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Inflation Targeting in a Small Open Economy: a Challenge to Monetary Theory

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The opinions expressed in this discussion paper are those of the author(s)
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Abstract

This paper aims to address the role of exchange rate under inflation targeting as a practical challenge to modern monetary policy facing a central bank in a small open economy – with a particular focus on Thailand. Monetary theory and empirical evidence have provided conflicting policy recommendations regarding the role of exchange rate under inflation targeting. In theory, the objective of monetary policy could be achieved by a single policy instrument – interest rate. Exchange rate is endogenous to the change in policy rate through UIP condition and plays only subsidiary role as a channel through which the policy rate can transmit. The paper proves that, in practice, the linkage between interest rate and exchange rate is weak as evident in the failure of UIP, while exchange rate movement is found to have an important implication on output but not so much on inflation. Therefore, exchange rate may be used as another policy instrument to complement interest rate. The optimal blend between the use of interest rate and exchange rate is an important practical challenge to a small open economy under inflation targeting.

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1. Introduction

Monetary theory addressed the problem of inflationary bias arising from temptation to stimulate the economy in the short-run. Several propositions have been made in attempts to solve the inflationary bias and among them was inflation targeting. Inflation targeting has gained increasing popularity amongst developed and developing countries alike. Monetary policy implementation under inflation targeting framework employs only interest rate as a single instrument to achieve the objective of monetary policy. The role of exchange rate is only supplemental. Exchange rate acts as a channel through which the policy rate can transmit and exchange rate is assumed to be determined by interest rate differentials. In practice, however, achieving the monetary policy objective with only one instrument is further complicated, especially in the case of a small open economy.

This paper aims to address the role of exchange rate under inflation targeting as a practical challenge to modern monetary policy facing a central bank in a small open economy – with a particular focus on Thailand. In the first Section, we will provide a brief overview of relevant framework for monetary theory to set a stage for further analysis. Based on the Thai economy, of which background is reviewed in Section 2, Section 3 tests the validity of uncovered interest parity (UIP) to verify the linkage between the policy instrument and exchange rate. Then, to examine the role of exchange rate in practice, empirical work on inflation dynamics is carried out followed by an investigation into the impact of exchange rate movement on output. Having done so, the empirical results will serve as a basis for policy implications and conclusions will then be drawn.

2. The theoretical framework of monetary policy and the role of exchange rate

2.1 Background

The root of modern monetary policy can be traced as far back as Friedman (1968), Kydland and Prescott (1977) and Barro and Gordon (1983) in the debate of rule versus discretion. They concluded that practicing rule was clearly a first-best solution to eliminating inflationary bias, which arose from the temptation to stimulate short-run expansion of output under discretion. The rule, however, had its own shortcomings in practicalities, thus subsequent literature focused on finding legitimate solutions to the problems of inflationary bias.

The development came in various forms and the prominent ones are conservative central bank (Rogoff, 1985), inflation contract (Walsh, 1995) and inflation targeting (RBNZ, 1989). These subsequent developments offered a similar message in that, to eliminate or minimise inflationary bias, monetary policy should be taken away from the hands of politicians and become the sole responsibility of an independent central bank, who is assigned/proposes a particular set of goals. In an analysis of a simple closed economy, the framework upon which analyses were based comprised the following basic elements: the loss function, aggregate supply function (the Phillips curve), IS curve, LM curve. In an open economy, exchange rate was endogenously determined by interest rate via Uncovered Interest parity condition (UIP). Given these basic elements, optimised reaction function of interest rate to output and inflation could be solved for.

2.2 Inflation targeting and importance of exchange rate in theory

Inflation targeting emerged as a practical solution to inflationary bias problems. In a similar fashion to traditional set-out framework, for an open economy, the framework consists of a few core equations,¹ the dynamics of each equation differs from one literature to another but normally the basic structure and variables are not dissimilar. The rationales and details of each equation are given in Appendix. To summarise, the theoretical framework comprises the followings:

$$\text{Loss function: } L = E_t \sum_{j=0}^{\infty} \beta^j \left\{ \lambda_{\pi} (\pi_{t+j} - \pi_{t+j}^*)^2 + \lambda_y (y_{t+j} - y_{t+j}^*)^2 \right\}$$

$$\text{AS: } \pi_t = \alpha \pi_{t-1} + (1 - \alpha) E_t \pi_{t+1} + \phi_y y_{t-1}^g + \phi_q \Delta s_{t-1}$$

$$\text{IS: } y_t^g = E_t y_{t+1}^g - \frac{1}{\eta} (i_t - E_t \pi_{t+1} - dr) + \delta \Delta s_{t-1}$$

$$\text{LM: } m_t - p_t = \gamma_i - \phi_i i_t + \varepsilon_{mt}$$

$$\text{UIP: } \Delta s_{t,t+1} = (i_t - i_t^*)$$

Theoretically, the loss function is optimised subject to AS, IS, LM and UIP, taken as a summary of economic structure captured by macroeconomic model. The theory suggests that the policy interest rate will be adjusted to achieve the policy objectives –

¹ Adapted from Batini and Nelson (2000), Batini and Haldane (1999), Ball (1999), Batini and Haldane (1999), McCallum and Nelson (1999) and Svensson (1997)

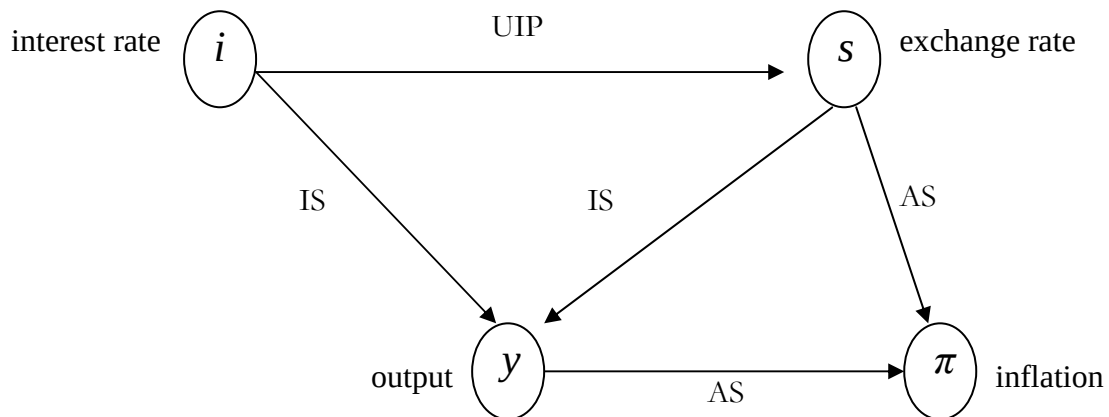
minimal deviations of inflation and output from their respective targets. Therefore, the policy instrument – interest rate – reacts to inflation (actual/forecasted) and output (actual/forecasted); some may also include lagged interest rate to account for gradual adjustments of interest rate, and some open economy versions of the reaction function include exchange rate.

Reaction function:

$$i_t = \chi(\pi_{t+i} - \pi^*) + \mu(y_{t+i} - y^*)$$

According to the theoretical framework, it is clear that the two objectives of monetary policy, inflation and output, are determined by interest rate and exchange rate. Interest rate has a direct impact on output and indirect impact on inflation via output and exchange rate. While exchange rate is one of the factors that drive output and inflation, it is endogenously determined by interest rate.

Chart 1: The impact of interest rate and exchange rate on output and inflation



The role of exchange rate under inflation targeting has been played down by its endogeneity, thus represents only one channel through which the changing policy instrument can be transmitted to the real economy via its appearance in IS and AS equations. Theoretically under inflation targeting with free flows of capital, exchange rate policy is only supplemental and endogenously determined by the decision on the policy interest rate through UIP via interest rate differentials. Interest rate is the only viable instrument for monetary policy conduct according to the monetary theory.

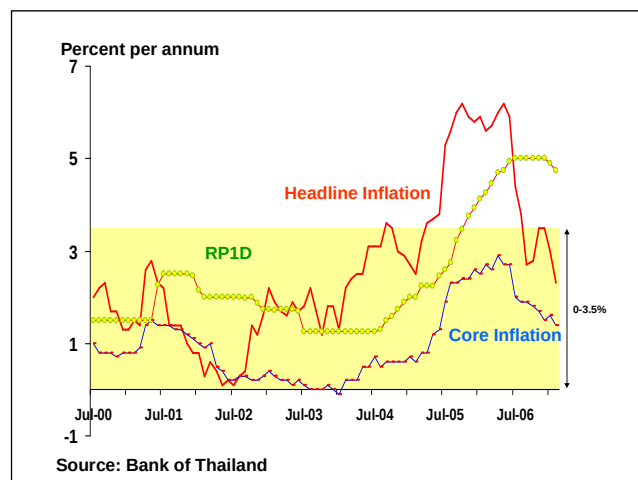
In Section 4, we will conduct an empirical investigation into the determination and the role of exchange rate to verify whether the theoretical form of inflation targeting can be taken at face value.

3. Thailand under inflation targeting

Thailand has adopted flexible inflation targeting since May 2000. Under flexible inflation targeting, the emphasis has been given to maintaining core inflation within the target range such that the economy can grow along a sustainable path in the long run. The 1-day repurchase rate² is used as a policy instrument to keep quarterly average of core inflation within the target range of 0-3.5 percent. If inflationary pressure heightens and thereby increases the possibility of core inflation breaching the target, interest rate would be raised. Bearing in mind a time lag of 4-8 quarters before a change in the policy rate can be fully transmitted to the rest of the economy, policy consideration needs to be forward-looking.

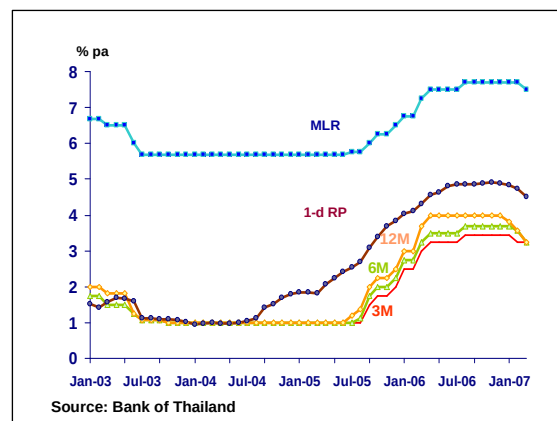
Chart 2: Policy rate and inflation

Upward inflationary pressure over the past few years, due to higher oil prices, has been tamed partly by pre-emptive monetary tightening. The monetary policy committee raised the policy rate 13 times between August 2004 and June 2006, bringing the policy rate to 5.00 percent from 1.25 percent per annum. Hikes in the policy rate have effectively brought the money market and commercial bank interest rates higher over the past 2 years. The policy response proved timely and effective, with inflation and its second round effects well contained.



² For practical reasons, 1-day repurchase rate has replaced 14-day repurchase rate, which was used as a policy instrument between May 2000 and 17 January 2007.

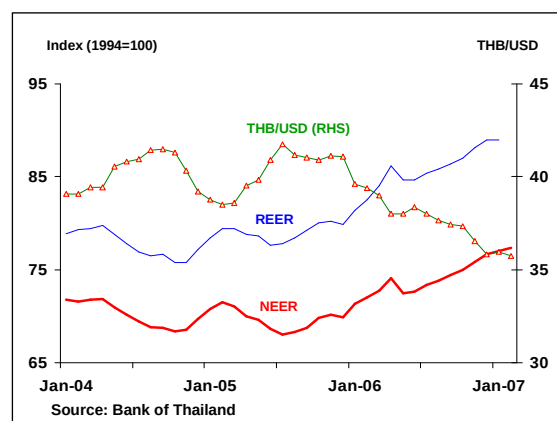
Chart 3: Policy rate and commercial bank interest rates



Recently, domestic demand, particularly private consumption and investment, showed signs of a slowdown while economic momentum from exports was expected to moderate, given the prospects of the global economy in 2007. Since inflationary pressures have subsided in line with easing energy prices, monetary policy could be eased in support of a

further expansion of the economy. The MPC, thus, lowered the 1-day repurchase rate, the policy rate, to 4.75 on 17 January meeting and a further 25 basis points reduction on 28 February and is expected to pursue a downward path of interest rate in a cautious manner. This accommodative monetary policy stance will help stimulate domestic demand by supporting economic sentiments, cutting down financial costs and preparing a stage for private investment recovery once confidence has returned, most likely in the latter half of this year.

Chart 4: THB/USD, NEER and REER



The strength in the Thai baht over the past year, both against US dollar and in effective terms, raised concerns over the country's competitiveness. In theory, under inflation targeting, exchange rate is largely determined by the policy rate and should be left to its own dynamics. However, in practice exchange rate is by all means of greater significance and its

determination is more complex than the theory suggests. The following section will examine exchange rate in relation to monetary policy.

4. Determination and role of exchange rate in practice

In this section, we follow on from the theoretical framework set out in Section 2 with regard to the determination of exchange rate and its role. First of all, the theoretical framework assumes that exchange rate is endogenous and being determined by the policy instrument, i.e. interest rate via UIP condition. The validity of UIP condition is tested to verify the linkage between the policy instrument and exchange rate or the effectiveness of exchange rate channel of transmission mechanism. We then test the role of exchange rate by examining inflation dynamics and find out whether exchange rate movement is effectively transmitted into changes in inflation. Finally, in this empirical section, the impact of exchange rate on real output is examined via a form of IS curve.

4.1 Empirical evidence on uncovered interest parity (UIP)

4.1.1 Background

The assumption of UIP is an important foundation for macroeconomic analysis of open economies.³ According to Isard (2006), the case for intervention depends on whether the empirical evidence rejects UIP. If UIP is valid at short time horizons, official intervention will not succeed at changing the spot rate relative to the expected future rate, unless the interest rate is allowed to change.

Closely related to UIP is Covered Interest Parity (CIP) condition. CIP is the condition following the assumption of arbitrage between spot and forward foreign exchange. Abstracting from risk, the ratio of the forward to the spot exchange rate will equal the interest differential between domestic and foreign assets of similar characteristics. After a simple mathematical manipulation, we have

$$f_{t,t+k} - s_t = (i_{t,k} - i_{t,k}^*)$$

where s_t is (natural) logarithm of S , which is the price of foreign currency in units of domestic currency at time t . $f_{t,t+k}$ is (natural) logarithm of the forward value of S for a contract expiring at time $t+k$. $i_{t,k}$ and $i_{t,k}^*$ are the k -period yield on domestic and foreign asset respectively.

The CIP is used as a rule of trade for actual traders in the foreign exchange market,⁴ which is one of the main reasons why it gains empirical support.

³ Derivation of UIP from CIP is based on Chinn and Meredith (2004)

⁴ Levich (1985)

To the extent that investors are risk-averse, the forward rate can differ from the expected future spot rate by a premium to compensate for the perceived riskiness. Given $s_{t,t+k}^e$ is the expectation of s_{t+k} at time t and $risk_{t,t+k}$ is the risk premium. We have the followings:

$$f_{t,t+k} = s_{t,t+k}^e + risk_{t,t+k}$$

We can then derive UIP of the form:

$$\Delta s_{t,t+k}^e = (i_{t,k} - i_{t,k}^*) - risk_{t,t+k}$$

This is UIP in a risk-adjusted form. UIP is, thus, a more dynamic form of CIP, which involves variables such as expectations, which could not be tested easily. The validity of UIP cannot be tested directly due to limited availability of data on exchange rate expectations. Adjustments are then made to allow empirical verification.

Under rational expectations, $s_{t,t+k}^e = s_{t+k} + \omega_{t,t+k}$ we have:

$$\Delta s_{t,t+k} = (i_{t,k} - i_{t,t+k}^*) - risk_{t,t+k} + \omega_{t,t+k}$$

The realised change in exchange rate from t to $t+k$ is equal to interest rate differential adjusted by risk premium.

The common regression equation used to test the validity of UIP is of the form:

$$\Delta s_{t,t+k} = \alpha + \beta(i_{t,k} - i_{t,k}^*) + \varepsilon_{t,t+k}$$

Empirical assessment of UIP as a framework to predict future exchange rate normally addresses two issues: the size of predictive errors and whether the predictions are systematically biased.⁵ On the first issue, several literature suggested that interest differentials account for only a small proportion of subsequent exchange rate movement and such movement is usually a consequence of information about economic conditions and policy. (See Frenkel, 1981) As for the second issue, the hypothesis of unbiasedness is to test whether $[\alpha, \beta]$ should equal $[0, 1]$.

The failure of UIP over the short time horizon is well-established (See, for example, Engle (1996), McCallum (1994), surveys by McDonald and Taylor (1992), Froot and Thaler (1990) and Hodrick (1987), also studies by Meese and Rogoff (1983)) while there is some evidence in support of UIP over a long horizon on longer-term maturity bonds, i.e. of 5 to 10 years (Chinn and Meredith (2004) and Alexius (2001)). The empirical investigation is mostly performed on US dollars vis-à-vis major currencies.

⁵ Isard *op. cit.*

4.1.2 Empirical evidence on Thailand

Relevant to our context, since UIP is the basic macroeconomic foundation regarding the determination of exchange rate in the conduct of monetary policy, it is imperative to test the validity of the UIP condition.

In this paper, UIP is tested using monthly data on 3-month and 1-year government bond yields for 10 countries and Thailand. The rationale behind selecting these maturities is the liquidity condition in the Thai government bond market, whereby bonds of maturity longer than 1 year are less liquid. As a consequence, interest rate on longer maturities may not reflect the underlying market conditions. The sample period is between 2000 and 2006. The data source on exchange rate of the baht vis-à-vis other currencies and interpolated bond yield is the Bank of Thailand, while the data on interest rates can be found on Bloomberg.

The following regression equation is tested:

$$\Delta s_{t,t+k} = \alpha + \beta(i_{t,k} - i_{t,k}^*) + \varepsilon_{t,t+k}$$

The data series on bond yields are transformed to account for the holding period of 3 months. If r_t is the current 3-month bond yield, $i_{t,t+3}$ is $(1+r_t)^{0.25}-1$.

The relationship can be tested. For a strict version of UIP, risk premium term is assumed away. Therefore, $[\alpha, \beta]$ should equal $[0, 1]$. Alternatively, allowing for a constant risk premium (risk) term, the hypothesis of $\beta=1$ is tested. Additionally, if the regression result rejects the hypothesis of $\beta=1$, we test the hypothesis of $\beta=0$, i.e. whether interest differential has an important bearing on the movement of exchange rate. Simple co-integration test by means of a unit root test on residuals is carried out to verify whether interest differential and the change in exchange rate do have a long-run relationship, and such relationship is not spurious or overwhelmed by omitted variables. Regression is estimated using OLS and Newey-West robust standard errors. If a *weak* form of UIP is valid, i.e. allowing for a constant risk premium term, all of the following conditions must be satisfied:

- 1) The hypothesis of $\beta=1$ is not rejected
- 2) The hypothesis of $\beta=0$ is rejected to confirm the significance of interest differentials
- 3) The relationship between exchange rate change and interest differential must be meaningful (i.e. not spurious), therefore, ADF test on residuals must be rejected.

Note: s_t is (natural) logarithm of S_t , which is the price of foreign currency in units of baht at time t , α represents the risk premium term and $i_{t,x}$ refers to annualised interest rate on x-month maturity. Data period is 2000-2006.

Table 1: Tests of UIP on Thai baht against other currencies (3-month maturity)^a

$\Delta s_{t,t+3} = \alpha + \beta(i_{t,3} - i_{t,3}^*) + \varepsilon_{t,t+3}$								
Country	α	β	F($\alpha=0$, $\beta=1$)	Condition 1) F($\beta=1$)	Condition 2) F($\beta=0$)	Condition 3) ADF test on ε	Adj- R ²	UIP Valid?
UK	0.004 [0.371]	1.534 [0.937]	0.069 (0.933)	0.106 (0.745)	0.877 (0.352)	(0.008)	0.002	× 2)
India	0.017 [1.406]	1.144 [0.860]	4.742 (0.012)	0.012 (0.914)	0.740 (0.393)	(0.010)	-0.001	× 2)
Japan	-0.029 [-3.050]	6.616 [3.962]	5.781 (0.005)	11.31 (0.001)	15.70 (0.000)	(0.063)	0.239	× 1) 3)
Korea	0.004 [0.600]	1.818 [1.547]	0.272 (0.763)	0.484 (0.489)	2.393 (0.127)	(0.000)	0.024	× 2)
Malaysia	0.008 [1.623]	0.923 [0.624]	1.344 (0.268)	0.003 (0.959)	0.390 (0.535)	(0.000)	-0.008	× 2)
Philippines	0.006 [0.547]	-0.305 [-0.342]	6.999 (0.002)	2.144 (0.148)	0.117 (0.733)	(0.000)	-0.013	× 2)
Singapore	-0.006 [-0.932]	4.458 [2.080]	1.569 (0.216)	2.604 (0.111)	4.327 (0.041)	(0.000)	0.065	√
US	0.009 [0.621]	1.858 [0.125]	0.339 (0.715)	0.003 (0.955)	0.016 (0.902)	(0.015)	-0.030	× 2)

^a t-values using Newey-West standard errors are within square brackets. p-values are within parentheses.

× i) refers to invalidity of UIP due to violation of condition i, √ refers to validity of UIP

Table 2: Tests of UIP Thai baht against other currencies (1-year maturity)^a

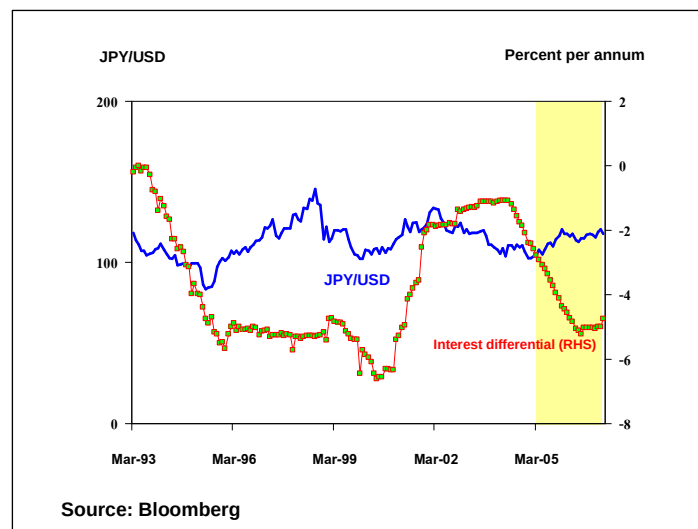
$\Delta s_{t,t+12} = \alpha + \beta(i_{t,12} - i_{t,12}^*) + \varepsilon_{t,t+12}$								
Country	α	β	F($\alpha=0$, $\beta=1$)	Condition 1) F($\beta=1$)	Condition 2) F($\beta=0$)	Condition 3) ADF test on ε	Adj- R ²	UIP Valid?
Australia	0.046 [0.983]	2.877 [1.892]	0.871 (0.423)	1.524 (0.221)	3.581 (0.063)	(0.399)	0.075	× 2) 3)
Euro	-0.014 [-1.238]	3.641 [2.705]	3.107 (0.051)	3.851 (0.054)	7.319 (0.009)	(0.078)	0.241	× 3)
UK	0.011 [0.457]	1.528 [1.674]	0.171 (0.844)	0.334 (0.565)	2.802 (0.099)	(0.138)	0.040	× 2) 3)
Japan	-0.087 [-3.704]	4.772 [4.488]	7.082 (0.002)	12.58 (0.001)	20.14 (0.000)	(0.150)	0.281	× 1) 3)
Korea	-0.046 [-1.492]	-1.070 [-0.886]	1.471 (0.237)	2.938 (0.091)	0.785 (0.379)	(0.264)	0.021	× 2) 3)
Malaysia	-0.002 [-0.028]	-0.876 [-0.468]	1.276 (0.286)	1.004 (0.320)	0.219 (0.641)	(0.126)	-0.004	× 2) 3)
Philippines	0.048 [1.725]	0.197 [0.724]	105.0 (0.000)	8.714 (0.004)	0.524 (0.471)	(0.315)	-0.007	× 1) 2) 3)
Singapore	-0.008 [-0.409]	0.510 [0.255]	0.719 (0.491)	0.060 (0.808)	0.065 (0.800)	(0.041)	-0.012	× 2)
US	0.037 [3.581]	3.837 [4.026]	8.355 (0.001)	8.861 (0.004)	16.21 (0.000)	(0.077)	0.471	× 1) 3)

^a t-values using Newey-West standard errors are within square brackets. p-values are within parentheses.

× i) refers to invalidity of UIP due to violation of condition i, √ refers to validity of UIP

The regression results reject the validity of UIP condition in all cases except Singapore on 3-month maturity. Thus, UIP, even in its weak form, fails as a prediction framework for future exchange rate movement in the case of Thailand. The failure of UIP could be partly attributed to the underpinning assumptions. For UIP condition to hold true, capital must be able to move freely between countries under freely floating exchange rate. Both assumptions are not valid given certain degree of capital controls and exchange rate manipulation – both on the sending and receiving ends.

Chart 5: Japanese Yen and interest rate

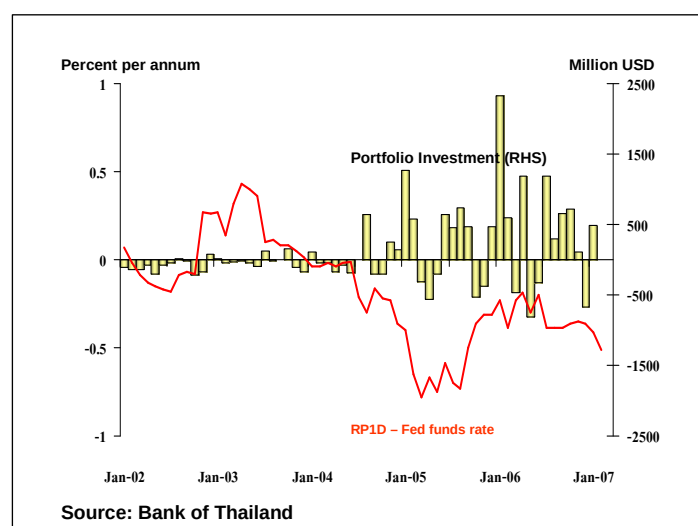


Evidence against UIP condition on an international scale can be seen from Yen carry trade. Investors or speculators borrow in currency with lower interest rate and invest in foreign denominated financial assets, which yield higher returns. The most common funding currency is Japanese Yen since the interest

rate on Yen-denominated assets has been low over the past years. According to UIP, exchange rate should adjust so that no profits can be gained, thus, Japanese Yen should have appreciated. However, over 2005-6, Japanese Yen has depreciated and arbitrage opportunity exists, whereby, speculators gain from interest differential along with further gain from Yen depreciation.

Furthermore, the coefficient β is found insignificant in most cases, which means that interest differential does not have a statistically significant impact on exchange rate. In the case where it is significant, the relationship proves to be spurious. Such findings deserve further investigations. The investigation will be based on the linkage between interest rate and exchange rate, which requires two necessary conditions: i) interest differential has a significant impact on capital flows and ii) capital flows have an important implication on exchange rate movements.

Chart 6: Interest differential and portfolio investment



On the first condition, capital flows to seek the highest return, in the form of yields on assets, i.e., interest rate. If interest differential (defined here as domestic less foreign interest rate) decreases, capital should flow out to acquire better returns abroad.

However, from the Thai experience, capital flows⁶ do not move consistently with interest differential. (See Chart 6) Between 2003-2005, interest differential continuously decreased while capital inflow was on a rise.

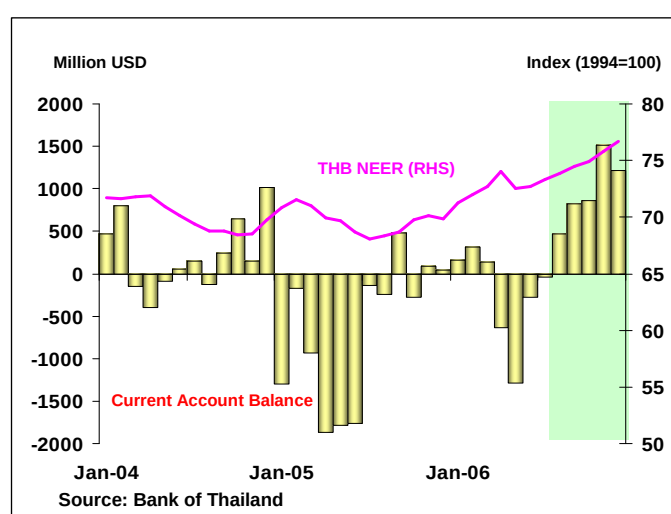
Interest rate was clearly not a single factor on investors' mind. Confidence and risks factor in as importantly. A good example was Emerging Market Risk Aversion in mid-2006 and beginning of 2007, whereby, emerging market faces capital outflows as foreign investors diverted from their exposures in high returns but riskier assets in emerging markets to more liquid assets in major markets. The incident was driven by concerns over rapid accumulation of exposure to emerging market economies while the spread between emerging market and major markets was considered insufficient to cover for the risks.

Another important factor is expectation of exchange rate movements. Movements in exchange rate have an important bearing on the overall returns of capital flows. If investors expect an appreciation in the baht, regardless the rate of interest, they will invest in Thai financial markets. Once the baht appreciates, the investment will yield returns both in terms of interest rate and exchange rate gain. Such investment was evident in 2006 and apparently contradicted the UIP condition, where arbitrage opportunity does not exist.

Since capital flows are sensitive to various factors, they are highly volatile despite no or small changes in interest differentials.

Chart 7: Exchange rate and current account balance

On the second condition, exchange rate, which is the price of a currency, changes according to factors governing the demand and supply of the currency. Capital flow is only one amongst many important factors determining exchange rate. Capital inflows increase the demand for the currency, hence exerting upward pressure on the exchange

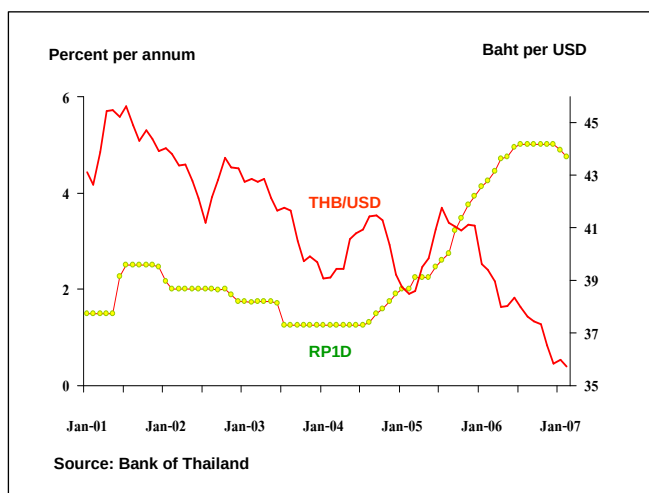


⁶ referred here to portfolio investment, since portfolio investment is more sensitive to interest rate than other types of capital flows.

rate. Setting capital flows aside, exchange rate over the recent years has been found to move in tandem with the current account. Large current account brings in foreign currency, increases the demand for Thai baht by exporters. In addition to the current account, Thai baht tends to move in the same direction as regional currencies over several years, albeit at different magnitude. This signifies the integration of the global financial market. The recent slide in the US dollar has caused regional currencies to appreciate across-the-board to different degrees. The co-movement in regional currencies may reflect common perceptions over regional economies, of which overall structure and development are not too dissimilar.

While capital flows depend on many factors, there are also various determinants of exchange rate, bearing in mind that no single factor could account for exchange rate movements at all times. This does not imply that interest rate has no effects on exchange rate. The impact of interest rate on exchange rate may have been overwhelmed by numerous other factors, which renders the relationship between interest rate and exchange rate weaker than the theory suggests.

Chart 8: Policy rate and THB/USD



On this issue, the past movement of the baht and the recent sharp appreciation provides some evidence. From Chart 8, during 2001-2003, the policy rate was continuously lowered but the baht was on an appreciating trend, while in 2006, interest rate cycle has peaked in July, the baht, both in bilateral and effective terms,

continued to appreciate due mainly to capital flows and current account surplus regardless of the relatively higher interest rate.

4.2 Empirical evidence on exchange rate passthrough

Under inflation targeting, the Bank of Thailand has a mandate to achieve inflation target. Since, the policy rate does not significantly affect exchange rate, the traditional exchange rate channel of monetary policy transmission mechanism is

somewhat muted. It is of concern, therefore, whether adverse movements in exchange rate will affect forecasted inflation – the intermediate target under inflation targeting regime. The degree of passthrough from exchange rate to inflation will be tested in this section.

According to the theory set out earlier, inflation is determined by the following relationship:

$$\pi_t = \alpha\pi_{t-1} + (1-\alpha)E_t\pi_{t+1} + \phi_y y_{t-1}^g + \phi_q \Delta s_{t-1}$$

Empirical estimates⁷ over 1996-2006 yield:

A1) with THB/USD (*s*)

$$\pi_t^{headline} = 0.001 + 0.267\pi_{t+1}^{headline} + 0.250\pi_{t-1}^{headline} + 0.005y_{t-1}^g + 0.024\Delta s_{t-1}$$

[2.962] [4.272] [2.798] [0.552] [1.074]

Adjusted-R²: 0.219 DW: 2.525 S.E. of regression: 0.004

A2) with NEER

$$\pi_t^{headline} = 0.001 + 0.272\pi_{t+1}^{headline} + 0.261\pi_{t-1}^{headline} + 0.004y_{t-1}^g - 0.026\Delta neer_{t-1}$$

[2.970] [4.477] [3.113] [0.511] [-0.878]

Adjusted-R²: 0.210 DW: 2.541 S.E. of regression: 0.004

Empirical estimates based on the theoretical form of inflation dynamics found no significant contribution to inflation from exchange rate. It could be argued that, theoretical equation on inflation remotely mimics the actual inflation dynamics. Some adjustments are then made to the theoretical equation to better reflect reality. We take into account monetary growth to factor in the policy effects on inflation and producer price inflation, which captures the cost of production in determining headline inflation. Output gap⁸ is found to be closely related to monetary growth and thus becomes statistically insignificant. Both bilateral exchange rate (THB per USD) and nominal effective exchange rate⁹ (NEER) have been included in the equation in turns. Using general-to-specific approach and judgments in line with economic theory, the following equation is found best-fitted for the Thai economy:

$$\pi_t^{headline} = \theta_0 + \theta_1\pi_{t-1}^{headline} + \theta_2\Delta m2_{t-2} + \theta_3\Delta s_t + \theta_4\pi_t^{producer}$$

⁷ without restrictions on the coefficients

⁸ Estimated by the deviation of manufacturing production index (MPI) relative to its Hodrick-Prescott trend

⁹ Trade-weighted average of 21 currencies

Estimation over 1996-2007 yields:

B1) with THB/USD (s)

$$\pi_t^{headline} = 0.001 + 0.153\pi_{t-1}^{headline} + 0.096\Delta m2_{t-2} - 0.010\Delta s_t + 0.245\pi_t^{producer}$$

[2.113] [2.187] [2.599] [-1.108] [7.595]

Adjusted-R²: 0.424 DW: 1.801 S.E. of regression: 0.003

B2) with NEER

$$\pi_t^{headline} = 0.001 + 0.152\pi_{t-1}^{headline} + 0.094\Delta m2_{t-2} + 0.016\Delta neer_t + 0.249\pi_t^{producer}$$

[2.140] [2.182] [2.522] [1.441] [7.792]

Adjusted-R²: 0.428 DW: 1.809 S.E. of regression: 0.003

Apparently, exchange rate in both cases are not statistically significant at 5% significant level. Since the regression results could be sensitive to the time period over which the equation is estimated, rolling regression (with 36 months rolling window) is then used to detect changes in the coefficient on exchange rate, if so exists.

Chart 9: Coefficient on exchange rate and 95% confidence interval

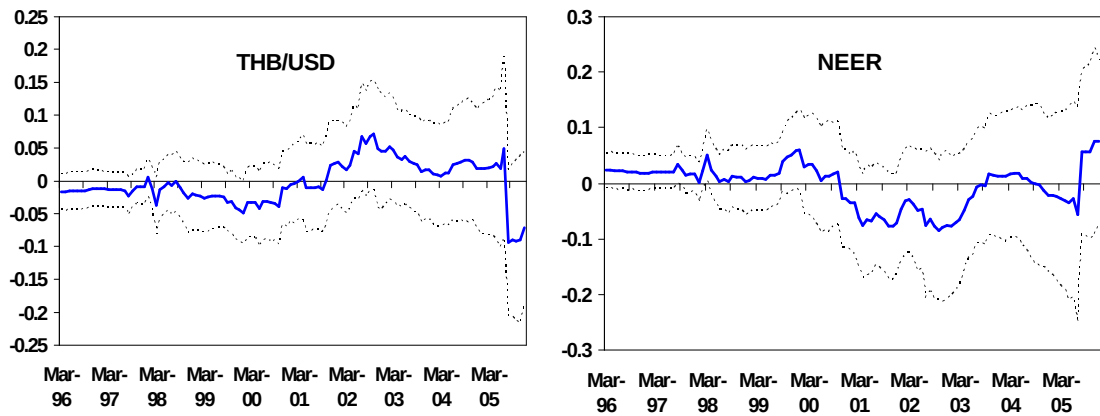


Chart 9 suggests, regardless the time period over which the equation is estimated, the coefficient on exchange rate is not significantly different from zero. This implies a subdued role of exchange rate in determining inflation. Thus, exchange rate passthrough is rather muted.

4.3 Importance of exchange rate to growth

According to the theory, exchange rate is a component in the IS equation, where output is determined. We estimate here an IS equation to find out whether exchange rate does have an impact on the real economy. General-to-specific approach suggests the following IS equation:

C1) with THB/USD (s)

$$y_t^g = 0.002 + 0.593y_{t+1}^g - 0.001(i_t - \pi_{t+1}) + 0.154\Delta s_{t-1}$$

[0.728] [7.346] [-0.857] [2.899]

Adjusted-R²: 0.388 DW: 2.503 S.E. of regression: 0.026

C2) with NEER

$$y_t^g = 0.002 + 0.594y_{t+1}^g - 0.001(i_t - \pi_{t+1}) - 0.164\Delta neer_{t-1}$$

[0.574] [7.165] [-0.716] [-3.172]

Adjusted-R²: 0.383 DW: 2.510 S.E. of regression: 0.028

The estimated result is not surprising, exchange rate can affect output via trade. As a small open economy, export contributes largely to economic growth. In 2006, the Thai economy grew at a satisfactory rate of 5 percent and substantial contribution came from export growth. (See Table 3)

Table 3: Contribution to growth of real GDP

	2006
GDP (Demand side)	5.0
Domestic Demand	3.0
- Private consumption	1.7
- Public consumption	0.3
- Gross fixed capital formation	0.9
Net Exports	4.8
- Exports of goods and services	5.7
- Imports of goods and services	0.9
Changes in inventories	-2.7

Source: NESDB

Table 4: Export elasticity

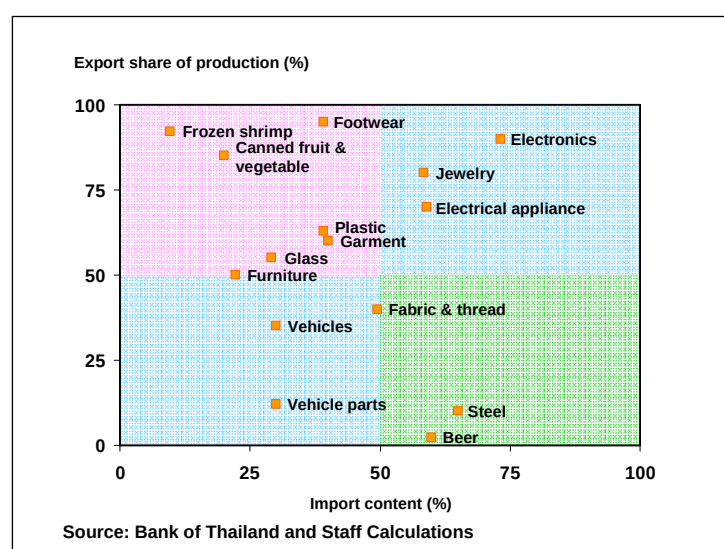
	Share of total export value	Elasticity (%)	
		Exchange rate	TPGDP
Agriculture	7.9%	0.36	0.65
Fishery	1.7%	0.05	0.53
Manufacturing	87.3%	0.07	1.44
Labour	8.5%	0.23	1.08
High tech	64.4%	0.07	1.79
Resource	9.9%	0.01	0.29
Total export		0.10	1.44

Source: Staff calculations

Export is largely determined by trading partners' GDP (TPGDP) and the price factor. The direct effect of exchange rate on export performance can be measured by

elasticity of export to exchange rate, which varies for different products. Exports of agricultural and labour-intensive manufacturing products are more sensitive to exchange rate than high-tech manufacturing, as clearly evident in higher elasticity to exchange rate, 0.36 and 0.23 compared to 0.07 (Table 4) due largely to the degree of competition in the world market. Besides the degree of competition, the sensitivity of sectoral performance to exchange rate also depends on production structure. (See Chart 10) The recent appreciation in the baht has asymmetric impact on different sectors in the real economy.

Chart 10: Import-content and export-orientation by sector



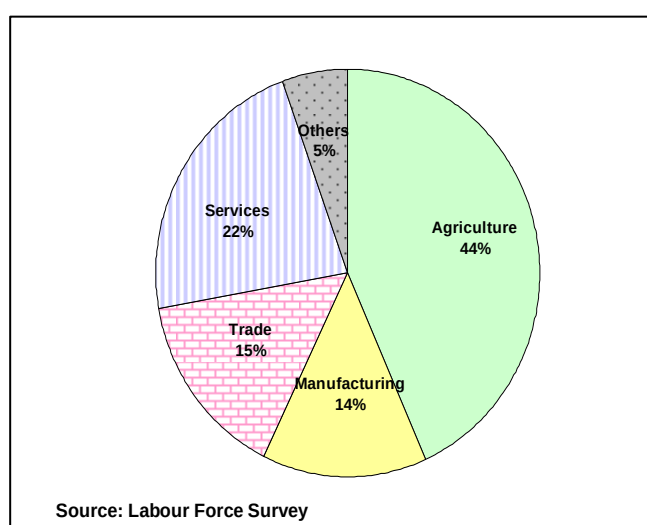
Sectors most adversely affected are export-oriented with low import content such as footwear and garment, while exports with high import content are less sensitive.

Although exchange rate-sensitive sectors contribute only a smaller proportion to total exports,

they have important implications on the labour market, thus significant spill-over effects on the economy. Chart 11 shows over 40% of labour employed are in agricultural sectors, relatively large compared to overall manufacturing and service sectors.

Chart 11: Labour force survey

The strength in the baht over the past year has not taken on a full effect. Exports continued to expand at a satisfactory rate in dollar terms, owing to favourable world economy. (Chart 12) However, growth in export earnings in baht terms has substantially declined, which will have a multiplier effect on the



domestic economy as is clear in Chart 13. Going forward, domestic demand shows signs of a slowdown while economic momentum from exports is expected to moderate, given the prospects of the global economy in 2007.

Chart 12: y-o-y Export growth (in US dollars), Trading partners' GDP and Exchange rate

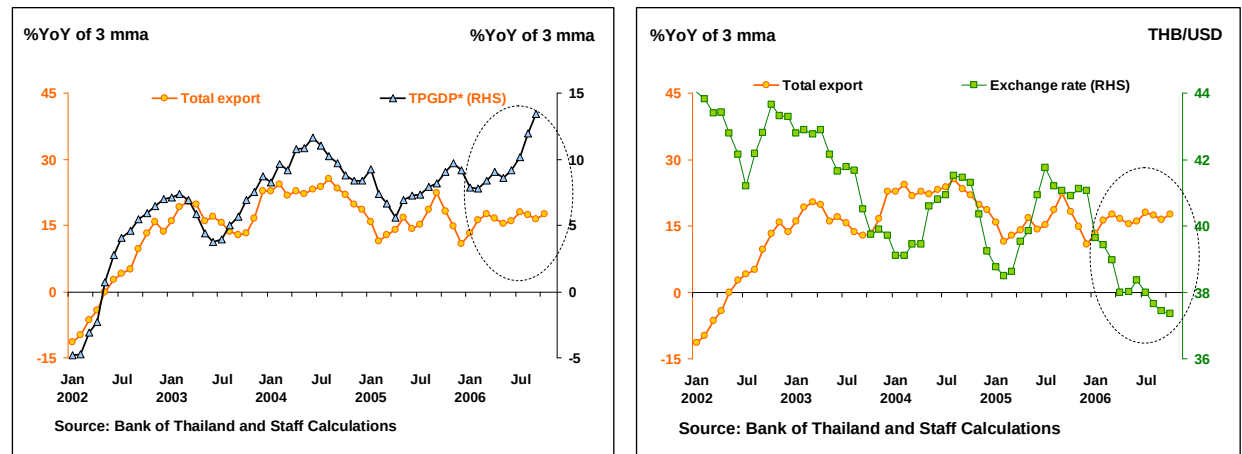
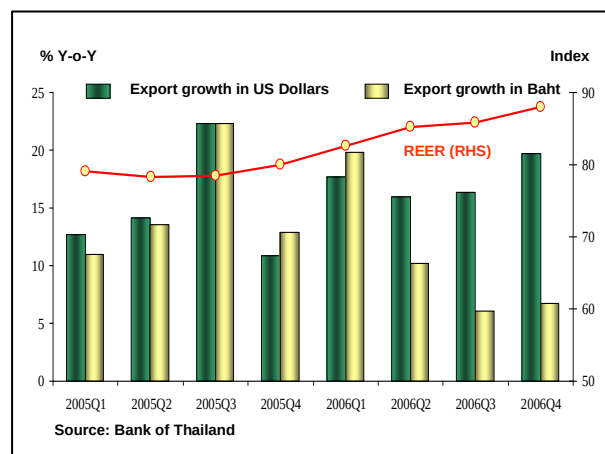


Chart 13: Export growth in US Dollars and Baht



In short, exchange rate has an important implication on growth both in terms of export performance and its multiplied effect on the economy.

5. Policy implications

Theoretically, under inflation targeting, interest rate is a single instrument used to achieve both inflation and output objectives. While exchange rate is endogenous to the policy instrument and plays a subsidiary role as a channel of monetary policy transmission mechanism, empirical evidence proves otherwise. The empirical analysis in the earlier section puts questions on the validity of UIP at least in the short run and suggests exchange rate as a weak monetary policy transmission channel. At the same time, exchange rate movement is found to have significant impact on output but not on inflation¹⁰.

Inflation targeting in practice, therefore, faces important challenges. While central banks under inflation targeting regime have mandates to keep inflation within the target, they are expected to take output growth on board when making policy decisions. In relation to this, it resembles theoretical objective function, which has two major economic variables of concern: output and inflation. However, central banks under inflation targeting are supposed to have only one eligible policy instrument under this regime – the policy rate. Whether an inflation targeting central bank should manage exchange rate and to what extent is an important question.

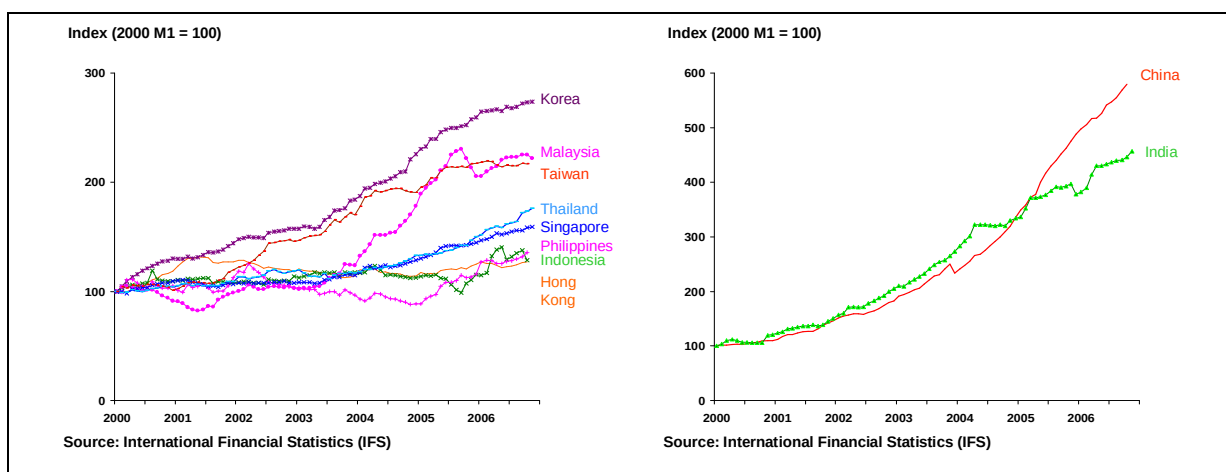
For a small open economy like Thailand, large capital flows relative to the size of the economy could cause a fluctuation in the exchange rate unjustified by its economic fundamentals. While this fluctuation may not directly jeopardise the inflation target, due to muted passthrough, it may be detrimental to growth.

To this end, a few policy options are open to a small open economy under inflation targeting. (1) Should a country continue to pursue inflation targeting with exchange rate intervention? (2) Should a country pursue explicit exchange rate target along with inflation target? or (3) Should a country abandon inflation target altogether and adopt exchange rate targeting? Each option has its own virtues and drawbacks.

Over the past years, Thailand along with many other small open economies have adopted the first option. This entails inflation targeting as a primary objective and exchange rate intervention is supplemental. In the case where the two policies are in conflict, inflation target will override exchange rate. The evidence on exchange rate intervention is clear – inflation targeting and non-inflation targeting countries alike.

¹⁰ Bearing in mind, different estimation methods and data periods may yield different results.

Chart 14: Gross international reserves



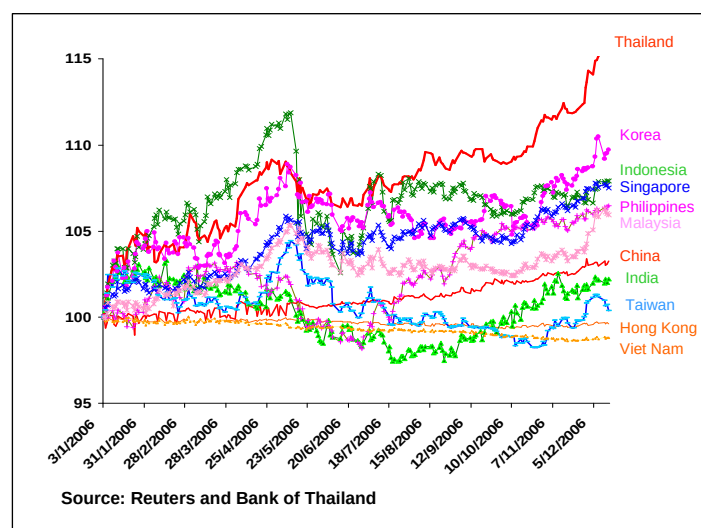
Although we could not exactly identify the extent of intervention due to limited data on international reserves net forward position for most countries, accumulation of gross international reserves in regional countries over the past few years is a rough indicator to the action of exchange rate intervention, commonly found both in the case of inflation targeting and non-inflation targeting countries. (See Chart 14)

Setting aside the issue of effectiveness, sterilised exchange rate intervention under inflation targeting is subject to practical limitations. In light of dollar slide, continued appreciation of regional currencies vis-à-vis US dollar requires regional central banks to intervene. Intervention against currency appreciation builds up net foreign assets (reserves) and domestic liabilities on the central bank balance sheet. The currency mismatch works adversely when domestic currency continues to appreciate and effectively shrinks the asset side of the balance sheet. On top of this, interest rates on domestic liabilities are, under normal circumstances, higher than that of foreign assets, therefore, exacerbating the loss further.

Apart from the losses occurred in the central bank balance sheet, under inflation targeting, intervention requires sterilisation to avoid fluctuations in the interest rate. Recent intervention to slow down the appreciation requires absorption of domestic liquidity. Such absorption can be carried out via various common means – swap, OMOs and issuance of central bank bonds. Continued one-way intervention could hit against the limitation in terms of instrument availability and operations. As the domestic market is relatively small with a small number of players, there is a limit to the amount of absorption the market could take on, and at the same time, the amount of instruments is unquestionably limited.

Thus, managing both interest rate and exchange rate at the same time is feasible subject to some practical difficulties. To relieve constraints on operational side, interest rate and inflation target may be allowed to become more flexible by lengthening the time horizon over which the target is to be met. Once restrictions on interest rate and inflation movement are slightly relaxed, there will be less operational pressure in terms of sterilisation arising from exchange rate intervention.

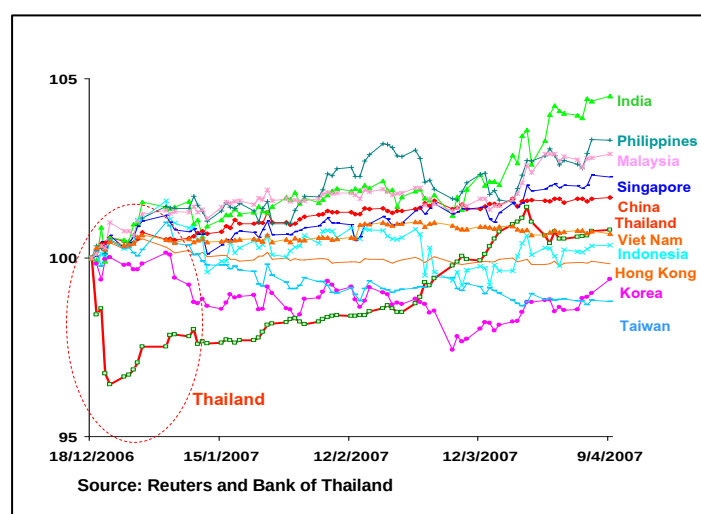
Chart 16: USD per regional currencies 3 Jan 06-15 Dec 06 (Index: 3 Jan 06 =100)



A harder and unconventional alternative to foreign exchange intervention is capital control measures. Ineffectiveness and limitations of intervention prompt countries to seek this harsh alternative and this was the case of Thailand. Capital control could be done in various forms – taxes, reserve

requirement or outright obstruction of capital flows. Leading up to the implementation of un-remunerated reserve requirement (URR) measure on short-term capital inflows, the baht appreciated both in bilateral and effective terms by 2.87% and 1.69% between November and 1-15 December 2006. Such appreciation was out of line with regional currencies and unwarranted by economic fundamental – indicating speculative flows.

Chart 17: USD per regional currencies 18 Dec 06 - 9 Apr 07 (Index: 18 Dec 06 =100)

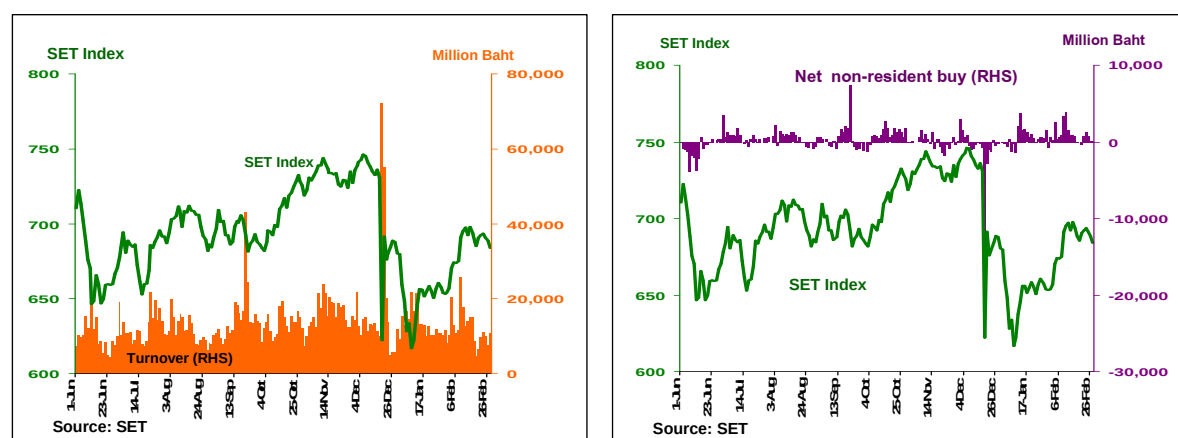


URR proves effective over the short horizon. The appreciating momentum was broken. One week after the implementation, between 15-25 December 2005 the baht depreciated by 3.33% and 3.21% vis-à-vis the US dollars and in effective terms respectively, before continuing

on its appreciating path, but at a much slower rate.

The measure was a double-edged sword. Imperfect understanding of the measure induced a large fall in the stock market the day after the measure was announced, stirring investors confidence. Nevertheless, after the measure was relaxed, the stock market rebounded on the day right after.

Chart 18: SET index, turnover and net non-resident buy



The measure was intended to be temporary and has been subject to occasional reviews. Once the one-way appreciation momentum had been successfully broken, greater flexibility was allowed to the measure without compromising the needs to contain excessive volatility – by providing the fully-hedging option for all categories of inflows that are covered under the reserve requirement measure. The hedging requirement will be closely monitored. If its implementation is effective, URR will be lifted, keeping only the hedging requirement.

Whether Thailand should adopt the second and the third option in place of the first is a matter of debate. The second option, where the central bank pursues an explicit exchange rate target along with inflation target, could be a feasible option given that interest rate does not interfere with the use of exchange rate (UIP condition does not hold). Although the action of central bank under this option is similar to the first option, explicit target means the action becomes much more transparent than under the first option, where intervention is done behind closed doors, and such transparency could enhance credibility in central banks conduct of policies. Nonetheless, effectiveness of the policy is questionable. Arbitrage opportunities may exist, which will impose speculative pressure on the financial market. Moreover, since there is no overriding objective and in the case where inflation and exchange rate send conflicting signals, the policymaker is accountable to the public in explaining its policy decision.

Finally, exchange rate targeting is not ruled out as an option. Some may argue that since exchange rate has important implications on output, it may be more appropriate for Thailand to adopt exchange rate targeting. Undeniably, intervention was aimed to manipulate exchange rate such that it provides supportive environment for economic growth. However, empirics suggest a weak relationship between exchange rate and inflation. If we aim to achieve the ultimate goal of price stability, exchange rate targeting may not suffice. Moreover, sustained one-way movement in exchange rate requires policy action which may be unfavourable. Depreciating path of exchange rate runs down reserves while continued appreciation contributes to central banks loss accumulation. Furthermore, a conventional argument against exchange rate targeting applies, where the highly integrated financial market could induce speculative attacks on the currency.

On practical notes, the regime requires a specific level or path of exchange rate, which needs to be consistent with economic fundamentals over the long period of time. Exchange rate target, overvalued or undervalued, is not stable and may be difficult to maintain. To pinpoint the 'equilibrium' level or path of exchange rate target is an intricate task. Moreover, exchange rate intervention is subject to its own limitations. To avoid excessive fluctuation in interest rate, intervention needs to be sterilised; however, ability to sterilise is constrained by availability of instruments as discussed earlier. Unsterilised intervention, on the other hand, would inevitably lead to fluctuations in interest rate and domestic liquidity, which may adversely affect the financial market.

6. Conclusion

Monetary theory and empirical evidence have provided conflicting policy recommendations regarding the role of exchange rate under inflation targeting. In theory, the objective of monetary policy, which is to minimise the deviation of output and inflation from their respective targets, could be achieved by a single policy instrument-interest rate. Exchange rate is endogenous to the change in policy rate through UIP condition and plays only subsidiary role as a channel through which the policy rate can transmit. In practice, however, the linkage between interest rate and exchange rate is weak, while exchange rate movement is found to have an important implication on output but not inflation.

Under inflation targeting, a central bank needs to ensure that inflation target, as clearly specified in its mandate, is not breached. At the same time, society expects the central bank to provide the environment conducive to economic growth. To achieve two monetary policy objectives, this may require two instruments. Exchange rate may be used as another policy instrument complementary to interest rate due to its important implications on economic growth and practical detachment from interest rate and inflation, bearing in mind the costs and limitations associated with the use of exchange rate. The combination between the two instruments varies, depending on the structure of the economy and its transmission mechanism, while there is no one-size-fits-all or the perfect solution suggested by monetary theory. Some flexibility in achieving inflation target may be allowed to relieve the operational constraints arising from exchange rate intervention. To find an optimal blend between the use of interest rate and exchange rate is, thus, an important practical challenge to a small open economy under inflation targeting.

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Appendix

Theoretical framework – the major equations:

1) Loss function

$$L = E_t \sum_{j=0}^{\infty} \beta^j \left\{ \lambda_{\pi} (\pi_{t+j} - \pi_{t+j}^*)^2 + \lambda_y (y_{t+j} - y_{t+j}^*)^2 \right\}$$

A typical dynamic loss function indicates the objective of policymakers to minimize the deviation of inflation (π) and output (y) from their respective targets over an infinite horizon, where β is a discount factor. Relative importance is expressed in the weighting parameters, λ_{π} and λ_y attached to inflation and output respectively. The loss function needs to be minimised subject to constraints, which come in the form of economic structure postulated in IS, LM, AS and UIP condition.

2) AS equation (Phillips curve)

An aggregate supply equation or the Phillips curve characterises the relationship between inflation and output. Modern theoretical framework of monetary policy usually bases on a New Keynesian framework¹¹ which assumes monopolistically competitive firms who are dynamic optimisers but face some degree of price stickiness. From the framework, a model emerges in that inflation is explained by expected future inflation and changes in firms' real marginal costs. Under certain restrictive conditions, real marginal costs can be linearly related to output gap (y_t^g). A model of inflation can be derived as follows:

$$\pi_t = \beta E_t \pi_{t+1} + \lambda y_t^g$$

The basic framework assumes closed economy, for an open economy exchange rate dynamics and inflation inertia may also have an impact on inflation. Thus, the adjusted version of inflation dynamics can be:

$$\pi_t = \alpha \pi_{t-1} + (1 - \alpha) E_t \pi_{t+1} + \phi_y y_{t-1}^g + \phi_q \Delta s_{t-1}$$

where s refers to exchange rate.

¹¹ Clarida et al. (1999)

3) IS equation

An IS equation accounts for the relationship between output, its future expected value and the expected real interest rate. The modern version of the IS curve is derived from theories of consumption, which assumes a forward-looking utility-maximising representative agent. Under perfectly competitive labour market, each infinitely-lived individual selects consumption and labour supply each period such that budget constraint is met. From this, a simple form of IS curve can be expressed as:

$$y_t^g = E_t y_{t+1}^g - \frac{1}{\eta} (i_t - E_t \pi_{t+1} - dr)$$

Where dr is the time discount rate, i refers to the nominal interest rate. Studies of open economies, such as Batini and Haldane (1999) also include a change in exchange rate.

$$y_t^g = E_t y_{t+1}^g - \frac{1}{\eta} (i_t - E_t \pi_{t+1} - dr) + \delta \Delta s_{t-1}$$

4) LM equation

$$m_t - p_t = \gamma i_t - \phi i_t + \varepsilon_{mt}$$

According to Keynes' liquidity preference theory, 3 main motives for holding money – transaction, precautionary and speculative, dictate the real money balances. An LM equation or money demand equation gives the real money balances as a function of real income and interest rate, an opportunity cost of holding money. In many cases, LM is assumed away under a given assumption that money market is in equilibrium.

5) UIP equation

$$\Delta s_{t,t+1} = (i_t - i_t^*)$$

An uncovered interest parity (UIP) or exchange rate equation expresses the relationship between the exchange rate and differentials between domestic and foreign interest rates. Assuming free flows of capital (and risk-neutrality under strict form of UIP), portfolio investors at time t have a choice of holding assets denominated in domestic currency, which yields a return of i_t between t and $t+1$ or holding assets denominated in foreign currency, offering a return of i_t^* over the same period. Exchange

rate is expected to adjust to eliminate profitable market arbitrage opportunities and the market will be in equilibrium where domestic and foreign return over t and $t+1$ will be indifferent given expected movement in exchange rate.