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Testing a Non Linear Model of Monetary Policy Reaction Function: Evidence from Malaysia

(Menguji Model Bukan Linear Fungsi Tindak Balas Dasar Monetari: Kajian di Malaysia)

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ABSTRACT

This paper estimates a nonlinear model of monetary policy reaction function by augmenting the standard Taylor rule equation for the case of Malaysia. Monetary policy reaction function is identified by which the BNM sets the current level of policy rates after observing the current level of output, inflation and exchange rate, and lags of these variables (backward looking). Using quarterly time series data set spanning from 1991 to 2014, the findings support the relevance of Taylor rule in which the Bank Negara Malaysia (BNM) sets their policy rates based on both inflation and output growth. In addition, the BNM has also considered the exchange rate in their reaction function.

Keywords: Monetary policy; interest rate; inflation; Taylor rule

ABSTRAK

Kajian ini menganggarkan model bukan linear fungsi tindak balas dasar monetari dengan menggunakan peraturan asas Taylor bagi kes Malaysia. Fungsi tindak balas dasar monetari dikenal pasti di mana Bank Negara Malaysia (BNM) menetapkan paras kadar polisi semasa selepas memerhatikan tahap semasa pengeluaran, inflasi dan kadar pertukaran, dan lag pembolehubah-pembolehubah ini (backward looking). Menggunakan data siri masa sukuan daripada 1991-2014, dapatan kajian menyokong dasar peraturan Taylor di mana BNM menetapkan kadar dasar mereka berdasarkan kedua-dua pertumbuhan inflasi dan output. Di samping itu, BNM juga telah mempertimbangkan kadar pertukaran dalam fungsi tindak balas mereka.

Kata kunci: Dasar monetari; kadar faedah; inflasi; peraturan Taylor

INTRODUCTION

Most economists have agreed that monetary policy has a real effect at least in the short run (Taylor 1997). Therefore, choosing the proper operating target of monetary policy (interest rates or monetary aggregates) is pivotal for the monetary authority to stimulate effectively the real sector's activity, and to maintain price stability. Poole (1970) used a Hicksian IS-LM model to show that interest rate targeting is superior to money stock targeting if the money market shocks (influencing the LM curve) are relatively smaller than the shocks arising in the commodity market (influencing the IS curve). Since the 1990s, most central banks around the world have shifted their monetary policy stance from targeting monetary aggregates towards targeting interest rates. The main reason is the instability in the relationship between monetary aggregates and aggregate expenditures due to financial innovations, and changes in the payments technology occurring in the 1990s (Handa 2009).

The interest among economists in estimating monetary policy reaction functions has increased dramatically. The reaction function can be used to evaluate the actions and policy of central bank in response to the economic environments. Therefore, testing the monetary policy reaction function is crucial to the central bank in understanding their behaviour of designing an optimal policy rates. The central bank will normally observe their current information in terms of output gap and inflation before deciding the optimal level of policy rates. This policy rule was proposed by Taylor (1993) and has been used extensively in modelling the central bank monetary policy reaction function, in particular in advanced countries like US and UK. For example, monetary policies of the European Central Bank (ECB) and US Federal Reserve can be characterized by 'Taylor rules' in which both central banks seem to set the policy rates by taking into account the output gap and inflation.

In spite of large number of studies to estimate the reaction functions from various countries and samples, researchers have not been successful in providing an accurate representation of the central bank behaviour. For instance, Khoury (1990) surveys 42 such empirical reaction functions from various studies and finds little consistency in the significance of regressors in the reaction functions. Judd and Rudebusch (1998) provided several possible explanations for such inconsistency such as the central bank's reaction function may be too complex for a simple linear regression and changes in the monetary policy committee over time which had different preferences for the policy reaction function. Therefore, nonlinear monetary reaction function may provide a more robust policy reaction function compared to a simple linear relationship. Many previous empirical studies have been conducted to test the validity of the Taylor rule, for example, Castro (2008) in United Kingdom, Molotsova et al. (2008) in German and Ncube and Tshuma (2010) in South Africa. The results have not yet come to an agreement about one robust long run relationship between inflation, nominal interest rates and output gap. Previous studies have shown that the outcomes were very sensitive to the sample used (country selected), period of study as well as the methodology. Furthermore, many studies (for instance Gerlach & Schnabel 2000, Woodford 2001, Smets 2002 and Orphanides 2003) assumed a linearity of monetary policy reaction function which is quite unrealistic assumption. This is because the monetary policy reaction function may be too complex to be sufficiently captured by a simple linear regression as the central bank may react differently towards different economic environment. Any studies on monetary policy reaction function will not be able to precisely represent the accurate form of policy reaction function. Leeper and Zha (2002) for instance, believe that a modest policy intervention, i.e., any changes in policy does not significantly shift agents' beliefs about policy regime and does not generate quantitatively important expectation is better in explaining policy reaction function. For example, whenever the central bank adjusts their short-term interest rate, they may react aggressively to the movement in interest rate if the current inflation is sufficiently above the stabilizing inflation rate. On the other hand, the short-term interest rate adjustment may be passive whenever the current inflation rate is around the targeted level. This will result in a non-linearity of the monetary policy.

In the Malaysian context, existing study relating to the Taylor rule and monetary policy reaction function are still limited in the literature. Pei-Tha and Kwek (2010), Umezaki (2007) and Ramayandi (2007) found that Malaysia monetary policy follows the Taylor Rule with inflation and output gap as the determinant of policy reaction function. Furthermore, Pei-Tha and Kwek (2010) conducted a Structural VAR and Impulse Response Function analysis and found that the BNM policy rates respond to the shock from inflation faster than the shock from the output gap. For example, Bank Negara Malaysia (BNM) respond to the shock from inflation immediately after the first quarter while BNM only respond to the shock from output gap at the third quarter. Another study for example Karim and Karim (2014), and Zaidi and Fisher (2010) have considered monetary policy reaction in Malaysia using a structural VAR model in an open-economy setting. They have included some foreign variables for example foreign monetary policy, foreign income, and oil prices in identifying monetary policy reaction function. Umezaki (2007) also studied the Taylor rule equation using Generalized Methods of Moments. The paper further tests the equation by using different proxy for exchange rate and found that the BNM's monetary policy reaction function also respond to the change in exchange rate and is best explained using real effective exchange rate.

An interesting study by Islam (2011) has estimated a linear Taylor rule for the case of Malaysia and found that BNM did not comply with the Taylor rule and the coefficients obtained were far from the expected value. Consequently, the author showed that using a counterfactual historical simulation, if BNM had been using the Taylor rule as the monetary policy reaction function, there would be a lower social cost to the economy and Malaysia would have a better overall macroeconomic performance. - Compared to previous studies in Malaysia, Pei-Tha and Han (2009) have estimated monetary policy reaction function differently by using Islamic interbank rate rather than the usual interest rate or the profit sharing ratio. They concluded that the Taylor rule using the Islamic interbank rate is superior and predicts the economy without riba better.

Thus, the main question is how does the BNM set their policy rates? Does the standard monetary policy reaction function, namely the Taylor rule really exist? Answering this two questions are pivotal for the BNM in designing their optimal policy rules in order to achieve the goal of price stability, and to sustain a long run economic growth.

The motivation of this study can be justified as follows. From the Malaysia's experience, the BNM has switched the monetary policy strategy from monetary targeting towards interest rate targeting in November 1995. Since then, monetary policy has been operating through short-term interest rates to attain the ultimate target that is a sustainable long-run economic growth, accompanied with price and financial stability. During the interest rate targeting, monetary policy in Malaysia can be categorized into three main evolutions. Firstly, from November 1995 up to September 1998, the BNM has introduced a new Base Lending Rate (BLR) framework, which takes into account the 3-month interbank rate in the BLR formula. Secondly, since September 1998, the BNM has employed interest rate targeting with a fixed exchange rate, and modified the BLR framework taking into account the Intervention Rate in the determination of BLR formula. At the same time, due to the currency crisis that occurred in the East Asian region, the BNM implemented capital controls to stabilize the economy. Thirdly, since April 2004, the BNM has introduced a new interest rates framework, the Overnight Policy Rate (OPR) to signal the monetary policy stance. During this period, the BNM has gradually liberalized capital control, and has eliminated the pegging with the US dollar since July 2005. The BNM believes that a change in the interest rates has a predominant effect on the domestic economy through monetary policy channel. Therefore, understanding how the BNM set its policy interest rates is very imperative for designing the optimal policy rates. This is due to the fact the BNM normally observes some macroeconomics indicators for example the current level of output gap and inflation in deciding the current level of policy rates.

This paper differs from the previous studies in few aspects. Firstly, this paper is the first to test the Taylor rule with non-linear parameters in Malaysia. Previous studies used various methods ranging from Ordinary Least Squares (Islam 2011), Structural VAR (Pei-Tha and Kwek 2010) and Generalized Methods of Moments (Ramayandi 2007 and Umezaki 2007). The non-linear parameter method is used compared to the other methods as monetary policy reaction function may be too complex to be sufficiently captured by a simple linear regression. Thus, the generalized form of Taylor rule may be a better device for the BNM to capture the key elements of policy in a variety of policy regimes. Secondly, although Judd and Rudebusch (1998) did not include exchange rate as a variable, this paper includes the exchange rate as a variable since Malaysia is considered a small open economy. Any change in the exchange rate will affect Malaysia's economic condition and as such, following Pei-Tha and Kwek (2010), Umezaki (2007) and Ramayandi (2007), the exchange rate is seen as an important variable to be included in the equation. Bank Negara Malaysia (1998) mentions the aim of the interest rate policy is "to balance the need to maintain price stability and a stable exchange rate while ensuring that productive activity is not undermined". Hence it reflects the importance of exchange rate in their monetary policy.

The plan of the paper is as follows. Section 2 explains model specification and the econometric model. The result of the empirical estimation is illustrated in section 3. Finally, section 4 concludes the paper.

MODEL SPECIFICATION AND ESTIMATION PROCEDURE

NON-LINEAR ESTIMATION OF THE TAYLOR RULE REACTION FUNCTION

Based on the Taylor's (1993) original work, the central bank targets the nominal interest rate, which is proxied by federal fund rate (i_t). The central bank targets its interest rate as a function of the equilibrium real interest rate (r_t^*), the current inflation rate (π_t), the percentage deviation of the real GDP from an estimate of its potential level (y_t) and the deviation of actual inflation from the rate of inflation targeted by the central bank (π^*). In functional form, the Taylor rule is given by:

$$i_t = \pi_t + r_t^* + 0.5y_t + 0.5(\pi_t - \pi^*) \quad (3)$$

where $y_t = 100\ (Y-Y^*)/Y^*$ with Y is the real GDP and Y^* is the last period real GDP. Taylor did not estimate this equation econometrically. However, he assumed that the weights on deviation of the real GDP and inflation from their potential level were both equal to 0.5. The intuition behind this monetary rule is straightforward. If the output gap is positive, it means GDP exceeds its potential level under full employment and this will put an upward pressure on wages and prices. In order to reduce the inflation pressure, the central bank will increase the targeted level of interest rates. In contrast, if the GDP gap is negative, the central bank will lower its targeted level of interest rate. Likewise, if inflation is greater than the targeted level, the central bank will increase the interest rate.

Judd and Rudebusch (1998) examined the alternatives to Taylor's simple specification by estimating the reaction function weights econometrically rather than simply choosing parameters equal to 0.5 as what Taylor did. They considered the dynamic specification in estimating reaction function base on the Taylor rule. In the specification, they replaced equation (3) with:

$$i_t^* = \pi_t + r_t^* + \lambda_1(\pi_t - \pi^*) + \lambda_2 y_t + \lambda_3 y_{t-1} \quad (4)$$

where i_t^* is the recommended interest rate that can be achieved through gradual adjustment. Equation (4) includes an additional lagged gap term along with the contemporaneous gap. This general specification would allow the central bank to respond to different variables proposed as effective monetary policy targets, including inflation, nominal GDP growth as well as both inflation and the GDP gap in level form.

The central bank may not be able to immediately reach its targeted level of interest rate. Now by taking into account the dynamics of adjustment of the actual level of interest rate, assume that the central bank's adjustment mechanism is:

$$\Delta i_t = (i_t^* - i_{t-1}) + \rho \Delta i_{t-1} \quad (5)$$

where γ is the speed of adjustment in the interest rate at time t and ρ reflects the persistence of the monetary policy that the central bank follows. After substituting equation (4) into equation (5), the following equation is obtained:

$$\Delta i_t = \gamma\pi_t + \gamma r^* + \gamma\lambda_1\pi_t - \gamma\lambda_1\pi^* + \gamma\lambda_2 y_{t-1} + \gamma\lambda_3 y_{t-1} - \gamma i_{t-1} + \rho\Delta i_{t-1} \quad (6)$$

which can be simplified as:

$$\Delta i_t = \gamma(r^* - \lambda_1\pi^*) + \gamma\pi_t(1 + \lambda_1) + \gamma\lambda_2 y_t + \gamma\lambda_3 y_{t-1} - \gamma i_{t-1} + \rho\Delta i_{t-1} \quad (7)$$

Denote $\alpha = r^* - \lambda_1\pi^*$, then

$$\Delta i_t = \gamma\alpha - \gamma i_{t-1} + \gamma\pi_t(1+\lambda_1) + \gamma\lambda_2 y_t + \gamma\lambda_3 y_{t-1} + \rho\Delta i_{t-1} \quad (8)$$

By adding an error term, Equation (8) can also be written in econometric form, which is as follows:

$$\Delta i_t = \beta_0 - \beta_1 i_{t-1} + \beta_2\pi_t + \beta_3 y_t + \beta_4 y_{t-1} + \beta_5\Delta i_{t-1} + \varepsilon_t \quad (9)$$

where: $\beta_0 = \gamma\alpha = \gamma(r^* - \lambda_1\pi^*)$
$\beta_1 = \gamma$
$\beta_2 = \gamma(1+\lambda_1) = \beta_1(1+\lambda_1)$
$\beta_3 = \gamma\lambda_2 = \beta_1\lambda_2$
$\beta_4 = \gamma\lambda_3 = \beta_1\lambda_3$
$\beta_5 = \rho$

Equation (9) is named as specification B in this study or so called Judd and Rudebusch's model that will be estimated.

Unlike Judd and Rudebusch (1998), we take a step further by considering an open economy version of the Taylor rule. Denoting E_t as the percentage change in the exchange rate and substituting this variable into equation (4), equation (10) is obtained:

$$i_t^* = \pi_t + r_t^* + \lambda_1(\pi_t - \pi^*) + \lambda_2 y_t + \lambda_3 y_{t-1} + \lambda_4 E_t \quad (10)$$

Again substituting equation (10) into equation (5), the following equation is obtained:

$$\Delta i_t = \gamma\alpha - \gamma i_{t-1} + \gamma(1+\lambda_1)\pi_t + \gamma\lambda_2 y_t + \gamma\lambda_3 y_{t-1} + \gamma\lambda_4 E_t + \rho\Delta i_{t-1} \quad (11)$$

By adding an error term, Equation (11) can also be written in econometric model form, which is as follows:

$$\Delta i_t = \beta_0 - \beta_1 i_{t-1} + \beta_2\pi_t + \beta_3 y_t + \beta_4 y_{t-1} + \beta_5 E_t + \beta_6 y_{t-1} + \varepsilon_t \quad (12)$$

where: $\beta_0 = \gamma\alpha = \gamma(r^* - \lambda_1\pi^*)$
$\beta_1 = \gamma$
$\beta_2 = \gamma(1+\lambda_1) = \beta_1(1+\lambda_1)$
$\beta_3 = \gamma\lambda_2 = \beta_1\lambda_2$
$\beta_4 = \gamma\lambda_3 = \beta_1\lambda_3$
$\beta_5 = \gamma\lambda_4 = \beta_1\lambda_4$
$\beta_6 = \rho$

Equation (12) is the econometric model to be estimated and is named as specification A. Hence, in this study, two model specifications of the Taylor rule are considered namely specification A and B. Since these reduced specifications are now restricted and nonlinear in parameters, we estimate equations (9) and (12) using nonlinear least square (to estimate these nonlinear models, we simply enter the nonlinear formula as in (9) and (12) and Eviews will automatically detect the nonlinearity and estimate the model using nonlinear least square). This method can estimate the parameters of reaction function separately as they appear in equation (9) and (12).

Based on all the parameters we can proceed with the hypothesis testing to examine the behaviour of the central bank. There are three possibilities about how the central bank sets its interest rate targeting. First, the central bank might respond by setting the interest rate according to the inflation alone (as in Meltzer 1987,Clarida, Gali and Gertler 1998 and Judd and Rudenbusch 1998), which is Ho: $\lambda_2 = \lambda_3 = \lambda_4 = 0$. Second if the central bank changes the interest rate based on the nominal output growth (as in McCallum 1981 and McCallum and Nelson 1999), the null hypothesis Ho: $\lambda_1 = \lambda_2 = -\lambda_3$, cannot be rejected. Finally if the Central bank reacts to inflation and output gap (as in Taylor 1993), the null hypothesis Ho: $\lambda_1 = \lambda_2 = \lambda_3 = 0$ will be rejected.

DESCRIPTION OF THE DATA

This study has employed quarterly frequency data for the period spanning from 1990 to 2014. The three-month Treasury bill is used as the nominal interest rate for the Taylor model (we confirmed in the Appendix (Figure 1) that the three month Treasury Bill move closely with the other benchmark interest rates). The real effective exchange rate is used as the proxy for the exchange rate. All the quarterly time series data for Gross Domestic Product (GDP), Consumer Price Index (CPI), three-month Treasury bill and the exchange rate were obtained from the International Financial Statistics by the International Monetary Fund (IMF). However, there is no data available for estimated output gap in Malaysia. Therefore, the potential GDP was estimated by applying a Hodrick-Prescott (1997) filter to the Malaysia's real GDP series. This technique was used by Taylor to estimate the potential GDP in his empirical studies of the monetary rule in U.S. This technique can generate a smooth estimate of the long-term trend component in a GDP series and can be used as a potential GDP.

RESULTS

In this subsection, we discuss the results obtained for nonlinear estimation of specifications A and B, which appear in previous equations (9) and (12) respectively. Table 1 summarizes the results for Taylor reaction function using different alternative specifications, namely specification A and specification B. The parameters λ_1, λ_2, λ_3 and λ_4 respectively represent the reaction coefficient on inflation, GDP gap, lagged GDP gap and the exchange rate. α and γ are constants and significantly different from zero for both specifications. The reaction coefficient on inflation, λ_1 is significant at 1 percent significant level with a negative coefficient of 0.79. This coefficient is relatively small compared to the findings by Taylor (1993, 1999) where the coefficient on inflation was equal to 1.5 for U.S. However the estimated weights on the GDP gap and on the lagged GDP gap are not significant for both the specifications. These finding are different from the past literatures, for instances Judd Rudebusch (1998), Rudebusch and Svensson (1999) and Taylor (1993, 1999) where the output gap is found to be important in determining how the central bank changes the interest rate.

Comparing with the past studies for Malaysia, this result is in line with studies by Pei-Tha and Kwek (2010), Umezaki (2007) and Ramayandi (2007) but is different from Islam (2011) who found no significant relationship between inflation and interest rate. The difference between our paper, Pei-Tha and Kwek (2010), Umezaki (2007) and Ramayandi (2007) and the one conducted by Islam (2011) is the inclusion of exchange rate as a variable in the Taylor equation. As Malaysia is a small open economy, the central bank takes into account the change in exchange rate as a factor for policy decision. As such, exchange rate plays a crucial role in the Taylor equation for the case of Malaysia.

It can also be seen that the exchange rate is important in determining the interest rate, targeted by the central bank. Thus, we can conclude that the specification 'A' with the exchange rate performs better than the other specifications and can be regarded as the best reaction function model. In addition, the coefficient on the lagged interest rate (ρ), which is a measure of the speed of adjustment of the interest rate to its targeted level, is not statistically significant for both specifications. The R^2 is very low for both the specifications with less than 20 percent variation in the dependent variable being explained by the independent variables in the model.

The main question of this study on the Taylor reaction function is to examine the benchmark variables that will enable the central bank to determine the interest rate. The first hypothesis is to test whether the central bank reacts based on inflation alone t (Ho: $\lambda_2 = \lambda_3 = \lambda_4 = 0$) cannot be rejected, suggesting that the inflation is the only variable that determines the policy rate. The same goes for the nominal output growth, where the hypothesis testing is not significant, only for specification B. Therefore the central bank does not set its interest rate based on the nominal output growth. However for the hypothesis whether the central bank determines the interest rate on the basis of both the inflation and output gap, only specification A is significantly different from zero while specification B is not significant. Therefore, for specification A (i.e., specification model with exchange rate) the central bank responds on the basis of both the inflation and output gap. This finding is similar to the results found by Taylor (1993).

To check for the robustness of the estimation, we have done several diagnostic tests. As summarized in Table 1, the diagnostic test shows that the residuals of the models are normally distributed and there is no ARCH effect. However the residuals have serial correlation. Although the serial correlation has problem with efficiency, i.e., standard errors will be smaller or greater than true standard errors, the results of nonlinear estimators are still unbiased or consistent. This is because the financial data is sensitive to the economic environment and hence the residuals tend to be correlated. In addition, we also estimate nonlinear monetary reaction function using other measurement or proxy for policy variable. Using 3 months interbank rate, we find that the coefficient signs and significance are not changing although there are slight changes in the size of coefficients (see Table A1 in Appendix). Furthermore, the implications on hypothesis testing also remain unchanged. Therefore, we can conclude that the previous results (in Table 1) are robust with respect to the measurement of policy variable used in the estimation. Perhaps, the reason is due to the fact that there is a direct and consistent movement between interbank rates and 3 month Treasury bill (see Figure 1 in the Appendix). We have also retested the model by considering the period of interest rates targeting regime, i.e. mid 1995. The results can be seen in the Appendix section, in Table A2. Again, the coefficient signs and significance of all variables remain unchanged although there are slight changes in the size of coefficient. In addition, the implications on hypothesis testing show consistent results with previous estimation that includes 1990-2014 as sample period. This result suggests that the previous results (in Table 1) are robust with respect to the sample period covered in the estimation.

CONCLUSIONS AND POLICY IMPLICATIONS

This study has examined the empirical validity of the Taylor reaction function for Malaysia using quarterly data from 1990 to 2014. In Malaysia, the interest rate targeting has been implemented to formulate the monetary policy and hence it is crucial to determine the factors that would affect the policy rate. The Taylor reaction function has been investigated using the nonlinear regression techniques for different alternative specifications. Since the exchange rate is significant in determining the policy rate, the specification that includes the exchange rate is the best model to reflect the monetary policy reaction function in Malaysia. The findings show that only inflation affect the policy rate while output gap is not an important variable in the determination of the policy rate. Using the Wald test to test the hypothesis, we found that the central bank sets its interest rate based on inflation alone or both inflation and output gap. However, the central bank does not set its interest rate according to nominal output growth. For the policy implication, this study helps various industries particularly the financial industries to better predict how central banks react to changes in economic well-being. Thus, it can provide a basis for forecasting the policy rate (i.e., short term interest rates) and for evaluating the effect of other policy actions such as fiscal policy as well as economic shocks. This paper suggests that the central bank of Malaysia

TABLE 1. Taylor Rule Reaction Functions – Alternative Specifications

	Specification A	Specification B
Parameters:		
γ	0.1623*	0.0807***
	(3.0525)	(1.9344)
α	-8.2121**	2.7421
	(-2.3368)	(1.5766)
λ_1	-0.7900*	-0.7483
	(-2.6691)	(-1.2442)
λ_2	0.1826	0.4078
	(1.5441)	(1.3713)
λ_3	0.0284	0.0207
	(0.2795)	(0.0990)
λ_4	0.1097*	
	(3.0669)	
ρ	-0.0537	-0.0771
	(-0.5121)	(-0.7199)
R^2	0.1709	0.1150
Adjusted R^2	0.1117	0.0630
Diagnostic Testing:		
Serial Correlation LM Test	0.6321	1.0227
Ho: No serial correlation	[0.5341]	[0.3641]
Jarque-Bera Normality Test	2.8846	2.8846
Ho: Normal	[0.2364]	[0.2364]
ARCH Test	0.1459	1.7446
Ho: No ARCH	[0.7034]	[0.1900]
Hypothesis Testing (Wald Test) F-Statistic		
The central bank responds based on:		
Inflation alone	3.7454**	1.0215
Ho: $\lambda_2 = \lambda_3 = \lambda_4 = 0$	[0.0141]	[0.3644]
Nominal Output Growth	4.0827**	1.2053
Ho: $\lambda_1 = \lambda_2 = -\lambda_3$	[0.0203]	[0.3047]
Both Inflation and Output Gap	2.732163*	0.849696
Ho: $\lambda_1 = \lambda_2 = \lambda_3 = 0$	[0.0488]	[0.4706]

*, **, *** = Significant at 1%, 5% and 10%

The number in ( ) and [ ] indicates the t-statistic and the probability respectively.

dampens inflationary pressure by changing its policy rate. The central bank follows the Taylor rule in formulating interest rates targeting to achieve the inflation target (price stability) and both inflation and output gap.

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APPENDIX

TABLE A1. Taylor Rule Reaction Functions – Using Interbank Rate as the Policy Rate

	Specification A	Specification B
Parameters:		
γ	0.1237**	0.0560
	(2.3976)	(1.2181)
α	-10.1527***	6.4215
	(-1.8979)	(1.4978)
λ_1	-1.3067**	-2.0477
	(-2.5899)	(-1.2776)
λ_2	0.1053	0.3423
	(0.7761)	(0.8448)
λ_3	0.1838	0.3653
	(1.2093)	(0.8402)
λ_4	0.1444**	
	(2.5028)	
ρ	0.1285	1.8686
	(1.2789)	(0.8636)
R^2	0.2129	0.1418
Adjusted R^2	0.1482	0.0838
Diagnostic Testing:		
Serial Correlation LM Test	2.6614	7.5055
Ho: No serial correlation	[0.0768]	[0.0011]
Jarque-Bera Normality Test	112.2646*	55.7313*
Ho: Normal	[0.0000]	[0.0000]
ARCH Test	5.3393	1.8217
Ho: No ARCH	[0.0235]	[0.1811]
Hypothesis Testing (Wald Test) F-Statistic		
The central bank responds based on:		
Inflation alone	2.2103***	0.4481
Ho: $\lambda_2 = \lambda_3 = \lambda_4 = 0$	[0.0941]	[0.7194]
Nominal Output Growth	3.4031**	0.8354
Ho: $\lambda_1 = \lambda_2 = -\lambda_3$	[0.0386]	[0.4378]
Both Inflation and Output Gap	2.3361***	0.5601
Ho: $\lambda_1 = \lambda_2 = \lambda_3 = 0$	[0.0808]	[0.6430]

, **, * = Significant at 1%, 5% and 10%*
The number in ( ) and [ ] indicates the t-statistic and the probability respectively.

TABLE A2. Taylor Rule Reaction Functions – Period after Interest Rate Targeting (1995-2014)

	Specification A	Specification B
Parameters:		
γ	0.1816*	0.0831***
	(3.1075)	(1.6861)
α	-10.3402**	2.9228***
	(-2.6125)	(1.7340)
λ_1	-0.7343*	-0.8941
	(-2.8067)	(-1.4203)

λ_2	0.1040 (1.0811)	0.3020 (1.1310)
λ_3	0.0324 (0.3405)	0.0829 (0.3704)
λ_4	0.1301* (3.2797)	
ρ	-0.1636 (-1.4961)	-0.1562 (-1.3617)
R^2	0.2081	0.1159
Adjusted R^2	0.1392	0.0528
Diagnostic Testing:		
Serial Correlation LM Test *Ho: No serial correlation*	0.7437 [0.4792]	2.1485 [0.1245]
Jarque-Bera Normality Test *Ho: Normal*	1994.183* [0.0000]	926.3424* [0.0000]
ARCH Test *Ho: No ARCH*	0.0008 [0.9769]	0.8024 [0.3733]
Hypothesis Testing (Wald Test) F-Statistic *The central bank responds based on:*		
Inflation alone *Ho:* $\lambda_2 = \lambda_3 = \lambda_4 = 0$	3.9225** [0.0120]	0.9486 [0.4220]
Nominal Output Growth *Ho:* $\lambda_1 = \lambda_2 = -\lambda_3$	4.4145** [0.0157]	1.2717 [0.2867]
Both Inflation and Output Gap *Ho:* $\lambda_1 = \lambda_2 = \lambda_3 = 0$	2.9436** [0.0390]	0.8631 [0.4645]

, **, * = Significant at 1%, 5% and 10%*
The number in ( ) and [ ] indicates the t-statistic and the probability respectively.

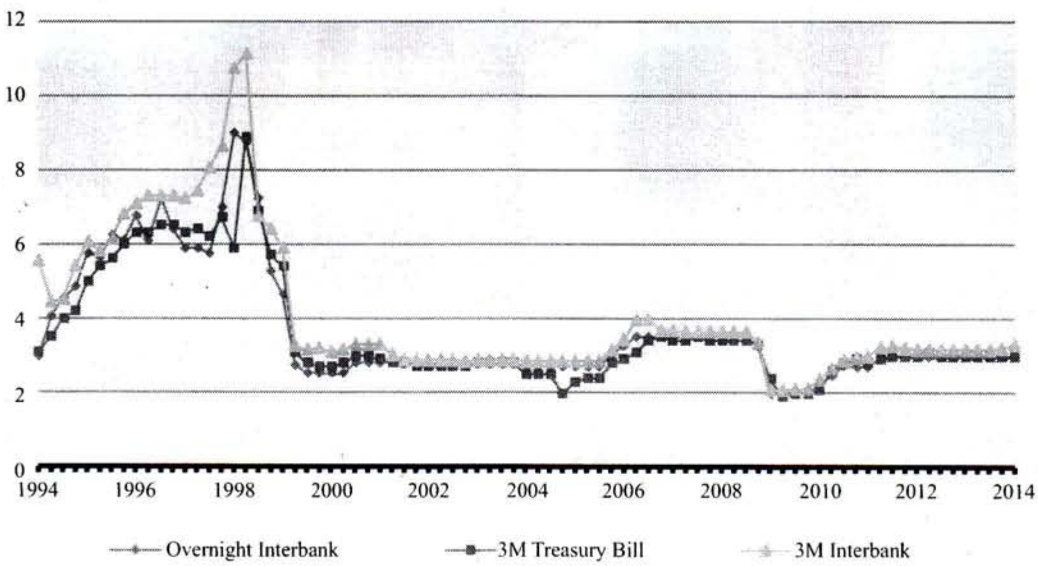

FIGURE 1. Trend of Various Measurements for Short Term Policy Rates
Source: International Financial Statistics, IMF