Essays on the Conduct of Monetary Policy in ASEAN Countries

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A thesis submitted for the degree of Doctor of Philosophy of the Australian National University

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I declare that:

This thesis is written by me when I was studying at the Australian National University; the work is my own, unless otherwise indicated, and it has not been submitted for any other degree or professional qualification.

January, 2008

Arief Ramayandi
Abstract

The thesis is an attempt to further understand the conduct of monetary policy in the countries of ASEAN. It exploits the new open economy macroeconomics approach to analyse the issue. The analysis has three main elements: (i) an examination of the historical conduct of monetary policy over the last fifteen years, (ii) analysis of the way in which monetary policy affected the aggregate economy, and (iii) an assessment of monetary policy efficiency. The results suggest that the conduct of monetary policy in ASEAN countries can be represented by a simple Taylor type rule that is generally consistent with the price stabilising objectives of their monetary authorities. The estimated simple small open economy model reveals the monetary transmission mechanisms and analyses the channel through which monetary policy affects the aggregate economy in each of the countries considered. The micro foundations embedded in the model also reveal the deep structural parameters characterising each of the economies, and provide a basis for comparing their structural characteristics. Additionally, the modelling enables one to approximate the aggregate social loss function faced by each of these economies and this function can be used to analyse the welfare implications of alternative monetary policy regimes. The thesis suggests that the conduct of monetary policy in the economies considered is not yet optimal, and hence there is room for exploring alternative designs for monetary policy in order to improve its efficiency.
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Chapter 1

Introduction

The outbreak of the Asian financial crisis in late 1997 sent many countries in East Asia into recession. The larger members of the Association of Southeast Asian Nations (ASEAN) were no exception. The crisis that originated in Thailand soon spread around the region and slashed the real gross domestic product (GDP) of these countries dramatically. In 1998, real GDP dropped by more than 13 per cent in Indonesia, 7 per cent in Malaysia, and 10 per cent in Thailand on top of the drop in real GDP of about 1.5 per cent in 1997. Even countries that were not considered to be heavily affected by the crisis also experienced a fall in real GDP. In Singapore, GDP dropped by about 1.5 per cent and in the Philippines by about 0.6 per cent in 1998.

This episode underscored the high level of inter-relationship among the economies in the region and renewed calls for tighter regional economic cooperation. In ASEAN, the heads of government set out their ASEAN ‘Vision 2020’ statement in December 1997 in response to the crisis. The vision contains messages that favoured moving towards closer regional cohesion and economic integration. The Vision statement was soon followed by an action plan concluded in the following year at the ASEAN Summit in Hanoi. The action plan called for, among other things, a strengthening of the financial system in the region to maintain regional macroeconomic and financial stability as well as efforts to intensify cooperation on monetary, tax and other financial related matters.

In addition to the responses calling for closer regional economic cooperation, most ASEAN countries also reviewed domestic strategies for conducting stabilisation policy. Commonly these economies, some sooner some later, shifted the direction of their monetary policy strategy towards inflation targeting. This shift in strategy was marked by the granting of more independence to the monetary authorities in conducting monetary policy. Central banks, particularly in ASEAN countries severely affected by the crisis, came to conduct monetary policy aimed at restoring the economy by way of stabilising inflation.

The economic performance of the five largest ASEAN (the ASEAN-5)\textsuperscript{3} economies progressed relatively well in the aftermath of Asian financial crisis. Although the speed of the economic recovery varied across countries, most of the ASEAN-5 have been relatively successful in stabilising their macroeconomic environments. Compared to the crisis period, the aggregate inflation rate and exchange rate volatility have generally been reduced, and interest rates have been reduced considerably relative to their level in the pre-crisis period. Some argue that this achievement was mainly due to favourable external conditions, which were exogenous to these countries' policies. However, the role of endogenous factors such as macroeconomic policy efforts from within the countries may also have played a role in achieving and maintaining this economic performance.

Monetary policy is viewed as playing a central role in maintaining price stability and has become a key tool in managing short-run business cycle fluctuations. For that reason, the conduct of monetary policy in ASEAN countries emerges as an important issue, especially in relation to the ability of these countries to conduct their monetary policy effectively and efficiently. In the context of the ASEAN economies, this issue has mostly been discussed normatively. Although the focus varies, the common conclusion is that the monetary policy regime adopted by these countries played some role in affecting improved economic outcomes. Another view in this context is that having a more integrated regional monetary system may provide a better economic environment for these countries. More formal cooperation in

\textsuperscript{3}Namely, Indonesia, Malaysia, Singapore, Thailand and the Philippines.
monetary policy, such as currency cooperation in ASEAN,\textsuperscript{4} has been contemplated. However, at present the general conclusion on the advantage of this form of monetary integration recommends caution on moves in that direction.

The European Union (EU) model is often used as a benchmark in analysing the prospect for economic integration within ASEAN. It is frequently argued that based on the economic criteria for an optimum currency area (OCA), the region is quite suited to the formation of a regional monetary arrangement.\textsuperscript{5} This view is justified on at least two grounds: (i) the increasing trend of trade intensity within the region, and (ii) similarities in the nature of economic shocks in regional economies. In terms of levels of economic development, however, these countries still tend to be quite heterogenous. Although this issue appears to be an impediment for fulfilling the ideal conditions for an OCA, it does not mean a regional monetary arrangement in the region is totally impossible.

Bayoumi et al. (2000) compare the ASEAN situation with the situation in the Euro area before the Maastricht Treaty. They argue that, in economic terms, although ASEAN is less suited to regional monetary cooperation, the situation in ASEAN is not much different to the situation in the Euro area prior to the signing of the treaty.

A more serious question about the desirability of establishing a regional monetary arrangement in ASEAN in fact comes from the region’s relatively weak performance in meeting the political preconditions for an OCA. The region is lacking in potential leaders for putting a regional monetary arrangement in place, and it also lags far behind the Euro area in terms of individual member country political commitment to move in that direction.

A strong political commitment that can survive for an extended period within the region is needed if a regional monetary arrangement is to be realised. This is not yet evident in the ASEAN countries. The idea for regional monetary cooperation was put forward as a possible vehicle for improving economic stability in the region,\textsuperscript{4,5}

\textsuperscript{4}As noted in the four pillars of the ASEAN roadmap for financial and monetary integration. (See the ASEAN fact sheet, 16\textsuperscript{th} of April 2007; available at http://www.aseansec.org/Fact%20Sheet/AEC/2007-AEC-009.pdf)

\textsuperscript{5}See, for example, Bayoumi et al. (2000) and Ramayandi (2005).
particularly in response to the financial crisis in 1997-1998. But there is still no consensus over how to undertake the difficult decisions required to push ahead with the arrangement, such as giving up the independence of national central banks, adhering to fiscal and exchange rate arrangements even if at some point they may be in conflict with what would be adopted on the basis of purely domestic considerations, and accepting supra-national directives (Bayoumi et al., 2000).

The OCA literature documents the benefits as well as costs of a regional monetary arrangement. In order to gain political commitment from potential participants in such an arrangement, the perceived benefit from participating needs to exceed the perceived cost of committing to it. Adequate recognition of the potential welfare gain from committing to regional policy cooperation by leaders of the potential participants is a necessary starting point for building political commitment. Analysis and research on the potential welfare payoffs from alternative monetary policy strategies for ASEAN, let alone from participating in a regional monetary arrangement, is still scant.

Hence, understanding the welfare implications of alternative monetary policy strategies for countries that are potential candidates in a regional monetary arrangement is important. This thesis seeks to contribute to that understanding by looking at macroeconomic modelling foundation that is appropriate for assessing the welfare implications of alternative monetary policies for the case of the ASEAN-5 countries. It focuses on analysis of the conduct of monetary policy in order to gain a better understanding about how monetary policy works in each of the individual countries within the ASEAN-5.

More specifically, the analysis that follows is designed to address the following questions: (i) What determines monetary policy in the selected ASEAN countries? (ii) How does the transmission mechanism of monetary policy work in these economies? (iii) Has monetary policy been conducted efficiently? And, (iv) is there scope for improving policy making?

The thesis limits its empirical analysis by focusing only on the ASEAN-5 coun-
tries. Aside from data availability considerations, this sample represents a group of emerging, open market economies with varying levels of development and different monetary policy regimes. The ASEAN group also represents the five largest economies in the region, and countries which are commonly considered as potentially the initial participants in any ASEAN monetary arrangement that might be formed.

The main methodology used for the analysis follows the tradition of the modern macroeconomic analysis by employing a dynamic, stochastic, general equilibrium (DSGE) model for a small open economy. The model is based on micro foundations that specify the structural relationships in an economy through the optimising behaviour of economic agents. The model is, therefore, firmly grounded in the principles of economic theory and often considered to be useful for conducting counterfactual policy experiments as well as assessing their welfare implications.6

The analysis of the thesis is structured as follows. Chapter 2 provides a brief overview of recent developments in modern open economy macroeconomic modelling and their relation to stabilisation policy analysis. It focuses on a small open economy version of a class of New Keynesian models and the empirical strategies to bring these models closer to the data. Chapter 2 also provides discussion of current developments in modelling monetary policy and assessing its efficiency.

In Chapter 3, the analysis seeks to approximate the historical conduct of monetary policy in each of the ASEAN-5 countries. This is done by applying a simple monetary policy reaction function that performs well in explaining the historical conduct of monetary policy in more advanced economies. The analysis shows that a simple monetary policy reaction function is able to explain the setting of monetary policy in the sample countries under consideration. Further, the findings also uncover the main drivers behind the conduct of monetary policy in these countries and provide a relatively consistent explanation of the monetary policy episodes in the sample economies.

6See the discussions in Chari and Kehoe (2006), Gali and Gertler (2007) and Mishkin (2007), among others.
Chapter 4 examines the suitability of a simple structural small open economy model in characterising the economic dynamics in the five ASEAN economies. The model employed is a variant of a small open economy model with imperfect competition and nominal rigidities. It is tested on the ASEAN-5 data using maximum likelihood estimation. The structure of the underlying model is able to produce estimated parameters that largely capture the economic characteristics and dynamics of each of the economies in a plausible manner. It enables one to compare and contrast the behaviour of the five economies under consideration, particularly their monetary transmission mechanisms. The chapter also revisits the issue of the correlation of structural shocks in the region. The structural model employed shows that the correlation of productivity shocks (a component of the structural shocks commonly considered for this type of analysis) among the five countries considered in the analysis is not as strong as often suggested by VAR-based studies.\(^7\)

Chapter 5 investigates whether or not monetary policy has been conducted efficiently in the five ASEAN economies. It derives a utility-consistent social loss function, as a metric for welfare, to assess monetary policy efficiency in a small open economy model representing the countries under consideration. The optimal monetary policy that minimises the social loss function is solved using the structural parameters obtained in Chapter 4. The results are largely consistent with the conventional wisdom from the literature, where policy based on credible commitment gives the best welfare outcome. The chapter further examines the welfare implications of the currently adopted simple monetary policy feedback rule for each of the sample economies. This exercise points out that there is room for improving the performance of monetary policy, and it should be explored further. It also suggests the possibility that monetary authorities in the sample countries may be optimising over an objective function that differs from the social welfare function derived in the chapter.

Finally, Chapter 6 provides some general conclusions and their implications for pol-

\(^7\)See Zhang et al. (2003), Kawai and Motonishi (2005), Tang (2006), Huang and Guo (2006) and Ahn et al. (2006), among others, for examples of the VAR-based studies.
icy. It summarises the main findings of the thesis and discusses some possible directions for future research.

The analysis of the thesis does not seek to address directly the issue of regional monetary cooperation in ASEAN. It instead steps back from that issue to focus on the making of monetary policy in each of the individual countries within the ASEAN-5. The aim, therefore, is to gain a better understanding of the formation and transmission of monetary policy in each of these countries. This analysis can be used to assess the scope for improving policy making in these countries. If it turns out that the conduct of monetary policy in each of the countries has been close to optimal, then contemplating regional monetary cooperation (like what is noted in the four pillars of the ASEAN roadmap for financial and monetary integration)

will be more difficult since the potential gain from such arrangements may not be substantial enough to promote stronger political commitment from the potential participants.

The findings of the thesis suggest that the conduct of monetary policy in the selected ASEAN economies is not yet optimal. There is considerable scope for improving monetary policy in these countries. This includes experimenting on better domestic monetary policy regimes that can potentially improve the welfare outcome as well as contemplating regional monetary arrangements within the region. These exercises are beyond the scope of this thesis. With respect to analysing the implications of regional monetary arrangements, however, the analysis provided in the thesis can be viewed as a step towards constructing a regional macroeconomic model that can be used to assess the welfare implications of such arrangements.

\(^{8}\)See footnote 4.
Chapter 2

Literature Review

2.1 Introduction

The high and volatile inflation episode in the 1970s has led the economics profession to question the effect of inflation on economic growth. Fischer (1993) and Andersen and Gruen (1995), for example, provide surveys of studies of the cost of inflation on real economic activities. Although a conclusive view on the issue is still under debate, the present general consensus is that high and volatile inflation tends to be detrimental to economic growth.\(^1\) Since then, the conduct of monetary policy, as the main device for pursuing a short run macroeconomic stabilisation program, has been directed to targeting for stable and relatively low inflation rates (Goodfriend, 2007).

Over the past three decades or so, average inflation worldwide has fallen noticeably. Rogoff (2003) noted that average inflation in the advanced economies fell from 9 per cent in the early 1980s to 2 per cent in the early 2000s, while in the case of developing economies, it fell from the average of 31 per cent to somewhere under 6 per cent within the same period. Besides the role of monetary policy, Rogoff argues that the process of globalisation has helped in supporting a political economy of low inflation. The latter is said to be a possible reason for lower inflation through engineering higher competition and productivity around the globe.

The success of monetary policy in reducing inflation around the world has benefited from the progress made in macroeconomic theory over recent decades. Chari and Kehoe (2006), Gali and Gertler (2007) and Mishkin (2007), among others, provide detailed reviews of this issue. They argue that, although the ‘art\(^2\) elements remain a part of the actual practice in shaping monetary policy, the role of modern macroeconomic models – that are heavily grounded in the principles of economic theory – is also very important. This recent vintage of macroeconomic models, widely known as the New Keynesian models, constitutes a modern macroeconomic theoretical consensus that synthesises both the Neoclassical and the Keynesian views about how the aggregate economy operates.\(^3\) According to Goodfriend and King (1997), these models are built by incorporating three key elements: (i) intertemporal optimisation of the economic agents in making their decisions, (ii) rational expectations, and (iii) imperfect competition and costly price adjustment. They are, therefore, rich enough to provide a micro-foundation for the representative agents’ behaviour, and hence tend to be less susceptible to the Lucas critique when used to evaluate alternative policies.

This class of the New Keynesian models generally entail significant welfare costs of inflation. Consequently, their policy implications are often associated with those that target inflation. Many monetary authorities and supra-national agencies have started to develop relatively large scale open economy models for helping them in conducting policy analysis, for example the SIGMA model of the US Federal Reserve (Erceg et al., 2006), the BEQM model of the Bank of England (Harrison et al., 2005), the ToTEM model of the Bank of Canada (Murchison and Rennison, 2006) and the GEM model of the IMF (Tchakarov et al., 2004, Laxton and Pesenti, 2003).

This chapter provides a brief overview of recent developments in monetary policy analysis, in particular, outlining the development of simple open economy New Keynesian models and their utilisation in helping to formulate and address stabilisation policy questions. Section 2.2 provides an overview and discussion of recent devel-

\(^2\)Mishkin (2007) defines ‘art’ as the use of judgement that is less explicitly based on the information obtained from a formal model.

\(^3\)Goodfriend and King (1997) dubbed these models the New Neoclassical Synthesis.
opments in the area of open economy macroeconomic models. Section 2.3 discusses modelling monetary policy in relation to the setting of these models. Section 2.4 discusses attempts in bringing these models closer to the data to obtain empirical economic models for addressing current and future policy questions. Section 2.5 concludes with a brief overview of applying such models to the ASEAN economies covered here.

2.2 The Workhorse of Modern Monetary Policy Analysis in an Open Economy

2.2.1 The rise of new open economy macroeconomics

In his seminal contribution, Lucas Jr (1976) criticises traditional structural macroeconomic models, arguing that the absence of an optimisation-based approach to the development of a model’s structural equations imply that the estimated model coefficients are not invariant to changes in policy regimes or other types of structural changes (the Lucas critique). Accordingly, these models are not suitable for evaluation of alternative policies. This critique had a large impact on the development of the literature, leading to an emergence of two distinct approaches to macroeconomic analysis. The first is vector autoregressive (VAR) analysis (Sims, 1980), which relies on time series analysis of macroeconomic relationships and pays less attention to modelling their theoretical structure. The second is the real business cycle (RBC) analysis (Kydland and Prescott, 1982 and Long and Plosser, 1983) that relies on the dynamic, stochastic, general equilibrium (DSGE) models based on micro foundations in economic theory to explain macroeconomic phenomena.

New Keynesian models are built on the RBC model, enriching its structure through incorporating imperfect competition and nominal price stickiness. It therefore has appropriate micro foundations in deriving its structural equations. The dimensionality of a simple closed economy version of this model can normally be reduced into a dynamic system with three equations that models the aggregate demand and supply
(AD-AS) sides of an economy. The AD side is denoted by a dynamic IS equation, formed by log-linearising the consumption Euler equation from the inter-temporal optimisation of the household sector, and an LM equation representing the money market equilibrium condition. The AS side is normally represented by the dynamic short run Phillips curve emanating from staggered nominal price setting mechanisms that characterise the firm sector in the economy.

In an open economy setup, the model is complicated by its connection with foreign economic activities. It involves introducing exchange rates, the terms of trade, export and import activities, as well as international financial markets explicitly into the model. Consequently, besides being affected by domestic supply and demand shocks as in a closed economy case, an open economy is also subject to various foreign disturbances. This implies a different transmission channel for domestic stabilisation policies since the exchange rate acts as an additional transmission channel for both stabilisation policies and the effect of foreign shocks to the domestic economy. Focusing on monetary policy, Clarida et al. (2001) argue that under certain assumptions, the policy problem faced by a small open economy is isomorphic to that of a closed economy. That is, the nature of the underlying output and inflation trade-off remains similar. Monacelli (2005), however, introduces an incomplete pass-through effect in import prices to an open economy model specification and points out that this similarity is no longer true once the particular assumptions were relaxed.

Obstfeld and Rogoff (1995) develop a two country dynamic general equilibrium model (the Redux model) with nominal price rigidities to analyse the dynamics of the exchange rate and other macro variables in response to changes in monetary and fiscal policies. This influential work has initiated a new wave of research on new open economy macroeconomics (NOEM). Lane (2001) and Sarno (2001) provide a more detailed survey on developments in this line of literature.

4See works by McCallum and Nelson (1999a) and Clarida et al. (1999), among others.

5The representation of the money market condition varies depending on the approach used in deriving the model. For example, McCallum and Nelson (1999a) motivate this representation by introducing money in the household’s utility function. Clarida et al. (1999), on the other hand, leave this out of the system by using the nominal interest rate as policy instrument. The latter implies that money only serves the role as a unit of account in the economy.
2.2.2 Basic structure of the NOEM models

Most of the open economy models that fall in the NOEM tradition build up their basic structure based on the Redux model. This model is a two country, dynamic general equilibrium model with micro foundations that allows for imperfect competition, nominal price rigidities, and a continuum of rational optimising agents who both produce a single differentiated good and consumes. The two countries are symmetrical, in the sense that both are populated by representative agents that have identical preferences, characterised by an intertemporal money in utility (MIU) function that is increasing on consumption and real money balances but decreasing on work effort. There is no capital in this model and agents have access to an international riskless assets market at a constant interest rate.

The representative agent maximises his/her lifetime utility subject to a dynamic budget constraint. The first order necessary conditions (FONCs) from this maximisation problem imply three fundamental features of the model. The first is the standard intertemporal Euler equation, which implies a flat time path of consumption over time. The second is the money market equilibrium condition that equates the marginal rate of substitution between consumption and real money balances to the nominal interest rate. The third is the standard infratemporal optimality condition for an agent’s labour-leisure choice, where the marginal utility from producing an extra unit of output (the real wage) equals its marginal disutility of effort.

There are no impediments to international trade in this model and the law of one price (LOP) holds for each good at all times. Consequently, purchasing power parity (PPP) holds for a basket of goods across the two countries and, by implication, the real exchange rate (RER) is constant. Any temporary variations in the RER are expected to revert back to its mean.

The Redux model also has a relatively simple structure of price setting mechanism, that is, firms are assumed to simultaneously set their prices one period in advance.

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6Examples for this kind of models are plenty. For example, Corsetti and Pesenti (2001), Betts and Devereux (2000), Obstfeld and Rogoff (2002) and Benigno and Benigno (2003), to name a few.
Accordingly, all adjustments are completed within one period. Subsequent work in the NOEM literature has introduced sticky prices as an argument to enrich the model’s structure. With this argument, monetary policy can have real effects in the short-run. An increase in money supply lowers the nominal interest rate and, via the uncovered interest parity (UIP) condition, the exchange rate depreciates. This induces real exchange rate depreciation and temporarily increases demand for domestically produced goods, hence leading to higher output. Although mostly introduced by assuming nominal price stickiness, this nominal stickiness can also be introduced by assuming nominal wage stickiness (for example, Hau, 2000) or even assuming both (for example, Christiano et al., 2005).

In order to match the dynamic features in the data, a smooth price level adjustment is preferred over a discrete one. To induce such a smooth adjustment, the literature has relied on some sort of staggered price mechanism in modelling the price adjustment process. One way to invoke this process is through introducing a Calvo-type (1983) price setting mechanism, where only a fixed random fraction of firms can reset their price optimally within each period. Often, however, this mechanism fails to capture the level of persistence observed in the data. Smets and Wouters (2003) and Christiano et al. (2005), among others, augment the Calvo pricing mechanism by allowing the non-optimising firms to adjust their prices by indexing it to the previous period’s inflation. Mankiw and Reis (2002) propose an alternative way by arguing that inflation inertia observed in the data comes from sticky information rather than sticky prices. Both approaches invoke a similar functional form for the inflation process, where current inflation are functions of previous and expected future inflation, and the marginal cost.\footnote{This function is often referred to as the New Keynesian Phillips Curve (NKPC), which represents the short run aggregate supply in the models.}

Labour is the only production factor considered in the redux model. In this respect, the model can be considered a short run model, viewing output as demand-determined. This parsimonious modelling approach to the supply side provides convenience by enhancing tractability of the model. Chari et al. (2002), however,
point out the benefit of incorporating capital into the model. An expansionary shock in monetary policy that lowers the interest rate can cause an investment boom in the model economy, hence providing another transmission channel for monetary policy. The explicit inclusion of capital in the model also opens room for relaxing the complete financial market assumption in the basic model. This assumption undermines the importance of financial frictions to the business cycle. Introducing imperfect financial market assumptions to the model, such as incorporating the financial accelerator model (Bernanke et al., 1999b) or the agency cost model (Carlstrom and Fuerst, 1997), can enrich the model further. This enrichment, however, does not come without costs. The inclusion of imperfect financial market assumptions increases the degree of complexity in the model, hence affecting its tractability. Schmitt-Grohe and Uribe (2003) point out that the small open economy models with incomplete asset markets are generally very sensitive to the choice of initial conditions and features equilibrium dynamics that possess a random walk component. They compare alternative assumptions (including imposing a complete asset market assumption) that are commonly used to close the model and argue that all models deliver virtually identical dynamics at business-cycle frequencies. Further, Chari et al. (2002) suggest that, under the pricing to market (PTM) assumptions, the incompleteness of financial markets makes little difference for the persistence of monetary shocks. Devereux et al. (2006) also argue that although it has a magnifying impact on volatility of some key variables in their model, the impact of financial frictions do not affect the ranking of monetary policy rules in their analysis. While some studies suggest that the role of financial frictions do not seem to be significant in altering the dynamics of the model, this area of expanding the model still needs to be studied further, particularly in how to incorporate financial frictions appropriately into policy deliberations (Mishkin, 2007).

Another common modification to the baseline Redux model is on relaxing the LOP assumption. This particular assumption tends to restrict the model in matching a persistent effect on real exchange rate frequently observed in the data. Introducing
international market segmentation into the baseline model, like introducing a PTM assumption as in Betts and Devereux (2000), or an incomplete exchange rate pass-through on import prices assumption as in Monacelli (2005).\(^8\) can potentially relax this restriction by allowing for a deviation from the LOP. A deviation from the law of one price suppresses the expenditure switching effects of changes in the exchange rate. It limits the impact on consumption, and hence increases the size of the exchange rate movements needed to satisfy the monetary equilibrium condition. In other words, it re-opens the possibility of short run exchange rate overshooting, which is absent in the basic Redux model.

The Redux based NOEM models generally focus their attention on a world economy composed of two countries that are comparable in size. This family of models is, therefore, often useful for analysing the welfare implications of macro-policy cooperation among nations.\(^9\) The framework, however, is not entirely suitable for analysing the case of an open economy that is too small to affect the foreign economies (a small open economy). Gali and Monacelli (2005) develop a model (SOE model) that is specifically designed to deal with this problem, where the small open economy (SOE) is modelled as one among a continuum of (infinitesimally small) economies making up the world economy.

The basic structure of the SOE model is similar to that of the Redux model, except for several important aspects. Gali and Monacelli emphasise the distinction between domestically produced and imported goods for consumption (a consumption split).\(^10\) Both importers and exporters are assumed to be price takers in a perfectly competitive world market, hence the LOP holds. Money does not generate utility and only functions as a unit of account in this model. The price setting structure in the SOE model is driven by the Calvo price setting mechanism.

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\(^8\)Obstfeld and Rogoff (2000), however, criticise the PTM-LCP (LCP stands for local currency pricing) approach as highly implausible because its assumptions and predictions appear to be inconsistent with many other facts discussed in their paper.

\(^9\)For example, see Corsetti and Pesenti (2001) and Obstfeld (2002).

\(^10\)McCallum and Nelson (1999b, 2000) offers an alternative way of treating import not as finished consumption goods, but rather as intermediate inputs for domestic production sector. They show that this treatment is able to provide some empirical attraction as well.
The most distinguishing feature of the SOE model lies in the share of imported goods in the consumption basket of the foreign economy in the model. The asymmetry between home economy and its foreign counterpart is introduced by assuming that the home economy is small relative to its foreign counterpart, in the sense that the share of home goods in foreign consumption is negligible. That is, this share is virtually zero in this case. Therefore, the home economy can be considered as a small open economy (SOE) and its foreign counterpart as the rest of the world (ROW).

Monacelli (2005) extends the Gali and Monacelli (2005) analysis further by introducing monopolistic competition in the importing sector. While competition in the world market may bring import prices close to their marginal cost at the wholesale level, the rigidities arising from inefficient distribution networks and monopolistic retailers allow domestic retail prices to deviate from the world prices. This treatment introduces the notion of deviations from the LOP and induces an incomplete exchange rate pass-through effect in the model, hence invoking rigidity in the nominal imported goods prices as well.

### 2.3 Monetary Policy

#### 2.3.1 Monetary policy representation

From a modelling perspective in general, a monetary sector is introduced to act as a closure for the model in order to obtain an identified structure. This sector is normally characterised by a function that describes the monetary authority’s behaviour or the monetary policy regime of the respective economy. The function summarises the monetary authority’s behaviour in the form of its policy reaction function, where the policy instrument responds to development of some key macro aggregates.

What instrument (interest rates or monetary aggregates) should be assigned for conducting monetary policy is an issue that has been debated for decades. Poole (1970) sets out the theoretical conditions under which one is preferred over the other.
Blinder (1997) has called this controversy history. On practical grounds, Goodfriend (1991) and Goodhart (1995) argue that regardless of what monetary regime a monetary authority claims it follows, the actual implementation of monetary policy can be approximated by looking at how a monetary authority sets the short-term interest rate. Nowadays, we see more and more cases in which volatility in money demand dominates volatility in aggregate spending. As suggested by Poole, most monetary authorities then use short run interest rates as their central policy instrument.

Consistent with this assessment, NOEM models generally describe the monetary sector by a simple interest reaction function (IRF), where the policy rate responds to deviation of inflation from its target and the output gap. Variants of this simple IRF have been documented to provide excellent fit to the actual movements in the policy rate, see Clarida et al. (1998, 2000), Taylor (1999) and de Brouwer and Gilbert (2005), among others. To an extent, these findings provide empirical justification for the suitability of the IRF in approximating the policy regime adopted by the monetary sector in the model.

The direct role of exchange rate changes in a simple IRF for a small open economy is an unsettled issue. Empirical investigations in this case offer mixed results. Historical estimates for some small open economies suggest a direct role of exchange rate changes in driving monetary policy, while some others do not. Ball (1999) proposes an alternative open economy monetary policy specification that is based on a monetary condition index (MCI), that is, an index of a weighted combination of interest rates and exchange rate changes. However, as discussed in Eika et al. (1996) and Batini and Turnbull (2002), this approach contains potential flaws and tends to perform less efficiently relative to the standard IRF (Batini et al., 2003). Moreover, Taylor (2001) argues that including exchange rates directly into an IRF does not yield much improvement in the performance of the optimal monetary policy rule. Even in the version of simple IRFs that excludes exchange rates, the impact of exchange rate movements is already reflected in the outcome of inflation and the

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12 See Clarida et al. (1998) and Lubik and Schorfheide (2007) for an example of these different findings.
output gap that are considered in making interest rate decisions. Therefore, adding exchange rates as additional information in the IRF will not make a substantial contribution.

Another thing worth mentioning is the fact that all empirical findings related to the historical IRF estimation suggest that the policy rate is subject to inertia. That is, changes in the level of monetary authority’s operating target occur through a series of adjustments in the same direction rather than immediately. This behaviour may be rationalised on the grounds that monetary authorities seek to smooth movements in interest rates in addition to other policy objectives such as inflation stabilisation. It is a common logic that nominal interest rates are bounded below at zero. The smoothing behaviour of the monetary authority may act as a device to avoid large movements in the policy instrument, particularly when interest rates have been practically low. In other words, the authority’s smoothing behaviour may possibly prevent the policy rate from going below zero. Further, Woodford (2003b) argues that this preference for interest rate smoothing on the part of a monetary authority can have desirable consequences since it can result in history dependent central bank behaviour which, when appropriately anticipated by the private agents, serves the authority’s stabilization objectives through its effects on current outcomes of anticipated future policy.13

2.3.2 Measuring monetary policy efficiency

More recently, the literature has devoted more attention to the study of optimal policy rules rather than the historical estimates of simple policy reaction functions. The focus of this line of studies is to identify the most efficient policy representation in order to meet the policy objective. A number of important implications stand out from this line of literature. The first is that optimal policy embeds inflation targeting in the sense that it calls for gradual adjustment to the optimal inflation rate. The second is the emergence of the Taylor principle (Woodford, 2001a), where

13Sack and Wieland (2000), Rudebusch (2006) and Christiano et al. (2007) provide similar argument along this line.
nominal interest rates should adjust more than one-for-one to expected inflation in order to ensure stability in an economy. The third is the idea that monetary policy can completely offset demand shocks but supply side shocks create a short-run trade-off between inflation and output variability. Finally, optimal policy depends critically on the degree of persistence in both inflation and output, which leads one to emphasise the needs for more realistic and empirically consistent models for conducting monetary policy analysis.

The analysis of optimal monetary policy is normally conducted by way of targeting rules. This analysis proceeds by defining an objective function that a monetary authority wants to optimise. Traditionally, this is done by introducing an ad-hoc quadratic aggregate loss function that is penalised by both inflation and output gap variances. An optimal policy is then defined as a policy reaction function that minimises this loss. The simple IRF (the Taylor type of rules) discussed above is often thought as consistent with an optimal policy rule (Woodford, 2001a), particularly when inflation is set as a target. Both the basic arguments in this simple IRF (deviation of inflation from its target and the output gap) are indicative of inflationary pressures. Therefore, it suggests that a monetary authority needs to react whenever there is pressure for prices to change.

While the ad-hoc quadratic loss function has been useful for analysing optimal monetary policy, this function is not so widely accepted as a representative of the social loss function of an economy. Woodford (2002) shows that this type of aggregate loss function can be approximated based on the welfare of private agents in the case of an explicit optimising model of private agents' behaviour. This utility-based aggregate loss function (the social loss function) justifies the importance of inflation stabilisation as the goal of monetary policy in the framework of optimising models. Therefore, the typically assumed ad-hoc quadratic loss functions for evaluating monetary policy can be characterised in a way that is consistent with a utility based welfare criterion, and hence can be used to gauge welfare implications of conducting

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14Svensson (1999) provides thorough discussion about the definition of 'instrument rules' and 'targeting rules'.

15Following an influential contribution of Barro and Gordon (1983).
monetary policy. There is a distinction between using it for analysing optimal monetary policy with respect to some arbitrary institutional objectives and to using it for evaluating a social welfare objective.

In relation to the importance of inertial behaviour in monetary policy often found empirically, many studies on optimal monetary policy have modified the aggregate quadratic loss function to include nominal interest rate variability in it (see, for example, Batini et al., 2003, Woodford, 2003b and Dennis, 2006). This inclusion implies that the optimal policy rule will have the lagged policy rate as one of its arguments, hence motivating the smoothing behaviour of the monetary authorities. While this treatment works well in terms of justifying the functional form of policy rules found in empirical estimations, it also implies that the loss function assigned to the problem deviates from the one consistent with social welfare. This aggregate loss function, however, does not necessarily have to be interpreted as ad-hoc. Woodford (2003a, Chapter 6) provides a welfare theoretic justification for this type of aggregate loss function, for example, by explicitly introducing a zero interest rate lower bound assumption or the effect of transaction frictions in the demand for money into the optimisation model.

2.4 Characterising the Model

During their initial development, the micro founded DSGE models were mostly used to conduct qualitative analysis to provide insights for policy makers. Although rich in theoretical foundations, these models are too stylised to capture the dynamics found in the data. More recently, there have been efforts to develop models that possess the power of DSGE theory but with a better empirical fit to complement existing macroeconomic tools for policy evaluation and forecasting analysis has been growing. This is done largely by taking the model structure to fit the data through characterising it using various different statistical techniques. This section briefly overviews the different methods currently available for estimating a DSGE model. Canova (2007) provides a more detailed analysis in comparing the methods outlined
in this section and Ruge-Murcia (2007) compares the performance of the method of moments based and the likelihood based estimation approaches in taking DSGE models to the data.

2.4.1 Parameter calibration

Earlier quantitative analysis of this class of models follows the RBC tradition by calibrating the model to match certain features of the observed data following the influential work of Kydland and Prescott (1982). As suggested in Kydland and Prescott (1991, 1996), this procedure involves first specifying a collection of empirical regularities (stylized facts) that the model is supposed to account for. It involves choosing a set of structural parameters to match a subset of these stylized facts, then simulating the model and evaluating the quality of its simulated outcomes in terms of its ability to mimic the empirical regularities of the data. The common criterion used is to match the unconditional moments of some defined key variables simulated from the model to their counterparts based on the data. In this sense, the theoretical model is treated as a tool to perform computational experiments rather than a structure to estimate a set of parameters characterising it.

Although useful in gaining empirical insights of the structural model, the calibration method is often considered to be insufficient to obtain an overall empirical evaluation for this class of models. In addition, calibration methods are often criticised for abstracting from the sampling uncertainty of the parameters in the model with limited means of formally assessing its statistical validity. More recently, the use of more formal estimation methods (to be discussed below) for applying DSGE models directly to the data has been growing. Unfortunately, these methods are not free from problems, especially when dealing with a relatively large system. This is one of the reasons why larger models such as those maintained by monetary authorities and supra-national agencies still tend to rely on this calibration method.
2.4.2 Minimum distance approach

This method belongs to the similar tradition of calibration methods. It essentially improves on the standard calibration method in the sense that it looks upon a wider set of information to be matched by the model’s structure. Rather than looking at a subset of stylised facts in the data, the minimum distance approach treats a VAR as a good summary of the underlying data generating process (DGP). Rotemberg and Woodford (1998) provide a detailed discussion on this approach. It involves generating some impulse response functions from a VAR structure that is deemed to represent the true DGP. The impulse response functions basically summarise the moments of the data and further decompose them into different noise components, hence allowing one to focus on some specific characteristics in the data. The theoretical model is then characterised by estimating the set of structural parameters by minimising the distance between the impulse responses of the structural model and of the VAR.

Geweke (1999) refers to this as a weak interpretation of structural models. Although seen as an improvement over traditional calibration techniques, the minimum distance approach still uses only limited information, which can amplify the identification problem. For example, a combination of sensible parameter values that matches the VAR’s responses may not be unique. Since impulse response functions depend nonlinearly on the structural parameters and it is usually intractable analytically, the identifiability conditions are not straightforward to check in practice. Furthermore, it is impossible to recover the size of structural disturbances from the impulse responses which often are of economic importance and for policy analysis. Another potential issue comes from the heavy reliance of this approach on the VAR structure chosen to produce the impulse response. As hinted in Kapetanios et al. (2007), this aspect needs to be handled carefully, in the sense that the chosen VAR structure has to be sufficient to represent the true DGP and comparable to the structure of the theoretical model that is to be characterised.
2.4.3 Generalised methods of moments

The minimum distance approach discussed above can be viewed as a special case of the generalised method of moments (GMM) estimator. A number of authors have utilized GMM techniques to estimate structural parameters in RBC models, such as, Christiano and den Haan (1996) and Burnside and Eichenbaum (1996). This method involves identifying a set of moments conditions derived from the structural model to begin with. The structural parameters characterising the model are then estimated by setting the corresponding sample moment conditions to zero. The GMM estimator is sometimes viewed as a more robust estimator because it does not rely on any distributional assumptions, and the estimation can be based on part of the model's FONCs rather than the full set of (non)linearised equations. The fully developed econometric framework also provides a means of making inferential statements as well as specification tests for the model.

This method, however, works as a partial system estimator, and therefore ignores many of the cross equation restrictions implied by the model, which can potentially amplify the problem of identification. The result is similar to the problem of weakly correlated instruments, or the weak identification problem, widely known in the GMM literature. A small sample distribution in the GMM estimation may deviate from the asymptotic one when the weighting matrix is poorly estimated, when the instruments are poorly correlated with the functions we want to instrument for and when too many moment conditions are used in testing relative to the sample size.

2.4.4 Maximum likelihood estimation

The maximum likelihood approach utilises all the information available from the data and inferences on the structural parameters of the model can be directly obtained from the likelihood function. A standard procedure for solving dynamic models is by first linearising the model (Sargent, 1989). The resulting solution of the system has a linear representation in state-space form that can be used to construct the likelihood function to be evaluated. Given a set of observed variables, the
likelihood of the entire model can be evaluated using the Kalman filter. The likelihood function of the model is then maximised in order to get the set of maximum likelihood estimators.

Unfortunately, numerical maximization of the likelihood function is difficult in practice due to the identification problems inherent in standard DSGE models. This issue surfaced in particular because of the stochastic singularity nature of DSGE models. When the number of shocks is smaller than the number of endogenous variables, parameter estimates can be obtained only from a restricted number of series, which essentially transforms full-information methods into limited-information ones. To deal with this issue, Ireland (2004a) suggests a hybrid model that combines the power of a DSGE model with the flexibility of a VAR. This method works well in addressing the identification issue and makes the maximum likelihood estimation method an appealing way for estimating a DSGE model. However, adding structural shocks to the model alters the structure of the original model. One needs to be cautious in justifying these additions.

### 2.4.5 Bayesian method

The use of Bayesian methods in estimating DSGE models has become very popular following the work of Smets and Wouters (2003). The basic idea of this method is, in principle, similar to that of maximum likelihood estimation. It, however, further combines the information contained in the data with some prior information (prior distribution) in estimating the structural parameters of the model. Inferences are based on the posterior distribution of the model (the likelihood weighted by the prior distribution). Further, various statistics of interest, such as the confidence band for the impulse responses, can be simulated directly from the posterior draws in the estimation process. Another advantage of using Bayesian methods is that the posterior distribution provides a probabilistic representation of the parameter and model uncertainty imbedded in quantitative macroeconometric models. An and

\footnote{As in, for example, Kim (2000) and Ireland (2001).}
Schorflieide (2007) provide a nice review of this literature.

Beside the fact that this method is a lot more computationally demanding relative to the ones mentioned above, there are also some drawbacks identified in the application of the Bayesian method. For example, a tightly specified prior can in fact produce a well behaved posterior distribution, so that even when the likelihood function has little information, it still gives the illusion of having collected useful evidence, such as a very small standard error for the estimated parameters. Furthermore, choosing appropriate priors to be used for initiating the estimation process is sometimes also a problem.

### 2.5 Application to the ASEAN Cases

Given the usefulness of this approach in macro policy analysis, it is surprising that its application for the case of developing countries, like the countries in ASEAN, is very limited. To fill in this gap, the thesis takes on the issue by applying the model for the case of selected ASEAN countries (the ASEAN-5) by focusing on monetary policy aspects.

In terms of characteristics, the ASEAN countries are practically open and relatively too small to directly affect the rest of the world. This assessment implies that an appropriate application of structural SOE models described earlier have the potential to improve understanding about the working of these economy by providing insights on their structure. The SOE model proposed by Gali and Monacelli (2005) is used as the foundation for characterising each of the ASEAN-5 economies considered in this thesis. The basic structure of the model needs to be modified in order to invite richer dynamics to improve its empirical consistency.

Introducing external habit formation into the utility function of the representative household is incorporated in order to invoke more persistence in the model’s consumption behaviour. The external habit stock is assumed to be proportional to aggregate past consumption that is taken as exogenous at each time the representative households made their decision. Another necessary extension to the basic model
is made in order to capture the level of persistence in inflation. This involves augmenting the Calvo staggered pricing mechanism with price indexation to previous period’s inflation by the non re-optimising firms to enhance the persistence effect of inflation in the model. Finally, the model also considers an incomplete pass-through effect as in Monacelli (2005).

To explain the historical conduct of monetary policy in ASEAN-5 countries, the thesis adopts a single equation approach as in Clarida et al. (1998) to represent the monetary sector. The equation is estimated using the GMM procedure discussed above in order to check the appropriateness of this particular functional form in representing the sector. Another thing that needs to be considered is the fact that most of the sampled countries underwent monetary policy regime changes within the last two decades. Chapter 3 considers this issue by taking into account the possible changes in the policy regime and provides a reasonable representation of the historical monetary policy regime in each country.

Chapter 4 augments this representation of the historical monetary policy regime into the variant of the SOE model described above and applies it to the data. This is done in order to obtain an appropriate characterisation of the model for each of the sampled countries based on their historical data. The estimation is conducted using a maximum likelihood estimation approach in order to make use of the cross restrictions implied by the model.

Finally, the specific characterisation of the SOE model for each of the economies is used to assess their monetary policy efficiency. Chapter 5 takes up this issue by deriving a utility-based loss function to be used for measuring social welfare. It shows that by using some forcing assumption about how private agents form their expectation on prices of imported goods, the social loss function can be represented in terms of variability of the output gap and inflation. Given the utility-based nature of this social loss function, its characterisation for each of the sampled economies depends on the estimated structural parameters in the theoretical model. The characterised social loss function is minimised under a commitment regime as the benchmark case.
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for measuring the relative level of monetary policy efficiency for each country.

Chapter 3

Approximating Monetary Policy: Case Study for the AMEAN System

1.1 Introduction

Monetary policy research often emphasizes different aspects of monetary policy, including understanding its role in macroeconomic stability. Monetary policy is often considered a crucial element in achieving economic growth and managing inflation. This chapter explores various approaches to approximating monetary policy, particularly focusing on the AMEAN System, which is known for its comprehensive and flexible framework.

The AMEAN System, developed by researchers at the University of XYZ, provides a robust framework for approximating monetary policy decisions. This chapter aims to contribute to the understanding by introducing a novel method for estimating the AMEAN System parameters, offering insights into the functioning of monetary policy under uncertainty.

To help in understanding the system, the chapter introduces a simple model of monetary policy decision-making. This model captures the essence of the AMEAN System, particularly focusing on the expected output gap and the policy reaction function. By doing so, it elucidates the underlying mechanisms that govern the adjustment of monetary policy to deviations from the natural rate of output.
Chapter 3

Approximating Monetary Policy: Case Study for the ASEAN-5

3.1 Introduction

Monetary policy plays a key role in managing economic fluctuations. For that reason, understanding the conduct of monetary policy is of considerable interest. Essentially, monetary policy making is an intricate process where a monetary authority gathers an extensive set of relevant economic information before delivering its policy action. This fact makes efforts for tracking the true representation of monetary policy very complicated. Therefore, a question about whether or not a simple representation can approximate the true conduct of monetary policy becomes relevant. A simple representation of monetary policy, although it may not be very precise, can help in understanding the conduct of monetary policy and provide pictures about possible directions of any future monetary policy stance.

To help in understanding the issues, the literature has sought a simple characterisation of policy reaction functions in order to summarise the monetary authority’s behaviour in setting policy. A common, successful simplification is generally known as the Taylor (1993) type of rule. In this type of rule, the monetary policy stance is typically seen to be driven by fluctuations of inflation around its long-run steady state target and fluctuations in measures of the economic cyclical variable, normally represented by the output gap. The literature in this area shows that variants of the
Taylor type rule have done reasonably well in explaining changes in the direction of monetary policy in the case of developed economy.\(^1\)

While this approach has been relatively successful in approximating monetary policy in the more advanced economies, little is known about the outcome from trying a similar exercise in developing economies. The purpose of this chapter is to examine the simple monetary policy reaction function (PRF) in the case of five ASEAN economies (Indonesia, Malaysia, the Philippines, Singapore and Thailand) in order to understand the setting of monetary policy in the region and to identify the key drivers behind monetary policy making. To serve this objective, I estimate a general form of the simple policy reaction function for each of the five ASEAN selected economies using a sample of quarterly data spanning 1989 to 2004.

One of the challenges in conducting this exercise is that monetary authorities in ASEAN make use of different tools and approaches to implement monetary policy. To deal with this problem, the inclusion of the key interest rate as a common proxy for the policy variable of those economies is justified. Another important issue is that most of the sample countries report shifts in their adopted monetary regime during the chosen sample period. Since the dates for these regime shifts are predetermined, the paper also presents the estimates of policy reaction functions using sub-samples that start or end around those known dates in each case and investigates whether the shifts are clearly reflected in the data.

The chapter is structured as follows. Section 2 provides a brief description of the nature of monetary policy in each of the economies in the sample. Section 3 offers a justification for the choice of proxy for the policy instrument and presents the methodology adopted to conduct the estimation. Section 4 outlines the data set and discusses the issues surrounding it. Section 5 reports and evaluates the findings. Section 6 provides some conclusions.

3.2 Monetary Policy in ASEAN-5 Countries: A Brief Description

The conduct of monetary policy in most of the five ASEAN countries under consideration has varied over the past two decades. This variation was mainly in response to the 1997 Asian financial crisis, and can clearly be seen in those economies that were hit the hardest by the crisis (such as Indonesia and Thailand). For the economies where the impact of the crisis was not as severe (such as Singapore and the Philippines), the changes are less obvious. This section provides a brief general description of the development of monetary policy in these countries over the relevant time period.

3.2.1 Indonesia

The ultimate goal of Bank Indonesia (BI – the central bank of Indonesia) has always been to achieve and maintain stability in the value of its currency (Rupiah). During the pre-crisis period, BI adopted a crawling peg exchange rate regime to achieve this goal.\(^2\) Severe depreciation pressure in the crisis period forced BI to abandon its exchange rate regime and adopt a freer regime within a tighter base money targeting framework. This was done to restore confidence in the currency and to tame inflation. In achieving the base money target, BI relies upon open market operations through the sale of BI certificates (SBI).

Institutionally, there was also a major change in the conduct of monetary policy in Indonesia in the post-crisis period. In 1999 a new central banking law was enacted establishing the independence of BI.\(^3\) The act obliges BI to set an inflation target every year and direct monetary policy to achieve it. In other words, the act requires BI to adopt an inflation targeting type of framework. More recently, the operating target in conducting monetary policy has also shifted from base money targeting to

\(^2\)Based on the classification of the International Monetary Fund (IMF), Indonesia is categorised as having adopted a managed floating exchange rate regime at that time. However, the Rupiah exchange rate was practically fixed to the US dollar with a fixed depreciation rate normally announced once a year.

\(^3\)See Bank Indonesia (2000) for further explanation.
targeting a key interest rate (the 30-day SBI rate).

3.2.2 Malaysia

Price stability that provides a supportive environment for promoting a sustainable level of economic activity is the ultimate objective of Bank Negara Malaysia (BNM – the central bank of Malaysia). To accomplish this objective, the BNM monetary policy strategy prior to the mid-1990s had been based on targeting monetary aggregates. The strategy was internal in the sense that it was not formally announced to the public, where BNM influenced the day-to-day volume of liquidity in the money market in a way that was consistent with its monetary growth target. Large capital inflows and their reversal in the early 1990s, however, were considered to be creating instability in the monetary aggregates, which then became a target of the bank (Cheong, 2005). Consequently, towards the mid-1990s, BNM shifted its focus from monetary targeting to interest rate targeting. For the operational policy target, BNM uses the 3-month interbank rate. As for the exchange rate regime, BNM is then categorised by the IMF as a managed floater. The Malaysian ringgit exchange rate is set to be free within some unannounced band and the BNM intervenes whenever needed.

In response to the Asian financial crisis, the ringgit exchange rate was fixed in the late 1998 and this exchange rate peg was coupled with an imposition of selective capital controls in order to provide BNM with greater monetary autonomy in influencing domestic interest rates to support the economic recovery.\footnote{As argued by Kim and Lee (2004), imposition of capital control and a fixed exchange rate regime may still provide independence for a central bank from an international influence.} In July 2005, however, BNM shifted back to adopting a managed float exchange rate regime for the Malaysian ringgit.
3.2.3 The Philippines

The primary objective of monetary policy of Bangko Sentral ng Pilipinas (BSP – the central bank of the Philippines) is to maintain price stability conducive for balanced and sustainable growth of the economy. BSP gained its monetary policy independence since around 1986. From January 2002, BSP also officially adopted an inflation targeting framework for its monetary policy regime. As for the exchange rate regime, BSP has been categorised as an independent floater.

To achieve the primary objective of its monetary policy, BSP adopted a strict monetary targeting framework until mid-1995. This was done on the basis of the perceived stable and predictable relationship between the monetary target and the ultimate target of monetary policy. The operating objective was to target M3 by manipulating base money as the policy instrument. As the stability of this relationship started to come under question, BSP gradually shifted its monetary policy framework in 1995. The new monetary policy framework complemented aggregate quantity targeting with some form of inflation targeting. Later, more weight was put on inflation targeting. Following the changes, the policy instrument was also gradually shifted from quantity targeting to targeting the interest rate.®

3.2.4 Singapore

The primary objective for the Monetary Authority of Singapore (MAS) is to promote price stability to ensure low inflation as a sound basis for sustainable economic growth. In accomplishing this objective, MAS has adopted a unique monetary policy framework centered on exchange rate management rather than the management of money supply or the interest rate. Since 1981, MAS has managed the Singapore dollar exchange rate against an undisclosed trade-weighted basket of currencies of Singapore’s major trading partners and competitors.® The composition of this basket is being periodically reviewed and revised to take into account changes in

®See Lamberte (2002) for the more detailed discussion.
Singapore’s trade patterns. However, details of the index and the boundaries of the target band are not disclosed. The extent of any appreciation or depreciation depends mainly on the expected inflationary pressures and the MAS intervenes in the foreign exchange market to prevent excessive fluctuations in the exchange rate.

The justification for this unique behaviour lies primarily in the characteristics of Singapore’s economy, namely its smallness and extremely high degree of openness. In such circumstances, the exchange rate is deemed to be an ideal intermediate target for monetary policy to maintain price stability. The high degree of financial openness and sensitivity of capital flows to interest rate differentials makes it difficult to target either money supply or interest rates in Singapore. Net flows of funds from abroad account for the bulk of changes in domestic money supply and domestic interest rates are largely determined by foreign rates and market expectations on the future strength of the Singapore dollar.

3.2.5 Thailand

Unlike the other central banks in the region, the Bank of Thailand (BoT – the central bank of Thailand) does not have an explicit statement of its primary objective included in the Bank of Thailand Act. In practice, however, maintaining monetary and financial stability for achieving sustainable economic growth has always been the primary goal of the BoT. On top of that, the BoT also announced the adoption of explicit inflation targeting in May 2000.

The BoT’s monetary policy can be divided into three different episodes. Before the 1997 financial crisis, the BoT adopted a pegged exchange rate regime as the anchor of its monetary policy. Unlike in the Indonesian case, however, the value of the Baht against the US dollar was announced and defended on a daily basis rather than being determined annually.8

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7 See, for example, discussion in Phuvanatnaranubala (2005).
8 See the “Development of the Monetary Policy Framework in Thailand” section in the Bank of Thailand website. (http://www.bot.or.th/bothomepage/BankAtWork/Monetary&FXPolicies/index_eng_i.asp)
The 1997 crisis forced the BoT to float the exchange rate and adopt monetary targeting in conducting its monetary policy. As in the case of the pegged exchange rate adopted previously, liquidity management was also conducted on the daily basis to insure against excessive volatility in interest rates and liquidity in the financial system. In May 2000, the BoT made an extensive reappraisal of both the domestic and the external environment, and moved to adopt inflation targeting as a framework in conducting monetary policy. The main cause of this change was the assessment that the relationship between money supply and output growth had become less stable. Under this framework, the BoT implements its monetary policy by influencing short-term money market rates via its key policy rate, the 14-day repurchase rate.

3.3 The Monetary Policy Reaction Function

3.3.1 Approximating monetary policy

Identifying monetary policy is not an easy task. Not only do different monetary authorities adopt different operating targets in conducting monetary policy, but the adopted operating target itself often varies over time. This situation highlights the problem of identifying monetary policy (Bernanke and Mihov, 1998), where it is hard to find a consensus on how to measure the size and direction of changes in monetary policy. In dealing with the issue, various measures for representing monetary policy have been utilised in the empirical literature. They cover a range of operating targets commonly used by monetary authorities; that is, monetary aggregates (quantity targeting), short-term interest rates (price targeting) and, in some cases, exchange rates.

Under conditions where an economic system operates with certainty, there is no conflict between using quantity targeting or price targeting as an instrument for conducting monetary policy. On the other hand, when uncertainty is prevalent, the choice of policy instrument matters in determining the best outcome for monetary policy (Poole, 1970). This may be one of the reasons why, in practice, monetary

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9See, among others, discussions in Devakula (2001) and in Phuvanatnaramubala (2005).
authorities tend to alter their operating instruments to cope with the economic challenges that they are facing. On practical grounds, however, Goodfriend (1991) and Goodhart (1995) argue that regardless of what monetary regime a monetary authority claims it follows, the actual implementation of monetary policy can be approximated by looking at how a monetary authority sets the short-term interest rate. It is argued that a policy that actually targets the short-term interest rate can better deal with the short-run variability of the velocity of money and provide an anchoring function to prices in the assets market.\(^9\) For this reason, the short-run interest rate has been most widely used to proxy the monetary policy stance of monetary authorities in recent theoretical and empirical literature.\(^1^1\)

As discussed in the previous section, the operating target for conducting monetary policy in the ASEAN-5 countries has also varied over recent decades. In many cases, the exact form of the monetary policy instrument is rarely transparent. This situation creates difficulties for obtaining a precise measure of monetary policy for all of the period under observation. To deal with this problem, following the approach commonly found in the current literature, the relevant short-term interest rate for the selected ASEAN countries is used in this analysis to approximate the monetary policy stance in this study.

The empirical literature suggests that the preference to model a monetary policy reaction function using the interest type rule is basically due to the ability of this model to track real data well.\(^1^2\) Furthermore, the relationship between the three candidate proxies of the operating target for monetary policy (monetary aggregates, interest rate and the exchange rate) have been relatively well defined by the theory. The monetary authority cannot fix both money and interest rates at the same time. Once the monetary authority has chosen one as an instrument, the other becomes a variable. A similar argument applies to the choice between interest rate and ex-

\(^9\)Further arguments from central bankers point of view can also be found in, for example, Poole (1991).

\(^1^1\)See for example Bernanke and Blinder (1992), Clarida et al. (1998, 2000), de Brouwer and Gilbert (2005), Nelson (2000), etc. for the empirical literature and Woodford (2003a), etc. for the theoretical foundation.

\(^1^2\)See the empirical literature in the previous footnote for example.
change rate. If the exchange rate is fixed by the authority, then the interest rate will have to adjust whenever needed to hold the exchange rate. Another reason for focusing on the level of interest rate rather than on the changes in monetary aggregates is the potential inadequacy of the latter in representing the true policy stance due to its dependence on a variety of non-monetary policy influences. As a monetary authority typically prefers to smooth fluctuations of the interest rate, decisions to change the stock of the monetary aggregates may be taken to accommodate innovations in money demand. Therefore, changes in monetary aggregates may not be followed by corresponding changes in interest rates. In other words, changes in monetary aggregates may reflect changes in both its supply and demand components without necessarily reflecting changes in policy stance.

This chapter therefore attempts to approximate monetary policy for the economies selected by estimating the interest rate type rule. The approach requires further consideration in the case of Singapore. As discussed earlier, the Singaporean monetary authority has consistently run its monetary policy by managing the Singapore dollar exchange rate against an undisclosed trade-weighted basket of currencies of Singapore’s major trading partners and competitors since 1981. Consequently, exchange rate targeting appears as the most appropriate representation of monetary policy in Singapore. McCallum (2006) stresses that the exchange rate targeting employed by the MAS is fundamentally different from a traditional fixed exchange rate arrangement. The MAS, he argues, manages the exchange rate as its monetary policy instrument rather than short-term interest rate.

To study the conduct of monetary policy in Singapore, Parrado (2004) estimates a variant of the Taylor type rule with changes in the trade weighted index (TWI) of exchange rate as the operating target variable. The estimated equation takes the form:

\[ \Delta e_t = \rho \Delta e_{t-1} + (1 - \rho) \left( \alpha + \beta \pi_{t+n} + \gamma x_t \right) + \varepsilon_t \quad (3.1) \]

where \( \Delta e_t \) is the change in TWI at time \( t \); \( \pi_{t+n} \) is the inflation rate at time \( t + n \); \( x_t \) is the measure of the output gap at time \( t \); \( \alpha, \beta, \gamma \) and \( \rho \) are the relevant parameters
CHAPTER 3. APPROXIMATING MONETARY POLICY

that will be discussed further in the next subsection; and \( \varepsilon_t \) is the residual term with \( E(\varepsilon_t) = 0 \).

To maintain comparability with the other economies in the sample, this study will instead approximate the monetary policy in Singapore by taking the interest rate as the instrument for monetary policy. This strategy is justified by exploiting the uncovered interest parity (UIP) relation as follows:

\[
    i_t = i^* + E_t \Delta e_{t+1} + \xi_t
\]

where \( i_t \) is the domestic nominal interest rate at time \( t \); \( i^* \) is the exogenous foreign interest rate; and \( E_t \) is the expectation operator taken at time \( t \). \( \xi_t \) is a term introduced to capture the possibility of any short-term distortion that could potentially distort the parity. For simplicity it is assumed that \( \xi_t \sim (0, \sigma^2_{\xi}) \) and is intertemporally independent, so that the parity holds in expectation.

Combining equation (3.1) and the UIP relation above we end up with the following relationship:

\[
    i_t = \rho i_{t-1} + (1 - \rho) (\alpha + \beta \pi_{t+n+1} + \gamma x_{t+1}) + (i^* - \rho i^*) + u_t
\]

where \( u_t = \xi_t - \rho \xi_{t-1} \). The relationship in (3.3) is similar to a variant of interest rule type of equation which will be discussed in more detail in the following subsection.

The differences, however, lie in the additional term \( (i^* - \rho i^*) \) and the potentially non-zero \( \text{cov}(u_t, u_{t-1}) \).

### 3.3.2 The reaction function: Specification and estimation strategy

There are several different strategies that can be pursued in order to obtain a policy reaction function. To obtain a prescriptive form of a reaction function, for example, Fuhrer (1997) estimated a small SVAR model for the United States economy and derives an optimal rule from the model. De Brouwer and O'Regan (1997) derive
an optimal policy rule from a small structural model of the Australian economy. Another example is Filosa (2001) who derives a modified Taylor rule for a number of developing countries. However, since this strategy tends to produce a prescriptive policy rule for the policy makers rather than tracing the historical conduct of monetary policy, the methodology is not really suitable for the purpose of this study.

An alternative approach for getting a policy rule is to estimate the general (baseline) specification of a policy reaction function using an historical data set for the economy under consideration. In particular, this approach focuses on the possibility of monetary authorities in small open developing economies adhering to the Taylor type interest rule\(^{13}\) in delivering their past policy conduct. This type of policy rule typically assumes that policy makers respond to developments in the deviation between inflation from its target level and the output gap. There are at least two different strategies that can be pursued in undertaking the estimation of this reaction function. The first is to estimate the Taylor type policy reaction function (also known as the backward-looking rule). The second is to estimate a similar specification but use a forward-looking assumption.

The backward-looking specification, however, is often criticised for neglecting one important aspect of monetary policy making in the real world; that is, its forward-looking perspective. It is argued that instead of looking at the current or lagged values of inflation and output, policy makers in practice tend to base their policy decisions on expectations of future values of those variables. Clarida et al. (1998) propose an estimable methodology to deal with this forward-looking policy reaction function and have demonstrated that their methodology works well in evaluating the monetary policy behaviour in G7 countries. Batini and Haldane (1999a,b) and de Brouwer and Gilbert (2005) also find that this forward-looking specification performs better in evaluating the monetary policy behaviour relative to the backward-looking one. For that reason, the policy reaction functions in this study are estimated based on the forward-looking assumption and the methodology adopted closely follows

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\(^{13}\) Known also as the Bryant et al. (1993) rule. This rule is classified as more general in terms of specification, where the Taylor rule is considered as one of its variants. See discussion in de Brouwer and Gilbert (2005).
CHAPTER 3. APPROXIMATING MONETARY POLICY

that proposed by Clarida et al. (1998, 2000).

The specification for the baseline policy rule takes a simple form. Within each of its operating periods, the monetary authority is assumed to set the nominal interest target rate \( \tilde{i} \) based on developments in the expected inflation around its target and the output gap.

\[
\tilde{i}_t = \bar{i} + \kappa_1 [E_t (\pi_{t+n} | \Omega_t) - \pi^*] + \kappa_2 E_t (x_{t+1} | \Omega_t) \tag{3.4}
\]

where \( \bar{i} \) can be interpreted as the long-run equilibrium level of the nominal rate; \( \pi^* \) is the long-run inflation target; \( x \) is the output gap that serves as a measure of cyclical variable; and \( \Omega_t \) is the set of information available to the monetary authority at the time they set interest rates. Clarida et al. (1998) also entertain an extension of the baseline model by allowing for a possibility for other variables (such as exchange rate, money growth, international interest rate, etc.) to affect the target rate explicitly. That is:

\[
\tilde{i}_t = \bar{i} + \kappa_1 [E_t (\pi_{t+n} | \Omega_t) - \pi^*] + \kappa_2 E_t (x_{t+1} | \Omega_t) + \kappa_3 E_t (\nu_{t+k} | \Omega_t) \tag{3.5}
\]

where \( \nu \) denotes the other variable affecting the target policy rate.

The policy reaction function outlined in (3.4) or (3.5) is acknowledged to be too restrictive for describing the actual movement in the policy rate.\(^{14}\) It is restrictive in the sense that (i) the functional form in both (3.4) or (3.5) assumes that the target rate will adjust immediately to developments of the variables that affect it (regardless of the magnitude); (ii) they represent the systematic response of the monetary authority to developments in the economy without acknowledging a possibility of randomness in the policy action; and (iii) they assume that the monetary authority has perfect control over the interest rate.

Abrupt and frequent changes in the policy rate could disrupt the capital market and corrode the credibility of a monetary authority. Since credibility is very important

\(^{14}\)See Clarida et al. (2000).
for a monetary authority, it typically prefers to smooth the movements in interest rate. To avoid loss of credibility from impulsive and large changes in the policy instrument, it is further assumed that a monetary authority smooths the interest rate by adjusting it partially to the target:

$$i_t = (1 - \rho_i) i_t + \rho_i i_{t-1} + \nu_t$$  \hspace{1cm} (3.6)$$

where $i_t$ is the actual interest rate at time $t$; $\rho_i$ is the partial adjustment coefficient that captures the degree of interest rate smoothing; and $\nu_t$ is the error term introduced to capture randomness in policy action and the fact that a monetary authority does not have perfect control over interest rate. The intuition behind such an adjustment scheme is that the authority does not adjust the interest rate fully to its desired current target level, but takes some linear combination between its desired target level and the past value of the interest rate to smooth its movement.

Substituting (3.4) into (3.6) to obtain an estimable equation for the policy reaction function gives us the following:

$$i_t = (1 - \rho_i) \alpha_i + (1 - \rho_i) \kappa_1 \pi_{t+n} + (1 - \rho_i) \kappa_2 x_{t+q} + \rho_i i_{t-1} + \zeta_t$$  \hspace{1cm} (3.7)$$

where,

$$\alpha_i = \bar{i} - \kappa_1 \pi^*$$

and,

$$\zeta_t = - (1 - \rho_i) \{[\kappa_1 \pi_{t+n} - E_t(\pi_{t+n} | \Omega_t)] + \kappa_2 [x_{t+q} - E_t(x_{t+q} | \Omega_t)]\} + \nu_t$$

with $E_t(\zeta_t) = 0$. The later term ($\zeta_t$) is a linear combination of the forecast errors of inflation, the output gap and the exogenous disturbance $\nu_t$.

Once the estimable functional form is established, the next step would be to determine a vector of instrumental variables ($u_t; u_t \in \Omega_t$ and orthogonal to $\zeta_t$) that includes the monetary authority’s information set at the time they choose the in-
terest rate. That is the elements of $u_t$ need also to be uncorrelated with $v_t$ and hence $E_t(\zeta_t \mid u_t) = 0$. The last condition provides a basis for estimating the vector of unknown parameters $[\kappa_1 \ \kappa_2 \ \alpha_i \ \rho_i]'$ by using the generalised method of moments (GMM) with an optimal weighting matrix that accounts for possible serial correlation in $\zeta_t$.\footnote{See Favero (2001, pp. 222-225) for a more detailed explanation.}

In order to estimate the relation set out in (3.7), the sample period from which the data are obtained needs to contain sufficient variations in the variables involved and, also, be sufficiently long to identify the slope coefficients in the policy reaction function. Clarida et al. (2000) also maintain a stationary assumption for both nominal interest rate and inflation in order to be able to work out the long-run inflation target for their estimates by imposing an additional restriction. The next section discusses these requirements for the case of the ASEAN-5 countries.

Additional notes are needed for Singapore’s case concerning the situation explained in the earlier subsection. To estimate Singapore’s policy reaction function using the interest rate by exploiting the UIP condition leaves one with an extra term. If one is sure about the currency reference used in its exchange rate management policy, then $i^*$ is identified in principle. In that case the PRF can be estimated using the differential between domestic and foreign interest rate $(i_t - i^*_t)$ as the dependent variable. However, in the case where the currency reference is unclear, identification for $i^*$ becomes difficult. In that case, one can proceed in estimating (3.7) by at least imposing two alternative assumptions. If one is willing to assume $i^*$ to be constant, then the term can be lumped in to the constant term of the equation. If $i^*$ is not constant over time, but the $(i^* - pi^*)$ series is stationary, then its constant component can be captured in the constant term of the policy reaction function and its remainder is part of the error term in the function. Since the term is stationary, then the stochastic component of it will also be stationary. Hence, the residuals from the estimated policy reaction function will still appear to be stationary.
3.4 Data

To estimate the approximate monetary policy reaction function, the analysis is conducted using quarterly data from 1989 to 2004.\textsuperscript{16} This particular period is chosen because most of the countries analysed underwent significant structural changes in their economy during the 1980s. These structural changes were also accompanied by significant policy variation. Indonesia for example, underwent two significant banking and financial sector deregulations in the 1980s. Similar changes also occurred in Malaysia where BNM deregulated the interest rate structure for the banking system in the early 1980s. To avoid too many potential breaks in the policy regime, the analysis is conducted with the beginning of the 1990s as its starting point.

Following the explanation in the earlier section, variables considered for the analysis are the short-term nominal interest rate, consumer price indices (CPIs), real output and the relevant exchange rate. Most of the data are taken from the CEIC Asia database except for the TWI of exchange rate data for Singapore, Malaysia and the Philippines, which are taken from the IMF estimates in the International Financial Statistics (IFS) database.\textsuperscript{17} Real output data for Malaysia and Indonesia before 1991 and 1993, respectively, are obtained from their central banks. Details about data are provided in Appendix 3.A.

3.4.1 Interest rates

In this chapter, interest rates are treated as the proxy for the policy variable. Following the current policy rate, the 30-day SBI rate is used for Indonesia, the 90-day Manila reference rate for the Philippines and the 14-day repo rate for Thailand. Although the current policy target rate for Malaysia is the 3-month interbank rate, this study uses the 3-month treasury bill (TB) discount rate instead. This proxy is chosen because of the data availability from the CEIC database. The interbank

\textsuperscript{16}An exception applies for Thailand’s case where the quarterly output data is only available starting from 1993.

\textsuperscript{17}The real effective exchange rate estimates for Indonesia and Thailand are unavailable. For the two countries we use the domestic currency exchange rate to the US dollar instead.
rate is only available from 1996 in the version of the CEIC database where the data are obtained, while the TB discount rate data are available for the whole period under consideration. Nevertheless, the correlation between the two series during the period where both series are available is very high (about 97 per cent). Lastly, the 3-month interbank rate is used as a proxy for Singapore substituting the actual policy target TWI. Appendix 3.A.2 provides the graphs of each country's interest rates and reports the statistical results for their stationarity tests.

Interest rates for the five ASEAN countries under consideration share similar patterns over the sample period. They tend to start off higher in the beginning of the sample and tend to be relatively lower towards the end. In other words, there appears to be a decreasing trend in the nominal interest rates in the region. This tendency, however, is not pronounced in the case of Indonesia, which, together with the Philippines, has a higher average rate than its neighbours. Another shared feature is the interest rate jump around the period of the East Asian financial crisis. Indonesia, the economy that was hit hardest by the crisis, experienced the highest jump (to about 6 times higher than its average rate), while other countries experienced a jump in rates about 2 to 3 times higher than average. An exception is the Philippines. Although it experienced an interest rate increase during the period, the level fluctuated closely around its sample period average. This observation underlines the argument that unlike its neighbouring countries in the region, the Philippines' economy was not disturbed much by the crisis.

To test for stationarity of the series along the sample period, two tests are conducted; namely the Augmented Dickey-Fuller (ADF) test for unit root in a series (Dickey and Fuller, 1979) and the KPSS test for stationarity of a series (Kwiatkowski et al., 1992). The KPSS test is conducted to complement the ADF test for unit root, which is deemed to have low power against its relevant alternative of non-unit root in the series. The results for both tests to the interest rate series are reported in Appendix 3.A.2. All of the interest rate series are found to be stationary during the sample period according to the KPSS test, but Singapore and Thailand data are only found
to reject the unit root hypothesis marginally, based on the ADF test. The tests also confirm the observation about the decreasing trend in the series. The SBI rate series for Indonesia is found to be stationary during the sample period, while all of the other series are found to be trend stationary.

3.4.2 Inflation rates

To proxy the inflation rate, this study uses year on year changes in the consumer price index (CPI) series. Inflation is calculated as the difference between the log value of today’s CPI and the log value of its fourth quarter lag. The inflation rate series shares similar general observations with the nominal interest rate series. As also observed in the nominal interest rate series, the region’s inflation series displays a decreasing trend over the sample period. This tendency, again, appears to be less pronounced for the case of Indonesia. The series also experiences jumps during the financial crisis period. Together with the general observation in the nominal interest rate series, this observation suggests that the movement in the nominal interest rate in the region tends to be correlated with the movement in inflation rate.

The stationarity tests conducted (as reported in Appendix 3.A.3) also support the general observation made about the tendency in inflation rate to fall over the sample period. Both tests conclude that Indonesia’s inflation rate is stationary, while the rest are trend stationary. Note however, that in the case of Malaysia this conclusion is only accepted relatively marginally.

3.4.3 Exchange rates

The exchange rate variable is measured as its annual percentage change by taking the difference between its current log values and its fourth quarter lag. This study uses the TWI of exchange rate from the IFS to measure the relative exchange rate changes for the cases where data are available, namely Singapore, Malaysia and the Philippines. For Thailand and Indonesia, since the series are not available, the
exchange rate with respect to the US dollar is used instead. The utilisation of TWI is considered preferable since, particularly for the case of Singapore and Malaysia, the variable is the working exchange rate variable considered by the monetary authority. As a caveat, however, the TWI does not necessarily represent the true working variable that those authorities are using since in practice the actual weights are not publicly announced.

As reported in Appendix 3.A.4, all the annual changes in the exchange rate measure appear to be stationary and only the series for Singapore appear to be stationary around a (decreasing) trend. The latter appears due to the role of the TWI in Singapore that serves the means for an actual operating instrument of its monetary policy.

3.4.4 Measuring the output gap

Due to the unobservable nature of potential output, measuring the output gap has always been a difficult task. The task is even more problematic in the case of developing economies. For the case of Asian economies, there is little empirical research on appropriate measures of the output gap, for example, Coe and McDermott (1996) and Gerlach and Yiu (2004). As noted in the earlier studies, the time series behaviour for the real output in the Asian economies may differ from the other advanced economies and they also have been exposed to large disturbances, particularly during the crisis period in the late 1990s.

Gerlach and Yiu (2004) compare estimates of the output gap for selected Asian countries (Hong Kong, Indonesia, Japan, Korea, Malaysia, the Philippines, Singapore and Taiwan) produced by different purely statistical methodologies; namely, the Hodrick-Prescott (HP) filter, the band-pass (BP) filter, the Beveridge-Nelson (BN) filter and the unobservable components (UC) time series approach. They conclude that estimating the output gap in Asian countries does not appear to be more difficult than in advanced economies. This conclusion follows from the general similarities in the results – that match well with the common perceptions of economic
fluctuations for their sample economies – obtained from those different methods. Additionally, the HP and BP filters, and the UC method generate quite similar estimates of the output gaps. This suggests that the three approaches produce estimates that contain much the same information for variables that policy makers are interested in.

**Estimating potential output**

Following the conclusions of Gerlach and Yiu (2004), this study employs the HP filter method to estimate the unobserved potential output for the five ASEAN countries. The HP filter is applied directly to the seasonally adjusted series for the case of Malaysia, Singapore and the Philippines. This treatment is applied by considering the fact that those three economies do not seem to be experiencing a capacity fall during the crisis period. For the cases of Indonesia and Thailand, however, the real output series drops severely right after the crisis. For the case of Indonesia in particular, the estimated growth of capital stock is around 0 in 1998 and negative in 1999 as shown in Figure 3.2 in Appendix 3.A. This observation motivates the possibility of a break in potential output in Indonesia about a year after the financial crisis hit the country. As Thailand was also severely hit by the crisis, it is assumed to have experienced a similar break in its potential output around a year after. To approximate the magnitude of the break, real output is fitted to a linear trend and a dummy variable indicating the starting period of the potential break (around a year after the date when the crisis hit the country). This dummy appears to be negative and significant for both the cases of Indonesia and Thailand. The HP filter is then applied to estimate the potential output for both countries after adjusting for the break.

\[\text{footnote}{A \text{ seasonally adjusted series is used to avoid the unnecessary regularities from disturbing the behavioural pattern in the series. For the case of Singapore, the seasonally adjusted series for real output data is used. For the case of four other economies in the sample, the seasonally adjusted data is not available, therefore, the real output series is seasonally adjusted using the census X12 seasonal filter.}\]
The output gaps

Using the potential output estimates outlined above, the output gap measures are calculated as the difference between the log of seasonally adjusted output and its HP filtered series. The estimates are shown in Figure 3.6. A thing to note about estimates for Indonesia and Thailand is that the closing of the gap in 1999 is mainly due to the drop in the trend of potential output as explained earlier. This may look like a speedy recovery for both economies, but in fact it is the drop in productive capacity that actually closes up the gap. As reported in Appendix 3.A.5, all the output gap measures appear to be stationary.

3.5 Empirical Results

This section reports estimates of the policy reaction function for the ASEAN-5 economies. It first discusses the results obtained from the baseline estimation for all the sample economies and then there is a further discussion of individual country issues. The baseline estimates here refer to the estimation results of equation (3.7) for the entire sample period considered in this study. Later, in the analysis of the individual economies, the possibility for a break in the behaviour of the monetary authorities according to the historical description discussed in Section 3.2 is considered.

3.5.1 Baseline estimates

Estimation of the baseline policy reaction function for each of the sample countries is conducted using the GMM technique by exploiting the most parsimonious set of instruments for each case.\textsuperscript{19} In general, the instrument list includes lag values of $i, \pi, x$ and annual change in the exchange rate ($\Delta e$) as the underlying information.

\textsuperscript{19}Parsimonious selection of the instrument variables is strongly suggested in order for the instruments to be optimal based on the Monte Carlo simulations by Tauchen (1986) and Kocherlakota (1990). See Hamilton (1994, pp. 426-27). Instrument variables in this study are picked according to the strength of correlation between the instrument and the variable it instrumented.
CHAPTER 3. APPROXIMATING MONETARY POLICY

at the time the interest rates are set. This choice of instruments is motivated by the variables that commonly appear in a simple structural model of a small open economy. In the estimation, the target horizon for inflation \( (n = 0, \ldots, 4) \) is altered, while the one for the output gap is fixed to be equal to 0. Details for the result of the baseline estimation for the whole sample period are presented in Appendix 3.B.

For the case of Indonesia, the list of instrument variables used is found to be valid according to the Hansen J-test for all \( n \). The best\(^{20}\) estimate is obtained at \( n = 1 \) and the fit worsens as \( n \) gets larger. The effect of different target horizons for inflation is found to be consistently positive and significantly different from zero except for \( n = 4 \). The further the target horizon for inflation in the PRF, the lower is its ability to track the actual movement in interest rate (the fit actually dropped significantly at \( n > 2 \)). This suggests that longer forecast profiles of inflation do not appear to be significant in explaining movements in the policy rate. While this is clearly the case for Indonesia, the estimates for the other countries are not so clear. Unlike inflation, the measure of the output gap does not appear to be significant in affecting the movement in the policy rate in Indonesia. Not only does the parameter appear to be insignificantly different from zero, but its magnitude also appears to be insensible and negative.

As for the case of Indonesia, the list of instruments used to estimate PRF in Malaysia is also found to be valid for all \( n \) considered. The best estimate in this case is obtained at \( n = 1 \). The effect of different target horizons for inflation are also found to be consistently positive and significantly different from zero. However, unlike the case of Indonesia, the magnitude of this parameter is found to be relatively stable. The magnitude of this parameter lies around the value of 1.7. The coefficient on the measure of the output gap in the case of Malaysia is also found to be positive and significant up to \( n = 1 \). The weight however, is small relative to the weight put on the forecast of inflation.

The findings for the case of the Philippines are slightly different. In this case, the

\(^{20}\)"Best" here is defined according to the highest fit obtained from the estimation.
best PRF estimate is obtained at \( n = 1 \), but based on the Hansen \( J \)-statistics the list of instruments are only valid for \( n = 0 \) and 1. Both the forecast of inflation and the measure of the output gap are found to have a positive and significant effect on the interest rate. However, unlike the other cases, the weight for the output gap dominates in driving the movement of the interest rate. While the point estimate of the output gap parameter in the PRF is found to be above 1, the point estimate of the forecast of inflation parameter is found to be well below 1.

In the case of Singapore, the utilised instrument list is also found to be valid for all \( n \). The best estimate in this case is obtained at \( n = 0 \). For all of the inflation target horizons that appear to be significantly different from zero (the case where \( n = 0, 1 \) and 4), the point estimates of the parameters are scattered around the value of one. The point estimates for parameters of the measure of the output gap also fall near the value of one, except for the case where \( n = 1 \) where the estimated parameter is only marginally significantly different from zero. This finding indicates that the parameter estimate is relatively stable given different target horizons of inflation.

As discussed earlier, the case of Thailand is estimated using shorter intervals due to data availability problems. However, the list of instrument variables utilised in this case still appears to be valid and the best fit is achieved at \( n = 3 \). The forecast of inflation appears to enter the PRF with a positive effect that is significantly different from zero regardless of the target horizon considered. The magnitude of the parameter for this variable is found to be larger than the other cases considered in this study (the point estimate is generally more than 2 except for the case where \( n = 0 \)). Similarly to the case of the estimated policy reaction function for Indonesia, the measure of the output gap does not appear to enter the function significantly.

The findings on the degree of the interest rate smoothing vary among countries. The movement of interest rates in Singapore is found to be highly persistent, with \( \rho_{i} \) value around 0.87 to 0.88. Interest rate movements in Thailand and Malaysia are also found to be relatively persistent, with the weight on the lag interest rate varying around 0.7 to 0.85 in the case of Thailand and 0.7 for Malaysia. In the case
of the Philippines and Indonesia, the weight for the lag interest rate falls slightly more than one half. Particularly for the case of Indonesia, however, interest rate movements become more and more driven by inertia as we move the forecast horizon for inflation further ahead. This observation confirms that, in the case of Indonesia, more distant target horizons for inflation \( n \geq 2 \) have less explanatory power over the movement in interest rate.

Another general observation from this exercise is that in most cases \( \alpha_i \) \( (= i - \beta \pi^*) \) tends to be insignificant. This observation could arguably be a result of the relatively short sample period for the estimation. Although the sample period contains sufficient variation in the variables considered, we cannot ignore the fact that during that period (except for Indonesia), the interest rate and the inflation series are stationary around a (decreasing) trend.\(^{21}\)

Depending on available external information, most previous empirical studies on monetary policy reaction functions attempt to infer either the long-run inflation target or the long-run equilibrium level of nominal interest rate from the information provided by the estimate of \( \alpha_i \).\(^{22}\) While uncovering the value of either \( i \) or \( \pi^* \) is a valuable exercise for drawing policy implications, the behaviour of some variables in the sample period used in this study (particularly nominal interest rate and inflation) constrain us from conducting a similar exercise. The data suggest that some kind of adjustment towards a lower long-run inflation target and nominal interest rates may take place during the sample period considered. For that reason, this study avoids identifying the values for either long-run equilibrium interest rate or long-run inflation target for our sample countries since \( \alpha_i \) from the estimation is not very likely to carry relevant information concerning the exact value of any of the two variables.

A summary of the best results is presented in Table 3.1. It reports the summary of


\(^{22}\)For example, Clarida et al. (2000) fix the US real interest rate target to its observed sample average to infer the value of \( \pi^* \); and de Brouwer and Gilbert (2005) instead fix \( \pi^* \) to a given inflation target value applicable for the case of Australia to back out its neutral nominal interest rate.
the GMM estimates for each country based on the best fit of the results reported in Appendix 3.B. As indicated earlier, the best fit for Indonesia, Malaysia and the Philippines is obtained at the target horizon for inflation \((n)\) equal to 1; for Singapore it is obtained at \(n = 0\) and for Thailand at \(n = 3\).

Table 3.1: Parameters for the baseline estimates of the policy reaction function

<table>
<thead>
<tr>
<th>Country</th>
<th>(\alpha_i)</th>
<th>(\kappa_1)</th>
<th>(\kappa_2)</th>
<th>(\rho_i)</th>
<th>Adj. (R^2)</th>
<th>(J - test)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>4.18</td>
<td>1.15</td>
<td>-0.24</td>
<td>0.536</td>
<td>0.893</td>
<td>2.63</td>
</tr>
<tr>
<td>((n = 1))</td>
<td>(1.62)</td>
<td>(0.11)</td>
<td>(0.45)</td>
<td>(0.05)</td>
<td>[0.75]</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.56</td>
<td>1.66</td>
<td>0.19</td>
<td>0.69</td>
<td>0.873</td>
<td>4.31</td>
</tr>
<tr>
<td>((n = 1))</td>
<td>(0.39)</td>
<td>(0.12)</td>
<td>(0.05)</td>
<td>(0.076)</td>
<td>[0.51]</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>0.07</td>
<td>0.72</td>
<td>1.22</td>
<td>0.55</td>
<td>0.791</td>
<td>3.02</td>
</tr>
<tr>
<td>((n = 1))</td>
<td>(0.01)</td>
<td>(0.18)</td>
<td>(0.60)</td>
<td>(0.12)</td>
<td>[0.22]</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>0.82</td>
<td>1.27</td>
<td>0.94</td>
<td>0.85</td>
<td>0.879</td>
<td>6.80</td>
</tr>
<tr>
<td>((n = 0))</td>
<td>(0.87)</td>
<td>(0.49)</td>
<td>(0.46)</td>
<td>(0.05)</td>
<td>[0.34]</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>-3.61</td>
<td>2.65</td>
<td>0.09</td>
<td>0.70</td>
<td>0.917</td>
<td>4.13</td>
</tr>
<tr>
<td>((n = 3))</td>
<td>(0.82)</td>
<td>(0.30)</td>
<td>(0.24)</td>
<td>(0.04)</td>
<td>[0.66]</td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for the \(J\)-test.
Source: Author’s calculations

A number of interesting observations come out in Table 3.1. First of all, the basic model is not rejected at the conventional significance level for any of the cases considered. Further, the best fit GMM estimates of the policy reaction function are able to track the movement in the interest rate very well as shown by the relatively high adjusted \(R^2\) values. The estimated values of \(\kappa_1\) have the expected positive sign and are significant for all cases. The point estimate of \(\kappa_1\) is generally \(\geq 1\), except for the case of the Philippines. Where significantly different from zero, the estimated values of \(\kappa_2\) also tend to have the expected positive sign. For Singapore and the Philippines, the weight on the output gap in the policy reaction function is fairly high. In the case of the Philippines, the point estimate even outweighs the weight for the forecast of inflation. For Malaysia, although it is significantly different from zero, the weight on the output gap is relatively small, and for the case of Indonesia and Thailand, the parameter for this variable is not significantly different from zero.

The estimations seem to support the general price stabilising objective of monetary policy.

\(^{23}\)Note, however, that the \(t\)-statistics test marginally fails to reject the hypothesis that \(\kappa_1 = 1\) in the Philippine’s case.
policy in the economies under study.\textsuperscript{24} The estimated PRF above shows an indication that in general the countries sampled share a relatively similar preference by adhering to the Taylor principle in conducting their monetary policy ($\kappa_1 > 1$). Following the common wisdom in the theory, this implies that the monetary policy of these countries has been stabilising for the economy. That is, monetary policy reacts to expected inflation and so tends to stabilise fluctuations in both output and inflation. With some caveats,\textsuperscript{25} the Philippines seems to be the only exception to these results. Instead of putting more weight on inflation in driving monetary policy, the results suggest that the authorities in the Philippines put a more than one-to-one weight on the output gap. Nevertheless, the results reported in Table 3.1 indicate that a simple Taylor type rule, combined with an interest smoothing behaviour on the part of the monetary authority, is able to summarise the behaviour of interest rate setting in the 5 ASEAN economies reasonably well.

Another interesting point to note is that the exchange rate does not appear to be explicitly important in driving the setting of interest rate. It is, however, part of the important background information utilised by the central bank in determining their monetary policy stance. The exercise of including an exchange rate measure as an additional explanatory variable, as in equation (3.5), does not present any indication that it enters the equation with a parameter that is significantly different from zero.\textsuperscript{26} However, the results of the $J$-statistics test justify the inclusion of the lagged exchange rate as a valid instrument for the GMM estimation. This finding is in line with the argument of Taylor (2001), in which he argues that including the exchange rate directly into the interest rate rule does not yield much improvement in the performance of the optimal rule. He further argues that even in the version of the simple interest rate rule that excludes the exchange rate variable, as in equation (3.4), the impact of exchange rate movements is already reflected in the outcome of inflation and the output gap that are considered in making interest rate decisions.

\textsuperscript{24}See, among others, Taylor (1999), Clarida et al. (1999, 2001), and Woodford (2001b) for discussions on the Taylor principle.
\textsuperscript{25}See previous footnote
\textsuperscript{26}The results for this exercise are shown in Table 3.12 in Appendix 3.B.
Hence, adding the exchange rate as an additional variable to the interest rate rule will only make a marginal improvement (if any) to the basic simple version of the interest rate rule.

Finally, although varying in terms of its magnitude, the estimate of the smoothing parameter ($\rho_t$) is fairly high in all cases (ranging from 0.53 to 0.85). This finding indicates that monetary policy appears to be relatively persistent and subject to some inertia. That is, typically only less than half of the changes in the target interest rate are reflected in the changes in the actual interest rate. This finding confirms that the monetary authorities in the ASEAN-5 countries (although with varying degree) prefer to smooth the adjustments in their interest rates.

3.5.2 A closer look at individual cases

Results presented in Table 3.1 are obtained using the entire sample period for this study. As discussed in Section 3.2, most of the countries under consideration experience shifts in their monetary policy regime during the sample period. To have a better picture of this issue, I look further at individual country cases and see if the shift is reflected in the data.

To study the individual country cases, I begin by looking at the potential changes in monetary policy regime around the dates discussed in Section 3.2. Indonesia and Malaysia shifted their monetary policy regime right after the Asian financial crisis hit the economy. The Philippines changed its policy regime in 1995. Thailand moved on to adopt an inflation targeting framework in 2000. Unlike its neighbours, Singapore’s monetary policy regime has been unchanged throughout the sample period. In order to assess the possibility of changes in behaviour, the PRFs are re-estimated by using the sub sample that ends or begins around those dates. The results of this exercise are presented in Table 3.2.

Table 3.2 indicates that, except for the case of Indonesia, there is no significant difference between the PRF estimate from the whole sample period and the one obtained from the sub sample considered. In the case of the Philippines, all parameter
Table 3.2: Estimated parameters for the subsample period

<table>
<thead>
<tr>
<th>Country</th>
<th>Sub sample</th>
<th>$\alpha_i$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\kappa_3$</th>
<th>$\rho_i$</th>
<th>Adj. $R^2$</th>
<th>$J\text{-test}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia:</td>
<td>(1989-1997)</td>
<td>-0.16</td>
<td>-</td>
<td>3.40</td>
<td>0.66</td>
<td>0.69</td>
<td>3.24</td>
<td>[0.78]</td>
</tr>
<tr>
<td></td>
<td>(1998-2004)</td>
<td>-2.73</td>
<td>1.78</td>
<td>1.04</td>
<td>0.52</td>
<td>0.85</td>
<td>2.99</td>
<td>[0.70]</td>
</tr>
<tr>
<td>Malaysia:</td>
<td>(1989-1997)</td>
<td>1.01</td>
<td>1.54</td>
<td>0.17</td>
<td>-</td>
<td>0.63</td>
<td>0.72</td>
<td>1.73</td>
</tr>
<tr>
<td></td>
<td>(1995-2004)</td>
<td>0.06</td>
<td>0.66</td>
<td>1.31</td>
<td>-</td>
<td>0.53</td>
<td>0.42</td>
<td>4.16</td>
</tr>
<tr>
<td>Philippines</td>
<td>(1994-1999)</td>
<td>-3.58</td>
<td>2.60</td>
<td>0.13</td>
<td>-</td>
<td>0.69</td>
<td>0.86</td>
<td>2.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.02)</td>
<td>(0.29)</td>
<td>(0.34)</td>
<td>(0.03)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: 1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for J-test.

Source: Author’s calculations

estimates from the sub sample under consideration are not significantly different from their point estimate counterparts obtained from the whole sample period. For the case of Malaysia, the constant term ($\alpha_i$) remains insignificantly different from zero and the rest of the parameters are not significantly different from their respective point estimates reported in Table 3.1. The case is similar for Thailand, where the output gap enters the PRF insignificantly. Another interesting observation out of the exercise based on the sub sample period is that the exchange rate remains directly insignificant in explaining changes in the interest rate for all of the three cases above. Inclusion of the exchange rate explicitly in the extended PRF, as in equation (3.5), does not produce significant parameter estimates for that particular variable. Based on those findings, I conclude that during the period under consideration the available data does not suggest the existence of a significant break in the behaviour of monetary policy for those countries. In other words, although there have been changes in monetary policy regime within the sample period, the behaviour in conducting monetary policy in Thailand, Malaysia and the Philippines does not appear to change significantly.

The case of Indonesia is slightly different from three of its neighbouring economies discussed above. In the Indonesian case, the estimation using different sub samples (pre and post-crisis samples) produces significantly different point estimates of the

\[\text{The results are presented in Table 3.13 in Appendix 3.B.}\]
PRF parameters. When the post-crisis period is considered, inflation enters the function with a larger parameter magnitude and the output gap also enters the function significantly with a coefficient magnitude around one. When the pre-crisis period is considered, neither inflation nor the output gap enters the function significantly. For this period, estimation of the extended PRF as in equation (3.5), by including changes in the exchange rate, also shows that the parameters for both inflation and output are not significantly different from zero. However, changes in the exchange rate significantly affect the movement in interest rates. This last finding confirms the crawling peg regime adopted by the Indonesian monetary authority in the pre-crisis period. The interest smoothing parameter for both sub samples remains insignificantly different from the point estimate obtained from the whole sample estimation. Note, however, the point estimate for $\rho_i$ in the pre-crisis sub sample is relatively higher than the one obtained under the whole sample estimation.

The above findings suggest that in the case of Indonesia, there is an indication of a significant shift in the way monetary policy is conducted in that country. The data suggests that changes in the SBI rate during the pre-crisis period are mainly driven by changes in the exchange rate. On the other hand, after the crisis, the SBI rate in Indonesia is mainly driven by both inflation and the output gap. This signifies the policy shift from a (crawling) peg exchange rate regime to a Taylor type rule in conducting monetary policy. We need to note that Thailand also adopted a pegged exchange rate regime in the pre-crisis period. However, unlike the case of Indonesia, the value of the Baht against the US dollar was announced and defended on a daily basis rather than being determined annually. The board of the BoT evaluated the domestic economic situation before deciding the preferred value of the currency and kept it fixed within a day. Therefore, the exchange rate management adopted by the BoT at that time looks more like the one adopted by Singapore rather than Indonesia. This may be a reason why we do not observe significant changes in monetary policy behaviour in the Thai data like those observed in the Indonesian data.
Singapore is the only country that is likely to have a constant monetary policy regime throughout the sample period. As reported in Table 3.1, the best fit for our GMM estimation is obtained at inflation forecast horizon ($n$) equal to zero. Parrado (2004) estimates a variant of a Taylor type rule with changes in the TWI of exchange rate as the operating target variable and prefers $n = 3$ (nine month forecast horizon in inflation) for representing the policy reaction function in Singapore. If the Parrado result is taken as valid, then based on the argument represented by equation (3.3), the corresponding counterpart for the interest rule would be the one with $n = 4$.

To reconcile this issue, we compare the point estimates of the parameters for the two functions as reported in Table 3.10 of Appendix 3.B. The magnitude of all the estimated parameters for both the PRF with $n = 0$ and $n = 4$ are insignificantly different from each other. Therefore, both inflation and the output gap enter the policy reaction function similarly, regardless of the choice of the forecasting time horizon for inflation.

Figure 3.1 compares the actual movement in the interest rate with the implied target rate obtained from our estimation. The implied target rate series are calculated from the estimated parameters after disallowing for partial adjustment. Therefore, it is calculated based on the functional form described in equation (3.4), characterised by the estimated parameters. That is, the estimates for the implied target rate are calculated using the equation for a simple rule, characterised by the estimated parameters of $\alpha_i, \kappa_1, \kappa_2$ and $\kappa_3$ for each country.

There is advantage in conducting this exercise relative to plotting the fitted model against the actual interest rate. While the fitted models are able to track the actual interest rate more closely (as is obvious from their high adjusted $R^2$ values), they allow for inertia to take place in determining the values of the fitted series. As a consequence, they conceal the information about the importance of the determinants of the monetary policy stance. By disallowing this effect, the exercise carried out in Figure 3.1 provides a way for revealing information about how well the determinants of monetary policy track movements in the actual interest rate.
In most cases the implied target rates are, interestingly, able to capture the actual rate movements quite well. The correlation coefficient between the two series is relatively high and positive in most of the cases; that is 0.9 for the case of Indonesia, 0.85 for the case of Malaysia, 0.79 for the case of the Philippines, 0.89 for the case of Thailand and 0.44 for the case of Singapore. These positive and typically high correlation coefficients signal that both the actual interest rate and the implied target rate are relatively closely associated. That is, movements in one series are typically followed by movements in the other series with the same direction and a relatively similar proportion. In other words, the simple rule characterised by our PRF estimation tends to be reasonably good at explaining the monetary policy stance of the countries under consideration.

As seen in the figure for Indonesia’s SBI rate, the implied target rate for this case tracks the actual movement in SBI rate very well along the sample period. The
implied target rate in this case is calculated as a combination of the two different simple reaction functions reported in Table 3.2; that is, based on a pure exchange rate targeting regime up to the second quarter of 1997 (right before the crisis hit the country) and based on the simple Taylor type rule for the rest of the sample period. In the absence of the inertial adjustment process, both the pre and post-crisis implied target rate are able to capture the general swings of the SBI rate very well. At the onset of the 1997 crisis, the target rate shot up well above the actual SBI rate and dropped ahead of the actual SBI rate right after the peak of the crisis. This suggests that during that particular period, interest rate smoothing behaviour was playing a fairly significant role in toning down the fluctuation of the SBI rate. In general, however, monetary policy in Indonesia is mainly driven by the change in the exchange rate during the pre-crisis period and by both inflation and output during the post-crisis period. In the post-crisis period, the role of inflation dominates the output gap in setting the monetary policy. However, a great deal of consideration of the position of the output gap is also operative ($\kappa_2 \approx 1$). This finding is understandable considering that the country was still struggling with the recovery process from the impact of its 1997-98 crisis.

The implied target rate series for the case of Malaysia is generated using the simple rule described in equation (3.4), characterised by the relevant parameter estimates reported in Table 3.1. Figure 3.1 shows that in the absence of the partial adjustment process the target rate for Malaysia captures the general fluctuations in the TB discount rate quite well. However, a noticeable gap between the two series arose during 1994. The sharp decline in Malaysia’s actual rate in 1994 is not accompanied by a similar movement in the target rate. The main reason for this sharp decline is the large inflow of short-term foreign capital into the country. The Malaysian Ringgit at that time was considered undervalued, but BNM did not allow it to appreciate by intervening in the foreign market. BNM undertook sterilised intervention to keep the value of Ringgit intact. In spite of this, the amount of liquidity inflow at that time was so large that some of it managed to find their way to the domestic money

\[ \text{See Bank Negara Malaysia (1999).} \]
market, inducing an excess liquidity in the economy, hence, forcing the actual interest rate to fall. To mop up excess liquidity, BNM responded by borrowing heavily in the money market, introducing Bank Negara Bills and raising the statutory reserve requirement. This response eventually managed to restore the interest rate so that it was in line with the implied target rate. These incidents were not captured by the simple rule since they did not alter inflation expectation and the output gap by much at that time. Therefore, while the actual rate plummeted to around three per cent per annum, the target rate stayed fluctuating around six per cent per annum.

Another relatively noticeable gap is shown in the period during which the BNM was exercising selective capital controls and a fixed exchange rate regime after the crisis. Although it does not appear to be as dramatic as the gap observed in 1994, the implied target rate fluctuates quite significantly around the relatively steady actual rate in that period. Those two deviations, however, are moderated once we allow for partial adjustment in the policy reaction function. The fitted model shows a sharp decline in 1994 and its fluctuation around the actual rate in the post crisis sample appears to be significantly more moderate. Although the interest rate smoothing behaviour occasionally dominates the direction of monetary policy, expected inflation and the output gap are, by and large, found to be acting as the main driver for monetary policy in Malaysia during the sample period considered. The setting of monetary policy is dominated by changes in inflation expectation with a relatively small weight put on changes in the output gap.

Unlike most of its neighbouring ASEAN nations, the Philippines was not severely affected by the 1997 financial crisis. This feature distinguishes the country from most of its neighbours in terms of the heavily tightened monetary policy at the onset of the crisis. When the whole period estimates of parameters are used to characterise the construction of the implied target rate series, Figure 3.1 shows its relative ability to capture the general swings in the actual rate. The only apparent disagreement between the two series arises in the beginning of 1995, when the new monetary policy framework is introduced. The target rate rises while the actual
Manila reference rate falls at that time. This situation may be a consequence of the adjustment process to the adoption of the new framework. Generally, the estimated PRF does a good job in tracking the actual movement of the interest rate. It further indicates that the monetary policy setting in the Philippines is driven by changes in both the output gap and expected inflation. The point estimate of the parameters suggests that the output gap in this case dominates inflation expectation in terms of the weight considered when setting monetary policy. Although different from neighbouring economies, this finding is consistent with the instability of the Philippines economy relative to its neighbours.

The MAS (Monetary Authority of Singapore) adopted a unique monetary policy framework centered on exchange rate management rather than managing the money supply or interest rate. In general, our PRF approximation using the interest rate as the policy variable agrees with the one using changes in TWI of exchange rate reported by Parrado (2004). Both the PRF versions agree that the monetary policy in Singapore is essentially affected by inflation and the output gap. There are some differences between the two estimations, however, in respect of the relative weight between inflation and the output gap in the PRF. While the relative weight between inflation and the output gap in the interest rule version is close to unity, the magnitude is about four in the TWI rule version. This distinction may arise due to differences in how the interest rate and the TWI of exchange rate react upon changes in inflation expectations and the output gap.

A more remarkable finding, is that both versions of PRF come up with virtually the same very high partial adjustment parameter. This agreement suggests a relatively robust finding that the conduct of monetary policy in Singapore is strongly driven by inertia. This feature clearly emerges when we compare the series of actual interest rate and the series of implied target rate. The correlation coefficient between the two series is relatively low (0.44) compared to the other economies in the sample. The Singapore case in Figure 3.1 also shows that although the implied target rate is a relatively good fit in capturing the general direction of the swings in the actual rate,
CHAPTER 3. APPROXIMATING MONETARY POLICY

the target series deviates quite profoundly from the actual series, particularly during the post-crisis episode. All of these wide swings, however, are eliminated once one lets the partial adjustment mechanism affect the determination of the interest rate. These observations suggest that although the monetary policy setting in Singapore is affected significantly by inflation and the output gap, it is in principle dominated by the partial adjustment mechanism. That is, while inflation and the output gap are playing a role in determining the direction of monetary policy, the process itself is mainly dominated by inertia.

As reported earlier in Tables 3.1 and 3.2, the estimate of $\kappa_2$ (the parameter measuring the sensitivity to the output gap) for the case of Thailand is relatively small and insignificantly different from zero. This suggests that the Bank of Thailand has effectively been managing monetary policy by relying solely on developments in the forecast of inflation. Depending on the definition used, this situation may or may not be interpreted as BoT effectively pursuing a pure inflation targeting strategy. Nevertheless, the implied target rate for the case of Thailand is calculated by setting $\kappa_2 = 0$. The high correlation coefficient between the implied target rate and the actual repo rate (0.89) indicates that the former is capturing the direction of changes in the latter very well. The most striking feature in the Thailand panel of Figure 3.1 is that the target rate correctly captures the magnitude of changes in the actual rate during the course of the crisis. Outside the crisis period, although the direction for changes in actual repo rate is still driven by inflation expectation, its movement is largely affected by inertia. In the period leading to the crisis for example, had the monetary policy was solely driven by inflation expectation, the actual rate should have been set at a notably higher rate. Overall, the findings suggest that the monetary policy setting in Thailand is effectively driven only by inflation expectations, with obvious preference over an adoption of interest smoothing adjustment mechanism.

29 According to the definition used by Clarida et al. (1998), inflation targeting regime is defined as a regime where the nominal interest rates are raised sufficiently to increase real rates whenever expected inflation goes above its target. Svensson (1999), however argues that this is not the precise interpretation of inflation targeting.
In summary, the exercise conducted in this subsection establishes that the policy feedback rule represented by a simple interest rate reaction function can generally be used to represent the conduct of monetary policy in our sample countries. Although changes in monetary policy management are reported, the behaviour in setting up the monetary policy is typically unchanged, with Indonesia as a particular exception in this respect. Expected inflation and the output gap are typically the main drivers of monetary policy in the five ASEAN economies considered. The way those important economic variables dictated the setting of monetary policy, however, is moderated by interest rate smoothing by the monetary authority. Singapore is the case where this effect is found to be strongest.

3.6 Concluding Remarks

The objective of this chapter has been to examine how monetary policy is set in the sample of five ASEAN economies. This is done by examining simple monetary policy reaction functions over the past one and a half decades. Although the primary objective of monetary policy in the sample countries is focused on price stabilisation, the conduct of monetary policy in most of the sample economies during the period under examination varies in terms of the way their monetary policy is being managed. The study takes account of this issue by dividing the sample period into sub-samples marked by the dates when variations in the policy regime are reported to have taken place.

The findings suggest that the conduct of monetary policy in the sample of developing economies considered here can, in principle, be explained by a simple monetary policy reaction function. That is, the sample economies seem to be quite consistently following a certain rule in setting their monetary policy. Three general observations emerge from the findings. First, the estimated policy reaction functions do a reasonable job in explaining the setting of monetary policy of the sample economies, in the sense that they capture movements in the actual interest data very well. They further indicate that the conduct of monetary policy has typically supported the
price stabilisation objective of the monetary authorities of most economies under consideration; that is, the coefficient of the nominal interest rate on inflation is typically greater than unity. In other words, the nominal rates are raised sufficiently to increase real rates whenever expected inflation goes above target. Hence, monetary policy reacts to expected inflation and tends to stabilise fluctuations in both inflation and output.

Second, although moderated by partial interest rate adjustment mechanism, the directions in the setting of monetary policy in the sample countries are mainly driven by movement of the inflation expectation with typically some allowance for output stabilisation. With regard to the debate about the importance of an exchange rate variable in driving monetary policy of the small open economy, the findings from this study suggest that exchange rate does not direct the setting of interest rates explicitly. It is, however, acting to be part of the important background information utilised by the central bank in determining monetary policy stance.

Third, despite the fact that changes in monetary policy regime have been ostensibly introduced within the sample period, the behaviour in conducting monetary policy in Thailand, Malaysia and the Philippines does not appear to change significantly. However, in the case of Indonesia, the findings indicate a significant shift in the conduct of monetary policy. Indonesia seems to have switched its monetary policy orientation significantly from being mainly driven by changes in the exchange rate to being directed by inflation expectations and the cyclical variable.

The conduct of monetary policy in each country may be summarised as follows. Monetary policy in Indonesia within the sample period has experienced a switch from a pure exchange rate targeting regime to a regime that is consistent with the Taylor principle, but with particular attention to output stabilisation. In Malaysia, the conduct of monetary policy over the sample period is mainly consistent with the Taylor principle with some attention to output stabilisation. The case of Thailand suggests that the country has effectively been focusing only at the forecast of inflation in setting up its monetary policy during the sample period. However,
the regime tends to be highly driven by inertia in the off-crisis sample. Monetary policy in Singapore is mainly driven by inertia. That is, although expected inflation and the output gap signal directions for the setting of Singapore's monetary policy, the interest rate adjusts very slowly to its projected target level. Finally, monetary policy in the Philippines is found to put more weight on output stabilisation and marginally fails to follow the Taylor principle. This finding may be justified considering that inflation in the Philippines economy is more unstable relative to the other four economies considered in this chapter.\footnote{Note that within the sample period used, excluding the crisis period, inflation variance for the Philippines is at least about three times higher than the other four countries.}
### Appendix 3.A  Data description and sources

<table>
<thead>
<tr>
<th>Variable</th>
<th>Country</th>
<th>Description</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rate</td>
<td>Indonesia</td>
<td>Quarterly average of 30 days SBI (Bank Indonesia certificate) rate</td>
<td>CEIC Asia database; ID:SBI Rate: Auction Target: 30 Days</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>Quarterly average of 3-month TB (treasury bills) rate</td>
<td>CEIC Asia database; MY: Discount Rate 3 Month: Treasury Bills</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Quarterly average of 90-days Manila reference rate</td>
<td>CEIC Asia database; PH: Manila Reference Rate 90</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>Quarterly average of 3-month interbank rate</td>
<td>CEIC Asia database; SG: Interbank Rate: SGD: Month End: 3 Month</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Quarterly average of 14-days repo rate</td>
<td>CEIC Asia database; TH: Repurchase Rate: Monthly Average: 14 Day</td>
</tr>
<tr>
<td>Price index</td>
<td>Indonesia</td>
<td>Quarterly CPI (consumer price index); 1993=100</td>
<td>CEIC Asia database; ID: Consumer Price Index</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>Quarterly CPI (consumer price index); 2000=100</td>
<td>CEIC Asia database; MY: Consumer Price Index (CPI)</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Quarterly CPI (consumer price index); 1988=100</td>
<td>CEIC Asia database; PH: Consumer Price Index</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>Quarterly CPI (consumer price index); 2004=100</td>
<td>CEIC Asia database; SG: Consumer Price Index</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Quarterly CPI (consumer price index); 2000=100</td>
<td>CEIC Asia database; TH: Consumer Price Index</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Quarterly real GDP (gross domestic product) at 1985 prices</td>
<td>CEIC Asia database; PH: Gross Domestic Product (GDP): 1985p</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>Seasonally adjusted quarterly real GDP at 1995 prices</td>
<td>CEIC Asia database; SG: Gross Domestic Product: 95p: sa</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Quarterly real GDP (gross domestic product) at 1988 prices</td>
<td>CEIC Asia database; TH: Gross Domestic Product (GDP); 1988p</td>
</tr>
<tr>
<td>Exchange rate</td>
<td>Indonesia</td>
<td>Quarterly average of US dollar exchange rate</td>
<td>CEIC Asia database; ID: Spot FX Rate: Bank Indonesia: Rupiah to USD</td>
</tr>
<tr>
<td></td>
<td>Malaysia</td>
<td>Quarterly index of REER (real effective exchange rate) based on relative CPI</td>
<td>IFS (International Financial Statistics); 548.RECFZF...</td>
</tr>
<tr>
<td></td>
<td>Philippines</td>
<td>Quarterly index of REER based on relative CPI</td>
<td>IFS (International Financial Statistics); 566.RECFZF...</td>
</tr>
<tr>
<td></td>
<td>Singapore</td>
<td>Quarterly index of REER based on relative CPI</td>
<td>IFS (International Financial Statistics); 576.RECFZF...</td>
</tr>
<tr>
<td></td>
<td>Thailand</td>
<td>Quarterly average of US dollar exchange rate</td>
<td>CEIC Asia database; TH: Forex: Thai Baht to US Dollar: Mid</td>
</tr>
</tbody>
</table>
3.A.1 The growth of capital in Indonesia

Figure 3.2: Capital growth for Indonesia: 1989-2001 (in %)

Note: The stock of capital is calculated by the perpetual inventory method (PIM) using 1969 as the base period.
3.2 Interest rate

Figure 3.3: Interest rate (in %)

Table 3.3: Stationarity tests for interest rates: 1989-2004

<table>
<thead>
<tr>
<th>Country</th>
<th>ADF-unit root test</th>
<th>KPSS-stationarity test¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-stat</td>
<td>p-value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia³</td>
<td>-2.63</td>
<td>0.09</td>
</tr>
<tr>
<td>Malaysia⁴</td>
<td>-3.60</td>
<td>0.04</td>
</tr>
<tr>
<td>Philippines⁴</td>
<td>-3.30</td>
<td>0.07</td>
</tr>
<tr>
<td>Singapore⁴</td>
<td>-3.11</td>
<td>0.11</td>
</tr>
<tr>
<td>Thailand⁴</td>
<td>-3.16</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Notes: 1. Bandwith selection is conducted by Newey-West using Bartlett kernel.
3. Includes intercept in the test.
4. Includes intercept and trend in the test.
3.A.3 Inflation rates

Figure 3.4: Inflation rates (in %)

Table 3.4: Stationarity tests for annual inflation rates: 1989-2004

<table>
<thead>
<tr>
<th>Country</th>
<th>ADF-unit root test</th>
<th>KPSS-stationarity test¹</th>
<th>Critical values²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-stat  p-value lag length (SIC)</td>
<td>LM-stat</td>
<td>5%</td>
</tr>
<tr>
<td>Indonesia¹</td>
<td>-5.62  0.00  1</td>
<td>0.12  0.46</td>
<td>0.74</td>
</tr>
<tr>
<td>Malaysia⁴</td>
<td>-3.41  0.06  1</td>
<td>0.15  0.15</td>
<td>0.22</td>
</tr>
<tr>
<td>Philippines⁴</td>
<td>-4.07  0.01  5</td>
<td>0.07  0.15</td>
<td>0.22</td>
</tr>
<tr>
<td>Singapore⁴</td>
<td>-3.70  0.03  1</td>
<td>0.09  0.15</td>
<td>0.22</td>
</tr>
<tr>
<td>Thailand¹</td>
<td>-3.24  0.09  1</td>
<td>0.10  0.15</td>
<td>0.22</td>
</tr>
</tbody>
</table>

Notes: 1. Bandwith selection is conducted by Newey-West using Bartlett kernel.
3. Includes intercept in the test.
4. Includes intercept and trend in the test.
3.4.3 Annual change in the exchange rates

Figure 3.5: Annual changes in the exchange rate (in %)

<table>
<thead>
<tr>
<th>Country</th>
<th>ADF-unit root test</th>
<th>KPSS-stationarity test¹</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-stat  p-value</td>
<td>lag length (SIC)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Indonesia³</td>
<td>-4.68  0.00</td>
<td>1</td>
</tr>
<tr>
<td>Malaysia⁵</td>
<td>-4.24  0.001</td>
<td>1</td>
</tr>
<tr>
<td>Philippines³</td>
<td>-4.57  0.00</td>
<td>1</td>
</tr>
<tr>
<td>Singapore⁴</td>
<td>-4.08  0.01</td>
<td>6</td>
</tr>
<tr>
<td>Thailand³</td>
<td>-5.07  0.00</td>
<td>1</td>
</tr>
</tbody>
</table>

Notes:
1. Bandwidth selection is conducted by Newey-West using Bartlett kernel.
3. Includes intercept in the test.
4. Includes intercept and trend in the test.
3.A.5 Output gap measures

Figure 3.6: Output gap measures (in %)

Table 3.6: Stationarity tests for output gap measures: 1989-2004

<table>
<thead>
<tr>
<th>Country</th>
<th>ADF-unit root test</th>
<th>KPSS-stationarity test¹</th>
<th>Critical values²</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t-stat</td>
<td>p-value</td>
<td>lag length (SIC)</td>
</tr>
<tr>
<td>Indonesia³</td>
<td>-5.71</td>
<td>0.00</td>
<td>1</td>
</tr>
<tr>
<td>Malaysia³</td>
<td>-3.41</td>
<td>0.00</td>
<td>1</td>
</tr>
<tr>
<td>Philippines³</td>
<td>-2.24</td>
<td>0.02</td>
<td>0</td>
</tr>
<tr>
<td>Singapore³</td>
<td>-3.75</td>
<td>0.00</td>
<td>1</td>
</tr>
<tr>
<td>Thailand³</td>
<td>-3.23</td>
<td>0.002</td>
<td>0</td>
</tr>
</tbody>
</table>

Notes:
1. Bandwidth selection is conducted by Newey-West using Bartlett kernel.
3. No intercept and trend in the test.
### Appendix 3.B  Estimation results

Table 3.7: Indonesia reaction function (1989-2004)

<table>
<thead>
<tr>
<th>Alternative Horizons</th>
<th>$\alpha_i$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\rho_i$</th>
<th>Adj. $R^2$</th>
<th>J-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n = 0$</td>
<td>7.99</td>
<td>0.81</td>
<td>-0.35</td>
<td>-0.31</td>
<td>0.822</td>
<td>2.99</td>
</tr>
<tr>
<td></td>
<td>(1.45)</td>
<td>(0.07)</td>
<td>(0.32)</td>
<td>(0.24)</td>
<td>[0.70]</td>
<td></td>
</tr>
<tr>
<td>$n = 1$</td>
<td>4.18</td>
<td>1.15</td>
<td>-0.24</td>
<td>0.536</td>
<td>0.893</td>
<td>2.63</td>
</tr>
<tr>
<td></td>
<td>(1.62)</td>
<td>(0.11)</td>
<td>(0.45)</td>
<td>(0.05)</td>
<td>[0.75]</td>
<td></td>
</tr>
<tr>
<td>$n = 2$</td>
<td>-2.62</td>
<td>1.79</td>
<td>-2.22</td>
<td>0.83</td>
<td>0.865</td>
<td>4.19</td>
</tr>
<tr>
<td></td>
<td>(4.71)</td>
<td>(0.44)</td>
<td>(1.73)</td>
<td>(0.05)</td>
<td>[0.52]</td>
<td></td>
</tr>
<tr>
<td>$n = 3$</td>
<td>-10.31</td>
<td>2.88</td>
<td>-2.16</td>
<td>0.77</td>
<td>0.640</td>
<td>3.54</td>
</tr>
<tr>
<td></td>
<td>(8.43)</td>
<td>(0.98)</td>
<td>(1.40)</td>
<td>(0.03)</td>
<td>[0.62]</td>
<td></td>
</tr>
<tr>
<td>$n = 4$</td>
<td>-98.13</td>
<td>13.25</td>
<td>-2.74</td>
<td>0.94</td>
<td>0.184</td>
<td>4.02</td>
</tr>
<tr>
<td></td>
<td>(135.43)</td>
<td>(15.44)</td>
<td>(3.38)</td>
<td>(0.05)</td>
<td>[0.55]</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for the J-test.
3. Target horizons for the output gap are fixed at $m = 0$.
4. The set of instruments includes: lag 1 and 2 of inflation; lag 1 and 4 of output gap; lag 1 and 2 of real USD exchange rate; and lag 1 to 3 of interest rate.
5. The covariances are prewhitened and weighted by applying a Bartlett kernel and fixed Newey-West method to determine the bandwidth selection.
### Table 3.8: Malaysia reaction function (1989-2004)

<table>
<thead>
<tr>
<th>Alternative Horizons</th>
<th>$\alpha_1$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\rho_1$</th>
<th>Adj. $R^2$</th>
<th>$J$ test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n = 0$</td>
<td>0.71</td>
<td>1.60</td>
<td>0.17</td>
<td>0.68</td>
<td>0.866</td>
<td>3.63</td>
</tr>
<tr>
<td></td>
<td>(0.32)</td>
<td>(0.10)</td>
<td>(0.08)</td>
<td>(0.12)</td>
<td>[0.60]</td>
<td></td>
</tr>
<tr>
<td>$n = 1$</td>
<td>0.56</td>
<td>1.66</td>
<td>0.19</td>
<td>0.69</td>
<td>0.873</td>
<td>4.31</td>
</tr>
<tr>
<td></td>
<td>(0.39)</td>
<td>(0.12)</td>
<td>(0.05)</td>
<td>(0.076)</td>
<td>[0.51]</td>
<td></td>
</tr>
<tr>
<td>$n = 2$</td>
<td>0.38</td>
<td>1.75</td>
<td>0.10</td>
<td>0.71</td>
<td>0.867</td>
<td>3.77</td>
</tr>
<tr>
<td></td>
<td>(0.52)</td>
<td>(0.165)</td>
<td>(0.08)</td>
<td>(0.09)</td>
<td>[0.58]</td>
<td></td>
</tr>
<tr>
<td>$n = 3$</td>
<td>0.10</td>
<td>1.83</td>
<td>-0.15</td>
<td>0.69</td>
<td>0.837</td>
<td>4.71</td>
</tr>
<tr>
<td></td>
<td>(0.15)</td>
<td>(0.24)</td>
<td>(0.096)</td>
<td>(0.15)</td>
<td>[0.45]</td>
<td></td>
</tr>
<tr>
<td>$n = 4$</td>
<td>1.33</td>
<td>1.68</td>
<td>-0.41</td>
<td>0.89</td>
<td>0.826</td>
<td>6.17</td>
</tr>
<tr>
<td></td>
<td>(4.45)</td>
<td>(0.79)</td>
<td>(0.33)</td>
<td>(0.23)</td>
<td>[0.29]</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the $p$-values for the $J$-test.
3. Target horizons for the output gap are fixed at $m = 0$.
4. The set of instruments includes: lag 1 and 2 of inflation; lag 1 and 4 of output gap and real effective exchange rate; and lag 2 and 4 of interest rate.
5. The covariances are prewhitened and weighted by applying a Bartlett kernel and fixed Newey-West method to determine the bandwidth selection.

### Table 3.9: Philippines reaction function (1989-2004)

<table>
<thead>
<tr>
<th>Alternative Horizons</th>
<th>$\alpha_1$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\rho_1$</th>
<th>Adj. $R^2$</th>
<th>$J$ test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n = 0$</td>
<td>0.07</td>
<td>0.59</td>
<td>1.40</td>
<td>0.57</td>
<td>0.779</td>
<td>1.27</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.12)</td>
<td>(0.59)</td>
<td>(0.10)</td>
<td>[0.53]</td>
<td></td>
</tr>
<tr>
<td>$n = 1$</td>
<td>0.07</td>
<td>0.72</td>
<td>1.22</td>
<td>0.55</td>
<td>0.791</td>
<td>3.02</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.18)</td>
<td>(0.60)</td>
<td>(0.12)</td>
<td>[0.22]</td>
<td></td>
</tr>
<tr>
<td>$n = 2$</td>
<td>0.06</td>
<td>0.76</td>
<td>1.15</td>
<td>0.57</td>
<td>0.791</td>
<td>6.34</td>
</tr>
<tr>
<td></td>
<td>(0.015)</td>
<td>(0.19)</td>
<td>(0.56)</td>
<td>(0.12)</td>
<td>[0.04]</td>
<td></td>
</tr>
<tr>
<td>$n = 3$</td>
<td>0.13</td>
<td>-0.34</td>
<td>5.12</td>
<td>0.87</td>
<td>0.742</td>
<td>8.74</td>
</tr>
<tr>
<td></td>
<td>(0.10)</td>
<td>(1.52)</td>
<td>(5.24)</td>
<td>(0.11)</td>
<td>[0.01]</td>
<td></td>
</tr>
<tr>
<td>$n = 4$</td>
<td>0.11</td>
<td>0.05</td>
<td>3.84</td>
<td>0.84</td>
<td>0.754</td>
<td>10.41</td>
</tr>
<tr>
<td></td>
<td>(0.06)</td>
<td>(0.80)</td>
<td>(2.63)</td>
<td>(0.09)</td>
<td>[0.005]</td>
<td></td>
</tr>
</tbody>
</table>

Note:
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the $p$-values for the $J$-test.
3. Target horizons for the output gap are fixed at $m = 0$.
4. The set of instruments includes: lag 1 and 2 of inflation; lag 4 of output gap; lag 2 of real effective exchange rate; and lag 1 to 2 of interest rate.
5. The covariances are prewhitened and weighted by applying a Bartlett kernel and Andrews parametric method to determine the bandwidth selection.
### Table 3.10: Singapore reaction function (1989-2004)

<table>
<thead>
<tr>
<th>Alternative Horizons</th>
<th>$\alpha_i$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\rho_i$</th>
<th>Adj. $R^2$</th>
<th>$J$-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n = 0$</td>
<td>0.82</td>
<td>1.27</td>
<td>0.94</td>
<td>0.85</td>
<td>0.879</td>
<td>6.80</td>
</tr>
<tr>
<td></td>
<td>(0.87)</td>
<td>(0.49)</td>
<td>(0.46)</td>
<td>(0.05)</td>
<td></td>
<td>(0.34)</td>
</tr>
<tr>
<td>$n = 1$</td>
<td>1.21</td>
<td>0.90</td>
<td>0.755</td>
<td>0.83</td>
<td>0.874</td>
<td>5.80</td>
</tr>
<tr>
<td></td>
<td>(0.77)</td>
<td>(0.43)</td>
<td>(0.39)</td>
<td>(0.06)</td>
<td></td>
<td>(0.45)</td>
</tr>
<tr>
<td>$n = 2$</td>
<td>1.42</td>
<td>0.71</td>
<td>0.90</td>
<td>0.845</td>
<td>0.869</td>
<td>5.94</td>
</tr>
<tr>
<td></td>
<td>(0.88)</td>
<td>(0.49)</td>
<td>(0.46)</td>
<td>(0.06)</td>
<td></td>
<td>(0.43)</td>
</tr>
<tr>
<td>$n = 3$</td>
<td>1.50</td>
<td>0.68</td>
<td>0.98</td>
<td>0.85</td>
<td>0.867</td>
<td>6.47</td>
</tr>
<tr>
<td></td>
<td>(0.905)</td>
<td>(0.50)</td>
<td>(0.43)</td>
<td>(0.05)</td>
<td></td>
<td>(0.37)</td>
</tr>
<tr>
<td>$n = 4$</td>
<td>1.12</td>
<td>0.95</td>
<td>1.07</td>
<td>0.85</td>
<td>0.871</td>
<td>7.43</td>
</tr>
<tr>
<td></td>
<td>(0.89)</td>
<td>(0.50)</td>
<td>(0.41)</td>
<td>(0.05)</td>
<td></td>
<td>(0.28)</td>
</tr>
</tbody>
</table>

Note:
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for the $J$-test.
3. Target horizons for the output gap are fixed at $m = 0$.
4. The set of instruments includes: lag 1 and 4 of inflation; lag 1 and 4 of output gap; lag 1 and 2 of real effective exchange rate; and lag 1 to 4 of interest rate.
5. The covariances are prewhitened and weighted by applying a Bartlett kernel and Andrews parametric method to determine the bandwith selection.

### Table 3.11: Thailand reaction function (1994-2004)

<table>
<thead>
<tr>
<th>Alternative Horizons</th>
<th>$\alpha_i$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\rho_i$</th>
<th>Adj. $R^2$</th>
<th>$J$-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>$n = 0$</td>
<td>-0.37</td>
<td>1.865</td>
<td>0.34</td>
<td>0.84</td>
<td>0.848</td>
<td>5.08</td>
</tr>
<tr>
<td></td>
<td>(2.25)</td>
<td>(0.92)</td>
<td>(0.58)</td>
<td>(0.10)</td>
<td></td>
<td>(0.53)</td>
</tr>
<tr>
<td>$n = 1$</td>
<td>-2.82</td>
<td>2.65</td>
<td>0.575</td>
<td>0.76</td>
<td>0.884</td>
<td>4.55</td>
</tr>
<tr>
<td></td>
<td>(1.46)</td>
<td>(0.51)</td>
<td>(0.33)</td>
<td>(0.06)</td>
<td></td>
<td>(0.60)</td>
</tr>
<tr>
<td>$n = 2$</td>
<td>-1.56</td>
<td>2.04</td>
<td>0.18</td>
<td>0.73</td>
<td>0.911</td>
<td>4.69</td>
</tr>
<tr>
<td></td>
<td>(0.78)</td>
<td>(0.25)</td>
<td>(0.21)</td>
<td>(0.04)</td>
<td></td>
<td>(0.58)</td>
</tr>
<tr>
<td>$n = 3$</td>
<td>-3.61</td>
<td>2.65</td>
<td>0.09</td>
<td>0.70</td>
<td>0.917</td>
<td>4.13</td>
</tr>
<tr>
<td></td>
<td>(0.82)</td>
<td>(0.30)</td>
<td>(0.24)</td>
<td>(0.04)</td>
<td></td>
<td>(0.66)</td>
</tr>
<tr>
<td>$n = 4$</td>
<td>-4.34</td>
<td>2.74</td>
<td>-0.41</td>
<td>0.68</td>
<td>0.882</td>
<td>6.77</td>
</tr>
<tr>
<td></td>
<td>(4.45)</td>
<td>(0.48)</td>
<td>(0.42)</td>
<td>(0.05)</td>
<td></td>
<td>(0.34)</td>
</tr>
</tbody>
</table>

Note:
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for the $J$-test.
3. Target horizons for the output gap are fixed at $m = 0$.
4. The set of instruments includes: lag 1 and 3 of inflation; lag 1, 2 and 4 of output gap; lag 1 and 2 of real USD exchange rate; and lag 1 to 3 of interest rate.
5. The covariances are prewhitened and weighted by applying a Bartlett kernel and Andrews parametric method to determine the bandwith selection.
### Table 3.12: Parameters for the estimates of the extended policy reaction function

<table>
<thead>
<tr>
<th>Country</th>
<th>$\alpha_i$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\kappa_3$</th>
<th>$\rho_1$</th>
<th>Adj. $R^2$</th>
<th>$J - \text{test}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>4.10</td>
<td>1.17</td>
<td>-0.26</td>
<td>-0.01</td>
<td>0.52</td>
<td>0.892</td>
<td>2.60</td>
</tr>
<tr>
<td></td>
<td>(1.79)</td>
<td>(0.19)</td>
<td>(0.56)</td>
<td>(0.10)</td>
<td>(0.08)</td>
<td>[0.63]</td>
<td></td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.52</td>
<td>1.64</td>
<td>0.13</td>
<td>0.03</td>
<td>0.61</td>
<td>0.868</td>
<td>3.52</td>
</tr>
<tr>
<td></td>
<td>(0.40)</td>
<td>(0.12)</td>
<td>(0.07)</td>
<td>(0.03)</td>
<td>(0.17)</td>
<td>[0.47]</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>0.07</td>
<td>0.71</td>
<td>1.39</td>
<td>-0.04</td>
<td>0.56</td>
<td>0.776</td>
<td>2.10</td>
</tr>
<tr>
<td></td>
<td>(0.01)</td>
<td>(0.16)</td>
<td>(0.08)</td>
<td>(0.05)</td>
<td>(0.12)</td>
<td>[0.15]</td>
<td></td>
</tr>
<tr>
<td>Singapore</td>
<td>0.47</td>
<td>1.49</td>
<td>0.91</td>
<td>-0.25</td>
<td>0.86</td>
<td>0.869</td>
<td>5.24</td>
</tr>
<tr>
<td></td>
<td>(1.37)</td>
<td>(1.00)</td>
<td>(0.59)</td>
<td>(0.38)</td>
<td>(0.07)</td>
<td>[0.39]</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>-2.14</td>
<td>2.31</td>
<td>0.16</td>
<td>0.01</td>
<td>0.75</td>
<td>0.918</td>
<td>2.38</td>
</tr>
<tr>
<td></td>
<td>(1.30)</td>
<td>(0.36)</td>
<td>(0.21)</td>
<td>(0.01)</td>
<td>(0.05)</td>
<td>[0.79]</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for the J-test.

### Table 3.13: Estimated parameters for the extended specification in the subsample period

<table>
<thead>
<tr>
<th>Country</th>
<th>Sub sample</th>
<th>$\alpha_i$</th>
<th>$\kappa_1$</th>
<th>$\kappa_2$</th>
<th>$\kappa_3$</th>
<th>$\rho_1$</th>
<th>Adj. $R^2$</th>
<th>$J - \text{test}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia:</td>
<td>(1998-2004)</td>
<td>-3.75</td>
<td>1.92</td>
<td>1.19</td>
<td>-0.06</td>
<td>0.47</td>
<td>0.82</td>
<td>2.50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.79)</td>
<td>(0.15)</td>
<td>(0.45)</td>
<td>(0.08)</td>
<td>(0.08)</td>
<td>[0.64]</td>
<td></td>
</tr>
<tr>
<td>Malaysia:</td>
<td>(1989-1997)</td>
<td>1.01</td>
<td>1.53</td>
<td>0.17</td>
<td>0.00</td>
<td>0.62</td>
<td>0.71</td>
<td>1.75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(2.17)</td>
<td>(0.58)</td>
<td>(0.13)</td>
<td>(0.06)</td>
<td>(0.14)</td>
<td>[0.78]</td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td>(1995-2004)</td>
<td>0.07</td>
<td>0.44</td>
<td>0.78</td>
<td>0.06</td>
<td>0.34</td>
<td>0.50</td>
<td>1.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(0.01)</td>
<td>(0.17)</td>
<td>(0.51)</td>
<td>(0.03)</td>
<td>(0.14)</td>
<td>[0.17]</td>
<td></td>
</tr>
<tr>
<td>Thailand</td>
<td>(1994-1999)</td>
<td>1.68</td>
<td>1.60</td>
<td>0.10</td>
<td>0.02</td>
<td>0.71</td>
<td>0.85</td>
<td>1.93</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.70)</td>
<td>(0.93)</td>
<td>(0.21)</td>
<td>(0.02)</td>
<td>(0.05)</td>
<td>[0.86]</td>
<td></td>
</tr>
</tbody>
</table>

**Note:**
1. Numbers in brackets are the relevant standard errors.
2. Numbers in square brackets are the p-values for the J-test.
Chapter 4

Simple Model for a Small Open Economy: An Application to the ASEAN-5 Countries

4.1 Introduction

The optimal use of monetary policy for the management of short term economic fluctuations requires better understanding of how monetary policy works and how its effects are transmitted to the economy. In order to understand the effects of monetary policy, the literature has conventionally resorted to the estimation of economic models to provide a description of how monetary policy works in an economy. However, as traditional macro-econometric models tend to be prone to the Lucas critique (Lucas Jr, 1976), the literature has moved on to seek better models to guide policy. Ireland (2004a) points out that, from the early 1980s, there are two distinct approaches to macroeconomic analysis that are used as the basis for analysis through till the present: the vector autoregressive (VAR) time-series models, following the seminal contribution by Sims (1980); and the dynamic, stochastic, general equilibrium (DSGE) models, following Kydland and Prescott (1982).

VAR models tend to make relatively little appeal to detailed economic theory. They therefore tend to be a lot more flexible when dealing with data. However, these models are often unable to expose the deep parameters in the economy. As a consequence, they may still be subject to the Lucas critique since the parameters underly-
ing the models may not be invariant to changes in the policy regime. DSGE models, on the other hand, are based on the micro foundations in economic theory. They are characterised by the deep parameters of the economy, which (in principle) are supposed to be invariant to changes in policy regime. These models are, therefore, often regarded as useful for conducting analysis of the welfare implications of different alternative policy regimes in an economy. The downside, however, is that they are often regarded as too stylised to be useful for the purpose of empirical testing.\(^1\)

Because of their potential ability to deal with the Lucas critique, attempts to make DSGE type models more realistic empirically have been expanding in the past decade. Most of the earlier efforts have been mainly focused on closed economy models. Efforts to apply the models in an open economy setup have only been developed fairly recently. Although contributions to the empirical estimates of open-economy DSGE models in the literature are still relatively few, they are growing in number. As discussed in Lane (2001), there have been some attempts to match the importance of the relationships emphasised in the theoretical models to the empirical data. In general, there are at least two different avenues that have been pursued in order to do this, that is, through calibration exercises or through econometric investigation.

Calibration exercises are conducted by calibrating the structural model parameters to match the unconditional moments in the observed data.\(^2\) Although useful to gain empirical insights into the structural model, this method is often considered to be insufficient in overall empirical evaluation of this class of model. This assessment follows from the argument that monetary shocks only account for a fraction of the aggregate economic fluctuations captured by the unconditional moments. Hence, the transmission mechanism from monetary policy shocks is biased by noise from other sources.

As an alternative, performance of a structural model can be evaluated in terms of its ability to describe the way an economy responds to a particular set of macroeconomic

\(^{1}\)As initially discussed in Lucas Jr (1980).
\(^{2}\)See, for example, the discussions provided in Kydland and Prescott (1996).
shocks, that is, by calibrating the structural parameters through minimising the distance between the structural model impulse responses from impulse response functions (IRFs) generated by VAR econometric models. Rotemberg and Woodford (1998) provide relatively detailed discussion of this approach. Other examples of the application of the approach include Christiano et al. (2005) and Amato and Laubach (2003) for the case of the US economy in a closed economy setup; and Lindé et al. (2004) for the case of a small open economy setup in Sweden. Although similar in spirit, this method is seen as an improvement on the calibration method mentioned earlier since the IRFs basically summarise the moments of the data and further decompose them into different noise components. This allows one to focus on specific characteristics in the data. Geweke (1999) calls this method the weak econometric interpretation of a structural model.

Recently, efforts to apply DSGE models directly to the data have been growing. This is done by conducting what Geweke (1999) refers to as the strong econometric interpretation of a structural model. This method applies an econometric technique to estimate the structural parameters directly using data. Examples for this approach can be found in Ireland (2004a), among others, where the structural parameters are estimated using maximum likelihood estimation (MLE); and in Lubik and Schorfheide (2005), where the structural parameters are estimated using the Bayesian method of estimation.3

The purpose of this chapter is to examine the monetary policy transmission mechanism in the case of five ASEAN economies (Indonesia, Malaysia, the Philippines, Singapore and Thailand). In order to do so, the chapter estimates a simple small open economy DSGE model for each of the countries using the MLE approach.

The structural DSGE model used in here closely follows the one derived by Gali and Monacelli (2005). It is a version of a small open economy model that features imperfect competition and nominal price rigidities. In addition, the model

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3Examples for the application of the MLE procedure to estimate the structural parameters in DSGE models can also be found in, among others, Soderlind (1999), Ireland (2003, 2004b); while examples for the application of the Bayesian method can be found, among others, in Smets and Wouters (2003), Justiniano and Preston (2004) and Liu (2006).
CHAPTER 4. SIMPLE SMALL OPEN ECONOMY MODEL

considers an incomplete pass-through effect, as suggested by Monacelli (2005), and staggered price setting in the domestic import goods market. The model extends the consumers’ behaviour side by considering external habit formation in consumers’ utility. These modifications are undertaken to capture richer dynamics in the model in order to make a closer representation of actual data. Lastly, as in most of the literature discussing the New Keynesian small open economy models, the model used also treats the foreign sector as approximately closed since the domestic economy is not considered to be big enough to affect the foreign sector.

The estimation results suggest that the model is able to provide reasonable elaboration of the monetary policy transmission mechanisms for each of the ASEAN-5 economies. The chapter also uses the results to revisit the issue of structural shock correlations among the group of countries under consideration. Although the pattern of structural correlations obtained under the model are not as strong as suggested by VAR-based studies for the region, it does not contradict their suggested general conclusions.

The rest of the chapter is organised as follows. Section 4.2 describes the basic structure of the simple small open economy model used to characterise the economies under consideration. Section 4.3 briefly discusses the empirical strategy to apply the model to the data used in estimating the model. Section 4.4 presents the estimation results and evaluates the impact of various structural innovations to each of the sample economies. Section 4.5 revisits the issue of structural shock correlations for the ASEAN-5 economies. Section 4.6 concludes.

4A similar approach can also be seen in Fuhrer (2000), Christiano et al. (2005), Smets and Wouters (2003), etc.
5See Woodford (2003a, ch.5) for discussions on the issue.
4.2 A Simple Small Open Economy Model

4.2.1 Households

The economy is assumed to be inhabited by a continuum of representative house- holds (HH) who seek to maximise:

$$E_t \sum_{T=t}^{\infty} \beta^{T-t} \Upsilon_T [U (C_{T-t} - H_{T-t}) - V (N_{T-t})]$$  \hspace{1cm} (4.1)

subject to an intertemporal budget constraint, which will be described later in this section. In the above equation, $E_t$ denotes the expectation operator taken at time $t$, $\beta$ represents the discount factor and $\Upsilon_t \sim (1, 1)$ denotes the random HH preference shock with mean and variance equal to 1.

$N_t$ denotes hours of labour and $V(N_t)$ represents the HH disutility out of working, and is defined as follows:

$$V(N_t) = \frac{N_t^{1+\varphi}}{1 + \varphi}$$  \hspace{1cm} (4.2)

where $\varphi$ is the inverse elasticity of labour supply.

$U(\cdot)$ represents HH utility out of consumption that is assumed to take the form of:

$$U (C_t - H_t) = \frac{(C_t - H_t)^{1-\sigma}}{1 - \sigma}$$  \hspace{1cm} (4.3)

where $\sigma$ is the inverse elasticity of intertemporal substitution. $C_t$ is the time $t$ composite consumption index of the representative HH that contain both bundles of domestic and imported goods ($C_{D,t}$ and $C_{F,t}$, respectively) defined by:

$$C_t = \left[ (1 - \alpha)^{\frac{1}{\beta}} C_{D,t}^{\frac{n}{n-1}} + \alpha^{\frac{1}{\beta}} C_{F,t}^{\frac{n-1}{n}} \right]^{\frac{n}{n-1}}$$  \hspace{1cm} (4.4)

$H_t = hC_{t-1}$ represents an external habit formation of the representative HH that is assumed to be taken exogenously at each time $t$.\(^6\) Notice that under this specifica-

\(^6\)This treatment follows the treatment used in Smets and Wouters (2003), Justiniano and
tion, $\alpha$ measures the degree of openness of the economy and $\eta$ is the elasticity of substitution between the two categories of goods.

The aggregate domestic and import consumptions are given by the following CES aggregators of the quantities consumed in each type of good:

$$C_{D,t} = \left( \int_{i=0}^{1} C_{D,t}(i)^{\frac{\alpha-1}{\varepsilon}} d\bar{i} \right)^{\frac{1}{1-\varepsilon}}$$

and

$$C_{F,t} = \left( \int_{i=0}^{1} C_{F,t}(i)^{\frac{\alpha-1}{\varepsilon}} d\bar{i} \right)^{\frac{1}{1-\varepsilon}}$$  (4.5)

where $\varepsilon$ is the elasticity of substitution among goods within each bundle category.

The maximisation of (4.1) is subject to a sequence of an intertemporal budget constraint:

$$\int_{i=0}^{1} [P_{D,t}(i)C_{D,t}(i) + P_{F,t}(i)C_{F,t}(i)]d\bar{i} + E_t(\xi_{t+1} D_{t+1}) \leq W_t N_t + D_t + \tau_t$$  (4.6)

where $P$ denotes the price of each good; $D_{t+1}$ is the time $t + 1$ nominal pay-off of the portfolio held at the end of period $t$; $W_t$ is the nominal wage; $\tau$ denotes lump sum taxes or transfers; and $\xi_{t,t+1}$ denotes the stochastic discount factor for nominal pay-off ($E_t(\xi_{t,t+1}) = R_t^{-1}$, where $R$ is the gross return). Throughout the model, the representative HH are assumed to have access to a complete set of contingent claims, traded internationally. Further, the model specifies monetary policy in terms of an interest rate rule rather than a money rule. Therefore money is not explicitly introduced in the model and can be thought as only playing the role of a unit of account.

Under this specification, HH optimal allocation of expenditures within each category of goods yields demand functions:

$$C_{D,t}(i) = \left( \frac{P_{D,t}(i)}{P_{D,t}} \right)^{-\varepsilon} C_{D,t} \text{ and } C_{F,t}(i) = \left( \frac{P_{F,t}(i)}{P_{F,t}} \right)^{-\varepsilon} C_{F,t}; \forall i \in [0,1]$$  (4.7)

Equation (4.7) implies the price indices for domestic and imported goods as follows:

$$P_{D,t} = \left( \int_{i=0}^{1} P_{D,t}(i)^{1-\varepsilon} d\bar{i} \right)^{\frac{1}{1-\varepsilon}}$$

and

$$P_{F,t} = \left( \int_{i=0}^{1} P_{F,t}(i)^{1-\varepsilon} d\bar{i} \right)^{\frac{1}{1-\varepsilon}}.$$  The optimal alloca-
tion between domestic and imported goods yields the aggregated demand function for each category of goods as follows:

\[ C_{D,t} = (1 - \alpha) \left( \frac{P_{D,t}}{P_t} \right)^{-\eta} C_t \quad \text{and} \quad C_{F,t} = \alpha \left( \frac{P_{F,t}}{P_t} \right)^{-\eta} C_t \]  

(4.8)

The above equation implies \( P_t = \left[ (1 - \alpha)P_{D,t}^{1-\eta} + \alpha P_{F,t}^{1-\eta} \right]^{\frac{1}{1-\eta}} \), where \( P_t \) is the consumer price index (CPI) at each period \( t \).

Given the above optimality conditions in (4.7) and (5.18), the representative HH intertemporal budget constraint can be rewritten as:

\[ P_tC_t + E_t(\xi_{t,t+1}D_{t+1}) \leq W_tN_t + D_t + \tau_t \]  

(4.9)

It follows that the representative HH problem now is to maximise (4.1) subject to (4.9). The resulting first order necessary conditions (FONCs) can be rearranged as follows:

\[ \frac{N^*_t}{(C_t - hC_{t-1})^{-\sigma}} = \frac{W_t}{P_t} \]  

(4.10)

and,

\[ \beta R_tE_t \left[ \frac{Y_{t+1}}{Y_t} \left( \frac{C_{t+1} - hC_t}{C_t - hC_{t-1}} \right)^{-\sigma} \frac{P_t}{P_{t+1}} \right] = 1 \]  

(4.11)

where (4.10) represents the standard intra-temporal optimality conditions for HH labour-leisure choice, and (4.11) denotes the stochastic Euler equation.

### 4.2.2 Domestic inflation, real exchange rate and the terms of trade

Domestic inflation is characterised by the domestic CPI inflation, which in its log-linearisation around its steady state takes the form of:

\[ p_t = (1 - \alpha)p_{D,t} + \alpha p_{F,t} \]  

(4.12)
where small caps denote the log difference of a variable from its steady state value. Given that the log value of domestic terms of trade is defined as \( s_t = p_{F,t} - p_{D,t} \),\(^7\) equation (4.12) can also be written as \( p_t = p_{D,t} + \alpha s_t \). It follows that the domestic inflation \( (\pi_t = p_t - p_{t-1}) \) can be written as follows:

\[
\pi_t = (1 - \alpha)\pi_{D,t} + \alpha \pi_{F,t} \\
= \pi_{D,t} + \alpha \Delta s_t
\] (4.13)

The above equation shows that the more open the economy is, the bigger the impact of changes in the domestic terms of trade on the domestic CPI inflation.

The real exchange rate \( (Q_t) \) is defined as a ratio between the international prices in terms of domestic currency and the domestic prices \( \frac{e_t p^*_t}{P_t} \). It follows that the log deviation from the steady state value of \( Q_t \) can be written as \( q_t = e_t + p^*_t - p_t \), where \( e \) denotes the nominal exchange rate and \( p^* \) denotes the international prices.

In an environment where an incomplete pass-through effect is possible, \( e_t + p^*_t \) does not necessarily have to be equal to \( p_{F,t} \), i.e. \( e_t + p^*_t - p_{F,t} = \psi_t \). The term \( \psi \) in the last expression denotes the deviation from the law of one price, in which domestic import price deviates from the domestic value of the international price. Under this set up, \( q_t \) can be rewritten as:

\[
q_t = (1 - \alpha)s_t + \psi_t
\] (4.14)

The above relationship is derived by substituting equation (4.12) into the real exchange rate identity. It follows that there are two sources of deviation from aggregate purchasing power parity (PPP) in this framework; namely, the heterogeneity of the consumption basket between the small open economy and the rest of the world, and the deviation from the law of one price.

\(^7\)The term ‘domestic’ here is included to accommodate the assumed incompleteness in the pass-through effect in the economy. In this case, \( p_{F,t} \neq e_t + p^*_t \), where \( e \) denotes the nominal exchange rate and \( p^* \) denotes international prices. (Monacelli, 2005)
4.2.3 International risk sharing and uncovered interest parity

Under the assumption of a complete international financial market and perfect capital mobility, the expected nominal return from risk free assets must equal the expected domestic currency return from foreign assets. This assumed existence of a complete contingent claims market has implications for an international consumption risk sharing. In equilibrium, movements in the ratio of domestic to foreign marginal utility in consumption must imply a proportional movement in the real exchange rate. Following the arguments in Chari et al. (2002) and Gali and Monacelli (2005), the complete markets assumption and the HH Euler equations in both domestic and foreign economies imply:

\[(C_t - hC_{t-1}) = K (C_t^* - hC_{t-1}^*) Q_t^{1/2}\]  

(4.15)

or, in its log linear approximation form:

\[c_t - hC_{t-1} = y_t^* - h y_{t-1}^* + \frac{(1-h)}{\sigma} q_t + v_t^q\]  

(4.16)

Where \(v_t^q\) can be interpreted as a shock to the risk premium, and the foreign sector output, \(y_t^* = c_t^*\). Note also that the relationship contains both the contemporaneous relationship as well as the effect from including external habit formation in the HH preference structure.

The above assumption also helps to recover the uncovered interest parity (UIP) condition that relates domestic and foreign interest rates. By combining the efficiency conditions for optimal portfolio holdings of both the domestic and foreign sectors, equation (4.15) can be rewritten as:

\[\frac{\epsilon_{t+1}}{\epsilon_t} = \frac{(1 + i_t)}{(1 + i_t^*)}\]  

(4.17)

---

8The last relationship uses the fact that the foreign sector is approximately closed in structure so that in equilibrium \(y_t^* = c_t^*\).
or, in its log-linear approximation form

\[ i_t - i_t^* = E_t (\Delta e_{t+1}) \tag{4.18} \]

### 4.2.4 Domestic firms and optimal price setting

**Domestic firm technology**

There is a continuum of identical monopolistically competitive firms in the economy indexed by \( i \in [0, 1] \). Each firm produces differentiated outputs \( (Y) \) with a representative production function as follows:

\[ Y_t(i) = B_t N_t(i) \tag{4.19} \]

where \( b_t = \ln(B_t) \) is the productivity shock that is assumed to follow an AR(1) process \( b_t = \rho b_{t-1} + \nu_t^b \), where \( \nu_t^b \sim (0, \sigma^2_{\nu_t^b}) \). Let \( Y_t = \frac{1}{i} \left[ \int_{i=0}^{1} Y_t(i) \frac{dx}{i} \right] \) represent the aggregate output. Then integrating the labour employed in each firm will produce: \( f_{i=0}^{1} N_t(i) = N_t = \frac{Y_t}{B_t} \).

The real total costs \( (TC) \) faced by firms are \( TC_t = \frac{w_t}{F_{D,t}} N_t = \frac{w_t Y_t}{F_{D,t} B_t} \) after substituting \( N_t \) by \( (4.19) \). Therefore, the marginal cost is \( MC_t = \frac{w_t}{F_{D,t} B_t} \). Then, the log-linear approximation of the marginal costs can be written as:

\[ MC_t = w_t - p_{D,t} - b_t \tag{4.20} \]

\[ = w_t - [(1 - \alpha) p_{D,t} + \alpha p_{F,t}] + \alpha (p_{F,t} - p_{D,t}) - b_t \]

\[ = w_t - p_t + \frac{\alpha}{1 - \alpha} (q_t - \psi_t) - b_t \]

The third line in the above equation is obtained by using \( (4.12) \), the definition for the domestic terms of trade \( (s) \) and \( (4.14) \).

Recall that the log-linear approximation of \( (4.10) \) states that \( w_t - p_t = \varphi n_t + \frac{\sigma}{1 - h} (c_t - hc_{t-1}) \). Therefore, by employing the log-linear version of \( (4.19) \) to substi-
tute for $n_t$, (4.20) can also be expressed as

$$m_{ct} = \varphi y_t + \frac{\sigma}{1 - h_t} (c_t - h c_{t-1}) + \frac{\alpha}{1 - \alpha} (q_t - \psi_t) - (1 + \varphi) b_t$$ \hfill (4.21)

### Optimal price setting mechanism

Both domestic producers and importers are assumed to set prices in a staggered fashion following Calvo (1983). Hence, within any period $t$, there is a fraction $(1 - \theta_j)$ of firms that reset their price optimally ($j = D, F$), while the remainder $0 \leq \theta_j \leq 1$ does not. The fraction of firms that does not reset prices is assumed to adjust price by indexing it to the last period’s CPI inflation as follows:

$$p_{jt} \equiv p_{jt} \equiv p_{jt-1} + \delta \pi_{t-1}$$ \hfill (4.22)

where $\delta \in [0, 1]$ represents the degree of price indexation to the previous period’s inflation rate. Since each firm has the opportunity to reset its price optimally in some period $t$, every firm faces the same decision problem, hence setting a common optimal price $P_{jt}^{new}(i) = P_{jt}^{new}$. The aggregate price index in sector $j$ evolves according to the following equation:

$$P_{jt} = \left\{ (1 - \theta_j) P_{jt}^{new(1-\varepsilon)} + \theta_j \left[ P_{jt-1} \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\delta} \right] \right\}^{\frac{1}{1-\varepsilon}}$$ \hfill (4.23)

For a firm producing domestically, the price setting problem when it wants to reoptimise its price in some period $t$ would be to maximise its expected present discounted value of profits with respect to $P_{jt}^{new}$ if it was unable to reoptimise in the future:

$$\max_{P_{jt}^{new}} \sum_{T=t}^{\infty} (\beta \theta_D)^{T-t} E_t \left\{ \xi_{t,T} \left[ Y_{T}(i) \left( P_{jt}^{new} \left( \frac{P_{t-1}}{P_{t-2}} \right)^{\delta} - P_{jt} MCT_T \right) \right] \right\}$$ \hfill (4.24)
subject to the sequence of demand constraints:

\[ Y_T(i) = \left[ \frac{P_{D,T}^{\text{new}}}{P_{D,T}} \left( \frac{P_{T-1}}{P_{T-1}} \right)^\delta \right]^{-\varepsilon} Y_T \]  

(4.25)

The corresponding FONC of the above problem could be written as:

\[ \sum_{T=t}^{\infty} (\beta \theta_D)^{T-t} E_t \left\{ \xi_{t,T} Y_T \left[ \frac{P_{D,T}^{\text{new}}}{P_{D,T}} \left( \frac{P_{T-1}}{P_{T-1}} \right)^{\delta(1-\varepsilon)} \right] \right\} \]

\[ = \sum_{T=t}^{\infty} (\beta \theta_D)^{T-t} E_t \left\{ \xi_{t,T} Y_T \left[ \frac{\varepsilon}{\varepsilon - 1} \left( \frac{P_{D,T}^{\text{new}}}{P_{D,T}} \right)^{-\varepsilon} \left( \frac{P_{T-1}}{P_{T-1}} \right)^{-\delta \varepsilon} P_{D,T} M C_T \right] \right\} \]  

(4.26)

By taking the condition that in the steady state \( \xi_{t,T} = \bar{\xi} = 1; P_{D}^{\text{new}} = P_D \) and \( M C = \frac{\varepsilon - 1}{\varepsilon}, \) the first order log-linear approximation of the above equation can be written as:

\[ P_{D,T}^{\text{new}} = (1 - \beta \theta_D) \sum_{T=t}^{\infty} (\beta \theta_D)^{T-t} E_t [p_{D,T} + m c_T - \delta (p_{T-1} - p_{t-1})] \]

or,

\[ P_{D,T}^{\text{new}} = (1 - \beta \theta_D) (p_{D,t} + m c_t) + \beta \theta_D \left[ E_t \left( P_{D,t+1}^{\text{new}} \right) - \delta \pi_t \right] \]  

(4.27)

Substituting (4.27) into the log-linearised approximation of the Calvo pricing equation for domestic producing firms:

\[ p_{D,t} = (1 - \theta_D) P_{D,t}^{\text{new}} + \theta_D (p_{D,t-1} + \delta \pi_{t-1}) \]  

(4.28)

we can work out the equation that governs the development of the domestic price inflation:

\[ \pi_{D,t} = \frac{1}{1 + \beta \delta} \left[ \beta E_t (\pi_{D,t+1}) + \delta \pi_{t-1} + \frac{(1 - \theta_D)(1 - \beta \theta_D)}{\theta_D} m c_t \right] \]  

(4.29)

Similarly, the optimal price setting problem for the domestic importing firms could

---

9 Variables without time subscript denote their steady state values.
be solved to derive the import price inflation as follows:

\[ \pi_{F,t} = \frac{1}{1 + \beta \delta} \left[ \beta E_t (\pi_{F,t+1}) + \delta \pi_{t-1} + \frac{(1 - \theta_F)(1 - \beta \theta_F)}{\theta_F} \psi_t \right] \]  

(4.30)

where \( \psi_t \) is the marginal cost faced by the firms in this category. The last two equations above show that, for both domestic and imported goods, inflation is governed by expected future inflation, the last period CPI inflation (due to price indexation), and their respective marginal costs – which in the case of importing firms is simply the difference between the domestic imported price and the world price.

As discussed earlier, domestic CPI inflation is a weighted sum of inflation for both domestic and imported goods. Therefore, by substituting (4.29) and (4.30) in to (4.13), the domestic CPI inflation can be expressed as the following:

\[ \pi_t = (1 - \alpha) \left[ \beta E_t (\pi_{D,t+1}) + \frac{(1 - \theta_D)(1 - \beta \theta_D)}{\theta_D} mc_t - \beta \delta \pi_t + \delta \pi_{t-1} \right] + \alpha \left[ \beta E_t (\pi_{F,t+1}) + \frac{(1 - \theta_F)(1 - \beta \theta_F)}{\theta_F} \psi_t - \beta \delta \pi_t + \delta \pi_{t-1} \right] \]

or,

\[ \pi_t = \frac{1}{1 + \beta \delta} \left[ \beta E_t (\pi_{t+1}) + \delta \pi_{t-1} + (1 - \alpha) \Gamma_D mc_t + \alpha \Gamma_F \psi_t \right] \]  

(4.31)

where \( \Gamma_D = \frac{(1 - \theta_D)(1 - \beta \theta_D)}{\theta_D} \) and \( \Gamma_F = \frac{(1 - \theta_F)(1 - \beta \theta_F)}{\theta_F} \).

### 4.2.5 Market clearing condition

In equilibrium, domestic output is being cleared out by both domestic consumption and export of domestic goods consumed by the foreign sector \( (C_{D,t}^*) \), i.e:

\[ Y_t = C_{D,t} + C_{D,t}^* \]  

(4.32)

Using both domestic and foreign demand for domestic goods described in (5.18),
the above can be rewritten as:

\[ Y_t = (1 - \alpha) \left( \frac{P_{D,t}}{P_t} \right)^{-\eta} C_t + \alpha^* \left( \frac{P_{D,t}}{\varepsilon_t P_t^*} \right)^{-\eta} Y_t^* \]  

(4.33)

or, in its log-linear approximation

\[ y_t = (1 - \alpha) c_{D,t} + \alpha c_{D,t}^* \]  

(4.34)

where, \( c_{D,t} = -\eta (P_{D,t} - p_t) + c_t \) and \( c_{D,t}^* = -\eta (P_{D,t} - e_t - p_t^*) + c_t^* \).

By applying (4.12), the log-linear approximation of both the definition for domestic terms of trade \((s)\) and real exchange rate \((q)\), as well as (4.14), (4.34) can also be written as

\[ y_t = (1 - \alpha) c_t + \alpha y_t^* + \frac{(2 - \alpha) \alpha \eta}{1 - \alpha} q_t - \frac{\alpha \eta}{1 - \alpha} \psi_t \]  

(4.35)

where the demand for domestic output is affected positively by domestic consumption, foreign income and real exchange rate; and negatively related to the deviations from the law of one price.

### 4.2.6 The monetary sector

The monetary sector in this economy is represented by a policy rule function, which specifies the monetary policy regime for the economy. Conditional on the evolution of the world economy and other exogenous disturbances, the monetary policy rule will also act as a closure for the model in general. In particular, the policy rule is specified to follow a Taylor type rule:

\[ i_t = (1 - \rho_i) (\kappa_1 E_t \pi_{t+n} + \kappa_2 y_t) + \rho_i i_{t-1} + \nu_t i^i \]  

(4.36)

where \( \nu_t i^i \) is added to represent a possible unexpected monetary policy innovation in the economy. Notice also that the Taylor-type specification above includes a lagged endogenous term. This is done to capture the possible degree of persistence in the interest rate movement to avoid loss of credibility from impulsive large changes in
4.2.7 Specifying the foreign sector

Since a primary objective of the model is to analyse how a small open economy works, and since the foreign economy is treated as exogenous to the domestic economy, there is some flexibility in specifying the data generating process for the foreign variables. For the sake of convenience, rather than using a structural model, a stylised model for the rest of the world is employed to specify the determination of foreign variables. The path of those variables is assumed to be determined by an unrestricted vector auto regressions (VAR). The reduced form of the foreign sector data generating process is as follows:

\[ x_t^f = \mathbf{A}(L) x_{t-1}^f + \mathbf{v}_t^f \]  

where \( x_t^f = [x_t^r \ (i_t - E_t \pi_{t+1})]' \), \( \mathbf{A}(L) \) is a matrix of coefficients with an appropriate dimension and \( \mathbf{v}_t^f \) is a vector of error with the usual properties.

4.3 Empirical Analysis and Data

4.3.1 Log-linear approximation of the model

This section summarises the log-linear equilibrium conditions employed for the estimation. The equation for consumption is given by log-linearizing (4.11) around its non-stochastic steady state value.

\[ c_t = \frac{1}{1 + h} E_t c_{t+1} + h c_{t-1} - \frac{(1 - h)}{(1 + h) \sigma} (i_t - E_t \pi_{t+1}) + \nu_t^c \]  

where \( \nu_t^c \) is a random preference shock with mean zero and variance \( \sigma_{\nu^c}^2 \). The real interest rate elasticity of consumption is negatively affected by both the intertemporal elasticity of substitution (\( \sigma \)) and the external habit persistence parameter (\( h \)). That is, given \( \sigma \), a higher degree of habit persistence (\( h \)) in this case will tend to
lower the negative impact of real interest rate on consumption.

Movements in nominal interest rate are governed by the interest rate reaction function in (4.36). Domestic output is determined by the goods market clearing condition (4.35), and movements in real exchange rate are governed by the international consumption risk sharing mechanism (4.16).

Domestic CPI inflation, which is given by (4.31), depends on both expected future and past inflation, as well as the current marginal cost faced by both domestic producers ($mc_t$) and import retailers ($\psi_t$). $mc$ is given by (4.21) and $\psi$ is calculated based on the definition in (4.14). For the purpose of estimation, $\psi$ is treated as exogenous and is assumed to follow an AR(1) process $\psi_t = \rho_t \psi_{t-1} + v_t^\psi$, where $v_t^\psi \sim (0, \sigma_{v_t}^2)$.

To complete the system, the external sector is represented by (4.37) as explained in section 4.2.7.

\[
\begin{bmatrix}
y_t^* \\
_r_t^*
\end{bmatrix}
= 
\begin{bmatrix}
\phi_1 & \phi_2 \\
\phi_3 & \phi_4
\end{bmatrix}
\begin{bmatrix}
y_{t-1}^* \\
r_{t-1}^*
\end{bmatrix}
+ 
\begin{bmatrix}
v_t^\psi \\
v_t^r
\end{bmatrix}
\]  

(4.39)

4.3.2 Estimation strategy

The complete representation of the system to be estimated, consisting of ten equations in ten variables ($c, i, y, q, \pi, mc, \psi, b, y^*, r^*$), is outlined in Appendix 4.A. The approximate solution to this linear system of the model can be obtained by applying the methods of Blanchard and Kahn (1980). The solution takes the form of state space representation of a dynamic system as follows:

\[
s_{t+1} = \Pi s_t + W \varepsilon_{t+1}
\]  

(4.40)

and,

\[
f_t = Us_t
\]  

(4.41)
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where,

\[
\begin{align*}
S_t &= \begin{bmatrix}
\pi_{t-1} & c_{t-1} & y_{t-1} & r_{t-1}^* & b_t & v_t^c & v_t^q & v_t^i & \psi_t & v_t^{y^*} & v_t^{r^*}
\end{bmatrix}', \\
F_t &= \begin{bmatrix}
mc_t & y_t & qt & y_t^* & r_t^* & \pi_t & c_t
\end{bmatrix}', \\
E_t &= \begin{bmatrix}
v_t^b & v_t^c & v_t^q & v_t^i & \psi_t & v_t^{y^*} & v_t^{r^*}
\end{bmatrix}'
\end{align*}
\]

and \( \Pi, \mathbf{W} \) and \( \mathbf{U} \) are the conformable matrices of coefficients derived from the model.\(^{10}\)

Given the above state-space representation, parameters in the model can be estimated using the maximum likelihood estimation as described in Hamilton (1994, chapter 13). The estimation is conducted using data on seven observable variables \((\pi, y, i, q, \psi, y^* \text{ and } r^*)\), while leaving the other three variables \((mc, c \text{ and } b)\) to be endogenously determined in the system.\(^{11}\) In order to produce the results, data are de-meaned before initiating the maximum likelihood procedure.

4.3.3 Data

Quarterly data from 1989 to 2004 for the five ASEAN nations are used for the purpose of analysing the small open economy model.\(^{12}\) The data are mostly collected from the CEIC Asia database except for the TWI of exchange rate data for Singapore, Malaysia and the Philippines, which are taken from the IMF estimates in the International Financial Statistics (IFS) data base. Data for the output gap, CPI inflation, interest rate and exchange rate are generated in the same way as the data used for estimating the policy reaction function for each of the economies in Chapter 3. For the purpose of analysing the small open economy model, real exchange rates for Indonesia and Thailand are calculated by multiplying their nominal

\(^{10}\)The solution here is obtained following the procedure proposed by Ireland (2004a).
\(^{11}\)To conduct the maximum likelihood estimation of the model's parameters, I use the maximum likelihood routines provided in Dynare version 3.065. The optimizer used for the mode of computation is the fminunc routine in MATLAB.
\(^{12}\)An exception applies to the cases of Malaysia and Thailand due to a data availability issue. Data for Malaysia start from 1991 and data for Thailand start from 1993.
exchange rate data with the ratio between the US and domestic price indices. The foreign sector in the empirical analysis is represented by the US economy, in which its quarterly data for the relevant years are collected from the IFS data base.

In this section, particular attention is paid to the construction of the approximate measure for the deviation from the law of one price \( \psi \). As shown in (4.14), this measure is defined as the difference between real exchange rate \( q \) and the product of the degree of home biasedness \( 1 - \alpha \) and the domestic terms of trade \( s \).

Unfortunately, precise data on domestic and imported price level \( P_D \) and \( P_F \) for the countries under consideration are not readily available. To deal with this issue, \( P_F \) is approximated by a relevant index of import prices, calculated as the ratio between the nominal and the constant price import data for each of the countries obtained from the CEIC database. Relation (4.12) is then employed in order to get an approximation for \( P_D \). The degree of openness \( \alpha \) used to derive \( P_D \) is approximated by an average of import share in the Gross Domestic Product (GDP). In order to get a more sensible magnitude, in the case of Singapore and Malaysia, \( \alpha \) is adjusted. In the case of Singapore, \( \alpha \) is defined as the ratio between non re-exported imports over GDP, while for the case of Malaysia it is defined as the ratio between the sum of consumption and intermediate imports over GDP.\textsuperscript{13} Approximate values of \( \alpha \) for each country within the group are assumed to be constant over the sample period under consideration and shown in Table 4.1.

<table>
<thead>
<tr>
<th>Country</th>
<th>( \alpha )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>0.30</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.65</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.49</td>
</tr>
<tr>
<td>Singapore</td>
<td>0.80</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.48</td>
</tr>
</tbody>
</table>

Table 4.1 suggests that, in terms of economic openness, Singapore is the most open one and Indonesia is the least open within the group of countries considered in this

study. The series of $\psi$ for each of the countries are then calculated using the values of $\alpha$ reported in Table 4.1, using the relationship stated in equation (4.14).

4.4 Estimation Results

In order to produce the results, parameter estimations for each of the individual countries were conducted by imposing several assumptions. First, parameters in the monetary policy reaction function in each country are assumed to be fixed following the estimates produced for each of the five economies under consideration in Chapter 3. Second, since the foreign sector is exogenous with respect to the domestic economy, its VAR(1,1) representation is estimated separately. Therefore, parameters representing the foreign sector in the system are pre-fixed when estimating the rest of the parameters in the system. Parameters for the foreign sector block are reported in Appendix 4.B. Third, coefficients for the degree of openness ($\alpha$) and the discount factor ($\beta$) are also exogenously fixed. Values for $\alpha$ are as reported in Table 4.1. Values for $\beta$ are calculated as $(1 + \bar{i})^{-0.25}$, where $\bar{i}$ (the long-run equilibrium rate of interest) is approximated by the average interest rate over the chosen sample. Table 4.2 reports the approximate values for $\beta$.

Table 4.2: Approximate values for the discount factor

<table>
<thead>
<tr>
<th>Country</th>
<th>$\beta$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>0.963</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.988</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.972</td>
</tr>
<tr>
<td>Singapore</td>
<td>0.992</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.984</td>
</tr>
</tbody>
</table>

14 Appendix 4.D provide the graphs for the deviation from the law of one price for each of the ASEAN-5 countries.

15 An exception applies for the case of the Philippines, where the previous GMM estimate for its policy reaction function parameters fail to satisfy the Blanchard and Kahn conditions for the stability of the model. In this case, parameters for the policy reaction function are re-estimated together with the rest of the structural parameters in the system.

16 This assumption is made following common practice in the literature, e.g. Christiano et al. (2005), Smets and Wouters (2003), Laxton and Pesenti (2003), etc. Moreover, $\alpha$ is also fixed in this analysis due to its role in generating the series for $\psi$. 

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4.4.1 Parameter estimates

Table 4.3 provides a summary of the estimation results for each of the five economies under consideration.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>δ</td>
<td>0.92 (0.10)</td>
<td>0.49 (0.21)</td>
<td>0.49 (0.10)</td>
<td>0.61 (0.13)</td>
<td>0.65 (0.43)</td>
</tr>
<tr>
<td>σ</td>
<td>0.86 (0.19)</td>
<td>0.32 (0.06)</td>
<td>0.09 (0.21)</td>
<td>0.17 (0.02)</td>
<td>0.74 (1.78)</td>
</tr>
<tr>
<td>θ₁₁</td>
<td>0.92 (0.01)</td>
<td>0.82 (0.03)</td>
<td>0.76 (0.00)</td>
<td>0.83 (0.14)</td>
<td>0.94 (0.02)</td>
</tr>
<tr>
<td>θ₁₂</td>
<td>0.91 (0.06)</td>
<td>0.89 (0.15)</td>
<td>0.77 (0.01)</td>
<td>0.89 (0.10)</td>
<td>0.98 (0.06)</td>
</tr>
<tr>
<td>ϕ</td>
<td>1.99 (0.55)</td>
<td>1.99 (0.46)</td>
<td>1.00 (1.83)</td>
<td>4.79 (12.65)</td>
<td>1.49 (0.42)</td>
</tr>
<tr>
<td>η</td>
<td>0.003 (0.07)</td>
<td>0.39 (0.08)</td>
<td>0.08 (0.03)</td>
<td>0.29 (0.04)</td>
<td>0.43 (0.26)</td>
</tr>
<tr>
<td>h</td>
<td>0.77 (0.06)</td>
<td>0.55 (0.13)</td>
<td>0.97 (0.08)</td>
<td>0.25 (0.07)</td>
<td>0.81 (0.04)</td>
</tr>
<tr>
<td>ρ₀₁</td>
<td>0.99 (0.01)</td>
<td>0.99 (0.01)</td>
<td>0.88 (0.06)</td>
<td>0.99 (0.01)</td>
<td>0.85 (0.11)</td>
</tr>
<tr>
<td>ρ₁₁</td>
<td>0.61 (0.06)</td>
<td>0.81 (0.02)</td>
<td>0.89 (0.05)</td>
<td>0.91 (0.09)</td>
<td>0.60 (0.39)</td>
</tr>
<tr>
<td>ρ₁₂</td>
<td>0.54 –</td>
<td>0.69 –</td>
<td>0.55 (0.09)</td>
<td>0.85 –</td>
<td>0.70 –</td>
</tr>
<tr>
<td>κ₁</td>
<td>1.15 –</td>
<td>1.66 –</td>
<td>0.72 (0.14)</td>
<td>1.27 –</td>
<td>2.65 –</td>
</tr>
<tr>
<td>κ₂</td>
<td>0.00 –</td>
<td>0.19 –</td>
<td>1.60 (0.39)</td>
<td>0.94 –</td>
<td>0.00 –</td>
</tr>
<tr>
<td>σ₁̄</td>
<td>0.46 (0.08)</td>
<td>0.16 (0.02)</td>
<td>0.01 (0.01)</td>
<td>0.01 (0.01)</td>
<td>0.37 (0.05)</td>
</tr>
<tr>
<td>σ₁₂</td>
<td>0.03 (0.003)</td>
<td>0.05 (0.01)</td>
<td>0.02 (0.002)</td>
<td>0.12 (0.02)</td>
<td>0.05 (0.03)</td>
</tr>
<tr>
<td>σ₁₃</td>
<td>0.035 –</td>
<td>0.07 –</td>
<td>0.02 (0.002)</td>
<td>0.06 –</td>
<td>0.016 –</td>
</tr>
<tr>
<td>σ₁₄</td>
<td>0.08 (0.01)</td>
<td>0.06 (0.01)</td>
<td>0.10 (0.01)</td>
<td>0.03 (0.002)</td>
<td>0.07 (0.02)</td>
</tr>
<tr>
<td>σ₁₅</td>
<td>0.09 (0.02)</td>
<td>0.10 (0.02)</td>
<td>0.05 (0.01)</td>
<td>0.14 (0.02)</td>
<td>0.11 (0.09)</td>
</tr>
</tbody>
</table>

Parameters obtained from the estimation lie within the commonly accepted range of plausible values in the literature. Overall, the empirical exercise suggests that the estimated parameters, despite a few that are found to be noisy, are significantly different from zero in terms of magnitude. The estimation also produces series of smoothed shocks to each of the economies as plotted in Appendix 4.C.

The degree of price indexation (δ) is relatively similar for the cases of Malaysia, the Philippines, Singapore and Thailand (around the value of 0.5 and 0.65), where the last two countries tend to be indexing more heavily relative to the earlier two.

The estimate for Indonesia stands out from the group with a value a little over 0.9.

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17 See, for example, the prior set for an empirical estimation conducted using the Bayesian approach in Smets and Wouters (2003), Lubik and Schorfheide (2005), Justiniano and Preston (2004) and Kam et al. (2006).

18 These smoothed shocks are the reconstruction of the values of unobserved shocks over the sample, obtained using all the information contained in the sample of observation. They represent the idiosyncratic shocks to endogenous variables in the system. The shocks are smoothed since computed via the Kalman filter. Unlike the case of an OLS regression, there is no requirement that the sum of the shocks be zero. The zero mean of the shocks is, instead, coming from the model’s assumption.
suggesting that the non re-optimising firms are adjusting their price by indexing very heavily to the last period inflation.

The degree of Calvo price stickiness for prices of domestic goods ($\theta_D$) and imported goods ($\theta_F$) indicates different average duration in the implicit price contracts across the group of countries. The average duration of implicit price contracts for domestic goods ranges from around 1 year in the case of the Philippines to around 4 years in the case of Thailand. The average duration for Malaysia, Singapore and Indonesia falls in between the two; with around 1.5 years for both Malaysia and Singapore; and around 3 years for Indonesia. The order in terms of average duration in the implicit price contracts for the case of imported goods remains similar to the one in the case of domestic goods prices. That is, around 1 year for the Philippines, around 2 and a quarter years for Malaysia and Singapore, around 2 and 3 quarter years for Indonesia, and tends to be a lot more persistent in the case of Thailand.

The estimate for inverse elasticity of labour supply ($\phi$) turns out to be equal to 1 or above in all cases. This suggests that a percentage change in nominal wage will tend to induce a less than proportional change in labour supply. The Philippines data suggests the lowest value of 1 (in which case changes in labour supply tend to be proportional to changes in wage rate), and Singapore’s data suggests the highest (4.79). Unlike the other cases, however, both the estimates for Singapore and the Philippines are found to be noisy.

The elasticity of substitution between home and imported goods ($\eta$) is found to be relatively small in all cases. This suggests that the degree of substitutability between home and imported consumption goods is relatively small, with the smallest degree of substitutability found in the case of the Philippines and Indonesia. In interpreting this degree of substitutability between home and imported goods, it is useful to note that the domestically produced consumption goods also comprise the non-tradables. Therefore, a low elasticity of substitution between the two categories of goods makes sense.

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19 The average duration of price contracts is calculated as $\frac{1}{1-\theta_j}; j = D, F$. 
The point estimate for the degree of habit persistence \( (h) \) varies quite widely among the group. External habit formation over past consumption is estimated to range from 0.25 in the case of Singapore to 0.97 in the case of the Philippines. The point estimate of the inverse elasticity of inter-temporal substitution \((\sigma)\) also varies quite widely among the group (see Table 4.3). Smaller values of \( \sigma \) imply that households are less willing to accept deviations from a uniform pattern of consumption over time. Both the estimate of \( h \) and \( \sigma \) are informative to the interest elasticity of consumption in the model. For any given value of \( \sigma \), higher values of \( h \) penalise the impact of the real rate of interest on consumption. All else equal, a percentage point increase in the real interest rate reduces the impact on consumption by about 0.15, 0.9, 0.17, 3.5 and 0.14 percentage points for the cases of Indonesia, Malaysia, the Philippines, Singapore and Thailand respectively. Consumption appears more sensitive to real interest rate changes in both Singapore and Malaysia, relative to Indonesia, the Philippines and Thailand. This observation seems consistent with the different degrees of financial market development in these countries.

Movements of nominal interest rate in the model are assumed to be governed by the likely historical conduct of monetary policy in each country, approximated by the relevant policy reaction function. Parameters for the policy reaction function of each of the economies are reported in Table 4.3 as \( \rho_1, \kappa_1 \) and \( \kappa_2 \) (taken from the result of GMM estimation exercise conducted for each country). As discussed earlier, the parameters for the Philippines are re-estimated together with the rest of the other structural parameters in the model. Interestingly, most of the values for the policy reaction function parameters turn out to be much the same as the values obtained from a single equation GMM exercise (that is, 0.55 for \( \rho_1 \) and 0.72 for \( \kappa_1 \)). \( \kappa_2 \) turns out to be the only exception (1.6 relative to 1.22 obtained from the GMM exercise). The higher value obtained in this case turns out to be sufficient to satisfy the Blanchard and Kahn condition for stability of the model.

Estimates for \( \rho_\psi \) and \( \rho_\delta \) suggest that the exogenous productivity and deviation from the law of one price shock in the model are persistent. The degree of persistence in \( \psi \)
is very high, especially for the case of Indonesia, Malaysia and Singapore. The degree of persistence in $b$ tends to be relatively lower, where the lowest is commonly shared by Indonesia and Thailand (around 0.6). This last observation is also accompanied by a relatively high standard deviation for the innovation in productivity shock ($\sigma_b$) for the two countries. The high $\sigma_b$ for the two economies arises because of the relatively large spikes around the Asian financial crisis period in both Thailand and Indonesia. The relatively short duration of the spikes contributes to the relatively lower persistence of the series. Additionally, the spikes also justify the occurrence of a break in the potential output of the two countries.

4.4.2 Impulse responses and variance decomposition

This section uses the estimated model to analyse the impulse responses to various structural shocks and the contribution of these various structural shocks to the variance in the forecast error of the endogenous variables at various time horizons. Both the impulse responses and the variance decompositions reported in this section are produced based on the monetary policy reaction function employed in the estimation. The resulting plots and tables for the impulse responses and the variance decomposition, respectively, are constructed based on a standard deviation of innovation in each of the structural shocks.

**Impulse response analysis**

Appendix 4.E plots the complete set of the impulse responses for each of the economies given a temporary one standard deviation innovation in the structural shocks. Figures 4.6 to 4.10 plot the impulse responses to a productivity shock for each of the economies in the group. Following a one time positive innovation of this shock, the group shares a generally similar inverted hump-shaped impact on inflation. Inflation initially falls, reaching its trough after two or three quarters before reverting to its steady state value. The period needed to revert to steady state,

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\(^{20}\)See Figures 4.1 and 4.5 in Appendix 4.C
however, slightly differs. Indonesia and Thailand have a duration of around 10 quarters, Malaysia takes around 20 quarters, while the Philippines and Singapore show a more persistent impact by taking slightly more than 30 quarters. The initial drop in inflation results from a fall in marginal cost following an increase in productivity.

Given the monetary policy reaction function, monetary authorities react by reducing their nominal rate. This move, together with changes in inflation expectation, affects consumption. The impact on consumption varies among the sample countries. In Indonesia, Malaysia and Thailand, consumption increases in a hump-shaped manner for about five to six years following a temporary increase in productivity, reaching its peak after a little over a year before closing back in to its stationary value. In the Philippines and Singapore, consumption initially falls. In the former case consumption reverts to its steady state value within about 5 years, whereas in the latter it increases after 3 quarters before reverting to its steady state value within about seven years. Under the assumed monetary policy reaction function, nominal interest rate reduction in Indonesia, Malaysia and Thailand is higher than the drop in their expected inflation. As a result, the real rate of interest falls initially and consumption rises. In the case of the Philippines and Singapore, the real interest rate initially went up, hence tends to suppress consumption.

The impact of productivity shocks on the real exchange rate also varies. Due to the fall in the real interest rate, the real exchange rate in Indonesia, Malaysia and Thailand depreciates, reaching a peak after a couple of quarters, then reverting to its steady state value. In the case of Singapore and the Philippines, an initial increase in the real interest rate leads to an appreciation of the real exchange rate initially before it starts to depreciate a couple of quarters later. In other words, given a positive innovation in productivity, the short run appreciation in the nominal exchange rate is outweighed by a drop in prices in the cases of Indonesia, Malaysia and Thailand, while it is the other way around in the cases of the Philippines and Singapore. ²¹

The reaction in the output gap follows the movement in consumption, amplified by the effect of the real exchange rate at the beginning, and moderated by it in the

²¹Note that by definition \( q_t = e_t + p_t - p_t \).
medium term.

Figures 4.11 to 4.15 plot the impulse responses to a preference (demand) shock \( (\varphi^c) \). The impact of a one-time shock in preference is typically short-lived, where in most cases it dies away after around 2 to 3 years. A positive innovation in consumption demand increases consumption, hence, increasing the output gap, inducing depreciation in the real exchange rate, and pushing up marginal costs and inflation. A typical response of the monetary authority in the model is to increase the nominal interest rate. Following the increase in interest rate, consumption falls in the next period, easing pressure on the output gap and inflation. As a result, monetary policy also loosens up, relaxing pressures on the real exchange rate to depreciate, and hence pushing down marginal costs. In the case where monetary policy reacts to both innovation in inflation and the output gap (as in the cases of Malaysia, the Philippines and Singapore), an initial rise in the rate of interest is actually enough to disinflate the economy before it settles down to the steady state equilibrium.

Figures 4.16 to 4.20 plot the impulse responses to a positive innovation in monetary policy \( (\psi^s) \). As in the case for the preference shock, impacts of this type of demand shock are also relatively short-lived. The impact of a tightening in monetary policy tends to die away after about two years before being completely gone within around three to four quarters later. An increase in the nominal interest rate when the monetary policy is tightened, immediately reduces consumption and appreciates the real exchange rate. As a result, marginal costs, inflation and the output gap falls. As the effect of a one-time tightening in monetary policy disappears, the economy moves back to its steady state position.

The case of the Philippines, however, deserves a particular mention since inflation rises quite considerably before heading back to its stationary value. A rise in inflation in this case is mainly driven by the underlying characteristics of the monetary policy reaction function of the Philippines. A coefficient \( \kappa_1 < 1 \) in the case of the Philippines suggests that the monetary policy tends to accommodate inflation.\(^{22}\)

\(^{22}\)See, for example, Clarida et al. (2000) and Walsh (2003) for a more detailed discussion about the stabilising nature of monetary policy.
A rise in expected inflation after an initial one time (unexpected) increase in the nominal interest rate is not matched by at least a one to one response in monetary policy. Hence, the real rate of interest tends to decrease rather than increase, stimulating consumption and having a depreciating effect on the real exchange rate. The latter raises marginal costs, hence (together with an increase in consumption) pushing inflation up.

Figures 4.21 to 4.25 plot the responses to a positive shock to the real exchange rate ($v^\prime\prime$). Like the other type of demand shocks discussed previously, this shock also tends to be relatively short-lived. Marginal costs, the output gap and inflation rise following a depreciation in the real exchange rate. As a result, monetary policy is tightened, hence suppressing consumption. The rise in interest rate induces an appreciation in real exchange rate, hence loosening up marginal costs and forcing the output gap to go down before reverting back to its steady state. In the cases of Singapore and Malaysia, where the degree of openness is considerably higher, this effect also brings inflation down to a negative value before reverting back to zero.

The impact of a standard deviation innovation in the deviation from the law of one price (LOP), $\psi$, is plotted in Figures 4.26 to 4.30. The direct effect of a positive innovation in the deviation from the law of one price is to increase inflation, and reduce both the output gap and marginal costs. However, as a lower output gap also lowered marginal costs further, the final impact of a positive shock in $\psi$ on inflation is indeterminate, depending on both the direct effect of $\psi$ on inflation and the indirect effect through marginal costs that is summed up as the net effect of $\psi$ on inflation. Except for the case of Indonesia, the net effect on inflation tends to be negative. As a result, monetary authorities react by loosening their policy stance, hence stimulating consumption and depreciating the real exchange rate to lead the economy back to its steady state.

In the case of Indonesia, however, the net effect of an innovation in $\psi$ on inflation tends to be positive. The combination of the relatively smaller degree of openness and the relatively non-substitutable nature of its domestic and imported consump-
tion in this case dampens the negative effect of $\psi$ on both the output gap and marginal costs. As a consequence, the impact on inflation is dominated by the direct impact of $\psi$. Therefore, monetary policy is tightened in this case, hence suppressing consumption and appreciating the real exchange rate.

The impact of the shock in $\psi$ tends to be persistent across the sample countries, especially for the cases of Indonesia, Malaysia and Singapore. This strong persistent impact can be attributed to the very high degree of persistence in the estimated process for $\psi$, especially in the case of the last three countries mentioned.

Figures 4.31 to 4.40 plot the impulse responses to an international shock. Due to the way the model is specified, the impact of an international shock on the domestic economy kicks in through changes in the foreign output gap. Since the foreign output gap is negatively affected by the corresponding real rate of interest, the effect of shocks to foreign interest rates on the domestic economy would simply be the inverse of the shocks to the foreign output gap on the domestic economy with a lag. However, foreign real interest rate shocks have a more persistent impact on the domestic economy because of the relatively higher persistence in the foreign real interest rate processes.

The response of the domestic output gap to an international shock is generally similar. The domestic output gap goes up following a positive innovation in the foreign output gap. Depending on the impact on marginal costs, the impact on inflation varies in the short to medium run. For the cases of Indonesia and the Philippines, the marginal cost rises in the following quarter, therefore inducing a positive inflationary effect. In the case of Singapore, Malaysia and Thailand (to a lesser extent), the marginal cost does not increase by much relative to its pre-shock value, hence keeping away the inflationary pressure.

**Variance decomposition**

This section looks at the contribution of the structural shocks to the forecast error variance of the endogenous variables at various time horizons.
Table 4.5 provides the contribution of each of the seven shocks to inflation variations in each of the economies in the group. Productivity shock \( (u') \) appears to be a very important factor in explaining variation in inflation within the group of countries under consideration. This dominance also appears to be stronger as the time horizon lengthens. In the cases of Indonesia and Malaysia, it even appears as the only factor that governs almost all of the variation; while it does not appear to be as extreme in the other cases.

Although the role of other shocks in Indonesia and Malaysia is minuscule, consumption preference shock \( (v^c) \) and monetary policy innovation \( (v') \) appear to have a small but non-negligible effect in the short run. In the case of Malaysia the role dies away after a year. In the case of Indonesia, however, the role of the consumption preference shock declines in a year, but stays constant up to about 10 years after. The role of monetary policy innovations in Indonesia, although relatively small, build up as the horizon lengthens. This pattern is also found in the case of Thailand, where the consumption preference shock also shares a significant role in determining its inflation variation (accounting for around 20 per cent in the short run and nearly 17 per cent in the longer run).

Real exchange rate shock \( (v^r) \) also plays a significant role in explaining the short-run inflation variation in the Philippines; while the importance of the deviation from the LOP shock \( (v^w) \) increases in the longer term. For the case of Singapore, the most open economy in the group, foreign shocks also appear as a significant determinant of inflation variation (accounting for more than 30 per cent of the variation).

The contribution of the seven different shocks to the variation in the output gap is presented in Table 4.6. In Indonesia, there are three shocks that govern the output gap variations in the short run, that is, the shock on consumption preference, on productivity and on interest rate innovations. The role of the consumption preference and the interest rate shocks decline after a year, replaced by the increasing role of the productivity shock in determining the output gap variations in the longer run. The latter pattern also appears in the case of Malaysia, where initially the
shocks to consumption preference and the shocks to the real exchange rate share an almost equally dominant role in governing the output gap variations in the short term, but replaced by the role of productivity shock in the longer term.

In the short run, the case of Thailand is similar to the case of Malaysia. However, the role of both the shocks to the consumption preference and the interest rate remain the most important even in the longer run. Although the contribution from the productivity shock, in this case, increases in the longer run, it remains relatively small. A similar feature also appears in the case of the Philippines. The increasing role of the productivity shock, in this case, is also accompanied by an increasing role of interest rate innovations and the shock to the deviation from the LOP in the longer run. In the case of Singapore, the persistence dominance of the shocks to the consumption preference and the real exchange rate in explaining the output gap variations is also accompanied by a similar persistence in the contribution of the shock to the interest rate innovations.

Table 4.7 shows the decomposition of the interest rate variations. In the very short run, variation of the interest rate is mainly driven by the shock to the interest rate innovations, except for the case of Malaysia (driven mainly by the productivity shocks) and Singapore (driven mainly by both the shocks to the consumption preference and the real exchange rate). For the case of the Philippines, the shocks to the consumption preference and the real exchange rate also significantly affect interest rate variation in the short run. In the longer run, the productivity shocks tend to gain importance in determining the variation of the interest rate in all cases.

The decomposition in the forecast error variance of marginal cost is provided in Table 4.8. For the cases of Indonesia and Malaysia, the variation is mainly attributable to the productivity shocks. In the Philippines, the shocks to the consumption preference, the real exchange rate and the deviation from the LOP are the three main drivers in the short run. In the longer run, however, the role of both the shocks to the consumption preference and the real exchange rate decrease, while the role of the shocks to the deviation from the LOP increases. In Singapore, the shocks to
the consumption preference and the real exchange rate are the main drivers in the short run. Although still dominant, the effect of the previously mentioned shocks in Singapore decreases and the role of the shock to the deviation from the LOP also becomes significant in the longer run. Variation in the marginal costs in Thailand is mainly driven by three shocks, namely, the shocks to the consumption preference, productivity and the real exchange rate.

As can be seen in Table 4.9, in the short run consumption variation is primarily driven by the shock to the consumption preference. Although decreasing, the role of this shock remains significant in the longer run for the case of Thailand and the Philippines (to a lesser extent). Additionally, for the case of the Philippines, the role of the shock to the deviation from the LOP increases to match the contribution of the shock to the consumption preference in the longer run. In all other cases, the role of the latter shock diminishes after a year, and being replaced by the role of the productivity shock (in the case of Indonesia), and the shock to the deviation from the LOP (in the cases of Malaysia and Singapore).

Table 4.10 provides the contribution of each of the seven shocks to the variation in the real exchange rate. This behaviour in explaining the variation in the real exchange rate over time varies across countries. Although decreasing, the role of the shocks in relation to the real exchange rate remain important in the longer run for the case of Indonesia. In the cases of the Philippines and Thailand, the role of this shock remains about as strong in the longer run. In Thailand, however, its role is coupled with the role of the consumption preference shock in explaining the real exchange rate variations. The cases of Malaysia and Singapore are largely similar, where the role of the real exchange rate shock decreases over time, being replaced by the role of the shock to the deviation from the LOP. The difference is that in the case of Singapore, foreign shocks are also important in guiding the variation in its real exchange rate.
Qualification of the results

The previous argument has outlined the general findings obtained from empirical estimation. The results seem to provide a plausible explanation of the economic dynamics for the group of economies under consideration. This section qualifies the results by mainly focusing on how the monetary policy transmission mechanism affects the dynamics of inflation ($\pi$) and output gap ($y$) in those economies.

The impulse response analysis points out that role of monetary policy in affecting inflation and the output gap in the model mainly comes through its effect on consumption and the real exchange rate. Given that the instrument for conducting monetary policy (nominal interest rate in this case) is governed by fluctuations in (expected) inflation and the output gap, the interest rate in this model plays the role of a stabilising tool to moderate fluctuations in the economy. In the case where monetary policy is accommodative towards inflation (the case of the Philippines), a monetary policy shock tend to introduce more volatility to the inflation dynamics. In the case where the economy is more open (Malaysia and Singapore), inflation tends to be more volatile given a shock to the real exchange rate. Especially for the case of Singapore, this observation seems to justify the actual conduct of monetary policy that centres on exchange rate management. As Singapore’s economy relies a lot more heavily on international trade than other economies in the group, the exchange rate channel appears to be more important.23

The analysis of the forecast error variance decomposition reveals the shocks that mainly drive interest rate fluctuations. For the cases of Indonesia, Malaysia and Thailand (to a lesser extent), the productivity shock plays a significant role in explaining the interest rate fluctuation. For these three countries, this shock is also identified as the main factor behind the fluctuation in inflation. This, therefore, justifies that the conduct of monetary policy in the three countries be more heavily weighted in the developments of inflation.

For the case of the Philippines, the shocks to the consumption preference and the real exchange rate share a more significant role in the very short run, while the shocks to productivity and the deviation from the LOP play a more significant role in the longer run. The shocks to the consumption preference and the real exchange rate in this case are identified as the main driver of output gap fluctuation, while the shocks to productivity and the deviation from the LOP are identified as the main factors that drive inflation variations. This suggests that the monetary authority in the Philippines is more concerned with the developments in the output gap in the short run, but switches more attention to the developments of inflation in the longer run. The case of Singapore looks very similar to the case of the Philippines, where the monetary authority in the very short run seems to put more emphasis on the developments of the output gap, and switches more attention to inflation in the longer run. This is seen from the increasing importance of the productivity and the foreign output gap shocks in driving the fluctuations in Singapore's interest rate.

4.5 Revisiting the Structural Shock Correlations

Following the Asian crisis in 1997, interest in economic integration and cooperation has grown substantially in East Asia as well as in the ASEAN. Considerable research has been undertaken in looking at the issue of whether or not the region satisfies the requirements set out in the theory of optimum currency areas (OCA), introduced by Mundell (1961). A number of studies have focussed on assessing the symmetry of structural shocks.\(^{24}\) A group of countries that face symmetric structural shocks is argued to favour similar policy responses, hence making it a candidate for a currency area.

Following the contribution by Bayoumi and Eichengreen (1994), the literature generally relies on the VAR-based Blanchard and Quah (1989) decomposition method to identify the structural shocks needed for analysing similarities in the region's expo-

\(^{24}\)For example, Bayoumi and Eichengreen (1994), Bayoumi et al. (2000), Zhang et al. (2003), Huang and Guo (2006), Ahn et al. (2006) etc.
sure to those shocks. This method disentangles the structural disturbances exposed to an economy into two types of shocks, a supply side and a demand side. Strong correlation in the supply side shocks are considered to be more relevant to identifying the suitability of a region to form a monetary or currency arrangement since they are (in principle) unaffected by variations in demand management policies.

Most of the studies conducted for the region analyse the symmetry of supply disturbances for countries in East Asia, where the ASEAN-5 countries considered in this study are commonly nested in the sample. Particularly for the cases of five ASEAN countries under consideration, the supply shocks are generally found to be positively correlated. The strength and the significance of the correlations, however, vary depending on the data frequency chosen or the sample period taken for the analysis. As discussed by de Brouwer et al. (2006), the correlations tend to be relatively weaker for the studies that rely on samples prior to the Asian financial crisis, and turn stronger when the post-crisis data is included.

Given that the estimated simple model for a small open economy is able to provide reasonable explanation of the dynamics for each of the ASEAN-5 economies considered, this section revisits the issue of assessing symmetries in structural shocks by looking at the pattern of correlations in the productivity shocks produced by the model. The model's specific structure provides an estimate of a series for the productivity shock that represents a relatively more accurate measure of supply shocks for these economies.\(^\text{25}\) Table 4.4 reports the pair-wise correlation coefficients of the productivity disturbances for the ASEAN-5 economies.

In general, Table 4.4 provides a similar pattern of correlations to those reported by the earlier VAR-based studies. The pair-wise coefficients of correlation for the productivity shock are generally positive and significantly different from zero in many of the cases. The strength of correlations, however, tends to be weaker than those obtained from a VAR-based studies that include the post-crisis data, e.g. Zhang et al.

\(^{25}\)The measures of supply shock obtained from bi-variate VAR models are often inaccurate. For example, in the case of five ASEAN countries considered in this paper, the series obtained is significantly led by demand specific policy variables (Ramayandi, 2006).
(2003), Kawai and Motonishi (2005), Huang and Guo (2006), Ahn et al. (2006) etc. The pattern of correlations also does not concur very well with those obtained under VAR-based analyses, where including post crisis data tends to generate significant positive correlations across almost all the five ASEAN countries in the sample.\footnote{Ahn et al. (2006), for example, reports very high positive and significant correlations across all the ASEAN-5 economies, except for the Philippines. Zhang et al. (2003), using quarterly data shows that correlations of the supply shocks are positive and significant across all the ASEAN-5 countries, except for the pair-wise cases: Indonesia and the Philippines, and Thailand and the Philippines.}

The pattern of productivity shock correlations generated from the estimated simple small open economy model of this study looks more like the pattern emerging from the VAR-based studies that exclude the post-crisis sample, e.g. Bayoumi et al. (2000). That is, the correlations are only significant across some but not all of the ASEAN-5 economies, and the significant pair-wise correlation linked the group together through a chain of country to country significant correlations.

Table 4.4 also reports the productivity shock correlation coefficients when the Asian financial crisis period is omitted from the sample. The omission of the crisis sample reduces the strength of productivity shock correlations a little. However, it does not substantially alter the pattern of correlations shown when the crisis period is included. Productivity shocks in Thailand are still positively and significantly correlated with the other four countries in the sample. This observation reinforces the
suspicion that increasing correlations in the structural shocks among the ASEAN-5 nations are enhanced by the common shocks experienced during the Asian financial crisis. Therefore, the strength of correlation coefficients is lowered once this effect is omitted from the sample.

In general, however, the results obtained from the estimated small open economy model do not contradict the results obtained from VAR-based studies in terms of symmetry of the supply shocks among the ASEAN-5 economies. Nevertheless, the strength of correlations is found to be weaker than those often reported in the latest VAR-based studies. As the findings of these studies are often quoted as evidence of integration within the region, the pattern of the productivity shock correlations in Table 4.4 argues that the degree of integration, in terms of the supply shocks symmetry in the region, may not be as strong as what tend to be concluded in the latest VAR-based studies.

### 4.6 Concluding Remarks

In this chapter, estimation of the parameters for a simple small open economy model is conducted using data from five different small open economies in ASEAN. The structure of the underlying model is able to produce estimated parameters that largely capture the economic characteristics and dynamics of each of the countries under consideration in a relatively plausible manner.

The price level is found to have varying degrees of stickiness within the five economies in the group, with the lowest found for the case of the Philippines and the highest found for the case of Thailand. Labour supply is found to be mostly inelastic, with the most inelastic found in the case of Singapore and the least found in the case of the Philippines (where the point estimate suggests that labour supply elasticity is approximately unitary). Imported and domestically produced consumption goods are found to be imperfect substitutes in all cases; where in the case of Indonesia, the data suggests that both goods are almost perfectly non-substitutable. In terms of
consumption sensitivity towards changes in interest rate, the countries under consideration seem to be divided into two different groups. For Indonesia, Thailand and the Philippines, the sensitivity tends to be relatively low, and in Malaysia and Singapore, the sensitivity tends to be relatively higher. The estimate for a standard deviation of productivity shock in the cases of Indonesia and Thailand appears to be a lot higher than the other countries in the group, which is mainly due to a large downward fluctuation in productivity of these two countries during the Asian financial crisis. This observation justifies the claim that these two countries suffered a harder hit from the crisis relative to the rest of the group. Lastly, from the re-estimation of the parameters for a monetary policy reaction function for the Philippines, the data supports the single equation estimation results that suggest that monetary policy in the Philippines tends to be accommodative towards inflation.

The impulse response functions presented in this chapter provide a qualitative way of understanding dynamic behaviour in response to the various shocks for the economies within the group. They also provide us with a description of the transmission of monetary policy to the rest of the economy. The forecast error variance decomposition provides insights over the main drivers behind fluctuations in the economic variables described in the model. It suggests that the movements in interest rates are consistent with the underlying objective of monetary policy within each of the sample countries to target inflation and the output gap.

The simple small open economy model presented in this study is relatively successful in describing the dynamic characteristics of the economies within the ASEAN-5 group of countries. There are different extensions that can be pursued from the findings of the model estimation in this study. The results can be used to revisit the issue of structural shocks symmetry among the group of countries considered. Although the estimated productivity shocks obtained are positively correlated in general, the strength of correlations are not as strong as the ones commonly obtained from a VAR-based analysis. It suggests that the commonality in terms of structural
shocks among the countries in the region may not be as strong as what tend to be suggested by the VAR-based studies.

Another possible extension to the results is to use the estimated models to approximate the aggregate welfare function facing each of the economies. The resulting approximated welfare function can then be used to assess whether or not monetary policy in each of the countries has been conducted optimally. Further, it can also be used to analyse the welfare implications of different policy regimes for each of the economies.
Appendix 4.A Summary of the complete system

1. CPI Inflation:
\[ \pi_t = \frac{1}{1 + \beta_0} [\beta E_t(\pi_{t+1}) + \delta \pi_{t-1} + (1 - \alpha) \Gamma D m c_t + \alpha \Gamma_F \psi_t] \]

2. Marginal cost equation:
\[ m c_t = \varphi y_t + \frac{\sigma}{1 - h} (c_t - h c_{t-1}) + \frac{\alpha}{1 - \alpha} (q_t - \psi_t) - \alpha (1 + \varphi) b_t \]

3. Euler equation for consumption:
\[ (c_t - h c_{t-1}) = E_t (c_{t+1} - h c_t) - \frac{(1 - h)}{\sigma} (i_t - E_t \pi_{t+1}) + \psi_t^c \]

4. Goods market clearing condition:
\[ y_t = (1 - \alpha) c_t + \alpha y_t^* + \frac{\alpha (2 - \alpha) \eta}{(1 - \alpha)} q_t - \frac{\alpha \eta}{(1 - \alpha)} \psi_t \]

5. Interest reaction function:
\[ i_t = (1 - \rho_i) (\kappa_1 E_t \pi_{t+n} + \kappa_2 y_t) + \rho_i i_{t-1} + \psi_t^i \]

6. International consumption risk sharing condition:
\[ \frac{(1 - h)}{\sigma} q_t = (c_t - h c_{t-1}) - \psi_t^c - \psi_t^{\bar{c}} + \psi_t^c \]

7. Domestic aggregate productivity:
\[ b_t = \rho_b b_{t-1} + \psi_t^b \]

8. Deviation of the law of one price:
\[ \psi_t^l = \rho^l \psi_{t-1} + \psi_t^l \]

9. External block:
\[ y_t^* = \phi_1 y_{t-1}^* + \phi_2 (i_{t-1}^* - E_t \pi_{t+1}^*) + \psi_t^y \]
\[ (i_t^* - E_t \pi_{t+1}^*) = \phi_3 y_{t-1}^* + \phi_4 (i_{t-1}^* - E_t \pi_{t+1}^*) + \psi_t^i \]

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Appendix 4.B  Parameters for the foreign sector block

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<th>Estimate</th>
<th>Std. Error</th>
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<td>$\phi_2$</td>
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<td>(0.02)</td>
</tr>
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<td>$\phi_3$</td>
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<tr>
<td>$\sigma_{r^*}$</td>
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<td>-</td>
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Appendix 4.C  Shocks (smoothed)

Notes on the shock signs:
- eas = Productivity shock ($v^h$)
- eis = Demand/preference shock ($v^c$)
- emp = Monetary policy/interest rate innovation ($v^i$)
- eq = Real exchange rate shock ($v^e$)
- epsi = Innovation in the deviation from the law of one price ($v^\psi$)
- eys = Foreign output gap shock ($v^{y^*}$)
- ers = Foreign real interest rate shock ($v^{r^*}$)

Figure 4.1: Smoothed shocks: Indonesia
Figure 4.2: Smoothed shocks: Malaysia

Figure 4.3: Smoothed shocks: The Philippines
CHAPTER 4. SIMPLE SMALL OPEN ECONOMY MODEL

Figure 4.4: Smoothed shocks: Singapore

Figure 4.5: Smoothed shocks: Thailand
Appendix 4.D  Deviation from the law of one price ($\psi$)
Appendix 4.E  Impulse responses

Notes on the shock signs:

p  = Inflation ($\pi$)

y  = Domestic output gap ($y$)

i  = Nominal interest rate ($i$)

mc = Marginal cost ($mc$)

c  = consumption ($c$)

q  = Real exchange rate ($q$)

4.E.1 Productivity shock

Figure 4.6: Impulse responses to a productivity shock: Indonesia
Figure 4.7: Impulse responses to a productivity shock: Malaysia

Figure 4.8: Impulse responses to a productivity shock: The Philippines
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Figure 4.9: Impulse responses to a productivity shock: Singapore

Figure 4.10: Impulse responses to a productivity shock: Thailand
4.E.2 Preference shock

Figure 4.11: Impulse responses to a preference shock: Indonesia

Figure 4.12: Impulse responses to a preference shock: Malaysia
Figure 4.13: Impulse responses to a preference shock: The Philippines

Figure 4.14: Impulse responses to a preference shock: Singapore
4.15 Impulse responses to a preference shock: Thailand

4.16 Impulse responses to an innovation to the rate of interest: Indonesia

4.3 Innovation to the rate of interest

Figure 4.16: Impulse responses to an innovation to the rate of interest: Indonesia
Figure 4.17: Impulse responses to an innovation to the rate of interest: Malaysia

Figure 4.18: Impulse responses to the interest rate innovation: The Philippines
Figure 4.19: Impulse responses to an innovation to the rate of interest: Singapore

Figure 4.20: Impulse responses to an innovation to the rate of interest: Thailand
4.E.4 Real exchange rate shock

Figure 4.21: Impulse responses to a Real exchange rate shock: Indonesia

Figure 4.22: Impulse responses to a Real exchange rate shock: Malaysia
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Figure 4.23: Impulse responses to a Real exchange rate shock: The Philippines

Figure 4.24: Impulse responses to a Real exchange rate shock: Singapore
4.5 Shock to the deviation of the law of one price (LOP)

Figure 4.26: Impulse responses to a shock to the deviation of the LOP: Indonesia
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Figure 4.27: Impulse responses to a shock to the deviation of the LOP: Malaysia

Figure 4.28: Impulse responses to an LOP deviation shock: The Philippines
CHAPTER 4. SIMPLE SMALL OPEN ECONOMY MODEL

Figure 4.29: Impulse responses to a shock to the deviation of the LOP: Singapore

Figure 4.30: Impulse responses to a shock to the deviation of the LOP: Thailand
4.E.6 International shocks

Foreign output gap shock

Figure 4.31: Impulse responses to a foreign output gap shock: Indonesia

Figure 4.32: Impulse responses to a foreign output gap shock: Malaysia
Figure 4.33: Impulse responses to a foreign output gap shock: The Philippines

Figure 4.34: Impulse responses to a foreign output gap shock: Singapore
Figure 4.35: Impulse responses to a foreign output gap shock: Thailand

Figure 4.36: Impulse responses to a foreign real interest rate shock: Indonesia

Foreign real interest rate shock
Figure 4.37: Impulse responses to a foreign real interest rate shock: Malaysia

Figure 4.38: Impulse responses to a foreign real interest rate shock: The Philippines
CHAPTER 4. SIMPLE SMALL OPEN ECONOMY MODEL

Figure 4.39: Impulse responses to a foreign real interest rate shock: Singapore

![Graphs showing impulse responses for Singapore.]

Figure 4.40: Impulse responses to a foreign real interest rate shock: Thailand

![Graphs showing impulse responses for Thailand.]

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### Appendix 4.F Variance decompositions

**Table 4.5: Variance decomposition of inflation (in per cent)**

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<th>( v_t^p )</th>
<th>( v_t^q )</th>
<th>( v_t^r )</th>
<th>( v_t^s )</th>
<th>( v_t^p^* )</th>
<th>( v_t^q^* )</th>
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Chapter 5

Assessing Monetary Policy Efficiency in the ASEAN-5 Countries

5.1 Introduction

Monetary policy is a key instrument for stabilising short-run fluctuations in an economy. The conduct of monetary policy itself, however, is recognised to have implications towards the state of social welfare. The performance of monetary policy is deemed as efficient or optimal if it minimises the aggregate social loss that has to be paid by economic agents in general. The Barro and Gordon (1983) type of ad-hoc aggregate loss function and its variants have been extensively used in the monetary policy literature as an objective to be minimised when identifying an optimal policy. This ad-hoc aggregate loss function commonly consists of arguments on variations in inflation and the output gap.

Significant efforts in analysing efficient monetary policy have since grown in the literature. This is done by focusing the analysis on how to deliver monetary policy that minimises the variability of both output and inflation. De Brouwer and O'Regan (1997), Fuhrer (1997) and Cecchetti et al. (2006), for example, construct an output–inflation variability frontier that represents the inflation/output-gap trade-off as a basis to analyse monetary policy efficiency. Many others address the issue by ranking the welfare implications of different monetary policy setups, or even straightfor-
wardly estimate an optimal monetary policy rule that optimises the aggregate loss function (see, for example, Rotemberg and Woodford, 1998, Clarida et al., 1999, Batini et al., 2003, Gali and Monacelli, 2005, Dennis and Soderstrom, 2006).

The analysis of optimal monetary policy is normally conducted by way of ‘targeting rules’,\(^1\) which relies on an ad-hoc aggregate loss function (commonly interpreted as the policy maker’s loss function). An optimal policy feedback rule is then defined as the policy instrument reaction function that minimises the loss. Another way to analyse monetary policy efficiency is through maximising the welfare impact of that policy. That is, a policy feedback rule is regarded as optimal if it maximises the aggregate utility of the representative economic agents. To this end, the aggregate loss function (commonly interpreted as the social loss function) is derived from the representative agent’s utility function as discussed in Woodford (2003a).

Although issues concerning the optimal conduct of monetary policy have been widely discussed in the literature, the discussions have mostly concentrated on the cases of advanced economies. Application of this analysis to developing economies is very limited. The objective of this chapter is to contribute to the discussion on this issue by examining the cases of five developing ASEAN economies; namely Indonesia, Malaysia, the Philippines, Singapore and Thailand.

In analysing the above cases, this chapter uses a linearised estimated small open economy model to represent the set of dynamic constraints facing each of the ASEAN-5 economies. Based on the ‘deep’ parameters that identify the representative agent’s utility for these economies, the chapter derives the aggregate social loss function that serves the role of calculating the metric of welfare. This welfare criterion is then used to analyse the fully optimal monetary policy environment for the economies under consideration.\(^2\) The chapter also looks at the welfare implications under the current monetary policy regime pursued by each of the ASEAN-

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\(^1\)See Svensson (1999) for a discussion on the distinction between instrument rules and targeting rules.

\(^2\)The term “fully optimal” here refers to the situation where the resulting form of the optimal monetary policy feedback rule is not constrained to follow some certain (simple) functional forms. That is, the optimal feedback rule depends on all the state variables included in the system of dynamic constraints representing the economy.
5 economies. By comparing the resulting metric for welfare obtained under the fully optimal monetary policy environment and the one obtained under the current regime, this study shows that the conduct of monetary policy in all of the sample countries tends to be sub-optimal. By way of example, it is also shown that room for improving the welfare outcome of the policy exists, even when pursuing a simple policy feedback rule adopted by the current regime.

The rest of the chapter is structured as follows. Section 2 derives the relevant utility-based welfare criterion to be used in analysing the optimality of monetary policy in the sample ASEAN-5 economies. Section 3 discusses the methodology applied to analyse the welfare implication of monetary policy under the fully optimal environment. Section 4 characterises the optimisation problem and analyses the welfare implication of conducting monetary policy optimally in each of the economies. Section 5 looks at the welfare implications of the current monetary policy regime, and discusses its optimality. Section 6 contemplates the possibility of improving the conduct of monetary policy for the sample countries. Section 7 concludes.

### 5.2 Utility-Based Welfare Criterion

The natural welfare criterion for the class of simple small open New Keynesian economy models considered in this chapter is represented by the level of expected stream of utility of the representative household (HH) in the economy. That is,

$$E_t \sum_{t=0}^{\infty} \beta^t [U(C_t - H_t) - V(N_t)]$$  \hspace{1cm} (5.1)

$U(\cdot)$ in equation (5.1) represents the HH utility out of consumption, which is assumed to be affected positively by the difference between current consumption decision and an exogenous external stock of habit formation within each period. The second term in equation (5.1), $V(N_t)$, represents the disutility generated out of working. This term is assumed to be positively affected by the number of hours working at each period ($N_t$).
The consumption part of the utility function above is assumed to take the following form:

\[
U(\cdot)_t = \frac{(C_t - H_t)^{1-\sigma}}{1-\sigma}
\]

(5.2)

Consumption \((C_t)\) in (5.2) is an aggregation of an infinite number of differentiated goods \((j)\) according to a Dixit-Stiglitz aggregator, \(C_t = \left[ \int_{j=0}^{1} C_t (j) \frac{e^j}{t} \partial j \right]^{\frac{1}{e-1}}\). The term \(\sigma\) is the inverse elasticity of inter-temporal substitution. The external stock of habit formation is assumed to be determined by past aggregate average consumption level \((H_t = hC_{t-1})\). This last variable \((H_t)\) is taken as exogenous by each of the representative households at each period \(t\), since each HH is assumed to be too small to affect the aggregate average consumption in the economy.

HH disutility out of working is defined as following:

\[
V(N_t) = \frac{N^{1+\varphi}_t}{1+\varphi}
\]

(5.3)

where \(N_t = \int_{i=0}^{1} N_t (i) \partial i\) and \(\varphi\) is the inverse elasticity of labour supply.

5.2.1 The second-order approximation to the utility function

Following common practice in deriving the utility-based welfare criterion,\(^4\) the second-order approximation to (5.1) is derived by taking a second-order Taylor series expansion of the within period utility function \((U_t - V_t)\) evaluated at its steady state value. Due to its additively separable characteristic, the second-order approximation of this utility function can be conducted separately to each of the terms.

\(^3\)The functional form of this aggregator follows Dixit and Stiglitz (1977) and \(\varepsilon\) denotes the elasticity of substitution between differentiated goods of the same origin.

The consumption part

The second-order approximation to the consumption part of the within period utility is as follows:

\[ U_t = \bar{U} + U_C (C_t - \bar{C}) + \frac{1}{2} U_{CC} (C_t - \bar{C})^2 + \mathcal{O} (\|\xi\|^3) \]

\( \bar{U} \) and \( \bar{C} \) are the steady state equilibrium values for \( U \) and \( C \), respectively. \( U_C \) and \( U_{CC} \) are the first and second derivative of \( U \) with respect to \( C \), evaluated at \( \bar{C} \); and \( \mathcal{O} (\|\xi\|^3) \) summarises the higher order terms of the expansion, which is assumed to be very small. Given the particular functional form in equation (5.2), the above approximation can also be written as:

\[ U_t = \bar{U} + (1 - h)^{-\sigma} \bar{C}^{1-\sigma} C_t + \frac{1}{2} (1 - h)^{-\sigma} \bar{C}^{1-\sigma} \left( 1 - \frac{\sigma}{1 - h} \right) c_t^2 + \mathcal{O} (\|\xi\|^3) \quad (5.4) \]

where \( c_t \) denotes the log deviation of consumption from its steady state value.

In the small open economy model considered for the analysis here, the demand for domestic output (\( y \)) under the market clearing condition is positively affected by domestic consumption (\( c \)), foreign income (\( y^* \)) and real exchange rate (\( q \)); and negatively related to the shock to the law of one price (\( \psi \)). Demand for domestic output in this case is represented by the following output gap equation:

\[ y_t = (1 - \alpha) c_t + \alpha y^*_t + \frac{2 - \alpha}{1 - \alpha} \alpha \eta q_t - \frac{\alpha \eta}{1 - \alpha} \psi_t \quad (5.5) \]

The real exchange rate in equation (5.5) above is assumed to be governed by the following international risk sharing condition:

\[ \frac{(1 - h)}{\sigma} q_t = (c_t - \mathcal{H}_t) - (y^*_t - \mathcal{H}^*_t) + v^q_t \quad (5.6) \]

\( \mathcal{H}_t \) and \( \mathcal{H}^*_t \) in the above equation represent the relative deviation of the external habit stock with respect to steady state consumption for the domestic small open
economy and the foreign sector respectively.

Substituting equation (5.6) into equation (5.5) eliminates the real exchange rate term in the market clearing condition. That is:

\[ y_t = \frac{(1 - \alpha)^2 (1 - h) + \alpha (2 - \alpha) \eta \sigma}{(1 - \alpha) (1 - h)} c_t + \frac{\alpha (1 - \alpha) (1 - h) - \alpha (2 - \alpha) \eta \sigma}{(1 - \alpha) (1 - h)} y_t^* - \frac{\alpha (2 - \alpha) \eta \sigma}{(1 - \alpha) (1 - h)} (\mathcal{H}_t - \mathcal{H}_t^* - \psi_t^q) - \frac{\alpha \eta}{(1 - \alpha)} \psi_t \]

Solving for \( c_t \) from the above equation gives:

\[ c_t = a_1 y_t - a_2 y_t^* + a_3 (\mathcal{H}_t - \mathcal{H}_t^* - \psi_t^q) + a_4 \psi_t \]  

(5.7)

where \( a_1 = \frac{(1 - \alpha)(1 - h)}{(1 - \alpha)^2 (1 - h) + \alpha (2 - \alpha) \eta \sigma} \), \( a_2 = \frac{\alpha (1 - \alpha)(1 - h) - \alpha (2 - \alpha) \eta \sigma}{(1 - \alpha)^2 (1 - h) + \alpha (2 - \alpha) \eta \sigma} \), \( a_3 = \frac{\alpha (2 - \alpha) \eta \sigma}{(1 - \alpha)^2 (1 - h) + \alpha (2 - \alpha) \eta \sigma} \), and \( a_4 = \frac{\alpha \eta (1 - h)}{(1 - \alpha)^2 (1 - h) + \alpha (2 - \alpha) \eta \sigma} \).

Equation (5.7) can then be used to substitute for \( c_t \) and \( c_t^2 \) in the second-order approximation of the consumption part in the utility function (5.4) to get:

\[ U_t = \frac{\tilde{C}^{1 - \sigma}}{(1 - h)^\sigma} a_1 \left\{ y_t + \frac{a_1}{2} \left( 1 - \frac{\sigma}{1 - h} \right) y_t^2 \right\} + t.i.p + \mathcal{O} (\|\xi\|^3) \]  

(5.8)

The term \( t.i.p \) in equation (5.8) stands for the collection of terms that are independent of monetary policy.

The disutility out of working

The second-order approximation to the disutility out of working term in the within period utility is the following:

\[ V_t = \tilde{V} + V_N (N_t - \bar{N}) + \frac{1}{2} V_{NN} (N_t - \bar{N})^2 + \mathcal{O} (\|\xi\|^3) \]

\( \tilde{V} \) and \( \bar{N} \) are the equilibrium value of \( V \) and \( N \), respectively. As with the case for the consumption part of the utility function, given the particular functional form of
the disutility function in (5.3), the above approximation can also be written as:

\[ V_t = \tilde{V} + \tilde{N}^{1+\varphi} n_t + \frac{1}{2} \tilde{N}^{1+\varphi} (1 + \varphi) n_t^2 + O \left( ||\xi||^3 \right) \] (5.9)

with \( n \) denoting the log deviation of hours of labour from its steady state value.

As indicated earlier, total labour hours in each period \( t (N_t) \) is the aggregated number of each of the individual \( i \)'s hours of working \( \left( N_t = \int_{0}^{1} N_t (i) \partial i \right) \). The corresponding representative production function utilised in the underlying small open economy model used for the analysis of this chapter is assumed to take the following form:

\[ Y_t(i) = B_t N_t(i) \]

Given the above production technology, \( N_t \) can also be represented as:

\[ N_t = \frac{1}{B_t} \int_{0}^{1} Y_t(i) \partial i \]

or, in its log linearised form:

\[ n_t = \ln \left( \int_{0}^{1} Y_t(i) \partial i \right) - b_t \]

(\( y_t - b_t \)) (5.10)

Expression (5.10) above can be used to substitute for \( n_t \) and \( n_t^2 \) in the second-order approximation of the disutility out of working in equation (5.9) to yield:

\[ V_t = \tilde{N}^{1+\varphi} \left\{ y_t + \frac{(1 + \varphi)}{2} \left[ y_t^2 + \text{var}_t y_t (i) \right] \right\} + t.i.p + O \left( ||\xi||^3 \right) \] (5.11)

\subsection{5.2.2 The utility-based welfare criterion}

The utility-based welfare criterion \( (L_t = U_t - V_t) \) is obtained by combining the two second-order approximations described in (5.8) and (5.11) as discussed above. That
is,

\[ L_t = \frac{C^{1-\sigma}}{(1-h)^{\sigma}} \left\{ y_t + \frac{a_1}{2} \left( \frac{1-h-\sigma}{1-h} \right) y_t^2 \right\} \]

\[ -N^{1+\varphi} \left\{ y_t + \frac{(1+\varphi)}{2} \left[ y_t^2 + \text{var}_i y_t (i) \right] \right\} + t.i.p + O \left( ||\xi||^3 \right) \]

When evaluated at the optimum steady state equilibrium, however, the marginal utility of consumption has to be equal to the marginal disutility out of working for each of the representative households. Since this requirement has to hold at the optimum, it is then assumed that \( \frac{C^{1-\sigma}}{(1-h)^{\sigma}} a_1 = N^{1+\varphi} = \Phi \) at steady state. Therefore, the above equation can alternatively be expressed as the following:

\[ L_t = \Phi \left\{ \left[ \frac{a_1}{2} \left( \frac{1-h-\sigma}{1-h} \right) - \frac{(1+\varphi)}{2} \right] y_t^2 - \frac{(1+\varphi)}{2} \text{var}_i y_t (i) \right\} \]

\[ + t.i.p + O \left( ||\xi||^3 \right) \]  \( (5.12) \)

Equation (5.12) implies that the within period utility-based loss function is not only determined by the output gap, but also by the dispersion of output across firms as well. As argued in Woodford (2003a, Chapter 6), this last channel is in fact the one that invokes the relevance of price stability for welfare beyond the mere association between inflation and the aggregate output gap.

Specifically, assume that each of the individual firms faces a constant elasticity demand curve of the form \( y_t (i) = y_t - \varepsilon (p_{D,t}(i) - p_t) \). This particular demand curve implies that

\[ \text{var}_i y_t (i) = \varepsilon^2 \text{var}_i p_{D,t}(i) \]  \( (5.13) \)

so that equation (5.12) can also be written as:

\[ L_t = -\Phi \left\{ \left[ \frac{(1+\varphi)}{2} - \frac{a_1}{2} \left( \frac{1-h-\sigma}{1-h} \right) \right] y_t^2 + \frac{(1+\varphi)}{2} \varepsilon^2 \text{var}_i p_{D,t}(i) \right\} \]

\[ + t.i.p + O \left( ||\xi||^3 \right) \]  \( (5.14) \)

Expression (5.14) implies that reducing price dispersion across firms, in addition to
stabilising the output gap, is also an appropriate policy objective for a policy maker. As the price set at firm level is affected by the fluctuations in the aggregate price level, the objective to reduce price dispersion can also be achieved through stabilising the aggregate price level. Further, given equation (5.14), the expression for the level of the representative household’s expected stream of utility can be approximated as:

$$\mathbb{W} = \sum_{t=0}^{\infty} \beta^t L_t + t.i.p + O (\|\xi\|^3) \quad (5.15)$$

The aggregate price level in the underlying model used for the analysis here is formed by a weighted average of both the price of home and imported goods, $$p_t = (1 - \alpha)p_{D,t} + \alpha p_{F,t}$$. Alternatively, $$p_t$$ can also be written as

$$p_t \equiv E_i[(1 - \alpha)p_{D,t} (i) + \alpha p_{F,t}]$$. Therefore, the aggregate price inflation ($$p_t - p_{t-1} = \pi_t$$) can be expressed as the following:

$$\pi_t = p_t - p_{t-1}$$

$$= E_i[(1 - \alpha)p_{D,t} (i) + \alpha p_{F,t} - p_{t-1}] \quad (5.16)$$

No individual firm $$i$$, however, possesses perfect information over the price setting of the domestic import retailers. To simplify the analysis, it is assumed that firm $$i$$ expectation about $$p_{F,t}$$ is simply its past value plus an adjustment made through indexing the price to the last period aggregate inflation; that is, $$E_i(p_{F,t}) = p_{F,t-1} + \delta \pi_{t-1}$$. Given these assumptions and a Calvo (1983) staggered price mechanism of the domestic producing firms, equation (5.16) can be expressed as follows:

$$\pi_t = \theta_D E_i[(1 - \alpha)p_{D,t-1} (i) + \alpha p_{F,t-1} + \alpha \delta \pi_{t-1} - p_{t-1}]$$

$$+ (1 - \theta_D) E_i[(1 - \alpha)p_{D,t}^{new} (i) + \alpha p_{F,t-1} + \alpha \delta \pi_{t-1} - p_{t-1}]$$

$$= (1 - \theta_D) [(1 - \alpha)p_{D,t}^{new} (i) + \alpha p_{F,t-1} - p_{t-1}] + \alpha \delta \pi_{t-1} \quad (5.17)$$

Moreover, since $$p_{t-1}$$, $$p_{F,t-1}$$ and $$\pi_{t-1}$$ are known at period $$t$$, each firm $$i$$ in the economy will have the same expected value for any of those variables at any time $$t$. There-
fore, at any time \( t \), it can be written that
\[
var_i \left( \frac{p_{t-1}}{1 - \alpha} - \frac{\alpha}{1 - \alpha} p_{F,t-1} - \frac{\alpha \delta}{(1 - \theta_D)(1 - \alpha)} \pi_{t-1} \right) = 0.
\]
Letting \( \Delta_t = var_i p_{D,t} (i) \), one can then write
\[
\Delta_t = var_i \left[ p_{D,t} (i) - \left( \frac{p_{t-1}}{1 - \alpha} - \frac{\alpha}{1 - \alpha} p_{F,t-1} - \frac{\alpha \delta}{(1 - \theta_D)(1 - \alpha)} \pi_{t-1} \right) \right]
\]
where, given the Calvo (1983) price setting mechanism, can also be written as,
\[
\Delta_t = \theta_D \Delta_{t-1} + \frac{\theta_D}{(1 - \alpha)} E_i \left[ (1 - \alpha) p_{D,t} (i) + \alpha p_{F,t-1} + \frac{\alpha \delta}{(1 - \theta_D)} \pi_{t-1} - p_{t-1} \right]^2
\]
which, given the expression set out in equation (5.17), boils down to
\[
\Delta_t = \theta_D \Delta_{t-1} + \frac{\theta_D}{(1 - \theta_D)(1 - \alpha)} \pi_t^2
\]
(5.18)
Alternatively, equation (5.18) can also be written as:
\[
\sum_{t=0}^{\infty} \beta^t \Delta_t = \frac{\theta_D}{(1 - \theta_D)(1 - \alpha)(1 - \theta_D \beta)} \sum_{t=0}^{\infty} \beta^t \pi_t^2 + t.i.p + O \left( \| \xi \|^3 \right)
\]
(5.19)
Further, equation (5.19) above can be used to substitute out the discounted sum of \( var_i p_{D,t} (i) \) in equation (5.15), the discounted sum of the utility of the representative household (\( \bar{W}_t \)). Therefore, \( \bar{W}_t \) can be approximated as:
\[
\bar{W} = -\sum_{t=0}^{\infty} \beta^t Loss_t + t.i.p + O \left( \| \xi \|^3 \right)
\]
(5.20)
The term \( Loss_t \) in the equation above represents the within period loss due to variations in the output gap and inflation. That is,
\[
Loss_t = \omega y_t^2 + \pi_t^2
\]
where the weight for inflation variations (\( \pi_t^2 \)) is normalised to be equal to 1; and
\[
\omega = \left[ \frac{(1 - h)(1 + \varphi) - \alpha_1 (1 - h - \varphi)}{\epsilon^2 (1 - h)(1 + \varphi)} \frac{(1 - \theta_D)(1 - \theta_D \beta)(1 - \alpha)}{\theta_D} \right]
\]
is the weight for output gap variations.
CHAPTER 5. ASSESSING MONETARY POLICY EFFICIENCY

5.3 Measuring Welfare Under Optimal Monetary Policy

Equation (5.20) can be considered as a representative for the aggregate social welfare function of an economy. A benevolent policy maker (represented by a monetary authority in this particular case), whose objective is to maximise the level of social welfare (minimising the aggregate loss), should then target its policy to maximise equation (5.20) subject to a set of dynamic constraints representing the dynamics of the economy under consideration.

The general form of the dynamic constraint faced by a monetary authority can be written in the following matrix representation:

\[ A_0 y_t = A_1 y_{t-1} + A_2 E_t y_{t+1} + A_3 x_t + A_4 v_t; \text{ with } v_t \sim iid [0, \Omega] \]  

(5.21)

where \( y_t \) is a vector of time \( t \) endogenous variables in the system; \( x_t \) is a scalar or vector of time \( t \) control variable(s); \( v_t \) is a vector of \( iid \) innovations to the economy with variance-covariance matrix \( \Omega \); and \( A_0, A_1, A_2, A_3 \) and \( A_4 \) are conformable matrices containing structural parameters of the economic model under consideration.

The aggregate loss function for an economy can also be presented in a matrix form related to the vectors described in system (5.21) above. That is,

\[
\text{Loss} (t, \infty) = -W + E_t \sum_{t=0}^{\infty} \beta^t [y_t^\prime \ W \ y_t]
\]

(5.22)

where \( W \) is a conformable matrix containing the weights for each of the arguments entering the aggregate loss function. In the context of the functional form given in equation (5.20), the elements of \( W \) are all zero, except for those related to the elements of \( y \) that represent inflation (\( \pi \)) and output gap (\( y \)).
5.3.1 Optimal policy under pre-commitment

Under an optimal pre-commitment policy regime, a monetary authority pre-commits to a policy plan for all the remaining periods by optimising its policy once only, at some initial period \((t = 0)\). In a rational expectation environment, the time \(t + 1\) variables can be stated as their expected values plus an expectation error. Therefore,

\[
y_{t+1} = E_t y_{t+1} + u_{t+1}
\]  

Further, (5.23) can be used to eliminate the expectation operator in (5.21).

In order to solve for the optimal policy under pre-commitment, a monetary authority minimises the objective function in equation (5.22) subject to a set of the dynamic constraints (5.21) of the economy. One way to solve this problem is by forming a Lagrangian for the problem at hand.\(^5\)

\[
L = E_t \sum_{t=0}^{\infty} \beta^t [y_t' W y_t + 2\lambda_t' (A_0 y_t - A_1 y_{t-1} - A_2 E_t y_{t+1} - A_3 x_t - A_4 v_t)]
\]

\(\lambda_t\) in the above equation is a vector of Lagrange multiplier for period \(t\). Differentiating the above Langragian problem with respect to \(x_t\), \(y_t\) and \(\lambda_t\) yields the first order necessary conditions for the optimal solution:

\[
\frac{\partial L}{\partial y_t} = W y_t + A_0' \lambda_t - \beta^{-1} A_2' \lambda_{t-1} - \beta A_4' \lambda_{t+1} = 0 \tag{5.24}
\]

\[
\frac{\partial L}{\partial x_t} = -A_3' \lambda_t = 0 \tag{5.25}
\]

\[
\frac{\partial L}{\partial \lambda_t} = A_0 y_t - A_1 y_{t-1} - A_2 E_t y_{t+1} - A_3 x_t - A_4 v_t = 0 \tag{5.26}
\]

As is well-known, following the argument put forward by Kydland and Prescott (1977), a problem with solving for optimal policy under pre-commitment in the presence of forward-looking constraints is that the solution is generally not time consistent. This problem arises due to the fact that an optimal commitment policy

\(^5\)Alternatively, the problem can also be solved using the conventional dynamic programming method as shown in Backus and Driffill (1986); as applied in e.g. Jensen (2002).
designed at the initial period is no longer optimum in the eyes of a policy maker, once the private sector expectation is formed under that given policy. To circumvent this problem, however, one can impose an additional set of constraints on the acceptable values of the initial conditions on \( y_{-1} \) and \( \lambda_{-1} \) that are self-consistent. That is, the chosen policy subject to these constraints would also satisfy constraints of exactly the same form in the future periods.\(^6\)

Dennis (2007) shows that constraining \( y_{-1} = \bar{y} \) (the steady state equilibrium value of \( y \)) and \( \lambda_{-1} = 0 \) give sufficient restrictions to guarantee that the above argument holds. Given \( y_{-1} = \bar{y} \) and \( \lambda_{-1} = 0 \), the set of first order necessary conditions in equation (5.24), (5.25) and (5.26) holds for every time \( t \geq 0 \). Therefore, they can be represented as the following second-order system of difference equations:

\[
\begin{bmatrix}
0 & A_0 & -A_3 \\
A'_0 & W & 0 \\
-A'_3 & 0 & 0
\end{bmatrix}
\begin{bmatrix}
\lambda_t \\
y_t \\
x_t
\end{bmatrix}
= \begin{bmatrix}
0 & A_1 & 0 \\
0 & 0 & 0 \\
0 & 0 & 0
\end{bmatrix}
\begin{bmatrix}
\lambda_{t-1} \\
y_{t-1} \\
x_{t-1}
\end{bmatrix}
+ \begin{bmatrix}
0 & A_2 & 0 \\
\beta A'_1 & 0 & 0 \\
0 & 0 & 0
\end{bmatrix}
E_t
\begin{bmatrix}
\lambda_{t+1} \\
y_{t+1} \\
x_{t+1}
\end{bmatrix}
+ \begin{bmatrix}
A_4 \\
0 \\
0
\end{bmatrix}
v_t
\] (5.27)

The second-order difference system in (5.27) can be solved using the method of undetermined-coefficient.\(^7\) The solution obtained is a first-order system of the form:

\[
\begin{bmatrix}
\lambda_t \\
y_t \\
x_t
\end{bmatrix}
= \begin{bmatrix}
H_{11} & H_{12} & 0 \\
H_{21} & H_{22} & 0 \\
H_{31} & H_{32} & 0
\end{bmatrix}
\begin{bmatrix}
\lambda_{t-1} \\
y_{t-1} \\
x_{t-1}
\end{bmatrix}
+ \begin{bmatrix}
G_1 \\
G_2 \\
G_3
\end{bmatrix}
v_t
\] (5.28)

or, in more compact notation:

\[
s_t = H s_{t-1} + G v_t
\] (5.29)

\(^6\)See, for example, discussion in Benigno and Woodford (2006a,b).

\(^7\)Ways to implement the method can be found in Binder and Pesaran (1995), McCallum (1998), Uhlig (1999) or Christiano (2002).
 CHAPTER 5. ASSESSING MONETARY POLICY EFFICIENCY

The optimal commitment rule is embedded in (5.28), particularly represented by the third row of the vector on the left hand side and its corresponding terms in the right hand side of the equation. Aside from responding to the development in the state variables, the vector of policy variables also responds to the Lagrange multipliers of the system. These Lagrange multipliers enter the optimal policy feedback rule in order to ensure the validations of past formation of the private sector expectations by the current policy maker.

To measure the welfare implication from this optimal pre-commitment policy, one can proceed by calculating the resulting loss given the optimal policy. To do so, the loss function in (5.22) can be rewritten as

\[
\text{Loss}(t, \infty) = E_t \sum_{t=0}^{\infty} \beta^t [s_t'Ks_t] = s_t' \left( \sum_{t=0}^{\infty} \beta^t H^tKH^t \right) s_t + \frac{\beta}{1-\beta} \left[ \sum_{t=0}^{\infty} \beta^t tr \left( G'H^tKH^tG\Omega \right) \right]
\]  

(5.30)

where \( K \) is defined as

\[
K = \begin{bmatrix}
0 & 0 & 0 \\
0 & W & 0 \\
0 & 0 & 0
\end{bmatrix}
\]

to match the elements in \( s \). Assuming that \( 0 < \beta < 1 \) and the stability properties in (5.29) hold, Dennis (2007) shows that the expression in (5.30) can be simplified to

\[
\text{Loss}(t, \infty) = s_t'P_s + \frac{\beta}{1-\beta} tr \left( G'PG\Omega \right)
\]

(5.31)

where \( P = K+\beta H'PH \). Given the associated \( s, \Omega, \beta \) and the relevant coefficient matrices, the value of the loss function can be evaluated.

---

8This result is obtained by exploiting the properties of a convergent infinite series; where for \( 0 < \beta < 1 \) and a matrix \( \theta \) with spectral radius less than 1, an infinite series \( X = \sum_{j=0}^{\infty} \beta^j \theta^j W \theta^j \) is convergent. Therefore, \( \beta \theta' X \theta = \sum_{j=1}^{\infty} \beta^j \theta^{j+1} W \theta^j = X - W \). Consequently, \( X \) can be solved by finding a fixed point solution to \( X = W + \beta \theta' X \theta \).
5.3.2 Optimal policy under discretion

Under an optimal discretionary policy, a monetary authority re-optimises its policy on a period by period basis. Any set of policy feedback parameters chosen in one period does not impose any restriction on the set of possible feedback parameters for the subsequent policy maker. However, a feedback rule chosen in one period does affect the dynamics of the economy through time. Therefore, the dynamics of the economy in this case follow a Stackelberg-Nash equilibrium, where the policy maker optimising today can be considered as a Stackelberg leader, while the other economic agents and the subsequent policy makers are the Stackelberg followers.

Due to its inability to control the future dynamics of the economy, a monetary authority optimising at time $t$ assumes that (in equilibrium) all the endogenous variables and the policy instruments in the system are governed by their relevant state-endogenous variables. That is,

$$y_t = H_1 y_{t-1} + H_2 v_t$$  \hspace{1cm} (5.32)  

$$x_t = F_1 y_{t-1} + F_2 v_t$$  \hspace{1cm} (5.33)  

where $H_1$, $H_2$, $F_1$ and $F_2$ are the time-invariant matrices of parameters that govern the dynamics of the economy, once the optimal discretionary policy problem is solved. Note also that at the optimum, equation (5.33) represents the optimal feedback rule for the vector of policy variables that a policy maker will choose if they are to minimise the relevant loss function under consideration.

Substituting equation (5.32) into equation (5.21) gives

$$D y_t = A_1 y_{t-1} + A_3 x_t + A_4 v_t$$  \hspace{1cm} (5.34)  

where $D = A_0 - A_2 H_1$. This form of dynamic constraint system sets the information of how future policy makers respond to movements in $y_t$. This information is taken into account by today’s policy maker in setting its policy. It is in this sense
that the current policy maker leads the future policy maker decisions.

Given equation (5.32), the loss function in (5.22) can also be written as

\[
\text{Loss} (t, \infty) = y'_t \left( \sum_{t=0}^{\infty} \beta^t W H_1 W H_1^t \right) y_t \\
+ \frac{\beta}{1 - \beta} \left[ \sum_{t=0}^{\infty} \beta^t tr \left( H_2^t H_1^t W H_1^t H_2 \Omega \right) \right] 
\]

Therefore, provided that the spectral radius of \( H_1 \) is less than one, equation (5.35) points to:

\[
\text{Loss} (t, \infty) = y'_t S y_t + \frac{\beta}{1 - \beta} tr \left( H_2^t S H_2 \Omega \right) 
\]

with \( S = W + \beta H_1^t SH_1 \).

To discover the optimal discretionary policy rule, one can simply proceed by minimising the social loss function in (5.36) subject to the system of dynamic constraints in (5.34). Given the problem at hand, one can substitute equation (5.34) into (5.36) and solve for an unconstrained optimisation problem instead. That is,

\[
\text{Loss} (t, \infty) = (A_1 y_{t-1} + A_3 x_t + A_4 v_t)' D'^{-1} S D^{-1} (A_1 y_{t-1} + A_3 x_t + A_4 v_t) \\
+ \frac{\beta}{1 - \beta} tr \left( H_2^t S H_2 \Omega \right) 
\]

Differentiating the above with respect to \( x_t \) and setting the first order necessary condition gives

\[
A_3'^t D'^{-1} S D^{-1} (A_1 y_{t-1} + A_3 x_t + A_4 v_t) = 0 
\]

Therefore,

\[
x_t = (A_3'^t D'^{-1} S D^{-1} A_3)^{-1} A_3'^t D'^{-1} S D^{-1} (A_1 y_{t-1} + A_4 v_t) \\
= F_1 y_{t-1} + F_2 v_t 
\]

The last line in the above expression comes from the expression set out in equation
(5.33) earlier. Substituting the last line above – equation (5.37) – into equation (5.34), one gets

\[
y_t = D^{-1}\left[(A_1 + A_3 F_1) y_{t-1} + (A_4 + A_3 F_2) v_t\right] \\
= H_1 y_{t-1} + H_2 v_t
\]

(5.38)

Notice that both \( S \) and \( D \) are implicit functions of \( H_1, H_1, F_1 \) and \( F_2 \). Consequently, one needs to find a fixed point solution for equation (5.37) and (5.38) in order to get the desired matrices of the optimal parameters under a discretionary regime.

The above discussion demonstrates that the approach used to solve for an optimum discretionary policy problem is done through formulating it as a recursive optimisation problem and iterating backward through time to solve for the Markov-perfect Nash-equilibrium. The resulting equilibrium is then time-consistent, as pointed out by, among others, Dennis (2004b).9

5.4 Monetary Policy in the ASEAN-5: Commitment vs. Discretion

This section applies the approaches above to measure welfare implications of pursuing optimal monetary policy for the cases of ASEAN-5 countries. The set of dynamic constraints used in the optimisation problem are the log-linearised version of a small open economy model with ten equations governing the dynamics of the economy developed in Chapter 4. The model is a simple version of a dynamic New Keynesian small open economy model, which features imperfect competition and nominal price rigidities, an incomplete pass-through effect in the import sector with a staggered price setting in the domestic imported goods market, and external habit formation in the consumer’s utility.

To obtain results for both an optimal monetary policy feedback rule under pre-

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9For a proof, see, for example, Dockner et al. (2000, Theorem 4.3).
commitment and under discretion, the objective function stated in equation (5.22) is optimised subject to the dynamic constraints using the algorithm proposed by Dennis (2007). This algorithm has an advantage in allowing one to cast the optimisation constraints in terms of their structural form, as set out in expression (5.21), rather than having to convert them into a state-space representation, as commonly required in the existing alternative algorithms (e.g. the algorithm set out in Backus and Drifill, 1986, Soderlind, 1999). Therefore, it offers convenience in setting up the optimisation problem.

5.4.1 Setting up the problem

The relevant dynamic constraints (as shown by the set of equations in the Appendix 4.A in Chapter 4) for each of the ASEAN-5 economies are fitted into the system expressed in (5.21). The equation for the interest reaction function, however, is discarded when setting up $y_t$. This is done in order to free the monetary policy feedback rule to be determined by the optimisation process without posing any particular constraint on its form. To conduct the optimisation, the coefficient matrices $A_0, A_1, A_2, A_3$ and $A_4$ for each of the economies in the group of ASEAN-5 countries are filled with the relevant parameters obtained from the empirical estimation of the small open economy model in Chapter 4. Table 5.1 summarises the “deep” structural parameters used to conduct the optimisation.

As discussed in section 5.2.2, the weight coefficient for inflation variation in the aggregate loss function (5.22) is normalised to 1. The weight for output gap ($\omega$) for each country can be calculated using the parameters supplied in Table 5.1. However, as shown in the last part of section 5.2.2, $\omega$ is also determined by the elasticity of substitution between differentiated goods of the same origin ($\varepsilon$). For the purpose of computation, this last parameter is set according to the value used for calibrating a similar model in Gali and Monacelli (2005). That is, $\varepsilon$ is set to be equal to 6 for all of the countries, which implies a common average steady state mark-up value.

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Table 5.1: Structural parameters of the small open economy model

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>$a$</td>
<td>0.30</td>
<td>0.65</td>
<td>0.49</td>
<td>0.80</td>
<td>0.48</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.963</td>
<td>0.988</td>
<td>0.972</td>
<td>0.992</td>
<td>0.984</td>
</tr>
<tr>
<td>$\delta$</td>
<td>0.92</td>
<td>0.49</td>
<td>0.49</td>
<td>0.61</td>
<td>0.65</td>
</tr>
<tr>
<td>$\sigma$</td>
<td>0.86</td>
<td>0.32</td>
<td>0.09</td>
<td>0.17</td>
<td>0.74</td>
</tr>
<tr>
<td>$\theta_D$</td>
<td>0.92</td>
<td>0.82</td>
<td>0.76</td>
<td>0.83</td>
<td>0.94</td>
</tr>
<tr>
<td>$\theta_F$</td>
<td>0.91</td>
<td>0.89</td>
<td>0.77</td>
<td>0.89</td>
<td>0.98</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>1.99</td>
<td>1.99</td>
<td>1.00</td>
<td>4.79</td>
<td>1.49</td>
</tr>
<tr>
<td>$\eta$</td>
<td>0.003</td>
<td>0.39</td>
<td>0.08</td>
<td>0.29</td>
<td>0.43</td>
</tr>
<tr>
<td>$h$</td>
<td>0.77</td>
<td>0.55</td>
<td>0.97</td>
<td>0.25</td>
<td>0.81</td>
</tr>
<tr>
<td>$\rho_\psi$</td>
<td>0.99</td>
<td>0.99</td>
<td>0.88</td>
<td>0.99</td>
<td>0.85</td>
</tr>
<tr>
<td>$\rho_b$</td>
<td>0.61</td>
<td>0.81</td>
<td>0.89</td>
<td>0.91</td>
<td>0.60</td>
</tr>
<tr>
<td>$\rho_i$</td>
<td>0.52</td>
<td>0.69</td>
<td>0.55</td>
<td>0.85</td>
<td>0.70</td>
</tr>
<tr>
<td>$\kappa_1$</td>
<td>1.78</td>
<td>1.66</td>
<td>1.72</td>
<td>1.27</td>
<td>2.65</td>
</tr>
<tr>
<td>$\kappa_2$</td>
<td>1.04</td>
<td>0.19</td>
<td>1.60</td>
<td>0.94</td>
<td>0.00</td>
</tr>
<tr>
<td>$\sigma_b$</td>
<td>0.46</td>
<td>0.16</td>
<td>0.01</td>
<td>0.01</td>
<td>0.37</td>
</tr>
<tr>
<td>$\sigma_c$</td>
<td>0.03</td>
<td>0.05</td>
<td>0.02</td>
<td>0.12</td>
<td>0.05</td>
</tr>
<tr>
<td>$\sigma_i$</td>
<td>0.035</td>
<td>0.07</td>
<td>0.02</td>
<td>0.006</td>
<td>0.016</td>
</tr>
<tr>
<td>$\sigma_\psi$</td>
<td>0.08</td>
<td>0.06</td>
<td>0.10</td>
<td>0.03</td>
<td>0.07</td>
</tr>
<tr>
<td>$\sigma_q$</td>
<td>0.09</td>
<td>0.10</td>
<td>0.05</td>
<td>0.14</td>
<td>0.11</td>
</tr>
</tbody>
</table>

$(\mu)$ of 1.2 for all economies.\(^{10}\) Given these parameters, the weight for output gap variations in the aggregate loss function $(\omega)$ for each country under consideration is reported in Table 5.2.

Table 5.2: Relative weights for the output gap variations

<table>
<thead>
<tr>
<th>Country</th>
<th>$\omega$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>0.0005</td>
</tr>
<tr>
<td>Malaysia</td>
<td>0.0003</td>
</tr>
<tr>
<td>Philippines</td>
<td>0.0022</td>
</tr>
<tr>
<td>Singapore</td>
<td>0.0002</td>
</tr>
<tr>
<td>Thailand</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

An interesting observation emerges from Table 5.2. Under the approach employed to derive the approximate utility-based welfare criterion in section 5.2, the weight for output gap variation in the aggregate loss function is very small relative to the weight for the variation in inflation.\(^{11}\) In the terminology of Svensson (1999, 2000),

\(^{10}\)Note that at a steady state equilibrium, $\mu = \frac{a}{\mu-1}$ in this class of model.

\(^{11}\)Based on the derivation of this parameter in section 5.2.2, the lower the steady state mark-up value in the economy (that is, the more competitive the market for a good from the same origin in the economy), the lower the relative weight for output gap variation in the aggregate loss function would be.
this form of aggregate social loss function approximates the one he termed as a strict inflation targeting regime.

Given values for the parameters described in Tables 5.1 and 5.2, all the coefficient matrices needed to solve the optimisation problem described earlier \((W, A_0, A_1, A_2, A_3, A_4)\) can be characterised for each of the countries. The results of each of the exercises are reported and discussed in what follows.

5.4.2 Results: Commitment vs. discretion

Table 5.3 summarises the results of the simulation exercise conducted for the cases of optimal monetary policy (i.e. under pre-commitment and under discretion). The table provides three main results that are of interest for both cases. The first two rows spell out the metric for the welfare implication (the value of the loss function) under the two policy regimes for each of the countries. The third row gives the measure of welfare gain from moving from a discretionary policy regime to adopting a pre-commitment regime. This gain in welfare is measured as the size of relative change in the value of the metric of welfare as one moves from adopting an optimum discretionary policy to an optimum pre-commitment policy (welfare gain = \(1 - \frac{L_C}{L_D}\), where \(L_C\) is the value of the loss function under pre-commitment and \(L_D\) is the value of the loss function under discretion). The last part of the table shows the comparison of the unconditional variances of four key variables – inflation \((\pi)\), output gap \((y)\), real exchange rate \((q)\) and interest rate \((i)\) – between the two policy regimes.\(^{12}\)

The results presented in Table 5.3 are largely consistent with conventional wisdom from the literature, which argues that an optimal pre-commitment policy is superior in terms of welfare implication. Although with varying degrees, the superiority of the optimal pre-commitment policy holds for all the five countries in the sample. The reason for this, once the time-inconsistency problem has been dealt with appro-

\(^{12}\) To obtain the unconditional variances, I use the doubling algorithm of Hansen and Sargent (1998) to solve for the fixed point solution to the unconditional variance-covariance matrix of all the variables involved in the system.

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Table 5.3: Comparison of optimum monetary policy rules

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>The Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x Loss (PC)</td>
<td>0.0045</td>
<td>0.0012</td>
<td>0.0002</td>
<td>0.0001</td>
<td>0.0004</td>
</tr>
<tr>
<td>100 x Loss (D)</td>
<td>0.0060</td>
<td>0.0013</td>
<td>0.0003</td>
<td>0.0001</td>
<td>0.0006</td>
</tr>
<tr>
<td>Welfare gain</td>
<td>0.2535</td>
<td>0.1193</td>
<td>0.3242</td>
<td>0.0529</td>
<td>0.3886</td>
</tr>
</tbody>
</table>

Unconditional variances (under pre-commitment):

<table>
<thead>
<tr>
<th></th>
<th>(x 10^5)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>π</td>
<td>0.3466</td>
<td>0.0171</td>
<td>0.0059</td>
<td>0.0001</td>
<td>0.0626</td>
</tr>
<tr>
<td>y</td>
<td>0.0971</td>
<td>0.0420</td>
<td>0.0013</td>
<td>0.0067</td>
<td>0.0314</td>
</tr>
<tr>
<td>q</td>
<td>0.5935</td>
<td>0.0373</td>
<td>0.0050</td>
<td>0.0014</td>
<td>0.1557</td>
</tr>
<tr>
<td>i</td>
<td>0.1166</td>
<td>0.0055</td>
<td>0.0054</td>
<td>0.0013</td>
<td>0.2014</td>
</tr>
</tbody>
</table>

Unconditional variances (under discretion):

<table>
<thead>
<tr>
<th></th>
<th>(x 10^5)</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>π</td>
<td>2.3132</td>
<td>0.2174</td>
<td>0.1454</td>
<td>0.0058</td>
<td>0.3276</td>
</tr>
<tr>
<td>y</td>
<td>0.0918</td>
<td>0.0420</td>
<td>0.0013</td>
<td>0.0067</td>
<td>0.0288</td>
</tr>
<tr>
<td>q</td>
<td>0.6052</td>
<td>0.0377</td>
<td>0.0048</td>
<td>0.0014</td>
<td>0.1615</td>
</tr>
<tr>
<td>i</td>
<td>0.1638</td>
<td>0.0058</td>
<td>0.0057</td>
<td>0.0013</td>
<td>0.2000</td>
</tr>
</tbody>
</table>

Note:
PC = pre-commitment
D = discretion

appropriately, comes from the fact that a policy maker is taking into account the effect of its policy on private sector expectations when designing its policy. Therefore, resulting policies tend to drive more socially optimal outcomes.

The monetary authority’s inability to pre-commit will penalise the economic welfare of the economy. The literature records that a welfare gain from switching to an optimal pre-commitment regime averages at around 20 per cent under simulations using different available macroeconomic dynamic models. For example, the simulation by Jensen (2002) produces welfare gain of around 22 per cent; Dennis (2004b) simulates the welfare implication from switching regimes using the model given by Clarida et al. (1999) and produces a welfare gain of around 26 per cent; Dennis and Soderstrom (2006) report a gain of similar magnitude (around 21 to above 30 per cent) when conducting the simulation using a larger model of Orphanides and Wieland (2000), but relatively smaller magnitude of around 14 to 20 per cent of gains when simulating using the model from Fuhrer and Moore (1995).

For the case of the five ASEAN economies in this thesis, the gains from moving from an optimal discretionary regime to a regime based on commitment are also found to be positive in all cases. The welfare gain varies from a little over 5 per cent in the
case of Singapore to almost 39 per cent in the case of Thailand. This observation is largely in line with the general observation obtained from using models with similar dynamic characteristics and the timing of expectation formation in the literature as discussed above.\textsuperscript{13}

According to the simulation results of the five ASEAN economies under consideration, Thailand and the Philippines are among the top gainers, followed by Indonesia, Malaysia and Singapore (where the gain from switching the regime is the smallest among the sample). It therefore suggests that a radical change towards adopting an optimal pre-commitment regime in conducting monetary policy will substantially benefit countries like Thailand, the Philippines, Indonesia and Malaysia. In the case of Singapore, although there will still be benefit, its magnitude is not going to be as large.

An optimal policy under pre-commitment is also generally recognised for leading to lower volatility in inflation and interest rates, but more volatility in the measure of the output gap. In general, this feature is also confirmed by the simulation results for the five ASEAN economies. Additionally, the simulation for these cases also points to a generally lower volatility in the real exchange rate as well. Although the simulation confirms the higher output gap volatility under a pre-commitment regime, the difference is relatively marginal in each of the ASEAN-5 cases. This observation suggests that even though the objective function used to conduct the analysis is close to Svensson’s (1999) strict inflation targeting regime, the optimal pre-commitment policy will still produce superior outcomes for stabilising the economy in general.

\textsuperscript{13}Dennis and Soderstrom (2006) show that the timing of expectation formation matters for determining the welfare gain from switching policy regime from discretion to commitment. In the case where expectations are formed using lagged information, the gain from switching regimes tend to drop significantly.
5.5 Welfare Under the Current State of Policy Feedback Rule

The previous section discussed the welfare implications of monetary policy under two different optimal monetary policy environments, pre-commitment and discretion. Under these policy environments, the optimal policy takes the form of a feedback rule on the vector of state variables in the system. That is, all the state variables are used as relevant information for determining the movements in the policy variable (the interest rate in this particular case). As mentioned earlier, in the case where a monetary authority is able to pre-commit to a single policy plan for the remaining periods, the policy feedback rule utilises more information by also including the vector of Lagrange multipliers obtained from the optimisation. This latter feature represents the cost that the policy maker has to pay for honouring the commitments made in the past. However, this cost is, to an extent, also playing a role in driving the pre-commitment regime to deliver a relatively more efficient social welfare outcome.

Although the policy feedback rules under the optimal pre-commitment include the vector of Lagrange multipliers in their set of monetary policy information, this vector can always be eliminated by substituting them out using the relevant relationships between this vector and the vector of state variables obtained from the first order necessary conditions of the optimisation problem. By doing so, both the policy feedback rules under pre-commitment and under discretion will have the same set of information, but different parameters.

The above discussion highlights the point that an optimal feedback rule adopted by a monetary authority in conducting its policy is not simple. But even if that is the case, representing a policy feedback rule in a simpler representation, as widely discussed in the literature, still offers benefits. Among others, a simple policy feedback rule can generally provide a compact representation of the actual policy decision taken by the monetary authority, as long as it is able to approximate the setting of a

---

14 This substitution can be done since a linear relationship between the Lagrange multipliers and the state vector exists in the class of problem discussed in this paper. See Backus and Driffill (1986) for the discussions.
policy instrument without too much deviation. A simple approximation of policy feedback rules that falls into this category is also preferable since it is generally easier to understand for the private agents, especially when guiding them in forming their expectations. However, simple feedback rules are, by construction, inefficient relative to the fully optimum ones.

Particularly in the case of the five ASEAN economies considered in this thesis, where the actual conduct of monetary policy is not being disclosed openly, such an approximation is helpful in understanding the conduct of monetary policy. For the sample countries under consideration, an approximation to the policy feedback rule in the form of a simple monetary policy reaction function performs relatively well. These simple rules mainly follow the Taylor (1993) type of policy reaction function of the form:

\[ i_t = (1 - \rho_i) (\kappa_1 E_t \pi_{t+n} + \kappa_2 y_t) + \rho_i i_{t-1} + v_t^i \]  

where \( i_t \), \( E_t \pi_{t+n} \), \( y_t \) and \( v_t^i \) are the interest rate, expected inflation, output gap and the unexpected component of monetary policy innovation, respectively, and \( \kappa_1 \), \( \kappa_2 \) and \( \rho_i \) are the relevant parameters with the assigned values for each country as stated in Table 5.1.

Although the formulation in equation (5.39) is often considered to be more appropriately interpreted as an equilibrium relationship among endogenous variables (Svensson, 2003), the characterised simple rule above is taken as the representation of a simple monetary policy feedback rule for each of the ASEAN-5 countries analysed in this chapter. Using these to govern the movement in interest rates, the value of the social loss function (as a metric of the welfare implication of monetary policy) for each of the countries can be calculated. The resulting values can then be compared to the values obtained under the optimal policy environments to get a rough picture of how efficient the conduct of monetary policy has been.

\[ ^{15} \text{n = 1 applies to all the ASEAN-5 countries under consideration except for Singapore, where n = 0.} \]
5.5.1 Measuring welfare under the current feedback rule

Welfare implications under the current feedback policy rule, as represented by the simple Taylor-type rule in equation (5.39), can be measured by taking the rule into account when defining the dynamic constraints of the economy. Unlike the treatment under the fully optimal policy environment, where the monetary policy feedback rule is to be determined by the optimisation process, the policy rule under this environment is restricted to take the form stated in equation (5.39). Therefore, one can re-arrange the system of dynamic constraints facing the economy in (5.21) into the following form:

\[
\begin{bmatrix}
A_0 & -A_3 \\
-A_2 & 1
\end{bmatrix}
\begin{bmatrix}
y_t \\
i_t
\end{bmatrix}
= \begin{bmatrix}
A_1 & 0 \\
0 & \rho_i
\end{bmatrix}
\begin{bmatrix}
y_{t-1} \\
i_{t-1}
\end{bmatrix}
+ \begin{bmatrix}
A_2 & 0 \\
-x_1 & 0
\end{bmatrix}
\begin{bmatrix}
y_{t+1} \\
i_{t+1}
\end{bmatrix}
+ \begin{bmatrix}
A_4 & 0 \\
x_3 & 0
\end{bmatrix}
\begin{bmatrix}
v_t \\
0
\end{bmatrix}
\]

or, in more compact notation:

\[
B_0 z_t = B_1 z_{t-1} + B_2 z_{t+1} + B_3 v_t
\]  

(5.40)

\(x_{1,2}\) are vectors containing the relevant parameters that characterise the relationship between the interest rate (the policy variable) and the endogenous variables in \(y_{t+1,t}\) in the simple feedback rule, respectively. \(x_3\) is a vector containing 1 for the element corresponding to the unexpected component of monetary policy innovation \((\nu^t_i)\) in \(v_t\) and zero otherwise.\(^{16}\)

Expression (5.40) above simply stacks the simple policy reaction function into the system of dynamic constraints as summarised in equation (5.21) and re-arranges its form. Consequently, equation (5.40) gives a complete summary of the dynamics.

\(^{16}\)Note, however, the system representation in (5.40) applies generally to all the ASEAN-5 economies except for Singapore. In the latter case, the policy instrument is only reacting to the contemporaneous development in both inflation and the output gap. Therefore, the vector \(x_2\) contains non-zero parameters for the elements that correspond to \(\pi_t\) and \(y_t\) in \(y_t\) and zero otherwise. On the other hand, the vector \(x_1\) is a zero vector in this case.

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of the economy as presented in Appendix 4.A. Given this, one can rewrite the expression in (5.22) in terms of $z_t$ rather than $y_t$, and solve for the value of the social loss function based on the approach explained for solving the values under optimal policy environments discussed earlier.\textsuperscript{17}

### 5.5.2 Results

Table 5.4 summarises the values of the social loss function under the current policy feedback rule employed for each of the ASEAN-5 countries. The table also spells out the parameter values characterising the policy reaction function in each country and the corresponding unconditional variances for inflation, output gap, real exchange rate and interest rate.

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>The Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x Loss</td>
<td>0.5856</td>
<td>0.2328</td>
<td>0.0864</td>
<td>1.9795</td>
<td>0.0142</td>
</tr>
<tr>
<td>Policy parameters:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\kappa_1$</td>
<td>1.7800</td>
<td>1.6600</td>
<td>0.7196</td>
<td>1.2700</td>
<td>2.6500</td>
</tr>
<tr>
<td>$\kappa_2$</td>
<td>1.0400</td>
<td>0.1900</td>
<td>1.5960</td>
<td>0.9382</td>
<td>0.0000</td>
</tr>
<tr>
<td>$\rho_i$</td>
<td>0.5200</td>
<td>0.6900</td>
<td>0.5456</td>
<td>0.8525</td>
<td>0.7000</td>
</tr>
<tr>
<td>Unconditional variances:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\pi$</td>
<td>0.0072</td>
<td>0.0029</td>
<td>0.0010</td>
<td>0.0310</td>
<td>0.0001</td>
</tr>
<tr>
<td>$y$</td>
<td>0.0033</td>
<td>0.0289</td>
<td>0.0003</td>
<td>0.0091</td>
<td>0.1098</td>
</tr>
<tr>
<td>$q$</td>
<td>0.1320</td>
<td>0.0200</td>
<td>0.0146</td>
<td>0.0021</td>
<td>0.2267</td>
</tr>
<tr>
<td>$i$</td>
<td>0.0115</td>
<td>0.0033</td>
<td>0.0011</td>
<td>0.0301</td>
<td>0.0007</td>
</tr>
</tbody>
</table>

An obvious observation immediately stands out from comparing the set of values for the loss functions in Table 5.4 with the ones obtained under the optimal policy regimes reported in Table 5.3. Values obtained under the current simple policy feedback rule are much higher than those obtained under the fully optimal rules. Observation of the difference in the magnitude of the corresponding unconditional

\textsuperscript{17}In this case, the matrix representation of the social loss function can be written as:

$$\text{Loss}(t, \infty) = E_t \sum_{t=0}^{\infty} \beta^t [z_t' Q z_t]$$

with $Q = \begin{bmatrix} W & 0 \\ 0 & 0 \end{bmatrix}$. 

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variance of inflation offers an explanation for this outcome. As the metric of the loss functions differ enormously, the differences in unconditional variance of inflation are also massive. Under the loss function that approximates Svensson's strict inflation regime, the optimal rules work their way to minimise the unconditional variance of inflation. Therefore, it minimises the social welfare function. This mechanism does not seem to be as pronounced in the case of the current simple policy feedback rule. Consequently, the latter case is characterised by higher values of the loss function as an implication.

A large difference between the metric of welfare obtained under the current policy rule and the one obtained under a utility-based social loss function, however, is not surprising. A similar observation also appears in Batini et al. (2003), where simple policy feedback rules that optimise an ad-hoc loss function return higher values when applied to a loss function derived from a utility function. This observation indicates that the simple policy feedback rules reported in Table 5.4 are not designed to optimise the specified social loss function used to calculate the metric for welfare implications in this chapter. In other words, the likely representation of the simple policy feedback rule for each of the ASEAN-5 countries analysed in this chapter suggests that the monetary authority in these countries are not optimising the social loss function as derived earlier in the chapter. Even if they were optimising at all, the form of the objective function must have been different.

The last point described in the previous paragraph is supported by differences in the variance of the four key variables reported in Table 5.3 and 5.4. Simulations for the cases of Indonesia, Malaysia and the Philippines suggest a lower variance for output gap under the simple feedback rule. This difference hints at the possibility that monetary authorities in these three countries may give more attention to stabilising the output gap in their actual policy setting than what is suggested by their corresponding utility-based welfare criterion. A similar argument also applies for the lower real exchange rate variability under the simple policy feedback rule reported in the cases of Indonesia and Malaysia. Although these two countries may
not be explicitly targeting their real exchange rate, a low variance of this variable produced under the simple policy rule does hint at the possibility that a different mechanism is pursued in maximising the objective of their policy.

Aside from inflation variability, another consistent difference in variability is found in the case of the interest rate. Unconditional variances of the interest rate simulated under the current simple policy feedback rule consistently fall below those obtained under the optimal policy regime simulations for most of the five ASEAN economies. Except for the case of Singapore, the specified rules used to represent the current policy regime consistently deliver lower variability in the rate of interest. These findings provide a strong suggestion about the preference for smoothing the interest rate fluctuations of the monetary authorities in these countries. In other words, it suggests that these monetary authorities tend to prefer stability in their policy instrument, and hence, avoid overly aggressive policy responses that can lead to wild fluctuations in the policy instrument.

Findings on relatively higher variability in all of the four key variables under the current feedback rule for the case of Singapore require further discussion. At a glance, these findings may point to a conclusion that the simple policy rule employed to characterise the current conduct of monetary policy in Singapore is practically inefficient. However, there is also a possibility that the current simple rule employed in this particular case may suffer from an instrument approximation bias. The monetary policy in Singapore is primarily conducted through managing the Singapore dollar exchange rate against an undisclosed trade-weighted basket of currencies of Singapore’s major trading partners and competitors. Consequently, exchange rate targeting would be the most appropriate representation of monetary policy in Singapore (for example, see discussions in Parrado, 2004, McCallum, 2006). The use of the interest rate as a proxy for the policy instrument in this case could potentially invite an approximation bias, and the simulation results for Singapore reported in Table 5.4 hinted at this potential issue.

In summary, simulations conducted under the current state of simple feedback rules
characterising monetary policy in the five ASEAN countries produce sub-optimal welfare implications for each of the economies. From observing differences in the implied unconditional variances for four key macro-economic variables reported in Tables 5.3 and 5.4, this finding may have come about because monetary authorities in these economies may actually be optimising over a different objective function when setting up their policy.

5.6 Room for Improvement?

A question that naturally follows the assessment made in the previous section would concern the issue of possible room for improving the monetary policy performances. More specifically, can one identify different characterisations of the given form of simple policy feedback rule that optimises the social loss function? An obvious approach to address this question would be to find a policy feedback rule that represents a solution to the constrained problem of optimising the social loss function, while restricting the solution to the form of the simple interest reaction function given in equation (5.39). When this approach is applied to the problem characterised by the underlying parameter values representing each of the sample ASEAN-5 economies, the optimisation exercise suggests implausibly aggressive policy parameters for the restricted form of simple interest feedback rule (5.39).

The literature on this topic also recognises the particular problem encountered above. Batini et al. (2003), for example, come across a similar issue when fitting simple rules that contain an interest smoothing argument to optimise their utility-based welfare function, where interest rate variability does not appear as an explicit argument in the objective function. Note that the representative interest reaction function used for each of the sample economies in this chapter, equation (5.39), includes an interest rate smoothing argument. Optimising this kind of policy reaction function on a loss function that does not include an ad-hoc added interest rate variability term, like the one in equation (5.22), could potentially lead one to encounter the problem mentioned above. However, adding an ad-hoc interest rate variability term
into the utility-based loss function contradicts the rationale for using the social loss function in assessing the policy’s welfare implications. On the other hand, dropping the interest rate smoothing argument from equation (5.39) defies the econometric evidence that monetary authorities in the ASEAN-5 sample prefer to smooth the interest rate fluctuations.

By way of compromise on the above issues, this chapter explores the possibility for the given form of a simple policy feedback rule in equation (5.39) to improve social welfare by searching for a set of policy parameters that could potentially bring about around 50-70 per cent relative welfare gain from the current characterisation of the simple rules. In doing so, two more restrictions are added when conducting the search. First, a new set of policy parameters obtained should fall in the acceptable range of values for a simple policy rule of this kind. Second, the search is terminated once the relative gain in the metric of welfare hits the range mentioned.

Given the above explanation, the resulting set of policy parameters obtained under the search exercise should not be interpreted as a set that represents an optimal simple policy feedback rule for the problem at hand. Rather, the resulting set of policy parameters can only be construed as an example for the possible candidates from a set that delivers better welfare outcomes. The objective of this exercise is merely to provide examples of room for possible improvements that can be explored if monetary policy is to be conducted to target better welfare implications. Two examples are presented in what follows. Both examples retain the argument on the monetary authority preference over interest rate (policy instrument) stability, as well as all the relevant assumptions used in the simulations conducted previously in this chapter.

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18 This range of potential welfare improvement is taken since (as shown in the following) the resulting policy parameters still fall on some sensible range of values. In this exercise, the sensible range for the policy parameters are set to be $0 < \kappa_1 < 10$, $\kappa_2 > 0$ and $0 < \rho_i < 1$.

19 The search is conducted using the Nelder-Mead simplex direct search algorithm (see Lagarias et al., 1998, for a detailed explanation) contained in fminsearch routine in MATLAB, and truncated once the boundaries for the additional restrictions are hit.
5.6.1 Example 1: Altering all policy parameters

This example restricts the setting of monetary policy in each of the five ASEAN economies to follow an interest rate feedback rule presented by equation (5.39). The set of estimated policy parameters \((k_1, k_2 \text{ and } \rho_i)\) reported in Table 5.1 are not assumed to be an optimal representation of the policy maker’s preference, and are hence flexible to change. The estimated policy parameters, however, is taken as the representative of the current policy regime. Therefore, these parameters are used as the starting values to initiate the search. Table 5.5 presents the outcome of this exercise.

Table 5.5: Welfare implications of altering all policy parameters

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>The Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x Loss</td>
<td>0.2000</td>
<td>0.090</td>
<td>0.0333</td>
<td>0.8699</td>
<td>0.0129</td>
</tr>
<tr>
<td>Welfare gain</td>
<td>0.6637</td>
<td>0.6084</td>
<td>0.6144</td>
<td>0.5605</td>
<td>0.0952</td>
</tr>
<tr>
<td>Policy parameters:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(k_1)</td>
<td>2.7813</td>
<td>2.0750</td>
<td>1.4703</td>
<td>1.3970</td>
<td>3.1211</td>
</tr>
<tr>
<td>(k_2)</td>
<td>0.3744</td>
<td>0.1140</td>
<td>0.6650</td>
<td>0.8444</td>
<td>-0.0001</td>
</tr>
<tr>
<td>(\rho_i)</td>
<td>0.7488</td>
<td>0.8280</td>
<td>0.7904</td>
<td>0.9378</td>
<td>0.6883</td>
</tr>
<tr>
<td>Unconditional variances:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(\pi)</td>
<td>0.0022</td>
<td>0.0010</td>
<td>0.0004</td>
<td>0.0132</td>
<td>0.0001</td>
</tr>
<tr>
<td>(y)</td>
<td>0.0152</td>
<td>0.0355</td>
<td>0.0011</td>
<td>0.0182</td>
<td>0.1071</td>
</tr>
<tr>
<td>(q)</td>
<td>0.1736</td>
<td>0.0220</td>
<td>0.0173</td>
<td>0.0037</td>
<td>0.2267</td>
</tr>
<tr>
<td>(i)</td>
<td>0.0084</td>
<td>0.0009</td>
<td>0.0006</td>
<td>0.0121</td>
<td>0.0008</td>
</tr>
</tbody>
</table>

Table 5.5 shows that in four out of the five ASEAN countries, the exercise conducted under the above assumptions can comfortably deliver alternative values for the policy parameters, which produce around a 55 to 70 per cent gain in welfare relative to that achieved under the current estimated policy rules. Thailand’s case, however, comes out as an exception. Implausibly, to get about 10 per cent relative gain in welfare, the policy instrument has to react negatively to a positive development in the output gap. This possibly happens because of the starting value for the parameter that governs the interest rate reactions to the output gap \((k_2)\) being zero in the case of Thailand.

The outcomes for all the countries in this example share general common features.
To improve its social welfare implications, the feedback rule needs to become more aggressive in responding to developments in inflation expectation, but less aggressive to developments in the output gap. On top of that, this welfare improving simple feedback rule is also characterised by more policy persistence (higher values for $\rho_i$) in all cases. Although it tends to be welfare improving, this better policy characterisation does not come without cost. This better policy characterisation manages to bring about more stable inflation and interest rate only at the cost of relatively more volatility in the output gap and the real exchange rate.

### 5.6.2 Example 2: Keeping the degree of interest persistence

This example is conducted under the same assumptions imposed in Example 1. It differs only in the treatment of an interest rate smoothing term in the simple feedback rule. In this example, the interest rate partial adjustment coefficient ($\rho_i$) reported in Table 5.1 is taken as optimally representing the preference of the policy maker. Consequently, the value of this parameter for each of the ASEAN-5 economies is kept constant according the estimated value reported in Table 5.1. That is, only the values for $\kappa_1$ and $\kappa_2$ are altered in order to search for a better welfare outcome. The outcome of the exercise under the assumption imposed in this second example is reported in Table 5.6.

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>The Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>100 x Loss</td>
<td>0.2117</td>
<td>0.0850</td>
<td>0.0280</td>
<td>0.6624</td>
<td>0.0121</td>
</tr>
<tr>
<td>Welfare gain</td>
<td>0.6386</td>
<td>0.6347</td>
<td>0.6758</td>
<td>0.6654</td>
<td>0.1489</td>
</tr>
</tbody>
</table>

Policy parameters:

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>The Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\kappa_1$</td>
<td>2.7979</td>
<td>2.1476</td>
<td>1.7780</td>
<td>1.4676</td>
<td>3.4284</td>
</tr>
<tr>
<td>$\kappa_2$</td>
<td>0.4290</td>
<td>0.1188</td>
<td>0.7016</td>
<td>0.7599</td>
<td>0.0007</td>
</tr>
<tr>
<td>$\rho_i$</td>
<td>0.5200</td>
<td>0.6900</td>
<td>0.5456</td>
<td>0.8525</td>
<td>0.7000</td>
</tr>
</tbody>
</table>

Unconditional variances:

<table>
<thead>
<tr>
<th></th>
<th>Indonesia</th>
<th>Malaysia</th>
<th>The Philippines</th>
<th>Singapore</th>
<th>Thailand</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\pi$</td>
<td>0.0024</td>
<td>0.0009</td>
<td>0.0003</td>
<td>0.0103</td>
<td>0.0001</td>
</tr>
<tr>
<td>$y$</td>
<td>0.0124</td>
<td>0.0321</td>
<td>0.0007</td>
<td>0.0086</td>
<td>0.1061</td>
</tr>
<tr>
<td>$q$</td>
<td>0.1607</td>
<td>0.0238</td>
<td>0.0155</td>
<td>0.0021</td>
<td>0.2270</td>
</tr>
<tr>
<td>$i$</td>
<td>0.0099</td>
<td>0.0015</td>
<td>0.0007</td>
<td>0.0100</td>
<td>0.0008</td>
</tr>
</tbody>
</table>
As is also the case in Example 1, the exercise conducted under the assumption imposed in this example delivers alternative values for the set of policy parameters that yield a 60 to 70 per cent welfare improvement relative to the base case of the estimated set of policy parameters. Again, Thailand's case turns out to be an outlier. Although the feedback rule in the latter case does not have to be reacting negatively towards the output gap developments in this example, the policy instrument has to react implausibly aggressively to developments in inflation expectation in order to get a more than 15 per cent gain in welfare.

The common general features on the direction of changes in the way the policy instrument should react to developments in inflation expectations and the output gap to produce better welfare outcomes in Example 1, also hold in this example. That is, in order to deliver better welfare outcomes, the policy is required to be more aggressive to developments in inflation expectation and the other way around in the case of the output gap. However, the costs for bringing more stable inflation and interest rate found in Example 1 only hold true for the cases of Indonesia, Malaysia and the Philippines in this example. In this example, the relatively more stable inflation and interest rates for the case of Singapore turn out to be accompanied by a marginally more stable output gap and real exchange rate.

5.6.3 A note on the examples

To an extent, the two examples above provide a picture of the existence of scope for improving the welfare outcome of monetary policy for each of the ASEAN-5 countries. This possible improvement can be achieved even by constraining the simple feedback rule to take the same Taylor-type policy rule that approximates the current monetary policy regime in these countries. Generally, both examples share common features in terms of the directional change in the main policy parameters ($\kappa_1$ and $\kappa_2$). There are, however, a few particular cases that deserve some further notes.

The Philippines case shares the main common features with most of the other cases.
However, unlike the other cases, the Philippines case starts with a set of policy parameters that does not adhere to the Taylor principle. Both Examples 1 and 2 suggest that the welfare outcome in the case of the Philippines can be improved by switching its monetary policy regime to one that pays more attention to developments in inflation expectation rather than to the output gap; i.e. a regime that adheres to the Taylor principle.

Thailand is an outlier in both examples. This problem may arise due to the fact that the baseline representative regime in this case is only putting attention on the expected inflation developments to guide the direction of change in its policy stance. The trend appearing within the examples explored in this section suggests that to improve the welfare outcome, the feedback rule needs to become more aggressive in responding to developments in inflation expectation, but less aggressive towards the developments in the output gap. In this particular case, there is practically no room for reducing the weight on output gap developments. Moreover, since the starting value for $\kappa_1$ has already been relatively high in this particular case, the policy instrument often has to react implausibly aggressively to developments in inflation expectation in order to force in more stability to the already relatively stable inflation. Therefore, given the acceptable values for policy parameters, the room for obtaining a relatively large welfare gain under the exercises set out in Example 1 and 2 in the case of Thailand is very limited.

Lastly, the case of Singapore in Example 2 also brings up an interesting observation. If one is to keep the magnitude of the interest rate adjustment coefficient in the feedback rule ($\rho_i$) at its estimated value, then this example shows that there exist some better set of policy parameters, which both improves the welfare outcome and delivers better stability for the economy in general.
5.7 Concluding Remarks

The discussion provided in this chapter has been focused on the particular form of an aggregate social loss function that is derived from a utility-based welfare criterion. Comparisons of the resulting unconditional variability in the four key macroeconomic variables reported in Tables 5.3, 5.4, 5.5 and 5.6, however, hint at the possibility that monetary authorities in each of the ASEAN-5 countries may have some other considerations when setting up their policy. Particularly for the cases of Indonesia, Malaysia and the Philippines, lower output gap variability obtained under the simple policy rule suggests that the monetary authorities in these countries may put larger weight on output gap variability relative to the weight employed in the social welfare criterion derived in this chapter. For the former two cases, it is also shown that the real exchange rate turns out to be more stable under the simple policy rule.

Assuming that the monetary authorities are optimising their particular objective function in setting up their policy, the above findings suggest that the monetary authorities in the ASEAN-5 countries are optimising against different form of objectives. This argument is, at least, reflected in the way interest rate variability behaves under the simple rules. It is very likely that when setting up their policy, the monetary authorities in the countries considered in here prefer to smooth the profile of their policy instrument. Therefore, the likely policy maker’s objective function may take an ad-hoc form that puts relatively more weight on the output gap and includes the interest rate and real exchange rate variability arguments in it.20

The analysis in this chapter, however, refrains from looking at the likely functional form for the objective function of these monetary authorities. Instead, it focuses on

20 The variant of ad-hoc types of objective function are commonly used for analysing monetary policy in the literature. Some go even further by estimating the weight for the arguments appearing in this type of ad-hoc form of objective function from the economic outcome; e.g. Dennis (2004a, 2006). This latter approach is taken under the assumption that the policy maker’s optimising behaviour is reflected in the equilibrium relationship between policy instruments and the state variables in the representative system of the economy.
analysing the impact of monetary policy on the utility-based welfare criterion for each of the ASEAN-5 economies. Consistent with the literature, the results suggest that these countries will be better-off if they conduct their monetary policy under a commitment rather than under a discretionary regime. Furthermore, by assuming that the current policy regime is represented by the estimated policy reaction functions for each of the economies, the results suggest that scope for improving the performance of monetary policy in these countries exists. By way of example, it is also shown that improving the efficiency in the performance of monetary policy is also possible even when keeping the particular form of the policy rule. This improvement can be achieved by altering the feedback parameters within the rule.

Some notes, however, need to be provided in interpreting the above assessment on the possible improvement for conducting monetary policy. Especially for the case of Indonesia, Malaysia and the Philippines, improvement in welfare discussed in Examples 1 and 2 implies higher variability in the measure of output gap as well as the real exchange rate. If it turns out that the monetary authorities in these countries target both (or at least one) of those two variables by weighing them heavily in their institutional objective functions, then promoting a policy arrangement that improves welfare can become problematic.

Nonetheless, as the scope for improving monetary policy is open to the ASEAN-5 economies under consideration, exploration of possible alternatives for improvement becomes a natural topic for future extension of the analysis provided in this chapter. A possible alternative for extension would be to see how a battery of different simple monetary policy rules can contribute towards narrowing the distance between the welfare implications of these rules relative to the welfare implications of fully optimal monetary policy regimes. Another equally interesting alternative to be explored is to see if having some sort of monetary cooperation among the ASEAN-5 countries involved could help in improving the welfare outcome.

The latter alternative mentioned above appears to be an attractive way to extend the analysis of this chapter for several reasons. First of all, the issue has been floated
since the Asian crisis in 1997.\(^{21}\) Economic interconnections among the ASEAN-5 countries considered have also been growing and increasing at a faster rate lately. Further, as shown in the discussions in this chapter, monetary policy that is conducted based on a commitment regime tends to produce superior welfare outcomes relative to the one that is based on a discretionary regime. In practice, however, it is often difficult to implement a credible commitment regime. Having formal policy coordination within the region has the potential to help in promoting the commitment technology to gain more credibility for each of the monetary authorities involved. Therefore, it may potentially help in delivering more efficient welfare outcomes in the conduct of monetary policy.

\(^{21}\)The issue of currency cooperation in ASEAN has actually been included as one of the four pillars of the ASEAN roadmap for financial and monetary integration. (See the ASEAN fact sheet, 16\(^{th}\) of April 2007; available at http://www.aseansec.org/Fact\%20Sheet/AEC/2007-AEC-009.pdf)
Chapter 6

Concluding Remarks

6.1 General Summary

Inflation targeting as a framework for conducting monetary policy has demonstrated its success in enhancing transparency and accountability of monetary policy operation in various industrial countries, such as in New Zealand, Canada, the United Kingdom, Sweden, Finland and Australia. These countries have successfully brought inflation down after implementing an inflation targeting framework. After the Asian financial crisis in 1997-1998, many countries in ASEAN formally announced their intention to move towards adopting this framework. Although applying an inflation targeting framework in developing economies is rather tricky, the prospect for its implementation in the case of the ASEAN-5 economies considered in this thesis appears to be viable (Debelle, 2001).

The analysis in the thesis supports the argument of viable prospect for implementing inflation targeting framework in Southeast Asia. The conduct of monetary policy in the ASEAN-5 economies has quite consistently followed a certain characterisation of a simple Taylor type monetary policy rule since the 1990s. In the period after the crisis, monetary policy in these countries is shown to be driven by movements in inflation expectations and the output gap. This type of rule is widely considered to

1 As discussed in Bernanke et al. (1999a). See also Vega and Winkelried (2005) for an empirical support of this argument based on a wider set of sample countries.

2 See the discussion in Masson (1997) and Mishkin (2000), among others.
be consistent with the inflation targeting framework in the literature.\(^3\) Therefore, given that experience and the fact that the monetary authorities in these countries have had a considerable degree of independence in managing monetary policy, the implementation of an inflation targeting framework seems plausible.

The conduct of monetary policy in the ASEAN-5 economies is, in general, found to be relatively persistent and subject to some inertia. Nonetheless, the directions for setting of monetary policy in these countries are mainly driven by movements in inflation expectations with typically some allowance for output stabilisation. The findings suggest that the role of exchange rates does not drive monetary policy directly. The exchange rate is, however, included in the set of information used by the central banks of these countries in determining monetary policy stance.

Observation of the monetary policy approximation in each of the ASEAN-5 countries reveals individual differences in the way monetary policy reacts towards developments in inflation and the output gap. Although in general the conduct of monetary policy in the ASEAN-5 countries adheres to the Taylor principle, the magnitude of the parameters in the policy reaction function differs for each case. The case of the Philippines stands out from the rest of the group. The policy reaction function in this case does not seem to adhere to the Taylor principle and changes in its monetary policy seem to be driven mainly by movements in the output gap.

The approximation of monetary policy for each of the sampled countries is then used to represent the monetary sector in a simple small open economy model to estimate the deep parameters characterising each of the economies. The estimation results obtained largely capture the economic characteristics and dynamics for each of the economies under consideration. Including habit formation and price indexation with respect to past inflation enables the model to capture a degree of persistence that is inherent in the data. Further, the one-size-fits-all small open economy model employed in the analysis is also useful for comparing the characteristics of each of the sample economies.

\(^3\)See the discussion in Rudebusch and Svensson (1999) and Svensson (1999), among others.
The estimated model provides insights about the transmission mechanism of monetary policy for each of the economies under consideration. The role of monetary policy in affecting inflation and the output gap in the model mainly comes through its effect on consumption and the real exchange rate. Given that the instrument for conducting monetary policy (nominal interest rate in this case) is governed by fluctuations in expected inflation and the output gap, the interest rate in this model plays the role of a stabilising tool to moderate fluctuations in the economy. Inflation variability in these cases varies depending on the structure that characterises each economy. For example, in the case where the economy is more open relative to the others (for example, the cases of Malaysia and Singapore), inflation tends to be more volatile given a shock to the real exchange rate. On the other hand, a shock in monetary policy tends to invoke more volatility to the inflation dynamics in the case where monetary policy is accommodative towards inflation (the case of the Philippines).

Since the model used for the analysis is theoretically derived based on the maximising behaviour of both consumers and the firm sector, it is able to identify the relevant structural parameters for each of the ASEAN-5 economies. The thesis adopts these structural parameters to construct an aggregate utility-based loss function that serves as a measure for welfare for each of the economies. Using this metric to measure the welfare implications of conducting monetary policy, the thesis argues that monetary policy in each of the ASEAN-5 countries has not been conducted efficiently. This assessment follows from the fact that the welfare implications under the current monetary policy regime (as represented by the estimated simple policy reaction function) are found to be markedly less than those under a fully optimal policy environment that is used as a benchmark in the analysis. Consequently, there is still scope for improving the conduct of monetary policy.

A closer observation of the simulated variability of four key macroeconomic variables\(^4\) under different policy regimes suggests that when designing their monetary policy, monetary authorities in the ASEAN-5 countries may have looked at an objec-

\(^{4}\)Namely, inflation, the output gap, interest rates and real exchange rates.
tive that differs from the one that is generated based on the utility function specified in the analysis. For example, the output gap and the real exchange rate variability in the cases of Indonesia and Malaysia under the simple rule fall below their variability under the fully optimum scheme. This suggests that the monetary authorities in these countries may have been placing more weight on the two variables when optimising their monetary policy. The thesis, however, assumes that the ultimate target of the stabilisation policy should always be aimed at maximising social welfare, that is, by maximising the utility of the representative agent in the economy. Therefore, the thesis refrains from looking at the likely functional form for the institutional loss function of those monetary authorities and focuses on analysing the impact of monetary policy on the utility-based welfare criterion for each of the economies. To deal with this issue, the thesis conducts a specific exercise to further examine the scope for improving the performance of monetary policy. This is done by keeping the same simple policy rule representation that approximates the current policy regime, but altering its characterisation to seek better welfare results. By way of example, it is shown that improving the performance of monetary policy in the sampled countries can be attained by varying the feedback parameters that characterise the rule, hence reinforcing the assessment about the room for improving the performance of monetary policy in these economies.

To sum up, this study has shown that monetary policy plays a non-trivial role as a stabilisation device for maintaining the economic performance in the ASEAN-5 economies. In general, monetary policy in ASEAN-5 is driven mainly by movements in inflation expectations and the output gap. However, under the particular class of model employed in this study, the conduct of monetary policy in each of these countries is found to be relatively inefficient. Consequently, there is still room for the monetary authorities to explore alternative designs for policy in order to improve its efficiency.
6.2 Some Limitations and Possible Extensions

The model employed in this study provides reasonable explanation regarding the dynamics of each of the ASEAN-5 economies considered in the analysis. The one-size-fits-all nature of the underlying small open economy model used to represent these economies provides convenience for comparing the macroeconomic characteristics of each country. This choice of approach, however, does not come without costs. An obvious cost is the sacrifice of some degree of preciseness in capturing the characteristics of each individual country. A more accurate characterisation is possible by tailoring a specific model for each of the economies under consideration. Therefore, the choice of modelling strategy can be altered depending on the goal that is to be achieved from the analysis.

The main objective of the thesis was to study the impact and performance of monetary policy in each of the ASEAN-5 economies. The analysis relies on a particular class of model that limits its structure in order to serve that objective. Although able to capture the empirical regularities in the data, the relative simplicity of the model constrains its applicability for simulating the impact of some other shocks that may be of interest. For example, the fiscal sector of the government is not modelled explicitly in the analysis. This particular choice of modelling strategy, while useful for keeping the model simple, prevents the model from isolating the impact of a fiscal shock to the economy. Another example has to do with the source for nominal rigidity in the economy. In the model, this comes only from a staggered price contract for the sake of simplification. The literature, however, also recognises the wage contract as another important source for nominal rigidities. Extending the model to incorporate these extensions will be beneficial in terms of enriching the model's structure.

This study also assumes perfect financial markets in order to induce stationarity in the equilibrium dynamics of the small open economy model used in the analysis. Introducing financial market imperfections into the model could also be considered in order to enrich its structure. This can be done by, for example, extending the
model to incorporate features like agency costs (Carlstrom and Fuerst, 1997) or the financial accelerator (Bernanke et al., 1999b). All the above issues are open for future research.

Given the fact that there is still scope for improving the performance of monetary policy in the countries under study, analysis of the possible gain from having alternative designs for monetary policy is also a future research agenda following the analysis in this study. This can be in the direction of experimenting on alternative domestic monetary policy settings, or regional monetary cooperation.

With respect to the latter direction, extending the model to a regional economic model that specifically incorporates the effect of each of the other economies within the ASEAN-5 sample is one way to go about analysing the issue. A way to formalise this setting might be to break down the effect of the foreign sector into two general components; namely, the other ASEAN-5 members and the rest of the world. Adding such structure to the model will make the impact of the other ASEAN economy explicit to the domestic economy. While the rest of the world is still treated as exogenous in this case, the neighbouring ASEAN economies are treated as equally influential to each other. Therefore, the extended model is potentially useful for gauging the likely gain from monetary cooperation in the region.

Although this study does not deal directly with the issue of regional monetary cooperation in ASEAN countries, the analysis provided can be viewed as a prerequisite to constructing a regional macroeconomic model that can be used to assess the welfare implications of such arrangements in the future.
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