The Lahore Journal of Economics
16 : SE (September 2011): pp. 215-232

The Economics of Inflation, Issues in the Design of Monetary Policy Rule, and Monetary Policy Reaction Function in Pakistan

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Abstract

The objective of this study is to estimate a monetary policy reaction function for Pakistan. To do this, we use data for the period 1992Q4–2010Q2. Our results show that the State Bank of Pakistan reacts to changes in the inflation rate and economic activity in a manner that is consistent with the Taylor (1993) rule, and with the explicit objective of interest rate smoothing and exchange rate management. This policy has remained consistent for most of the sample period, except for the last two years, during which a price hike and the massive depreciation of domestic currency led to a significant change in the parameters of the policy reaction function. We also find evidence of nonlinearity in the reaction function as the response to an inflation rate above 6.4 percent is found to be more aggressive than that in low inflationary episodes.

Keywords: Inflation, Monetary Policy, Pakistan.

JEL Classification: E52, P44.

1. Introduction

The ultimate objective of monetary policy is to maximize society's welfare, which can be achieved by keeping unemployment at its natural rate and prices stable. If some labor is unemployed, output remains below its potential level, which results in lower living standards. If the inflation rate exceeds a certain threshold, it is harmful for economic growth. Price instability is a major source of uncertainty in financial markets since it distorts economic choices for economic agents, thereby causing the economy to perform below its potential level.[1] The stability of certain other

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[1] Note, however, that central banks can reduce unemployment and promote output growth in the long run only through price stability.

economic indicators such as the interest rate and exchange rate also helps achieve the objective of social welfare. Abrupt changes in the interest rate, for instance, destabilize the financial system, resulting in the poor intermediation of loanable funds. Sudden changes in the exchange rate destabilize international trade and discourage foreign investment. Therefore, monetary policy is concerned mostly with keeping output at its potential level while keeping prices, the interest rate, and exchange rate stable. The real challenge for monetary authorities, however, is to resolve the tradeoff among these objectives, especially in the short run. Thus, the art of monetary policy lies in being able to achieve an optimal mix of these variables, in which case policy is said to be optimal.

In designing monetary policy, an important issue is the choice of appropriate variables to target and the numerical targets for those variables. The vector of chosen variables may include the inflation rate, a measure of real activity, the interest rate, and the exchange rate. A zero-output gap may be used as a benchmark for real activity, but the real gross domestic product (GDP) growth rate is also an option. It must be said at the outset, however, that monetary policy alone cannot maintain a high growth rate in the long run. To achieve price stability, which is the primary objective, the threshold rate of inflation (above which inflation is harmful for economic growth) can be considered a target. The nominal exchange rate is adjusted such that the misalignment of the actual real exchange rate from its equilibrium value is minimal. Finally, the interest rate—the policy instrument—is adjusted gradually to avoid abrupt changes.

Monetary authorities achieve these objectives through one of two alternative policy frameworks: rules and discretion. The discretionary framework is more flexible on the part of the policymaker, and so appropriate decisions can be made according to current and expected future economic conditions. However, Kydland and Prescott (1977) argue that even optimal discretionary policies are time-inconsistent. These inconsistent policies create uncertainty in financial markets and even in the labor and goods markets.

A policymaker may lose credibility through policy reversals. Taylor (1993) prescribed a simple, easily verifiable rule for monetary policy according to which the short-term interest rate (the monetary policy instrument) responds to the deviation of the inflation rate from the target and that of output from its potential level. Later, this rule was augmented by incorporating the exchange rate and lagged interest rate. An important issue in this regard is the functional form of the reaction function. In one setting, the monetary policy instrument is formulated as a linear function of the target variables. At the same time, this would be inappropriate if there were regime shifts in the history of monetary policy, in which case the rule would become nonlinear (Davig & Leeper, 2007; for details on regime shifts, see Hamilton, 1989).

The objective of this study is to compare the monetary policy reaction function in Pakistan with the benchmark Taylor rule. More specifically, we carry out the following. First, we estimate a policy reaction function with the short-term interest rate as the policy instrument and the output gap and inflation rate as target variables. Second, we re-estimate the reaction function by augmenting the vector of the target variables with the lagged interest rate and exchange rate. Third, we use recursive estimates to investigate policy consistency. Fourth, we estimate the threshold rate of inflation, which is the turning point of the monetary authority's degree of leaning against the wind. Fifth, we compare the monetary authority's response to inflation in a high inflationary regime to that in low inflationary episodes. Finally, we carry out all this twice: one for the full sample period 1992Q4–2010Q2 and the other for a subsample 1992Q4–2008Q1. The rationale for this division is the price hike and massive currency depreciation that occurred during the last two years of the sample period. Thus, these years are treated as abnormal.

The rest of the study proceeds as follows. The methodology is explained in Section 2. Detailed results are presented and discussed in Section 3, while Section 4 concludes the study.

2. Methodology and Data

Linear Monetary Policy Reaction Function

We begin the estimation by adopting the static version of the Taylor rule, in which the short-term nominal interest rate is the sum of the equilibrium real interest rate, current inflation rate, and a weighted average of deviation of output from its potential and that of the inflation rate from its target.

The original specification in Taylor (1993) is given as:

$$i_t = r^* + \pi_t + \alpha_y y_t + \alpha_\pi (\pi_t - \pi^*) \quad (1)$$

Here, i is the nominal short-term interest rate (the monetary policy instrument), r^* is the equilibrium real interest rate, π is the current inflation rate, y is the output gap, and π^* is the target inflation rate. α_y and α_π are the response coefficients. As r^* and π^* are assumed to be constant, the equation can be converted into estimable form as:

$$i_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + u_t \qquad (2)$$

Here, $\beta_0 = r^* - \alpha_\pi \pi^*, \beta_1 = \alpha_y, \beta_2 = 1 + \alpha_\pi$, and u is the error term capturing any deviation from the Taylor rule. The hypothesized values of these parameters are $\beta_1 > 0$, $\beta_2 > 1$, and β_0 may be negative or positive.

The original model is augmented by incorporating the difference of the exchange rate as an additional policy variable, since exchange rate management is one of the important objectives of monetary policy (see, for instance, Lubik & Schorfeide, 2005). This version is to verify whether or not the SBP pursues exchange rate stability:

$$i_t = \beta_0 + \beta_1 y_t + \beta_2 \pi_t + \beta_3 (e_t - e_{t-1}) + u_t \qquad (3)$$

Here, e is the nominal direct exchange rate (domestic currency price of one unit of foreign currency), so an increase in e means that the domestic currency has depreciated and $(e_t - e_{t-1})$ is the difference of the exchange rate. β_3 is assumed to be positive since the depreciation of domestic currency calls for an increase in the interest rate to discourage capital outflows.

In the third step, we move to the dynamic version of the rule, under which monetary authorities try to change the interest rate gradually to stabilize the financial system. This implies that most central banks follow the explicit objective of interest rate smoothing. In fact, the earliest function of a central bank was to ensure financial stability. This objective makes the error term in the static version of the Taylor rule serially correlated, in which case the results of this version are subject to a specification bias. Thus, the appropriate model is constructed as:

$$\begin{aligned} i_t &= \beta_0 + \beta_1 y_t + \beta_2 \pi_t + u_t \\ u_t &= \rho u_{t-1} + \xi_t \end{aligned} \qquad (4)$$

The error term is assumed to be serially correlated of order 1, where ρ is the autocorrelation coefficient. ξ is an error term with mean 0 and constant variance, and is serially uncorrelated. This two-equation system can be solved to determine the dynamic version of the Taylor rule as:

$$i_t = \rho i_{t-1} + (1-\rho)(\beta_0 + \beta_1 y_t + \beta_2 \pi_t) + \xi_t \quad (5)$$

Here, (1 - ρ) β_1 and (1 - ρ) β_2 are short-run response coefficients while β_1 and β_2 remain the same in the long run. Finally, we incorporate the exchange rate into the dynamic version to complete the specification.

$$i_t = \rho i_{t-1} + (1-\rho)(\beta_0 + \beta_1 y_t + \beta_2 \pi_t + \beta_3 (e_t - e_{t-1}) + \xi_t \quad (6)$$

Nonlinear Monetary Policy Reaction Function

The equations above (Taylor rule) specify the interest rate as a linear function of the target variables. However, the policy maker's response to these target variables may change under different regimes, such as during a boom and recession or high and low inflationary episodes. In this study, we estimate the threshold rate of inflation, which is the turning point of the policy response coefficients. For this purpose, we use the following specification:

$$i_t = \rho i_{t-1} + (1-\rho)(\beta_0 + \beta_1 y_t + \beta_2 \pi_t + \beta_3 (e_t - e_{t-1}) + \beta_4 \pi_t * DUM + \xi_t \quad (7)$$

DUM is a dummy variable with a value of 1 if the inflation rate is above the threshold and 0 otherwise. To estimate the threshold, the data on inflation is arranged in ascending order and 30 percent of the observations with extreme values on either side are excluded. Every remaining value of the rest of the series is considered, in turn, to be the threshold. For each of these values, we construct a dummy variable and estimate Equation (7). The regression with the lowest residual sum of squares yields the threshold rate of inflation (for more details on this estimation procedure, see Enders, 2010).

Data and Variables

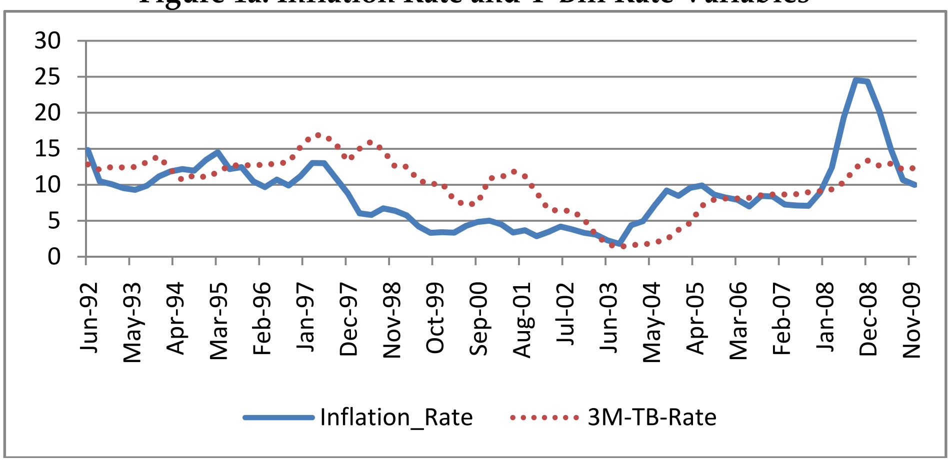
We use the three-month t-bill rate as the monetary policy instrument. In Pakistan, the interest rate charged on discount window borrowing is used as the policy rate, whereas the overnight offered rate is the operational target. However, due to data limitations for the sample period, we use the t-bill rate as the policy instrument. Prior to 2009, the State Bank of Pakistan (SBP) would decide on a cut-off yield on the auction of t-bills that was mostly in line with the overall monetary policy stance.

For the output gap, we fit the quadratic trend in constant price GDP and then calculate the percentage deviation of actual output from the trend values. The inflation rate is measured as the percentage difference of the consumer price index (CPI) in the current quarter over the CPI in the corresponding quarter of the previous year. Data on the interest rate, nominal spot exchange rate, and CPI is taken from the SBP bulletin, and data on GDP from Arby (2008).

3. Results and Discussion

Before embarking on a formal estimation procedure, it is constructive to illustrate the variables used in the study. Figure 1a shows that the short-term interest rate is positively related to the inflation rate, but the turning points show that the latter takes the lead and the interest rate follows.

Figure 1a: Inflation Rate and T-Bill Rate Variables

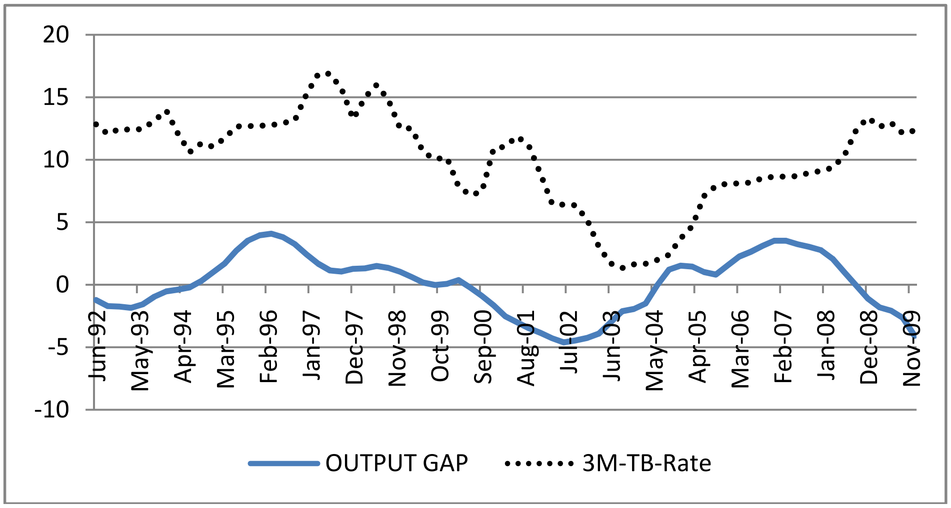


Source: Authors' calculations based on data from the State Bank of Pakistan and Arby (2008).

After the first quarter of 2007/08, the inflation rate begins to accelerate and reaches the historically high level (i.e., for the sample period) of 25 percent. The interest rate, however, does not increase much during this period. The interest rate is also positively related to the output gap, which it largely follows except for the last two years when both series follow almost opposite trends (Figure 1b). The inflation rate was quite high at the time, and the SBP raised the interest rate to curb inflation despite there being an economic downturn.

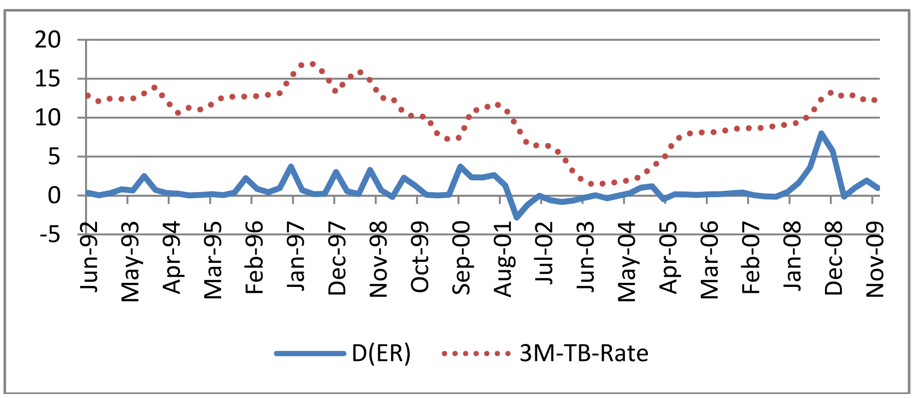
Changes in the exchange rate seem to be mostly independent of the interest rate. However, both series are strongly correlated in the last two years of the sample period in which they show an increasing trend. This is when the rupee depreciated against the dollar by almost 38 percent after a long period of overvaluation (of the rupee). To discourage capital outflow, the SBP raised the interest rate.

Figure 1b: Output Gap and T-Bill Rate Variables



Source: Authors' calculations based on data from the State Bank of Pakistan and Arby (2008).

Figure 1c: Exchange Rate and T-Bill Rate Variables



Source: Authors' calculations based on data from the State Bank of Pakistan and Arby (2008).

Estimating the Linear Policy Reaction Function

In the first step toward formally estimating the linear policy reaction function, we estimate four specifications of the Taylor-type reaction function: (i) the static version without the exchange rate, (ii) the static version with the exchange rate, (iii) the dynamic version without the exchange rate, and (iv) the dynamic version with the exchange rate. As Table 1 shows, in the first rule, the coefficient of the inflation rate is significantly greater than 0 but less than 1, and the coefficient of the output gap is not different from 0. However, these results are spurious as the Durbin-Watson (DW) statistic is close to 0, indicating strong positive autocorrelation. This almost perfect autocorrelation is a symptom of missing variables in the rule, especially the lagged interest rate.

The low value of R^2 also indicates the same problem. To augment the reaction function with the objective of stabilizing the exchange rate, we estimate the reaction function with a difference of exchange rate as one of the regressors. Again, the results remain more or less the same—the coefficient of the exchange rate is not different from 0. This points once again to missing variables since both the R^2 and DW statistics are quite low. We then estimate the dynamic version of the policy reaction function, which explicitly considers the central bank's objective of smoothing the interest rate. This time, R^2 is quite high, which indicates a good fit for the model. At the same time, however, we cannot reject the null hypothesis of no autocorrelation with a 95 percent degree of confidence.[2]

[2] We use the LM statistic to test the presence of autocorrelation as the lagged dependent variable is one of the regressors.

Table 1: Estimation Results for Monetary Policy Reaction Function for Whole Sample

	Rule 1	Rule 2	Rule 3	Rule 4
Constant	6.93	7.19	1.38	2.90
	(0.00)	(0.00)	(0.71)	(0.41)
Output gap	0.24	0.26	1.07	1.08
	(0.19)	(0.16)	(0.05)	(0.03)
Inflation rate	0.35	0.28	0.98	0.61
	(0.00)	(0.01)	(0.00)	(0.04)
Lagged interest rate			0.90	0.89
			(0.00)	(0.00)
Exchange rate difference		0.37		1.89
		(0.23)		(0.03)
Adjusted R-squared	0.22	0.22	0.93	0.93
DW statistic	0.12	0.17		
F-statistic	10.74	7.41	306.79	246.09
	(0.00)	(0.00)	(0.00)	(0.00)
LM statistic			3.75	1.28
			(0.05)	(0.26)

The sample period is 1992:2–2010:2. P-values are given in parentheses.
Source: Authors' calculations.

The policy response coefficients of the output gap and inflation rate and the coefficient of the lagged interest rate are still statistically different from 0. The coefficient of the inflation rate is 1, which fulfills the basic requirement of stability of the system. The coefficient of the output gap is somewhat greater than that of the inflation rate, showing to a greater degree the central bank's concern with real stabilization. The statistical significance and relatively high value of the coefficient of the lagged interest rate confirms the central bank's objective of smoothing the interest rate. We can conclude from the results that only the dynamic version of the Taylor rule fits the Pakistani data well.

Finally, we estimate the dynamic version of the model with the difference of the exchange rate as a regressor. The results in the last column in Table 1 show that the results above remain robust given this change in the model. The only difference is the decrease in magnitude of the coefficient of the inflation rate, which could be due to multicollinearity between the exchange rate and inflation rate. The results also verify that the SBP does focus on exchange rate stabilization.

Results of the Subsample

In the last specification of the policy reaction function, the overall fit of the model was good but of the model itself did not conform to the Taylor principle since the coefficient of the inflation rate was significantly lower than 1. This may have been due to the abnormal inflation rate observed in the last two years of the sample period, during which inflation was a supply-side issue and the economy faced stagflation. Thus, any deflationary policy would have further slowed down economic activity.

As Figures A1 and A2 (see Annexure) show, the benchmark Taylor rule would suggest an interest rate as high as 35 percent. This rate is psychologically too high, and the SBP may not have been able to garner public support for the policy. Instead, it chose to set the interest rate at only about 14 percent during the high-inflationary episode. To avoid this abnormal period, we estimate all four specifications using a subsample that excludes the last two years (see Table 2).

The results of this subsample conform to those in the full sample. The objective of interest rate smoothing is given a high weight in policy design, while the exchange rate plays a role in monetary policy setting. The response coefficients of the inflation rate and output gap are significant only if we eliminate autocorrelation from the model. The only difference in the results is the magnitude of the coefficient of the inflation rate: it is greater than 1 in both specifications of the dynamic version of the rule. Moreover, the magnitude of this coefficient is now greater than that of the output gap, implying that the SBP gives more weight to the inflation rate than to real stabilization when setting the policy instrument. The results of the full sample were, therefore, biased due to the high rate of inflation, which acted as an outlier.

Table 2: Estimation Results for Monetary Policy Reaction Function for Subsample

	Rule 1	Rule 2	Rule 3	Rule 4
Constant	5.46	4.77	-0.04	-0.212
	(0.00)	(0.00)	(0.99)	(0.95)
Output gap	0.16	0.05	0.88	0.49
	(0.48)	(0.84)	(0.20)	(0.36)
Inflation rate	0.56	0.57	1.19	1.06
	(0.00)	(0.00)	(0.02)	(0.00)
Lagged interest rate			0.90	0.87
			(0.00)	(0.00)
Exchange rate difference		1.06		2.38
		(0.01)		(0.00)
Adjusted R-squared	0.22	0.33	0.93	0.94
DW statistic	0.12	0.38		
F-statistic	10.74	10.89	266.07	221.66
	(0.00)	(0.00)	(0.00)	(0.00)
LM statistic			3.70	0.10
			(0.05)	(0.75)

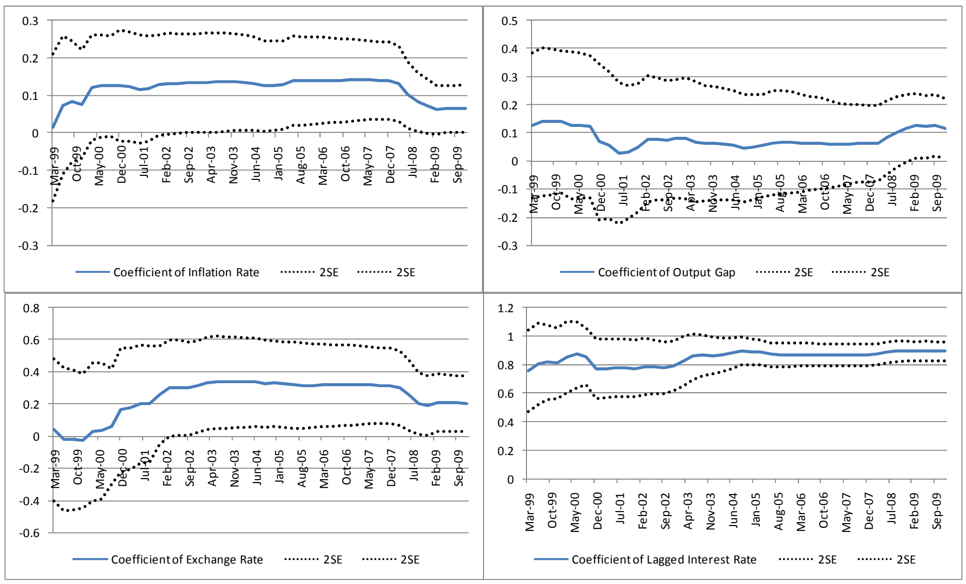
The sample period is 1992:4–2008:1. P-values are given in parentheses.
Source: Authors' calculations.

Consistency of Policy

Next, we investigate the consistency of the monetary authority in setting the monetary policy instrument. For this purpose, we use recursive estimates of the coefficients and their standard errors for the last (fourth) specification of the Taylor rule as applied to the full sample. Figure 2 shows that the only stable parameter is the coefficient of the lagged interest rate, indicating the consistent behavior of policymakers with regard to interest rate smoothing. The coefficients of the other three variables—the inflation rate, output gap, and difference of exchange rate—are not stable throughout the sample period.

It is worth noting that all these coefficients are stable for the period 2001–07. The coefficient of the inflation rate decreases after 2007, which shows a fall in the weight given to price stability. However, this could be attributed to an abnormally high rate of inflation when the monetary authority could not increase the interest rate. At the time that the SBP tried to raise the discount rate, it came under serious criticism from industry and from academic circles. The interest rate was thus set at a level that was smaller than half of what the benchmark Taylor rule would have prescribed.

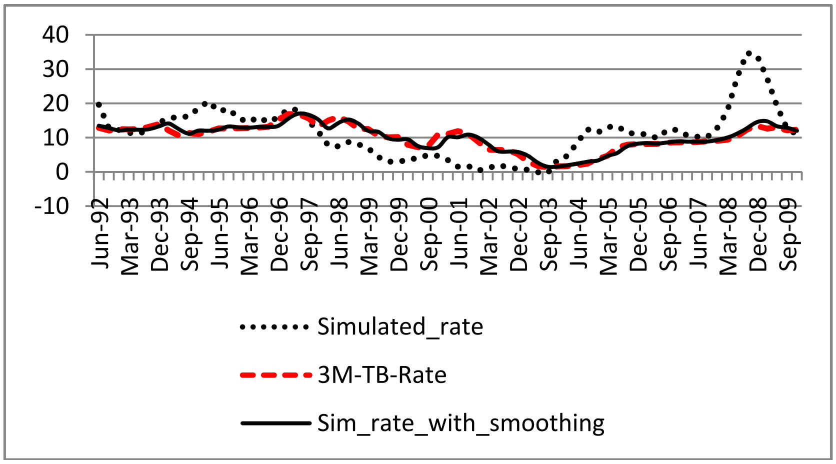
Figure 2: Recursive Estimates for Policy Reaction Function



Source: Authors' calculations.

Since economic activity was shrinking at the time, the SBP did not adopt a deflationary policy for fear of further slowing down business activity. This is evident from the upper-right panel of Figure 2 as the coefficient of the output gap begins to rise after 2007. The decline in the coefficient of the exchange rate post-2007 can be similarly interpreted. At the time, domestic currency had depreciated by almost 38 percent, so the SBP tried to raise the interest rate to discourage capital outflow. However, the rise in the interest rate was not comparable with the increase in the exchange rate.

Figure 3: Actual and Simulated Interest Rate



Source: Authors' calculations.

Estimating Nonlinear Policy Reaction Function

Finally, we estimate the threshold inflation rate in order to identify different policy responses to high and low inflationary regimes. To do this, we use the methodology outlined in Section 3, i.e., we use the dynamic version of the Taylor rule with price stability, real stabilization, exchange rate stability, and interest rate smoothing as policy goals. This is carried out both for the whole and subsamples (see Table 3).

Table 3: Estimation of Nonlinear Taylor Rule

	Coefficient	**P-Value**	**Coefficient**	**P-Value**
	Sample: 1992:2–2010:2		Sample: 1992:2–2008:1	
Constant	-3.27	(0.42)	-8.13	(0.01)
Output gap	1.45	(0.00)	0.81	(0.04)
Inflation rate above threshold	2.91	(0.00)	3.75	(0.00)
Inflation rate below threshold	1.09	(0.00)	1.69	(0.00)
Lagged interest rate	0.89	(0.00)	0.84	(0.00)
Exchange rate difference	1.27	(0.10)	1.81	(0.00)
Threshold inflation rate	6.37		6.37	
Adjusted R-squared	0.94		0.95	
F-statistic	216.19		228.24	
	(0.00)		(0.00)	

Source: Authors' calculations.

The threshold inflation rate is found to be 6.4 percent. Thus, in terms of the monetary authority's reaction to a price hike, the period marked by an inflation rate above this threshold rate is considered a high inflationary period. Moreover, we find that the SBP gives more weight to price stability when the economy falls under a high inflationary regime. Again, the results of the subsample confirm that the relatively high response coefficient of the output gap is due to the high inflation rate prevailing in the last two years of the sample.

4. Summary Findings and Concluding Remarks

The study's objective was to estimate a monetary policy reaction function for Pakistan for the sample period 1992Q4–2010Q2. We have estimated both static and dynamic versions of the Taylor rule with exchange rate stabilization as a monetary policy objective. The results have shown that the dynamic version of the rule fits the data fairly well but the static version does not. The SBP focuses on price stability along with some real stabilization and exchange rate management, but its most significant objective is to smooth the interest rate in order to protect the financial system from abrupt changes.

The response of the interest rate to the target variables is significantly different for the period 2008Q1–2101Q2 compared to other sample periods. The inflation rate jumped to 25 percent during this period, economic activity slowed down, and the rupee depreciated by almost 38 percent. Given the high inflation rate and massive depreciation of domestic currency in the last two years of the period, the benchmark Taylor rule would have suggested setting an interest rate as high as 35 percent, whereas the SBP faced serious criticism at the time and increased the discount rate to 15 percent. We have also found that the threshold rate of inflation is 6.4 percent, above which the SBP reacts more strongly to inflation.

The different responses of policy in the last two years of the sample period raise some issues that need further discussion. First, the SBP faces a great deal of pressure from politicians, industry, the media, and even academia when it raises the interest rate. This may be due to lobbying by rent seekers who enjoy a handsome rent through low interest rates. Second, central banks make only gradual changes to the interest rate in order to stabilize financial markets. Third, central banks face serious trouble in periods of stagflation. Raising the interest rate to curb inflation could cause economic activity to slow down. In the last two years of the sample period, prices and the exchange rate increased along with the negative output gap, and so the SBP did not take the tight stance that it would otherwise have taken.[3] Finally, most contemporary central banks in the world are forward-looking, so any price hike that is expected to be short-lived, does not call for changes in the policy instrument.

[3] The SBP raised its policy rate at the time, but the increase was smaller than the growth rate of prices, which reduced the real cost of borrowing.

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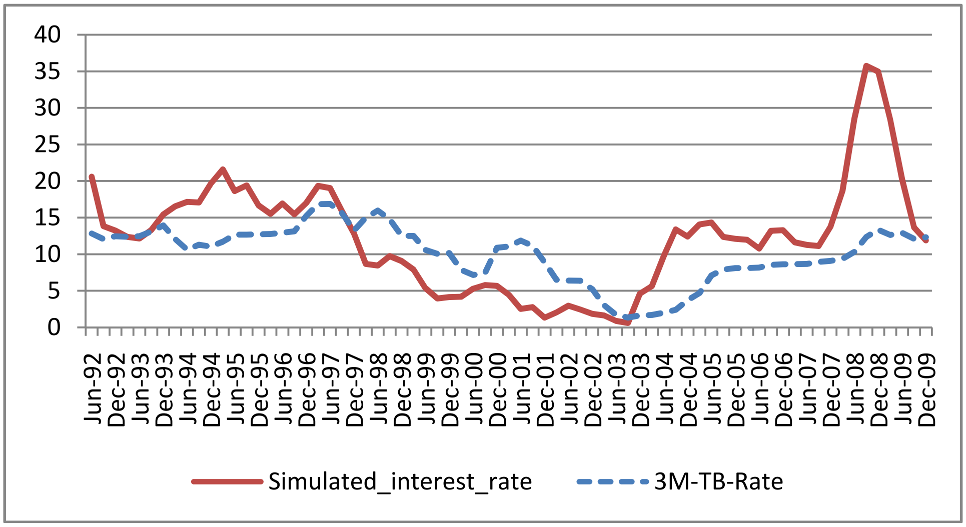
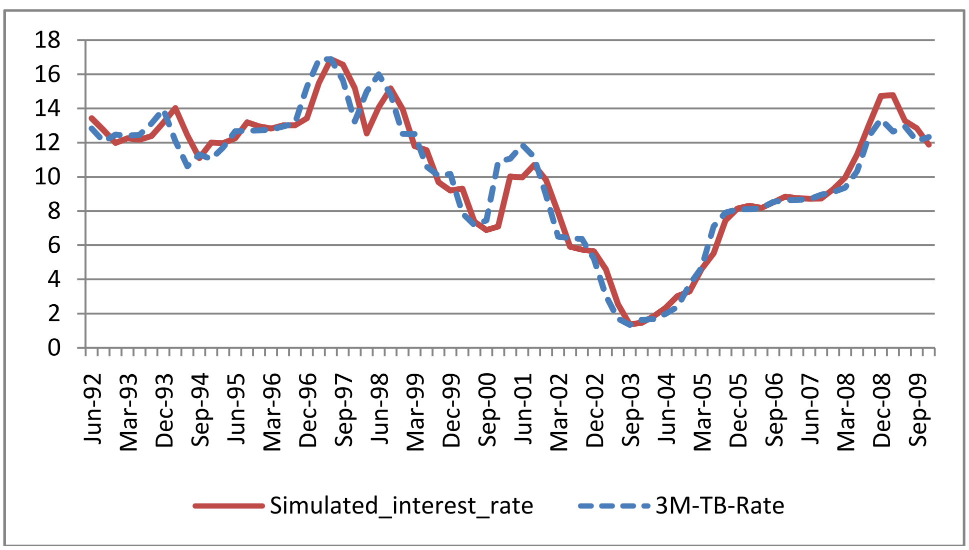
Annexure

Figure: A1



Source: Authors' calculations based on data from the State Bank of Pakistan and Arby (2008).

Figure: A2



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