Does Monetary Policy Credibility Matter for Exchange Rate Volatility? A Small Open Economy Case

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Abstract

This paper explores the effect of monetary policy credibility on exchange rate volatility, even if the exchange rate is not an explicit target set by the central bank. Using an open economy framework modified from Galí and Monacelli (2005) and Walsh (2006), it shows that monetary policy credibility helps to stabilize the exchange rate as supply and demand side shocks hit the domestic economy. The monetary policy credibility can be achieved by the central bank’s commitment to certain rules aiming for output/price smoothing. In the empirical analysis inflation targeting is used as a proxy variable for monetary credibility. The GARCH model of selected South-East Asian countries indicates that countries with inflation targeting policies have exhibited reduced exchange rate volatility when other factors are controlled.

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Key Words: Exchange rate; Volatility; Monetary Policy; Credibility; Inflation Targeting

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1 Introduction

Many developing countries have fixed exchange rate regimes and are considering the option of flexible ones. The most recent example is that given the large depreciation of the U.S. dollar in recent years, the OPEC countries seek to exit from pegging to the dollar and form a common currency for the region. Indeed, a floating exchange rate has many benefits. For example, it serves as a "shock absorber" to the domestic economy when there are exogenous shocks. And it would free the monetary authority from tedious targeting of its currency value and allow the central bank to focus on other more important tasks such as inflation control. However, one disadvantage of a floating exchange rate is that it is usually more volatile than a successfully fixed one. For countries which have made the shift either in a voluntary or involuntary way, i.e., during the 1997 Asian financial crisis, and the Brazilian and Argentine crises in 1999 and 2001 respectively, their exchange rates became more volatile within and after the shift.

Intuitively, high exchange rate volatility may result in misaligned currencies and distort terms of trade and investment flows. The empirical evidence on this issue is mixed since exchange rates are endogenously determined by many factors such as interest rate differential and inflation (see IMF 1984, 2004 and Rose 2000). Nevertheless, most studies agree that excessive volatility (especially short term) increases the exchange rate risk and the costs of hedging for traders and investors. Furthermore, it may make the price level more volatile via the pass-through effect. It is not surprising that many monetary authorities use the exchange rate as one of policy indicators, e.g., the Monetary Condition Index (MCI) monitored by Bank of Canada before 2007. Therefore although the impact of exchange rate volatility on many macroeconomic variables is uncertain, it becomes one major concern for countries which are considering the option.

The purpose of this study is to explore the effect of monetary policy credibility on exchange rate volatility in a small open economy model with optimizing agents and firms. The credibility of monetary policy is built on the commitment to some rules made by the monetary authority. This paper does not aim to compare the volatility between fixed and flexible exchange rate regimes since a well-kept fixed regime has lower volatilities than the flexible one, ceteris paribus. Rather, the paper asks the following question: when the central bank does not explicitly target exchange rates, does monetary policy credibility matter to exchange rate volatility? While the advantages of monetary credibility in eliminating inflation bias and output smoothing are well-known, this paper looks for additional merits of monetary credibility, or the marginal effect of “rules versus discretion” on the exchange rate.
The comparison, which hasn’t been addressed in the literature of New Open Economy Models (NOEM), shows that under commitment to certain rules, exchange rate is less volatile when exogenous shocks hit the economy.

1.1 A short literature review

There are a large number of studies in the literature of exchange rate modeling. Many empirical studies since Meese and Rogoff (1983) have shown that exchange rate volatility is not closely related to the fundamentals, except in hyper-inflation countries. The old monetary approach developed in 1980s has been proved to be inefficient in explaining exchange rate changes. In most cases the exchange rate fluctuation can be better modeled as a random walk rather than any precisely described model (see also Flood and Rose 1995, 1999). Since the mid 1990s, economists started to reconsider the exchange rate modeling using sticky price, open economy models as described in Obstfeld and Rogoff (1995, 1996), Clarida, Galí and Gertler (2001, 2002). These studies assume optimizing agents and profit-maximizing firms, as in the New Classical economic theories. Therefore the results would be identical to the classical dichotomy if prices were assumed to be flexible. One important feature of the NOEM models is that they include the stickiness of prices by assuming firms adjust their prices with one-period lag (Obstfeld and Rogoff 1995) or in a staggered manner (Calvo 1983). With inflexible price and wage adjustment, the models are able to generate some persistent effects observed in the real economy and the possibility of overshooting of exchange rate, similar to earlier Keynesian models such as Dornbusch (1976). The studies above provide an alternative work horse with sound micro-foundations for the analysis of international monetary policy and exchange rate.

Another stream of literature related to this paper is about monetary policy credibility issues, i.e., rules versus discretion. This literature began with the seminal work of Kydland and Prescott (1977). This was followed by Barro and Gordon (1983), who show that the central bank could eliminate the inflation bias by committing to the public about its inflation targets. King (1997) and Svensson (1997) compare the loss functions of the central bank through a Lucas-type aggregate production function under commitment and discretion, respectively. Kuttner and Posen (1999, 2000) extend this idea to exchange rate volatility in such a way that under commitment to certain rules, the central bank could let the public anchor future inflation expectations so as to reduce the exchange rate volatility. One shortcoming of these studies is that most arguments are based on some aggregate relationships

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1 Lane (2001) provides a complete survey of the literature of New Open Economy Models (NOEM).
which lack micro-foundation and are subject to the Lucas critique that the parameters would shift according to shocks. A recent work using NOEM by Galí and Monacelli (2005) indicates that exchange rate volatility is quite asymmetric depending on the monetary policy targets, varying from domestic inflation targeting, CPI inflation targeting, to exchange rate pegs. Yet the question of the impact of lack of credibility on exchange rate variability hasn’t been discussed in the studies cited above, since they assumed all policy targets credible and well kept by the monetary authority.

1.2 A brief description of the methodology

The small open economy is described by a two-equation system known as New Keynesian Phillips Curve (NKPC) and New Keynesian IS curve (NKIS), developed from the behavior of optimizing agents, the profit-maximizing firms and labor market equilibrium. The monetary policy is conducted by the central bank using the interest rate adjustment and the central bank also has some loss functions made by a weighted average of inflation and output gap variations.

Discrete monetary policies mean the central bank only minimizes the single period loss function, and re-optimizes at the beginning of each period. Under commitment to certain rules the discounted sum of all future loss functions are considered. Both Svensson (1997) and Walsh (2006) show that there exist inflation bias and stabilizing bias under discrete policies if the economy faces supply side shocks, therefore the central bank has policy tradeoffs when they choose between a more accommodative policy (allowing for more inflation) and a more defensive one (allowing for more output gap). Intuitively, if the central bank focuses more on price stability (put more weight on inflation), the interest rate would be increased to reduce inflation, given a negative supply shock. If the central bank makes a commitment to certain rules, previous studies also show that both inflation and stabilization bias can be eliminated so the inflation will not be so high compared to discrete policies under the same shock. Assuming that the short-term exchange rate movement is determined by uncovered interest rate parity (UIP) and the long-term exchange rate parity is dominated by purchasing power parity (PPP), I can derive and compare the exchange rate responses caused by both supply and demand side shocks, given different focus and credibility of the central bank’s policies. The response of the exchange rate can be simulated through model calibration and compared by the implied impulse-response functions.

For empirical evidence, the exchange rate volatility is analyzed through the Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model, with dummy variables
standing for monetary policy credibility measures (i.e., announcement of inflation targeting),
exchange rate regimes and period of crisis. Individual country data is examined to identify
the effects of these factors on exchange rates. While it is true that the micro-market struc-
ture, i.e., bid-ask spreads, market size and risk premium, does contribute to the short-term
exchange rate volatility, I limit the scope on the monetary side and explore the marginal
effect of credibility issues such as keeping inflation within targets.

The rest of the paper is organized as follows: section 2 lays out the open economy model;
section 3 derives and compares the exchange rate responses under both discrete and credible
monetary policies, and some calibration and simulation of the model are presented; section 4
provides the empirical evidence from four South-East Asian countries, followed by concluding
remarks in section 5.

2 A Small Open Economy Model for Policy Compar-
isons

In this section I present the open economy model, which is modified from Galí and Monacelli
(2005) and Walsh (2006). Suppose there are two countries, Home and Foreign. The home
and foreign countries are denoted by the superscript $h$ and $f$, respectively. In both countries
the preferences and technologies are the same, and they both produce traded consumption
goods which are imperfect substitutes.

2.1 Consumers

Suppose the representative consumer consumes a CES composite of home and foreign goods,
deﬁned as,

$$C_t = \left[ (1 - \gamma)^{\frac{1}{\gamma}} (C^h_t)^{\frac{\eta-1}{\eta}} + \gamma^{\frac{1}{\gamma}} (C^f_t)^{\frac{\eta-1}{\eta}} \right]^{\frac{\eta}{\eta-1}}$$ (1)

where $C^h_t$ and $C^f_t$ are indices of consumption of domestic and foreign goods. Such indices
are in turn given by the following CES aggregates of the quantities consumed of each type
of the good,

$$C^h_t = \left( \int_0^1 C^h_t(i)^{\frac{\tau+1}{\tau}} di \right)^{\frac{\tau}{\tau-1}} \quad \text{and} \quad C^f_t = \left( \int_0^1 C^f_t(i)^{\frac{\tau+1}{\tau}} di \right)^{\frac{\tau}{\tau-1}}$$ (2)

From the CES form of consumption, it is obvious that the parameter $\eta$ measures the
substitution elasticity between domestic and foreign goods, and $\tau$ measures the substitution
elasticity within each category$^2$. $\eta > 0$ and $\tau > 1$ are assumed.

$^2$The assumption that the elasticities of substitution of foreign goods and domestic goods are the same
The price indices for domestic and foreign goods are \( P^h_t = (\int_0^1 P^h_t(i)^{1-\tau} di)^{\frac{1}{1-\tau}} \) and \( P^f_t = (\int_0^1 P^f_t(i)^{1-\tau} di)^{\frac{1}{1-\tau}} \). The consumer price index for the home country is given by,

\[
P_t = \left[ (1 - \gamma)(P^h_t)^{1-\eta} + \gamma(P^f_t)^{1-\eta} \right]^{\frac{1}{1-\eta}}
\]  

(3)

The domestic consumer’s relative demand for \( C^h_t \) and \( C^f_t \) will depend on their relative prices. Given the CES specification for preferences\(^3\),

\[
\frac{C^h_t}{C^f_t} = \left( \frac{1 - \gamma}{\gamma} \right) \left( \frac{P^h_t}{P^f_t} \right)^{-\eta}
\]  

(4)

Use (1), (3) and (4), the optimal allocation of expenditures between domestic and foreign goods are given by,

\[
C^h_t = (1 - \gamma) \left( \frac{P^h_t}{P_t} \right)^{-\eta} C_t \quad \text{and} \quad C^f_t = \gamma \left( \frac{P^f_t}{P_t} \right)^{-\eta} C_t
\]  

(5)

The home consumer’s utility depends on the consumption of the composite good and on its labor supply. Assume the sum of discounted utility is given by,

\[
E_0 \sum_{t=0}^{\infty} \beta^t [U(C_t, N_t)] = E_0 \sum_{t=0}^{\infty} \beta^t \left[ \frac{C_t^{1-\sigma}}{1 - \sigma} - \frac{N_t^{1+\varphi}}{1 + \varphi} \right]
\]  

(6)

The home consumer’s intertemporal budget constraint can be written as,

\[
P_tC_t + E_t (Q_{t,t+1}D_{t+1}) \leq D_t + W_t N_t + T_t
\]  

(7)

where \( D_t, D_{t+1} \) are nominal value of security returns held by the consumer in period \( t \) and \( t + 1 \), and \( Q_{t,t+1} \) is the discount factor for nominal payoffs. \( W_t \) denotes for the nominal wage and \( T_t \) is the government taxes/transfers\(^4\). Under the assumption of complete international financial markets, all agents can buy and sell these securities at any time therefore net holdings of securities are zero in the steady state.

The intertemporal optimization of (6) subject to (7) yields the following first-order con-

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\(^3\) This is obtained by minimizing \( P^h_t C^h_t + P^f_t C^f_t \) for given level of \( C_t \).

\(^4\) It is worth noting that money appears neither in the budget constraint nor in the utility function. In most of the recent literature the money supply is assumed to be controlled by the central bank through the interest rate adjustment; hence, money is not introduced explicitly in the model. However, it can be viewed that there exists a money market which is always in equilibrium and the central bank continuously adjusts the money supply by open market operations to ensure that money supply equals money demand given shocks, and given the interest rate rule such as equation (52) below.
dition,

\[ C_t^\sigma N_t^\sigma = \frac{W_t}{P_t} \quad (8) \]

\[ C_t^{-\sigma} = \beta R_t E_t \left( \frac{P_t}{P_{t+1}} \right) C_{t+1}^{-\sigma} \quad (9) \]

Where \( R_t \) is nominal gross interest rate\(^5\) and (9) is the standard intertemporal Euler equation.

Let lower case letters denote the percentage deviation of the steady state variables. The log-linearization of (1), (3), (8) and (9) yields\(^6\),

\[ c_t = (1 - \gamma)c_t^h + \gamma c_t^f \quad (10) \]

\[ p_t = (1 - \gamma)p_t^h + \gamma p_t^f \quad (11) \]

\[ \varphi n_t + \sigma c_t = w_t - p_t^\pi \quad (12) \]

\[ c_t = E_{t} c_{t+1} - \frac{1}{\sigma} (i_t - E_t \pi_{t+1}) \quad (13) \]

Where \( \pi_t \equiv p_t - p_{t-1} \) is the CPI inflation of the home country (lower case letters denotes the variables in log form).

Let’s define terms of trade as the relative price of foreign goods in terms of domestic goods,

\[ \Delta_t \equiv \frac{P_t^f}{P_t^h} \quad \text{and} \quad \delta_t \equiv p_t^f - p_t^h \quad (14) \]

From (11) and (14), it can be shown that,

\[ p_t = (1 - \gamma)p_t^h + \gamma p_t^f = p_t^h + \gamma \delta_t \quad (15) \]

\[ c_t^f = -\eta \delta_t + c_t^h \quad (16) \]

\(^5\)Following Uhlig (1998), let’s denote \( \hat{x} \) as the percentage deviations of a variable \( x \) around its steady state, where \( x_t \equiv x^{ss}(1 + \hat{x}_t) \), the basic rules for log-linearization are: (1) \( \ln x = \ln x^{ss} + \ln(1 + \hat{x}) \approx \ln x^{ss} + \hat{x} \); (2) \( \Delta^\alpha = (x^{ss})^\alpha (1 + \hat{x})^\alpha \approx (x^{ss})^\alpha (1 + \alpha \hat{x}) \).\(^6\)I assume \( P_t^h = P_t^f \) in the steady state. For interest rates and inflation, the log-linearization formulas are: \( \ln R_t = \ln(1 + i_t) \approx i_t \) and \( \pi_t = \ln P_t/P_{t-1} = p_t - p_{t-1} \).\(^7\)Clarida, Galí and Gertler (2001) add a stochastic wage markup \( \mu_t^w \) to (12) to represent deviations from the marginal rate of substitution between leisure and consumption, so that, \( \varphi n_t + \sigma c_t + \mu_t^w = w_t - p_t \). They motivate this markup as arising from the monopoly power of labor suppliers who set wages as a markup over the marginal rate of substitution. The markup is assumed to be subject to exogenous stochastic variations known as supply side shocks. I don’t include the wage markup in (12) but assume there is an exogenous cost shock to the economy.
2.2 Domestic firms

Each firm in the home country produces a differentiated good with identical production functions given by,

\[ Y^h_t(i) = e^{\varepsilon_t} N_t(i) \]  

Let \( Y_t \equiv \left[ \int_0^1 Y_t(i)(i)^{1-\frac{1}{d}} di \right]^{\frac{1}{1-\gamma}} \) represents an index for aggregate output, similar to the one introduced for consumption. Note that \( N_t \equiv \int_0^1 N_t(i) di \), so in aggregate,

\[ Y^h_t = e^{\varepsilon_t} N_t \]  

which is the aggregate production function of the home country.

The firm’s marginal real cost is real wage divided by the marginal product of labour:

\[ MC_t = \frac{W_t}{e^{\varepsilon_t}} \]  

In terms of percentage deviations around the steady state, (19) becomes,

\[ mc_t = w_t - p^h_t - \varepsilon_t \]  

Assuming that firms set prices in a staggered way as in Calvo (1983), i.e., only of \( 1 - \theta \) randomly selected firms set new prices each period, Galí and Monacelli (2005) show that the optimal price setting strategy for a firm resetting its price in period \( t \) can be represented by the (log-linear) rule,

\[ \bar{p}^h_t = \ln \frac{\tau}{\tau - 1} + (1 - \beta \theta) \sum_{i=0}^{\infty} (\beta \theta)^i E_t(mc_{t+i} + p^h_i) \]  

Where \( \bar{p}^h_t \) denotes the (log) of newly set domestic prices. An analogous price setting rule obtains for firms in the foreign country.

Under the assumed price-setting structure, the dynamics of the domestic price index are described by,

\[ P^h_t = \left[ (1 - \theta) (\bar{p}^h_t)^{1-\gamma} + \theta (P^h_{t-1})^{1-\gamma} \right]^{\frac{1}{1-\gamma}} \]  

Galí and Monacelli (2005) show that the domestic inflation, which is \( \pi^h_t \equiv p^h_t - p^h_{t-1} \), can be rewritten by using (21) and (22) as,

\[ \pi^h_t = \beta E_t \pi^h_{t+1} + \kappa mc_t, \text{ where } \kappa = \frac{(1 - \theta)(1 - \beta \theta)}{\theta} \]  

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2.3 The foreign country

It is assumed that the foreign country is very large relative to the home country. This assumption implies that it is unnecessary to distinguish between consumer price inflation and domestic inflation in the foreign country, and that the domestic consumption and output in the foreign country are always equal. Let $c_t^h$ denote the foreign consumption of the good produced by the home country. The foreign country’s demand for the home country’s output depends on the terms of trade. Assuming the preferences are the same across countries (so demand elasticities are the same), similar to (16), it can be shown that (in terms of percentage deviations from the steady state values),

$$c_t^h = \eta \delta_t + y_t^f$$  \hspace{1cm} (24)

Where $y_t^f$ is the foreign output.

The Euler equation of foreign households is similar to the one of home country, given by (13), except that the foreign consumption and output are equal. So it gives,

$$y_t^f = E_t y_{t+1}^f - \frac{1}{\sigma} (i_t^f - E_t \pi_{t+1}^f)$$  \hspace{1cm} (25)

Denoting $r_t^f = i_t^f - E_t \pi_{t+1}^f$ as the foreign real interest rate (as deviations from the steady state), it gives,

$$r_t^f = i_t^f - E_t \pi_{t+1}^f = \sigma (E_t y_{t+1}^f - y_t^f)$$  \hspace{1cm} (26)

2.4 Equilibrium conditions

Equilibrium requires that domestic production and consumption (including goods consumed domestically and exported goods) are equal. For the home country, it implies that,

$$y_t = (1 - \gamma)c_t^h + \gamma c_t^{h*}$$  \hspace{1cm} (27)

In addition, from the assumption of complete international financial markets, uncovered interest rate parity holds,

$$E_t \Delta e_{t+1} = i_t^h - i_t^f$$  \hspace{1cm} (28)

where $e$ is the log of the exchange rate denoted as domestic currency per unit of foreign currency (DC/FC), so an increase in $e$ indicates exchange rate depreciation.

If the law of one price holds (PPP) holds\(^8\) such that $e_t = p_t^f - p_t^{f*}$, where $p_t^{f*}$ is the price

\(^8\text{If PPP holds, there is perfect exchange rate pass-through. This assumption can be relaxed by adding}\)
of imported goods denoted in foreign currency\(^9\), and use the definition of terms of trade in (14), plus (26), (28) can be rewritten as,

\[
i_t^h - E_t \pi_t^{h+1} = r_t^f + E_t(\delta_t + \delta_t)
\]

(29)

Where by definition, \(\pi_t^{h+1} = p_t^h - p_{t-1}^h\).

From (10) and (16) one can derive the aggregate consumption for home:

\[
c_t = c_t^h - \gamma \eta \delta_t
\]

(30)

Using (24) and (30), (27) can be written as,

\[
y_t = (1 - \gamma)c_t + (2 - \gamma)\gamma \eta \delta_t + \gamma y_t^f
\]

(31)

Using the Euler condition given by (13) to eliminate \(c_t\), plus the uncovered interest rate parity condition given by (29) and rearrange terms, the output for the home country can be solved as,

\[
y_t = E_t y_{t+1} - \left( \frac{1 + w}{\sigma} \right) \left[ i_t^h - E_t \pi_t^{h+1} - \left( \frac{w}{1 + w} \right) r_t^f \right], \text{ where } w = \gamma(\sigma \eta - 1)(2 - \gamma)
\]

(32)

2.5 Equilibrium dynamics: deviation from the flexible price equilibrium

If prices are sticky, output and terms of trade can differ from their flexible price equilibrium values (see the Appendix for a detailed description of the flexible price equilibrium). Define the output gap as,

\[
x_t \equiv y_t - y_t^0, \text{ where } y_t^0 \text{ is the level of output under flexible prices}
\]

(33)

Note that the real marginal cost, given by (20) \(mc_t = w_t - p_t^h - \epsilon_t\), is the gap between the real product wage and the marginal product of labor. (Note that all these variables are in log forms). When prices are sticky, the real wage can deviate from the marginal product

\(\star\)\(^9\)The PPP equation can also be written as: \(e_t = p_t^h - p_t^{h*}\), where \(p_t^{h*}\) is the price of exported goods in foreign currency to the foreign country. Since the foreign economy is large, we don’t differentiate between \(p_t^{h*}\) and \(p_t^{f*}\).
of labor. Under flexible wages, the real consumption wage is still equal to the marginal rate of substitution between leisure and consumption. Therefore using (12), one obtains,

\[ mc_t = [(\sigma + \varphi)y_t - \varphi \varepsilon_t + \gamma(1 - \sigma)\delta_t] - \varepsilon_t \]  

(34)

In the appendix I show that the (log) marginal product of labor, \( \varepsilon_t \), is equal to \( \varepsilon_t = (\sigma + \varphi)y_t^0 - \varphi \varepsilon_t + \gamma(1 - \sigma)\delta_t^0 \). Therefore substituting it into (34), it gives,

\[ mc_t = (\sigma + \varphi)x_t + \gamma(1 - \sigma)(\delta_t - \delta_t^0) \]  

(35)

Using (A5) in the Appendix that \( \delta_t^0 = \left( \frac{\sigma}{1 + w} \right) (y_t^0 - y_t^f) \), it is easy to show that \( (\delta_t - \delta_t^0) = \left( \frac{\sigma}{1 + w} \right) x_t \). The domestic inflation can be rewritten from (23) as,

\[ \pi_t^h = \beta E_t \pi_{t+1}^h + \kappa \left[ \sigma + \varphi + \left( \frac{\gamma \sigma(1 - \sigma)}{1 + w} \right) \right] x_t \]  

(36)

Where (36) is the so-called New-Keynesian Philips Curve (NKPC) under inflexible prices.

From (32) and (33), it can be shown that the output gap is,

\[ x_t = E_t x_{t+1} - \left( \frac{1 + w}{\sigma} \right) \left[ i_t^h - E_t \pi_{t+1}^h - \left( \frac{w}{1 + w} \right) r_t^f \right] + E_t y_t^0 - y_t^0 \]  

(37)

Where \( r_t^0 \) is the real interest rate under flexible price equilibrium given by (A4) in the appendix. Equation (37) may be called the New-Keynesian IS curve for the open economy.

### 3 Exchange rate responses to shocks: discretion versus commitment to certain rules

After describing the economy in a two-equation system given by (36) and (37), I can consider the problem of exchange rate variations to both supply and demand shocks. Kuttner and Posen (1999, 2000) show how the exchange rate responds to supply side shocks under central bank’s monetary policy targets, i.e., under discretion or under commitment to certain rules. While they use an aggregate Lucas-type supply function and an ad-hoc IS equation to close the model and only consider supply shocks, the exchange rate response in this study is to be derived through the general equilibrium model in the previous section with optimizing agents and profit-maximizing firms.
Let’s rewrite (28), the uncovered interest rate parity relationship, as
\[ E_t \Delta e_{t+1} = i_t^h - i_t^f \] (38)

The UIP equation can be iterated forward to yield:
\[ e_t = E_t \sum_{j=0}^{\infty} (i_{t+j}^f - i_{t+j}^h) + \hat{\epsilon} \] (39)

where \( \hat{\epsilon} \) is the long-run equilibrium exchange rate. An increase in the domestic interest rate will lead to a decrease in the exchange rate (an appreciation).

The long run relationship represented by PPP determines the long run equilibrium exchange rate \( \hat{\epsilon} \). Following Gali and Monacelli (2005), I obtain the following the relationship via PPP (in log term)
\[ \hat{\epsilon} = \lim_{j \to \infty} E_t (p_{t+j}^h - p_{t+j}^*)^{10} \] (40)

Where \( p^h \) and \( p^* \) are domestic and foreign price levels. Since \( \pi_t^h \equiv p_t^h - p_{t-1}^h \), this condition can also be expressed by the following,
\[ \hat{\epsilon} = p_{t-1}^h - p_{t-1}^* + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - \pi_{t+j}^*) \] (41)

Combining the equations of UIP and PPP, equation (41) becomes,
\[ e_t = E_t \sum_{j=0}^{\infty} (i_{t+j}^f - i_{t+j}^h) + p_{t-1}^h - p_{t-1}^* + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - \pi_{t+j}^*) \] (42)

This equation can provide us some intuition towards the exchange rate response to certain shocks under different policy regimes. For example, given that the foreign interest rate and foreign inflation are not changed, if there is a supply shock which increases domestic inflation, in the long run the exchange rate tends to depreciate due to higher inflation. If the central bank raises the interest rate to fight inflation, the exchange rate will appreciate. These two effects, when combined, mean the exchange rate can go in either direction, depending on the magnitude of shocks and interest rate changes. As it shows below, the exchange rate response can be different under central bank’s discretion or commitment policy.

\(^{10}p^*\) denotes for the foreign price level (in log term). Since the foreign country is relatively very large, its domestic inflation and CPI inflation are not differentiated.
3.1 Central bank’s optimal policy decisions and the exchange rate response

Assume that when supply shocks hit the economy the central bank faces a trade-off between minimizing the impact on inflation versus output. Depending on the weights attached to the trade-offs that the central bank chooses this will impact the volatility in the exchange rate. Suppose the central bank’s problem is to minimize the discounted sum of single-period loss functions of the form,

\[ \text{Min } E_0 \left[ \sum_{t=1}^{\infty} \beta^{t-1} (\pi_t^h + \lambda x_t^2) \right] \] (43)

Where \( \pi_t^h \) is the domestic inflation rate and \( x_t \) is the output gap, and without loss of generality I assume that the preferred inflation target is set to zero. The value of \( \lambda \) is the weight that the policy maker put on output stabilization and it is known to the public.

If the central bank’s primary objective is price stability (assumption of an inflation targeting framework is not essential), so when there is a supply shock which threatens price stability, it raises the interest rate to insure that the inflation objective is met. If the market believes that the central bank’s action is credible, i.e., that the interest rate increase is sufficient to deliver the inflation objective, expectations about the exchange rate will not be affected and the exchange rate remains fairly unchanged. Thus, in this framework, the central bank’s emphasis on price stability and the market’s confidence in the ability of the central bank to deliver its objective, reduce the short-term volatility in the exchange rate.

On the other hand, if the central bank follows an accommodative policy in an attempt to reduce the negative impact on output that an interest rate increase may imply, inflation expectations will increase leading to a depreciation of both the short-run and the long-run exchange rate and also causing volatility in the exchange rate.

From Section 2, I use the New-Keynesian Phillips Curve and New-Keynesian IS Curve to describe the economy, and these two equations are reproduced below,

\[ \pi_t^h = \beta E_t \pi_{t+1}^h + \hat{\kappa} x_t + \mu_t \] (44)

\[ x_t = E_t x_{t+1} - \frac{1}{\hat{\sigma}} [\pi_t^h - E_t \pi_{t+1}^h] + \psi_t \] (45)

where \( \hat{\kappa} = \kappa \left[ \sigma + \varphi + \left( \frac{\gamma \sigma (1 - \sigma)}{1 + w} \right) \right] \), \( \frac{1}{\hat{\sigma}} = \frac{1 + w}{\sigma} \).

I assume there is an exogenous but auto-correlated cost shock to the domestic economy, \( \mu_t = \rho \mu_{t-1} + \nu_t \), which is the counterpart of the wage markup specified in Clarida, Galí and Gertler (2001, 2002). Also, \( \psi_t = \left( \frac{1 + w}{\sigma} \right) r_t^0 = \rho \psi_{t-1} + \zeta_t \) denotes for the demand
side shocks to the IS equation through the real interest rate under flexible prices. \( \nu_t, \zeta_t \) are mean-zero, white noises with \( E_{t-1}\nu_t = E_{t-1}\zeta_t = 0 \).

Conditional on period \( t \) expectations of next period’s inflation, the central bank chooses the nominal short-term interest rate consistent with the real rate that would yield the desired combination of output and inflation. With auto-correlated shocks, the problem becomes a dynamic one\(^{11} \), and the policy maker must set \( i \) to minimize the discounted sum of the current and future loss functions.

The problem of monetary policy under discretion and commitment was raised first by Kydland and Prescott (1977), followed by Barro and Gordon (1983), King (1997) and Svensson (1997). Most recently, by using NOEM models Walsh (2006) show that under discretion, the central bank will only minimize the current period loss function subject to the NKPC in (44). This leads to the following optimal policy,

\[
\hat{\kappa}\pi_t^h + \lambda x_t = 0 \tag{46}
\]

Where both coefficients are positive. The monetary authority accommodates supply shocks by allowing them to affect inflation. Substituting (46) into (44), I can solve the first-order difference equation and get the expression for equilibrium inflation and output gap as,

\[
\pi_t^h = -\frac{\lambda}{\hat{\kappa}} x_t = \left( \frac{\lambda}{\lambda(1 - \beta \rho) + \hat{\kappa}^2} \right) \mu_t \tag{47}
\]

To derive how the exchange rate will respond to supply and demand side shocks under discrete monetary policy, by combining (45), (46) and (47), the short-term nominal interest rate can be solved as,

\[
i_t^h = \left[ \frac{\lambda \rho + (1 - \rho)\hat{\kappa}}{\lambda(1 - \beta \rho) + \hat{\kappa}^2} \right] \mu_t + \hat{\sigma} \psi_t \tag{48}
\]

The coefficients on both error terms are positive, indicating that an increase in interest rate is needed to reduce inflation, given a negative supply shock.

Now suppose there is a negative supply shock \( \nu_t = 1 \), which will initially introduce a positive inflation and a negative output gap. Using the UIP and long term PPP relationship derived in (42), and assuming that the shocks affect the domestic economy only such that the foreign interest rate and inflation are stable, the exchange rate response under discrete

\(^{11}\)Certainly the auto-correlated shock is not the only way to make this model dynamic, i.e., output persistence can also be introduced to add additional persistence, as Svensson (1997), Kuttener and Posen (1999,2000) did.
optimal monetary policy can be solved as

\[ e_{t+j} = - \left[ \frac{(\bar{\sigma} \hat{k} - \lambda)}{\lambda(1 - \beta \rho) + \hat{k}^2} \right] \rho^j + \left[ \frac{\lambda}{\lambda(1 - \beta \rho) + \hat{k}^2} \right] \frac{1 - \rho^j}{1 - \rho} \]  

(49)

The first term, which is negative\(^{13}\), comes from the interest rate differential and tends to appreciate the exchange rate, reflecting the increase in domestic interest rates used to fight inflation. The second term captures the long run effect of the shock on the price level and it will lead to a depreciation since expected inflation is higher under negative supply shocks. The overall effect can go either way, but in the long run the first term will eventually die out so the second term will dominate. Therefore in the long run an adverse supply shock will cause exchange rate depreciation.

Under commitment, if the central bank can commit to a rule that targets a constant inflation (without loss of generality, let’s assume the target is \( \pi^* = 0 \)), the optimal monetary policy is to minimize the discounted sum of loss functions as shown in (43). Walsh (2006) shows that under such a rule, the optimal decision rule is given by,

\[ \pi_t^h = \left[ \frac{\lambda(1 - \beta \rho)}{\lambda(1 - \beta \rho)^2 + \hat{k}^2} \right] \mu_t \]  

(50)

\[ x_t = - \left[ \frac{\hat{k}}{\lambda(1 - \beta \rho)^2 + \hat{k}^2} \right] \mu_t \]  

(51)

Similarly, I can derive the equilibrium nominal interest rate and the response of the nominal exchange rate to a unit of adverse supply shock as\(^{14}\),

\[ i_t^h = \left[ \frac{\lambda(1 - \beta \rho)\rho + (1 - \rho)\bar{\sigma} \hat{k}}{\lambda(1 - \beta \rho)^2 + \hat{k}^2} \right] \mu_t + \bar{\sigma} \psi_t \]  

(52)

\[ e_{t+j} = - \left[ \frac{(\bar{\sigma} \hat{k} - \lambda(1 - \beta \rho))}{\lambda(1 - \beta \rho)^2 + \hat{k}^2} \right] \rho^j + \left[ \frac{\lambda(1 - \beta \rho)}{\lambda(1 - \beta \rho)^2 + \hat{k}^2} \right] \frac{1 - \rho^j}{1 - \rho} \]  

(53)

Denoting \( \hat{\lambda} = \lambda(1 - \beta \rho) \), which is less than \( \lambda \), and comparing (53) to the exchange rate response (49) under discretion, it is quite straightforward that the first term is now larger (in absolute value), which represents a stronger appreciation effect under commitment to rules. Also the second term is smaller: \( \lambda(1 - \beta \rho) \) reflects the effect of lower expected future inflation on the exchange rate. The overall effect is that the exchange rate will depreciate less under

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\(^{12}\) A detailed proof is shown in the Appendix B.

\(^{13}\) I assume the central bank focus more on price stability such that \( \lambda \) is small and \( \bar{\sigma} \hat{k} - \lambda > 0 \). Even if \( \bar{\sigma} \hat{k} - \lambda < 0 \), the results on exchange rate volatility still hold. The simulation results are available upon request.

\(^{14}\) See also Appendix B for detailed calculation.
commitment than it does under discretion, indicating lower exchange rate volatility in both short run and long run.

What would happen if there are demand side shocks? Unlike supply shocks, demand shocks will not cause monetary policy trade offs since it always move the inflation and output gap in the same direction, e.g., a positive demand shock will increase the aggregate demand and cause inflation and a positive output gap simultaneously. Therefore an increase in interest rate would be sufficient to stabilize both inflation and output. From the above equations I can easily derive the exchange rate response under demand shocks. The exchange rate response will be the same for both discretion and commitment, i.e., a positive demand shock that \( \zeta_t = 1 \).

\[
e_{t+j} = -\hat{\sigma}_1 \rho^j (54)
\]

This indicates that the exchange rate tends to appreciate given a positive demand shock at period \( t \), and this effect will eventually die out in the long run.

3.2 Model calibrations

The exchange rate response can also be solved numerically by calibrating the model in the previous section. There are five parameters to be specified: \( \hat{\kappa}, \beta, \lambda, \hat{\sigma}, \) and \( \rho \). The discount factor, \( \beta \), is set equal to 0.99, as suggested by Walsh (2006). The weight on output gap fluctuations, \( \lambda \), is equal to 0.1, corresponding to a more conservative central bank (focus more on inflations)\(^{15}\). Jensen (2002) uses a baseline value of \( \hat{\kappa} = 0.1 \) for closed economy models, instead I use \( \hat{\kappa} = 0.2 \) for the open economy to capture the greater disturbance it faces. The coefficient of the NKIS, \( \hat{\sigma} \), is set to 0.9 and the shock persistence parameter, \( \rho \), is equal to 0.5.

Figure 1 and 2 give us the simulated impulse-response function for exchange rate given supply and demand side shocks. It is consistent to the arguments in previous section that the exchange rate will depreciate less under central bank’s commitment to certain rules compared to discretion. Furthermore, under commitment the exchange rate even appreciates a little during the first period, indicating that the effect of interest rate differentials dominates in the short run.

To summarize, the model in section 3 illustrates the exchange rate volatility under both supply and demand shocks. Compared to the pure discretion case, commitment to a rule

\(^{15}\)Jensen (2002), McCallum and Nelson (2000) use the value of 0.25 for \( \lambda \), but it doesn’t change the results except that exchange rates will depreciate since the first period when there is a negative supply shock. The intuition behind this is that if the central bank puts more weight on output gap, it will increase the interest rate less given a negative supply shock, therefore the appreciation of the exchange rate is modest.
by the central bank will transparently anchor future inflation expectations and reduce the inflation bias. Furthermore, under commitment the central bank becomes more conservative ($\lambda$ becomes $\hat{\lambda} = \lambda(1-\beta\rho)$), and it will raise the interest rate more to fight inflation. Therefore it produces a more stable exchange rate in both the short run and long run than it does under a discretionary policy, as indicated by calibration. It is worth noting that the real exchange rate volatility is not discussed in the model, but intuitively it should also be lower under commitment since the inflation will be more stable than under discretion.

4 Empirical evidence: GARCH Models

From the theoretical model laid out in the previous section it is clearly shown that monetary policy credibility helps to reduce exchange rate volatility. To test this intuition, I apply some GARCH models for four South-East Asian countries, which are Indonesia, Korea, Philippines and Thailand, and investigate the marginal impact of changing monetary policy framework and exchange rate regimes on exchange rate volatility. After the Asian Financial Crisis, all these four countries in this region adopted more flexible exchange rate regimes and employed the inflation-targeting monetary policy (see Table 1 for a summary). Therefore this transition provides us a good opportunity to examine the issue of exchange rate volatility under different monetary policy frameworks. Yet one difficulty to incorporate central banks’ credibility into empirical analysis is that there is no widely accepted measure for monetary policy credibility. Kuttner and Posen (2000) give certain criteria for the evaluation of central banks’ policy transparency, and provide an ordinal measure for the case of G3 countries, but I find it is difficult to apply it to South-East Asian countries due to lack of record and documentations. Alternatively, I use adoption of inflation targeting a proxy variable to indicate the credibility of monetary policy, in such a way that the central bank clearly announces its inflation target with enhanced communication to the public, which helps to build the central bank’s policy credibility.

Figures 3 and 4 report nominal and real effective exchange rate volatility by using 12-month rolling standard deviation. I find that all four countries exhibit a period of high exchange rate volatility during the Asian Financial Crisis, accompanied by large depreciation both in nominal and real terms. Indonesia suffered from the crisis with its exchange rate depreciating by over 50% and recorded the highest exchange rate volatility during this period. Unlike the other three countries, where the fluctuations in the economy reduced substantially after the crisis, the high volatility continued in Indonesia for several years since 1997, and the gap is not closing until recently. Figure 5 gives a closer look of the exchange rate volatility
after the crisis by using bilateral exchange rate with U.S. dollars and the Indonesia Rupiah still exhibits comparatively high volatility.

It has been shown that Figures 3, 4 and 5 capture clearly the degree of instability during and after the Asian crisis, as well as the changes in other social economic conditions such as the exchange rate regime and monetary policy target. The varying degree of exchange rate volatility displayed in these figures suggests that exchange rate volatility can be explained by GARCH models. While most GARCH-based empirical work on exchange rate volatility has ignored, both in the mean and variance equations, the potential role of alternative monetary policy regimes, Edwards (2006) argues that we should consider the impact of inflation targeting on exchange rate volatility while controlling the exchange rate regime. So the correct policy question is that whether the adoption of inflation targeting changes the exchange rate volatility, given that the exchange rate regime is controlled. Let’s consider the following GARCH(p, q) model for exchange rate volatility,

\[ \Delta \log E_t = \phi_0 + \sum \phi_j \Delta z_{t-j} + \text{CRISIS}_t + \eta_t \]  \hspace{1cm} (55)

\[ \sigma_t^2 = \alpha_1 \eta_{t-1} + \sum \alpha_i \eta_{t-i} + \sum \gamma_i \sigma_{t-i}^2 + \sum \delta_i y_i + \text{DIT}_t + \text{FLOAT}_t \]  \hspace{1cm} (56)

Where \( E \) is the nominal or real effective exchange rate; the \( z \)'s are variables that affect changes in the exchange rate, and may include lagged values of \( \Delta \log E_t \), as well as other domestic or international variables (in log difference), such as oil price, output gap, money supply and inflation; \( \eta_t \) are innovations to exchange rate changes, with zero mean and conditional variance \( \sigma_t^2 \). The \( y_i \) in equation (56), are variables other than past squared innovations or lagged forecast variance that help explain exchange rate volatility.

Additionally, in equation (55) there is a dummy variable \( \text{CRISIS} \) for the Asian Financial Crisis in 1997, which represents a structural change in the mean equation. In equation (56) two more dummy variables are included for each country: (1). \( \text{DIT} \), which takes the value of one after the country has implemented the inflation targeting policy, and zero otherwise. It is the variable used to control for monetary policy targets. By default, a value of zero means the country still targets the money aggregates with discretion. (2). \( \text{FLOAT} \), which takes the value of one after the country has a floating/managed floating exchange rate regime, and zero otherwise.

4.1 Data description

Four South-East Asian economies: Indonesia, Korea, Philippines and Thailand are included in the sample. The monthly data is from January 1990 to April 2007. All price series and
production indices are seasonally adjusted before estimation. The nominal and real effective exchange rate indices are defined such that an increase in the index implies domestic currency depreciation. As a monetary policy variable, base money (M0) is used for Korea, Philippines, and Thailand. Due to data availability, I alternatively use M1 for Indonesia. The output gap is obtained by applying the HP filter to the natural log of the industrial production index. The oil price is the US dollar based monthly average and I use monthly CPI index to denote inflation. The data sources for all variables are IMF, International Financial Statistics and CEIC Asia database.

Table 1 gives us a summary of current monetary policy and exchange regimes for each country. After the Asian crisis, many countries have adopted inflation targeting to stabilize the economy with a more flexible exchange rate arrangement. More specifically, Indonesia implemented inflation-targeting policy in July 2005, Korea in January 1998, Philippines in January 2002, and Thailand in May 2000. Accordingly, in these countries the exchange rate regimes have been changed to more flexible ones to complement this policy.

4.2 GARCH results

I estimated the GARCH model for each individual country with an inflation targeting policy. The selected results are reported by Table 2 and Table 3, for nominal and real effective exchange rates, respectively. First, the impact of monetary policy targets on exchange rate volatility is reflected by the coefficients of the dummy variable $\text{DIT}$ in (56). From both Tables 2 and 3 I find that the coefficients of $\text{DIT}$ are significantly negative for three out of four countries with the exception of Philippines, for which the coefficient is negative but not significantly different from zero for nominal exchange rate volatility$^{16}$. Overall, the negative coefficients of $\text{DIT}$ do indicate that the adoption of inflation targeting indeed reduces the exchange rate volatility in both nominal and real terms for most of the countries.

Second, the exchange rate regime also plays an important role in explaining exchange rate volatility. A negative coefficient on $\text{FLOAT}$ means that the shift from fixed to float exchange rate regime increases both nominal and real exchange rate volatility. For individual countries, Indonesia, Korea and Thailand show increased volatility after floating. Again Philippines does not have a significant coefficient in either table. Since keeping a fixed exchange rate successfully is another indicator of monetary credibility, it is not surprising that exchange rates become more volatile after floating due to the lack of nominal anchors as before. Somehow I do not give merit to fixed exchange rate regimes since not many countries

$^{16}$To address this problem, in next section there is additional argument about the effectiveness of inflation targeting.
manage to do so (see examples from Flood and Garber (1984), Flood, Garber and Kramer (1996)). Moreover, the overall benefit of a floating exchange rate regime is greater since the flexible exchange rate is well known as a "Shock Absorber". Finally, the Asian Financial Crisis contributes to large exchange rate depreciation in both real and nominal terms, as expected. Note that the variable of CRISIS only appear in (55) since it is assumed that the crisis affects the mean of the equilibrium exchange rate as a structural change but does not contribute to the volatility. Although I did robustness checks by adding it into the conditional variance equation, in most cases it is not significant.

4.3 The performance of inflation targeting policies

Inflation targeting is used as an indicator or proxy variable for monetary policy credibility in the above GARCH models. It is worth noting that in some cases even though the central bank announces such a policy, but does not implement it successfully or the inflation targets are not met, it might not enhance the credibility. Figure 6 examines the inflation target and actual inflation for these four countries, which are Indonesia, Korea, Philippines and Thailand, after they adopt inflation targeting. It shows that in Korea and Thailand the inflation is generally kept well within the target, compared to the large deviation from the target in Philippines. This can partially explain why the coefficient of inflation targeting is not significant for Philippines in both nominal and real exchange rate GARCH models since inflation targeting might not be a good indicator of credibility in this sense. For Indonesia, it seems that the inflation is slightly above the target since late 2005 due to the oil price increase. The Bank Indonesia (the central bank) adjusted the median target by 2% in 2006, reflecting the oil price changes. If core inflation which excludes the food and energy price is considered, it is still within the target.

5 Conclusion

This study examines exchange rate volatility in the content of monetary policy credibility and the central bank’s policy target. Using an open economy model with new Keynesian features, I show that exchange rate volatility is lower when central banks adhere to a commitment-of-rule based monetary policy (thus establishing credibility) vis-a-vis a discretion-based policy (when the market is left to guess the central bank’s reaction to a shock). I take inflation targeting as representing the former kind of policy and find a negative correlation between exchange rate volatility and the existence of inflation targeting regime, as confirmed by the
empirical evidence shown in GARCH models\textsuperscript{17}.

Of the four countries, Indonesia has the highest exchange rate volatility, although it has declined. In general, exchange rate volatility is affected by various factors, including both supply and demand side shocks, and how the central bank responds to them. As shown in section 3, commitment to certain rules by the central bank and successfully meeting these commitments (e.g. inflation targets under an inflation targeting framework) helps to build credibility and to reduce exchange rate volatility. For these countries recovering from the Asian crisis, if the central bank implements inflation targeting as envisaged, the volatility may decline further.

References


\textsuperscript{17}Thacker and Wang (2007) also attribute the difference in exchange volatility to the degree of central bank intervention or to market turnover (in terms of thinness of the foreign exchange market), while in this study I focus on the monetary side of the economy and explore the marginal effect of monetary policy credibility on exchange rate volatility.


Appendix

A  The flexible price equilibrium

Let’s denote the lower case letters as percentage deviations from the steady state level under the flexible price equilibrium. The flexible price equilibrium satisfies,

\[ y_t^0 = c_t^0 + \gamma \delta_t^0 \]  \hspace{1cm} (A1)

\[ \varepsilon_t = (\sigma + \varphi)y_t^0 - \varphi \varepsilon_t + \gamma (1 - \sigma)\delta_t^0 \]  \hspace{1cm} (A2)
Where (A1) is derived from balanced trade condition under flexible prices $P_t^h X_t^h = P_tC_t^0$, (A2) is from the labor market equilibrium (12) and the production function (18) when I equal the marginal product of labor to the real product wage (which implies the percentage deviation of the marginal cost, $mc_t$, is zero under flexible prices).

From (29), the real interest rate under flexible prices can be represented by,

$$r_t^0 = r_t - E_t \pi_{t+1}^h = r_t^f + E_t \delta_{t+1}^0 - \delta_t^0$$

(A3)

From (32), (A3) can be rewritten as,

$$r_t^0 = \left( \frac{\sigma}{1 + w} \right) (E_t y_{t+1}^0 - y_t^0) + \left( \frac{w}{1 + w} \right) r_t^f$$

(A4)

Under flexible price, all future expectations on the percentage deviations are zero, I can derive the terms of trade under flexible prices as,

$$\delta_t^0 = \left( \frac{\sigma}{1 + w} \right) \left[ (E_t y_{t+1}^0 - y_t^0) - (E_t y_{t+1} - y_t) \right]$$

(A5)

If substituting (A5) into (A2) to eliminate the terms of trade, one can get the flexible-price equilibrium output as,

$$y_t^0 = \frac{1 + \varphi}{\sigma + \varphi + \frac{\varphi(1-\sigma)}{1+w}} \left( y_t^0 + \left. \frac{\varphi(1-\sigma)}{1+w} \right) y_t^f \right)$$

(A6)

Therefore if the price is flexible, the output in the small open economy is linked to the productivity changes $\varepsilon_t$, as well as the foreign income effect $y_t^f$.

B The exchange rate response to shocks

To derive the exchange rate response to both supply and demand side shocks, I use the NKPC and NKIS equations to derive the equilibrium short term interest rate for given shocks, and then substitute it into the UIP and long run PPP relationship.

Under discretion, $\hat{\kappa} \pi_t^h + \lambda x_t = 0$, so it gives,

$$i_t^h = \left[ \lambda \rho (1-\rho) \sigma K \right] \mu_t + \hat{\sigma} \psi_t$$

(B1)
(B1) shows that an increase in interest rate is needed to reduce inflation, given a negative supply shock.

Now suppose there is a negative supply shock with \( \nu_t = 1 \), which will initially introduce a positive inflation and a negative output gap. If I assume that the shocks affect the domestic economy only such that the foreign interest rate and inflation are stable. Without loss of generality, we take foreign interest rate and price as numeraire and one can have,

\[
e_t = E_t \sum_{j=0}^{\infty} (i_{t+j}^* - i_{t+j}^h) + p_{t-1}^h - p_t^* + E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - \pi_{t+j}^*) = E_t \sum_{j=0}^{\infty} (\pi_{t+j}^h - i_{t+j}^h) + p_{t-1}^h \tag{B2}
\]

Substitute (B1) and the inflation relationship (47) into (B2),

\[
e_t = - \left[ \frac{(1-\rho)(\hat{\sigma} \hat{\kappa} - \lambda)}{\lambda(1-\beta \rho) + \hat{\kappa}^2} \right] E_t(\sum_{k=0}^{\infty} \mu_{t+k}) + p_{t-1}^h \tag{B3}
\]

Suppose the economy is in equilibrium at \( t - 1 \) before the shock occurs, given that the initial output gap \( x_{t-1} = 0 \), \( p_{t-1}^h = 0 \), \( \nu_t = 1 \) and \( E_t v_{t+1} = 0 \), it gives,

\[
e_t = - \left[ \frac{(\hat{\sigma} \hat{\kappa} - \lambda)}{\lambda(1-\beta \rho) + \hat{\kappa}^2} \right] \tag{B4}
\]

Similarly, by iterating forward, it gives,

\[
e_{t+j} = - \left[ \frac{(1-\rho)(\hat{\sigma} \hat{\kappa} - \lambda)}{\lambda(1-\beta \rho) + \hat{\kappa}^2} \right] E_t(\sum_{k=0}^{\infty} \mu_{t+k+j}) + p_{t+j-1}^h \tag{B5}
\]

\[
= - \left[ \frac{(1-\rho)(\hat{\sigma} \hat{\kappa} - \lambda)}{\lambda(1-\beta \rho) + \hat{\kappa}^2} \right] E_t(\sum_{k=0}^{\infty} \mu_{t+k+j}) + \sum_{j=0}^{j-1} \pi_{t+j-1}^h
\]

\[
= - \left[ \frac{(\hat{\sigma} \hat{\kappa} - \lambda)}{\lambda(1-\beta \rho) + \hat{\kappa}^2} \right] \rho^j + \left[ \frac{\lambda}{\lambda(1-\beta \rho) + \hat{\kappa}^2} \right] \frac{1-\rho^j}{1-\rho} \tag{B6}
\]

Which gives us (49), the exchange rate response given one unit of adverse supply shocks under discretion.

Under commitment to a rule, if comparing (50) and (51) to (47) one will find that everything in (50) and (51) remain the same except that \( \hat{\lambda} = \lambda(1-\beta \rho) \) is different from \( \lambda \). By substituting \( \hat{\lambda} = \lambda(1-\beta \rho) \) for \( \lambda \) into (B5), one can get (53).

Under demand side shocks such that \( \zeta_t = 1 \), if I substitute it into (B1) under both discretion and commitment the interest rate will be given by \( i_t^h = \hat{\sigma} \psi_t \). Using (B2), it gives,

\[
e_t = - \frac{\hat{\sigma}}{1-\rho} \text{ and } e_{t+j} = - \frac{\hat{\sigma} \rho^j}{1-\rho} \tag{B6}
\]

which yields (54).
Figure 1: Exchange rate response to one unit of negative supply shock

![Graph of exchange rate response to negative supply shock with two curves: Discretion and Commitment to certain rules.]

Figure 2: Exchange rate response to one unit of positive demand shock

![Graph of exchange rate response to positive demand shock with curves for Both discretion and commitment.]

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Figure 3: NEER monthly volatility: 1990-2006

Figure 4: REER monthly volatility: 1990-2006
Figure 5: Bilateral exchange rate volatility with U.S. dollar

Figure 6: Inflation targets and actual inflation
Table 1. Monetary policy and exchange rate regimes

<table>
<thead>
<tr>
<th>Country</th>
<th>Monetary policy regime</th>
<th>Exchange rate regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>Inflation targeting (07/2005)</td>
<td>Managed float (07/1997)</td>
</tr>
<tr>
<td>Thailand</td>
<td>Inflation targeting (05/2000)</td>
<td>Managed float (07/1997)</td>
</tr>
</tbody>
</table>

Note:
1. Exchange rate regimes are de facto.
Source: “De Facto Classification of Exchange Rate Regimes and Monetary Policy Framework”, IMF, 2006

Table 2. GARCH estimates: Nominal exchange rate volatility, selected results
(Monthly data: 1990:1-2007:4)

<table>
<thead>
<tr>
<th>Country</th>
<th>GARCH</th>
<th>CRISIS</th>
<th>DIT</th>
<th>FLOAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>(0,1)</td>
<td>0.028**</td>
<td>-5.870e-04**</td>
<td>4.820e-04**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(4.960)</td>
<td>(-2.603)</td>
<td>(2.128)</td>
</tr>
<tr>
<td>Korea</td>
<td>(1,1)</td>
<td>0.026**</td>
<td>-1.307e-03**</td>
<td>1.324e-03**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(11.196)</td>
<td>(-12.338)</td>
<td>(10.977)</td>
</tr>
<tr>
<td>Philippines</td>
<td>(1,1)</td>
<td>0.039**</td>
<td>-8.125e-05</td>
<td>9.480e-05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(9.369)</td>
<td>(-1.060)</td>
<td>(1.578)</td>
</tr>
<tr>
<td>Thailand</td>
<td>(1,1)</td>
<td>0.032**</td>
<td>-4.960e-04**</td>
<td>4.920e-04**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.641)</td>
<td>(-21.103)</td>
<td>(27.244)</td>
</tr>
</tbody>
</table>

Note:
1. The numbers in brackets are z-statistics.
2. “**” indicates significance at 5 percent, “*” for 10 percent.

Table 3. GARCH estimates: Real exchange rate volatility, selected results
(Monthly data: 1990:1-2007:4)

<table>
<thead>
<tr>
<th>Country</th>
<th>GARCH</th>
<th>CRISIS</th>
<th>DIT</th>
<th>FLOAT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indonesia</td>
<td>(1,0)</td>
<td>0.090**</td>
<td>-5.611e-03**</td>
<td>5.543e-03**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.310)</td>
<td>(-38.665)</td>
<td>(130.10)</td>
</tr>
<tr>
<td>Korea</td>
<td>(1,1)</td>
<td>0.024**</td>
<td>-1.995e-03**</td>
<td>1.997e-03**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(10.454)</td>
<td>(-16.523)</td>
<td>(18.032)</td>
</tr>
<tr>
<td>Philippines</td>
<td>(2,1)</td>
<td>0.027**</td>
<td>-1.180e-04**</td>
<td>4.330e-05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(5.114)</td>
<td>(-1.878)</td>
<td>(0.703)</td>
</tr>
<tr>
<td>Thailand</td>
<td>(1,1)</td>
<td>0.024**</td>
<td>-8.210e-04**</td>
<td>8.160e-04**</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(3.675)</td>
<td>(-5.333)</td>
<td>(5.259)</td>
</tr>
</tbody>
</table>

Note:
1. The numbers in brackets are z-statistics.
2. “**” indicates significance at 5 percent, “*” for 10 percent.