\alpha}_{Nt} \quad \text{... (2)}$$

(3) Cost minimization of domestically produced and imported traded goods consumption to get demand functions for domestically produced and imported traded goods; setting consumption tax rate equal for domestically produced and imported traded goods

$$\min_{\breve{C}_{Ht}, \breve{C}_{Fnt}} (1+t_C)\, \overline{P}_{Ht}\, \breve{C}_{Ht} + (1+t_C) \sum_{n=1}^{10} e_{nt}\, \overline{P}^*_{Fnt}\, \breve{C}_{Fnt}$$

subject to

$$\breve{C}_{Tt} = \omega_0^{-\omega_0}\, \breve{C}^{\omega_0}_{Ht} \prod_{n=1}^{10} \omega_n^{-\omega_n}\, \breve{C}^{\omega_n}_{Fnt} \quad \text{... (3)}$$

5.1.1.2. Firms

5.1.1.2.1. Firms Producing Intermediate Goods

Production functions for firms producing intermediate goods in the non-traded and traded sector, respectively:

$$Y_{Nt}(i) = A_{Nt} L_{NIt}^{\varphi_N} K_{NIt}^{1-\varphi_N} \qquad ; i \in [0,1] \qquad \dots (4)$$

$$Y_{Tt}(j) \equiv Y_{Ht}(j) + \sum_{n=1}^{10} Y_{Hnt}^{*}(j) = A_{Tt} L_{TIt}^{\varphi_T} K_{TIt}^{1-\varphi_T} \qquad ; j \in [0,1] \qquad \dots (5)$$

where L_{NIt} and K_{NIt} are labor and capital for non-traded intermediate good production; L_{TIt} and K_{TIt} are labor and capital for traded intermediate good production; A_{Nt} and A_{Tt} are shocks in the non-traded and traded sectors, respectively.

The log-linearized form of productivity shocks in each sector are stated as:

$$\hat{a}_{Nt} = \text{ƅ}_1 \, \hat{a}_{Nt-1} + \text{ƅ}_{12} \, \hat{a}_{Tt-1} + \varepsilon_{Nt} \qquad ; \qquad \varepsilon_{Nt} \sim i.i.d.(0, \sigma_{Nt}^2) \qquad \dots (6)$$

$$\hat{a}_{Tt} = \varrho_1 \, \hat{a}_{Nt-1} + \varrho_2 \, \hat{a}_{Tt-1} + \varepsilon_{Tt} \qquad ; \qquad \varepsilon_{Tt} \sim i.i.d.(0, \sigma_{Tt}^2) \qquad \dots (7)$$

where

ƅ_1, ƅ_2 , ϱ_1, ϱ_2 are shock parameters; ε_{Nt} and ε_{Tt} are error terms for non-traded and traded sector, respectively.

5.1.1.2.1.1. Firms Producing Non-traded Intermediate Goods

Firms producing non-traded intermediate goods face two optimization problems:

(i) Cost minimization to derive optimum unit cost of inputs in the non-traded sector V_{NIt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{NIt},\, K_{NIt}} W_t \, L_{NIt}(i) + R_t^{kap} K_{NIt}(i)$$

subject to

$$A_{Nt} \, L_{NIt}^{\varphi_N}(i) \; K_{NIt}^{1-\varphi_N}(i) = Y_{Nt}(i) \equiv \left(\frac{P_{Nt}(i)}{\bar{P}_{Nt}}\right)^{-\theta_N} Y_{Nt} \qquad \dots (8)$$

(ii) Profit maximization to derive optimum pricing rules for non-traded intermediate goods

$$\max_{P_{Nt(i)}} E_t \sum_{ϟ=t}^{\infty} \gamma_N^{ϟ-t} \left[P_{Nt}(i) \, (1+\tau_N) - V_{NIϟ}\right] Y_{Nϟ}^{d}(i) \qquad \dots (9)$$

5.1.1.2.1.2. Firms Producing Traded Intermediate Goods

Firms producing traded intermediate goods face two optimization problems:

(i) Cost minimization to derive optimum unit cost of inputs in the traded sector V_{TIt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{TIt}, K_{TIt}} W_t \, L_{TIt}(j) + R_t^{kap} K_{TIt}(j)$$

subject to

$$A_{Tt} \, L_{TIt}^{\varphi_T}(j) \, K_{TIt}^{1-\varphi_T}(j) = Y_{Tt}(j) \equiv \left(\frac{P_{Tt}(j)}{\bar{P}_{Tt}}\right)^{-\theta_T} Y_{Tt} \qquad \dots (10)$$

(ii) Profit maximization to derive optimum pricing rules for traded intermediate goods (Prices of intermediate goods to be sold in foreign countries are assumed to be benchmarked to domestic prices before converted to foreign market prices using the respective country's exchange rates)

$$\max_{P_{Ht(j)}} E_t \sum_{ϟ=t}^{\infty} {\gamma_T}^{ϟ-t} \left[P_{Ht}(j)(1+\tau_T) - V_{TIϟ} \right] Y_{Tϟ}^{d}(j)$$

where

$$Y_{Tϟ}(j) = Y_{Hϟ}(j) + \sum_{n=1}^{10} Y_{Hnϟ}^{*}(j) \qquad \dots (11)$$

5.1.1.2.2. Firms Producing Final Goods

Aggregation of final goods in the non-traded and traded sectors are formulated as:

$$Y_{Nt} = \left[\int_0^1 Y_{Nt}(i)^{(\theta_N-1)/\theta_N} \, di \right]^{\theta_N/(\theta_N-1)} \qquad \dots (12)$$

$$Y_{Tt} = Y_{Ht} + \sum_{n=1}^{10} Y_{Fnt} \qquad \dots (13)$$

where

$$Y_{Ht} = \left[\int_0^1 Y_{Ht}(j)^{(\theta_T-1)/\theta_T} \, dj \right]^{\theta_T/(\theta_T-1)} \qquad \dots (13a)$$

$$Y_{Fnt} = \left[\int_0^1 Y_{Fnt}(j)^{(\theta_T-1)/\theta_T} \, dj \right]^{\theta_T/(\theta_T-1)} \qquad \dots (13b)$$

5.1.1.2.2.1. Firms Producing Non-traded Final Goods

The representative firm producing non-traded final goods faces the following optimization problems:

(i) Cost minimization to derive optimum unit cost of inputs in the non-traded sector V_{NCt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{NCt},\, K_{NCt}} W_t \, L_{NCt} + R_t^{kap} K_{NCt}$$

subject to

$$A_{Nt} \, L_{NCt}^{\varphi_N} \, K_{NCt}^{1-\varphi_N} = Y_{Nt} \qquad \dots (14)$$

where L_{NCt} and K_{NCt} are labor and capital for non-traded final good production.

(ii) Profit maximization to obtain Home demand function for non-traded final goods

$$\max_{P_{Nt}(i)} \overline{P}_{Nt} \left[\int_0^1 Y_{Nt}(i)^{\frac{(\theta_N-1)}{\theta_N}} \, di \right]^{\frac{\theta_N}{(\theta_N-1)}} - \int_0^1 P_{Nt}(i) \, Y_{Nt}(i) \, di - V_{NCt} \qquad \dots (15)$$

5.1.1.2.2.2. Firms Producing Traded Final Goods

The representative firm producing traded final goods faces the following optimization problems:

(i) Cost minimization to derive optimum labor unit cost in the traded sector V_{TCt} (which is the Lagrange multiplier obtained from optimization)

$$\min_{L_{TCt},\, K_{TCt}} W_t\, L_{TCt} + R_t^{kap} K_{TCt}$$

subject to

$$A_{Tt}\, L_{TCt}^{\varphi_T}\, K_{TCt}^{1-\varphi_T} = Y_{Tt} \qquad \dots (16)$$

where L_{TCt} and K_{TCt} are labor and capital for traded final good production.

(ii) Profit maximization to obtain demand function for traded final goods
(Prices of final goods to be sold in foreign countries are assumed to be benchmarked to domestic prices before converted to foreign market prices using the respective country's exchange rates)

$$\max_{P_{Ht}(j)} \overline{P}_{Ht} \left[\int_0^1 Y_{Tt}(j)^{(\theta_T-1)/\theta_T}\, dj\right]^{\theta_T/(\theta_T-1)} - \int_0^1 P_{Ht}(j)\, Y_{Tt}(j)\, dj - V_{TCt} \qquad \dots (17)$$

5.1.1.3. Government or Supranational Planner Exercising Fiscal Policy

The government (supranational planner's) fiscal balance at time t is formulated as:

$$\int_0^1\left((1+t_C)\, G_t + TR_t + (1+R_{t-1})\, B_{t-1}\right) dx + \int_0^1 \tau_N\, P_{Nt}(i)\, Y_{Nt}^d(i)\, di + \int_0^1 \tau_T\, P_{Ht}(j)\, Y_{Tt}^d(j)\, dj$$
$$= \int_0^1\left(t_C\left(\check{C}_t + G_t\right) + t_L\, W_t\, L_t + B_t\right) dx \qquad \dots (18)$$

The government (supranational planner) faces three optimization problems:

(i) Utility maximization (prepared for household) at steady state to obtain optimum labor allocations in the non-traded and traded sectors

$$\max_{L_N, L_T} U = \ln C - \Psi L + v \ln\left(\frac{M}{P}\right)$$

subject to

$$C = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}\, Y_N^{1-\alpha}\left(Y_T^{\omega_0} \prod_{n=1}^{10}\left(Y_{Tn}^{*\,\omega_n}\right)\right)^{\alpha}$$
$$\equiv \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}\left(L_N^{\varphi_N}\, K_N^{1-\varphi_N}\right)^{1-\alpha}\left(\left(L_T^{\varphi_T}\, K_T^{1-\varphi_T}\right)^{\omega_0} \prod_{n=1}^{10}\left(Y_{Tn}^{*\,\omega_n}\right)\right)^{\alpha}$$

$$L = L_N + L_T \qquad \dots (19)$$

(ii) Cost minimization of government spending on non-traded and traded goods to get the government or supranational planner's demand functions for non-traded and traded goods at time t

$$\min_{G_{Tt}, G_{Nt}} (1+t_C)\, \overline{P}_{Tt}\, G_{Tt} + (1+t_C)\, \overline{P}_{Nt}\, G_{Nt}$$

subject to

$$G_t = \alpha^{-\alpha}(1-\alpha)^{-(1-\alpha)}\, G_{Tt}^{\alpha}\, G_{Nt}^{1-\alpha} \qquad \dots (20)$$

(iii) Cost minimization of domestically produced and imported traded goods consumption to obtain the government's or supranational planner's demand functions for domestically produced and imported traded goods at time t

$$\min_{G_{Ht}, G_{Fnt}} (1 + t_C)\, \overline{P}_{Ht}\, G_{Ht} + (1 + t_C) \sum_{n=1}^{10} e_{nt}\, \overline{P}^{*}_{Fnt}\, G_{Fnt}$$

subject to

$$G_{Tt} = \omega_0^{-\omega_0}\, G_{Ht}^{\omega_0} \prod_{n=1}^{10} \omega_n^{-\omega_n}\, G_{Fnt}^{\omega_n} \quad \ldots (21)$$

5.1.1.4. Central Bank or Supranational Planner Exercising Monetary Policy

5.1.1.4.1. Welfare Optimization Under the "No Coordination" (Nash) Regime

Welfare optimization problem for the central bank under the "No Coordination" regime is formulated as:

$$\mathbb{W}^{NC} = \min_{\pi_{Nt}, \tilde{y}_{Nt}, \pi_{Ht}, \tilde{y}_{Tt}} -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \{LOSS_t + TIP + O(\|\xi\|^3)\}$$

$$\equiv \min_{\pi_{Nt}, \tilde{y}_{Nt}, \pi_{Ht}, \tilde{y}_{Tt}} -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \beta^t \left\{ \begin{array}{c} \frac{(1-\alpha)}{(1-\varphi_N)} \left[\tilde{y}_{Nt}^2 + (1-\varphi_N) \frac{\theta_N}{\kappa_N} \pi_{Nt}^2\right] + \frac{\alpha\omega_0}{(1-\varphi_T)} \left[\tilde{y}_{Tt}^2 + (1-\varphi_T) \frac{\theta_T}{\kappa_T} \pi_{Ht}^2\right] \\ + (1+v)\, \alpha \sum_{n=1}^{10} \omega_n\, \tilde{y}^{*}_{Tnt} + v\,(1-\alpha)\, \tilde{y}_{Nt} + v\, \alpha\, \omega_0\, \tilde{y}_{Tt} \\ + TIP + O(\|\xi\|^3) \end{array} \right\}$$

subject to

$$\pi_{Nt} = \beta\, E_t\, \pi_{Nt+1} + \kappa_N\, \tilde{y}_{Nt}$$

$$\pi_{Ht} = \beta\, E_t\, \pi_{Ht+1} + \kappa_T\, \tilde{y}_{Tt}$$

$$\Delta\, \tilde{y}_{Nt} + \pi_{Nt} + \Delta\, \hat{a}_{Nt} = \Delta\, \tilde{y}_{Tt} + \pi_{Ht} + \Delta\, \hat{a}_{Tt}$$

$$(1-\alpha)\, \tilde{y}_{Nt} + \alpha\, \tilde{y}_{Tt} = E_t\big[(1-\alpha)\, \tilde{y}_{Nt+1} + \alpha\, \tilde{y}_{Tt+1}\big] - \{\hat{r}_t - E_t[(1-\alpha)\, \pi_{Nt+1} + \alpha\, \pi_{Ht+1}]\} \quad \ldots (22)$$

where

TIP = terms independent of policy and shocks

$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks

5.1.1.4.2. Welfare Optimization Under the "Bilateral Coordination" Regime

Welfare optimization problem for the supranational planner under the "Bilateral Coordination" regime is formulated as:

$$\mathbb{W}^{BC} = \min_{\pi_{Nt}, \tilde{y}_{Nt}, \pi_{Ht}, \tilde{y}_{Tt}, \pi^{*}_{N1t}, \tilde{y}^{*}_{N1t}, \pi^{*}_{H1t}, y^{*}_{T1t}} -\frac{1}{2} E_0 \sum_{t=0}^{\infty} \left\{ \begin{array}{c} \frac{(\rho_0+\rho_1)}{\rho_0} \left(\beta^{\blacksquare t} LOSS_t + TIP + O(\|\xi^3\|)\right) \\ + \frac{(\rho_0+\rho_1)}{\rho_1} \left(\beta^{\blacksquare t}\, LOSS^{*}_{1t} + TIP^{*}_{1t} + O^{*}_1(\|\xi_1^{*3}\|)\right) \end{array} \right\}$$

subject to

$$\pi_{Nt} = \beta^{\blacksquare} E_t\, \pi_{Nt+1} + \kappa_N\, \tilde{y}_{Nt}$$

$$\pi_{Ht} = \beta^{\blacksquare} E_t\, \pi_{Ht+1} + \kappa_T\, \tilde{y}_{Tt}$$

$$\Delta\, \tilde{y}_{Nt} + \pi_{Nt} + \Delta\, \hat{a}_{Nt} = \Delta\, \tilde{y}_{Tt} + \pi_{Ht} + \Delta\, \hat{a}_{Tt}$$

$$(1-\alpha)\, \tilde{y}_{Nt} + \alpha\, \tilde{y}_{Tt} = E_t[(1-\alpha)\, \tilde{y}_{Nt+1} + \alpha\, \tilde{y}_{Tt+1}] - \{\hat{r}_t - E_t[(1-\alpha)\, \pi_{Nt+1} + \alpha\, \pi_{Ht+1}]\}$$

$$\Delta\, \tilde{y}_{Nt} + \pi_{Nt} + \Delta\, \hat{a}_{Nt} = \Delta\, \tilde{y}_{Tt} + \pi_{Ht} + \Delta\, \hat{a}_{Tt}\, \pi^{*}_{N1t} = \beta^{\blacksquare} E_t\, \pi^{*}_{N1t+1} + \kappa^{*}_{N1} \tilde{y}^{*}_{N1t}$$

$$\pi^*_{H1t} = \beta^{\blacksquare} E_t \pi^*_{H1t+1} + \kappa^*_{T1}\tilde{y}^*_{T1t}$$

$$\Delta \tilde{y}^*_{N1t} + \pi^*_{N1t} + \Delta\hat{a}^*_{N1t} = \Delta \tilde{y}^*_{T1t} + \pi^*_{H1t} + \Delta\hat{a}^*_{T1t}$$

$$(1-\alpha^*)\tilde{y}^*_{N1t} + \alpha\, \tilde{y}^*_{T1t} = E_t\left[(1-\alpha^*)\tilde{y}^*_{N1t+1} + \alpha^*\tilde{y}^*_{T1t+1}\right] - \{\hat{r}^*_{1t} - E_t[(1-\alpha^*)\pi^*_{N1t+1} + \alpha^*\pi^*_{H1t+1}]\}$$

… (23)

where

$$\beta^{\blacksquare} = \frac{\rho_0\, \beta + \rho_1\, \beta^*_1}{(\rho_0+\rho_1)}$$

$$LOSS_t = \frac{(1-\alpha)}{(1-\varphi_N)}\left[\tilde{y}^2_{Nt} + \frac{\theta_N}{\kappa_N}\pi^2_{Nt}\right] + \frac{\alpha\omega_0}{(1-\varphi_T)}\left[\tilde{y}^2_{Tt} + \frac{\theta_T}{\kappa_T}\pi^2_{Ht}\right]$$
$$+ (1+v)\,[\alpha\omega_1\, \tilde{y}^*_{T1t} + \alpha \textstyle\sum_{n=2}^{10} \omega_n\, \tilde{y}^*_{Tnt}] + v\,(1-\alpha)\, \tilde{y}_{Nt} + v\, \alpha\omega_0\, \tilde{y}_{Tt}$$

$$LOSS^*_{1t} = \frac{(1-\alpha^*_1)}{(1-\varphi^*_{N1})}\left[{\tilde{y}^*_{N1t}}^2 + \frac{\theta^*_{N1}}{\kappa^*_{N1}}{\pi^*_{N1t}}^2\right] + \frac{\alpha^*_1\omega^*_{1-1}}{(1-\varphi^*_{T1})}\left[{\tilde{y}^*_{T1t}}^2 + \frac{\theta^*_{T1}}{\kappa^*_{T1}}{\pi^*_{H1t}}^2\right]$$
$$+ (1+v^*_1)\,[\alpha^*_1\, \omega^*_{1\cdot 0}\, \tilde{y}_{Tt} + \alpha^*_1 \textstyle\sum_{n=2}^{10} \omega^*_{1\cdot n}\, \tilde{y}^*_{Tnt}] + v^*_1(1-\alpha^*_1)\, \tilde{y}^*_{N1t} + v^*_1\, \alpha^*_1\omega^*_{1\cdot 1}\, \tilde{y}^*_{T1t}$$

TIP = terms independent of policy and shocks for the home economy

$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the home economy

TIP^*_{1t} = terms independent of policy and shocks for the Foreign Country

$O^*_1(\|{\xi^*_1}^3\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the Foreign Country

5.1.1.4.3. Welfare Optimization Under the "Multilateral Coordination" Regime

Welfare optimization problem for the supranational planner under the "Multilateral Coordination" regime is formulated as

$$\mathbb{W}^{MC} = \min_{\pi_{Nt},\tilde{y}_{Nt},\pi_{Ht},\tilde{y}_{Tt},\pi^*_{N1t},\tilde{y}^*_{N1t},\pi^*_{H1t},y^*_{T1t}\,\dots\,\pi^*_{Nkt},\tilde{y}^*_{Nkt},\pi^*_{Hkt},y^*_{Tkt}}$$

$$-\frac{1}{2}\, E_0 \sum_{t=0}^{\infty} {\beta^{\blacklozenge}}^t \left\{\begin{array}{c} \frac{(\rho_0+\rho_1+\,\dots\,+\rho_k)}{\rho_0}\left(LOSS_t + TIP + O(\|\xi^3\|)\right) \\ +\frac{(\rho_0+\rho_1+\,\dots\,+\rho_k)}{\rho_1}\left(LOSS^*_{1t} + TIP^*_{1t} + O^*_1(\|{\xi^*_1}^3\|)\right) \\ +\ \dots \\ +\frac{(\rho_0+\rho_1+\,\dots\,+\rho_k)}{\rho_k}\left(LOSS^*_{kt} + TIP^*_{kt} + O^*_k(\|{\xi^*_k}^3\|)\right) \end{array}\right\}$$

subject to

$$\pi_{Nt} = \beta^{\blacklozenge} E_t \pi_{Nt+1} + \kappa_N\, \tilde{y}_{Nt}$$

$$\pi_{Ht} = \beta^{\blacklozenge} E_t \pi_{Ht+1} + \kappa_T\, \tilde{y}_{Tt}$$

$$\Delta \tilde{y}_{Nt} + \pi_{Nt} + \Delta\, \hat{a}_{Nt} = \Delta \tilde{y}_{Tt} + \pi_{Ht} + \Delta\, \hat{a}_{Tt}$$

$$(1-\alpha)\, \tilde{y}_{Nt} + \alpha\, \tilde{y}_{Tt} = E_t\left[(1-\alpha)\, \tilde{y}_{Nt+1} + \alpha\, \tilde{y}_{Tt+1}\right] - \{\hat{r}_t - E_t[(1-\alpha)\, \pi_{Nt+1} + \alpha\, \pi_{Ht+1}]\}$$

$$\pi^*_{N1t} = \beta^{\blacklozenge} E_t \pi^*_{N1t+1} + \kappa^*_{N1}\tilde{y}^*_{N1t}$$

$$\pi^*_{H1t} = \beta^{\blacklozenge} E_t \pi^*_{H1t+1} + \kappa^*_{T1}\tilde{y}^*_{T1t}$$

$$\Delta\, \tilde{y}^*_{N1t} + \pi^*_{N1t} + \Delta\hat{a}^*_{N1t} = \Delta\, \tilde{y}^*_{T1t} + \pi^*_{H1t} + \Delta\hat{a}^*_{T1t}$$

$$(1-\alpha^*_1)\tilde{y}^*_{N1t} + \alpha^*_1\, \tilde{y}^*_{T1t} = E_t\left[(1-\alpha^*_1)\tilde{y}^*_{N1t+1} + \alpha^*_1\tilde{y}^*_{T1t+1}\right] - \{\hat{r}^*_{1t} - E_t[(1-\alpha^*_1)\pi^*_{N1t+1} + \alpha^*_1\pi^*_{H1t+1}]\}$$

…

$$\pi^*_{Nkt} = \beta^{\blacklozenge} E_t\, \pi^*_{Nkt+1} + \kappa^*_{Nk}\tilde{y}^*_{Nkt}$$

$$\pi^*_{Hkt} = \beta^{\blacklozenge} E_t\, \pi^*_{Hkt+1} + \kappa^*_{Tk}\tilde{y}^*_{kt}$$

$$\Delta\, \tilde{y}^*_{Nkt} + \pi^*_{Nkt} + \Delta\hat{a}^*_{Nkt} = \Delta\, \tilde{y}^*_{Tkt} + \pi^*_{Hkt} + \Delta\hat{a}^*_{Tkt}$$

$$(1-\alpha^*_k)\tilde{y}^*_{Nkt} + \alpha^*_k\, \tilde{y}^*_{Tkt} = E_t\left[(1-\alpha^*_k)\tilde{y}^*_{Nkt+1} + \alpha^*_k\tilde{y}^*_{Tkt+1}\right] - \{\hat{r}^*_{kt} - E_t[(1-\alpha^*_k)\pi^*_{Nkt+1} + \alpha^*_k\pi^*_{Hkt+1}]\}$$

… (24)

where

k = number of participating countries – 1

$$\beta^{\blacklozenge} = \frac{\rho_0\, \beta + \rho_1\, \beta^*_1 + \cdots + \rho_k\, \beta^*_k}{(\rho_0 + \rho_1 + \cdots + \rho_k)}$$

$$LOSS_t = \frac{(1-\alpha)}{(1-\varphi_N)}\left[\tilde{y}^2_{Nt} + \frac{\theta_N}{\kappa_N}\, \pi^2_{Nt}\right] + \frac{\alpha\omega_0}{(1-\varphi_T)}\left[\tilde{y}^2_{Tt} + \frac{\theta_T}{\kappa_T}\pi^2_{Ht}\right]$$
$$+ (1+v)\, [\alpha\omega_1\, \tilde{y}^*_{T1t} + \alpha \textstyle\sum_{n=2}^{10} \omega_n\, \tilde{y}^*_{Tnt}] + v\, (1-\alpha)\, \tilde{y}_{Nt} + \alpha\omega_0\, \tilde{y}_{Tt}$$

$$LOSS^*_{1t} = \frac{(1-\alpha^*_1)}{(1-\varphi^*_{N1})}\left[{\tilde{y}^*_{N1t}}^2 + \frac{\theta^*_{N1}}{\kappa^*_{N1}}\, {\pi^*_{N1t}}^2\right] + \frac{\alpha^*_1\, \omega^*_{1\cdot 1}}{(1-\varphi^*_{T1})}\left[{\tilde{y}^*_{T1t}}^2 + \frac{\theta^*_{T1}}{\kappa^*_{T1}}\, {\pi^*_{H1t}}^2\right]$$
$$+ (1+v^*_1)\, [\alpha^*_1\, \omega^*_{1\cdot 0}\, \tilde{y}_{Tt} + \alpha^*_1\, \textstyle\sum_{n=2}^{10} \omega^*_{1\cdot n}\, \tilde{y}^*_{Tnt}] + v^*_1\, (1-\alpha^*_1)\, \tilde{y}^*_{N1t} + v^*_1\alpha^*_1\omega^*_{1\cdot 1}\, \tilde{y}^*_{T1t}$$

…

$$LOSS^*_{kt} = \frac{(1-\alpha^*_k)}{(1-\varphi^*_{Nk})}\left[{\tilde{y}^*_{Nkt}}^2 + \frac{\theta^*_{Nk}}{\kappa^*_{Nk}}\, {\pi^*_{Nkt}}^2\right] + \frac{\alpha^*_k\, \omega^*_{k\cdot k}}{(1-\varphi^*_{Tk})}\left[{\tilde{y}^*_{Tkt}}^2 + \frac{\theta^*_{Tk}}{\kappa^*_{Tk}}\, {\pi^*_{Hkt}}^2\right]$$
$$+ (1+v^*_k)\left[\alpha^*_k\, \omega^*_{k\cdot 0}\, \tilde{y}_{Tt} + \alpha^*_k\, \omega^*_{k\cdot 1}\, \tilde{y}^*_{T1t} + \cdots + \alpha^*_k\, \textstyle\sum_{n=k-1}^{10} \omega^*_{k\cdot n}\, \tilde{y}^*_{Tnt}\right]$$
$$+ v^*_k\, (1-\alpha^*_k)\, \tilde{y}^*_{Nkt} + v^*_k\, \alpha^*_k\omega^*_{k\cdot k}\, \tilde{y}^*_{Tkt}$$

TIP = terms independent of policy and shocks for the Home economy

$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the home economy

TIP^*_{1t} = terms independent of policy and shocks for Foreign Country-1

$O^*_1(\|{\xi^*_1}^3\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-1

…

TIP^*_{kt} = terms independent of policy and shocks for Foreign Country-k

$O^*_k(\|{\xi^*_k}^3\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-k

5.1.2. Optimum Solutions to Economic Agents' Problems

Below are the solutions for agents' optimization problems.

5.1.2.1. Households

- **Utility maximization**

- Optimum real wage

$$\frac{W_t}{P_t} = \frac{(1+t_C)}{(1-t_L)} \Psi C_t \qquad \ldots (1)$$

- Euler equation

$$\frac{1}{1+R_t} = \beta E_t \left(\frac{P_t C_t}{P_{t+1} C_{t+1}}\right) \qquad \ldots (2)$$

- Optimum real money balance ... (3)

$$\frac{M_t}{P_t} = \left(\frac{1+R_t}{R_t}\right) v (1 + t_C) C_t$$

- Optimum capital rent rate

$$R_t^{kap} = R_t + \delta \qquad \ldots (4)$$

- **Cost minimization of non-traded and traded goods consumption**

- Demand function for non-traded goods

$$\check{C}_{Nt} = (1-\alpha) \frac{P_t \check{C}_t}{\bar{P}_{Nt}} \qquad \ldots (5)$$

- Demand function for traded goods

$$\check{C}_{Tt} = \alpha \frac{P_t \check{C}_t}{\bar{P}_{Tt}} \qquad \ldots (6)$$

- **Cost minimization of domestically produced and imported traded goods consumption**

- Demand function for domestically produced traded goods

$$\check{C}_{Ht} = \omega_0 \frac{\bar{P}_{Tt} \check{C}_{Tt}}{\bar{P}_{Ht}} \qquad \ldots (7)$$

- Demand function for imported traded goods from Foreign Country-n; n = 1, 2, …, 10

$$\check{C}_{Fnt} = \omega_n \frac{\bar{P}_{Tnt} \check{C}_{Tnt}}{e_{Nt} \bar{P}_{Fnt}} \qquad \ldots (8)$$

5.1.2.2.1. Firms Producing Intermediate Goods

5.1.2.2.1.1. Firms Producing Non-traded Intermediate Goods

- **Cost minimization**

- Optimum unit cost of inputs

$$V_{NIt} = \frac{W_t}{(1-\varphi_N) A_{Nt}} \left(\frac{L_{NIt}(\mathrm{i})}{K_{NIt}(\mathrm{i})}\right)^{\varphi_N} = \frac{R_t^{kap}}{\varphi_N A_{Nt}} \left(\frac{L_{NIt}(\mathrm{i})}{K_{NIt}(\mathrm{i})}\right)^{(1-\varphi_N)} \qquad \ldots (9)$$

- Optimum labor to capital input ratio

$$\frac{L_{NIt}(\mathrm{i})}{K_{NIt}(\mathrm{i})} = \frac{(1-\varphi_N)}{\varphi_N} \frac{R_t^{kap}}{W_t} \qquad \ldots (10)$$

- **Profit maximization**

- Optimum pricing rule for non-traded intermediate good i

$$P_{Nt}(i) = \frac{\mu_N}{(1+\tau_N)} \frac{E_t \sum_{ϟ=t}^{\infty} \gamma_N^{ϟ-t} \ V_{NIϟ} \ Y_{Nϟ}(i)}{E_t \sum_{ϟ=t}^{\infty} \gamma_N^{ϟ-t} \ Y_{NIϟ}(i)} \quad \dots (11)$$

with

$$\mu_N = \theta_N / (\theta_N - 1)$$

5.1.2.2.1.2. Firms Producing Traded Intermediate Goods

- **Cost minimization**

- Optimum unit cost of inputs

$$V_{TIt} = \frac{W_t}{(1-\varphi_T) \, A_{Tt}} \left(\frac{L_{TIt}(j)}{K_{TIt}(j)}\right)^{\varphi_T} = \frac{R_t^{kap}}{\varphi_T \, A_{Tt}} \left(\frac{L_{TIt}(j)}{K_{TIt}(j)}\right)^{(1-\varphi_T)} \quad \dots (12)$$

- Optimum labor to capital input ratio

$$\frac{L_{TIt}(j)}{K_{TIt}(j)} = \frac{(1-\varphi_T)}{\varphi_T} \frac{R_t^{kap}}{W_t} \quad \dots (13)$$

- **Profit maximization**

- Optimum pricing rule for non-traded intermediate good i

$$P_{Ht}(j) = \frac{\mu_T}{(1+\tau_T)} \frac{E_t \sum_{ϟ=t}^{\infty} \gamma_T^{ϟ-t} V_{TIϟ} \left(Y_{Hϟ}(j) + \sum_{n=1}^{10} Y_{Hnϟ}^{*}(j)\right)}{E_t \sum_{ϟ=t}^{\infty} \gamma_T^{ϟ-t} \left(Y_{Hϟ}(j) + \sum_{n=1}^{10} Y_{Hnϟ}^{*}(j)\right)} \quad \dots (14)$$

with

$$\mu_T = \theta_T / (\theta_T - 1)$$

5.1.2.2.2. Firms Producing Final Goods

5.1.2.2.2.1. Firms Producing Non-traded Final Goods

- **Cost minimization**

- Optimum unit cost of inputs

$$V_{NCt} = \frac{W_t}{(1-\varphi_N) \, A_{Nt}} \left(\frac{L_{NCt}(\mathrm{i})}{K_{NCt}(\mathrm{i})}\right)^{\varphi_N} = \frac{R_t^{kap}}{\varphi_N \, A_{Nt}} \left(\frac{L_{NCt}(\mathrm{i})}{K_{NCt}(\mathrm{i})}\right)^{(1-\varphi_N)} \quad \dots (15)$$

- Optimum labor to capital input ratio

$$\frac{L_{NCt}(\mathrm{i})}{K_{NCt}(\mathrm{i})} = \frac{(1-\varphi_N)}{\varphi_N} \frac{R_t^{kap}}{W_t} \quad \dots (16)$$

- **Profit maximization**

- Demand function for non-traded intermediate good i

$$Y_{Nt}(i) = \left(\frac{P_{Nt}(i)}{\bar{P}_{Nt}}\right)^{-\theta_N} Y_{Nt} \quad \dots (17)$$

where

$$\bar{P}_{Nt} = \left[\int_0^1 P_{Nt}^{1-\theta_N}(i) \, di\right]^{1/(1-\theta_N)}$$

5.1.2.2.2.2. Firms Producing Traded Final Goods

- **Cost minimization**

- Optimum unit cost of inputs

$$V_{TCt} = \frac{W_t}{(1-\varphi_T)\, A_{Tt}} \left(\frac{L_{Tt}}{K_{Tt}}\right)^{\varphi_T} = \frac{R_t^{kap}}{\varphi_T\, A_{Tt}} \left(\frac{L_{Tt}}{K_{Tt}}\right)^{(1-\varphi_T)} \quad \dots (18)$$

- Optimum labor to capital input ratio

$$\frac{L_{Tt}}{K_{Tt}} = \frac{(1-\varphi_T)}{\varphi_T} \frac{R_t^{kap}}{W_t} \quad \dots (19)$$

- **Profit maximization**

- Demand function for domestically produced traded intermediate good j

$$Y_{Ht}(j) = \left(\frac{P_{Ht}(j)}{\bar{P}_{Ht}}\right)^{-\theta_T} Y_{Ht} \quad \dots (20)$$

where

$$\bar{P}_{Ht} = \left[\int_0^1 P_{Ht}^{1-\theta_T}(j)\, dj\right]^{1/(1-\theta_T)}$$

- Demand function for imported traded intermediate good j from Foreign Country-n

$$Y_{Fnt}(j) = \left(\frac{P_{Fnt}(j)}{\bar{P}_{Fnt}}\right)^{-\theta_T} Y_{Fnt} \quad \dots (21)$$

where

$$\bar{P}_{Fnt} = \left[\int_0^1 P_{Fnt}^{1-\theta_T}(j)\, dj\right]^{1/(1-\theta_T)}$$

5.1.2.3. Government or Supranational Planner Exercising Fiscal Policy

- **Utility maximization**

- Optimum labor allocation in the non-traded sector

$$\Psi\, L_N = (1-\varphi_N)\,(1-\alpha) \quad \dots (22)$$

- Optimum labor allocation in the traded sector

$$\Psi\, L_T = (1-\varphi_T)\,\alpha\,\omega_0 \quad \dots (23)$$

- Optimum labor allocation in the Home economy

$$\Psi\, L \equiv \Psi\,(L_N + L_T) = (1-\varphi_N)\,(1-\alpha) + (1-\varphi_T)\,\alpha\,\omega_0 \quad \dots (24)$$

- **Cost minimization of non-traded and traded goods consumption**

- Demand function for non-traded goods consumption

$$G_{Nt} = (1-\alpha)\,\frac{P_t\, G_t}{\bar{P}_{Nt}} \quad \dots (25)$$

- Demand function for traded goods consumption

$$G_{Tt} = \alpha\,\frac{P_t\, G_t}{\bar{P}_{Tt}} \quad \dots (26)$$

- **Cost minimization of domestically produced and imported traded goods consumption**

- Demand function for domestically produced traded goods

$$G_{Ht} = \omega_0\,\frac{\bar{P}_{Tt}\, G_{Tt}}{\bar{P}_{Ht}} \quad \dots (27)$$

- Demand function for imported traded goods consumption from Foreign Country-n

$$G_{Fnt} = \omega_n \frac{\bar{P}_{Tnt} G_{Tnt}}{e_{Nt} \bar{P}_{Fnt}} \quad \dots (28)$$

5.1.3. Market Clearing Conditions, Aggregations, and Equilibria

Below are the market clearing conditions, aggregations of agents' optimum solutions, and market equilibria.

5.1.3.1. Market Clearing Conditions

- Non-traded goods market clearing condition for each country in period t, where each country's aggregate supply of non-traded goods equals the respective country's aggregate demand for non-traded goods

  - For the Home economy

  $$\bar{P}_{Nt} Y_{Nt} = (1-\alpha) P_t (C_t + K_t)$$

  - For each of the foreign countries (n = 1, 2, …, 10)

  $$\bar{P}_{Nnt} Y_{Nnt} = (1-\alpha_n^*) \bar{P}_{nt}^* (C_{nt}^* + K_{nt}^*) \quad \dots (29)$$

- Traded goods market clearing condition in period t, where the global aggregate supply of traded goods equals the global aggregate demand for traded goods

$$\bar{P}_{Ht} Y_{Tt} + \sum_{i=0}^{10} \bar{P}_{Fnt}^* Y_{Tnt}^* = \alpha P_t (C_t + K_t) + \sum_{n=1}^{10} \{\alpha_n^* \bar{P}_{nt}^* (C_{nt}^* + K_{nt}^*)\} \quad \dots (30)$$

- Labor market clearing condition for each economy at time t, where the labor supply equals the market demand from the non-traded and traded sectors

  - For the Home economy

  $$L_t = L_{Nt} + L_{Tt}$$

  - For each of the Foreign Countries (n = 1, 2, …, 10)

  $$L_{nt}^* = L_{Nnt}^* + L_{Tnt}^* \equiv L_{NInt}^* + L_{NCnt}^* + L_{TInt}^* + L_{TCnt}^* \quad \dots (31)$$

- Capital market clearing condition, where the global supply of capital goods equals the global demand for capital goods

$$K_{Ht} + \sum_{n=1}^{10} K_{Fnt} + \sum_{n=1}^{10} \left[K_{nt}^* + \sum_{\substack{i=0, \\ n \neq i}}^{10} K_{Fnt}^* \right] = K_{Nt} + K_{Tt} + \sum_{n=1}^{10} \left[K_{Nnt}^* + \sum_{\substack{i=0, \\ n \neq i}}^{10} K_{Tnt}^* \right] \quad \dots (32)$$

  with

  $$K_{Nt} = K_{NIt} + K_{Nct}$$

  $$K_{Tt} = K_{TIt} + K_{Tct}$$

  $$K_{Nnt}^* = K_{NInt}^* + K_{NCnt}^*$$

  $$K_{Tnt}^* = K_{TInt}^* + K_{TCnt}^*$$

- International bond market clearing condition at period t, where there is no excess supply or excess demand of bonds in the world economy (households in the other countries will absorb an excess supply of bonds in one country, while buying bonds from other countries can meet the excess demand for bonds in one country)

$B_t + \sum_{n=1}^{10} e_{nt} B_{nt}^* = 0$ ... (33)

- International risk-sharing condition under the balanced-trade steady state, where real effective exchange rate of the Home economy (Ϙ_t) is determined by consumption in all economies in the world

  - For the Home economy

  $\text{Ϙ}_t = \sum_{n=1}^{10} \left(\frac{\alpha}{\alpha_n} \frac{\omega_0}{(1-\omega_n^*)} \frac{C_t}{C_{nt}^*} \right)$

  - For each of the Foreign Countries (n = 1, 2, …, 10)

  $\text{Ϙ}_{nt}^* = \sum_{\substack{i=0, \\ n \neq i}}^{10} \left(\frac{\alpha_n^*}{\alpha_i} \frac{\omega_{n \cdot n}^*}{(1-\omega_{n \cdot i}^*)} \frac{C_{nt}^*}{C_{n \cdot it}^*} \right)$ ... (34)

- Uncovered interest parity between the Home economy and Foreign Country-n

  - For the Home economy

  $R_t^{nat} - R_{nt}^{*\,nat} = E_t \hat{e}_{nt+1}^{nat} - \hat{e}_{nt}^{nat} + u_t \equiv E_t \hat{s}_{nt+1}^{nat} - \hat{s}_{nt}^{nat} + E_t \pi_{Ht+1} + E_t \pi_{Hnt+1}^* + u_t$

  - For each of the Foreign Countries (n = 1, 2, ⋯, 10 ; i = 0, 1, ⋯ 10; $i \neq$ n)

  $R_{nt}^{*\,nat} - R_{it}^{*\,nat} = E_t \hat{e}_{n \cdot it+1}^{*\;\;nat} - \hat{e}_{n \cdot it}^{*\;\;nat} + u_t$

  $\equiv E_t \hat{s}_{n \cdot it+1}^{*\;\;nat} - \hat{s}_{n \cdot it}^{*\;\;nat} + E_t \pi_{Fnt+1}^* + E_t \pi_{Fit+1}^* + u_t$ ... (35)

  where u_t is a global exchange rate shock felt by all countries.

5.1.3.2. Aggregations of Optimum Solutions

- Terms of trade of Home economy with respect to Foreign Country-n at period t (S_{nt})

  $S_{nt} = \frac{Y_{Tt}}{Y_{Tnt}^*}$ ... (36)

- Real aggregate demand for goods in the non-traded sector at period t (Y_{Nt})

  $Y_{Nt} = (1-\alpha)(C_t + K_t) Q_{Nt}^{\;-\alpha}$ ... (37)

  where $Q_{Nt} = \frac{\bar{P}_{Nt}}{\bar{P}_{Tt}}$ is the relative price of non-traded goods to traded goods

- Real aggregate demand for goods in the traded sector at period t (Y_{Tt})

  $Y_{Tt} = \alpha (C_t + K_t) Q_{Nt}^{\;1-\alpha} \prod_{n=1}^{10} S_{nt}^{\omega_n}$ ... (38)

- Aggregate domestic demand at period t (C_t^A)

  $C_t^A \equiv (C_t + K_t) = \alpha^{-\alpha}(1-\alpha)^{\alpha-1} Y_{Nt}^{\;1-\alpha} \left(Y_{Tt}^{\omega_0} \prod_{n=1}^{10} Y_{Tnt}^{*\;\omega_n} \right)^{\alpha}$

  ... (39)

- Aggregate demand for labour in the non-traded sector at period t (L_{Nt})

  $K_{Nt} L_{Nt} = \frac{1}{A_{Nt}} \int_0^1 Y_{Nt}^d(i)\, di = \frac{\hat{\Sigma}_{Nt}}{A_{Nt}} Y_{Nt}$ ... (40)

  where $\hat{\Sigma}_{Nt} = \int_0^1 \left(\frac{P_N(i)}{\bar{P}_N} \right)^{-\theta_N} di$ measures price dispersion within non-traded sector

- Aggregate demand for labour in the traded sector at period t (L_{Tt})

  $K_{Tt} L_{Tt} = \frac{1}{A_{Tt}} \int_0^1 (Y_{Ht}(j) + Y_{Ht}^*(j))\, dj = \frac{\hat{\Sigma}_{Ht}}{A_{Tt}} Y_{Tt}$ ... (41)

where $\hat{\Sigma}_{Ht} = \int_0^1 \left(\frac{P_H(i)}{\bar{P}_H}\right)^{-\theta_N} dj$ measures price dispersion within the traded sector

5.1.3.3. Natural Rate Equilibrium

- Natural rate of non-traded output ($\hat{y}_{Nt}^{nat}$)
  $\hat{y}_{Nt}^{nat} = \varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Nt}$ … (42)
- Natural rate of traded output ($\hat{y}_{Tt}^{nat}$)
  $\hat{y}_{Tt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \hat{a}_{Tt}$ … (43)
- Natural rate of the terms of trade of Home economy with Foreign Country-n ($\hat{s}_{nt}^{nat}$)
  $\hat{s}_{nt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{Tn}^* \left({\hat{k}_{Tnt}^*}^{nat} - {\hat{l}_{Tnt}^*}^{nat}\right) + (\hat{a}_{Tt} - \hat{a}_{Tnt}^*)$ … (44)
- Natural rate of aggregate domestic demand $\left({\hat{c}_t^A}^{nat}\right)$
  ${\hat{c}_t^A}^{nat} = (1-\alpha)\left[\varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Nt}\right] + \alpha \left[\varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \hat{a}_{Tt}\right] - \alpha \sum_{n=1}^{10} \omega_n \hat{s}_t^{nat}$
  … (45)
- Real interest rate ($\widehat{rr}_t^{nat}$) in the flexible-price equilibrium
  $\widehat{rr}_t^{nat} = E_t \Delta \hat{c}_{t+1}^{nat} = 0$ … (46)
- Relative price of non-traded goods in terms of traded goods ($\hat{q}_{Nt}^{nat}$)
  $\hat{q}_{Nt}^{nat} \equiv \hat{p}_{Nt}^{nat} - \hat{p}_{Tt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha \sum_{n=1}^{10} \omega_n \hat{s}_t^{nat}$
  … (47)

5.1.3.4. Sticky Price Equilibrium

- Phillips curve in the non-traded sector
  $\pi_{Nt} = \beta E_t \pi_{Nt+1} + \kappa_N \tilde{y}_{Nt}$ … (48)
  where
  $\kappa_N = \frac{(1-\beta \gamma_N)(1-\gamma_N)}{\gamma_N}$
  is a constant that measures the responsiveness of pricing decision to the variations in the real marginal cost gap in the non-traded sector
- Phillips curve in the traded sector
  $\pi_{Ht} = \beta E_t \pi_{Ht+1} + \kappa_T \tilde{y}_{Tt}$ … (49)
  where
  $\kappa_T = \frac{(1-\beta \gamma_T)(1-\gamma_T)}{\gamma_T}$
  is a constant that measures the responsiveness of pricing decision to the variations in the real marginal cost gap in the traded sector
- Relation between changes on output in the non-traded and traded sectors
  $\Delta \tilde{y}_{Nt} + \Delta \hat{a}_{Nt} + \pi_{Nt} = \Delta \tilde{y}_{Tt} + \Delta \hat{a}_{Tt} + \pi_{Ht}$ … (50)
- Relations between output, inflation, and nominal interest rate
  $(1-\alpha)\tilde{y}_{Nt} + \alpha \tilde{y}_{Tt} = E_t [(1-\alpha)\tilde{y}_{Nt+1} + \alpha \tilde{y}_{Tt+1}] - \{r_t - E_t [(1-\alpha)\pi_{Nt+1} + \alpha \pi_{Ht+1}]\}$
  … (51)

5.1.4. Model Solution and Welfare Calculation

As in the case of one-production-factor model, welfare calculation in the two-factor model follows the linear quadratic (LQ) approximation solution technique as suggested by Díaz-Giménez (2004).

Below are the steady state equation systems for each interaction regime among the ASEAN-5+3. For the definitions of notations, please see Appendix 5.1. (page 156 – 161).

- **For the "No Coordination" regime**

$$\hat{a}_{Nt} = \text{ƅ}_1\ \hat{a}_{Nt-1} + \text{ƅ}_2\ \hat{a}_{Tt-1} + \varepsilon_{Nt} \quad \dots (1)$$

$$\hat{a}_{Tt} = \varrho_1\ \hat{a}_{Nt-1} + \varrho_2\ \hat{a}_{Tt-1} + \varepsilon_{Tt} \quad \dots (2)$$

$$\hat{a}^*_{N1t} = \text{ƅ}^*_{1\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + \text{ƅ}^*_{1\cdot 2}\ \hat{a}^*_{T1t-1} + \varepsilon^*_{N1t} \quad \dots (3)$$

$$\hat{a}^*_{T1t} = \varrho^*_{1\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{1\cdot 2}\ \hat{a}^*_{T1t-1} + \varepsilon^*_{T1t} \quad \dots (4)$$

$$\hat{a}^*_{N2t} = \text{ƅ}^*_{2\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + \text{ƅ}^*_{2\cdot 2}\ \hat{a}^*_{T2t-1} + \varepsilon^*_{N2t} \quad \dots (5)$$

$$\hat{a}^*_{T2t} = \varrho^*_{2\cdot 1}\ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{2\cdot 2}\ \hat{a}^*_{T2t-1} + \varepsilon^*_{T2t} \quad \dots (6)$$

$$\hat{a}^*_{N3t} = \text{ƅ}^*_{3\cdot 1}\ \hat{a}^*_{N3t\cdot 1} + \text{ƅ}^*_{3\cdot 2}\ \hat{a}^*_{T3t-1} + \varepsilon^*_{N3t} \quad \dots (7)$$

$$\hat{a}^*_{T3t} = \varrho^*_{3\cdot 1}\ \hat{a}^*_{N3t-1} + \varrho^*_{3\cdot 2}\ \hat{a}^*_{T3t-1} + \varepsilon^*_{T3t} \quad \dots (8)$$

$$\hat{a}^*_{N4t} = \text{ƅ}^*_{4\cdot 1}\ \hat{a}^*_{N4t\cdot 1} + \text{ƅ}^*_{4\cdot 2}\ \hat{a}^*_{T4t-1} + \varepsilon^*_{N4t} \quad \dots (9)$$

$$\hat{a}^*_{T4t} = \varrho^*_{4\cdot 1}\ \hat{a}^*_{N4t\cdot 1} + \varrho^*_{4\cdot 2}\ \hat{a}^*_{T4t-1} + \varepsilon^*_{T4t} \quad \dots (10)$$

$$\hat{a}^*_{N5t} = \text{ƅ}^*_{5\cdot 1}\ \hat{a}^*_{N5t\cdot 1} + \text{ƅ}^*_{5\cdot 2}\ \hat{a}^*_{T5t-1} + \varepsilon^*_{N5t} \quad \dots (11)$$

$$\hat{a}^*_{T5t} = \varrho^*_{5\cdot 1}\ \hat{a}^*_{N5t\cdot 1} + \varrho^*_{5\cdot 2}\ \hat{a}^*_{T5t-1} + \varepsilon^*_{T5t} \quad \dots (12)$$

$$\hat{a}^*_{N6t} = \text{ƅ}^*_{6\cdot 1}\ \hat{a}^*_{N6t\cdot 1} + \text{ƅ}^*_{6\cdot 2}\ \hat{a}^*_{T6t-1} + \varepsilon^*_{N6t} \quad \dots (13)$$

$$\hat{a}^*_{T6t} = \varrho^*_{6\cdot 1}\ \hat{a}^*_{N6t\cdot 1} + \varrho^*_{6\cdot 2}\ \hat{a}^*_{T6t-1} + \varepsilon^*_{T6t} \quad \dots (14)$$

$$\hat{a}^*_{N7t} = \text{ƅ}^*_{7\cdot 1}\ \hat{a}^*_{N7t\cdot 1} + \text{ƅ}^*_{7\cdot 2}\ \hat{a}^*_{T7t-1} + \varepsilon^*_{N7t} \quad \dots (15)$$

$$\hat{a}^*_{T7t} = \varrho^*_{7\cdot 1}\ \hat{a}^*_{N7t\cdot 1} + \varrho^*_{7\cdot 2}\ \hat{a}^*_{T7t-1} + \varepsilon^*_{T7t} \quad \dots (16)$$

$$\hat{a}^*_{N8t} = \text{ƅ}^*_{8\cdot 1}\ \hat{a}^*_{N8t\cdot 1} + \text{ƅ}^*_{8\cdot 2}\ \hat{a}^*_{T8t-1} + \varepsilon^*_{N8t} \quad \dots (17)$$

$$\hat{a}^*_{T8t} = \varrho^*_{8\cdot 1}\ \hat{a}^*_{N8t\cdot 1} + \varrho^*_{8\cdot 2}\ \hat{a}^*_{T8t-1} + \varepsilon^*_{T8t} \quad \dots (18)$$

$$\hat{a}^*_{N9t} = \text{ƅ}^*_{9\cdot 1}\ \hat{a}^*_{N9t\cdot 1} + \text{ƅ}^*_{9\cdot 2}\ \hat{a}^*_{T9t-1} + \varepsilon^*_{N9t} \quad \dots (19)$$

$$\hat{a}^*_{T9t} = \varrho^*_{9\cdot 1}\ \hat{a}^*_{N9t\cdot 1} + \varrho^*_{9\cdot 2}\ \hat{a}^*_{T9t-1} + \varepsilon^*_{T9t} \quad \dots (20)$$

$$\hat{a}^*_{N10t} = \text{ƅ}^*_{10\cdot 1}\ \hat{a}^*_{N10t\cdot 1} + \text{ƅ}^*_{10\cdot 2}\ \hat{a}^*_{T10t-1} + \varepsilon^*_{N10t} \quad \dots (21)$$

$$\hat{a}^*_{T10t} = \varrho^*_{10\cdot 1}\ \hat{a}^*_{N10t\cdot 1} + \varrho^*_{10\cdot 2}\ \hat{a}^*_{T10t-1} + \varepsilon^*_{T10t} \quad \dots (22)$$

$$\hat{y}_{Nt}^{nat} = \varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Nt} \qquad \ldots (23)$$

$$\hat{y}_{Tt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \hat{a}_{Tt} \qquad \ldots (24)$$

$$\hat{s}_{1t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T1}^{*} \left(\hat{k}_{T1t}^{*}{}^{nat} - \hat{l}_{T1t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T1t}^{*}\right) \qquad \ldots (25)$$

$$\hat{s}_{2t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T2}^{*} \left(\hat{k}_{T2t}^{*}{}^{nat} - \hat{l}_{T2t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T2t}^{*}\right) \qquad \ldots (26)$$

$$\hat{s}_{3t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T3}^{*} \left(\hat{k}_{T3t}^{*}{}^{nat} - \hat{l}_{T3t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T3t}^{*}\right) \qquad \ldots (27)$$

$$\hat{s}_{4t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T4}^{*} \left(\hat{k}_{T4t}^{*}{}^{nat} - \hat{l}_{T4t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T4t}^{*}\right) \qquad \ldots (28)$$

$$\hat{s}_{5t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T5}^{*} \left(\hat{k}_{T5t}^{*}{}^{nat} - \hat{l}_{T5t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T5t}^{*}\right) \;.. \qquad \ldots (29)$$

$$\hat{s}_{6t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T6}^{*} \left(\hat{k}_{T6t}^{*}{}^{nat} - \hat{l}_{T6t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T6t}^{*}\right) \;. \qquad \ldots (30)$$

$$\hat{s}_{7t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T7}^{*} \left(\hat{k}_{T7t}^{*}{}^{nat} - \hat{l}_{T7t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T7t}^{*}\right) \qquad \ldots (31)$$

$$\hat{s}_{8t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T8}^{*} \left(\hat{k}_{T8t}^{*}{}^{nat} - \hat{l}_{T8t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T8t}^{*}\right) \qquad \ldots (32)$$

$$\hat{s}_{9t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T9}^{*} \left(\hat{k}_{T9t}^{*}{}^{nat} - \hat{l}_{T9t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T9t}^{*}\right) \qquad \ldots (33)$$

$$\hat{s}_{10t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T10}^{*} \left(\hat{k}_{T10t}^{*}{}^{nat} - \hat{l}_{T10t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T10t}^{*}\right) \qquad \ldots (34)$$

$$\hat{c}_t^{A^{nat}} = (1-\alpha)\left[\varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Nt}\right] + \alpha \left[\varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \hat{a}_{Tt}\right] - \alpha \sum_{n=1}^{10} \omega_n \hat{s}_{nt}^{nat} \qquad \ldots (35)$$

$$\widehat{rr}_t^{nat} = E_t \, \Delta\hat{c}_{t+1}^{A}{}^{nat} = 0 \qquad \ldots (36)$$

$$\hat{q}_{Nt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha \sum_{n=1}^{10} \omega_n \hat{s}_{nt}^{nat} \qquad \ldots (37)$$

$$u_t = u_{t-1} + \varepsilon_{ut} \qquad \ldots (38)$$

$$\Delta_{R_t^{nat} R_{1t}^{*}{}^{nat}} = E_t \hat{s}_{1t+1}^{nat} - \hat{s}_{1t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H1t+1}^{*} + u_t \qquad \ldots (39)$$

$$\Delta_{R_t^{nat} R_{2t}^{*}{}^{nat}} = E_t \hat{s}_{2t+1}^{nat} - \hat{s}_{2t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H2t+1}^{*} + u_t \qquad \ldots (40)$$

$$\Delta_{R_t^{nat} R_{3t}^{*}{}^{nat}} = E_t \hat{s}_{3t+1}^{nat} - \hat{s}_{3t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H3t+1}^{*} + u_t \qquad \ldots (41)$$

$$\Delta_{R_t^{nat} R_{4t}^{*}{}^{nat}} = E_t \hat{s}_{4t+1}^{nat} - \hat{s}_{4t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H4t+1}^{*} + u_t \qquad \ldots (42)$$

$$\Delta_{R_t^{nat} R_{5t}^{*}{}^{nat}} = E_t \hat{s}_{5t+1}^{nat} - \hat{s}_{5t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H5t+1}^{*} + u_t \qquad \ldots (43)$$

$$\Delta_{R_t^{nat} R_{6t}^{*}{}^{nat}} = E_t \hat{s}_{6t+1}^{nat} - \hat{s}_{6t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H6t+1}^{*} + u_t \qquad \ldots (44)$$

$$\Delta_{R_t^{nat} R_{7t}^{*}{}^{nat}} = E_t \hat{s}_{7t+1}^{nat} - \hat{s}_{7t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H7t+1}^{*} + u_t \quad \ldots (45)$$

$$\Delta_{R_t^{nat} R_{8t}^{*}{}^{nat}} = E_t \hat{s}_{8t+1}^{nat} - \hat{s}_{8t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H8t+1}^{*} + u_t \quad \ldots (46)$$

$$\Delta_{R_t^{nat} R_{9t}^{*}{}^{nat}} = E_t \hat{s}_{9t+1}^{nat} - \hat{s}_{9t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H9t+1}^{*} + u_t \quad \ldots (47)$$

$$\Delta_{R_t^{nat} R_{10t}^{*}{}^{nat}} = E_t \hat{s}_{10t+1}^{nat} - \hat{s}_{10t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H10t+1}^{*} + u_t \quad \ldots (48)$$

$$\tilde{y}_{T1t}^{*} = ב_1^{*} \tilde{y}_{T1t-1}^{*} + \varepsilon_{T1t}^{*} \quad \ldots (49)$$

$$\tilde{y}_{T2t}^{*} = ב_2^{*} \tilde{y}_{T2t-1}^{*} + \varepsilon_{T2t}^{*} \quad \ldots (50)$$

$$\tilde{y}_{T3t}^{*} = ב_3^{*} \tilde{y}_{T3t-1}^{*} + \varepsilon_{T3t}^{*} \quad \ldots (51)$$

$$\tilde{y}_{T4t}^{*} = ב_4^{*} \tilde{y}_{T4t-1}^{*} + \varepsilon_{T4t}^{*} \quad \ldots (52)$$

$$\tilde{y}_{T5t}^{*} = ב_5^{*} \tilde{y}_{T5t-1}^{*} + \varepsilon_{T5t}^{*} \quad \ldots (53)$$

$$\tilde{y}_{T6t}^{*} = ב_6^{*} \tilde{y}_{T6t-1}^{*} + \varepsilon_{T6t}^{*} \quad \ldots (54)$$

$$\tilde{y}_{T7t}^{*} = ב_7^{*} \tilde{y}_{T7t-1}^{*} + \varepsilon_{T7t}^{*} \quad \ldots (55)$$

$$\tilde{y}_{T8t}^{*} = ב_8^{*} \tilde{y}_{T8t-1}^{*} + \varepsilon_{T8t}^{*} \quad \ldots (56)$$

$$\tilde{y}_{T9t}^{*} = ב_9^{*} \tilde{y}_{T9t-1}^{*} + \varepsilon_{T9t}^{*} \quad \ldots (57)$$

$$\tilde{y}_{T10t}^{*} = ב_{10}^{*} \tilde{y}_{T10t-1}^{*} + \varepsilon_{T10t}^{*} \quad \ldots (58)$$

$$\tilde{y}_{Nt} = \frac{1}{\kappa_N} E_t[\pi_{Nt} - \beta\, \pi_{Nt+1}] \quad \ldots (59)$$

$$\tilde{y}_{Tt} = \frac{1}{\kappa_T} E_t\, [\pi_{Ht} - \beta\, \pi_{Ht+1}] \quad \ldots (60)$$

$$\pi_{Nt} = -\frac{(1+\kappa_N)}{(1+\kappa_N+\beta\,\theta_N)}\left(\tilde{y}_{Nt} - \hat{r}_{t-1} + \alpha\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) - \alpha\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_N+\beta\,\theta_N)}\tilde{y}_{Nt-2}$$

… (61)

$$\pi_{Ht} = -\frac{(1+\kappa_T)}{(1+\kappa_T+\beta\,\theta_T)}\left(\tilde{y}_{Tt} - \hat{r}_{t-1} - (1-\alpha)\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) + (1-\alpha)\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_T+\beta\,\theta_T)}\tilde{y}_{Tt-2}$$

… (62)

$$\hat{r}_t = \frac{1}{[(1-\varphi_N)(1-\alpha) + (1-\varphi_T)\,\alpha\omega_0]}\left\{\begin{matrix} (1-\alpha)\,E_t\left(\tilde{y}_{Nt+1} + \pi_{Nt+1} + \alpha\,(\hat{a}_{Nt+1} - \hat{a}_{Nt}) - \alpha\,(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right) \\ +\alpha\omega_0\, E_t\left(\tilde{y}_{Tt+1} + \pi_{Ht+1} - (1-\alpha)(\hat{a}_{Nt+1} - \hat{a}_{Nt}) + (1-\alpha)(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right)\end{matrix}\right\}$$

… (63)

- **For the "Bilateral Coordination" regime**

$$\hat{a}_{Nt} = \text{ƅ}_1 \ \hat{a}_{Nt-1} + \text{ƅ}_2 \ \hat{a}_{Tt-1} + \varepsilon_{Nt} \qquad \dots (1)$$

$$\hat{a}_{Tt} = \varrho_1 \ \hat{a}_{Nt-1} + \varrho_2 \ \hat{a}_{Tt-1} + \varepsilon_{Tt} \qquad \dots (2)$$

$$\hat{a}^*_{N1t} = \text{ƅ}^*_{1\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \text{ƅ}^*_{1\cdot 2} \ \hat{a}^*_{T1t-1} + \varepsilon^*_{N1t} \qquad \dots (3)$$

$$\hat{a}^*_{T1t} = \varrho^*_{1\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{1\cdot 2} \ \hat{a}^*_{T1t-1} + \varepsilon^*_{T1t} \qquad \dots (4)$$

$$\hat{a}^*_{N2t} = \text{ƅ}^*_{2\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \text{ƅ}^*_{2\cdot 2} \ \hat{a}^*_{T2t-1} + \varepsilon^*_{N2t} \qquad \dots (5)$$

$$\hat{a}^*_{T2t} = \varrho^*_{2\cdot 1} \ \hat{a}^*_{N1t\cdot 1} + \varrho^*_{2\cdot 2} \ \hat{a}^*_{T2t-1} + \varepsilon^*_{T2t} \qquad \dots (6)$$

$$\hat{a}^*_{N3t} = \text{ƅ}^*_{3\cdot 1} \ \hat{a}^*_{N3t\cdot 1} + \text{ƅ}^*_{3\cdot 2} \ \hat{a}^*_{T3t-1} + \varepsilon^*_{N3t} \qquad \dots (7)$$

$$\hat{a}^*_{T3t} = \varrho^*_{3\cdot 1} \ \hat{a}^*_{N3t-1} + \varrho^*_{3\cdot 2} \ \hat{a}^*_{T3t-1} + \varepsilon^*_{T3t} \qquad \dots (8)$$

$$\hat{a}^*_{N4t} = \text{ƅ}^*_{4\cdot 1} \ \hat{a}^*_{N4t\cdot 1} + \text{ƅ}^*_{4\cdot 2} \ \hat{a}^*_{T4t-1} + \varepsilon^*_{N4t} \qquad \dots (9)$$

$$\hat{a}^*_{T4t} = \varrho^*_{4\cdot 1} \ \hat{a}^*_{N4t\cdot 1} + \varrho^*_{4\cdot 2} \ \hat{a}^*_{T4t-1} + \varepsilon^*_{T4t} \qquad \dots (10)$$

$$\hat{a}^*_{N5t} = \text{ƅ}^*_{5\cdot 1} \ \hat{a}^*_{N5t\cdot 1} + \text{ƅ}^*_{5\cdot 2} \ \hat{a}^*_{T5t-1} + \varepsilon^*_{N5t} \qquad \dots (11)$$

$$\hat{a}^*_{T5t} = \varrho^*_{5\cdot 1} \ \hat{a}^*_{N5t\cdot 1} + \varrho^*_{5\cdot 2} \ \hat{a}^*_{T5t-1} + \varepsilon^*_{T5t} \qquad \dots (12)$$

$$\hat{a}^*_{N6t} = \text{ƅ}^*_{6\cdot 1} \ \hat{a}^*_{N6t\cdot 1} + \text{ƅ}^*_{6\cdot 2} \ \hat{a}^*_{T6t-1} + \varepsilon^*_{N6t} \qquad \dots (13)$$

$$\hat{a}^*_{T6t} = \varrho^*_{6\cdot 1} \ \hat{a}^*_{N6t\cdot 1} + \varrho^*_{6\cdot 2} \ \hat{a}^*_{T6t-1} + \varepsilon^*_{T6t} \qquad \dots (14)$$

$$\hat{a}^*_{N7t} = \text{ƅ}^*_{7\cdot 1} \ \hat{a}^*_{N7t\cdot 1} + \text{ƅ}^*_{7\cdot 2} \ \hat{a}^*_{T7t-1} + \varepsilon^*_{N7t} \qquad \dots (15)$$

$$\hat{a}^*_{T7t} = \varrho^*_{7\cdot 1} \ \hat{a}^*_{N7t\cdot 1} + \varrho^*_{7\cdot 2} \ \hat{a}^*_{T7t-1} + \varepsilon^*_{T7t} \qquad \dots (16)$$

$$\hat{a}^*_{N8t} = \text{ƅ}^*_{8\cdot 1} \ \hat{a}^*_{N8t\cdot 1} + \text{ƅ}^*_{8\cdot 2} \ \hat{a}^*_{T8t-1} + \varepsilon^*_{N8t} \qquad \dots (17)$$

$$\hat{a}^*_{T8t} = \varrho^*_{8\cdot 1} \ \hat{a}^*_{N8t\cdot 1} + \varrho^*_{8\cdot 2} \ \hat{a}^*_{T8t-1} + \varepsilon^*_{T8t} \qquad \dots (18)$$

$$\hat{a}^*_{N9t} = \text{ƅ}^*_{9\cdot 1} \ \hat{a}^*_{N9t\cdot 1} + \text{ƅ}^*_{9\cdot 2} \ \hat{a}^*_{T9t-1} + \varepsilon^*_{N9t} \qquad \dots (19)$$

$$\hat{a}^*_{T9t} = \varrho^*_{9\cdot 1} \ \hat{a}^*_{N9t\cdot 1} + \varrho^*_{9\cdot 2} \ \hat{a}^*_{T9t-1} + \varepsilon^*_{T9t} \qquad \dots (20)$$

$$\hat{a}^*_{N10t} = \text{ƅ}^*_{10\cdot 1} \ \hat{a}^*_{N10t\cdot 1} + \text{ƅ}^*_{10\cdot 2} \ \hat{a}^*_{T10t-1} + \varepsilon^*_{N10t} \qquad \dots (21)$$

$$\hat{a}^*_{T10t} = \varrho^*_{10\cdot 1} \ \hat{a}^*_{N10t\cdot 1} + \varrho^*_{10\cdot 2} \ \hat{a}^*_{T10t-1} + \varepsilon^*_{T10t} \qquad \dots (22)$$

$$\hat{y}^{nat}_{Nt} = \varphi_N \left(\hat{k}^{nat}_{Nt} - \hat{l}^{nat}_{Nt}\right) + \hat{a}_{Nt} \qquad \dots (23)$$

$$\hat{y}^{nat}_{Tt} = \varphi_T \left(\hat{k}^{nat}_{Tt} - \hat{l}^{nat}_{Tt}\right) + \hat{a}_{Tt} \qquad \dots (24)$$

$$\hat{y}^{*}_{N1t}{}^{nat} = \varphi^*_{N1} \left(\hat{k}^{*}_{N1t}{}^{nat} - \hat{l}^{*}_{N1t}{}^{nat}\right) + \hat{a}^*_{N1t} \qquad \dots (25)$$

$$\hat{y}^{*\;nat}_{T1t} = \varphi^{*}_{T1}\left(\hat{k}^{*\;nat}_{T1t} - \hat{l}^{*\;nat}_{T1t}\right) + \hat{a}^{*}_{T1t} \quad \ldots (26)$$

$$\hat{y}^{*\;nat}_{N2t} = \varphi^{*}_{N2}\left(\hat{k}^{*\;nat}_{N2t} - \hat{l}^{*\;nat}_{N2t}\right) + \hat{a}^{*}_{N2t} \quad \ldots (27)$$

$$\hat{y}^{*\;nat}_{T2t} = \varphi^{*}_{T2}\left(\hat{k}^{*\;nat}_{T2t} - \hat{l}^{*\;nat}_{T2t}\right) + \hat{a}^{*}_{T2t} \quad \ldots (28)$$

$$\hat{y}^{*\;nat}_{N3t} = \varphi^{*}_{N3}\left(\hat{k}^{*\;nat}_{N3t} - \hat{l}^{*\;nat}_{N3t}\right) + \hat{a}^{*}_{N3t} \quad \ldots (29)$$

$$\hat{y}^{*\;nat}_{T3t} = \varphi^{*}_{T3}\left(\hat{k}^{*\;nat}_{T3t} - \hat{l}^{*\;nat}_{T3t}\right) + \hat{a}^{*}_{T3t} \quad \ldots (30)$$

$$\hat{y}^{*\;nat}_{N4t} = \varphi^{*}_{N4}\left(\hat{k}^{*\;nat}_{N4t} - \hat{l}^{*\;nat}_{N4t}\right) + \hat{a}^{*}_{N4t} \quad \ldots (31)$$

$$\hat{y}^{*\;nat}_{T4t} = \varphi^{*}_{T4}\left(\hat{k}^{*\;nat}_{T4t} - \hat{l}^{*\;nat}_{T4t}\right) + \hat{a}^{*}_{T4t} \quad \ldots (32)$$

$$\hat{y}^{*\;nat}_{N5t} = \varphi^{*}_{N5}\left(\hat{k}^{*\;nat}_{N5t} - \hat{l}^{*\;nat}_{N5t}\right) + \hat{a}^{*}_{N5t} \quad \ldots (33)$$

$$\hat{y}^{*\;nat}_{T5t} = \varphi^{*}_{T5}\left(\hat{k}^{*\;nat}_{T5t} - \hat{l}^{*\;nat}_{T5t}\right) + \hat{a}^{*}_{T5t} \quad \ldots (34)$$

$$\hat{y}^{*\;nat}_{N6t} = \varphi^{*}_{N6}\left(\hat{k}^{*\;nat}_{N6t} - \hat{l}^{*\;nat}_{N6t}\right) + \hat{a}^{*}_{N6t} \quad \ldots (35)$$

$$\hat{y}^{*\;nat}_{T6t} = \varphi^{*}_{T6}\left(\hat{k}^{*\;nat}_{T6t} - \hat{l}^{*\;nat}_{T6t}\right) + \hat{a}^{*}_{T6t} \quad \ldots (36)$$

$$\hat{y}^{*\;nat}_{N7t} = \varphi^{*}_{N7}\left(\hat{k}^{*\;nat}_{N7t} - \hat{l}^{*\;nat}_{N7t}\right) + \hat{a}^{*}_{N7t} \quad \ldots (37)$$

$$\hat{y}^{*\;nat}_{T7t} = \varphi^{*}_{T7}\left(\hat{k}^{*\;nat}_{T7t} - \hat{l}^{*\;nat}_{T7t}\right) + \hat{a}^{*}_{T7t} \quad \ldots (38)$$

$$\hat{y}^{*\;nat}_{N8t} = \varphi^{*}_{N8}\left(\hat{k}^{*\;nat}_{N8t} - \hat{l}^{*\;nat}_{N8t}\right) + \hat{a}^{*}_{N8t} \quad \ldots (39)$$

$$\hat{y}^{*\;nat}_{T8t} = \varphi^{*}_{T8}\left(\hat{k}^{*\;nat}_{T8t} - \hat{l}^{*\;nat}_{T8t}\right) + \hat{a}^{*}_{T8t} \quad \ldots (40)$$

$$\hat{y}^{*\;nat}_{N9t} = \varphi^{*}_{N9}\left(\hat{k}^{*\;nat}_{N9t} - \hat{l}^{*\;nat}_{N9t}\right) + \hat{a}^{*}_{N9t} \quad \ldots (41)$$

$$\hat{y}^{*\;nat}_{T9t} = \varphi^{*}_{T9}\left(\hat{k}^{*\;nat}_{T9t} - \hat{l}^{*\;nat}_{T9t}\right) + \hat{a}^{*}_{T9t} \quad \ldots (42)$$

$$\hat{y}^{*\;nat}_{N10t} = \varphi^{*}_{N10}\left(\hat{k}^{*\;nat}_{N10t} - \hat{l}^{*\;nat}_{N10t}\right) + \hat{a}^{*}_{N10t} \quad \ldots (43)$$

$$\hat{y}^{*\;nat}_{T10t} = \varphi^{*}_{T10}\left(\hat{k}^{*\;nat}_{T10t} - \hat{l}^{*\;nat}_{T10t}\right) + \hat{a}^{*}_{T10t} \quad \ldots (44)$$

$$\hat{s}^{nat}_{1t} = \varphi_{T}\left(\hat{k}^{nat}_{Tt} - \hat{l}^{nat}_{Tt}\right) - \varphi^{*}_{T1}\left(\hat{k}^{*\;nat}_{T1t} - \hat{l}^{*\;nat}_{T1t}\right) + \left(\hat{a}_{Tt} - \hat{a}^{*}_{T1t}\right) \quad \ldots (45)$$

$$\hat{s}_{2t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T2}^{*} \left({\hat{k}_{T2t}^{*}}^{nat} - {\hat{l}_{T2t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T2t}^{*}\right) \quad \ldots (46)$$

$$\hat{s}_{3t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T3}^{*} \left({\hat{k}_{T3t}^{*}}^{nat} - {\hat{l}_{T3t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T3t}^{*}\right) \quad \ldots (47)$$

$$\hat{s}_{4t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T4}^{*} \left({\hat{k}_{T4t}^{*}}^{nat} - {\hat{l}_{T4t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T4t}^{*}\right) \quad \ldots (48)$$

$$\hat{s}_{5t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T5}^{*} \left({\hat{k}_{T5t}^{*}}^{nat} - {\hat{l}_{T5t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T5t}^{*}\right) \;.. \quad \ldots (49)$$

$$\hat{s}_{6t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T6}^{*} \left({\hat{k}_{T6t}^{*}}^{nat} - {\hat{l}_{T6t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T6t}^{*}\right) \;. \quad \ldots (50)$$

$$\hat{s}_{7t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T7}^{*} \left({\hat{k}_{T7t}^{*}}^{nat} - {\hat{l}_{T7t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T7t}^{*}\right) \quad \ldots (51)$$

$$\hat{s}_{8t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T8}^{*} \left({\hat{k}_{T8t}^{*}}^{nat} - {\hat{l}_{T8t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T8t}^{*}\right) \quad \ldots (52)$$

$$\hat{s}_{9t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T9}^{*} \left({\hat{k}_{T9t}^{*}}^{nat} - {\hat{l}_{T9t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T9t}^{*}\right) \quad \ldots (53)$$

$$\hat{s}_{10t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T10}^{*} \left({\hat{k}_{T10t}^{*}}^{nat} - {\hat{l}_{T10t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T10t}^{*}\right) \quad \ldots (54)$$

$${\hat{c}_t^{A}}^{nat} = (1-\alpha)\left[\varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Nt}\right] + \alpha \left[\varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \hat{a}_{Tt}\right] - \alpha \sum_{n=1}^{10} \omega_n \, \hat{s}_{nt}^{nat} \quad \ldots (55)$$

$$\widehat{rr}_t^{nat} = E_t \, \Delta {\hat{c}_{t+1}^{A}}^{nat} = 0 \quad \ldots (56)$$

$$\hat{q}_{Nt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha \sum_{n=1}^{10} \omega_n \, \hat{s}_{nt}^{nat} \quad \ldots (57)$$

$${\hat{s}_{1\cdot 0_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{Tt}\right) \quad \ldots (58)$$

$${\hat{s}_{1\cdot 2_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T2}^{*} \left({\hat{k}_{T2t}^{*}}^{nat} - {\hat{l}_{T2t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T2t}^{*}\right) \quad \ldots (59)$$

$${\hat{s}_{1\cdot 3_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T3}^{*} \left({\hat{k}_{T3t}^{*}}^{nat} - {\hat{l}_{T3t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T3t}^{*}\right) \quad \ldots (60)$$

$${\hat{s}_{1\cdot 4_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T4}^{*} \left({\hat{k}_{T4t}^{*}}^{nat} - {\hat{l}_{T4t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T4t}^{*}\right) \quad \ldots (61)$$

$${\hat{s}_{1\cdot 5_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T5}^{*} \left({\hat{k}_{T5t}^{*}}^{nat} - {\hat{l}_{T5t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T5t}^{*}\right) \quad \ldots (62)$$

$${\hat{s}_{1\cdot 6_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T6}^{*} \left({\hat{k}_{T6t}^{*}}^{nat} - {\hat{l}_{T6t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T6t}^{*}\right) \quad \ldots (63)$$

$${\hat{s}_{1\cdot 7_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T7}^{*} \left({\hat{k}_{T7t}^{*}}^{nat} - {\hat{l}_{T7t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T7t}^{*}\right) \quad \ldots (64)$$

$${\hat{s}_{1\cdot 8_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T8}^{*} \left({\hat{k}_{T8t}^{*}}^{nat} - {\hat{l}_{T8t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T8t}^{*}\right) \quad \ldots (65)$$

$$\hat{s}^{*}_{1\cdot 9_t}{}^{nat} = \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) - \varphi^{*}_{T9}\left(\hat{k}^{*}_{N9t}{}^{nat} - \hat{l}^{*}_{N9t}{}^{nat}\right) + (\hat{a}^{*}_{T1t} - \hat{a}^{*}_{T9t}) \qquad \dots (66)$$

$$\hat{s}^{*}_{1\cdot 10_t}{}^{nat} = \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) - \varphi^{*}_{T10}\left(\hat{k}^{*}_{N10t}{}^{nat} - \hat{l}^{*}_{N10t}{}^{nat}\right) + (\hat{a}^{*}_{T1t} - \hat{a}^{*}_{T10t}) \qquad \dots (67)$$

$$\hat{c}^{A*}_{1t}{}^{nat} = (1-\alpha^{*}_{1})\left[\varphi^{*}_{N1}\left(\hat{k}^{*}_{N1t}{}^{nat} - \hat{l}^{*}_{N1t}{}^{nat}\right) + \hat{a}^{*}_{N1t}\right] + \alpha^{*}_{1}\left[\varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) + \hat{a}^{*}_{T1t}\right]$$
$$-\alpha^{*}_{1}\sum_{n=0,n\neq 1}^{10}\omega^{*}_{1}\,\hat{s}^{*}_{1\cdot n_t}{}^{nat} \qquad \dots (68)$$

$$\widehat{rr}^{*}_{1t}{}^{nat} = E_t\,\Delta\hat{c}^{A*}_{1t+1}{}^{nat} = 0 \qquad \dots (69)$$

$$\hat{q}^{*}_{N1t}{}^{nat} = \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) - \varphi^{*}_{N1}\left(\hat{k}^{*}_{N1t}{}^{nat} - \hat{l}^{*}_{N1t}{}^{nat}\right) + \hat{a}^{*}_{T1t} - \hat{a}^{*}_{N1t}$$
$$-\alpha^{*}_{1}\sum_{n=0,n\neq 1}^{10}\omega^{*}_{1}\,\hat{s}^{*}_{1\cdot n_t}{}^{nat} \qquad \dots (70)$$

$$u_t = u_{t-1} + \varepsilon_{ut} \qquad \dots (71)$$

$$\Delta_{R_t^{nat}R_{1t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{1t+1} - \hat{s}^{nat}_{1t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H1t+1} + u_t \qquad \dots (72)$$

$$\Delta_{R_t^{nat}R_{2t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{2t+1} - \hat{s}^{nat}_{2t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H2t+1} + u_t \qquad \dots (73)$$

$$\Delta_{R_t^{nat}R_{3t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{3t+1} - \hat{s}^{nat}_{3t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H3t+1} + u_t \qquad \dots (74)$$

$$\Delta_{R_t^{nat}R_{4t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{4t+1} - \hat{s}^{nat}_{4t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H4t+1} + u_t \qquad \dots (75)$$

$$\Delta_{R_t^{nat}R_{5t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{5t+1} - \hat{s}^{nat}_{5t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H5t+1} + u_t \qquad \dots (76)$$

$$\Delta_{R_t^{nat}R_{6t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{6t+1} - \hat{s}^{nat}_{6t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H6t+1} + u_t \qquad \dots (77)$$

$$\Delta_{R_t^{nat}R_{7t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{7t+1} - \hat{s}^{nat}_{7t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H7t+1} + u_t \qquad \dots (78)$$

$$\Delta_{R_t^{nat}R_{8t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{8t+1} - \hat{s}^{nat}_{8t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H8t+1} + u_t \qquad \dots (79)$$

$$\Delta_{R_t^{nat}R_{9t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{9t+1} - \hat{s}^{nat}_{9t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H9t+1} + u_t \qquad \dots (80)$$

$$\Delta_{R_t^{nat}R_{10t}^{*}{}^{nat}} = E_t\hat{s}^{nat}_{10t+1} - \hat{s}^{nat}_{10t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H10t+1} + u_t \qquad \dots (81)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_t^{nat}} = \hat{s}^{*}_{1\cdot 0_{t+1}}{}^{nat} - \hat{s}^{*}_{1\cdot 0_t}{}^{nat} + E_t\pi^{*}_{H1t+1} - E_t\pi_{Ht+1} + u_t \qquad \dots (82)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{2t}^{*}{}^{nat}} = \hat{s}^{*}_{1\cdot 2_{t+1}}{}^{nat} - \hat{s}^{*}_{1\cdot 2_t}{}^{nat} + E_t\pi^{*}_{H1t+1} - E_t\pi^{*}_{H2t+1} + u_t \qquad \dots (83)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{3t}^{*}{}^{nat}} = \hat{s}^{*}_{1\cdot 3_{t+1}}{}^{nat} - \hat{s}^{*}_{1\cdot 3_t}{}^{nat} + E_t\pi^{*}_{H1t+1} - E_t\pi^{*}_{H3t+1} + u_t \qquad \dots (84)$$

$$\Delta_{R_{1t}^{*}{}^{nat}R_{4t}^{*}{}^{nat}} = \hat{s}^{*}_{1\cdot 4_{t+1}}{}^{nat} - \hat{s}^{*}_{1\cdot 4_t}{}^{nat} + E_t\pi^{*}_{H1t+1} - E_t\pi^{*}_{H4t+1} + u_t \qquad \dots (85)$$

$$\Delta_{R^*_{1t}{}^{nat}R^*_{5t}{}^{nat}} = \hat{s}^*_{1\cdot 5_{t+1}}{}^{nat} - \hat{s}^*_{1\cdot 5_t}{}^{nat} + E_t\pi^*_{H1t+1} - E_t\pi^*_{H5t+1} + u_t \qquad \ldots (86)$$

$$\Delta_{R^*_{1t}{}^{nat}R^*_{6t}{}^{nat}} = \hat{s}^*_{1\cdot 6_{t+1}}{}^{nat} - \hat{s}^*_{1\cdot 6_t}{}^{nat} + E_t\pi^*_{H1t+1} - E_t\pi^*_{H6t+1} + u_t \qquad \ldots (87)$$

$$\Delta_{R^*_{1t}{}^{nat}R^*_{7t}{}^{nat}} = \hat{s}^*_{1\cdot 7_{t+1}}{}^{nat} - \hat{s}^*_{1\cdot 7_t}{}^{nat} + E_t\pi^*_{H1t+1} - E_t\pi^*_{H7t+1} + u_t \qquad \ldots (88)$$

$$\Delta_{R^*_{1t}{}^{nat}R^*_{8t}{}^{nat}} = \hat{s}^*_{1\cdot 8_{t+1}}{}^{nat} - \hat{s}^*_{1\cdot 8_t}{}^{nat} + E_t\pi^*_{H1t+1} - E_t\pi^*_{H8t+1} + u_t \qquad \ldots (89)$$

$$\Delta_{R^*_{1t}{}^{nat}R^*_{9t}{}^{nat}} = \hat{s}^*_{1\cdot 9_{t+1}}{}^{nat} - \hat{s}^*_{1\cdot 9_t}{}^{nat} + E_t\pi^*_{H1t+1} - E_t\pi^*_{H9t+1} + u_t \qquad \ldots (90)$$

$$\Delta_{R^*_{1t}{}^{nat}R^*_{10t}{}^{nat}} = \hat{s}^*_{1\cdot 10_{t+1}}{}^{nat} - \hat{s}^*_{1\cdot 10_t}{}^{nat} + E_t\pi^*_{H1t+1} - E_t\pi^*_{H10t+1} + u_t \qquad \ldots (91)$$

$$\tilde{y}^*_{T2t} = \beth^*_2\, \tilde{y}^*_{T2t-1} + \varepsilon^*_{T2t} \qquad \ldots (92)$$

$$\tilde{y}^*_{T3t} = \beth^*_3\, \tilde{y}^*_{T3t-1} + \varepsilon^*_{T3t} \qquad \ldots (93)$$

$$\tilde{y}^*_{T4t} = \beth^*_4\, \tilde{y}^*_{T4t-1} + \varepsilon^*_{T4t} \qquad \ldots (94)$$

$$\tilde{y}^*_{T5t} = \beth^*_5\, \tilde{y}^*_{T5t-1} + \varepsilon^*_{T5t} \qquad \ldots (95)$$

$$\tilde{y}^*_{T6t} = \beth^*_6\, \tilde{y}^*_{T6t-1} + \varepsilon^*_{T6t} \qquad \ldots (96)$$

$$\tilde{y}^*_{T7t} = \beth^*_7\, \tilde{y}^*_{T7t-1} + \varepsilon^*_{T7t} \qquad \ldots (97)$$

$$\tilde{y}^*_{T8t} = \beth^*_8\, \tilde{y}^*_{T8t-1} + \varepsilon^*_{T8t} \qquad \ldots (98)$$

$$\tilde{y}^*_{T9t} = \beth^*_9\, \tilde{y}^*_{T9t-1} + \varepsilon^*_{T9t} \qquad \ldots (99)$$

$$\tilde{y}^*_{T10t} = \beth^*_{10}\, \tilde{y}^*_{T10t-1} + \varepsilon^*_{T10t} \qquad \ldots (100)$$

$$\tilde{y}_{Nt} = \frac{1}{\kappa_N} E_t[\pi_{Nt} - \beta^{\blacksquare}\, \pi_{Nt+1}] \qquad \ldots (101)$$

$$\tilde{y}_{Tt} = \frac{1}{\kappa_T} E_t[\pi_{Ht} - \beta^{\blacksquare}\, \pi_{Ht+1}] \qquad \ldots (102)$$

$$\pi_{Nt} = -\frac{(1+\kappa_N)}{(1+\kappa_N+\beta^{\blacksquare}\,\theta_N)}\left(\tilde{y}_{Nt} - \hat{r}_{t-1} + \alpha\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) - \alpha\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_N+\beta^{\blacksquare}\,\theta_N)}\tilde{y}_{Nt-2}$$

$$\ldots (103)$$

$$\pi_{Ht} = -\frac{(1+\kappa_T)}{(1+\kappa_T+\beta^{\blacksquare}\,\theta_T)}\left(\tilde{y}_{Tt} - \hat{r}_{t-1} - (1-\alpha)\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) + (1-\alpha)\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_T+\beta^{\blacksquare}\,\theta_T)}\tilde{y}_{Tt-2}$$

$$\ldots (104)$$

$$\hat{r}_t = \frac{1}{[(1-\varphi_N)(1-\alpha) + (1-\varphi_T)\,\alpha\omega_0]}\begin{Bmatrix} (1-\alpha)E_t\left(\tilde{y}_{Nt+1} + \pi_{Nt+1} + \alpha\,(\hat{a}_{Nt+1} - \hat{a}_{Nt}) - \alpha\,(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right) \\ +\alpha\omega_0\, E_t\left(\tilde{y}_{Tt+1} + \pi_{Ht+1} - (1-\alpha)(\hat{a}_{Nt+1} - \hat{a}_{Nt}) + (1-\alpha)(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right) \end{Bmatrix}$$

$$\ldots (105)$$

$$\tilde{y}^*_{N1t} = \frac{1}{\kappa^*_{N1}} E_t[\pi^*_{N1t} - \beta^{\blacksquare}\, \pi^*_{N1t+1}] \qquad \ldots (106)$$

$$\tilde{y}^*_{T1t} = \frac{1}{\kappa^*_{T1}} E_t[\pi^*_{H1t} - \beta^{\blacksquare}\, \pi^*_{H1t+1}] \qquad \ldots (107)$$

$$\pi^*_{N1t} = -\frac{(1+\kappa^*_{N1})}{(1+\kappa^*_{N1}+\beta\blacksquare\theta^*_{N1})}\left(\tilde{y}^*_{N1t} - \hat{r}^*_{1t-1} + \alpha^*_1(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) - \alpha^*_1(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right)$$

$$-\frac{1}{(1+\kappa^*_{N1}+\beta\blacksquare\theta^*_{N1})}\tilde{y}^*_{N1t-2} \qquad \ldots (108)$$

$$\pi^*_{H1t} = -\frac{(1+\kappa^*_{T1})}{(1+\kappa^*_{T1}+\beta\blacksquare\theta^*_{T1})}\left(\tilde{y}^*_{T1t} - \hat{r}^*_{1t-1} - (1-\alpha^*_1)(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) + (1-\alpha^*_1)(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right)$$

$$-\frac{1}{(1+\kappa^*_{T1}+\beta\blacksquare\theta^*_{T1})}\tilde{y}^*_{T1t-2} \qquad \ldots (109)$$

$$\hat{r}^*_{1t} =$$

$$\frac{1}{[(1-\varphi^*_{N1})(1-\alpha^*_1) + (1-\varphi^*_{T1})\,\alpha^*_1\omega^*_1]}\left\{\begin{matrix}(1-\alpha^*_1)\,E_t\left(\tilde{y}^*_{N1t+1} + \pi^*_{N1t+1} + \alpha^*_1(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) - \alpha^*_1(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\right)\\ +\alpha^*_1\omega^*_1\,E_t\left(\tilde{y}^*_{T1t+1} + \pi^*_{T1t+1} - (1-\alpha^*_1)(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) + (1-\alpha^*_1)(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\right)\end{matrix}\right\}$$

$$\ldots (110)$$

- **For the "Multilateral Coordination" regime**

$\hat{a}_{Nt} = \text{ɓ}_1 \; \hat{a}_{Nt-1} + \text{ɓ}_2 \; \hat{a}_{Tt-1} + \varepsilon_{Nt}$ … (1)

$\hat{a}_{Tt} = \varrho_1 \; \hat{a}_{Nt-1} + \varrho_2 \; \hat{a}_{Tt-1} + \varepsilon_{Tt}$ … (2)

$\hat{a}^*_{N1t} = \text{ɓ}^*_{1\cdot 1} \; \hat{a}^*_{N1t\cdot 1} + \text{ɓ}^*_{1\cdot 2} \; \hat{a}^*_{T1t-1} + \varepsilon^*_{N1t}$ … (3)

$\hat{a}^*_{T1t} = \varrho^*_{1\cdot 1} \; \hat{a}^*_{N1t\cdot 1} + \varrho^*_{1\cdot 2} \; \hat{a}^*_{T1t-1} + \varepsilon^*_{T1t}$ … (4)

$\hat{a}^*_{N2t} = \text{ɓ}^*_{2\cdot 1} \; \hat{a}^*_{N1t\cdot 1} + \text{ɓ}^*_{2\cdot 2} \; \hat{a}^*_{T2t-1} + \varepsilon^*_{N2t}$ … (5)

$\hat{a}^*_{T2t} = \varrho^*_{2\cdot 1} \; \hat{a}^*_{N1t\cdot 1} + \varrho^*_{2\cdot 2} \; \hat{a}^*_{T2t-1} + \varepsilon^*_{T2t}$ … (6)

$\hat{a}^*_{N3t} = \text{ɓ}^*_{3\cdot 1} \; \hat{a}^*_{N3t\cdot 1} + \text{ɓ}^*_{3\cdot 2} \; \hat{a}^*_{T3t-1} + \varepsilon^*_{N3t}$ … (7)

$\hat{a}^*_{T3t} = \varrho^*_{3\cdot 1} \; \hat{a}^*_{N3t-1} + \varrho^*_{3\cdot 2} \; \hat{a}^*_{T3t-1} + \varepsilon^*_{T3t}$ … (8)

$\hat{a}^*_{N4t} = \text{ɓ}^*_{4\cdot 1} \; \hat{a}^*_{N4t\cdot 1} + \text{ɓ}^*_{4\cdot 2} \; \hat{a}^*_{T4t-1} + \varepsilon^*_{N4t}$ … (9)

$\hat{a}^*_{T4t} = \varrho^*_{4\cdot 1} \; \hat{a}^*_{N4t\cdot 1} + \varrho^*_{4\cdot 2} \; \hat{a}^*_{T4t-1} + \varepsilon^*_{T4t}$ … (10)

$\hat{a}^*_{N5t} = \text{ɓ}^*_{5\cdot 1} \; \hat{a}^*_{N5t\cdot 1} + \text{ɓ}^*_{5\cdot 2} \; \hat{a}^*_{T5t-1} + \varepsilon^*_{N5t}$ … (11)

$\hat{a}^*_{T5t} = \varrho^*_{5\cdot 1} \; \hat{a}^*_{N5t\cdot 1} + \varrho^*_{5\cdot 2} \; \hat{a}^*_{T5t-1} + \varepsilon^*_{T5t}$ … (12)

$\hat{a}^*_{N6t} = \text{ɓ}^*_{6\cdot 1} \; \hat{a}^*_{N6t\cdot 1} + \text{ɓ}^*_{6\cdot 2} \; \hat{a}^*_{T6t-1} + \varepsilon^*_{N6t}$ … (13)

$\hat{a}^*_{T6t} = \varrho^*_{6\cdot 1} \; \hat{a}^*_{N6t\cdot 1} + \varrho^*_{6\cdot 2} \; \hat{a}^*_{T6t-1} + \varepsilon^*_{T6t}$ … (14)

$\hat{a}^*_{N7t} = \text{ɓ}^*_{7\cdot 1} \; \hat{a}^*_{N7t\cdot 1} + \text{ɓ}^*_{7\cdot 2} \; \hat{a}^*_{T7t-1} + \varepsilon^*_{N7t}$ … (15)

$\hat{a}^*_{T7t} = \varrho^*_{7\cdot 1} \; \hat{a}^*_{N7t\cdot 1} + \varrho^*_{7\cdot 2} \; \hat{a}^*_{T7t-1} + \varepsilon^*_{T7t}$ … (16)

$\hat{a}^*_{N8t} = \text{ɓ}^*_{8\cdot 1} \; \hat{a}^*_{N8t\cdot 1} + \text{ɓ}^*_{8\cdot 2} \; \hat{a}^*_{T8t-1} + \varepsilon^*_{N8t}$ … (17)

$\hat{a}^*_{T8t} = \varrho^*_{8\cdot 1} \; \hat{a}^*_{N8t\cdot 1} + \varrho^*_{8\cdot 2} \; \hat{a}^*_{T8t-1} + \varepsilon^*_{T8t}$ … (18)

$\hat{a}^*_{N9t} = \text{ɓ}^*_{9\cdot 1} \; \hat{a}^*_{N9t\cdot 1} + \text{ɓ}^*_{9\cdot 2} \; \hat{a}^*_{T9t-1} + \varepsilon^*_{N9t}$ … (19)

$\hat{a}^*_{T9t} = \varrho^*_{9\cdot 1} \; \hat{a}^*_{N9t\cdot 1} + \varrho^*_{9\cdot 2} \; \hat{a}^*_{T9t-1} + \varepsilon^*_{T9t}$ … (20)

$\hat{a}^*_{N10t} = \text{ɓ}^*_{10\cdot 1} \; \hat{a}^*_{N10t\cdot 1} + \text{ɓ}^*_{10\cdot 2} \; \hat{a}^*_{T10t-1} + \varepsilon^*_{N10t}$ … (21)

$\hat{a}^*_{T10t} = \varrho^*_{10\cdot 1} \; \hat{a}^*_{N10t\cdot 1} + \varrho^*_{10\cdot 2} \; \hat{a}^*_{T10t-1} + \varepsilon^*_{T10t}$ … (22)

$\hat{y}^{nat}_{Nt} = \varphi_N \left(\hat{k}^{nat}_{Nt} - \hat{l}^{nat}_{Nt}\right) + \hat{a}_{Nt}$ … (23)

$\hat{y}^{nat}_{Tt} = \varphi_T \left(\hat{k}^{nat}_{Tt} - \hat{l}^{nat}_{Tt}\right) + \hat{a}_{Tt}$ … (24)

$\hat{y}^{*\;nat}_{N1t} = \varphi^*_{N1} \left(\hat{k}^{*\;nat}_{N1t} - \hat{l}^{*\;nat}_{N1t}\right) + \hat{a}^*_{N1t}$ … (25)

$$\hat{y}_{T1t}^{*}{}^{nat} = \varphi_{T1}^{*} \left(\hat{k}_{T1t}^{*}{}^{nat} - \hat{l}_{T1t}^{*}{}^{nat}\right) + \hat{a}_{T1t}^{*} \quad \ldots (26)$$

$$\hat{y}_{N2t}^{*}{}^{nat} = \varphi_{N2}^{*} \left(\hat{k}_{N2t}^{*}{}^{nat} - \hat{l}_{N2t}^{*}{}^{nat}\right) + \hat{a}_{N2t}^{*} \quad \ldots (27)$$

$$\hat{y}_{T2t}^{*}{}^{nat} = \varphi_{T2}^{*} \left(\hat{k}_{T2t}^{*}{}^{nat} - \hat{l}_{T2t}^{*}{}^{nat}\right) + \hat{a}_{T2t}^{*} \quad \ldots (28)$$

$$\hat{y}_{N3t}^{*}{}^{nat} = \varphi_{N3}^{*} \left(\hat{k}_{N3t}^{*}{}^{nat} - \hat{l}_{N3t}^{*}{}^{nat}\right) + \hat{a}_{N3t}^{*} \quad \ldots (29)$$

$$\hat{y}_{T3t}^{*}{}^{nat} = \varphi_{T3}^{*} \left(\hat{k}_{T3t}^{*}{}^{nat} - \hat{l}_{T3t}^{*}{}^{nat}\right) + \hat{a}_{T3t}^{*} \quad \ldots (30)$$

$$\hat{y}_{N4t}^{*}{}^{nat} = \varphi_{N4}^{*} \left(\hat{k}_{N4t}^{*}{}^{nat} - \hat{l}_{N4t}^{*}{}^{nat}\right) + \hat{a}_{N4t}^{*} \quad \ldots (31)$$

$$\hat{y}_{T4t}^{*}{}^{nat} = \varphi_{T4}^{*} \left(\hat{k}_{T4t}^{*}{}^{nat} - \hat{l}_{T4t}^{*}{}^{nat}\right) + \hat{a}_{T4t}^{*} \quad \ldots (32)$$

$$\hat{y}_{N5t}^{*}{}^{nat} = \varphi_{N5}^{*} \left(\hat{k}_{N5t}^{*}{}^{nat} - \hat{l}_{N5t}^{*}{}^{nat}\right) + \hat{a}_{N5t}^{*} \quad \ldots (33)$$

$$\hat{y}_{T5t}^{*}{}^{nat} = \varphi_{T5}^{*} \left(\hat{k}_{T5t}^{*}{}^{nat} - \hat{l}_{T5t}^{*}{}^{nat}\right) + \hat{a}_{T5t}^{*} \quad \ldots (34)$$

$$\hat{y}_{N6t}^{*}{}^{nat} = \varphi_{N6}^{*} \left(\hat{k}_{N6t}^{*}{}^{nat} - \hat{l}_{N6t}^{*}{}^{nat}\right) + \hat{a}_{N6t}^{*} \quad \ldots (35)$$

$$\hat{y}_{T6t}^{*}{}^{nat} = \varphi_{T6}^{*} \left(\hat{k}_{T6t}^{*}{}^{nat} - \hat{l}_{T6t}^{*}{}^{nat}\right) + \hat{a}_{T6t}^{*} \quad \ldots (36)$$

$$\hat{y}_{N7t}^{*}{}^{nat} = \varphi_{N7}^{*} \left(\hat{k}_{N7t}^{*}{}^{nat} - \hat{l}_{N7t}^{*}{}^{nat}\right) + \hat{a}_{N7t}^{*} \quad \ldots (37)$$

$$\hat{y}_{T7t}^{*}{}^{nat} = \varphi_{T7}^{*} \left(\hat{k}_{T7t}^{*}{}^{nat} - \hat{l}_{T7t}^{*}{}^{nat}\right) + \hat{a}_{T7t}^{*} \quad \ldots (38)$$

$$\hat{y}_{N8t}^{*}{}^{nat} = \varphi_{N8}^{*} \left(\hat{k}_{N8t}^{*}{}^{nat} - \hat{l}_{N8t}^{*}{}^{nat}\right) + \hat{a}_{N8t}^{*} \quad \ldots (39)$$

$$\hat{y}_{T8t}^{*}{}^{nat} = \varphi_{T8}^{*} \left(\hat{k}_{T8t}^{*}{}^{nat} - \hat{l}_{T8t}^{*}{}^{nat}\right) + \hat{a}_{T8t}^{*} \quad \ldots (40)$$

$$\hat{y}_{N9t}^{*}{}^{nat} = \varphi_{N9}^{*} \left(\hat{k}_{N9t}^{*}{}^{nat} - \hat{l}_{N9t}^{*}{}^{nat}\right) + \hat{a}_{N9t}^{*} \quad \ldots (41)$$

$$\hat{y}_{T9t}^{*}{}^{nat} = \varphi_{T9}^{*} \left(\hat{k}_{T9t}^{*}{}^{nat} - \hat{l}_{T9t}^{*}{}^{nat}\right) + \hat{a}_{T9t}^{*} \quad \ldots (42)$$

$$\hat{y}_{N10t}^{*}{}^{nat} = \varphi_{N10}^{*} \left(\hat{k}_{N10t}^{*}{}^{nat} - \hat{l}_{N10t}^{*}{}^{nat}\right) + \hat{a}_{N10t}^{*} \quad \ldots (43)$$

$$\hat{y}_{T10t}^{*}{}^{nat} = \varphi_{T10}^{*} \left(\hat{k}_{T10t}^{*}{}^{nat} - \hat{l}_{T10t}^{*}{}^{nat}\right) + \hat{a}_{T10t}^{*} \quad \ldots (44)$$

$$\hat{s}_{1t}^{nat} = \varphi_{T} \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T1}^{*} \left(\hat{k}_{T1t}^{*}{}^{nat} - \hat{l}_{T1t}^{*}{}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T1t}^{*}\right) \quad \ldots (45)$$

$$\hat{s}_{2t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T2}^{*} \left({\hat{k}_{T2t}^{*}}^{nat} - {\hat{l}_{T2t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T2t}^{*}\right) \quad \ldots (46)$$

$$\hat{s}_{3t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T3}^{*} \left({\hat{k}_{T3t}^{*}}^{nat} - {\hat{l}_{T3t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T3t}^{*}\right) \quad \ldots (47)$$

$$\hat{s}_{4t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T4}^{*} \left({\hat{k}_{T4t}^{*}}^{nat} - {\hat{l}_{T4t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T4t}^{*}\right) \quad \ldots (48)$$

$$\hat{s}_{5t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T5}^{*} \left({\hat{k}_{T5t}^{*}}^{nat} - {\hat{l}_{T5t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T5t}^{*}\right) \;.. \quad \ldots (49)$$

$$\hat{s}_{6t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T6}^{*} \left({\hat{k}_{T6t}^{*}}^{nat} - {\hat{l}_{T6t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T6t}^{*}\right) \;. \quad \ldots (50)$$

$$\hat{s}_{7t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T7}^{*} \left({\hat{k}_{T7t}^{*}}^{nat} - {\hat{l}_{T7t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T7t}^{*}\right) \quad \ldots (51)$$

$$\hat{s}_{8t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T8}^{*} \left({\hat{k}_{T8t}^{*}}^{nat} - {\hat{l}_{T8t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T8t}^{*}\right) \quad \ldots (52)$$

$$\hat{s}_{9t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T9}^{*} \left({\hat{k}_{T9t}^{*}}^{nat} - {\hat{l}_{T9t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T9t}^{*}\right) \quad \ldots (53)$$

$$\hat{s}_{10t}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_{T10}^{*} \left({\hat{k}_{T10t}^{*}}^{nat} - {\hat{l}_{T10t}^{*}}^{nat}\right) + \left(\hat{a}_{Tt} - \hat{a}_{T10t}^{*}\right) \quad \ldots (54)$$

$${\hat{c}_t^{A}}^{nat} = (1-\alpha)\left[\varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Nt}\right] + \alpha \left[\varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \hat{a}_{Tt}\right] - \alpha \sum_{n=1}^{10} \omega_n \hat{s}_{nt}^{nat} \quad \ldots (55)$$

$$\widehat{rr}_t^{nat} = E_t \, \Delta {\hat{c}_{t+1}^{A}}^{nat} = 0 \quad \ldots (56)$$

$$\hat{q}_{Nt}^{nat} = \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) - \varphi_N \left(\hat{k}_{Nt}^{nat} - \hat{l}_{Nt}^{nat}\right) + \hat{a}_{Tt} - \hat{a}_{Nt} - \alpha \sum_{n=1}^{10} \omega_n \hat{s}_{nt}^{nat} \quad \ldots (57)$$

$${\hat{s}_{1\cdot 0_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_T \left(\hat{k}_{Tt}^{nat} - \hat{l}_{Tt}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{Tt}\right) \quad \ldots (58)$$

$${\hat{s}_{1\cdot 2_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T2}^{*} \left({\hat{k}_{T2t}^{*}}^{nat} - {\hat{l}_{T2t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T2t}^{*}\right) \quad \ldots (59)$$

$${\hat{s}_{1\cdot 3_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T3}^{*} \left({\hat{k}_{T3t}^{*}}^{nat} - {\hat{l}_{T3t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T3t}^{*}\right) \quad \ldots (60)$$

$${\hat{s}_{1\cdot 4_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T4}^{*} \left({\hat{k}_{T4t}^{*}}^{nat} - {\hat{l}_{T4t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T4t}^{*}\right) \quad \ldots (61)$$

$${\hat{s}_{1\cdot 5_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T5}^{*} \left({\hat{k}_{T5t}^{*}}^{nat} - {\hat{l}_{T5t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T5t}^{*}\right) \quad \ldots (62)$$

$${\hat{s}_{1\cdot 6_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T6}^{*} \left({\hat{k}_{T6t}^{*}}^{nat} - {\hat{l}_{T6t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T6t}^{*}\right) \quad \ldots (63)$$

$${\hat{s}_{1\cdot 7_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T7}^{*} \left({\hat{k}_{T7t}^{*}}^{nat} - {\hat{l}_{T7t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T7t}^{*}\right) \quad \ldots (64)$$

$${\hat{s}_{1\cdot 8_t}^{*}}^{nat} = \varphi_{T1}^{*} \left({\hat{k}_{T1t}^{*}}^{nat} - {\hat{l}_{T1t}^{*}}^{nat}\right) - \varphi_{T8}^{*} \left({\hat{k}_{T8t}^{*}}^{nat} - {\hat{l}_{T8t}^{*}}^{nat}\right) + \left(\hat{a}_{T1t}^{*} - \hat{a}_{T8t}^{*}\right) \quad \ldots (65)$$

$$\hat{s}^{*}_{1\cdot 9_t}{}^{nat} = \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) - \varphi^{*}_{T9}\left(\hat{k}^{*}_{N9t}{}^{nat} - \hat{l}^{*}_{N9t}{}^{nat}\right) + \left(\hat{a}^{*}_{T1t} - \hat{a}^{*}_{T9t}\right) \quad \ldots (66)$$

$$\hat{s}^{*}_{1\cdot 10_t}{}^{nat} = \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) - \varphi^{*}_{T10}\left(\hat{k}^{*}_{N10t}{}^{nat} - \hat{l}^{*}_{N10t}{}^{nat}\right) + \left(\hat{a}^{*}_{T1t} - \hat{a}^{*}_{T10t}\right) \quad \ldots (67)$$

$$\hat{c}^{A*}_{1t}{}^{nat} = (1-\alpha^{*}_{1})\left[\varphi^{*}_{N1}\left(\hat{k}^{*}_{N1t}{}^{nat} - \hat{l}^{*}_{N1t}{}^{nat}\right) + \hat{a}^{*}_{N1t}\right] + \alpha^{*}_{1}\left[\varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) + \hat{a}^{*}_{T1t}\right]$$
$$-\alpha^{*}_{1}\sum_{n=0,n\neq 1}^{10}\omega^{*}_{1}\,\hat{s}^{*}_{1\cdot n_t}{}^{nat}$$

$$\ldots (68)$$

$$\widehat{rr}^{*}_{1t}{}^{nat} = E_t\,\Delta\hat{c}^{A*}_{1t+1}{}^{nat} = 0 \quad \ldots (69)$$

$$\hat{q}^{*}_{N1t}{}^{nat} = \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) - \varphi^{*}_{N1}\left(\hat{k}^{*}_{N1t}{}^{nat} - \hat{l}^{*}_{N1t}{}^{nat}\right) + \hat{a}^{*}_{T1t} - \hat{a}^{*}_{N1t}$$
$$-\alpha^{*}_{1}\sum_{n=0,n\neq 1}^{10}\omega^{*}_{1}\,\hat{s}^{*}_{1\cdot n_t}{}^{nat} \quad \ldots (70)$$

…

$$\hat{s}^{*}_{k\cdot 0_t}{}^{nat} = \varphi^{*}_{Tk}\left(\hat{k}^{*}_{Tkt}{}^{nat} - \hat{l}^{*}_{Tkt}{}^{nat}\right) - \varphi_{T}\left(\hat{k}^{nat}_{Tt} - \hat{l}^{nat}_{Tt}\right) + \left(\hat{a}^{*}_{Tkt} - \hat{a}_{Tt}\right) \quad \ldots (71)$$

$$\hat{s}^{*}_{k\cdot 1_t}{}^{nat} = \varphi^{*}_{Tk}\left(\hat{k}^{*}_{Tkt}{}^{nat} - \hat{l}^{*}_{Tkt}{}^{nat}\right) - \varphi^{*}_{T1}\left(\hat{k}^{*}_{T1t}{}^{nat} - \hat{l}^{*}_{T1t}{}^{nat}\right) + \left(\hat{a}^{*}_{Tkt} - \hat{a}^{*}_{T1t}\right) \quad \ldots (72)$$

…

$$\hat{s}^{*}_{k\cdot n_t,k\neq n}{}^{nat} = \varphi^{*}_{Tk}\left(\hat{k}^{*}_{Tkt}{}^{nat} - \hat{l}^{*}_{Tnt}{}^{nat}\right) - \varphi^{*}_{Tn}\left(\hat{k}^{*}_{Tnt}{}^{nat} - \hat{l}^{*}_{Tnt}{}^{nat}\right) + \left(\hat{a}^{*}_{Tkt} - \hat{a}^{*}_{Tnt}\right) \quad \ldots (73)$$

$$\hat{c}^{A*}_{kt}{}^{nat} = (1-\alpha^{*}_{k})\left[\varphi^{*}_{Nk}\left(\hat{k}^{*}_{Nkt}{}^{nat} - \hat{l}^{*}_{Nkt}{}^{nat}\right) + \hat{a}^{*}_{Nkt}\right] + \alpha^{*}_{k}\left[\varphi^{*}_{Tk}\left(\hat{k}^{*}_{Tkt}{}^{nat} - \hat{l}^{*}_{Tkt}{}^{nat}\right) + \hat{a}^{*}_{Tkt}\right]$$
$$-\alpha^{*}_{k}\sum_{n=0,n\neq 1}^{10}\omega^{*}_{k}\,\hat{s}^{*}_{k\cdot n_t}{}^{nat}$$

$$\ldots (74)$$

$$\widehat{rr}^{*}_{kt}{}^{nat} = E_t\,\Delta\hat{c}^{A*}_{kt+1}{}^{nat} = 0 \quad \ldots (75)$$

$$\hat{q}^{*}_{Nkt}{}^{nat} = \varphi^{*}_{Tk}\left(\hat{k}^{*}_{Tkt}{}^{nat} - \hat{l}^{*}_{Tkt}{}^{nat}\right) - \varphi^{*}_{Nk}\left(\hat{k}^{*}_{Nkt}{}^{nat} - \hat{l}^{*}_{Nkt}{}^{nat}\right) + \hat{a}^{*}_{Tkt} - \hat{a}^{*}_{Nkt}$$
$$-\alpha^{*}_{k}\sum_{n=0,n\neq 1}^{10}\omega^{*}_{k}\,\hat{s}^{*}_{k\cdot n_t}{}^{nat} \quad \ldots (76)$$

$$u_t = u_{t-1} + \varepsilon_{ut} \quad \ldots (77)$$

$$\Delta_{R^{nat}_{t}R^{*}_{1t}{}^{nat}} = E_t\hat{s}^{nat}_{1t+1} - \hat{s}^{nat}_{1t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H1t+1} + u_t \quad \ldots (78)$$

$$\Delta_{R^{nat}_{t}R^{*}_{2t}{}^{nat}} = E_t\hat{s}^{nat}_{2t+1} - \hat{s}^{nat}_{2t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H2t+1} + u_t \quad \ldots (79)$$

$$\Delta_{R^{nat}_{t}R^{*}_{3t}{}^{nat}} = E_t\hat{s}^{nat}_{3t+1} - \hat{s}^{nat}_{3t} + E_t\pi_{Ht+1} - E_t\pi^{*}_{H3t+1} + u_t \quad \ldots (80)$$

$$\Delta_{R_t^{nat} R_{4t}^{*}\,^{nat}} = E_t \hat{s}_{4t+1}^{nat} - \hat{s}_{4t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H4t+1}^{*} + u_t \quad \dots (81)$$

$$\Delta_{R_t^{nat} R_{5t}^{*}\,^{nat}} = E_t \hat{s}_{5t+1}^{nat} - \hat{s}_{5t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H5t+1}^{*} + u_t \quad \dots (82)$$

$$\Delta_{R_t^{nat} R_{6t}^{*}\,^{nat}} = E_t \hat{s}_{6t+1}^{nat} - \hat{s}_{6t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H6t+1}^{*} + u_t \quad \dots (83)$$

$$\Delta_{R_t^{nat} R_{7t}^{*}\,^{nat}} = E_t \hat{s}_{7t+1}^{nat} - \hat{s}_{7t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H7t+1}^{*} + u_t \quad \dots (84)$$

$$\Delta_{R_t^{nat} R_{8t}^{*}\,^{nat}} = E_t \hat{s}_{8t+1}^{nat} - \hat{s}_{8t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H8t+1}^{*} + u_t \quad \dots (85)$$

$$\Delta_{R_t^{nat} R_{9t}^{*}\,^{nat}} = E_t \hat{s}_{9t+1}^{nat} - \hat{s}_{9t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H9t+1}^{*} + u_t \quad \dots (86)$$

$$\Delta_{R_t^{nat} R_{10t}^{*}\,^{nat}} = E_t \hat{s}_{10t+1}^{nat} - \hat{s}_{10t}^{nat} + E_t \pi_{Ht+1} - E_t \pi_{H10t+1}^{*} + u_t \quad \dots (87)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_t^{nat}} = \hat{s}_{1\cdot 0_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 0_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{Ht+1} + u_t \quad \dots (88)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{2t}^{*}\,^{nat}} = \hat{s}_{1\cdot 2_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 2_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H2t+1}^{*} + u_t \quad \dots (89)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{3t}^{*}\,^{nat}} = \hat{s}_{1\cdot 3_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 3_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H3t+1}^{*} + u_t \quad \dots (90)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{4t}^{*}\,^{nat}} = \hat{s}_{1\cdot 4_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 4_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H4t+1}^{*} + u_t \quad \dots (91)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{5t}^{*}\,^{nat}} = \hat{s}_{1\cdot 5_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 5_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H5t+1}^{*} + u_t \quad \dots (92)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{6t}^{*}\,^{nat}} = \hat{s}_{1\cdot 6_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 6_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H6t+1}^{*} + u_t \quad \dots (93)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{7t}^{*}\,^{nat}} = \hat{s}_{1\cdot 7_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 7_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H7t+1}^{*} + u_t \quad \dots (94)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{8t}^{*}\,^{nat}} = \hat{s}_{1\cdot 8_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 8_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H8t+1}^{*} + u_t \quad \dots (95)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{9t}^{*}\,^{nat}} = \hat{s}_{1\cdot 9_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 9_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H9t+1}^{*} + u_t \quad \dots (96)$$

$$\Delta_{R_{1t}^{*}\,^{nat} R_{10t}^{*}\,^{nat}} = \hat{s}_{1\cdot 10_{t+1}}^{*}\,^{nat} - \hat{s}_{1\cdot 10_t}^{*}\,^{nat} + E_t \pi_{H1t+1}^{*} - E_t \pi_{H10t+1}^{*} + u_t \quad \dots (97)$$

…

$$\Delta_{R_{kt}^{*}\,^{nat} R_t^{nat}} = \hat{s}_{k\cdot 0_{t+1}}^{*}\,^{nat} - \hat{s}_{k\cdot 0_t}^{*}\,^{nat} + E_t \pi_{Hkt+1}^{*} - E_t \pi_{Ht+1} + u_t \quad \dots (98)$$

$$\Delta_{R_{kt}^{*}\,^{nat} R_{1t}^{*}\,^{nat}} = \hat{s}_{k\cdot 1_{t+1}}^{*}\,^{nat} - \hat{s}_{k\cdot 1_t}^{*}\,^{nat} + E_t \pi_{Hkt+1}^{*} - E_t \pi_{H1t+1}^{*} + u_t \quad \dots (99)$$

…

$$\Delta_{R_{kt}^{*}\,^{nat} R_{nt,n\neq k}^{*}\,^{nat}} = \hat{s}_{k\cdot n_{t+1},n\neq k}^{*}\,^{nat} - \hat{s}_{k\cdot n_t,n}^{*}\,^{nat} + E_t \pi_{Hkt+1}^{*} - E_t \pi_{Hnt+1,n\neq k}^{*} + u_t \quad \dots (100)$$

$$\tilde{y}_{T(n-k)t}^{*} = \beth_{(n-k)}^{*}\, \tilde{y}_{T(n-k)t-1}^{*} + \varepsilon_{Tn-kt}^{*} \quad \dots (101)$$

…

$$\tilde{y}^*_{Tnt} = ב^*_n\, \tilde{y}^*_{Tnt-1} + \varepsilon^*_{Tnt} \qquad \text{… (102)}$$

$$\tilde{y}_{Nt} = \frac{1}{\kappa_N} E_t[\pi_{Nt} - \beta^{\blacklozenge}\, \pi_{Nt+1}] \qquad \text{… (103)}$$

$$\tilde{y}_{Tt} = \frac{1}{\kappa_T}\, E_t[\pi_{Ht} - \beta^{\blacklozenge}\, \pi_{Ht+1}] \qquad \text{… (104)}$$

$$\pi_{Nt} = -\frac{(1+\kappa_N)}{(1+\kappa_N+\beta^{\blacklozenge}\,\theta_N)}\left(\tilde{y}_{Nt} - \hat{r}_{t-1} + \alpha\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) - \alpha\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_N+\beta^{\blacklozenge}\,\theta_N)}\tilde{y}_{Nt-2} \qquad \text{… (105)}$$

$$\pi_{Ht} = -\frac{(1+\kappa_T)}{(1+\kappa_T+\beta^{\blacklozenge}\,\theta_T)}\left(\tilde{y}_{Tt} - \hat{r}_{t-1} - (1-\alpha)\,(\hat{a}_{Nt} - \hat{a}_{Nt-1}) + (1-\alpha)\,(\hat{a}_{Tt} - \hat{a}_{Tt-1})\right) - \frac{1}{(1+\kappa_T+\beta^{\blacklozenge}\,\theta_T)}\tilde{y}_{Tt-2} \qquad \text{… (106)}$$

$$\hat{r}_t = \frac{1}{[(1-\varphi_N)(1-\alpha) + (1-\varphi_T)\,\alpha\omega_0]}\begin{Bmatrix} (1-\alpha)E_t\left(\tilde{y}_{Nt+1} + \pi_{Nt+1} + \alpha\,(\hat{a}_{Nt+1} - \hat{a}_{Nt}) - \alpha\,(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right) \\ +\alpha\omega_0\, E_t\left(\tilde{y}_{Tt+1} + \pi_{Ht+1} - (1-\alpha)(\hat{a}_{Nt+1} - \hat{a}_{Nt}) + (1-\alpha)(\hat{a}_{Tt+1} - \hat{a}_{Tt})\right) \end{Bmatrix} \qquad \text{… (107)}$$

$$\tilde{y}^*_{N1t} = \frac{1}{\kappa^*_{N1}}\, E_t[\pi^*_{N1t} - \beta^{\blacklozenge}\, \pi^*_{N1t+1}] \qquad \text{… (108)}$$

$$\tilde{y}^*_{T1t} = \frac{1}{\kappa^*_{T1}}\, E_t[\pi^*_{H1t} - \beta^{\blacklozenge}\, \pi^*_{H1t+1}] \qquad \text{… (109)}$$

$$\pi^*_{N1t} = -\frac{(1+\kappa^*_{N1})}{(1+\kappa^*_{N1}+\beta^{\blacklozenge}\theta^*_{N1})}\left(\tilde{y}^*_{N1t} - \hat{r}^*_{1t-1} + \alpha^*_1(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) - \alpha^*_1\,(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right) - \frac{1}{(1+\kappa^*_{N1}+\beta^{\blacklozenge}\theta^*_{N1})}\tilde{y}^*_{N1t-2} \qquad \text{… (110)}$$

$$\pi^*_{H1t} = -\frac{(1+\kappa^*_{T1})}{(1+\kappa^*_{T1}+\beta^{\blacklozenge}\theta^*_{T1})}\left(\tilde{y}^*_{T1t} - \hat{r}^*_{1t-1} - (1-\alpha^*_1)\,(\hat{a}^*_{N1t} - \hat{a}^*_{N1t-1}) + (1-\alpha^*_1)\,(\hat{a}^*_{T1t} - \hat{a}^*_{T1t-1})\right) - \frac{1}{(1+\kappa^*_{T1}+\beta^{\blacklozenge}\theta^*_{T1})}\tilde{y}^*_{T1t-2} \qquad \text{… (111)}$$

$\hat{r}^*_{1t} =$

$$\frac{1}{[(1-\varphi^*_{N1})(1-\alpha^*_1) + (1-\varphi^*_{T1})\,\alpha^*_1\omega^*_1]}\left\{\begin{matrix} (1-\alpha^*_1)\,E_t\big(\tilde{y}^*_{N1t+1} + \pi^*_{N1t+1} + \ \alpha^*_1\,(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) - \alpha^*_1\,(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\big) \\ +\alpha^*_1\omega^*_1\,E_t\big(\tilde{y}^*_{T1t+1} + \pi^*_{T1t+1} - (1-\alpha^*_1)(\hat{a}^*_{N1t+1} - \hat{a}^*_{N1t}) + (1-\alpha^*_1)(\hat{a}^*_{T1t+1} - \hat{a}^*_{T1t})\big) \end{matrix}\right\}$$

… (112)

…

$$\tilde{y}^*_{Nkt} = \frac{1}{\kappa^*_{Nk}}\,E_t[\pi^*_{Nkt} - \ \beta^{\blacklozenge}\,\pi^*_{Nkt+1}]$$ … (113)

$$\tilde{y}^*_{Tkt} = \ \frac{1}{\kappa^*_{Tk}}\,E_t[\pi^*_{Hkt} - \ \beta^{\blacklozenge}\,\pi^*_{Hkt+1}]$$ … (114)

$$\pi^*_{Nkt} = -\frac{(1+\kappa^*_{Nk})}{(1+\kappa^*_{Nk}+\beta^{\blacklozenge}\theta^*_{Nk})}\big(\tilde{y}^*_{Nkt} - \hat{r}^*_{kt-1} + \alpha^*_k(\hat{a}^*_{Nkt} - \hat{a}^*_{Nkt-1}) - \alpha^*_k\,(\hat{a}^*_{Tkt} - \hat{a}^*_{Tkt-1})\big)$$
$$-\frac{1}{(1+\kappa^*_{Nk}+\beta^{\blacklozenge}\theta^*_{Nk})}\tilde{y}^*_{Nkt-2}$$ … (115)

$$\pi^*_{H2t} = -\frac{(1+\kappa^*_{Tk})}{(1+\kappa^*_{Tk}+\beta^{\blacklozenge}\theta^*_{Tk})}\big(\tilde{y}^*_{Tkt} - \hat{r}^*_{kt-1} - (1-\alpha^*_k)\ \ (\hat{a}^*_{Nkt} - \hat{a}^*_{Nkt-1}) + (1-\alpha^*_k)\,(\hat{a}^*_{Tkt} - \hat{a}^*_{Tkt-1})\big)$$

$$-\frac{1}{(1+\kappa^*_{Tk}+\beta^{\blacklozenge}\theta^*_{Tk})}\tilde{y}^*_{Tkt-2}$$ … (116)

$\hat{r}^*_{kt} =$

$$\frac{1}{[(1-\varphi^*_{Nk})(1-\alpha^*_k) + (1-\varphi^*_{Tk})\,\alpha^*_k\omega^*_k]}\left\{\begin{matrix} (1-\alpha^*_k)\,E_t\big(\tilde{y}^*_{Nkt+1} + \pi^*_{Nkt+1} + \ \alpha^*_k\,(\hat{a}^*_{Nkt+1} - \hat{a}^*_{Nkt}) - \alpha^*_k\,(\hat{a}^*_{Tkt+1} - \hat{a}^*_{Tkt})\big) \\ +\alpha^*_k\omega^*_k\,E_t\big(\tilde{y}^*_{Tkt+1} + \pi^*_{Tkt+1} - (1-\alpha^*_k)(\hat{a}^*_{Nkt+1} - \hat{a}^*_{Nkt}) + (1-\alpha^*_k)(\hat{a}^*_{Tkt+1} - \hat{a}^*_{Tkt})\big) \end{matrix}\right\}$$

… (117)

5.2. Results

5.2.1. Parameter Estimates and Derived Parameter Values

Appendix 5.2. displays the results of parameter estimation for the ASEAN-5+3 countries. Appendix 5.3. shows the results of Z-test to determine whether there are significant differences between parameter values under different interaction regimes: ”No Coordination” (NC), ”Bilateral Coordination” (BC), and ”Multilateral Coordination” (MC). Appendix 5.4. displays the values of derived parameters.

There is no clear pattern of value changes when a country moves from one regime to another. It implies that the parameter values are specifically determined by the economic structures of the interacting countries. This finding is consistent with the finding from the one-production-factor model.

Parameter estimation results show that, for all the ASEAN-5 + 3 countries and in all types of interaction regimes, intermediate goods producers' pricing decision responsiveness in the traded sector (κ_T) is higher than the responsiveness of intermediate goods producers in the non-traded sector (κ_N). The finding from κ_N and κ_T estimates in the two-production-factor model is consistent with the finding in the one-production factor model.

The parameter estimates show that the elasticity of substitution between differentiated products in the non-traded sector (θ_N) is higher than the elasticity in the traded sector (θ_T) for all the ASEAN-5 + 3 countries and in all types of interaction regimes. The direction of inequalities signs between θ_N and θ_T in the-two-production-factor model is more consistent than those in the one-production-factor model (where θ_N is greater than θ_T in some cases, but smaller in other cases).

The Z-test results show that the two-production factor model have more parameters with significantly different values under different regimes compared to those in the one-production factor model. In other words, there are more variations in parameters values across different interaction regimes in the two-production factor model than in the one-production-factor model.

The values of derived parameters γ_N and γ_T are both less than 10% for all the ASEAN-5 + 3 countries in all the interaction regimes, implying a high likelihood of intermediate goods producers in the non-traded and traded sectors changing their prices in the presence of economic shocks. γ_T is smaller than γ_N in all the ASEAN-5 + 3 countries and in all the types of interaction regimes. This finding is consistent with the finding in the one-production-factor model

The values of derived parameter μ_T are higher than μ_N for all the ASEAN-5 + 3 countries and in all the types of interaction regimes. The direction of inequalities signs between μ_N and μ_T in the-two-production-factor model is more consistent than those in the one-production-factor model (where μ_N is greater than μ_T in some cases, but smaller in other cases).

5.2.2. Welfare

Tables 5.1. display the welfare values for each of the ASEAN-5+3 countries under the three interaction regimes. All variables in the model for each the ASEAN-5+3 economies have zero values in the steady state. It implies that the model has a unique solution for each country and for each interaction regime, and the all parameters of in the model converges.

The following are the findings with respect to the welfare of each of the ASEAN-5+3 countries:

(1) Indonesia

The highest welfare is achieved when Indonesia enters MC scheme with the ASEAN-5+3. The lowest welfare is when Indonesia bilaterally coordinates policy with Japan. Indonesia's welfare in the ASEAN+1 with any CJK country is higher than its welfare under the NC regime and in any BC case. Indonesia's welfare in the ASEAN-5 MC is lower than its welfare under the NC regime and most of BC cases (except BC with Japan). Indonesia's welfare under the NC regime is lower than its welfare under BC cases with most of the other ASEAN-5+3 countries, except in BC cases with the Philippines and with Singapore.

(2) Malaysia

The highest welfare is achieved when Malaysia enters MC scheme with the ASEAN-5+3. The lowest welfare is when Malaysia under the NC regime. Malaysia's welfare under MC in the ASEAN-5+1 scheme with any CJK country is always higher than its welfare in any BC case. Malaysia's welfare in the ASEAN-5 MC is higher than its welfare in most BC cases, except in BC cases with China and with Indonesia.

(3) Singapore

The highest welfare is achieved when Singapore enters MC scheme with the ASEAN-5+3. The lowest welfare is when Singapore under the NC regime. Singapore's welfare under MC in the ASEAN-5+1 scheme with any CJK country is always higher than its welfare in any BC case. Singapore's welfare in the ASEAN-5 MC is higher than its welfare in most BC cases, except in BC cases with Indonesia, with China, and with the Philippines.

(4) Thailand

The highest welfare is achieved when Thailand enters MC scheme with the ASEAN-5+3. The lowest welfare is when Thailand under the NC regime. Thailand's welfare under MC in the ASEAN-5+1 scheme with any CJK country is always higher than its welfare in any BC case. Thailand's welfare in the ASEAN-5 MC is higher than its welfare in most BC cases, except in BC cases with China, with Indonesia, and with Japan.

(5) The Philippines

The highest welfare is achieved when the Philippines enters MC scheme with the ASEAN-5+3. The lowest welfare is when the Philippines bilaterally coordinates policy with Thailand. The Philippines' welfare under MC in the ASEAN-5+1 scheme with any CJK country is always higher than its welfare in any BC case. The Philippines' welfare in the ASEAN-5 MC is higher than its welfare in most BC cases, except in BC cases with Indonesia, with China, and with Singapore. The Philippines' welfare in BC cases with Indonesia, China, or Singapore are higher than its welfare in BC cases with Japan, Malaysia, South Korea, or Thailand.

(6) China

The highest welfare is achieved when China enters MC scheme with the ASEAN-5+3. The lowest welfare is when China enters the CJK MC scheme. China's welfare under MC in the ASEAN-5 + China scheme is always higher than its welfare under the NC regime and in any BC case. China's welfare under the NC regime is always lower than its welfare in BC cases with any other ASEAN-5+3 countries.

(7) Japan

The highest welfare is achieved when Japan enters MC scheme with the ASEAN-5+3. The lowest welfare is when Japan enters the CJK MC scheme. Japan’s welfare under MC in the ASEAN-5 + Japan scheme is always higher than its welfare under the NC regime and in any BC case. Japan’s welfare under the NC regime is always lower than its welfare in any BC case with any other ASEAN-5+3 countries.

(8) South Korea

The highest welfare is achieved when South Korea enters MC scheme with the ASEAN-5+3. The lowest welfare is when Japan enters the CJK MC scheme. South Korea’s welfare under MC in the ASEAN-5 + South Korea scheme is always higher than its welfare under the NC regime and in any BC case. South Korea’s welfare under the NC regime is always lower than its welfare in BC cases with almost any other ASEAN-5+3 countries, except in BC with Japan.

Table 5.2 displays the best to the worst ”potential” cooperation partners under the BC regime for each of the ASEAN-5+3 countries. Table 5.27 displays the best to worst ”potential” cooperation MC schemes for each of the ASEAN-5+3 countries. ”Potential” here means that while it may be beneficial for a country to enter a BC or an MC scheme to improve its welfare, policy coordination may or may not happen depending on whether such scheme also benefits the counterpart country (countries).

Within the ASEAN-5+3 group, Indonesia is the best BC partner for Singapore, the Philippines, and South Korea; China is the best BC partner for Malaysia and Thailand; the Philippines is the best BC partner for Indonesia; and Thailand is the best BC partner for Japan. Within the (sub)group of ASEAN-5 Indonesia is the best coordination partner for other countries. Within the CJK (sub)group, China is the best coordination partner for Japan and South Korea.

The ASEAN-5+3 scheme is the best MC scheme for all the ASEAN-5+3 countries. The ASEAN-5 is the worst MC scheme for all the ASEAN-5 countries, while the CJK is the worst scheme for all the CJK countries.

Table 5.1. Welfare Values

- **No Coordination Cases**

	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	South Korea
Welfare	-0.08843	-0.09488	-0.09514	-0.09505	-0.09224	-0.09454	-0.09659	-0.09337

- **Bilateral Coordination Cases**

	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	South Korea
Indonesia	---	-0.09059	-0.08815	-0.09078	-0.08771	-0.09061	-0.09365	-0.09001
Malaysia	-0.09059	---	-0.09332	-0.09382	-0.09244	-0.08663	-0.09271	-0.09331
Singapore	-0.08815	-0.09332	---	-0.09327	-0.09198	-0.09163	-0.09432	-0.09258
Thailand	-0.09078	-0.09382	-0.09327	---	-0.09259	-0.08960	-0.09091	-0.09323
Philippines	-0.08771	-0.09244	-0.09198	-0.09259	---	-0.08906	-0.09242	-0.09254
China	-0.09061	-0.08663	-0.09163	-0.08960	-0.08906	---	-0.09377	-0.09248
Japan	-0.09365	-0.09271	-0.09432	-0.09091	-0.09242	-0.09377	---	-0.09452
South Korea	-0.09001	-0.09331	-0.09258	-0.09323	-0.09254	-0.09248	-0.09452	---

- **Multilateral Coordination Cases**

	CJK	ASEAN-5	ASEAN-5 + China	ASEAN-5 + Japan	ASEAN-5 + South Korea	ASEAN-5 + 3
Indonesia	---	-0.09209	0.01288	0.02596	-0.01405	0.81320
Malaysia	---	-0.09209	0.01288	0.02596	-0.01405	0.81320
Singapore	---	-0.09209	0.01288	0.02596	-0.01405	0.81320
Thailand	---	-0.09209	0.01288	0.02596	-0.01405	0.81320
Philippines	---	-0.09209	0.01288	0.02596	-0.01405	0.81320
China	-0.11077	---	0.01288	---	---	0.81320
Japan	-0.11077	---	---	0.02596	---	0.81320
South Korea	-0.11077	---	---	---	-0.01405	0.81320

Source: Author's calculation.

Table 5.2. Best to Worst "Potential" Bilateral Coordination Partners for the ASEAN-5+3 Countries

	1	2	3	4	5	6	7
Indonesia	Philippines	Singapore	S. Korea	Malaysia	China	Thailand	Japan
Malaysia	China	Indonesia	Philippines	Japan	S. Korea	Singapore	Thailand
Singapore	Indonesia	China	Philippines	S. Korea	Thailand	Malaysia	Japan
Thailand	China	Indonesia	Japan	Philippines	S. Korea	Singapore	Malaysia
Philippines	Indonesia	China	Singapore	Japan	Malaysia	S. Korea	Thailand
China	Malaysia	Philippines	Thailand	Indonesia	Singapore	S. Korea	Japan
Japan	Thailand	Philippines	Malaysia	Indonesia	China	Singapore	S. Korea
S. Korea	Indonesia	China	Philippines	Singapore	Thailand	Malaysia	Japan

(1) Within the ASEAN-5 Group

	1	2	3	4
Indonesia	Philippines	Singapore	Malaysia	Thailand
Malaysia	Indonesia	Philippines	Singapore	Thailand
Singapore	Indonesia	Philippines	Thailand	Malaysia
Thailand	Indonesia	Philippines	Singapore	Malaysia
Philippines	Indonesia	Singapore	Malaysia	Thailand

(2) Within the CJK Group

	1	2
China	South Korea	Japan
Japan	China	South Korea
South Korea	China	Japan

Source: Author's calculation

Table 5.3. Best to Worst "Potential" Multilateral Coordination Schemes for the ASEAN-5+3 Countries

	1	2	3	4	5
Indonesia	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5 + S. Korea	ASEAN-5
Malaysia	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5 + S. Korea	ASEAN-5
Singapore	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5 + S. Korea	ASEAN-5
Thailand	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5 + S. Korea	ASEAN-5
Philippines	ASEAN-5+3	ASEAN-5 + Japan	ASEAN-5 + China	ASEAN-5 + S. Korea	ASEAN-5
China	ASEAN-5+3	ASEAN-5 + China	CJK	---	---
Japan	ASEAN-5+3	ASEAN-5 + Japan	CJK	---	---
S. Korea	ASEAN-5+3	ASEAN-5 + S. Korea	CJK	---	---

Source: Author's calculation

5.2.3. Coordination Payoff Matrix

This section displays payoff matrices based on the assumption of one-shot-game with perfect information to examine which bilateral coordination or multilateral monetary policy coordination schemes are feasible for each of the ASEAN-5+3 countries. When dealing with its potential partner(s), each country can opt to coordinate or not to coordinate its policy.

5.2.3.1. Bilateral Coordination vs. No Coordination

The following are the payoff matrices for each of the ASEAN-5+3 countries when they choose between not coordinating (No Coordination) or coordinating policies (Coordination):

- **Indonesia - Malaysia**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08943), while the best strategy for Malaysia is to coordinate policy (welfare loss = -0.09059). Policy coordination is not feasible in this scenario.

		MALAYSIA	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09488)	(-0.08843 ; -0.09059)
	Coordination	(-0.09059 ; -0.09488)	(-0.09059 ; -0.09059)

- **Indonesia - Singapore**

  The best strategy for Indonesia is to coordinate policy (welfare loss = -0.08815), while the best strategy for Singapore is to coordinate policy (welfare loss = -0.08815). Policy coordination is feasible in this scenario.

		SINGAPORE	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09514)	(-0.08843 ; -0.08815)
	Coordination	(-0.08815 ; -0.09514)	(-0.08815 ; -0.08815)*

- **Indonesia – Thailand**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08943), while the best strategy for Thailand is to coordinate policy (welfare loss = -0.09078). Policy coordination is not feasible in this scenario.

		THAILAND	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09505)	(-0.08843 ; -0.09078)
	Coordination	(-0.09078 ; -0.09505)	(-0.09078 ; -0.09078)

- **Indonesia – The Philippines**

  The best strategy for Indonesia is to coordinate policy (welfare loss = -0.08771), while the best strategy for the Philippines is to coordinate policy (welfare loss = -0.08771). Policy coordination is feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09224)	(-0.08843 ; -0.08771)
	Coordination	(-0.08771 ; -0.09224)	(-0.08771 ; -0.08771)*

- **Indonesia – China**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08943), while the best strategy for China is to coordinate policy (welfare loss = -0.09061). Policy coordination is not feasible in this scenario.

		CHINA	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09454)	(-0.08843 ; -0.09061)
	Coordination	(-0.09061 ; -0.09454)	(-0.09061 ; -0.09061)

- **Indonesia – Japan**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08943), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09365). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09659)	(-0.08843 ; -0.09365)
	Coordination	(-0.09365 ; -0.09659)	(-0.09365 ; -0.09365)

- **Indonesia – South Korea**

  The best strategy for Indonesia is not to coordinate policy (welfare loss = -0.08943), while the best strategy for South Korea is to coordinate (welfare loss = -0.09001). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
INDONESIA	**No Coordination**	(-0.08843 ; -0.09337)	(-0.08843 ; -0.09001)
	Coordination	(-0.09001 ; -0.09337)	(-0.09001 ; -0.09001)

- **Malaysia – Singapore**

  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.09332), while the best strategy for Singapore is to coordinate policy (welfare loss = -0.09332). Policy coordination is feasible in this scenario.

		SINGAPORE	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09488 ; -0.09514)	(-0.09488 ; -0.09332)
	Coordination	(-0.09332; -0.09514)	(-0.09332 ; -0.09332)*

- **Malaysia – Thailand**

  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.09382), while the best strategy for Thailand is to coordinate policy (welfare loss = -0.09382). Policy coordination is feasible in this scenario.

		THAILAND	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09488 ; -0.09505)	(-0.09488 ; -0.09382)
	Coordination	(-0.09382 ; -0.09505)	(-0.09382 ; -0.09382)*

- **Malaysia – The Philippines**
  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.09244), while the best strategy for the Philippines is not to coordinate (welfare loss = -0.09224). Policy coordination is not feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09488 ; -0.09224)	(-0.09488 ; -0.09244)
	Coordination	(-0.09244 ; -0.09224)	(-0.09244 ; -0.09244)

- **Malaysia – China**
  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.08663), while the best strategy for China is to coordinate policy (welfare loss = -0.08663). Policy coordination is feasible in this scenario.

		CHINA	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09488 ; -0.09454)	(-0.09488 ; -0.08663)
	Coordination	(-0.08663 ; -0.09454)	(-0.08663 ; -0.08663)*

- **Malaysia – Japan**
  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.09271), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09271). Policy coordination is feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09488 ; -0.09659)	(-0.09488 ; -0.09271)
	Coordination	(-0.09271 ; -0.09659)	(-0.09271 ; -0.09271)*

- **Malaysia – South Korea**
  The best strategy for Malaysia is to coordinate policy (welfare loss = -0.09331), while the best strategy for South Korea is to coordinate policy (welfare loss = -0.09331). Policy coordination is feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
MALAYSIA	**No Coordination**	(-0.09488 ; -0.09337)	(-0.09488 ; -0.09331)
	Coordination	(-0.09331 ; -0.09337)	(-0.09331 ; -0.09331)*

- **Singapore – Thailand**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09327), while the best strategy for Thailand is to coordinate policy (welfare loss = -0.09327). Policy coordination is feasible in this scenario.

		THAILAND	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09514 ; -0.09505)	(-0.09514 ; -0.09327)
	Coordination	(-0.09327 ; -0.09505)	(-0.09327 ; -0.09327)*

- **Singapore – The Philippines**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09198), while the best strategy for the Philippines is to coordinate (welfare loss = -0.09198). Policy coordination is feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09514 ; -0.09224)	(-0.09514 ; -0.09198)
	Coordination	(-0.09198 ; -0.09224)	(-0.09198 ; -0.09198)*

- **Singapore – China**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09454), while the best strategy for China is to coordinate policy (welfare loss = -0.09454). Policy coordination is feasible in this scenario.

		CHINA	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09514 ; -0.09454)	(-0.09514 ; -0.09163)
	Coordination	(-0.09163 ; -0.09454)	(-0.09163 ; -0.09163)*

- **Singapore – Japan**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09432), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09432). Policy coordination is feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09514 ; -0.09659)	(-0.09514 ; -0.09432)
	Coordination	(-0.09432 ; -0.09659)	(-0.09432 ; -0.09432)*

- **Singapore – South Korea**
  The best strategy for Singapore is to coordinate policy (welfare loss = -0.09258), while the best strategy for Korea is to coordinate policy (welfare loss = -0.09258). Policy coordination is feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
SINGAPORE	**No Coordination**	(-0.09514 ; -0.09337)	(-0.09514 ; -0.09258)
	Coordination	(-0.09258 ; -0.09337)	(-0.09258; -0.09258)*

- **Thailand – The Philippines**
  The best strategy for Thailand is to coordinate policy (welfare loss = -0.09259), while the best strategy for the Philippines is not to coordinate (welfare loss = -0.09224). Policy coordination is not feasible in this scenario.

		THE PHILIPPINES	
		No Coordination	**Coordination**
THAILAND	**No Coordination**	(-0.09505 ; -0.09224)	(-0.09505 ; -0.09259)
	Coordination	(-0.09259 ; -0.09224)	(-0.09259 ; -0.09259)

- **Thailand – China**
  The best strategy for Thailand is to coordinate policy (welfare loss = -0.08960), while the best strategy for China is to coordinate policy (welfare loss = -0.08960). Policy coordination is feasible in this scenario.

		CHINA	
		No Coordination	Coordination
THAILAND	No Coordination	(-0.09505 ; -0.09454)	(-0.09505 ; -0.08960)
	Coordination	(-0.08960 ; -0.09454)	(-0.08960 ; -0.08960)*

- **Thailand – Japan**
  The best strategy for Thailand is to coordinate policy (welfare loss = -0.09091), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09091). Policy coordination is feasible in this scenario.

		JAPAN	
		No Coordination	Coordination
THAILAND	No Coordination	(-0.09505 ; -0.09659)	(-0.09505 ; -0.09091)
	Coordination	(-0.09091 ; -0.09659)	(-0.09091 ; -0.09091)*

- **Thailand – South Korea**
  The best strategy for Thailand is to coordinate policy (welfare loss = -0.09323), while the best strategy for Korea is to coordinate policy (welfare loss = -0.09323). Policy coordination is feasible in this scenario.

		SOUTH KOREA	
		No Coordination	Coordination
THAILAND	No Coordination	(-0.09505 ; -0.09337)	(-0.09505 ; -0.09323)
	Coordination	(-0.09323 ; -0.09337)	(-0.09323; -0.09323)*

- **The Philippines – China**
  The best strategy for Philippines is to coordinate policy (welfare loss = -0.08906), while the best strategy for China is to coordinate policy (welfare loss = -0.08906). Policy coordination is feasible in this scenario.

		CHINA	
		No Coordination	Coordination
THE PHILIPPINES	No Coordination	(-0.09224 ; -0.09454)	(-0.09224 ; -0.08906)
	Coordination	(-0.08906 ; -0.09454)	(-0.08906 ; -0.08906)*

- **The Philippines – Japan**
  The best strategy for Philippines is not to coordinate policy (welfare loss = -0.09224), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09242). Policy coordination is not feasible in this scenario.

		JAPAN	
		No Coordination	Coordination
THE PHILIPPINES	No Coordination	(-0.09224 ; -0.09659)	(-0.09224 ; -0.09242)
	Coordination	(-0.09242 ; -0.09659)	(-0.09242 ; -0.09242)

- **The Philippines – South Korea**
  The best strategy for Philippines is not to coordinate policy (welfare loss = -0.09224), while the best strategy for Korea is to coordinate policy (welfare loss = -0.09254). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
THE PHILIPPINES	**No Coordination**	(-0.09224 ; -0.09337)	(-0.09224 ; -0.09254)
	Coordination	(-0.09254 ; -0.09337)	(-0.09254 ; -0.09254)

- **China – Japan**
  The best strategy for China is to coordinate policy (welfare loss = -0.09377), while the best strategy for Japan is to coordinate policy (welfare loss = -0.09377). Policy coordination is feasible in this scenario.

		JAPAN	
		No Coordination	**Coordination**
CHINA	**No Coordination**	(-0.09454 ; -0.09659)	(-0.09454 ; -0.09377)
	Coordination	(-0.09377 ; -0.09659)	(-0.09377 ; -0.09377)*

- **China – South Korea**
  The best strategy for China is to coordinate policy (welfare loss = -0.09248), while the best strategy for South Korea is to coordinate policy (welfare loss = -0.09248). Policy coordination is feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
CHINA	**No Coordination**	(-0.09454 ; -0.09337)	(-0.09454 ; -0.09248)
	Coordination	(-0.09248 ; -0.09337)	(-0.09248 ; -0.09248)*

- **Japan – South Korea**
  The best strategy for Japan is to coordinate policy (welfare loss = -0.09452), while the best strategy for South Korea is not to coordinate policy (welfare loss = -0.09337). Policy coordination is not feasible in this scenario.

		SOUTH KOREA	
		No Coordination	**Coordination**
JAPAN	**No Coordination**	(-0.09659 ; -0.09337)	(-0.09659 ; -0.09452)
	Coordination	(-0.09452 ; -0.09337)	(-0.09452 ; -0.09452)

To summarize, the following are feasible bilateral policy coordination based on payoff matrices above:
1) Indonesia – Singapore BC
2) Indonesia – the Philippines BC
3) Malaysia – Singapore BC
4) Malaysia – Thailand BC
5) Malaysia – China BC
6) Malaysia – Japan BC

7) Malaysia – South Korea BC
8) Singapore – Thailand BC
9) Singapore – the Philippines BC
10) Singapore – China BC
11) Singapore – Japan BC
12) Singapore – South Korea BC
13) Thailand – China BC
14) Thailand – Japan BC
15) Thailand – South Korea BC
16) The Philippines - China BC
17) China – Japan BC
18) China – South Korea BC

5.2.3.2. Multilateral Coordination vs. No Coordination

As displayed in Table 5.4, multilateral coordination under the scheme of ASEAN-5 + China, ASEAN-5 + Japan, ASEAN-5 + South Korea, and ASEAN-5+3 are feasible for the participating countries. In these three scenarios, welfare for each participating country under the Multilateral Policy Coordination regime is higher than welfare under the No Coordination regime. Meanwhile, multilateral policy coordination under the CJK scheme is not feasible as these schemes only produce lower welfare for each participating country than the welfare level under the No Coordination regime.

Table 5.4. Multilateral Coordination vs. No Coordination Pay-off Matrixes

	No Coordination	ASEAN-5	ASEAN-5 + China*	ASEAN-5 + Japan*	ASEAN-5 + Korea*	CJK	ASEAN-5 + CJK*
Indonesia	-0.08843	-0.09209	0.01288	0.02596	-0.01405	---	0.81320
Malaysia	-0.09488	-0.09209	0.01288	0.02596	-0.01405	---	0.81320
Singapore	-0.09514	-0.09209	0.01288	0.02596	-0.01405	---	0.81320
Thailand	-0.09505	-0.09209	0.01288	0.02596	-0.01405	---	0.81320
Philippines	-0.09224	-0.09209	0.01288	0.02596	-0.01405	---	0.81320
China	-0.09454	---	0.01288	---	---	-0.11077	0.81320
Japan	-0.09659	---	---	0.02596	---	-0.11077	0.81320
S. Korea	-0.09337	---	---	---	-0.01405	-0.11077	0.81320

Source: Author's calculation

5.3. Analysis

By incorporating capital as another production factor besides labor, the two-production-factor model produces different values of estimated and derived parameters compared to those in the one-production-factor model. In the two-production-factor model, intermediate good producers have options to produce the same level of output using different combinations of factors, to change the proportion of labor and capital in the input bundles without changing output prices when labor productivity or exchange rate shock occurs, and/or to change their degree of product differentiation to adjust to types of output demanded by final-good producers and competitive landscape in the intermediate goods markets.

Parameter estimates show that κ_N is higher than κ_T for all the ASEAN-5+3 countries and in all types of interaction regimes. This is because the market for traded intermediate goods is more competitive than the market for non-traded intermediate goods. International trade makes the traded intermediate goods market competitive, as final goods producers have options to buy products from more sellers (intermediate goods producers) while intermediate goods producers have options to sell to more buyers (final goods producers). On the contrary, the demand for non-traded intermediate goods comes entirely from domestic final goods producers. Thus, intermediate goods producers in the traded sector are more flexible in changing prices to cope with economic shocks than intermediate goods producers in the non-traded sector are.

The parameter estimates θ_N is higher than θ_T for all the ASEAN-5+3 countries and in all types of interaction regimes. This finding shows that non-traded intermediate goods are easier for similar products to substitute than traded intermediate goods are. Non-traded final goods producers require less specific intermediate goods for their production because these firms aim their production of final goods only at domestic consumers with less diverse preferences. On the contrary, final producers of traded goods need more specific intermediate goods, as they sell their products to domestic and foreign consumers with more diverse preferences. The finding also implies that, for all the ASEAN-5+3 countries, non-traded intermediate goods producers have a lower bargaining position against final goods producers compared with the bargaining position of intermediate goods producers in the traded sector.

There is a high likelihood of intermediate goods producers in the non-traded and traded sectors to change their output prices in the presence of economic shocks, as shown by the values of γ_N and γ_T which are both less than 10% for all the ASEAN-5+3 countries in all the interaction regimes. It is noticeable that γ_N values in the two-production-factor model are much lower than $\gamma_T$in the one-production-factor model. This finding is in line with the previous finding that intermediate goods producers in the traded sector are more-price responsive and have stronger bargaining position against final good producers compared to intermediate goods producers in the non-traded sector. It is easier for intermediate goods producers in the traded sector to change their prices, as they have access to buyers (final goods producers) in the domestic and foreign markets and thus have more bargaining power than buyers. Intermediate goods producers in the non-traded sector have a weaker bargaining position to change their prices as they can only sell to domestic buyers.

The values of derived parameter μ_T are higher than μ_N for all the ASEAN-5 + 3 countries and in all the types of interaction regimes. This implies that the governments of the ASEAN-5 + 3 countries must provide bigger subsidies to reduce the price markup for intermediate goods producers in the traded sector than the subsidies for intermediate goods producers in the non-traded sector. Intermediate goods producers in the traded sector can set a higher price markup as they have a relatively stronger bargaining position in relation to buyers compared with intermediate goods producers in the non-traded sector.

As in the one-production-factor model, welfare in the two-production-factor model is defined as macroeconomic stability, as reflected by the welfare equation that contains inflations and output gaps in the non-traded sectors. The benefit of international policy coordination is the improvement of welfare for the participating countries. The cost of policy coordination is the loss of flexibility for the central bank of the participating to country to conduct monetary policy in the presence of shock, compared to if it does not coordinate policy. Participating central banks must be committed to maintain their natural interest rate gap targets as jointly set with their partner in coordination.

There are many components that affect welfare which are included in the model's system of equations in the two-production-factor model: (1) relative size of the country (in the case of NC) or participating countries (ρ); (2) non-traded sector inflation in each country (π_N); (3) traded sector inflation in each country (π_T); (4) output gap in the non-traded sector of each country ($\tilde{y}_N$); (5) output gap in the traded sector of each country ; (5) discount factor (ρ); (6) share of traded sector in each country's economy (α); (7) share of imported goods to total traded goods in each country's economy (ω_0); (8) share of imported traded goods from Foreign Country-n (n = 1, … 10) to total traded goods (ω_0); (9) responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector (κ_N); (10) responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector (κ_T); (11) labor input elasticity in the non-traded sector (φ_N); (12) labor input elasticity in the traded sector (φ_T); responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector (κ_T); (13) elasticity of substitution between differentiated products in the non-traded sector (θ_N); (14) elasticity of substitution between differentiated products in the non-traded sector; and (15) elasticity of substitution between differentiated products in the traded sector (θ_T).

Among these components, it is relative sizes of the participating countries that mostly determines the feasibility of monetary policy coordination. Nonetheless, capital has important role in determining the feasibility of policy coordination in the two-production-factor model. The inclusion of capital in the model increases the number of feasible policy coordination cases compared to the number of cases in the one-production-factor model. Besides capital, parameter θ_T has important role to make Thailand – China BC feasible.

In the two-production-factor model, the ASEAN-5+3 MC provides the highest ”potential welfare” for all participants. The second-best "potential" welfare for the ASEAN-5 countries and for Japan is obtained through BC with Japan; for China through the ASEAN-5 + China MC; and for South Korea through the ASEAN-5 + South Korea. This finding is in line with the finding in the one-production-factor model.

Unlike in the one-production-factor model with only one feasible BC case and three feasible MC cases, there are 18 BC and four MC feasible cases in the two-production-factor model. Large disparity in economic size remains main reason that hinders monetary policy coordination among the ASEAN-5 countries (Table 5.6). With the weighted sum aggregation technology, countries with bigger size (here: bigger economic size) must bear more cost in the provision of the impure public good (here: macroeconomic stability). Nonetheless, the introduction of capital (through parameters φ_N and φ_N in the welfare equation system) allows the two-production factor to produce more feasible BC and MC cases.

From the economic point of view, by having capital as another production input besides labor, intermediate-good-producing firms becomes more adaptable in terms of pricing decision responsiveness and more able to differentiate their products and prices. This leads to more competitive and efficient intermediate goods markets compared to the markets in the one-production factor. Although firms are more flexible in changing their output prices, it does not lead to spiking inflation since there are many other products that can substitute their products. If firms decide to raise their output prices, the increase is likely to be lower than the increase in the less-competitive markets. Competitive markets help to reduce price markups and manage inflation, thus helps the supranational planner to control inflation. The supranational planner can also be more flexible in its fiscal policy as the markets are efficient in allocating resources.

Among the feasible BC cases, Singapore has the highest number of feasible cases. Singapore has relatively lower inflation and fewer output gaps than the other ASEAN-5 countries, hence allowing it to form BC with countries with low inflation and/or small output gaps (i.e., Malaysia, Thailand, the PRC, Japan, and the Republic of Korea). For Indonesia (which is the best "potential" partner for other ASEAN-5 countries), the feasible schemes are BC with Singapore and the Philippines. Within the CJK group, the PRC–Japan and PRC–Republic of Korea schemes are feasible, while the Japan–Republic of Korea scheme is not feasible.

Almost all MC cases are feasible in the two-production-factor model, except the ASEAN-5 MC and the CJK schemes. For Indonesia, the costs for entering the ASEAN-5 MC scheme still exceeds the benefits, although for other ASEAN-5 countries this MC scheme is beneficial. Likewise, the costs for China and Japan to establish CJK MC exceed the benefits. This finding explains why the CJK countries prefer to attach themselves to the extended ASEAN-5 policy coordination. Unlike in the one-production-factor model, the ASEAN-5 + South Korea is feasible in the two-production factor model.

The main finding from the two-production-factor model in this study that policy coordination is feasible for the ASEAN-5+3 countries partially supports the conclusions from Branson dan Healy (2005), Gupta (2012), and Tan (2014). The two-production-factor DSGE model in this study provides more feasible cases of policy coordination among the ASEAN-5+3 than the one-production-factor model for the ASEAN-5 countries that Sugandi (2016, 2018) developed. With more cases of feasible bilateral and multilateral policy coordination, the two-production-factor envisages stronger prospect of international monetary policy coordination than the one-production-factor model does.

Table 5.5. Feasible Policy Coordination Cases in the Two-Production-Factor Model

	Feasible Policy Coordination Cases
Bilateral Coordination	1) Indonesia – Singapore 2) Indonesia – the Philippines 3) Malaysia – Singapore 4) Malaysia – Thailand 5) Malaysia – China 6) Malaysia – Japan 7) Malaysia – South Korea 8) Singapore – Thailand 9) Singapore – the Philippines 10) Singapore – China 11) Singapore – Japan 12) Singapore – South Korea 13) Thailand – China 14) Thailand – Japan 15) Thailand – South Korea 16) The Philippines - China 17) China – Japan 18) China – South Korea
Multilateral Coordination	1) ASEAN-5 + China 2) ASEAN-5 + Japan 3) ASEAN-5 + South Korea 4) ASEAN-5+3

Source: Author's calculation

Table 5.6. Relative Economic Size (ρ) of the ASEAN-5 + 3 Countries in the Model (%)

	EU	**US**	**CN**	**JP**	**SK**	**AU**	**ID**	**TH**	**MY**	**SG**	**PH**	**TOTAL**
ρ	35.52	32.67	12.89	10.87	2.36	2.32	1.35	0.65	0.50	0.46	0.41	**100.00**

Note: EU = European Union US = United States CN = China JP = Japan
SK = South Korea ID = Indonesia TH = Thailand MY = Malaysia
SG = Singapore PH = the Philippines

Source: Author's calculation

APPENDIX 5.1.

Definitions of Notations

- **Indexes and Mathematical Operators**

t = time index

n = country index

k = number of participating countries in Multilateral Coordination – 1

i = index for firms in the non-traded sector

j = index for firms in the traded sector

E_{t} = expectation operator in period t

E_0 = expectation operator in period t = 0

- **Parameters**

- Calculated Parameters

β = subjective discount factor in the Home economy

$\beta^{\blacksquare}$ = weighted joint subjective discount factor in Bilateral Coordination

$\beta^{\blacklozenge}$ = weighted joint subjective discount factor in Multilateral Coordination

ρ_0 = relative size of the Home economy to the total size of the 11 economies in the model

ρ_1 = relative size of Foreign Country-1 to the total size of the 11 economies in the model

ρ_{k} = relative size of Foreign Country-k to the total size of the 11 economies in the model

α = share of traded goods in the total goods in the home economy

α_1^* = share of traded goods in the total goods in Foreign Country-1

α_k^* = share of traded goods in the total goods in Foreign Country-k

ω_0 = share of domestically-produced traded goods to total traded goods in the Home economy

$\omega_{1\cdot 1}^*$ = share of domestically-produced traded goods to total traded goods in Foreign Country-1

$\omega_{k\cdot k}^*$ = share of domestically-produced traded goods to total traded goods in Foreign Country-k

ω_n = share of imported traded goods from Foreign Country-n to the total imported traded goods

$\omega_{1\cdot n,n\neq 1}^*$ = share of imported traded goods from other Foreign Country-n to total traded goods in Foreign Country-1

$\omega_{k\cdot n,n\neq 1}^*$ = share of imported traded goods from other Foreign Country-n to total traded goods in Foreign Country-k

$\omega_0 + \sum_{n=1}^{10} \omega_n = 1$

$\omega_{1\cdot 1}^* + \sum_{n=0,n\neq 1}^{10} \omega_{1\cdot n}^* = 1$

$\omega_{k\cdot k}^* + \sum_{n=0,n\neq k}^{10} \omega_{k\cdot n}^* = 1$

$\Psi =$ marginal disutility of labor

φ_N = labor input elasticity in the non-traded sector of the Home economy

φ_{N1}^*= labor input elasticity in the non-traded sector of Foreign Country-1

φ_{Nk}^{*}= labor input elasticity in the non-traded sector of Foreign Country-k
φ_{T} = labor input elasticity in the traded sector of the Home economy
φ_{T1}^{*}= labor input elasticity in the traded sector of Foreign Country-1
φ_{Tk}^{*}= labor input elasticity in the traded sector of Foreign Country-k

v = income elasticity of money demand in the Home economy
v_1^{*} = income elasticity of money demand in Foreign Country-1
v_k^{*} = income elasticity of money demand in Foreign Country-k

- Calibrated Parameters

$\text{ƅ}_1 =$ parameter for shock from the non-traded sector in the Home economy's non-traded sector equation

$\text{ƅ}_2 =$ parameter for shock from the traded sector in the Home economy's non-traded sector equation

$\varrho_1 =$ parameter for shock from the non-traded sector in the Home economy's traded sector equation

$\varrho_2 =$ parameter for shock from the traded sector in the Home economy's traded sector equation

- Estimated Parameters

θ_N = elasticity of substitution between differentiated products in the non-traded sector of the Home economy

θ_{N1}^{*}= elasticity of substitution between differentiated products in the non-traded sector of Foreign Country-1

θ_{Nk}^{*}= elasticity of substitution between differentiated products in the non-traded sector of Foreign Country-k

θ_T = elasticity of substitution between differentiated products in the traded sector

θ_{T1}^{*}= elasticity of substitution between differentiated products in the traded sector of the Foreign Country-1

θ_{Tk}^{*}= elasticity of substitution between differentiated products in the traded sector of the Foreign Country-k

κ_N = responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector

κ_{N1}^{*}= responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector of Foreign Country-1

κ_{Nk}^{*}= responsiveness of pricing decisions to variations in the real marginal cost gaps of the non-traded sector of Foreign Country-k

κ_T = responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector

κ_{T1}^{*}= responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector of Foreign Country-1

κ_{Tk}^{*}= responsiveness of pricing decisions to variations in the real marginal cost gaps of the traded sector of Foreign Country-k

- **Variables**

- Productivity and Exchange Rate Shocks

A_{Nt} = productivity shock in the non-traded sector in period t

A_{Tt} = productivity shocks in the traded sector in period t

$\hat{a}_{Nt}$ = log-linearized productivity shock in the non-traded sector of the Home economy in period t

$\hat{a}^*_{N1t}$ = log-linearized productivity shock in the non-traded sector of Foreign Country-1 in period t

…

$\hat{a}^*_{N10t}$= log-linearized productivity shock in the non-traded sector of Foreign Country-10 in period t

$\hat{a}_{Tt}$ = log-linearized productivity shock in the traded sector of the Home economy in period t

$\hat{a}^*_{T1t}$ = log-linearized productivity shock in the traded sector of Foreign Country-1 in period t

…

$\hat{a}^*_{T10t}$= log-linearized productivity shock in the traded sector of Foreign Country-10 in period t

ε_{Nt} = error term in the productivity shock equation for the non-traded sector of the Home economy in period t

ε^*_{N1t} = error term in the productivity shock equation for the non-traded sector of Foreign Country-1 in period t

…

ε^*_{N10t} = error term in the productivity shock equation for the non-traded sector of Foreign Country-10 in period t

ε_{Tt} = error term in the productivity shock equation for the traded sector of the Home economy in period t

ε^*_{T1t} = error term in the productivity shock equation for traded sector of Foreign Country-1 in period t

…

ε^*_{T10t} = error term in the productivity shock equation for traded sector of Foreign Country-10 in period t

u_t = log-linearized global exchange rate shock felt by all countries

- Representative Households in the Home Economy
(Analogously for Foreign Countries)

C_t = household's consumption of final goods in period t

$\check{C}_t$ = self-purchased household's consumption in period t

$\check{C}_{Nt}$ = self-purchased household's consumption of non-traded goods

$\check{C}_{Tt}$ = self-purchased household's consumption of traded goods in period t

$\check{C}_{Ht}$ = self-purchased household's consumption of domestically-produced traded goods in period t

$\check{C}_{Fnt}$ = self-purchased household's consumption of imported traded goods from Foreign Country-n in period t $(\check{C}_{Fnt})$

G_t = household's consumption of government-provided-goods in period t

$\frac{M_t}{P_t}$ = real money demand in period t

W_t = nominal wage in period t

L_t = labor supply (in ratio of working hours to total hours per week) in period t

TR_t = transfers from the government in period t

K_t = capital (in nominal amount) in period t

δ = capital rate of depreciation

R_t^{kap} = rent rate of capital

B_t = nominal amount of domestic government bonds held by household in period t

B_{nt}^* = nominal amount of Foreign Country-n government bonds held household in period t

R_t = nominal interest rate of bond in period t

t_L = income tax

t_C = consumption tax

P_t = aggregate price level in period t

$\bar{P}_{Nt}$ = price index of non-traded goods in period t

$\bar{P}_{Tt}$ = price index of traded goods in period t

$\bar{P}_{Ht}$ = price index of domestically-produced traded goods in period t

e_{nt} = exchange rate of domestic currency per currency of Foreign Country-n in period t

$e_{nt}\,\bar{P}_{Fnt}^*$ = price index of imported traded goods from Foreign Country-n measured in domestic currency in period t

- ***Representative Firms (Analogously for Foreign Countries)***

+ *Intermediate Goods Producers*

$Y_{Nt}(i)$ = non-traded intermediate good i produced in the Home economy in period t

$Y_{Tt}(j)$ = traded intermediate goods j produced in the Home economy in period t

$Y_{Ht}(j)$ = domestically produced traded intermediate goods sold in the Home economy in period t

$Y_{Hnt}^*(j)$ = domestically produced traded intermediate goods exported to Foreign Country-n in period t

$L_{NIt}(i)$= labor input for firm producing non-traded intermediate good i in period t

$K_{NIt}(i)$ = capital input for firm producing non-traded intermediate good i in period t

γ_N = probability of non-traded intermediate good i producer to keep output price unchanged

τ_N = government subsidy for firm producing non-traded intermediate good i

V_{NIt} = unit cost of firm producing non-traded intermediate good i in period t

$L_{TIt}(j)$ = labor input for firm producing traded intermediate good j in period t

$K_{TIt}(j)$ = capital input for firm producing traded intermediate good j in period t

γ_T = probability traded intermediate good j producer to keep output price unchanged

τ_T = government subsidy for firm producing traded intermediate good j
V_{TIt} = unit cost of firm producing traded intermediate good j in period t

+ Final Goods Producers
Y_{Nt} = aggregate demand for non-traded final goods in the Home economy period t
Y_{Tt} = aggregate demand for traded final goods in the Home economy in period t
Y_{Ht} = demand for domestically produced traded final goods in the Home economy in period t
Y_{Fnt} = demand for imported traded final goods from Foreign Country-n sold in the Home economy in period t
L_{NCt}= labor input for firm producing non-traded final goods in period t
K_{NCt} = capital input for firm producing non-traded final good in period t
V_{NCt} = unit cost of firm producing non-traded final good in period t
L_{TCt}= labor input for firm producing traded final goods in period t
K_{TCt} = capital input for firm producing traded final good in period t
V_{TCt} = unit cost of firm producing traded final good in period t

- Government or Supranational Planner Exercising Fiscal Policy (Analogously for Foreign Countries)
L_N = labor supply in the non-traded sector of the Home economy at the steady state
L_T = labor supply in the traded sector of the Home economy at the steady state
L = total labor supply in the Home economy at the steady state
Y_N = traded sector output (final goods) in the Home at the steady state
Y_T = traded sector output (final goods) in the Home at the steady state
Y^*_{Tn} = traded sector output in Foreign Country-n at the steady state
$\frac{M}{P}$ = real money demand at the steady state
G_{Nt} = government spending to provide non-traded final goods for households in period t
= household's consumption of government-provided non-traded final goods in period t
G_{Tt} = government spending to provide traded final goods for households in period t
= household's consumption of government-provided traded final goods in period t
G_{Ht} = government spending on domestically produced final goods for households in period t
G_{Fnt} = government spending to import traded final goods from Foreign Country-n for households in period t

- Central Bank or Supranational Planner Exercising Fiscal Policy (Analogously for Foreign Countries)
$\tilde{y}_{Nt}$ = output gap in the non-traded sector of the Home economy in period t
$\tilde{y}_T$ = output gap in the traded sector of the Home economy in period t
π_{Nt} = inflation in the non-traded sector of the Home economy in period t
π_{Ht} = inflation in the traded sector of the Home economy in period t
$\hat{r}_t$ = nominal interest rate gap in the Home economy in period t
$LOSS_t$ = loss function of central bank (supranational planner) of the Home economy in period t
TIP = terms independent of policy and shocks for the Home economy

$O(\|\xi\|^3)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for the home economy

$\tilde{y}^*_{N1t}$ = output gap in the non-traded sector of Foreign Country-1 in period t

$\tilde{y}^*_{T1t}$ = output gap in the traded sector of Foreign Country-1 in period t

π^*_{N1t} = inflation in the non-traded sector of Foreign Country-1 in period t

π^*_{H1t} = inflation in the traded sector of Foreign Country-1 in period t

$\hat{r}^*_{1t}$ = nominal interest rate gap in Foreign Country-1 in period t

$LOSS^*_{1t}$ = loss function of central bank (supranational planner) of Foreign Country-1 in period t

TIP^*_{1t} = terms independent of policy and shocks for Foreign Country-1

$O^*_1(\|\xi_1^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-1

$\tilde{y}^*_{Nkt}$ = output gap in the non-traded sector of Foreign Country-k in period t

$\tilde{y}^*_{Tkt}$ = output gap in the traded sector of Foreign Country-k in period t

π^*_{Nkt} = inflation in the non-traded sector of Foreign Country-k in period t

π^*_{Hkt} = inflation in the traded sector of Foreign Country-k in period t

$\hat{r}^*_{kt}$ = nominal interest rate gap in Foreign Country-k in period t

$LOSS^*_{kt}$ = loss function of central bank (supranational planner) of Foreign Country-k in period t

TIP^*_{kt} = terms independent of policy and shocks for Foreign Country-k

$O^*_k(\|\xi_k^{*3}\|)$ = terms that are of third or higher order in an appropriate bound on the amplitude of the shocks for Foreign Country-k

- ***Market Clearing Conditions, Natural Rate Equilibrium, and Sticky Price Equilibrium***

R_t^{nat} = natural nominal interest rate of the Home economy in period t

${R^*_{nt}}^{nat}$ = natural nominal interest rate of Foreign Country-n in period t

${\hat{e}_{nt}}^{nat}$ = natural exchange rate gap of the Home economy in period t

$E_t\ \hat{e}^{nat}_{nt+1}$ = expected natural exchange rate gap of the Home economy in period t+1

${\hat{s}_{nt}}^{nat}$ = natural rate of the terms of trade of Home economy with Foreign Country-n ($\hat{s}^{nat}_{nt}$) in period t

$E_t\hat{s}^{nat}_{nt+1}$ = natural rate of the terms of trade of Home economy with Foreign Country-n ($\hat{s}^{nat}_{nt}$) in period t+1

$♀_t$ = real effective exchange rate of the Home economy in period t

$\hat{y}^{nat}_{Nt}$ = natural rate of non-traded output in period t

$\hat{y}^{nat}_{Tt}$ = natural rate of traded output in period t

$\hat{l}^{nat}_{Nt}$ = natural labor input gap in the non-traded sector in period t

$\hat{k}^{nat}_{Nt}$ = natural capital input gap in the non-traded sector in period t

$\hat{l}^{nat}_{Tt}$ = natural labor input gap in the traded sector in period t

$\hat{k}^{nat}_{Tt}$ = natural capital input gap in the traded sector in period t

${\hat{c}_t^A}^{nat}$ = natural rate of aggregate domestic demand in period t

$\widehat{rr}^{nat}_t$ = natural real interest rate gap in period t

$\hat{q}^{nat}_{Nt}$ = natural gap of relative price of non-traded goods in terms of traded goods in period t

APPENDIX 5.2.

Estimated Posterior Means and Standard Deviations of Parameters Under Different Policy Interaction Regimes

(1) Indonesia

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.758	34.999	11.295	10.405	0.480	0.051	0.535	0.525
Bilateral coordination								
with Malaysia	8.749	34.999	11.307	10.411	0.466	0.050	0.543	0.507
with Singapore	8.745	34.999	11.306	10.413	0.475	0.049	0.535	0.504
with Thailand	8.747	34.999	11.309	10.414	0.475	0.049	0.528	0.528
with the Philippines	8.749	34.999	11.304	10.411	0.474	0.051	0.536	0.518
with China	8.746	34.999	11.296	10.407	0.477	0.049	0.528	0.516
with Japan	8.747	34.999	11.306	10.405	0.469	0.050	0.540	0.512
with South Korea	8.754	34.999	11.303	10.409	0.471	0.049	0.547	0.512
Multilateral coordination								
in ASEAN-5	8.751	34.999	11.312	10.408	0.465	0.049	0.511	0.529
in ASEAN-5 + China	8.746	34.999	11.309	10.397	0.463	0.051	0.552	0.506
in ASEAN-5 + Japan	8.760	34.999	11.314	10.413	0.481	0.049	0.531	0.534
in ASEAN-5 + S. Korea	8.767	35.000	11.286	10.397	0.475	0.048	0.523	0.510
in ASEAN-5 + 3	8.755	35.000	11.296	10.409	0.440	0.051	0.543	0.505

Source: Author's calculation

(2) Malaysia

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.703	34.999	11.374	10.003	0.464	0.050	0.537	0.049
Bilateral coordination								
with Indonesia	8.703	34.999	11.376	10.013	0.456	0.049	0.511	0.099
with Singapore	8.702	35.000	11.378	10.012	0.463	0.049	0.524	0.101
with Thailand	8.696	34.999	11.375	10.012	0.481	0.048	0.551	0.100
with the Philippines	8.703	34.999	11.374	10.011	0.466	0.049	0.527	0.100
with China	8.695	34.998	11.375	10.011	0.480	0.050	0.541	0.104
with Japan	8.692	34.999	11.362	10.012	0.475	0.049	0.544	0.100
with South Korea	8.693	35.000	11.371	10.013	0.449	0.049	0.539	0.102
Multilateral coordination								
in ASEAN-5	8.708	34.998	11.391	10.012	0.462	0.051	0.559	0.101
in ASEAN-5 + China	8.707	34.998	11.358	10.014	0.455	0.050	0.529	0.091
in ASEAN-5 + Japan	8.709	34.998	11.364	10.011	0.426	0.050	0.515	0.096
in ASEAN-5 + S. Korea	8.694	34.997	11.380	10.013	0.457	0.048	0.503	0.101
in ASEAN-5 + 3	8.683	34.998	11.387	10.010	0.467	0.048	0.565	0.093

Source: Author's calculation

(3) Singapore

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.608	34.999	11.462	10.135	0.465	0.049	0.551	0.513
Bilateral coordination								
with Indonesia	8.611	34.999	11.458	10.132	0.460	0.048	0.530	0.511
with Malaysia	8.623	35.000	11.461	10.142	0.451	0.051	0.536	0.514
with Thailand	8.605	34.999	11.456	10.136	0.459	0.050	0.536	0.504
with the Philippines	8.611	34.999	11.462	10.137	0.476	0.050	0.536	0.520
with China	8.606	35.000	11.459	10.123	0.457	0.050	0.538	0.502
with Japan	8.608	35.000	11.457	10.139	0.462	0.050	0.527	0.508
with South Korea	8.611	35.000	11.459	10.140	0.466	0.050	0.532	0.503
Multilateral coordination								
in ASEAN-5	8.610	35.000	11.460	10.126	0.451	0.050	0.523	0.502
in ASEAN-5 + China	8.601	34.998	11.453	10.127	0.480	0.051	0.515	0.479
in ASEAN-5 + Japan	8.605	34.998	11.468	10.136	0.454	0.051	0.540	0.518
in ASEAN-5 + S. Korea	8.599	34.999	11.468	10.111	0.490	0.049	0.533	0.489
in ASEAN-5 + 3	8.607	34.999	11.470	10.132	0.476	0.048	0.539	0.515

Source: Author's calculation

(4) Thailand

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.660	34.999	11.398	10.233	0.459	0.050	0.539	0.508
Bilateral coordination								
with Indonesia	8.663	34.999	11.394	10.247	0.466	0.049	0.545	0.504
with Malaysia	8.677	34.999	11.399	10.243	0.450	0.050	0.545	0.511
with Singapore	8.667	35.000	11.396	10.010	0.454	0.051	0.524	0.099
with the Philippines	8.656	35.000	11.406	10.235	0.452	0.050	0.526	0.510
with China	8.660	35.000	11.394	10.242	0.467	0.051	0.538	0.512
with Japan	8.661	34.999	11.408	10.246	0.467	0.051	0.532	0.527
with South Korea	8.660	35.000	11.400	10.245	0.479	0.050	0.530	0.532
Multilateral coordination								
in ASEAN-5	8.656	34.998	11.391	10.241	0.435	0.049	0.543	0.504
in ASEAN-5 + China	8.664	34.998	11.398	10.236	0.469	0.049	0.530	0.502
in ASEAN-5 + Japan	8.650	34.999	11.402	10.248	0.469	0.049	0.514	0.501
in ASEAN-5 + S. Korea	8.666	34.999	11.400	10.245	0.457	0.049	0.515	0.533
in ASEAN-5 + 3	8.652	35.000	11.382	10.242	0.486	0.049	0.509	0.492

Source: Author’s calculation

(5) The Philippines

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.660	34.999	11.405	10.252	0.454	0.050	0.529	0.500
Bilateral coordination								
with Indonesia	8.656	34.999	11.412	10.248	0.468	0.049	0.550	0.505
with Malaysia	8.654	34.999	11.409	10.257	0.478	0.050	0.539	0.496
with Singapore	8.652	34.999	11.409	10.248	0.474	0.048	0.545	0.504
with Thailand	8.653	35.000	11.398	10.259	0.472	0.051	0.542	0.510
with China	8.653	34.999	11.406	10.255	0.478	0.051	0.544	0.515
with Japan	8.648	35.000	11.399	10.248	0.464	0.052	0.537	0.525
with South Korea	8.647	34.996	11.400	10.245	0.472	0.103	0.523	0.513
Multilateral coordination								
in ASEAN-5	8.653	34.998	11.399	10.239	0.462	0.048	0.522	0.517
in ASEAN-5 + China	8.666	34.999	11.405	10.262	0.469	0.050	0.523	0.539
in ASEAN-5 + Japan	8.659	35.001	11.412	10.250	0.443	0.050	0.512	0.509
in ASEAN-5 + S. Korea	8.666	34.999	11.403	10.256	0.424	0.051	0.555	0.512
in ASEAN-5 + 3	8.651	35.001	11.400	10.243	0.487	0.048	0.524	0.532

Source: Author’s calculation

(6) China

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.914	34.999	11.136	10.402	0.466	0.050	0.534	0.531
Bilateral coordination								
with Indonesia	8.917	35.000	11.133	10.402	0.480	0.050	0.513	0.515
with Malaysia	8.916	34.999	11.141	10.405	0.488	0.050	0.543	0.514
with Singapore	8.914	34.999	11.142	10.402	0.481	0.049	0.539	0.506
with Thailand	8.915	34.999	11.139	10.409	0.478	0.050	0.526	0.509
with the Philippines	8.916	34.999	11.127	10.403	0.483	0.050	0.531	0.507
with Japan	8.913	34.999	11.135	10.401	0.468	0.050	0.540	0.525
with South Korea	8.916	34.999	11.135	10.412	0.475	0.050	0.544	0.516
Multilateral coordination								
in CJK	8.916	34.999	11.129	10.393	0.461	0.049	0.536	0.509
in ASEAN-5 + China	8.899	34.998	11.141	10.396	0.464	0.048	0.529	0.512
in ASEAN-5 + 3	8.920	34.998	11.144	10.407	0.493	0.049	0.556	0.508

Source: Author’s calculation

(7) Japan

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.659	34.999	11.411	10.282	0.463	0.050	0.542	0.508
Bilateral coordination								
with Indonesia	8.658	34.999	11.421	10.280	0.479	0.050	0.548	0.523
with Malaysia	8.656	35.000	11.417	10.289	0.458	0.051	0.527	0.504
with Singapore	8.656	34.999	11.415	10.282	0.454	0.051	0.546	0.518
with Thailand	8.652	34.999	11.419	10.291	0.458	0.050	0.534	0.525
with the Philippines	8.659	35.000	11.415	10.289	0.476	0.049	0.518	0.503
with China	8.661	34.999	11.416	10.293	0.474	0.049	0.528	0.511
with South Korea	8.653	35.001	11.410	10.286	0.469	0.049	0.538	0.506
Multilateral coordination								
in CJK	8.649	34.999	11.404	10.285	0.468	0.050	0.534	0.505
in ASEAN-5 + Japan	8.645	34.998	11.410	10.267	0.461	0.051	0.508	0.499
in ASEAN-5 + 3	8.661	34.998	11.411	10.292	0.421	0.049	0.522	0.493

Source: Author's calculation

(8) South Korea

	Posterior Means				Posterior Standard Deviations			
	κ_N	κ_T	θ_N	θ_T	σ_{κ_N}	σ_{κ_T}	σ_{θ_N}	σ_{θ_T}
No coordination	8.662	35.000	11.407	10.249	0.457	0.050	0.512	0.512
Bilateral coordination								
with Indonesia	8.677	34.999	11.416	10.251	0.452	0.048	0.520	0.504
with Malaysia	8.669	34.999	11.411	10.251	0.468	0.048	0.550	0.520
with Singapore	8.667	35.000	11.409	10.249	0.449	0.049	0.513	0.491
with Thailand	8.675	34.999	11.407	10.245	0.476	0.049	0.557	0.511
with the Philippines	8.682	34.997	11.418	10.247	0.466	0.102	0.547	0.512
with China	8.666	34.999	11.407	10.243	0.485	0.048	0.529	0.498
with Japan	8.671	34.999	11.417	10.247	0.477	0.050	0.540	0.520
Multilateral coordination								
in CJK	8.670	34.999	11.405	10.245	0.459	0.050	0.546	0.503
in ASEAN-5 + S. Korea	8.679	34.998	11.416	10.226	0.441	0.050	0.532	0.522
in ASEAN-5 + 3	8.663	35.002	11.414	10.258	0.479	0.050	0.565	0.537

Source: Author’s calculation

APPENDIX 5.3.
Z-test Results of Parameters Under Different Policy Regimes

(H0: No difference between means of the two populations; H1: otherwise. $\alpha = 5\%$)

(1) Indonesia

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
ID_NC vs. ID_MY	ID_NC vs. ID_MY	ID_NC vs. ID_MY	ID_NC vs. ID_MY
ID_NC vs. ID_SG	ID_NC vs. ID_SG*	ID_NC vs. ID_SG	ID_NC vs. ID_SG
ID_NC vs. ID_TH	ID_NC vs. ID_TH	ID_NC vs. ID_TH	ID_NC vs. ID_TH
ID_NC vs. ID_PH	ID_NC vs. ID_PH*	ID_NC vs. ID_PH	ID_NC vs. ID_PH
ID_NC vs. ID_CN	ID_NC vs. ID_CN	ID_NC vs. ID_CN*	ID_NC vs. ID_CN*
ID_NC vs. ID_JP	ID_NC vs. ID_JP*	ID_NC vs. ID_JP	ID_NC vs. ID_JP*
ID_NC vs. ID_SK*	ID_NC vs. ID_SK	ID_NC vs. ID_SK	ID_NC vs. ID_SK*

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
ID_NC vs. ASEAN-5	ID_NC vs. ASEAN-5*	ID_NC vs. ASEAN-5	ID_NC vs. ASEAN-5*
ID_NC vs. ASEAN-5+CN	ID_NC vs. ASEAN-5+CN	ID_NC vs. ASEAN-5+CN	ID_NC vs. ASEAN-5+CN
ID_NC vs. ASEAN-5+JP*	ID_NC vs. ASEAN-5+JP*	ID_NC vs. ASEAN-5+JP	ID_NC vs. ASEAN-5+JP
ID_NC vs. ASEAN-5+SK	ID_NC vs. ASEAN-5+SK	ID_NC vs. ASEAN-5+SK	ID_NC vs. ASEAN-5+SK
ID_NC vs. ASEAN-5 + 3*	ID_NC vs. ASEAN-5 + 3	ID_NC vs. ASEAN-5 + 3*	ID_NC vs. ASEAN-5 + 3*

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
ID_MY vs. ASEAN-5*	ID_MY vs. ASEAN-5*	ID_MY vs. ASEAN-5	ID_MY vs. ASEAN-5*
ID_SG vs. ASEAN-5	ID_SG vs. ASEAN-5*	ID_SG vs. ASEAN-5	ID_SG vs. ASEAN-5
ID_TH vs. ASEAN-5*	ID_TH vs. ASEAN-5*	ID_TH vs. ASEAN-5*	ID_TH vs. ASEAN-5
ID_PH vs. ASEAN-5*	ID_PH vs. ASEAN-5*	ID_PH vs. ASEAN-5	ID_PH vs. ASEAN-5*
ID_CN vs. ASEAN-5	ID_CN vs. ASEAN-5*	ID_CN vs. ASEAN-5	ID_CN vs. ASEAN-5*
ID_JP vs. ASEAN-5*	ID_JP vs. ASEAN-5*	ID_JP vs. ASEAN-5	ID_JP vs. ASEAN-5*
ID_SK vs. ASEAN-5*	ID_SK vs. ASEAN-5*	ID_SK vs. ASEAN-5	ID_SK vs. ASEAN-5*
ID_MY vs. ASEAN-5+CN*	ID_MY vs. ASEAN-5+CN*	ID_MY vs. ASEAN-5+CN*	ID_MY vs. ASEAN-5+CN
ID_SG vs. ASEAN-5+CN*	ID_SG vs. ASEAN-5+CN	ID_SG vs. ASEAN-5+CN*	ID_SG vs. ASEAN-5+CN
ID_TH vs. ASEAN-5+CN*	ID_TH vs. ASEAN-5+CN*	ID_TH vs. ASEAN-5+CN*	ID_TH vs. ASEAN-5+CN
ID_PH vs. ASEAN-5+CN*	ID_PH vs. ASEAN-5+CN	ID_PH vs. ASEAN-5+CN*	ID_PH vs. ASEAN-5+CN
ID_CN vs. ASEAN-5+CN*	ID_CN vs. ASEAN-5+CN*	ID_CN vs. ASEAN-5+CN	ID_CN vs. ASEAN-5+CN
ID_JP vs. ASEAN-5+CN*	ID_JP vs. ASEAN-5+CN	ID_JP vs. ASEAN-5+CN*	ID_JP vs. ASEAN-5+CN
ID_SK vs. ASEAN-5+CN	ID_SK vs. ASEAN-5+CN*	ID_SK vs. ASEAN-5+CN	ID_SK vs. ASEAN-5+CN
ID_MY vs. ASEAN-5+JP	ID_MY vs. ASEAN-5+JP*	ID_MY vs. ASEAN-5+JP	ID_MY vs. ASEAN-5+JP*
ID_SG vs. ASEAN-5+JP	ID_SG vs. ASEAN-5+JP*	ID_SG vs. ASEAN-5+JP	ID_SG vs. ASEAN-5+JP*
ID_TH vs. ASEAN-5+JP	ID_TH vs. ASEAN-5+JP*	ID_TH vs. ASEAN-5+JP	ID_TH vs. ASEAN-5+JP*
ID_PH vs. ASEAN-5+JP	ID_PH vs. ASEAN-5+JP*	ID_PH vs. ASEAN-5+JP	ID_PH vs. ASEAN-5+JP*
ID_CN vs. ASEAN-5+JP	ID_CN vs. ASEAN-5+JP*	ID_CN vs. ASEAN-5+JP	ID_CN vs. ASEAN-5+JP
ID_JP vs. ASEAN-5+JP	ID_JP vs. ASEAN-5+JP*	ID_JP vs. ASEAN-5+JP	ID_JP vs. ASEAN-5+JP
ID_SK vs. ASEAN-5+JP	ID_SK vs. ASEAN-5+JP*	ID_SK vs. ASEAN-5+JP	ID_SK vs. ASEAN-5+JP*
ID_MY vs. ASEAN-5+SK	ID_MY vs. ASEAN-5+SK	ID_MY vs. ASEAN-5+SK	ID_MY vs. ASEAN-5+SK
ID_SG vs. ASEAN-5+SK	ID_SG vs. ASEAN-5+SK	ID_SG vs. ASEAN-5+SK	ID_SG vs. ASEAN-5+SK
ID_TH vs. ASEAN-5+SK	ID_TH vs. ASEAN-5+SK	ID_TH vs. ASEAN-5+SK	ID_TH vs. ASEAN-5+SK
ID_PH vs. ASEAN-5+SK	ID_PH vs. ASEAN-5+SK	ID_PH vs. ASEAN-5+SK	ID_PH vs. ASEAN-5+SK
ID_CN vs. ASEAN-5+SK	ID_CN vs. ASEAN-5+SK	ID_CN vs. ASEAN-5 + SK	ID_CN vs. ASEAN-5+SK
ID_JP vs. ASEAN-5+SK	ID_JP vs. ASEAN-5+SK	ID_JP vs. ASEAN-5+SK	ID_JP vs. ASEAN-5+SK
ID_SK vs. ASEAN-5+SK	ID_SK vs. ASEAN-5+SK	ID_SK vs. ASEAN-5+SK	ID_SK vs. ASEAN-5+SK
ID_MY vs. ASEAN-5 + 3	ID_MY vs. ASEAN-5 + 3	ID_MY vs. ASEAN-5 + 3	ID_MY vs. ASEAN-5 + 3&
ID_SG vs. ASEAN-5 + 3	ID_SG vs. ASEAN-5 + 3	ID_SG vs. ASEAN-5 + 3	ID_SG vs. ASEAN-5 + 3
ID_TH vs. ASEAN-5 + 3	ID_TH vs. ASEAN-5 + 3	ID_TH vs. ASEAN-5 + 3	ID_TH vs. ASEAN-5 + 3
ID_PH vs. ASEAN-5 + 3	ID_PH vs. ASEAN-5 + 3	ID_PH vs. ASEAN-5 + 3	ID_PH vs. ASEAN-5 + 3*
ID_CN vs. ASEAN-5 + 3	ID_CN vs. ASEAN-5 + 3	ID_CN vs. ASEAN-5 + 3*	ID_CN vs. ASEAN-5 + 3*
ID_JP vs. ASEAN-5 + 3	ID_JP vs. ASEAN-5 + 3	ID_JP vs. ASEAN-5 + 3	ID_JP vs. ASEAN-5 + 3*
ID_SK vs. ASEAN-5 + 3*	ID_SK vs. ASEAN-5 + 3	ID_SK vs. ASEAN-5 + 3	ID_SK vs. ASEAN-5 + 3*

Source: Author's calculation.   Note: * = H_0 accepted at $\alpha = 5\%$.

(2) Malaysia

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
MY_NC vs. MY_ID*	MY_NC vs. MY_ID*	MY_NC vs. MY_ID*	MY_NC vs. MY_ID
MY_NC vs. MY_SG*	MY_NC vs. MY_SG	MY_NC vs. MY_SG*	MY_NC vs. MY_SG
MY_NC vs. MY_TH	MY_NC vs. MY_TH*	MY_NC vs. MY_TH*	MY_NC vs. MY_TH
MY_NC vs. MY_PH*	MY_NC vs. MY_PH*	MY_NC vs. MY_PH*	MY_NC vs. MY_PH
MY_NC vs. MY_CN	MY_NC vs. MY_CN	MY_NC vs. MY_CN*	MY_NC vs. MY_CN
MY_NC vs. MY_JP	MY_NC vs. MY_JP*	MY_NC vs. MY_JP	MY_NC vs. MY_JP
MY_NC vs. MY_SK	MY_NC vs. MY_SK	MY_NC vs. MY_SK*	MY_NC vs. MY_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
MY_NC vs. ASEAN-5	MY_NC vs. ASEAN-5	MY_NC vs. ASEAN-5	MY_NC vs. ASEAN-5
MY_NC vs. ASEAN-5+CN*	MY_NC vs. ASEAN-5+CN	MY_NC vs. ASEAN-5+CN	MY_NC vs. ASEAN-5+CN
MY_NC vs. ASEAN-5+JP	MY_NC vs. ASEAN-5+JP	MY_NC vs. ASEAN-5+JP	MY_NC vs. ASEAN-5+JP
MY_NC vs. ASEAN-5+ SK	MY_NC vs. ASEAN-5+ SK	MY_NC vs. ASEAN-5+ SK	MY_NC vs. ASEAN-5+ SK
MY_NC vs. ASEAN-5 + 3	MY_NC vs. ASEAN-5 + 3*	MY_NC vs. ASEAN-5 + 3	MY_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
MY_ID vs. ASEAN-5	MY_ID vs. ASEAN-5	MY_ID vs. ASEAN-5	MY_ID vs. ASEAN-5
MY_SG vs. ASEAN-5	MY_SG vs. ASEAN-5	MY_SG vs. ASEAN-5	MY_SG vs. ASEAN-5*
MY_TH vs. ASEAN-5	MY_TH vs. ASEAN-5	MY_TH vs. ASEAN-5	MY_TH vs. ASEAN-5*
MY_PH vs. ASEAN-5	MY_PH vs. ASEAN-5	MY_PH vs. ASEAN-5	MY_PH vs. ASEAN-5*
MY_CN vs. ASEAN-5	MY_CN vs. ASEAN-5	MY_CN vs. ASEAN-5	MY_CN vs. ASEAN-5*
MY_JP vs. ASEAN-5	MY_JP vs. ASEAN-5	MY_JP vs. ASEAN-5	MY_JP vs. ASEAN-5*
MY_SK vs. ASEAN-5	MY_SK vs. ASEAN-5	MY_SK vs. ASEAN-5	MY_SK vs. ASEAN-5
MY_ID vs. ASEAN-5+CN	MY_ID vs. ASEAN-5+CN	MY_ID vs. ASEAN-5+CN	MY_ID vs. ASEAN-5+CN*
MY_SG vs. ASEAN-5+CN	MY_SG vs. ASEAN-5+CN	MY_SG vs. ASEAN-5+CN	MY_SG vs. ASEAN-5+CN
MY_TH vs. ASEAN-5+CN	MY_TH vs. ASEAN-5+CN	MY_TH vs. ASEAN-5+CN	MY_TH vs. ASEAN-5+CN
MY_PH vs. ASEAN-5+CN*	MY_PH vs. ASEAN-5+CN	MY_PH vs. ASEAN-5+CN	MY_PH vs. ASEAN-5+CN
MY_CN vs. ASEAN-5+CN	MY_CN vs. ASEAN-5+CN*	MY_CN vs. ASEAN-5+CN	MY_CN vs. ASEAN-5+CN
MY_JP vs. ASEAN-5+CN	MY_JP vs. ASEAN-5+CN	MY_JP vs. ASEAN-5+CN*	MY_JP vs. ASEAN-5+CN
MY_SK vs. ASEAN-5+CN	MY_SK vs. ASEAN-5+CN	MY_SK vs. ASEAN-5+CN	MY_SK vs. ASEAN-5+CN
MY_ID vs. ASEAN-5+JP	MY_ID vs. ASEAN-5+JP	MY_ID vs. ASEAN-5+JP	MY_ID vs. ASEAN-5+JP
MY_SG vs. ASEAN-5+JP	MY_SG vs. ASEAN-5+JP	MY_SG vs. ASEAN-5+JP	MY_SG vs. ASEAN-5+JP*
MY_TH vs. ASEAN-5+JP	MY_TH vs. ASEAN-5+JP	MY_TH vs. ASEAN-5+JP	MY_TH vs. ASEAN-5+JP*
MY_PH vs. ASEAN-5+JP	MY_PH vs. ASEAN-5+JP	MY_PH vs. ASEAN-5+JP	MY_PH vs. ASEAN-5+JP*
MY_CN vs. ASEAN-5+JP	MY_CN vs. ASEAN-5+JP*	MY_CN vs. ASEAN-5+JP	MY_CN vs. ASEAN-5+JP*
MY_JP vs. ASEAN-5+JP	MY_JP vs. ASEAN-5+JP	MY_JP vs. ASEAN-5+JP*	MY_JP vs. ASEAN-5+JP
MY_SK vs. ASEAN-5+JP	MY_SK vs. ASEAN-5+JP	MY_SK vs. ASEAN-5+JP	MY_SK vs. ASEAN-5+JP
MY_ID vs. ASEAN-5+SK	MY_ID vs. ASEAN-5+SK	MY_ID vs. ASEAN-5+SK*	MY_ID vs. ASEAN-5+SK*
MY_SG vs. ASEAN-5+SK	MY_SG vs. ASEAN-5+SK	MY_SG vs. ASEAN-5+SK*	MY_SG vs. ASEAN-5+SK*
MY_TH vs. ASEAN-5+SK*	MY_TH vs. ASEAN-5+SK	MY_TH vs. ASEAN-5+SK	MY_TH vs. ASEAN-5+SK
MY_PH vs. ASEAN-5+SK	MY_PH vs. ASEAN-5+SK	MY_PH vs. ASEAN-5+SK	MY_PH vs. ASEAN-5+SK
MY_CN vs. ASEAN-5+SK*	MY_CN vs. ASEAN-5+SK	MY_CN vs. ASEAN-5+SK*	MY_CN vs. ASEAN-5+SK
MY_JP vs. ASEAN-5+SK*	MY_JP vs. ASEAN-5+SK	MY_JP vs. ASEAN-5+SK	MY_JP vs. ASEAN-5+SK*
MY_SK vs. ASEAN-5+SK*	MY_SK vs. ASEAN-5+SK	MY_SK vs. ASEAN-5+SK	MY_SK vs. ASEAN-5+SK*
MY_ID vs. ASEAN-5 + 3	MY_ID vs. ASEAN-5 + 3	MY_ID vs. ASEAN-5 + 3	MY_ID vs. ASEAN-5 + 3
MY_SG vs. ASEAN-5 + 3	MY_SG vs. ASEAN-5 + 3	MY_SG vs. ASEAN-5 + 3	MY_SG vs. ASEAN-5 + 3
MY_TH vs. ASEAN-5 + 3	MY_TH vs. ASEAN-5 + 3	MY_TH vs. ASEAN-5 + 3	MY_TH vs. ASEAN-5 + 3
MY_PH vs. ASEAN-5 + 3	MY_PH vs. ASEAN-5 + 3	MY_PH vs. ASEAN-5 + 3	MY_PH vs. ASEAN-5 + 3
MY_CN vs. ASEAN-5 + 3	MY_CN vs. ASEAN-5 + 3*	MY_CN vs. ASEAN-5 + 3	MY_CN vs. ASEAN-5 + 3
MY_JP vs. ASEAN-5 + 3	MY_JP vs. ASEAN-5 + 3	MY_JP vs. ASEAN-5 + 3	MY_JP vs. ASEAN-5 + 3
MY_SK vs. ASEAN-5 + 3	MY_SK vs. ASEAN-5 + 3	MY_SK vs. ASEAN-5 + 3	MY_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(3) Singapore

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
SG_NC vs. SG_ID*	SG_NC vs. SG_ID*	SG_NC vs. SG_ID*	SG_NC vs. SG_ID*
SG_NC vs. SG_MY	SG_NC vs. SG_MY	SG_NC vs. SG_MY*	SG_NC vs. SG_MY
SG_NC vs. SG_TH*	SG_NC vs. SG_TH*	SG_NC vs. SG_TH	SG_NC vs. SG_TH*
SG_NC vs. SG_PH*	SG_NC vs. SG_PH*	SG_NC vs. SG_PH*	SG_NC vs. SG_PH*
SG_NC vs. SG_CN*	SG_NC vs. SG_CN	SG_NC vs. SG_CN*	SG_NC vs. SG_CN
SG_NC vs. SG_JP*	SG_NC vs. SG_JP	SG_NC vs. SG_JP*	SG_NC vs. SG_JP*
SG_NC vs. SG_SK*	SG_NC vs. SG_SK	SG_NC vs. SG_SK*	SG_NC vs. SG_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SG_NC vs. ASEAN-5*	SG_NC vs. ASEAN-5	SG_NC vs. ASEAN-5*	SG_NC vs. ASEAN-5
SG_NC vs. ASEAN-5 + CN	SG_NC vs. ASEAN-5 + CN	SG_NC vs. ASEAN-5 + CN	SG_NC vs. ASEAN-5+CN
SG_NC vs. ASEAN-5 + JP*	SG_NC vs. ASEAN-5 + JP	SG_NC vs. ASEAN-5 + JP	SG_NC vs. ASEAN-5+JP*
SG_NC vs. ASEAN-5 + SK	SG_NC vs. ASEAN-5 + SK*	SG_NC vs. ASEAN-5 + SK	SG_NC vs. ASEAN-5+ SK
SG_NC vs. ASEAN-5 + 3*	SG_NC vs. ASEAN-5 + 3*	SG_NC vs. ASEAN-5 + 3	SG_NC vs. ASEAN-5+3*

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SG_ID vs. ASEAN-5*	SG_ID vs. ASEAN-5*	SG_ID vs. ASEAN-5*	SG_ID vs. ASEAN-5
SG_MY vs. ASEAN-5	SG_MY vs. ASEAN-5*	SG_MY vs. ASEAN-5*	SG_MY vs. ASEAN-5
SG_TH vs. ASEAN-5	SG_TH vs. ASEAN-5*	SG_TH vs. ASEAN-5*	SG_TH vs. ASEAN-5
SG_PH vs. ASEAN-5*	SG_PH vs. ASEAN-5	SG_PH vs. ASEAN-5*	SG_PH vs. ASEAN-5
SG_CN vs. ASEAN-5*	SG_CN vs. ASEAN-5*	SG_CN vs. ASEAN-5*	SG_CN vs. ASEAN-5*
SG_JP vs. ASEAN-5*	SG_JP vs. ASEAN-5*	SG_JP vs. ASEAN-5*	SG_JP vs. ASEAN-5
SG_SK vs. ASEAN-5*	SG_SK vs. ASEAN-5*	SG_SK vs. ASEAN-5	SG_SK vs. ASEAN-5
SG_ID vs. ASEAN-5+CN	SG_ID vs. ASEAN-5+CN	SG_ID vs. ASEAN-5+CN*	SG_ID vs. ASEAN-5+CN*
SG_MY vs. ASEAN-5+CN	SG_MY vs. ASEAN-5+CN	SG_MY vs. ASEAN-5+CN	SG_MY vs. ASEAN-5+CN
SG_TH vs. ASEAN-5+CN*	SG_TH vs. ASEAN-5+CN	SG_TH vs. ASEAN-5+CN*	SG_TH vs. ASEAN-5+CN
SG_PH vs. ASEAN-5+CN	SG_PH vs. ASEAN-5+CN	SG_PH vs. ASEAN-5+CN	SG_PH vs. ASEAN-5+CN
SG_CN vs. ASEAN-5+CN	SG_CN vs. ASEAN-5+CN	SG_CN vs. ASEAN-5+CN	SG_CN vs. ASEAN-5+CN
SG_JP vs. ASEAN-5+CN	SG_JP vs. ASEAN-5+CN	SG_JP vs. ASEAN-5+CN*	SG_JP vs. ASEAN-5+CN
SG_SK vs. ASEAN-5+CN	SG_SK vs. ASEAN-5+CN	SG_SK vs. ASEAN-5+CN	SG_SK vs. ASEAN-5+CN
SG_ID vs. ASEAN-5+JP	SG_ID vs. ASEAN-5+JP	SG_ID vs. ASEAN-5+JP	SG_ID vs. ASEAN-5+JP*
SG_MY vs. ASEAN-5+JP	SG_MY vs. ASEAN-5+JP	SG_MY vs. ASEAN-5+JP	SG_MY vs. ASEAN-5+JP
SG_TH vs. ASEAN-5+JP*	SG_TH vs. ASEAN-5+JP	SG_TH vs. ASEAN-5+JP	SG_TH vs. ASEAN-5+JP*
SG_PH vs. ASEAN-5+JP	SG_PH vs. ASEAN-5+JP	SG_PH vs. ASEAN-5+JP	SG_PH vs. ASEAN-5+JP*
SG_CN vs. ASEAN-5+JP*	SG_CN vs. ASEAN-5+JP	SG_CN vs. ASEAN-5+JP	SG_CN vs. ASEAN-5+JP
SG_JP vs. ASEAN-5+JP*	SG_JP vs. ASEAN-5+JP	SG_JP vs. ASEAN-5+JP	SG_JP vs. ASEAN-5+JP*
SG_SK vs. ASEAN-5+JP	SG_SK vs. ASEAN-5+JP	SG_SK vs. ASEAN-5+JP	SG_SK vs. ASEAN-5+JP*
SG_ID vs. ASEAN-5+SK	SG_ID vs. ASEAN-5+SK*	SG_ID vs. ASEAN-5+SK	SG_ID vs. ASEAN-5+SK
SG_MY vs. ASEAN-5+SK	SG_MY vs. ASEAN-5+SK	SG_MY vs. ASEAN-5+SK	SG_MY vs. ASEAN-5+SK
SG_TH vs. ASEAN-5+SK	SG_TH vs. ASEAN-5+SK*	SG_TH vs. ASEAN-5+SK	SG_TH vs. ASEAN-5+SK
SG_PH vs. ASEAN-5+SK	SG_PH vs. ASEAN-5+SK*	SG_PH vs. ASEAN-5+SK	SG_PH vs. ASEAN-5+SK
SG_CN vs. ASEAN-5+SK	SG_CN vs. ASEAN-5+SK	SG_CN vs. ASEAN-5+SK	SG_CN vs. ASEAN-5+SK
SG_JP vs. ASEAN-5+SK	SG_JP vs. ASEAN-5+SK	SG_JP vs. ASEAN-5+SK	SG_JP vs. ASEAN-5+SK
SG_SK vs. ASEAN-5+SK	SG_SK vs. ASEAN-5+SK	SG_SK vs. ASEAN-5+SK	SG_SK vs. ASEAN-5+SK
SG_ID vs. ASEAN-5 + 3	SG_ID vs. ASEAN-5 + 3*	SG_ID vs. ASEAN-5 + 3	SG_ID vs. ASEAN-5 + 3*
SG_MY vs. ASEAN-5 + 3	SG_MY vs. ASEAN-5 + 3	SG_MY vs. ASEAN-5 + 3	SG_MY vs. ASEAN-5 + 3
SG_TH vs. ASEAN-5 + 3*	SG_TH vs. ASEAN-5 + 3*	SG_TH vs. ASEAN-5 + 3	SG_TH vs. ASEAN-5 + 3*
SG_PH vs. ASEAN-5 + 3*	SG_PH vs. ASEAN-5 + 3*	SG_PH vs. ASEAN-5 + 3	SG_PH vs. ASEAN-5 + 3*
SG_CN vs. ASEAN-5 + 3*	SG_CN vs. ASEAN-5 + 3	SG_CN vs. ASEAN-5 + 3	SG_CN vs. ASEAN-5 + 3
SG_JP vs. ASEAN-5 + 3*	SG_JP vs. ASEAN-5 + 3	SG_JP vs. ASEAN-5 + 3	SG_JP vs. ASEAN-5 + 3
SG_SK vs. ASEAN-5 + 3	SG_SK vs. ASEAN-5 + 3	SG_SK vs. ASEAN-5 + 3	SG_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(4) Thailand

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
TH_NC vs. TH_ID*	TH_NC vs. TH_ID	TH_NC vs. TH_ID*	TH_NC vs. TH_ID
TH_NC vs. TH_MY	TH_NC vs. TH_MY*	TH_NC vs. TH_MY*	TH_NC vs. TH_MY
TH_NC vs. TH_SG	TH_NC vs. TH_SG	TH_NC vs. TH_SG*	TH_NC vs. TH_SG
TH_NC vs. TH_PH	TH_NC vs. TH_PH	TH_NC vs. TH_PH	TH_NC vs. TH_PH*
TH_NC vs. TH_CN*	TH_NC vs. TH_CN	TH_NC vs. TH_CN	TH_NC vs. TH_CN
TH_NC vs. TH_JP*	TH_NC vs. TH_JP*	TH_NC vs. TH_JP	TH_NC vs. TH_JP
TH_NC vs. TH_SK*	TH_NC vs. TH_SK	TH_NC vs. TH_SK*	TH_NC vs. TH_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
TH_NC vs. ASEAN-5	TH_NC vs. ASEAN-5	TH_NC vs. ASEAN-5	TH_NC vs. ASEAN-5
TH_NC vs. ASEAN-5+CN*	TH_NC vs. ASEAN-5+CN	TH_NC vs. ASEAN-5+CN*	TH_NC vs. ASEAN-5+CN*
TH_NC vs. ASEAN-5+JP	TH_NC vs. ASEAN-5+JP*	TH_NC vs. ASEAN-5+JP*	TH_NC vs. ASEAN-5+JP
TH_NC vs. ASEAN-5+SK	TH_NC vs. ASEAN-5+SK*	TH_NC vs. ASEAN-5+SK*	TH_NC vs. ASEAN-5+SK
TH_NC vs. ASEAN-5 + 3	TH_NC vs. ASEAN-5 + 3*	TH_NC vs. ASEAN-5 + 3	TH_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
TH_ID vs. ASEAN-5	TH_ID vs. ASEAN-5*	TH_ID vs. ASEAN-5*	TH_ID vs. ASEAN-5
TH_MY vs. ASEAN-5	TH_MY vs. ASEAN-5	TH_MY vs. ASEAN-5	TH_MY vs. ASEAN-5*
TH_SG vs. ASEAN-5	TH_SG vs. ASEAN-5	TH_SG vs. ASEAN-5	TH_SG vs. ASEAN-5
TH_PH vs. ASEAN-5*	TH_PH vs. ASEAN-5	TH_PH vs. ASEAN-5	TH_PH vs. ASEAN-5
TH_CN vs. ASEAN-5	TH_CN vs. ASEAN-5	TH_CN vs. ASEAN-5*	TH_CN vs. ASEAN-5*
TH_JP vs. ASEAN-5	TH_JP vs. ASEAN-5	TH_JP vs. ASEAN-5	TH_JP vs. ASEAN-5
TH_SK vs. ASEAN-5*	TH_SK vs. ASEAN-5	TH_SK vs. ASEAN-5	TH_SK vs. ASEAN-5*
TH_ID vs. ASEAN-5+CN*	TH_ID vs. ASEAN-5+CN	TH_ID vs. ASEAN-5+CN*	TH_ID vs. ASEAN-5+CN
TH_MY vs. ASEAN-5+CN	TH_MY vs. ASEAN-5+CN	TH_MY vs. ASEAN-5+CN*	TH_MY vs. ASEAN-5+CN
TH_SG vs. ASEAN-5+CN*	TH_SG vs. ASEAN-5+CN	TH_SG vs. ASEAN-5+CN*	TH_SG vs. ASEAN-5+CN
TH_PH vs. ASEAN-5+CN	TH_PH vs. ASEAN-5+CN	TH_PH vs. ASEAN-5+CN	TH_PH vs. ASEAN-5+CN*
TH_CN vs. ASEAN-5+CN*	TH_CN vs. ASEAN-5+CN	TH_CN vs. ASEAN-5+CN*	TH_CN vs. ASEAN-5+CN
TH_JP vs. ASEAN-5+CN*	TH_JP vs. ASEAN-5+CN	TH_JP vs. ASEAN-5+CN	TH_JP vs. ASEAN-5+CN
TH_SK vs. ASEAN-5+CN*	TH_SK vs. ASEAN-5+CN	TH_SK vs. ASEAN-5+CN*	TH_SK vs. ASEAN-5+CN
TH_ID vs. ASEAN-5+JP	TH_ID vs. ASEAN-5+JP*	TH_ID vs. ASEAN-5+JP	TH_ID vs. ASEAN-5+JP*
TH_MY vs. ASEAN-5+JP	TH_MY vs. ASEAN-5+JP*	TH_MY vs. ASEAN-5+JP*	TH_MY vs. ASEAN-5+JP*
TH_SG vs. ASEAN-5+JP	TH_SG vs. ASEAN-5+JP	TH_SG vs. ASEAN-5+JP	TH_SG vs. ASEAN-5+JP
TH_PH vs. ASEAN-5+JP	TH_PH vs. ASEAN-5+JP	TH_PH vs. ASEAN-5+JP*	TH_PH vs. ASEAN-5+JP
TH_CN vs. ASEAN-5+JP	TH_CN vs. ASEAN-5+JP	TH_CN vs. ASEAN-5+JP	TH_CN vs. ASEAN-5+JP
TH_JP vs. ASEAN-5+JP	TH_JP vs. ASEAN-5+JP*	TH_JP vs. ASEAN-5+JP	TH_JP vs. ASEAN-5+JP*
TH_SK vs. ASEAN-5+JP	TH_SK vs. ASEAN-5+JP	TH_SK vs. ASEAN-5+JP*	TH_SK vs. ASEAN-5+JP*
TH_ID vs. ASEAN-5+SK*	TH_ID vs. ASEAN-5+SK	TH_ID vs. ASEAN-5+SK	TH_ID vs. ASEAN-5+SK*
TH_MY vs. ASEAN-5+SK	TH_MY vs. ASEAN-5+SK*	TH_MY vs. ASEAN-5+SK*	TH_MY vs. ASEAN-5+SK*
TH_SG vs. ASEAN-5+SK*	TH_SG vs. ASEAN-5+SK	TH_SG vs. ASEAN-5+SK*	TH_SG vs. ASEAN-5+SK
TH_PH vs. ASEAN-5+SK	TH_PH vs. ASEAN-5+SK	TH_PH vs. ASEAN-5+SK	TH_PH vs. ASEAN-5+SK
TH_CN vs. ASEAN-5+SK	TH_CN vs. ASEAN-5+SK	TH_CN vs. ASEAN-5+SK	TH_CN vs. ASEAN-5+SK*
TH_JP vs. ASEAN-5+SK	TH_JP vs. ASEAN-5+SK*	TH_JP vs. ASEAN-5+SK	TH_JP vs. ASEAN-5+SK*
TH_SK vs. ASEAN-5+SK	TH_SK vs. ASEAN-5+SK	TH_SK vs. ASEAN-5+SK*	TH_SK vs. ASEAN-5+SK*
TH_ID vs. ASEAN-5 + 3	TH_ID vs. ASEAN-5 + 3	TH_ID vs. ASEAN-5 + 3	TH_ID vs. ASEAN-5 + 3
TH_MY vs. ASEAN-5 + 3	TH_MY vs. ASEAN-5 + 3*	TH_MY vs. ASEAN-5 + 3	TH_MY vs. ASEAN-5 + 3*
TH_SG vs. ASEAN-5 + 3	TH_SG vs. ASEAN-5 + 3	TH_SG vs. ASEAN-5 + 3	TH_SG vs. ASEAN-5 + 3
TH_PH vs. ASEAN-5 + 3*	TH_PH vs. ASEAN-5 + 3*	TH_PH vs. ASEAN-5 + 3	TH_PH vs. ASEAN-5 + 3
TH_CN vs. ASEAN-5 + 3	TH_CN vs. ASEAN-5 + 3*	TH_CN vs. ASEAN-5 + 3	TH_CN vs. ASEAN-5 + 3*
TH_JP vs. ASEAN-5 + 3	TH_JP vs. ASEAN-5 + 3	TH_JP vs. ASEAN-5 + 3	TH_JP vs. ASEAN-5 + 3*
TH_SK vs. ASEAN-5 + 3	TH_SK vs. ASEAN-5 + 3	TH_SK vs. ASEAN-5 + 3	TH_SK vs. ASEAN-5 + 3*

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(5) Philippines

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
PH_NC vs. PH_ID	PH_NC vs. PH_ID*	PH_NC vs. PH_ID	PH_NC vs. PH_ID*
PH_NC vs. PH_MY	PH_NC vs. PH_MY*	PH_NC vs. PH_MY*	PH_NC vs. PH_MY
PH_NC vs. PH_SG	PH_NC vs. PH_SG*	PH_NC vs. PH_SG*	PH_NC vs. PH_SG*
PH_NC vs. PH_TH	PH_NC vs. PH_TH	PH_NC vs. PH_TH	PH_NC vs. PH_TH
PH_NC vs. PH_CN	PH_NC vs. PH_CN*	PH_NC vs. PH_CN*	PH_NC vs. PH_CN*
PH_NC vs. PH_JP	PH_NC vs. PH_JP	PH_NC vs. PH_JP	PH_NC vs. PH_JP*
PH_NC vs. PH_SK	PH_NC vs. PH_SK	PH_NC vs. PH_SK*	PH_NC vs. PH_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
PH_NC vs. ASEAN-5	PH_NC vs. ASEAN-5	PH_NC vs. ASEAN-5	PH_NC vs. ASEAN-5
PH_NC vs. ASEAN-5+CN	PH_NC vs. ASEAN-5+CN*	PH_NC vs. ASEAN-5+CN*	PH_NC vs. ASEAN-5+CN
PH_NC vs. ASEAN-5+JP*	PH_NC vs. ASEAN-5+JP	PH_NC vs. ASEAN-5+JP	PH_NC vs. ASEAN-5+JP*
PH_NC vs. ASEAN-5+ SK	PH_NC vs. ASEAN-5+ SK*	PH_NC vs. ASEAN-5+ SK*	PH_NC vs. ASEAN-5+ SK*
PH_NC vs. ASEAN-5 + 3	PH_NC vs. ASEAN-5 + 3	PH_NC vs. ASEAN-5 + 3	PH_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
PH_ID vs. ASEAN-5*	PH_ID vs. ASEAN-5	PH_ID vs. ASEAN-5	PH_ID vs. ASEAN-5
PH_MY vs. ASEAN-5*	PH_MY vs. ASEAN-5	PH_MY vs. ASEAN-5	PH_MY vs. ASEAN-5
PH_SG vs. ASEAN-5*	PH_SG vs. ASEAN-5	PH_SG vs. ASEAN-5	PH_SG vs. ASEAN-5
PH_TH vs. ASEAN-5*	PH_TH vs. ASEAN-5	PH_TH vs. ASEAN-5*	PH_TH vs. ASEAN-5
PH_CN vs. ASEAN-5*	PH_CN vs. ASEAN-5	PH_CN vs. ASEAN-5	PH_CN vs. ASEAN-5
PH_JP vs. ASEAN-5	PH_JP vs. ASEAN-5	PH_JP vs. ASEAN-5*	PH_JP vs. ASEAN-5
PH_SK vs. ASEAN-5	PH_SK vs. ASEAN-5	PH_SK vs. ASEAN-5*	PH_SK vs. ASEAN-5
PH_ID vs. ASEAN-5+CN	PH_ID vs. ASEAN-5+CN*	PH_ID vs. ASEAN-5+CN	PH_ID vs. ASEAN-5+CN
PH_MY vs. ASEAN-5+CN	PH_MY vs. ASEAN-5+CN*	PH_MY vs. ASEAN-5+CN*	PH_MY vs. ASEAN-5+CN
PH_SG vs. ASEAN-5+CN	PH_SG vs. ASEAN-5+CN*	PH_SG vs. ASEAN-5+CN*	PH_SG vs. ASEAN-5+CN
PH_TH vs. ASEAN-5+CN	PH_TH vs. ASEAN-5+CN	PH_TH vs. ASEAN-5+CN	PH_TH vs. ASEAN-5+CN*
PH_CN vs. ASEAN-5+CN	PH_CN vs. ASEAN-5+CN	PH_CN vs. ASEAN-5+CN*	PH_CN vs. ASEAN-5+CN
PH_JP vs. ASEAN-5+CN	PH_JP vs. ASEAN-5+CN*	PH_JP vs. ASEAN-5+CN	PH_JP vs. ASEAN-5+CN
PH_SK vs. ASEAN-5+CN	PH_SK vs. ASEAN-5+CN	PH_SK vs. ASEAN-5+CN	PH_SK vs. ASEAN-5+CN
PH_ID vs. ASEAN-5+JP*	PH_ID vs. ASEAN-5+JP	PH_ID vs. ASEAN-5+JP*	PH_ID vs. ASEAN-5+JP*
PH_MY vs. ASEAN-5+JP	PH_MY vs. ASEAN-5+JP	PH_MY vs. ASEAN-5+JP*	PH_MY vs. ASEAN-5+JP
PH_SG vs. ASEAN-5+JP	PH_SG vs. ASEAN-5+JP	PH_SG vs. ASEAN-5+JP*	PH_SG vs. ASEAN-5+JP*
PH_TH vs. ASEAN-5+JP	PH_TH vs. ASEAN-5+JP*	PH_TH vs. ASEAN-5+JP	PH_TH vs. ASEAN-5+JP
PH_CN vs. ASEAN-5+JP	PH_CN vs. ASEAN-5+JP	PH_CN vs. ASEAN-5+JP	PH_CN vs. ASEAN-5+JP
PH_JP vs. ASEAN-5+JP	PH_JP vs. ASEAN-5+JP	PH_JP vs. ASEAN-5+JP	PH_JP vs. ASEAN-5+JP*
PH_SK vs. ASEAN-5+JP	PH_SK vs. ASEAN-5+JP	PH_SK vs. ASEAN-5+JP	PH_SK vs. ASEAN-5+JP
PH_ID vs. ASEAN-5+SK	PH_ID vs. ASEAN-5+SK*	PH_ID vs. ASEAN-5+SK	PH_ID vs. ASEAN-5+SK
PH_MY vs. ASEAN-5+SK	PH_MY vs. ASEAN-5+SK*	PH_MY vs. ASEAN-5+SK	PH_MY vs. ASEAN-5+SK*
PH_SG vs. ASEAN-5+SK	PH_SG vs. ASEAN-5+SK	PH_SG vs. ASEAN-5+SK	PH_SG vs. ASEAN-5+SK
PH_TH vs. ASEAN-5+SK	PH_TH vs. ASEAN-5+SK	PH_TH vs. ASEAN-5+SK	PH_TH vs. ASEAN-5+SK*
PH_CN vs. ASEAN-5+SK	PH_CN vs. ASEAN-5+SK*	PH_CN vs. ASEAN-5+SK*	PH_CN vs. ASEAN-5+SK*
PH_JP vs. ASEAN-5+SK	PH_JP vs. ASEAN-5+SK	PH_JP vs. ASEAN-5+SK	PH_JP vs. ASEAN-5+SK
PH_SK vs. ASEAN-5+SK	PH_SK vs. ASEAN-5+SK	PH_SK vs. ASEAN-5+SK*	PH_SK vs. ASEAN-5+SK
PH_ID vs. ASEAN-5 + 3	PH_ID vs. ASEAN-5 + 3	PH_ID vs. ASEAN-5 + 3	PH_ID vs. ASEAN-5 + 3
PH_MY vs. ASEAN-5 + 3*	PH_MY vs. ASEAN-5 + 3	PH_MY vs. ASEAN-5 + 3	PH_MY vs. ASEAN-5 + 3
PH_SG vs. ASEAN-5 + 3*	PH_SG vs. ASEAN-5 + 3	PH_SG vs. ASEAN-5 + 3	PH_SG vs. ASEAN-5 + 3
PH_TH vs. ASEAN-5 + 3*	PH_TH vs. ASEAN-5 + 3	PH_TH vs. ASEAN-5 + 3*	PH_TH vs. ASEAN-5 + 3
PH_CN vs. ASEAN-5 + 3*	PH_CN vs. ASEAN-5 + 3	PH_CN vs. ASEAN-5 + 3	PH_CN vs. ASEAN-5 + 3
PH_JP vs. ASEAN-5 + 3*	PH_JP vs. ASEAN-5 + 3	PH_JP vs. ASEAN-5 + 3*	PH_JP vs. ASEAN-5 + 3
PH_SK vs. ASEAN-5 + 3	PH_SK vs. ASEAN-5 + 3	PH_SK vs. ASEAN-5 + 3*	PH_SK vs. ASEAN-5 + 3*

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(6) China

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
CN_NC vs. CN_ID*	CN_NC vs. CN_ID*	CN_NC vs. CN_ID*	CN_NC vs. CN_ID*
CN_NC vs. CN_MY*	CN_NC vs. CN_MY*	CN_NC vs. CN_MY	CN_NC vs. CN_MY*
CN_NC vs. CN_SG*	CN_NC vs. CN_SG*	CN_NC vs. CN_SG	CN_NC vs. CN_SG*
CN_NC vs. CN_TH*	CN_NC vs. CN_TH*	CN_NC vs. CN_TH*	CN_NC vs. CN_TH
CN_NC vs. CN_PH*	CN_NC vs. CN_PH*	CN_NC vs. CN_PH	CN_NC vs. CN_PH*
CN_NC vs. CN_JP*	CN_NC vs. CN_JP*	CN_NC vs. CN_JP*	CN_NC vs. CN_JP*
CN_NC vs. CN_SK*	CN_NC vs. CN_SK*	CN_NC vs. CN_SK*	CN_NC vs. CN_SK

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
CN_NC vs. CJK*	CN_NC vs. CJK	CN_NC vs. CJK	CN_NC vs. CJK
CN_NC vs. ASEAN-5+CN	CN_NC vs. ASEAN-5+CN	CN_NC vs. ASEAN-5+CN	CN_NC vs. ASEAN-5+CN
CN_NC vs. ASEAN-5 + 3	CN_NC vs. ASEAN-5 + 3	CN_NC vs. ASEAN-5+3	CN_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
CN_ID vs. CJK*	CN_ID vs. CJK	CN_ID vs. CJK*	CN_ID vs. CJK
CN_MY vs. CJK*	CN_MY vs. CJK	CN_MY vs. CJK	CN_MY vs. CJK
CN_SG vs. CJK*	CN_SG vs. CJK*	CN_SG vs. CJK	CN_SG vs. CJK
CN_TH vs. CJK*	CN_TH vs. CJK*	CN_TH vs. CJK	CN_TH vs. CJK
CN_PH vs. CJK*	CN_PH vs. CJK	CN_PH vs. CJK*	CN_PH vs. CJK
CN_JP vs. CJK*	CN_JP vs. CJK	CN_JP vs. CJK	CN_JP vs. CJK
CN_SK vs. CJK*	CN_SK vs. CJK	CN_SK vs. CJK	CN_SK vs. CJK
CN_ID vs. ASEAN-5+CN	CN_ID vs. ASEAN-5+CN	CN_ID vs. ASEAN-5+CN	CN_ID vs. ASEAN-5+CN
CN_MY vs. ASEAN-5+CN	CN_MY vs. ASEAN-5+CN	CN_MY vs. ASEAN-5+CN*	CN_MY vs. ASEAN-5+CN
CN_SG vs. ASEAN-5+CN	CN_SG vs. ASEAN-5+CN	CN_SG vs. ASEAN-5+CN*	CN_SG vs. ASEAN-5+CN
CN_TH vs. ASEAN-5+CN	CN_TH vs. ASEAN-5+CN	CN_TH vs. ASEAN-5+CN*	CN_TH vs. ASEAN-5+CN
CN_PH vs. ASEAN-5+CN	CN_PH vs. ASEAN-5+CN	CN_PH vs. ASEAN-5+CN	CN_PH vs. ASEAN-5+CN
CN_JP vs. ASEAN-5+CN	CN_JP vs. ASEAN-5+CN	CN_JP vs. ASEAN-5+CN	CN_JP vs. ASEAN-5+CN
CN_SK vs. ASEAN-5+CN	CN_SK vs. ASEAN-5+CN	CN_SK vs. ASEAN-5+CN	CN_SK vs. ASEAN-5+CN
CN_ID vs. ASEAN-5 + 3*	CN_ID vs. ASEAN-5 + 3	CN_ID vs. ASEAN-5 + 3	CN_ID vs. ASEAN-5 + 3
CN_MY vs. ASEAN-5 + 3	CN_MY vs. ASEAN-5 + 3	CN_MY vs. ASEAN-5 + 3*	CN_MY vs. ASEAN-5 + 3*
CN_SG vs. ASEAN-5 + 3	CN_SG vs. ASEAN-5 + 3*	CN_SG vs. ASEAN-5 + 3*	CN_SG vs. ASEAN-5 + 3
CN_TH vs. ASEAN-5 + 3	CN_TH vs. ASEAN-5 + 3*	CN_TH vs. ASEAN-5 + 3	CN_TH vs. ASEAN-5 + 3*
CN_PH vs. ASEAN-5 + 3*	CN_PH vs. ASEAN-5 + 3	CN_PH vs. ASEAN-5 + 3	CN_PH vs. ASEAN-5 + 3*
CN_JP vs. ASEAN-5 + 3	CN_JP vs. ASEAN-5 + 3	CN_JP vs. ASEAN-5 + 3	CN_JP vs. ASEAN-5 + 3
CN_SK vs. ASEAN-5 + 3	CN_SK vs. ASEAN-5 + 3	CN_SK vs. ASEAN-5 + 3	CN_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(7) Japan

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
JP_NC vs. JP_ID*	JP_NC vs. JP_ID*	JP_NC vs. JP_ID	JP_NC vs. JP_ID*
JP_NC vs. JP_MY*	JP_NC vs. JP_MY*	JP_NC vs. JP_MY	JP_NC vs. JP_MY
JP_NC vs. JP_SG*	JP_NC vs. JP_SG	JP_NC vs. JP_SG*	JP_NC vs. JP_SG*
JP_NC vs. JP_TH	JP_NC vs. JP_TH*	JP_NC vs. JP_TH	JP_NC vs. JP_TH
JP_NC vs. JP_PH*	JP_NC vs. JP_PH*	JP_NC vs. JP_PH*	JP_NC vs. JP_PH
JP_NC vs. JP_CN*	JP_NC vs. JP_CN*	JP_NC vs. JP_CN	JP_NC vs. JP_CN
JP_NC vs. JP_SK	JP_NC vs. JP_SK	JP_NC vs. JP_SK*	JP_NC vs. JP_SK*

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
JP_NC vs. CJK	JP_NC vs. CJK	JP_NC vs. CJK	JP_NC vs. CJK*
JP_NC vs. ASEAN-5+JP	JP_NC vs. ASEAN-5+JP	JP_NC vs. ASEAN-5+JP*	JP_NC vs. ASEAN-5+JP
JP_NC vs. ASEAN-5 + 3*	JP_NC vs. ASEAN-5 + 3	JP_NC vs. ASEAN-5+3*	JP_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
JP_ID vs. CJK	JP_ID vs. CJK	JP_ID vs. CJK	JP_ID vs. CJK
JP_MY vs. CJK	JP_MY vs. CJK	JP_MY vs. CJK	JP_MY vs. CJK*
JP_SG vs. CJK	JP_SG vs. CJK*	JP_SG vs. CJK	JP_SG vs. CJK*
JP_TH vs. CJK*	JP_TH vs. CJK*	JP_TH vs. CJK	JP_TH vs. CJK
JP_PH vs. CJK	JP_PH vs. CJK	JP_PH vs. CJK	JP_PH vs. CJK*
JP_CN vs. CJK	JP_CN vs. CJK*	JP_CN vs. CJK	JP_CN vs. CJK
JP_SK vs. CJK*	JP_SK vs. CJK	JP_SK vs. CJK	JP_SK vs. CJK*
JP_ID vs. ASEAN-5+JP	JP_ID vs. ASEAN-5+JP	JP_ID vs. ASEAN-5+JP	JP_ID vs. ASEAN-5+JP
JP_MY vs. ASEAN-5+JP	JP_MY vs. ASEAN-5+JP	JP_MY vs. ASEAN-5+JP	JP_MY vs. ASEAN-5+JP
JP_SG vs. ASEAN-5+JP	JP_SG vs. ASEAN-5+JP*	JP_SG vs. ASEAN-5+JP	JP_SG vs. ASEAN-5+JP
JP_TH vs. ASEAN-5+JP	JP_TH vs. ASEAN-5+JP	JP_TH vs. ASEAN-5+JP	JP_TH vs. ASEAN-5+JP
JP_PH vs. ASEAN-5+JP	JP_PH vs. ASEAN-5+JP	JP_PH vs. ASEAN-5+JP	JP_PH vs. ASEAN-5+JP
JP_CN vs. ASEAN-5+JP	JP_CN vs. ASEAN-5+JP	JP_CN vs. ASEAN-5+JP	JP_CN vs. ASEAN-5+JP
JP_SK vs. ASEAN-5+JP	JP_SK vs. ASEAN-5+JP	JP_SK vs. ASEAN-5+JP*	JP_SK vs. ASEAN-5+JP
JP_ID vs. ASEAN-5 + 3*	JP_ID vs. ASEAN-5 + 3	JP_ID vs. ASEAN-5 + 3	JP_ID vs. ASEAN-5 + 3
JP_MY vs. ASEAN-5 + 3	JP_MY vs. ASEAN-5 + 3	JP_MY vs. ASEAN-5 + 3	JP_MY vs. ASEAN-5 + 3*
JP_SG vs. ASEAN-5 + 3	JP_SG vs. ASEAN-5 + 3	JP_SG vs. ASEAN-5 + 3*	JP_SG vs. ASEAN-5 + 3
JP_TH vs. ASEAN-5 + 3	JP_TH vs. ASEAN-5 + 3	JP_TH vs. ASEAN-5 + 3	JP_TH vs. ASEAN-5 + 3*
JP_PH vs. ASEAN-5 + 3*	JP_PH vs. ASEAN-5 + 3	JP_PH vs. ASEAN-5 + 3	JP_PH vs. ASEAN-5 + 3*
JP_CN vs. ASEAN-5 + 3*	JP_CN vs. ASEAN-5 + 3	JP_CN vs. ASEAN-5 + 3	JP_CN vs. ASEAN-5 + 3*
JP_SK vs. ASEAN-5 + 3	JP_SK vs. ASEAN-5 + 3	JP_SK vs. ASEAN-5 + 3*	JP_SK vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

(8) South Korea

No Coordination vs. Bilateral Coordination

κ_N	κ_T	θ_N	θ_T
SK_NC vs. SK_ID	SK_NC vs. SK_ID*	SK_NC vs. SK_ID	SK_NC vs. SK_ID*
SK_NC vs. SK_MY	SK_NC vs. SK_MY*	SK_NC vs. SK_MY	SK_NC vs. SK_MY*
SK_NC vs. SK_SG	SK_NC vs. SK_SG*	SK_NC vs. SK_SG*	SK_NC vs. SK_SG*
SK_NC vs. SK_TH	SK_NC vs. SK_TH*	SK_NC vs. SK_TH*	SK_NC vs. SK_TH*
SK_NC vs. SK_PH	SK_NC vs. SK_PH	SK_NC vs. SK_PH	SK_NC vs. SK_PH*
SK_NC vs. SK_CN*	SK_NC vs. SK_CN*	SK_NC vs. SK_CN*	SK_NC vs. SK_CN
SK_NC vs. SK_JP	SK_NC vs. SK_JP	SK_NC vs. SK_JP	SK_NC vs. SK_JP*

No Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SK_NC vs. CJK	SK_NC vs. CJK*	SK_NC vs. CJK*	SK_NC vs. CJK*
SK_NC vs. ASEAN-5+SK	SK_NC vs. ASEAN-5+SK	SK_NC vs. ASEAN-5+SK	SK_NC vs. ASEAN-5+SK
SK_NC vs. ASEAN-5 + 3*	SK_NC vs. ASEAN-5 + 3	SK_NC vs. ASEAN-5+3	SK_NC vs. ASEAN-5 + 3

Bilateral Coordination vs. Multilateral Coordination

κ_N	κ_T	θ_N	θ_T
SK_ID vs. CJK	SK_ID vs. CJK*	SK_ID vs. CJK	SK_ID vs. CJK
SK_MY vs. CJK*	SK_MY vs. CJK*	SK_MY vs. CJK	SK_MY vs. CJK
SK_SG vs. CJK*	SK_SG vs. CJK*	SK_SG vs. CJK*	SK_SG vs. CJK
SK_TH vs. CJK	SK_TH vs. CJK*	SK_TH vs. CJK*	SK_TH vs. CJK*
SK_PH vs. CJK	SK_PH vs. CJK	SK_PH vs. CJK	SK_PH vs. CJK*
SK_CN vs. CJK*	SK_CN vs. CJK*	SK_CN vs. CJK*	SK_CN vs. CJK*
SK_JP vs. CJK*	SK_JP vs. CJK	SK_JP vs. CJK	SK_JP vs. CJK*
SK_ID vs. ASEAN-5+SK*	SK_ID vs. ASEAN-5+SK	SK_ID vs. ASEAN-5+SK*	SK_ID vs. ASEAN-5+SK
SK_MY vs. ASEAN-5+SK	SK_MY vs. ASEAN-5+SK	SK_MY vs. ASEAN-5+SK*	SK_MY vs. ASEAN-5+SK
SK_SG vs. ASEAN-5+SK	SK_SG vs. ASEAN-5+SK	SK_SG vs. ASEAN-5+SK	SK_SG vs. ASEAN-5+SK
SK_TH vs. ASEAN-5+SK*	SK_TH vs. ASEAN-5+SK	SK_TH vs. ASEAN-5+SK	SK_TH vs. ASEAN-5+SK
SK_PH vs. ASEAN-5+SK*	SK_PH vs. ASEAN-5+SK	SK_PH vs. ASEAN-5+SK*	SK_PH vs. ASEAN-5+SK
SK_CN vs. ASEAN-5+SK	SK_CN vs. ASEAN-5+SK	SK_CN vs. ASEAN-5+SK	SK_CN vs. ASEAN-5+SK
SK_JP vs. ASEAN-5+SK	SK_JP vs. ASEAN-5+SK*	SK_JP vs. ASEAN-5+SK*	SK_JP vs. ASEAN-5+SK
SK_ID vs. ASEAN-5 + 3	SK_ID vs. ASEAN-5 + 3	SK_ID vs. ASEAN-5 + 3*	SK_ID vs. ASEAN-5 + 3
SK_MY vs. ASEAN-5 + 3	SK_MY vs. ASEAN-5 + 3	SK_MY vs. ASEAN-5 + 3*	SK_MY vs. ASEAN-5 + 3
SK_SG vs. ASEAN-5 + 3*	SK_SG vs. ASEAN-5 + 3	SK_SG vs. ASEAN-5 + 3	SK_SG vs. ASEAN-5 + 3
SK_TH vs. ASEAN-5 + 3	SK_TH vs. ASEAN-5 + 3	SK_TH vs. ASEAN-5 + 3	SK_TH vs. ASEAN-5 + 3
SK_PH vs. ASEAN-5 + 3	SK_PH vs. ASEAN-5 + 3	SK_PH vs. ASEAN-5 + 3	SK_PH vs. ASEAN-5 + 3
SK_CN vs. ASEAN-5 + 3*	SK_CN vs. ASEAN-5 + 3	SK_CN vs. ASEAN-5 + 3	SK_CN vs. ASEAN-5 + 3
SK_JP vs. ASEAN-5 + 3	SK_JP vs. ASEAN-5 + 3	SK_JP vs. ASEAN-5 + 3*	SK_JP vs. ASEAN-5 + 3

Source: Author's calculation. Note: * = H_0 accepted at $\alpha = 5\%$.

APPENDIX 5.4.

Values of Derived Parameters Under Different Policy Interaction Regimes

(1) Indonesia

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	**Traded Sector (γ_T)**	**Non-traded Sector (μ_N)**	**Traded Sector (μ_T)**
No coordination	9.395%	2.706%	1.097	1.106
Bilateral coordination				
with Malaysia	9.401%	2.706%	1.097	1.106
with Singapore	9.403%	2.706%	1.097	1.106
with Thailand	9.401%	2.706%	1.097	1.106
with the Philippines	9.402%	2.706%	1.097	1.106
with China	9.396%	2.705%	1.097	1.106
with Japan	9.390%	2.705%	1.097	1.106
with South Korea	9.392%	2.706%	1.097	1.106
Multilateral coordination				
in ASEAN-5	9.396%	2.706%	1.097	1.106
in ASEAN-5 + China	9.396%	2.705%	1.097	1.106
in ASEAN-5 + Japan	9.380%	2.705%	1.097	1.106
in ASEAN-5 + S. Korea	9.379%	2.706%	1.097	1.106
in ASEAN-5 + 3	9.385%	2.705%	1.097	1.106

Source: Author's calculation

(2) Malaysia

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.434%	2.705%	1.096	1.111
Bilateral coordination				
with Indonesia	9.442%	2.706%	1.096	1.111
with Singapore	9.434%	2.705%	1.096	1.111
with Thailand	9.440%	2.705%	1.096	1.111
with the Philippines	9.436%	2.706%	1.096	1.111
with China	9.440%	2.705%	1.096	1.111
with Japan	9.438%	2.705%	1.097	1.111
with South Korea	9.443%	2.705%	1.096	1.111
Multilateral coordination				
in ASEAN-5	9.433%	2.706%	1.096	1.111
in ASEAN-5 + China	9.431%	2.706%	1.097	1.111
in ASEAN-5 + Japan	9.425%	2.705%	1.096	1.111
in ASEAN-5 + S. Korea	9.445%	2.706%	1.096	1.111
in ASEAN-5 + 3	9.450%	2.705%	1.096	1.111

Source: Author's calculation

(3) Singapore

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.517%	2.705%	1.096	1.109
Bilateral coordination				
with Indonesia	9.524%	2.706%	1.096	1.110
with Malaysia	9.505%	2.705%	1.096	1.109
with Thailand	9.522%	2.705%	1.096	1.109
with the Philippines	9.519%	2.706%	1.096	1.109
with China	9.522%	2.705%	1.096	1.110
with Japan	9.514%	2.705%	1.096	1.109
with South Korea	9.517%	2.705%	1.096	1.109
Multilateral coordination				
in ASEAN-5	9.523%	2.706%	1.096	1.110
in ASEAN-5 + China	9.527%	2.706%	1.096	1.110
in ASEAN-5 + Japan	9.519%	2.705%	1.096	1.109
in ASEAN-5 + S. Korea	9.531%	2.706%	1.096	1.110
in ASEAN-5 + 3	9.519%	2.705%	1.096	1.110

Source: Author's calculation

(4) Thailand

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.472%	2.705%	1.096	1.108
Bilateral coordination				
with Indonesia	9.476%	2.706%	1.096	1.108
with Malaysia	9.458%	2.705%	1.096	1.108
with Singapore	9.465%	2.705%	1.096	1.111
with the Philippines	9.479%	2.706%	1.096	1.108
with China	9.472%	2.705%	1.096	1.108
with Japan	9.466%	2.705%	1.096	1.108
with South Korea	9.473%	2.705%	1.096	1.108
Multilateral coordination				
in ASEAN-5	9.481%	2.706%	1.096	1.108
in ASEAN-5 + China	9.470%	2.706%	1.096	1.108
in ASEAN-5 + Japan	9.478%	2.705%	1.096	1.108
in ASEAN-5 + S. Korea	9.470%	2.706%	1.096	1.108
in ASEAN-5 + 3	9.478%	2.705%	1.096	1.108

Source: Author's calculation

(5) The Philippines

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.478%	2.706%	1.096	1.108
Bilateral coordination				
with Indonesia	9.485%	2.706%	1.096	1.108
with Malaysia	9.481%	2.706%	1.096	1.108
with Singapore	9.481%	2.705%	1.096	1.108
with Thailand	9.482%	2.706%	1.096	1.108
with China	9.479%	2.705%	1.096	1.108
with Japan	9.478%	2.705%	1.096	1.108
with South Korea	9.486%	2.706%	1.096	1.108
Multilateral coordination				
in ASEAN-5	9.484%	2.706%	1.096	1.108
in ASEAN-5 + China	9.468%	2.705%	1.096	1.108
in ASEAN-5 + Japan	9.470%	2.705%	1.096	1.108
in ASEAN-5 + S. Korea	9.470%	2.706%	1.096	1.108
in ASEAN-5 + 3	9.479%	2.705%	1.096	1.108

Source: Author's calculation

(6) China

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.247%	2.705%	1.099	1.106
Bilateral coordination				
with Indonesia	9.246%	2.705%	1.099	1.106
with Malaysia	9.246%	2.705%	1.099	1.106
with Singapore	9.248%	2.705%	1.099	1.106
with Thailand	9.247%	2.705%	1.099	1.106
with the Philippines	9.246%	2.705%	1.099	1.106
with Japan	9.246%	2.705%	1.099	1.106
with South Korea	9.246%	2.705%	1.099	1.106
Multilateral coordination				
in CJK	9.244%	2.705%	1.099	1.106
in ASEAN-5 + China	9.261%	2.706%	1.099	1.106
in ASEAN-5 + 3	9.241%	2.705%	1.099	1.106

Source: Author's calculation

(7) Japan

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.468%	2.705%	1.096	1.108
Bilateral coordination				
with Indonesia	9.470%	2.705%	1.096	1.108
with Malaysia	9.471%	2.705%	1.096	1.108
with Singapore	9.470%	2.705%	1.096	1.108
with Thailand	9.474%	2.705%	1.096	1.108
with the Philippines	9.468%	2.705%	1.096	1.108
with China	9.469%	2.705%	1.096	1.108
with South Korea	9.474%	2.705%	1.096	1.108
Multilateral coordination				
in CJK	9.480%	2.705%	1.096	1.108
in ASEAN-5 + Japan	9.483%	2.705%	1.096	1.108
in ASEAN-5 + 3	9.470%	2.705%	1.096	1.108

Source: Author’s calculation

(8) South Korea

	Probability of Unchanged Prices		Price Markups	
	Non-traded Sector (γ_N)	Traded Sector (γ_T)	Non-traded Sector (μ_N)	Traded Sector (μ_T)
No coordination	9.476%	2.706%	1.096	1.108
Bilateral coordination				
with Indonesia	9.462%	2.706%	1.096	1.108
with Malaysia	9.465%	2.705%	1.096	1.108
with Singapore	9.467%	2.705%	1.096	1.108
with Thailand	9.459%	2.705%	1.096	1.108
with the Philippines	9.454%	2.706%	1.096	1.108
with China	9.467%	2.705%	1.096	1.108
with South Korea	9.457%	2.705%	1.096	1.108
Multilateral coordination				
in CJK	9.461%	2.705%	1.096	1.108
in ASEAN-5 + S. Korea	9.459%	2.706%	1.096	1.108
in ASEAN-5 + 3	9.468%	2.705%	1.096	1.108

Source: Author's calculation

CHAPTER 6

COMPARISON BETWEEN THE ONE-PRODUCTION-FACTOR AND TWO-PRODUCTION FACTOR MODELS

6.1. Model Performance

This study uses deviations of smoothed observable variables values in the model from the actual values of these variables to measure performance of the model. The deviation is formulated as:

$$Deviation = \frac{Smoothed\ value - Actual\ value}{Actual\ value}$$

Non-traded sector inflation and traded sector inflation are the observable variables in this study, both for the one-production-factor and two-production-factor model. The actual values of these two variables are the seasonally adjusted quarter on quarter inflation rates in the non-traded and non-traded sector from Q3-2003 to Q2-2018. The performance of a model improves when the deviations of smoothed observable variables from their actual values gets smaller.

Table 6.1. summarizes the results of performance measurement for the one-production-factor and two-production-factor model. Charts 6.1. and Charts 6.2. display the deviations of smoothed inflation rates from their actual values for each of the ASEAN-5+3 countries for the one-production-factor and the two-production factor model, respectively.

Table 6.1. shows that the two-production-factor model has better performance than the one-production factor. Both the one-production-factor and two-production-factor model can produce smoothed inflation values in the non-traded sector which are very close the actual values. As for the traded sector, there are relatively big differences between the smoothed variable and the actual values in the one-production factor model, while the two-production model still produces smoothed values which are very close the actual values.

Table 6.1. Deviations of Smoothed Inflation Variable Values from Their Actual Values

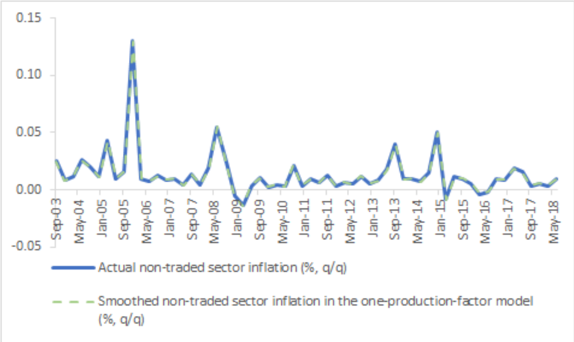
	Deviations in the Non-traded Sector		Deviations in the Traded Sector	
	One-production-factor Model	**Two-production-factor Model**	**One-production-factor Model**	**Two-production-factor Model**
Indonesia	0.000	0.000	-0.926	0.000
Malaysia	0.000	0.000	27.748	0.000
Singapore	0.000	0.000	78.347	0.000
Thailand	0.000	0.000	-263.372	0.000
Philippines	0.000	0.000	28.380	0.000
China	0.000	0.000	71.589	0.000
Japan	0.000	0.000	-0.215	0.000
South Korea	0.000	0.000	-40.902	0.000

Source: Author's calculation

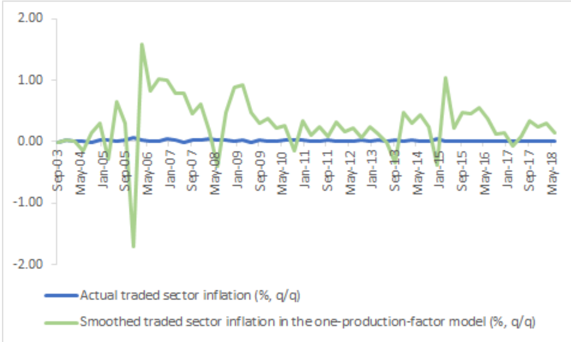
Charts 6.1: Actual vs. Smoothed Variables in the One-Production-Factor Model

(1) Indonesia

Non-traded sector

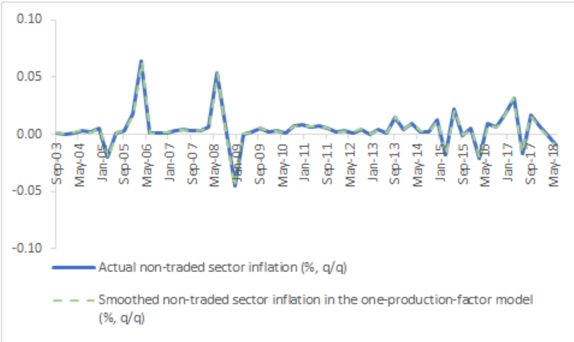


Traded sector

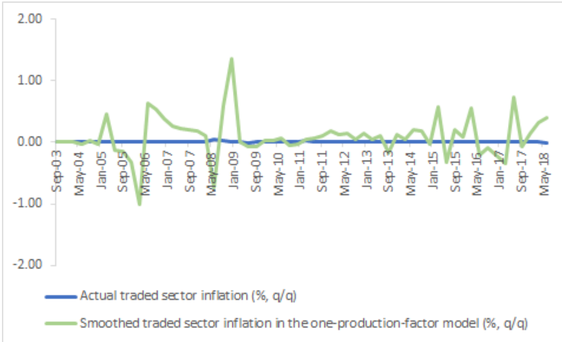


(2) Malaysia

Non-traded sector

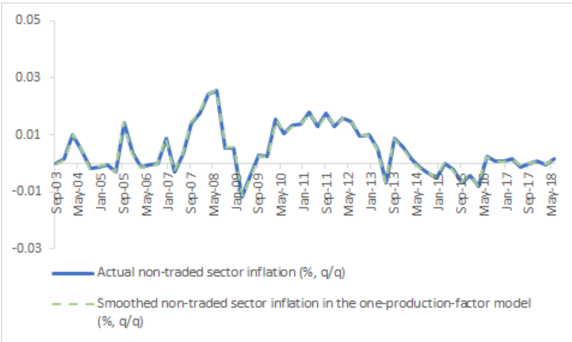


Traded sector

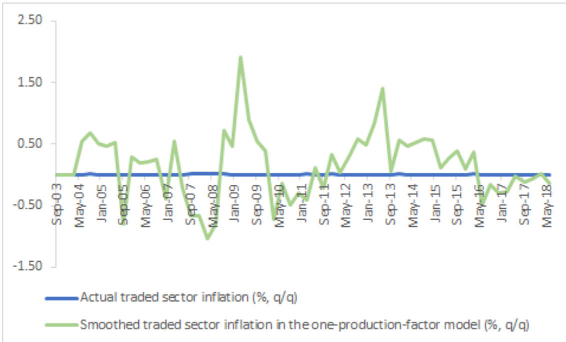


(3) Singapore

Non-traded sector

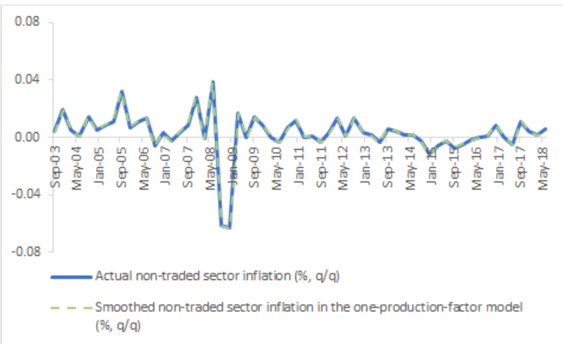


Traded sector



(4) Thailand

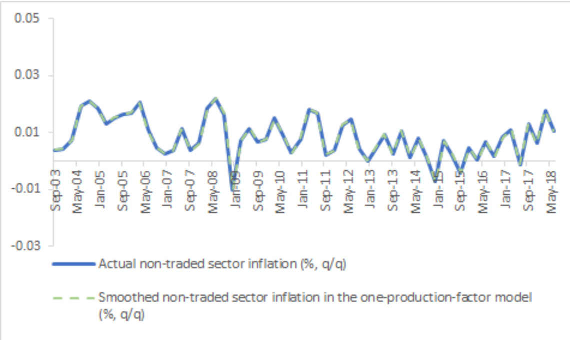
Non-traded sector



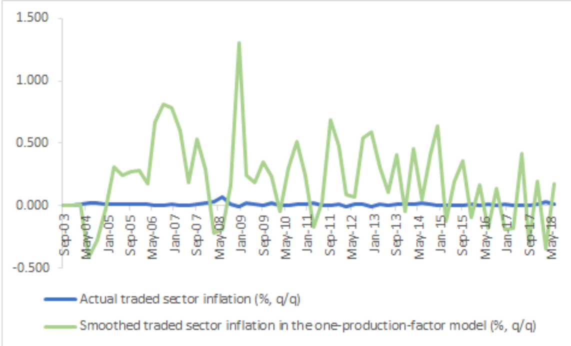
Traded sector

(5) The Philippines

Non-traded sector

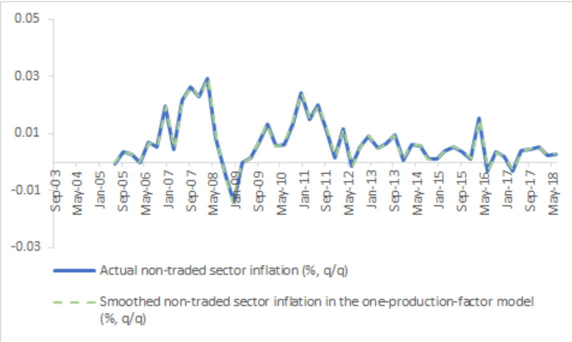


Traded sector

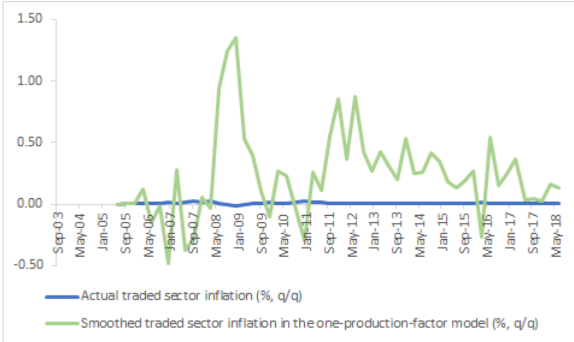


(6) China

Non-traded sector

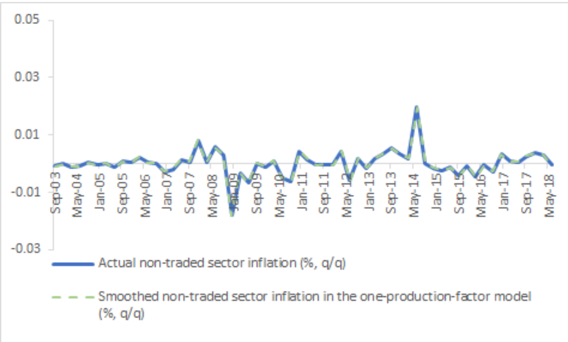


Traded sector

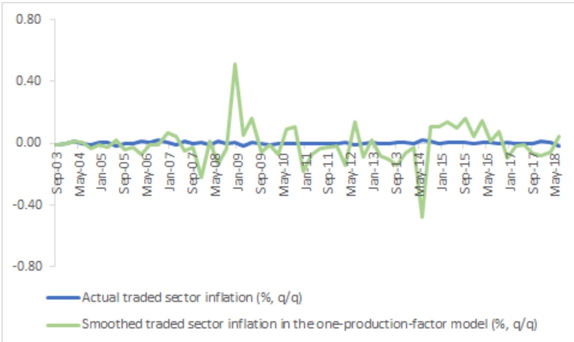


(7) Japan

Non-traded sector

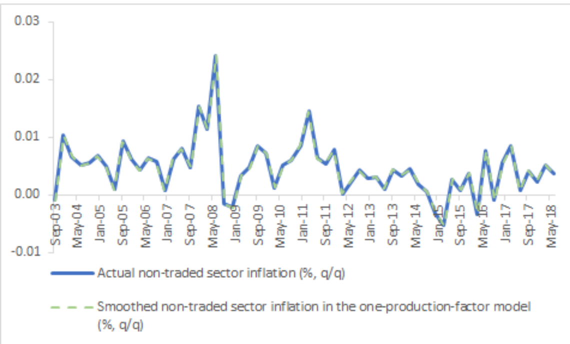


Traded sector



(8) South Korea

Non-traded sector



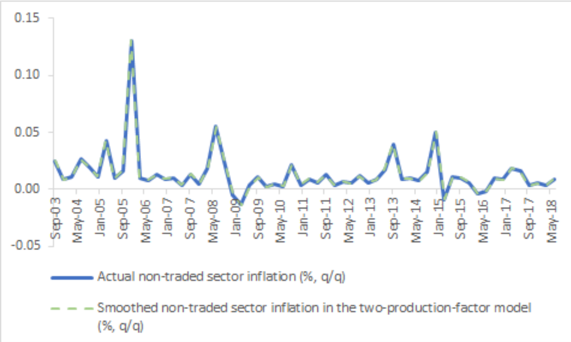
Traded sector

Source: Author's calculation

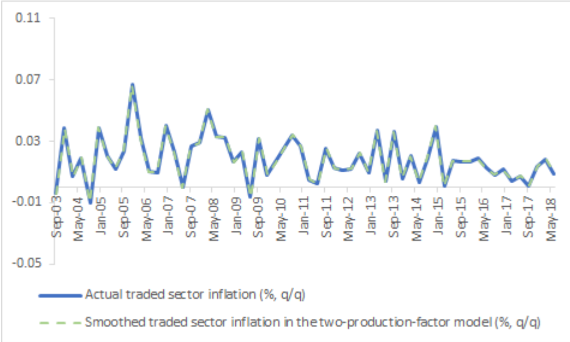
Charts 6.2: Actual vs. Smoothed Variables in the Two-Production-Factor Model

(1) Indonesia

Non-traded sector

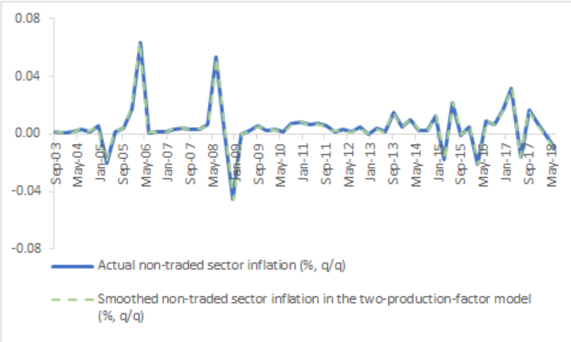


Traded sector

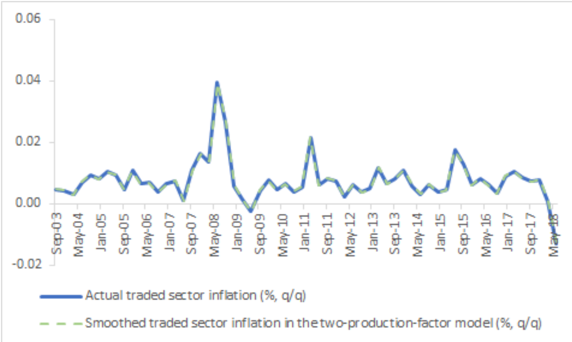


(2) Malaysia

Non-traded sector

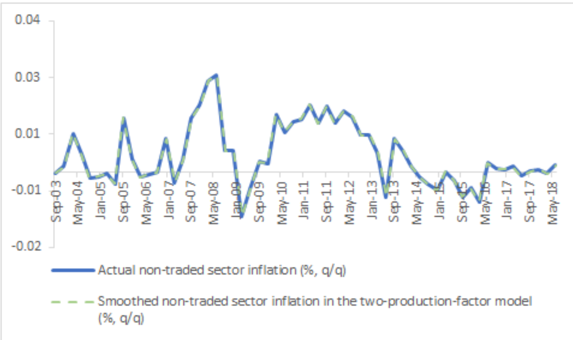


Traded sector

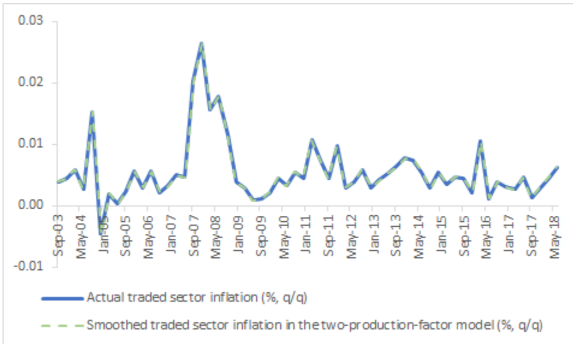


(3) Singapore

Non-traded sector

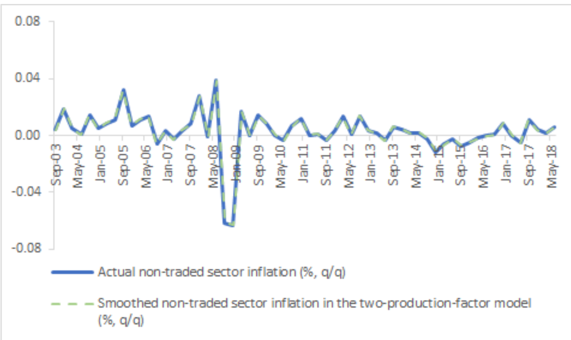


Traded sector

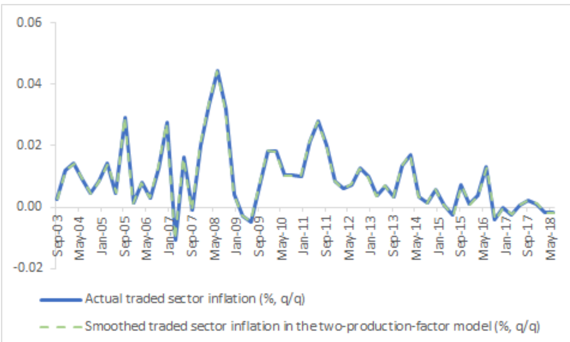


(4) Thailand

Non-traded sector

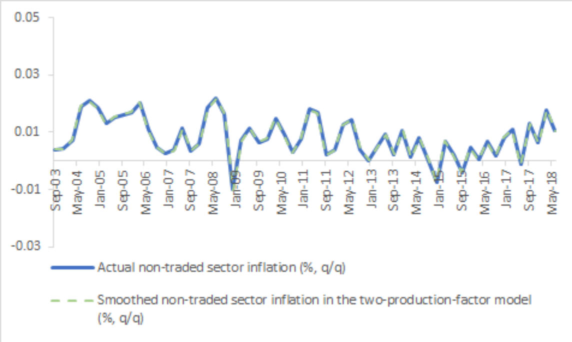


Traded sector

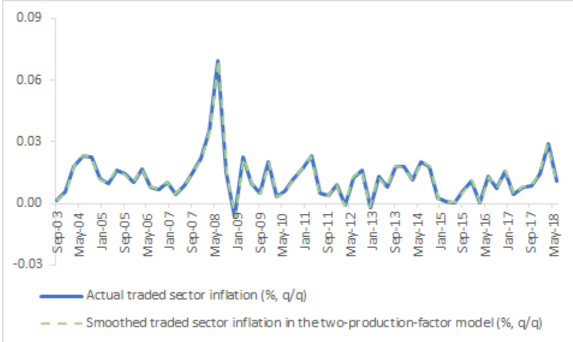


(5) The Philippines

Non-traded sector

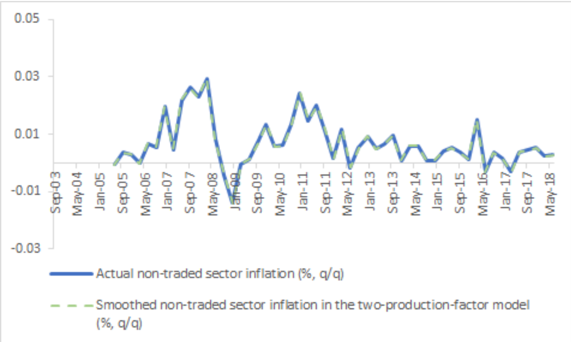


Traded sector

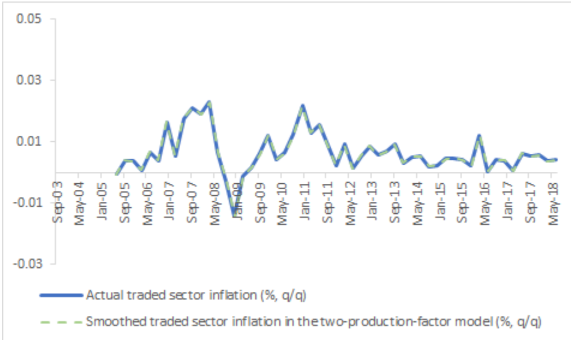


(6) China

Non-traded sector

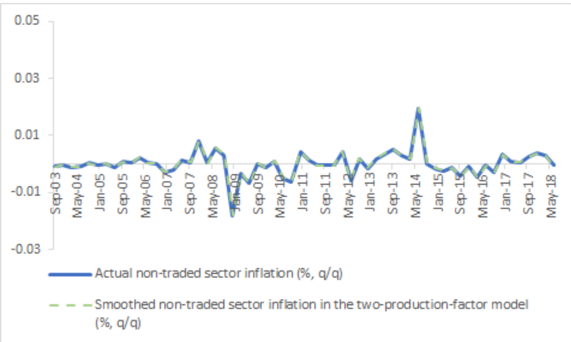


Traded sector

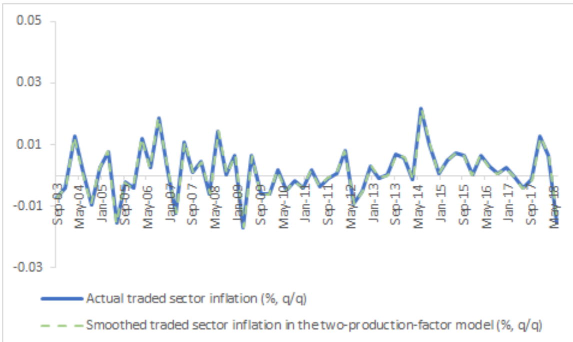


(7) Japan

Non-traded sector



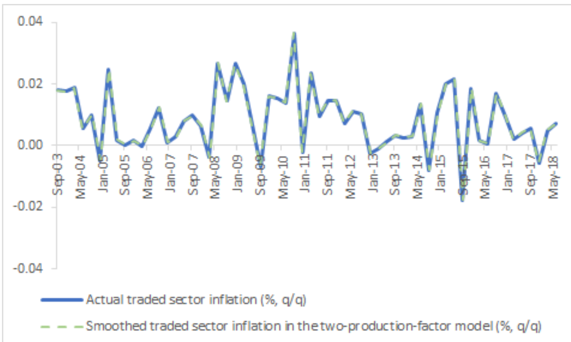
Traded sector



(8) South Korea

Non-traded sector

Traded sector



Source: Author's calculation

6.2. Parameter Estimates

Tables 6.2 display comparison between the value of each parameter estimate for the non-traded and traded sector in the one-production-factor (1-PF) model and the two-production factor (2-PF) model, for each of the ASEAN-5+3 countries.

The following are the findings from the comparison:

(1) Indonesia

- κ_N is always smaller than κ_T, both in the 1-PF and the 2-PF models.
- θ_N is always smaller than θ_T in the 1-PF model, θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T, both in the 1-PF and the 2-PF models.
- μ_N is bigger than μ_T in almost all interaction cases of the 1-PF model (except in the ASEAN-5+3 MC), μ_N is always smaller than μ_T in 2-PF model

(2) Malaysia

- κ_N is always smaller than κ_T, both in the 1-PF and the 2-PF models.
- θ_N is always bigger than θ_T, both in the 1-PF and the 2-PF models.
- γ_N is always bigger than γ_T, both in the 1-PF and the 2-PF models.
- μ_N is always smaller than μ_T, both in the 1-PF and the 2-PF models.

(3) Singapore

- κ_N is always smaller than κ_T, both in the 1-PF and the 2-PF models.
- θ_N is always smaller than θ_T in the 1-PF model, θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T, both in the 1-PF and the 2-PF models.
- μ_N is always bigger than μ_T in the 1-PF model, μ_N is always smaller than μ_T in 2-PF model.

(4) Thailand

- κ_N is always smaller than κ_T, both in the 1-PF and the 2-PF models.
- θ_N is always smaller than θ_T in the 1-PF model, θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T, both in the 1-PF and the 2-PF models.
- μ_N is always bigger than μ_T in the 1-PF model, μ_N is always smaller than μ_T in 2-PF model.

(5) The Philippines

- κ_N is always smaller than κ_T, both in the 1-PF and the 2-PF models.
- In the 1-PF model, θ_N is bigger than θ_T in the "No Coordination" (NC) regime and in almost all cases of the "Bilateral Coordination" (BC) regime (the exception is Thailand – Singapore BC). θ_N is smaller than θ_T in almost all cases of "Multilateral Coordination" (MC) regime (the exception is the ASEAN-5+3 MC scheme).

  θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T, both in the 1-PF and the 2-PF models.
- In the 1-PF model, μ_N is smaller than μ_T in the "No Coordination" (NC) regime and in almost all cases of the "Bilateral Coordination" (BC) regime (the exceptions is BC with Singapore). μ_N is always bigger than μ_T in all cases of "Multilateral Coordination" (MC).

  μ_N is always smaller than μ_T in 2-PF model.

(6) China

- κ_N is always smaller than κ_T , both in the 1-PF and the 2-PF models.
- θ_N is always smaller than θ_T in the 1-PF model, θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T , both in the 1-PF and the 2-PF models.
- In the 1-PF model, μ_N is equal than μ_T in the NC regime and in almost all cases of the BC regime (the exceptions are China – Indonesia BC and China – Japan BC). μ_N is bigger than μ_T in the cases of ASEAN-5+3 MC and ASEAN-5 + China MC, but μ_N is smaller than μ_T in the case of CJK MC.

  μ_N is always smaller than μ_T in 2-PF model.

(7) Japan

- κ_N is always smaller than κ_T , both in the 1-PF and the 2-PF models.
- In the 1-PF model, θ_N is bigger than θ_T in the NC regime and in almost all cases of the BC regime (the exception is Japan – Singapore BC). θ_N is bigger than θ_T in almost all cases of "Multilateral Coordination" (MC) regime (the exception is the ASEAN-5+3 MC scheme).

  θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T , both in the 1-PF and the 2-PF models.
- μ_N is always smaller than μ_T , both in the 1-PF and the 2-PF models.

(8) South Korea

- κ_N is always smaller than κ_T , both in the 1-PF and the 2-PF models.
- θ_N is always smaller than θ_T in the 1-PF model, θ_N is always bigger than θ_T in 2-PF model.
- γ_N is always bigger than γ_T , both in the 1-PF and the 2-PF models.
- μ_N is always bigger than μ_T in the 1-PF model, μ_N is always smaller than μ_T in 2-PF model.

These findings show that the parameters of responsiveness of pricing decision (κ_N and κ_T) and the probability of intermediate-good-producing firms to keep prices unchanged (γ_N and γ_T) have consistent direction of inequality relations in both the one-production-factor and the two-production-factor models; while the direction of inequality for the parameter of elasticity of substitution between differentiated intermediate goods (θ_N and θ_T) and price markups (μ_N and μ_T) are diverse.

These findings also show that the two-production-factor model produces consistent directions of inequality relations for all types of parameters in all the ASEAN-5+3 countries, while the one-production-factor does not produce such consistent directions.

Table 6.2. Comparison between Parameter Estimates in the One-Production-Factor and Two-Production-Factor Model

(1) Indonesia

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	2-PF Model	1-PF Model	2-PF Model	1-PF Model	2-PF Model	1-PF Model	2-PF Model
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in ASEAN-5	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5 + 3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$

Source: Author's calculation

(2) Malaysia

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in ASEAN-5	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
in ASEAN-5 + 3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$

Source: Author’s calculation

(3) Singapore

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in ASEAN-5	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5 + 3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$

Source: Author's calculation

(4) Thailand

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in ASEAN-5	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5 + 3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$

Source: Author’s calculation

(5) The Philippines

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in ASEAN-5	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5 + 3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$

Source: Author's calculation

(6) China

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in CJK	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N = \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$

Source: Author's calculation

(7) Japan

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
with South Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in CJK	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N > \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N < \mu_T$	$\mu_N < \mu_T$

Source: Author's calculation

(8) South Korea

	κ_N vs. κ_T		θ_N vs. θ_T		γ_N vs. γ_T		μ_N vs. μ_T	
	1-PF Model	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**	**1-PF Model**	**2-PF Model**
No coordination	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Bilateral coordination								
with Indonesia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Malaysia	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Singapore	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Thailand	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with the Philippines	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with China	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
with Japan	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
Multilateral coordination								
in CJK	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+Korea	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$
in ASEAN-5+3	$\kappa_N < \kappa_T$	$\kappa_N < \kappa_T$	$\theta_N < \theta_T$	$\theta_N > \theta_T$	$\gamma_N > \gamma_T$	$\gamma_N > \gamma_T$	$\mu_N > \mu_T$	$\mu_N < \mu_T$

Source: Author's calculation

6.3. Feasible International Monetary Policy Coordination Schemes

Tables 6.3. depict the appropriate policy options which correspond to the rank of "potential" welfare for each of the ASEAN-5+3 countries. Table 6.3(1) displays the policy options for the one-production-factor model, while Table 6.3(2) for the two-production-factor model. While some of policy coordination options can potentially improve welfare of a country, their feasibilities are determined by policy decision by the respective country's partner(s).

In the one-production-factor-model, the best policy option for all the ASEAN-5+3 countries are the ASEAN-5+3 "Multilateral Coordination" (MC) scheme. The worst policy option for each of the ASEAN-5 countries is "Bilateral Coordination"(BC) with Japan, while the worst policy option for the CJK countries is the CJK MC scheme.

In the two-production-factor-model, the best policy option for all the ASEAN-5+3 countries are to enter the ASEAN-5+3 MC scheme. The worst policy option for Malaysia, Singapore, and Thailand is the "No Coordination" (NC) regime. The worst policy option for Indonesia is BC with Japan; while the worst option for the Philippines is BC with Thailand. The worst policy option for the CJK countries is the CJK MC scheme.

Despite the differences in the one-production-factor and the two-production model with respect to the ranking of most policy options, both models show that ASEAN-5+3 MC is the first-best policy option for all the ASEAN-5+3 countries, while the CJK MC scheme is the worst scheme for the CJK countries. Both models also show that the ASEAN-5 + Japan MC is the second-best policy for the ASEAN-5 countries and Japan; the ASEAN-5 + China MC scheme is the second-base policy option for China; and the ASEAN-5 + South Korea MC is the second-best option for South Korea.

Table 6.4. displays feasible international monetary policy coordination options for the ASEAN-5+3 countries in the one-production-factor and the two-production-factor models. There is only one feasible BC option in the one-production-factor model (i.e. Thailand – China) BC, while there are 18 feasible BC options in the two-production factor model. With respect to the MC options, the one-production-factor model has three feasible options, while the two-production-factor model has four feasible options. In brief, the two-production-factor model reveals that there are more options of international monetary policy coordination options for the ASEAN-5+3 economies than what the one-production-factor can map.

Table 6.3. Appropriate Policy Options Corresponding to "Potential" Welfare for the ASEAN-5+3 Countries*

(1 = the highest welfare for ASEAN-5+3; 11 = the lowest for CJK; 13 = the lowest for ASEAN-5)

(1) One-Production-Factor Model

	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	Korea
1	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3
2	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + CN	ASEAN-5 + JP	ASEAN-5 + SK
3	ASEAN-5 + CN	ASEAN-5 + CN	ASEAN-5 + CN	ASEAN-5 + CN	ASEAN-5 + CN	CN – ID	JP – CN	SK – ID
4	NC	MY – ID	SG – ID	TH – ID	PH – ID	CN – PH	JP – ID	SK – PH
5	ID – PH	ASEAN-5	ASEAN-5	ASEAN-5	ASEAN-5	CN – MY	JP – TH	NC
6	ID – MY	ASEAN-5 + SK	ASEAN-5 + SK	ASEAN-5 + SK	NC	CN – TH	JP – SK	SK – MY
7	ID – SG	MY – PH	SG – PH	TH – PH	ASEAN-5 + SK	CN – SK	JP – PH	SK - CN
8	ID – TH	NC	SG - CN	TH – MY	PH – MY	NC	JP – MY	SK – TH
9	ASEAN-5	MY – TH	SG – SK	TH – CN	PH – TH	CN - SG	JP – SG	SK – SG
10	ASEAN-5 + SK	MY – CN	SG – MY	TH – SK	PH – SG	CN - JP	NC	SK - JP
11	ID – SK	MY – SK	SG – TH	NC	PH – SK	CJK	CJK	CJK
12	ID – CN	MY – SG	NC	TH – SG	PH – CN	---	---	---
13	ID – JP	MY – JP	SG – JP	TH – JP	PH – JP	---	---	---

* Note: NC = No Coordination
ID = Indonesia MY = Malaysia SG = Singapore TH = Thailand
PH = the Philippines CN = China JP = Japan SK = South Korea
CJK = China, Japan, and South Korea PH = the Philippines

Source: Author's calculation

(2) Two-Production-Factor Model

	Indonesia	Malaysia	Singapore	Thailand	Philippines	China	Japan	Korea
1	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3	ASEAN-5 + 3
2	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + JP	ASEAN-5 + CN	ASEAN-5 + JP	ASEAN-5 + SK
3	ASEAN-5 + CN	ASEAN-5 + CN	ASEAN-5 + CN	ASEAN-5 + CN	ASEAN-5 + CN	CN – MY	JP – TH	SK – ID
4	ASEAN-5 + SK	ASEAN-5 + SK	ASEAN-5 + SK	ASEAN-5 + SK	ASEAN-5 + SK	CN – PH	JP – PH	SK – CN
5	ID – PH	MY – CN	SG – ID	TH – CN	PH – ID	CN – TH	JP – MY	SK – PH
6	ID – SG	MY – ID	SG – CN	TH – ID	PH – CN	CN – ID	JP – ID	SK – SG
7	NC	ASEAN-5	SG – PH	TH – JP	PH – SG	CN – SG	JP – CN	SK – TH
8	ID – SK	MY – PH	ASEAN-5	ASEAN-5	ASEAN-5	CN – SK	JP – SG	SK – MY
9	ID – MY	MY – JP	SG – SK	TH – PH	NC	CN – JP	JP – SK	NC
10	ID – CN	MY – SK	SG – TH	TH – SK	PH – JP	NC	NC	SK – JP
11	ID – TH	MY – SG	SG – MY	TH – SG	PH – MY	CJK	CJK	CJK
12	ASEAN-5	MY – TH	SG - JP	TH - MY	PH – SK	---	---	---
13	ID – JP	NC	NC	NC	PH – TH	---	---	---

Source: Author's calculation

* Note: NC = No Coordination
ID = Indonesia MY = Malaysia SG = Singapore TH = Thailand
PH = the Philippines CN = China JP = Japan SK = South Korea
CJK = China, Japan, and South Korea

Table 6.4. Feasible International Monetary Policy Coordination Options in the One-Production-Factor and the Two-Production Factor Models

	One-Production-Factor Model	Two-Production Factor Model
Bilateral Coordination	Thailand – China BC	1) Indonesia – Singapore 2) Indonesia – the Philippines 3) Malaysia – Singapore 4) Malaysia – Thailand 5) Malaysia – China 6) Malaysia – Japan 7) Malaysia – South Korea 8) Singapore – Thailand 9) Singapore – the Philippines 10) Singapore – China 11) Singapore – Japan 12) Singapore – South Korea 13) Thailand – China 14) Thailand – Japan 15) Thailand – South Korea 16) The Philippines - China 17) China – Japan 18) China – South Korea
Multilateral Coordination	1) ASEAN-5+3 2) ASEAN-5 + Japan 3) ASEAN-5 + China	1) ASEAN-5+3 2) ASEAN-5 + Japan 3) ASEAN-5 + China 4) ASEAN-5 + South Korea

Source: Author's calculation

CHAPTER 7

SUMMARY AND CONCLUSIONS

7.1. Summary

Here is the summary of the discussions in Chapters 2 to 6 of the dissertation.

Chapter 2 discusses theoretical modelling, previous empirical studies, and other theoretical foundations related to international monetary policy coordination. On the modelling part, it elaborates the New Open Economy Macroeconomic (NOEM) model, the Dynamic General Equilibrium (DGE) and the Dynamic Stochastic General Equilibrium (DSGE) models, and international monetary policy coordination models. It also discusses previous studies on international policy coordination in the Asia-Pacific, where some studies suggested that international policy coordination is feasible for the Asian or ASEAN countries while other studies showed rather discouraging results on the prospects of coordination. This chapter also elaborates theoretical foundations on international externalities, international public goods, and the game theory framework related to international monetary policy coordination.

Chapter 3 starts with a section discussing basic settings for the one-production-factor and two-production-factor models. Both models assume the existence of a world of 11 countries. As this research focuses on the ASEAN-5+3 countries, the rest of these countries are considered as external environment. There are three types of interaction regimes among the ASEAN-5+3 countries: (1) No Coordination; (2) Bilateral Coordination; and (3) Multilateral Coordination. There are four types of economic agents (households, firms, government or supranational planner exercising fiscal policy, and central bank or supranational planner exercising monetary policy) live in each country; each agent faces optimization problems. The following sections discusses the steps to solve the models, the game theory framework to assess the feasibility of international monetary policy coordination, and the models' variables, parameters, data, and data sources.

Chapter 4 elaborates the one-production-factor model, where labor is assumed to be the only available production factor for firms. It starts with a section discussing the specifications of the models: (1) agents' optimization problems; (2) optimum solutions for agents' optimization problems; (3) market clearing conditions, aggregations of optimum solutions, and equilibria; and (4) model solution technique to find the steady state values of the variables and estimated parameters and the welfare calculation technique. The following sections are the presentation of results and analysis. The model shows that international monetary policy coordination for the ASEAN-5+3 is feasible but limited to few cases: only one feasible case of bilateral coordination (out of 28 possible interaction cases) and three feasible multilateral coordination cases (out of six possible schemes).

Chapter 5 elaborates the two-production-factor model, where firms use labor and capital as production factors. The chapter starts with a section discussing the specifications of the models: (1) agents' optimization problems; (2) optimum solutions for agents' optimization problems; (3) market clearing conditions, aggregations of optimum solutions, and equilibria; and (4) model solution technique to find the steady state values of the variables and estimated parameters and the welfare calculation technique. The next sections are the presentation of results and analysis. Compared to the one-production-factor model, the two-production-factor model shows more feasible cases of international monetary policy coordination for the ASEAN-5+3 countries: 18

feasible cases of bilateral coordination (out of 28 possible interaction cases) and four feasible multilateral coordination cases (out of six possible schemes).

Chapter 6 compares the one-production-factor and the two-production-factor models. The first section of this chapter compares the performance of the models using deviations of smoothed observable variable values from their actual values. The comparison shows that the two-production-factor model has better performance than the one-production factor. The next section compares the values of parameter estimates, which shows that the two-production-factor model produces consistent directions of inequality relations between the non-traded and traded sector parameters in all the ASEAN-5+3 countries, while the one-production-factor does not produce such consistent directions. The last section compares the number of feasible bilateral and multilateral coordination cases between the two models, which shows that there are more feasible bilateral and multilateral coordination cases in the two-production-factor model than in the one-production-factor model.

7.2. Conclusions

This research examines the feasibility of international monetary policy coordination among the ASEAN-5+3 countries using the Dynamic Stochastic General Equilibrium (DSGE) approach. Three types of interaction regimes among these countries were explored: ”No Coordination”, ”Bilateral Coordination”, and ”Multilateral Coordination”. Two types of the DSGE New Open Economy Macro (NOEM) models were constructed: (1) the one-factor-production model; and (2) the two-production-factor model. Besides calculating welfare in each type of interaction among the ASEAN-5+3 countries, this research estimates parameters that affect the welfare in each country.

International monetary policy coordination in the ASEAN-5+3 countries can be seen as a collective effort to provide an impure public good, which is a collective welfare that can be enjoyed by the participating countries. Welfare here is defined as macroeconomic stability. The benefit of policy coordination is the improvement of welfare for the participating countries. Meanwhile, the cost of policy coordination is the loss of flexibility for the central bank of the participating to country to conduct monetary policy in the presence of shock. When the benefits of coordination for a country exceeds its costs, then the coordination is “potential” to improve the respective country’s welfare. However, the feasibility of such a coordination also depends on the cost-benefit considerations by the “potential” partner(s). A coordination scheme is deemed as “feasible” when **all** countries in the coordination have higher welfare compared to when they do not coordinate policies.

The following are the key findings from the two models:

7.2.1. One-Production-Factor Model

The ASEAN-5+3 multilateral monetary policy coordination is the best feasible policy option for the ASEAN-5 countries. The second-best policy option for the ASEAN-5 countries and Japan is the ASEAN-5 + Japan policy coordination. In these two multilateral coordination schemes, the distributed costs are acceptable both by the bigger and the smaller countries.

Bilateral monetary policy coordination is not feasible for almost all the ASEAN-5+3 countries, where the only exception is bilateral coordination between Thailand and China. It implies that the costs for establishing bilateral coordination exceeds the benefits, except in the case of bilateral coordination between Thailand and China.

Relative size of the participating countries is a factor that affects welfare in most cases of monetary policy coordination. As the provision of the impure public good in this model is based on the weighted sum aggregation technology, countries with bigger weights (measured by their relative economic sizes) will bear more costs than smaller countries. However, it is still possible to establish policy coordination despite big disparity of economic sizes among the participating countries, if other factor(s) have significant impact on the welfare. For instance, strong trade and investment linkages in the global supply chain makes Thailand – China bilateral coordination feasible.

There are only few cases in the one-production-factor model where the difference of parameter values under different interaction regimes are significant. It implies that intermediate-good-producing firms tend to keep their pricing behavior and production differentiation if their country change the interaction regime.

7.2.2. Two Production Factor Model

The ASEAN-5+3 multilateral monetary policy coordination is the best feasible policy option for all the ASEAN-5+3 countries. The second-best policy option is the ASEAN-5 + Japan policy coordination. This finding is in line with the finding in the one-production factor model.

Unlike in the one-production-factor model with only one feasible BC case and three feasible MC cases, there are 18 BC and four MC feasible cases in the two-production-factor model. By having capital as another production input besides labor, intermediate-good-producing firms becomes more adaptable in terms of pricing decision responsiveness and more able to differentiate their products and prices. This leads to more competitive and efficient intermediate goods markets compared to the markets in the one-production factor. Competitive markets help to reduce price markups and manage inflation, thus helps the supranational planner to control inflation.

Unlike in the one-production factor model, there are more cases in the two-production-factor model where there are significant differences between parameter values under different interaction regimes. With the introduction of capital, intermediate-good-producing firms have more ways to produce the same level of output using different combinations of inputs and to differentiate their products, compared to when they have labor as the only production factor.

7.3. Limitations to This Research

There are some limitations to this research, including the following:

(1) This research assumes behaviour uniformity of economic agents to allow the existence of a single representative agent for households, a single representative agent for intermediate-good-producing agent in each sector of the economy, and a single representative agent for final goods producers of the economy. In reality, there are differences in behavior among households and among firms.
(2) This research assumes the use of constant return to scale (CRS) technology by intermediate-good-producing firms. In reality, some intermediate-good-producing firms may have increasing return to scale (IRS) technology.
(3) This research assumes free capital mobility of capital. In reality, there are restrictions of capital movement across countries.

(4) This research assumes that interest rate is the only available monetary policy instrument for central banks. In reality, central banks also have other monetary policy instruments, such as foreign exchange reserves and government and/or central bank securities.

(5) The research uses static (one-off) game theory model rather than the dynamic (sequential) model. In reality, the ASEAN-5+3 countries interact continuously one to another and can opt to coordinate or not coordinate monetary policies at different point of times.

7.4. Suggestions for Future Studies

Future studies on policy coordination or economic integration can improve the models used in this research and expand the scope of the analysis. The models in this research can be improved by (but not limited to) the following options: (i) introduction of restrictions on capital mobility across countries; (ii) introduction of other production factor besides labor and capital (such as oil); (iii) differentiation between physical and financial capital; (iv) differentiation of economic agents (such as differentiation of households based on their income group); and (v) introduction of other monetary instruments available for central banks or supranational planner. Further study can also expand the scope of international policy coordination by including fiscal policy coordination, exchange rate coordination, and/or trade policy coordination.

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