Indian Journal of Science and Technology, Vol 9(48), DOI: 10.17485/ijst/2016/v9i48/109305, December 2016
ISSN (Print) : 0974-6846
ISSN (Online) : 0974-5645

Can Taylor Rule be a Good Representation of Monetary Policy Function for ASEAN5?

Lavaneesvari Manogaran* and Siok Kun Sek

School of Mathematical Sciences, University Sains Malaysia, Minden – 11800, Penang, Malaysia;
resshma06@yahoo.com, sksek@usm.my

Abstract

Objectives: This paper examines whether monetary policy in ASEAN5 can be more accurately described by the baseline Taylor rule or instead by the augmented Taylor rule with exchange rate. Then, we performed empirical analyses to estimate the policy function in asymmetric form to detect the nonlinearity elements. Finally, we also investigate if there is any intervention of policymaker through policy rate adjustments in response to exchange rate changes. Methods/Statistical Analysis: The nonlinear augmented distributed lags model (NARDL) is applied to capture the asymmetric effect of policy reaction function to exchange rate changes using data ranging from 1980 to 2015. The estimations applied two different approaches, i.e. the time series data for each individual ASEAN5 and the combined all ASEAN5 data in a panel set using Pooled Mean Group (PMG) method. Findings: Empirical analyses from both these methods conjectured that the augmented Taylor rule with exchange rate term reflects the monetary policy rule in ASEAN5. Concurrently, all the ASEAN5 countries are actively responding to exchange rate changes with higher or lower policy rates. This affirms that the policy rates are adjusted asymmetrically to exchange rate changes in the long-run. Nevertheless, majority of these countries implementing inflation targeting strategy, policymakers are still skeptical to allow much fluctuation in their exchange rates through intervention with "fear of floating" behaviour.

Keywords: ASEAN5, Exchange Rate, Monetary Policy, Taylor Rule

1. Introduction

Taylor rule is a simple mechanical equation used to represent a policy function under inflation targeting framework. This rule uses central bank policy rate as a policy tool that reacts to two policy targets: inflation gap and output gap. For past two decades, this rule gained widespread influence because it can be implemented with dual mandate either for price stability or economic growth[1]. However, this rule also been criticized and remain as a subject of debate among policymakers and economists. Where, they are interested to know how well this rule can represent the actual monetary policy function. Therefore, suggestions with augmented or modified Taylor rule for the betterment of the policy reaction function have been published by many researchers[2]. One of the main related arguments is either to include the exchange rate variables in the policy reaction function. As in real world, economies are quite open and exchange rate movements can be matter of designing the monetary policy framework. Especially for inflation targeting regime with reasons such as high degree of pass-through of the exchange rate into domestic prices, ensuring competitiveness of the tradable sector and to maintain financial stability[3]. So for that, it is interesting to estimate the Taylor rule (as a benchmark rule) compared with other augmented rules.

Therefore, this paper extends the studies to investigate if Taylor rule is a good representation of policy function in ASEAN5 (Indonesia, Malaysia, Philippines, Thailand and Singapore) or augmented rule (including exchange rate) is a better representation. We also intended to provide a nonlinear setup for policy reaction function for better policy interpretation. Finally, we also intended to discover the empirical evidences of intervention in these

*Author for correspondence

countries through exchange rate movements. For the purpose of analyses, the NARDL is applied on estimating the policy reaction function using two approaches. First, we estimated the policy reaction function using time series data for each individual ASEAN5. Later, the time series data were stacked to form the panel data and the policy reaction function is estimated using PMG method. The data used are ranging from 1980 to 2015. Both single time series modelling and panel data analysis provide evidence that monetary policy is reacting asymmetrically to exchange rate in all ASEAN5 countries. Likewise, monetary policy also reacts significantly to inflation and output gap. Our results imply the presence of central bank intervention through exchange rate adjustments, suggesting that the augmented policy rule (including exchange rate) is simply a better representation of the monetary policy in ASEAN5.

The remainder of this paper proceeds as follows. Section two presents a review on Taylor Rule. Section three is about materials and methods. Section four offers the results and discussions. Section five concludes the findings.

2. Taylor Rule - A Review

2.1 Framework

Taylor rule is the fundamental instrument rule used in modelling the central bank monetary policy reaction function. This rule allows the central bank interest rate (instrument tool) to adjust the inflation at the targeted level and output at the potential level by studying the deviation between targeted and actual levels of inflation and output, as to keep the economy in equilibrium.

The Taylor rule equation can be explained as: $i_t = r^* + \delta\,(\pi_t - \pi^*) + \omega\,(y_t - y_t^*)$ where i_t is the central bank rate at time t, r^* is the real interest rate (usually treated as a constant 2 percent), π_t is the inflation rate, $(\pi_t - \pi^*)$ is the deviation of the inflation rate from its target level π^* and $(y_t - y_t^*)$ is the deviation of output, y_t from its full-employment level, y_t^*. The weights δ and ω, indicate the sensitivity of the central bank rate changes to inflation gap $(\pi_t - \pi^*)$ and output gap $(y_t - y_t^*)$. This equation indicating the larger the coefficients, the more aggressive the monetary policy will be[4].

2.2 Issues and Arguments

Taylor rule was a great benchmark for policymakers and economists for evaluating and predicting current and future monetary policy[5]. On the other hand, the rule also been criticized by a number economist with miscellaneous reasons. Therefore, Taylor rule remains as a focus discussion of monetary policy around the world in both advanced and emerging economies[6]. The three main issues or arguments are: to include exchange rate in Taylor rule, asymmetric form of Taylor rule and forward versus backward rule.

In the first issue, there are suggestions to include exchange rate term in Taylor rule as to be implemented in emerging economies. Since, these economies are small but very open in trades. Hence, they are vulnerable to external shocks and sensitive to exchange rate changes[7–12]. Whereby, these economies are termed with "fear of floating" behavior (i.e. reluctant to float their currencies as over fluctuation in exchange rate is not healthy to their economy). Therefore, it is argued that including exchange rate in the policy rule will improve the performance of the monetary policy in these economies[13–18]. Contradicting to the first view, the second group holds that monetary policy should not include a direct exchange rate term because adding the exchange rate term into the monetary policy might cause loss of credibility in the inflation targeting. Theoretically, monetary policy already has an indirect effect of exchange rate on inflation and output, and no direct reaction to exchange rate terms are needed as it generates negative effects on real output and inflation[19]. In line with the opinion pioneered by Taylor, similar conclusion were also drawn in other studies[20–23]. In addition, there are also researchers failed to deduce evidence on the responses of monetary policy to the exchange rate terms[24–26].

In the second issue, some researchers recommended for asymmetric or nonlinear policy rule. The Taylor rule originally is constructed based on a linear relationship[4]. However, this assumption been disapproved by some researchers with recommendation of asymmetric or nonlinear policy rule. Where empirical studies, affirm the asymmetric model surpasses the symmetric model in terms of its capability to capture the actual policy rate[27–31]. This is because the asymmetric policy reaction function results from the responses of central bank to inflation and output gap with weights assigned to negative vs. positive output gap and low vs. high inflation rate which might

fluctuate based on multiple preferences of policymakers on broader set of factors[28].

While in the third issue, Taylor rule is written as the backward-looking conventional form where the policy rate responds to inflation and output gap and their own past values[32–34]. Since this rule has only emphasizes on predetermined values of inflation and economic growth to formulate the monetary policy. Hence, some pundits criticize this rule as inadequate to predict the future state of the economy with current inflation and output gap[28]. At the same time, Clarida forms the forward-looking model, which is so-called the forecast based policy rule that takes into account the expected inflation and output gap on setting the policy rate. In this rule the policy rate reacts to predictable variables such as inflation and output gap as opposed to lagged ones[35,36]. Nevertheless, this rule was questioned as it becomes less clear in deciding how far the policymakers look into the future. Such inconsistency in forward-looking models cause many researchers switch to the hybrid model. The hybrid rule is a model which includes backward-looking and forward-looking elements in the monetary policy rule[37]. From evidence of past researcher, hybrid rule is suggested to be better in reducing the volatility of inflation, output and policy rates[38,39].

2.3 Empirical Results on Policy Rule in ASEAN5

Based on empirical research, the adoption of Taylor rule is widely known to have significant impact on economic performance mainly in advanced and closed economies such as UK and U.S. While, in emerging open economies, Taylor rule and the performance of monetary policy functions are still with contrasting discussions, as if it requires modification in the baseline-rule[40].

In the context of ASEAN5, there are absolutely limited studies in this matter. As some researchers claim for Taylor-type rule in their policy reaction function and others with extension of Taylor-rule, where some modification suggested as safeguarding the economic stability. For the first view, Ramayandi[41] examined the monetary policy reaction function of ASEAN5 using the GMM technique of estimation with quarterly data ranging from 1989 to 2004. This study found that the setting of the monetary policy in this region can be explained by a simple Taylor rule. Then, Gan and Kwek[7] through the SVAR approach with quarterly data ranging from 1995 to 2006, also highlighted that the monetary policy of ASEAN3 (Indonesia, Malaysia and Thailand) been reflecting the Taylor principle function.

While for the alternate view, the original Taylor rule has been modified in various ways. As the policymakers seem to look on the broader set of macroeconomic factors, where the inclusion of related parameters are essential. This is identified in some studies. Raghavan and Dungey[42] examined the monetary policy reaction function of ASEAN5 using the SVECM approach. The results claimed that the policy reaction function of ASEAN5 is additionally responding to stock market term. Following, Shrestha and Semmler[43] estimated the simple Taylor rule using the ARDL model for five East Asian countries (Malaysia, Korea, Thailand, Indonesia and Philippines) and concluded that the baseline Taylor rule is not adequate in describing the policy function of these economies as other variables are needed for financial stability. While, studies by Caporale *et al*[44] using the GMM estimation for five emerging countries namely, Indonesia, Thailand, Israel, South Korea and Turkey. Specified, that the augmented nonlinear Taylor rule (including exchange rate) meticulously presents the behavior of policy rule in these countries.

Apart from that, individual-country studies in ASEAN5 also acknowledged the augmented Taylor-rule. For instance, Khalid *et al*[12] used the nonlinear regression techniques and identified that the policy rule of Malaysia implies the augmented Taylor-type with exchange rate term. While, Luengwilai[10] used the BLM estimation and affirmed that the policy reaction function of Thailand follows the modified Taylor rule, since it is alternatively responding to exchange rate movements. Chow *et al*[45] used the DSGE – VAR approach and concluded that the policy reaction function of Singapore pursues the modified Taylor principle as its controlled by the exchange rate rule.

3. Materials and Methods

In this paper, we employed yearly time series data which cover the period ranging from 1980 to 2015. The relevant data were extracted from *DataStream*. The main variables are namely, central bank interest rate *(INT)* in percentage, Consumer Price Index *(CPI)* in index form, Gross Domestic Product *(GDP)* in U.S. dollar and nominal Exchange Rate *(EX)* per US dollar. All the variables involved are converted to natural logarithm, except the interest rates which are in percentages form with the pur-

pose to streamline the data. Further, CPI inflation *(CINF)* is obtained using log *CPI (LCPI)* deviates from its lagged 1 (proxy for annual rate). While, output gap *(GAP)* is constructed as Log Gross Domestic Product *(LGDP)* deviates from its trend obtained via the Hodrick-Prescott filter. On the whole, the study concentrated in ASEAN5 economies, namely Indonesia, Malaysia, Philippines, Thailand and Singapore.

3.1 NARDL Method

The NARDL approach advanced by Shin *et al*[46] is employed in this study. This has included the asymmetric element in the model and it is an extended form developed from the linear ARDL model of Pesaran & Shin[47] and Pesaran *et al*[48]. Therefore, this model is applicable to analyze the asymmetric effect of exchange rate changes on monetary policy (interest rate) for ASEAN5 member countries.

In this model, the short and long-run nonlinearities estimations are introduced via positive and negative partial sum decompositions of the explanatory variables which produce reliable results for small sample size data. Thus, in modelling the monetary policy reaction function, the dependent variable (INT) can be explained by the exogenous variables ($CINF, GAP, LEX^+, LEX^-$) through $NARDL(p, q_1, q_2, q_3, q_4)$ specification:

$$INT_t = \sum_{j=1}^{p} \lambda_j INT_{t-j} + \sum_{j=0}^{q1} a_j' CINF_{t-j} + \sum_{j=0}^{q2} b_j' GAP_{t-j} + \sum_{j=0}^{q3} c_j' LEX_{t-j}^{+} + \sum_{j=0}^{q4} d_j' LEX_{t-j}^{-} + \varepsilon_t \quad (1)$$

Where $t = 1, 2, ..., T$ indicates the number of periods; λ_j is the vector of scalars and a_j, b_j, c_j, d_j are the coefficient vectors and ε_t is the disturbance term with zero mean and finite variance. Exchange rate variable is then decomposed into exchange rate increases and decreases series, denoted as LEX_t^+ and LEX_t^- respectively. LEX_t^+ and LEX_t^- are proxy for exchange rate depreciation and exchange rate appreciation and they are obtained via partial sums of positive and negative changes in exchange rates respectively:

$$LEX_t^+ = \sum_{t=1}^{T} \Delta LEX_t^+ = \sum_{t=1}^{T} \max(\Delta LEX_t^+, 0) \quad \text{and} \quad LEX_t^- = \sum_{t=1}^{T} \Delta LEX_t^- = \sum_{t=1}^{T} \min(\Delta LEX_t^-, 0)$$

Equation (1) can be written in the error correction form as:

$$\Delta INT_t = \phi INT_{t-1} + \beta_1' CINF_t + \beta_2' GAP_t + \beta_3' LEX_t^+ + \beta_4' LEX_t^- + \sum_{j=1}^{p-1} \lambda_j \Delta INT_{t-j} + \sum_{j=0}^{q1-1} a_j' \Delta CINF_{t-j} + \sum_{j=0}^{q2-1} b_j' \Delta GAP_{t-j} + \sum_{j=0}^{q3-1} c_j' \Delta LEX_{t-j}^{+} + \sum_{j=0}^{q4-1} d_j' \Delta LEX_{t-j}^{-} + \varepsilon_t \quad (2)$$

where, $\phi = -1(1 - \sum_{j=1}^{p} \lambda_j)$. By regrouping the error correction equation (2), the NARDL model can be written as:

$$\Delta INT_t = \phi(INT_{t-1} - \theta_1' CINF_t - \theta_2' GAP_t - \theta_3^+ LEX_t^+ - \theta_4^- LEX_t^-) + \sum_{j=1}^{p-1} \lambda_j \Delta INT_{t-j} + \sum_{j=0}^{q1-1} a_j' \Delta CINF_{t-j} + \sum_{j=0}^{q2-1} b_j' \Delta GAP_{t-j} + \sum_{j=0}^{q3-1} c_j' \Delta LEX_{t-j}^{+} + \sum_{j=0}^{q4-1} d_j' \Delta LEX_{t-j}^{-} + \varepsilon_t \quad (3)$$

where, ϕ is the error correction coefficient or the speed of adjustment on measuring the convergence speed of *INT* in moving to its long-run equilibrium due to changes in the exogenous variables. This coefficient must be in negative value to ensure the stability in the long-run relationship. While, $\theta_j = -(\beta_j / \phi)$ captures the long-run relationship among the dependent and independent variables in equation (3). Then, θ_3^+ and θ_4^- are the long-run effects of exchange rate increases and decreases on monetary policy,

while $\sum_{j=0}^{q3-1} c_j$ and $\sum_{j=0}^{q4-1} d_j$ measure the short-run impacts of exchange rate increases and decreases on monetary policy respectively.

The ARDL and NARDL are only applicable to variables with order of integration not higher than 1, i.e. *I(0), I(1)* or the combination of them. Prior to the estimation, unit-root tests are performed to ensure the fulfilment of the pre-condition required to adopt NARDL model. After confirming the model requirement, we proceed with the NARDL model specification using the optimal lag length criterion of Akaike Information Criterion (AIC). Then, the model was estimated and the bounds testing[46,48] was conducted to detect the long-run cointegration relationship among the variables with null hypothesis of $H_0 = \theta_1 = \theta_2 = \theta_3 = \theta_4 = 0$ against the alternative hypothesis of $\theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq 0$.

Consequently, with the presence of cointegration, we examined the short and long-run estimates in relations between variables (*CINF, GAP, LEX*$^{+,}$ *LEX*$^{-}$) and monetary policy reaction function (*INT*) for all countries in ASEAN5, then inferences are made. Finally, to check the robustness of our model, we used the Breush-Godfrey Serial Correlation Lagrange Multiplier (LM) tests, ARCH tests, CUSUM tests and CUSUM of squares tests.

3.2 Estimation – Time Series versus Panel Data

We conduct the estimation using time series data and panel data. Where, equation (3) is estimated separately

for each ASEAN5 using time series data. Besides, we also combined the data for all countries in a panel form and re-estimate the same equation by adding *i* as number of countries into equation (3). The new equation is in panel form which denoted by (3*). This (3*) equation is estimated using panel data PMG technique. This technique restricts the long-run coefficients (θ_{1i} , θ_{2i} , θ_{3i}^{+} , θ_{4i}^{-}) to be common across all countries but no restriction is imposed on the short-run coefficients. Such restriction is based on the assumption that all countries share the same equilibrium or steady state level in the long-run. For detail in PMG, see Pesaran and Smith[49] and Pesaran *et al*[50].

$$\Delta INT_{it} = \phi_i (INT_{it-1} - \theta_{1i}^{'} CINF_{it} - \theta_{2i}^{'} GAP_{it} - \theta_{3i}^{+'} LEX_{it}^{+} - \theta_{4i}^{-'} LEX_{it}^{-}) + \sum_{j=0}^{p-1} \lambda_{ij} \Delta INT_{it-j} + \sum_{j=0}^{q1-1} a_{ij}^{'} \Delta CINF_{it-j} + \sum_{j=0}^{q2-1} b_{ij}^{'} \Delta GAP_{it-j} + \sum_{j=0}^{q3-1} c_{ij}^{'} \Delta LEX_{it-j}^{+} + \sum_{j=0}^{q4-1} d_{ij}^{'} \Delta LEX_{it-j}^{-} + \varepsilon_{it} \quad (3^*)$$

4. Results and Discussions

We performed estimations on the NARDL models (equation 3 and 3*) using times series data and panel data respectively. Since, NARDL model requires no variable with integrated order higher than 1, unit-root tests are performed on checking the integrated order of all variables. Prior to the estimation, unit-root tests of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are performed using time series data for each country. Also, panel unit-root tests of Levin, Lin & Chu (LLC) and IM, Pesaran and Shin (PPS) are performed on panel data. The results are omitted here to save space. Our results of unit-root tests from both time series data and panel data showed that not all variables are stationary at levels but eventually all became stationary at first differencing. Our results confirmed that no variable with integration order higher than one. So, the NARDL model is applicable in this study.

Hence, we proceeded to model specifications using AIC (searching up to lag 4 for time series data and up to lag 2 for panel data) for the selection of optimal lag length, followed by estimations and cointegration or bounds tests and finally residual diagnostic tests.

Table 1. Results of NARDL estimates

Estimates	Variables	Indonesia	Malaysia	Philippines	Thailand	Singapore
Short-run	*DINT(t-1)*	-	0.2519***	0.3646***	-	-
	DCINF(t)	56.6167***	52.5674***	12.7638*	61.3981***	24.0853**
	DCINF(t-1)	-	10.3704	-	-	-
	DCINF(t-2)	-	48.1538***	-	-	-
	DGAP(t)	-11.8123**	-8.3720***	12.9786***	-10.8071***	9.6930**
	DLEX⁺(t)	-0.3607	-8.5295**	-1.1011	0.5006	34.9231***
	DLEX⁺(t-1)	-	-5.1756*	7.5612**	-	-
	DLEX⁺(t-2)	-	-	5.1390	-	-
	DLEX⁺(t-3)	-	-	7.8394**	-	-
	DLEX⁻(t)	4.4233	-22.9660***	0.5550	-17.3724***	13.2004
	DLEX⁻(t-1)	-	9.7540*	11.1237**	-	-
	DLEX⁻(t-2)	-	29.8083***	-	-	-
	C	-	7.5324***	13.6786***	-	3.8025***
	ϕ	-0.6359***	-0.9081***	-0.8767***	-0.8445***	-0.6293***
Long-run	*CINF (t)*	57.8597***	42.9010	10.8462	84.0475***	30.6647
	GAP (t)	-1.5078	12.9997**	18.0444***	-2.2640	-0.1342
	LEX⁺ (t)	0.8698	6.9634	-2.1143	-8.7750***	-1.4588
	LEX⁻ (t)	17.0904**	-16.7672*	10.2267***	-3.8313	7.8120*
	C	10.3316***	-	-	7.7052***	-
	Trend	-	-0.5952*	-	-	-
	Bounds Test	3.7756**	12.1972***	8.9717***	15.2947***	4.3080**
	R^2	0.9459	0.9304	0.9770	0.9407	0.8559

Note: *, ** and *** denote the statistical significance at the 10%, 5% and 1% level respectively.

4.1 Estimation – Time Series Data

First of all, we discuss on the results of estimation using time series data as summarized in Table 1. There are evidences that policy reaction functions in ASEAN5 are reactive to exchange rate changes asymmetrically in the short-run and long-run. However, the policy function may react differently to exchange rate changes across countries. In Thailand, the policy reaction only responds to exchange rate increases or depreciation but not reactive to exchange rate decreases or appreciation in the long-run. The monetary policy tends to keep the exchange rate depreciated as the policy function shows reduction in interest rate in response to exchange rate depreciation in the long-run.

Table 2. Results of NARDL model diagnostic tests

Country	LM Test	ARCH Test
Indonesia	2.3231 (0.1400)	0.0240 (0.8778)
Malaysia	2.3846 (0.1312)	2.2867 (0.1413)
Philippines	0.0705 (0.9323)	0.2103 (0.6501)
Thailand	0.5410 (0.5894)	2.2648 (0.1425)
Singapore	2.2331 (0.1290)	0.0193 (0.8905)

Note: The numbers in brackets are the associated p-values.

Conversely, the policy functions in the other four ASEAN5 countries do not respond to exchange rate increases or depreciation, but they react to exchange rate decreases or appreciation in the long-run. Malaysia exhibits the "fear of appreciation" behavior as the policy function shows a decline in policy rate in response to exchange rate appreciation, i.e. policymaker tends to implement the expansionary policy to boost economy growth and so for the exchange rate to depreciate back. On the other hand, Indonesia, Philippines and Singapore are comfortable with exchange rate appreciation by increasing the policy rates to attract and gain benefits from higher foreign capital flows so that their exchange rates will keep appreciating in future.

At the same time, the policy functions also show different behavior in reacting to inflation gap and output gap across countries. The monetary policy function for countries with higher inflation background (Indonesia and Thailand) tend to react strongly to inflation gap in the long-run as low inflation is their ultimate goal to improvise the price stability. Malaysia and Philippines are far more sensitive to output gap. This might due to situation where their actual output is higher than the potential or targeted output. Therefore, the policymakers increase the policy rates in order to keep down the actual output to the targeted level as to abstain from higher inflation in the long-run.

While the coefficient of error correction term is negative and significant in all cases, indicating the convergence of monetary policies toward the long-run steady state due to changes in the determinant variables as to ensure the stability of our model. Correspondingly, the CUSUM tests and CUSUM of squares tests with the movements of equations inside the 5% critical lines (results are not reported for brevity) for all ASEAN5 also illustrated that our monetary policy estimations are stable.

In terms of bounds testing, the results are significant in all cases which supporting the existence of long-run relationship between dependent and explanatory variables.

Further, Table 2 presents the testing on the residuals of estimates for autocorrelation (LM test) and heteroscedasticity (ARCH test). Both these tests failed to reject the null hypothesis of autocorrelation and heteroscedasticity, as confirming our results are reliable.

To summarize the results from Table 1, the policy reaction functions in ASEAN5 are not only responding to inflation gap and output gap, but also reacting asymmetrically to exchange rate changes. Thus, the results confirm that the policy reaction functions in ASEAN5 are not accommodating to the benchmark Taylor rule, indicating that augmented Taylor rule with exchange rate term and asymmetric form is a better representation for monetary policy reaction of these countries.

4.2 Estimation – Panel Data (PMG)

Table 3 presents the results of panel PMG estimation of long and short-run coefficients with optimal lag length criterion of AIC (searching up to lag 2) for ASEAN5. Since the adjustment coefficient ($\phi = -0.5386$), has the negative sign and statistically significance at 1% level, this indicates that the error correction mechanism has been placed correctly and there is convergence of the policy rate to the long-run equilibrium level. Further, the Kao cointegration test has detected the long-run relationship

between dependent and explanatory variables in the policy reaction function.

Table 3. Results of panel PMG estimates

Estimates	Variables	Coefficient	P-value
Long-run	*CINF*	66.3319***	0.0000
	GAP	6.6069***	0.0004
	LEX^{+}	-1.4425*	0.0610
	LEX^{-}	6.7393***	0.0000
	ϕ	-0.5386***	0.0000
Short-run	*DCINF(t-1)*	15.0273**	0.0170
	DGAP(t-1)	-5.7189	0.1461
	$DLEX^{+}(t-1)$	6.1770	0.3318
	$DLEX^{-}(t-1)$	-2.1127	0.7141
	C	3.8545***	0.0000
Kao Test (Engle-Granger based)		t-stat = -5.2262***	

Note: *, ** and *** denote the statistical significance at the 10%, 5% and 1% level respectively.

The results from panel data are consistent to the results reported in time series data. Where, we observed significant responses from the policy rate to inflation gap, output gap and exchange rate changes in the long-run. The policymakers in ASEAN5 tend to increase the policy rate in response to higher inflation gap and output gap in the long-run. Also, the policy reaction function reacts asymmetrically to exchange rate changes (increases and decreases) in the long-run and exhibiting the "fear of floating" behavior.

This affirms that the policymakers in ASEAN5 are not accommodating to the Taylor type policy rule as benchmark. The results suggest that the augmented policy rule with exchange rate is simply a better representation of the monetary policy reaction function for ASEAN5. Besides the long-run estimation, the panel PMG estimator also reported the short-run parameters, where only the inflation gap has positive influences on policy rates as other variables remain trivial.

5. Conclusion

In this paper, empirical analyses are carried out on estimating the Taylor rule by augmenting exchange rate variable in the policy rule for the emerging ASEAN5 countries. The paper has three main objectives. First, we intended to investigate either the Taylor rule or the augmented Taylor rule can be a better representation of policy rule for ASEAN5. Second, we performed empirical analyses to estimate the policy function in asymmetric form in detecting nonlinearity elements in the policy rule. Third, the study also conducted to detect if there is any intervention of policymaker through policy rate adjustments in reactive to exchange rate changes. The NARDL is applied to capture the asymmetric responses of policy reaction to exchange rate changes with data ranging from 1980 to 2015. The estimations applied two approaches, i.e. using time series data for each individual ASEAN5 and to combine all ASEAN5 data into a panel set for further estimation using PMG method.

The main findings of this study reveal that the augmented Taylor rule with exchange rate term reflects the monetary policy rule in ASEAN5. This is because all the ASEAN5 countries are effectively responding to exchange rate movements with higher or lower policy rates. Although, majority of these countries implementing inflation targeting strategy, policymakers are still skeptical to tolerate much variation in their exchange rates through intervention regards to "fear of floating" behavior. The policy rates are adjusted asymmetrically to exchange rate changes (increases and decreases) in the long-run. In the same way, the ASEAN5 policy reaction functions also strongly reacting to both inflation and output gap. The results also reveal different reactions from policy rule towards inflation gap, output gap and exchange rate changes across countries in accommodating to their monetary policy framework and policy targets.

6. Acknowledgement

This work is supported under the Fundamental Research Grant Scheme FRGS (203/PMATHS/6711431).

7. References

1. Asso PF, Kahn GA, Leeson R. The taylor rule and the practice of central banking. 2010; RWP 10– 05:1–52.
2. Käfer B. The taylor rule and financial stability - A literature review with application for the Eurozone. EconPapers. 2014; 65(2):159–92.
3. Mohanty MS, Klau M. Monetary policy rules in emerging market economies: Issues and evidence. BIS Work Paper. 2004; 149:205–45.
4. Taylor JB. Discretion versus policy rules in practice. Carnegie-Rochester Conference Series On Public Policy. 1993 Dec; 39:195–214.

5. Orphanides A. Monetary policy rules based on real-time data. The American Economic Review. 2001; 91(4):964–85.
6. Koenig E., Leeson R, Kahn GA. The taylor rule and the transformation of monetary policy. Stanford, California: Hoover Press; 2012.
7. Gan PT, Kwek KT. The monetary policy reaction function: Evidence from ASEAN-3. Asian Academy of Management Journal of Accounting and Finance. 2010; 6(1):1–24.
8. Aizenman J, Ito H. The impossible trinity, the international monetary framework, and the pacific rim. Handbook of the Economics of the Pacific Rim. London: Oxford University Press; 2011. p. 1–43.
9. Sek SK, Ooi CP, Ismail MT. Investigating the relationship between exchange rate and inflation targeting. Applied Mathematical Sciences. 2012; 6(32):1571–83.
10. Lueangwilai K. Monetary policy rules and exchange rate uncertainty: A structural investigation in Thailand. Procedia Economics and Finance. 2012; 2:325–34.
11. Adenan M. Reaction function model of monetary policy under inflation targeting framework in Indonesia. International Review of Management and Business Research. 2014; 3(1):211–21.
12. Khalid N, Karim ZA, Yussof I. Testing a non linear model of monetary policy reaction function: Evidence from Malaysia. Jurnal Ekonomi Malaysia. 2014; 48(2):19–27.
13. De Paoli B. Monetary policy and welfare in a small open economy. Journal of International Economics. 2009; 77(1):11–22.
14. Sek SK. Economic structures , the nature of shocks and the role of exchange rate in the monetary policy formation in the emerging countries of East- Asia. Doctoral dissertation, Christian-Albrechts-Universität zu Kiel; 2009.
15. Santacreu AM. Monetary policy in small open economies : The role of exchange rate rules. Federal Reserve Bank St Louis Review. 2015; 97(3):217–32.
16. Garcia CJ, Restrepo JE, Roger S. How much should inflation targeters care about the exchange rate? Journal of International Money and Finance. 2011; 30(7):1590–617.
17. Mihov I, Santacreu AM. Exchange rate as an instrument of monetary policy. Unpublished Manuscript; 2013.
18. Buyandelger O-E. Exchange rate pass-through effect and monetary policy in Mongolia: Small open economy DSGE model. Procedia Economics and Finance. 2015; 26(15):1185–92.
19. Taylor JB. The role of the exchange rate in monetary-policy rules. The American Economic Review. 2001; 91(2):263–7.
20. Edwards S. The relationship between exchange rates and inflation targeting revisited. NBER Working Paper Series. 2006 Apr; 12163:1–47.
21. Leitemo K, Soderstrom U. Simple monetary policy rule and exchange rate uncertainty. Journal of International Money and Finance. 2005; 24(3):481–507.
22. Adolfson M. Incomplete exchange rate pass-through and simple monetary policy rules. Journal of International Money and Finance. 2007; 26(3):468–94.
23. Mccallum BT. Monetary policy in East Asia: The case of Singapore. Institute for Monetary and Economic Studies (IMES) Bank of Japan Discuss Paper Series. 2007 Aug; E-10(1):1–24.
24. Osawa N. Monetary policy responses to the exchange rate: Empirical evidence from three East Asian inflation-targeting countries. Bank Japan Working Paper Series. 2006 Sep; E-14(6):1–16.
25. Sek SK. Interactions between monetary policy and exchange rate in inflation targeting emerging countries: The case of three east Asian countries. International Journal of Economics and Finance. 2009; 1(2):27–44.
26. Lopcu K. Taylor rule in an open economy: Has the conduct of monetary policy changed in Turkey? In: International Conference on Eurasian Economies; 2014. p. 1–8.
27. Petersen K. Does the federal reserve follow a non-linear Taylor rule? Economics Working Papers. University of Connecticut, UCONN Library. 2007 Sep; 37:2–21.
28. Ncube M, Tshuma MM. Monetary policy conduct based on nonlinear Taylor Rule: Evidence from South Africa. Working Paper Series. Tunisia. 2010 Aug; 113:2–39.
29. Bruggemann R, Riedel J. Nonlinear interest rate reaction functions for the UK. Economic Modelling. 2011; 28(3):1174–85.
30. Baaziz Y. Estimating interest rate setting behavior in Brazil: A LSTR model approach. Economies. 2015; 3(2):55–71.
31. Fatima M, Malik WS. Choice of functional form in the nonlinear Taylor rule: The case of Pakistan. Pakistan Economic and Social Review. 2015; 53(2):225–50.
32. Rudebusch G, Svensson LEO. Policy rules for inflation targeting. In: NBER Chapters; 1999. p. 203–62.
33. Ball L. Efficient rules for monetary policy. International Finance. 1999; 2(1):63–83.
34. Woglom G. How has inflation targeting affected monetary policy in South Africa? South African Journal of Economics. 2003 Feb; 71(2):198–210.
35. Clarida R, Galí J, Gertler M. Monetary policy rules in practice: Some international evidence. European Economic Review. 1998; 42(6):1033–67.
36. Batini N, Haldane AG. Forward-looking rules for monetary policy. National Bureau of Economic Research. 1999; I:157–92.
37. Lindé J. The empirical relevance of simple forward- and backward- looking models: A view from a dynamic general equilibrium model; 2001.
38. Kahn GA. Beyond inflation targeting: should central banks target the price level? Economic Review Third Quart; 2009 Oct 22. p. 35–64.

39. Patra MD, Kapur M. Alternative monetary policy rules for India. International Monetary Fiance (IMF) Working Papers. 2012 May; 118:1–43.
40. Basilio JR. Empirics of monetary policy rules: The Taylor rule in different countries [Doctoral thesis]. Chicago, University of Illinois at Chicago; 2013.
41. Ramayandi A. Approximating monetary policy: Case study for the ASEAN-5. Working Paper in Economics and Development Studies. 2007 Aug; 7:3–39.
42. Raghavan M, Dungey M. Should ASEAN-5 monetary policy-makers act pre-emptively against stock market bubbles? Applied Economics. 2015; 47(11):1086–105.
43. Shrestha PK, Semmler W. Monetary policy and international reserves in emerging economies: Theory and empirics. In: Emerging markets and sovereign risk. Palgrave Macmillan,UK; 2015. p. 213–30.
44. Caporale GM, Çatık AN, Helmi MH, Ali FM, Akdeniz C. Monetary policy rules in emerging countries: Is there an augmented nonlinear Taylor rule? DIW Berlin Disussion Papers. 2016; 1588:1–35.
45. Chow HK, Lim GC, McNelis PD. Monetary regime choice in Singapore: Would a Taylor rule outperform exchange-rate management? Journal of Asian Economics. 2014; 30:63–81.
46. Shin Y, Yu B, Greenwood-Nimmo M. Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In: The Festschrift in Honor of Peter Schmidt. Springer New York; 2014 Feb 5. p. 281–314.
47. Pesaran MH, Shin Y. An autoregressive distributed lag modelling approach to cointegration analysis. Economic Soc Monogr. 1999; 31(7):371–413.
48. Pesaran MH, Shin Y, Smith RJ. Bounds testing approaches to the analysis of level relationships. Journal of Applied Econometrics. 2001; 16(3):289–326.
49. Pesaran MH, Smith R. Estimating long-run relationships from dynamic heterogeneous panels. Journal of Econometrics. 1995; 68(1):79–113.
50. Pesaran MH, Shin Y, Smith R. Pooled mean group estimation of dynamic heterogeneous panels. Journal of the American Statistical Association. 1999; 94(446):621–34.