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Taylor Rule and the Macroeconomic Performance in Pakistan

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A near-consensus position in modern macroeconomics is that policy rules have greater advantage over discretion in improving economic performance. For developing countries in particular, simple instrument rules appear to be feasible options as pre-requisites since more sophisticated targeting rules are generally lacking. Using Pakistan's data, this study has attempted to estimate the Taylor rule and use it as monetary policy strategy to simulate the economy. Our results indicate that the State Bank of Pakistan (SBP) has not been following the Taylor rule. In fact, the actual policy has been an extreme deviation from it. On the other hand, counterfactual simulation confirms that macroeconomic performance could have been better in terms of stability of inflation and output, had the Taylor rule been adopted as monetary policy strategy. The study also establishes that further gains are possible if the parameter values of the rule are slightly modified.

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1. INTRODUCTION

A near-consensus position in modern macroeconomics is that policy rules have greater advantage over discretion in improving economic performance [Taylor (1993)]. Through seminal papers, Kydland and Prescott (1977) and Barro and Gordon (1983) have convincingly shown that discretionary policies are time inconsistent. However, the adverse outcome can be avoided if private agents pursue a punishment policy of higher inflationary expectations that may cause loss of reputation of the monetary authority [Barro and Gordon (1983a)]. Alternatively, ensuring independence of the Central Bank may also reduce inflationary bias [Sargent and Wallace (1981), Rogoff (1985), Alesina and Summers (1993), and Walsh (1995) among others].

Interestingly, despite this overwhelming support initially for money growth targeting and later for inflation targeting, it was not clear how a rule could be used in practical policy formulation process until Taylor (1993) presented a state-contingent interest rate rule that is both, practicable and simple.[1] It calls for changes in the short-

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[1]As instrument rules are simple, robust, easily verifiable and strict and there is fundamentally no role of policy-maker's judgment in time to time decisions, commitment to these rules is a good and feasible monetary policy strategy for developing countries. Compared to this, targeting rules (attributed to Svensson) are even though optimal and flexible, but not simple.

term interest rate (monetary policy instrument) in response to deviation of output from trend or potential level and that of inflation from the target with *equal weight* given to both these objectives in the policy reaction function. Taylor argues that adoption of the simple rule not only has the potential of improving macroeconomic performance, it also avoids the time inconsistency problem. He further maintains that the rule does not suffer from enforcement problem because of its easy verifiability by agents outside the central bank. In this context, commitment to this rule becomes technically feasible.

The purpose of the present study is to revalidate the Taylor rule by estimating it for Pakistan. It needs to be established whether or not the State Bank of Pakistan (SBP)—the Monetary Authority—has been following such a policy rule for the simple reason that historically Pakistan has experienced cycles in inflation and real economic activity. Inflation reached its peak of 23 percent in 1974, and touched the lowest level of 2.4 percent in 2002. Similarly, the real output growth varied between 8.7 percent in 1980 and –0.1 percent in 1997.[2] Besides this inconsistent macroeconomic performance, Pakistan's economy also suffered from weak institutional set -up. Not only that the independence of the central bank was continuously challenged, it also had to withstand regular fiscal pressures which largely weakened the monetary policy stance. Furthermore, there was a constant struggle for maintaining stability of the exchange rate.

Given these weaknesses, one would have argued that adoption of a simple instrument rule—like the Taylor rule—might have been a natural and feasible option. Given this perspective, the second objective of the study is to assess the macroeconomic performance on the basis of variability of inflation and output. For this purpose, the economy has been simulated, with and without Taylor rule, as monetary policy strategy. Finally, using counterfactual simulations, the study also investigates whether the parameter values of the Taylor rule (the weights on output and inflation stabilisation, and the inflation target) are optimal for Pakistan or some modification is needed to have better results.

The paper proceeds as follows. In Section 2, the two types of monetary policy rules, namely the instrument rules and the targeting rules, are defined and explained. The methodology for estimation, backcasting, and counterfactual simulation is presented in Section 3. An exhaustive discussion of empirical findings is the subject matter of Section 4. The final section summarises the main findings and offers insights for further research.

2. MONETARY POLICY RULES

A monetary policy rule can be defined as a description—expressed algebraically, numerically, and/or graphically—of how the instruments of policy, such as monetary base or the discount rate, change in response to economic variables [Taylor (1999b)]. Policy rules are similar to constant growth rate rules for money supply. However, in a broader sense, feedback rules such as money supply response to changes in unemployment and/or inflation etc. are preferred policy rules. As indicated, there is a near-consensus among macroeconomists that policy rules have greater advantage over discretion in improving economic performance. This, however, requires that the rule is

[2]It may be recalled that a country cannot graduate from low-income to middle-income status unless it registers a long period of high and sustained growth where the stability of prices is also ensured [Fischer (1993)].

adopted and followed for a reasonably long period of time to reap the benefits of stabilisation and the credibility associated with the rule. The literature related to rules versus discretion debate distinguishes between simple *instrument rules* [proposed by McCallum (1988); Taylor (1993) and others] and *targeting rules* due largely to Svensson (1997, 2002, 2003). The choice between the two reduces to such concerns as simplicity, robustness, reliability, practicability, technical feasibility, result-orientation and the role of policy-maker's judgment in decision-making. We begin with a brief review of the two rules.

Instrument Rules: Instrument rules are state-contingent reaction functions that link the policy tool with performance indicators of the economy [Meltzer (1987), McCallum (1988), Taylor (1993), and Henderson and McKibbin (1993)]. These rules are simple to follow and require little amount of information. These are robust and technically feasible in the sense that commitment to rule is easily verifiable. Of different variants, the one that has attracted most of the attention during 1990s has been the Taylor (1993) rule. Taylor offered an instrument rule to conduct monetary policy operations by setting the target for federal funds rate (operational target) equal to an 'equilibrium' real funds rate plus the current inflation and adding to it a weighted average of monetary authority's response to the deviation of current inflation from the target and percentage deviation of the real GDP from an estimate of its potential or full-employment level. He considered it to be an 'optimal' policy as it relates a plausible instrument to reasonable goal variables and performs reasonably well in a variety of macroeconomic models.[3] The rule can be described by the following equation:

$$i_t = r^* + \pi_t + \alpha_1 y_t + \alpha_2 (\pi_t - \pi^*) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (1)$$

where r^* is the long-run equilibrium real interest rate, π_t is the current inflation rate (Taylor takes this as last four quarters average inflation including the current quarter), π^* is the target inflation rate, and y_t is the deviation of output in period t from its long-run trend. The restrictions on the coefficients to have macroeconomic stability are: $\alpha_1 \geq 0$ and $\alpha_2 \geq 0$. Supposing that the coefficient on inflation deviation is less than zero, then a rise in inflation would lead to an interest rate cut, which will induce increased spending. In turn, this would tend to increase aggregate demand, thereby increasing the inflation further (an unstable solution). On the other hand, if it is greater than zero then this instability does not arise, because then the rule ensures that inflation is equal to its targeted value π^* [Taylor (1999a)].

Targeting Rules: Some of the central banks adopted an elaborate framework to keep inflation on target and output on track during the 1990s. To start with, this framework was not 'tightly' supported by academic research. However, it recovered from this deficiency with the evolution of literature on 'inflation targeting' or 'inflation forecast targeting' [Svensson (1997)]. The revised framework starts with a rule that allows some discretion to the central bankers. Hence it was also regarded as 'constrained discretion' by Bernanke and Mishkin (1997) and targeting rule by Svensson (2002). It proceeds like this. The central bank announces a numerical inflation target (point target or target range) and monetary policy has a legislated mandate for achieving this target with clear instrumental independence. There is a high degree of monetary policy transparency and accountability of concerned authorities. The inflation forecast is taken as the intermediate target.

[3]This indicates the robustness of the rule.

Within targeting rules, a further distinction is made between 'general targeting rule' and 'specific targeting rule'. While the former specifies an operational loss function, which the monetary policy is committed to minimise, in the case of the latter a condition for setting the instrument is specified, e.g., marginal rate of transformation and substitution between the target variables is equalised. It gives an implicit reaction function of the monetary authority that need not be announced. According to this framework, central banks collect large amount of data and use a complex policy formulation to set the path of instrument.[4] The rule has a good theoretical base as there is no ad hoc representation of reaction function. Here the condition for instrument path is described by optimal first order Euler conditions and the central bank behaviour is not modeled in a mechanical way. There is also a clear role of judgment in the formulation and implementation of monetary policy [Svensson (2005)].

3. MODEL SPECIFICATION AND METHODOLOGY

Ever since the introduction of the Taylor rule, three issues that have occupied much space in research are positive analysis of central banks' strategy to control inflation, robustness of rule to changes in transmission mechanism and ex-post macroeconomic performance once the rule is adopted. As indicated, the objective of the present study is not to identify the policy reaction function of SBP, instead our focus is on drawing a comparison of actual policy with the one suggested by the Taylor rule. We are also interested in knowing whether the economic performance would have improved had the Taylor rule been followed.

Starting with the first objective, the issue can be addressed either by invoking the standard regression techniques or through a simple comparison of the actual and the simulated data similar to one used by Taylor (1993). Regarding the first option, let us re-specify the Taylor rule as:

$$i_t = r^* + \pi_t + \alpha_1 y_t + \alpha_2^* (\pi_t - \pi^*) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (2)$$

where

r^* – Long run equilibrium real interest rate.
i_t – Short interest rate taken as monetary policy instrument.
π_t – Average inflation over previous four quarters including the current one.
y_t – Output gap calculated as percentage deviation of actual output from the normal level.
π^* – Long run inflation target of the central bank.

There are four parameters, r^*, π^*, α_1 and α_2^* in expression 2. The values of these parameters adopted by Taylor were: 2 percent, 2 percent, 0.5 and 0.5, respectively. Following in Taylor's footsteps, we have also assumed that the central bank has information on current output and inflation.

The above rule (expression 2) can easily be converted into an estimable form as

$$i_t = \alpha_0 + \alpha_1 y_t + \alpha_2 \pi_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

[4]Examples of such policy formulation are the Reserve Bank of New Zealand and the Bank of England.

where $\alpha_0 = r^* + \alpha_2 \pi^*$ and $\alpha_2 = (1 + \alpha_2^*)$

It is contended that if the SBP strictly follows the rule then parameter values should be $\alpha_0 = 1$, $\alpha_1 = 0.5$ and $\alpha_2 = 1.5$, and if it is not then $\alpha_1 > 0$ and $\alpha_2 \geq 1$ must hold, otherwise the system would be unstable. It is relevant to point out that the second condition is referred to as 'Taylor Principle' in the literature [Taylor (1999) and Woodford (2001)].

Expression 3 can be estimated by OLS if time-series properties are satisfied. Otherwise the results are not consistent [Enders (2004)].[5] For super consistency of the OLS estimates even in the case of non-stationary variables, the estimated residuals have to be stationary. To enforce these constraints, the model parameters in the present study are estimated after testing the presence or otherwise of unit root in the estimated residuals of the equation. In the second step, the short term interest rate is simulated with actual data on output and inflation assuming the Taylor rule as monetary policy strategy. The conjecture is that if the central bank has been following the Taylor rule, then both actual and simulated series should be close to each other showing similar behaviour and the same basic statistics like mean, range, standard deviation etc. It may, however, be added that even though Taylor (1993) has used this approach to evaluate the Fed's policy, this method is somewhat less sophisticated. It can, nonetheless, perform well in identifying the behaviour of monetary policy instrument.

To accomplish the second objective of the study, the economy needs to be simulated with and without the Taylor rule as monetary policy strategy to assess the macroeconomic performance on the basis of variability in inflation and output and the loss to society. This analysis is undertaken for historical as well as stochastic simulation. In this regard, some issues need further elaboration. The first relates to macroeconomic model on the basis of which the economy is to be simulated. The literature highlights three types of transmission mechanisms emanating from the Lucas-type expectations-augmented Phillips curve model, Neo-Keynesian model, or the New-Keynesian model [Cukierman (2002)]. The estimation of the first and the third model not only requires the assumption of rational expectations, one also needs to have knowledge of prior values of some of the parameters for model calibration. Since the rational expectations hypothesis has not yet been tested in Pakistan, and also no earlier studies are available to provide prior values of the parameters, the obvious choice for the present study has been restricted to the use of the Neo-Keynesian type model suggested by Svensson (1997) and estimated by Rudebusch and Svensson (1999). According to Svensson (1997) the model although simple, has reasonably sound theoretical properties and captures the essential features of more elaborate models which some of the central banks use for policy analysis. The model is backward looking and assumes price rigidity in the economy.[6] It can be described by the following two equations along with the central bank's reaction function given as expression 3,

$$y_t = \beta_1 y_{t-1} + \beta_2 (i_{t-1} - \pi_{t-1}) + u_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

[5]Other techniques like Two Stage Least Squares (TSLS), Generalised Method of Moments (GMM), and Vector Autoregression (VAR) etc. may improve estimation efficiency, but it would be at the cost of loss of rule's theory, as the rule specifies interest rate as a linear function of output gap and inflation.

[6]In the case of Pakistan, inertia in output and inflation is consistent with VAR study by Malik (2006).

$$\pi_t = \gamma_1 \pi_{t-1} + \gamma_2 y_{t-1} + \varepsilon_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (5)$$

The parameter restrictions are: $0 < \beta_1 < 1$, $\beta_2 < 0$, $0 < \gamma_1 > 1$, and $\gamma_2 > 0$. Since prices are assumed to be rigid, the central bank can affect aggregate demand through changes in the real interest rate. Output is affected by one period lagged real interest rate and its effect on inflation is indirect and takes effect after one period. This model can be estimated by OLS as long as the variables under consideration are stationary and there is no cross and contemporaneous correlation between the residuals of the equations in the model. If the variables are non-stationary, then this property can be imposed in the estimation and restricted OLS can be used to estimate the model [Rudebusch and Svensson (1999)]. Furthermore, if there is contemporaneous correlation across the equations, then the system needs to be estimated as a Seemingly Unrelated (SUR) model.

The final objective of the study concerns finding the optimal parameter values of the rule for Pakistan. This has been done by back-casting the economy with different combinations of the parameters in the rule and then comparing the results. The optimal set of parameters is the one that decreases output and inflation variability and hence minimises the loss to society. The expression 6 in the following describes the loss function which is defined over the variances of output gap and inflation respectively.

$$Ł = ½ \left[var\,(y_t) + \alpha\, var\,(\pi_t) \right] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

where α is the relative weight assigned by society to inflation. Finally, stochastic simulation establishes the statistical significance of the set of parameters.

4. ESTIMATION RESULTS AND DISCUSSION

Regression Approach

To see whether the SBP has been following the Taylor rule, the model has been estimated for the period 1991-2006 using quarterly data on call money rate (short interest rate taken as monetary policy instrument),[7] consumer price index (CPI) as a measure of inflation, and real output gap. The results clearly indicate that the actual policy of the SBP does not correspond to the Taylor rule. The coefficient of output gap has opposite sign while the magnitude of inflation is different than the one prescribed by Taylor (1993).[8] Since the residual series from this estimated equation is stationary as null of the unit root in Augmented Dickey Fuller (ADF) test, it is easily rejected at the conventional level of significance; therefore, we conclude that the results are super consistent.

$$i_t = 4.34 - 0.38\, y_t + 0.51\, \pi_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$
$$\quad (4.28)\ (-2.28)\quad (4.17)$$

Adjusted $R^2 = 0.22$, DW= 0.89
ADF-stats for residuals = –4.11

There are several points related to these results that need further discussion. First, the outcome that the SBP has not been following the Taylor rule should not be

[7]This is the only interest rate data on which are available for the sample period. Call money rate indicates liquidity conditions in the money market and is not directly an indicator of monetary policy stance.

[8]*t*-statistics in parentheses.

taken as a surprise it has never claimed to be following such a rule. Not only that the policy was ineffective, it was not pursued independently since prior to the 1990s the SBP was mainly directed by the government. The monetary authority only got quasi-independence as a consequence of financial sector reforms initiated during early 1990s. Since then the job is entrusted to the SBP, but it is being conducted in a fairly discretionary manner.

The second point relates to the coefficient of output gap. According to the estimates, the SBP, over the years, has either raised interest rate or contracted money whenever the economy was in the recessionary phase; and this policy was relaxed whenever there was inflationary pressure or the output was above trend or the potential level. This outcome not only contradicts Taylor (1993), it is difficult to justify also. One possible explanation could be that, being the central bank of a developing country, SBP might have resisted leaning against the wind assuming that the economy is less elastic to domestic policy changes compared to external shocks. Therefore, whenever the economy started to blossom due to exogenous factors, the SBP allowed it to do so to keep the momentum going. While this justification makes sense only when there is an up-swing, it is less convincing in the opposite case scenario, especially raising interest rate during a recession. But to be fair with the monetary authority, one cannot rule out the possibility of getting such results in an economy where the central bank's loss function contains monetary policy objectives other than output and inflation, implying that the reaction function (expression 7) is mis-specified.

The third issue is concerned with the coefficient of inflation. According to Taylor Principle, the response of the central bank to inflation must be at least one-for-one otherwise the system would be divergent. This is so because the central bank's persistence with easy money approach when inflation is above target would mean that prices can potentially move without bounds. We have found the coefficient of inflation to be substantially less than one. This implies a pro-cyclical response of monetary policy to the business cycle.[9] Once again this may have been due to the dominance of shocks to the economy that were outside the purview of the monetary sector.

Fourth, the R^2 is only 0.22 indicating that only about one-fifth of the variation in short interest rate is explained by output gap and inflation. If so, it is essential to identify factors, other than output gap and inflation, which play important role in monetary policy. It is well established that the monetary authority in Pakistan, like in other developing countries, is also worried about exchange rate stability, interest rate smoothing, financial sector stability etc. [Malik (2007)]. Thus an extended specification of the model remains an alternative option to be considered.

Finally, the value of Durbin-Watson (DW) statistics indicates a high degree of autocorrelation in the residuals of the estimated reaction function. One possible implication of this outcome is that the SBP, instead of pursuing a policy consistent with the Taylor type rule that might have increased the interest rate volatility, has preferred to smooth interest rate.[10] Alternatively, it might also be a reflection of a mis-specified model where important variables have been omitted.

[9]SBP, being central bank of a developing country, does not always play a reactionary role. If the economy is in boom it may let it go. While in other times it is proactive in stimulating the economy.

[10]While alternative variants of the Taylor rule are proposed in the literature to deal with interest rate smoothing, the weight on this objective is not yet agreed upon.

Simulation Approach

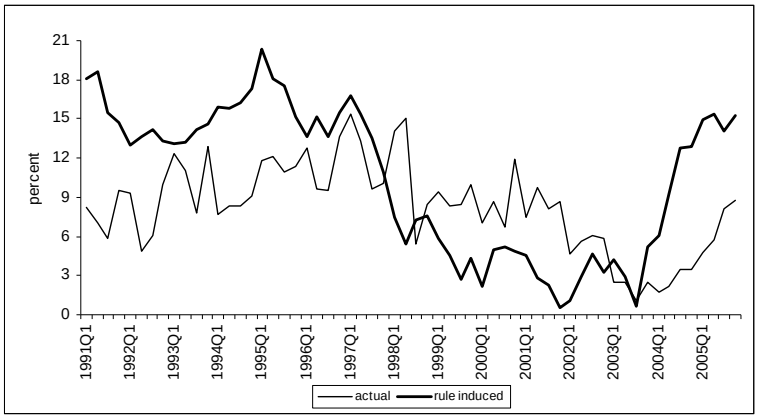
Using an alternative methodology, it has been shown that the rule-induced and the actual short-run interest rate have shown fairly different behaviour (Figure 1 and Table 1). With the exception of 1997-99 and 2002-04, the latter has lower average level and the fluctuations are also not as wild as has been the case with the former. It means that the rule would have favoured a more aggressive response to output and inflationary fluctuations than the one adopted by the SBP. This is why the level of variation in the actual interest rate has been quite low as compared to the rule-induced interest rate.

Table 1

Actual and Taylor Rule-induced Short Interest Rate

	Actual	Rule-induced
Mean	8.24	10.42
Maximum	15.42	20.30
Minimum	1.05	0.51
Range	14.37	19.79
Variance	11.80	32.96
St. Deviation	3.44	5.74

Fig. 1. Actual and the Taylor Rule-induced Short Interest Rate



Next, following Judd and Rudebusch (1998), the time-series was divided into three sub-samples consistent with the era of three former heads of the SBP to see whether or not there was an inclination towards rule-based policy (expressions 8-10). It is quite revealing to find that none of the past three Governors of SBP had an appetite for rule-based policy during 1991-2006. While there was no consideration for output or inflation during 1991-93, the emphasis changed towards growth during 2000-06, probably due to the fact that inflation was already too low. The period in the middle had no clear-cut policy objective—in fact it could be placed somewhere in between the two policy regimes.

$$i_t = 17.04 - 0.60\, y_t - 0.78\, \pi_t \quad \text{(1991-93 period)} \qquad \ldots \quad \ldots \quad \ldots \quad (8)$$

$i_t = 8.68 - 0.08\, y_t - 0.19\, \pi_t$ (1993-99 period) … … … (9)

$i_t = 5.77 - 0.18\, y_t - 0.14\, \pi_t$ (2000-06 period) … … … (10)

Macroeconomic Performance with Taylor Rule

One of the important considerations in managing the economy is that there should be consistency of policies irrespective of the nature of the rule. As indicated, the macroeconomic performance of the economy has been measured by estimating the society's loss function[11] where improved macroeconomic performance is defined in terms of less inflation and less output variability. It is argued that inflation variability is negatively correlated with growth because it generates uncertainty that distorts the agents' major economic decisions like saving and investment [Fischer (1993)].

Given this perspective and to accomplish the second objective of the paper, the economy has been back-casted for a period ranging between 1992 and 2006 and the results are compared with the original Taylor rule (using the original parameter values) while the search for the optimal parameter values in the rule is delayed till the next subsection.[12] Counter-factual simulations require estimation of the transmission mechanism (macroeconomic model) of the economy on the basis of which the previous data can be regenerated with alternative monetary policy setting. For this purpose, the Neo-Keynesian type model for Pakistan has been estimated by OLS. The results of estimation are reported as expressions 11 and 12 (with t-statistics in parenthesis).[13]

$$y_t = 0.53 y_{t-1} - 0.27(\bar{i}_{t-1} - \bar{\pi}_{t-1}) \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

(4.68) (–3.96)

S.E = 1.60, DW = 2.08

$$\pi_t = 3.72 + 0.51\pi_{t-1} + 0.39 y_{t-1} \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

(3.89) (4.61) (1.88)

S.E = 3.42, DW = 2.04

It is evident that the signs of the estimated parameters are consistent with economic theory and the coefficient values are also in the acceptable range. Output is affected by its own lagged values and the average real interest rate over the previous four quarters. Inflation too has one-period inertia and it is also affected by the output gap of the previous quarter. These results confirm that, contrary to popular stance held by the central bank, only about one third of inflation in Pakistan is explained by monetary factors. Using these results and invoking the assumption that the Taylor rule has been the monetary policy strategy, the back-casting exercise of the economy was undertaken by incorporating in each period the estimated shocks (to output and inflation) from Equations 11 and 12. The striking outcome of this exercise has

[11]It is assumed that the society puts equal weight to inflation and output stability.

[12]The entire process has followed the following course of action. The three-equation model includes demand and supply equations and a money reaction function. Here the Taylor rule generates the value of real interest rate, which when used in the demand function allows us to determine the value of output *y*. When substituted in the supply function, it generates value of π. The rule based values of *y* and π are then compared with actual values. An outcome is preferred where variations in these variables are low.

[13]Results by SUR model and by FIML have been found almost the same as there is insignificant contemporaneous correlation between the residuals of the two equations in the model.

been that the economy would have performed better if the Taylor rule had been adopted rather than sticking with the discretionary policy stance (Table 2). Adoption of the Taylor rule would have decreased the variability in output gap and inflation.

To reconfirm these results further and to avoid over-reliance on historical simulation (one time estimates), stochastic simulation has also been carried out. This has been done by bootstrapping the standard deviation of output and inflation. The average results of 1000 trials along with the standard errors of estimates, presented in Table 2, reconfirm the earlier results (reduction in output and inflation variability) that continue to hold true even when the bootstrapped measure of variation is used. Similarly the probability (p-value) of standard deviation of rule based output gap and inflation, being greater than the one found in the actual data, is quite low. We have found that in only 20 out of 1000 simulations the standard deviation of simulated output gap has been greater than or equal to that of the actual data. For inflation series, it was true for 100 simulations. These results again prompt us to conclude that the Taylor rule would have performed significantly better than the actual policy that was pursued by SBP during 1991-2006.[14]

Table 2

Simulation with the Taylor Rule and the Estimated Model

			Rule Based		
		Actual	Historical	Stochastic*	p-value**
Interest Rate	Average	8.28	9.24		
	St Deviation	3.53	3.18		
Output Gap	Average	–0.24	–0.83		
	St Deviation	2.47	1.72	1.80 (0.21) (0.21)	0.002
Inflation	Average	7.36	7.00		
	St Deviation	4.31	3.50	4.04 (0.47) (0.47)	0.10

*Average of 1000 values of standard deviations in bootstrap simulation. Standard errors in parenthesis.

** Probability of standard deviation of a variable with rule being greater than that of actual data.

Finding the Optimal Parameter Values for Pakistan

In an effort to find optimal parameter values (in Taylor rule) for Pakistan, we start with the optimal inflation target. The anecdotal evidence suggests that the central banks that have adopted inflation-targeting as monetary policy strategy announce about 2 percent inflation target, though with some tolerance range.[15] This is in line with Taylor (1993) who advocated an inflation target of 2 percent that was consistent with the 2 percent real economic growth of the USA. Compared to this, Pakistan being a developing country with a natural requirement for higher growth rate, cannot opt for a low real growth (and inflation) target of 2 percent. But to avoid ad hocism, we have used seven different inflation target options for simulation purpose. To start this process, the 2 percent target was adopted to simulate the economy.

[14]The comparison of actual and backcasted data on inflation, output-gap and interest rate using Taylor rule is given in Appendix A, Figure 2.

[15]None of the central banks, with any monetary policy strategy, target zero-inflation as central banks are not inflation nutters in King (1997a) terminology.

Since Pakistan experienced an average rate of about 5 percent real GDP growth over the period 1980-2006, this rate was selected as another option. Similarly, following the empirical evidence of Khan and Senhadji (2001) and Mubarik (2005) five values ranging between 7 percent and 11 percent have also been used.

The long-run equilibrium real interest rate has been calculated for Pakistan as the difference between the average nominal interest rate and inflation over the periods, 1973-2006, 1981-2006 and 1991-2006 as shown in Table 3.[16] Even though the results do not portray a clear pattern, nevertheless in all the three periods the average real interest rate was found to be close to zero. As a result, the equilibrium value of zero real interest rate has been used as benchmark in the counterfactual simulation.

Finally, the optimal weights for output and inflation in the Taylor rule for Pakistan have been estimated. Even though Taylor (1993) used equal weight of 0.5 for both the objectives, i.e., output and inflation, we have used this scheme as a starting point only. In two subsequent scenarios, either the entire weight was assigned to output stabilisation with no regard for inflation deviation or according more importance to inflation than output deviation. While the former alternative could be more attractive for the developing countries (at least with asymmetric response) where output was the primary and inflation the secondary issue, the latter possibility is obviously more attractive for stable economies where more emphasis is on inflation control or price stability.[17]

Table 3

Estimation of Long-run Real Interest Rate

	1973–2006	1981–2006	1991–2006
Average Interest Rate	8.34	8.01	8.24
Average CPI Inflation	9.16	7.52	7.89
Average GDPD Inflation	8.92	8.02	8.92
Equilibrium Real Interest Rate*	–0.82	0.49	0.35
Equilibrium Real Interest Rate**	–0.58	0.00	–0.68

* When inflation is calculated as percentage growth in CPI.

** When inflation is calculated as percentage growth in GDP Deflator.

We have taken these three sets of weights and seven different targets of inflation (a total of 21 cases) and back-casted the output gap, inflation, and interest rate using estimated parameters and shocks in the macroeconomic model comprising equations 11 and 12. From the results of 21 cases, the best set of parameter values for Pakistan was selected on the basis of minimised variability in inflation and output and the minimum values of the loss to society. We have found that variability in inflation is a decreasing function of the level of inflation target but the variability of output started increasing above a certain level of inflation target.

The first best set of parameter values with which the rule has performed well in reducing the variability of inflation and output is the case when the central bank assigns

[16]Judd and Rudebusch (1998) used this methodology for the U.S. data.

[17]It should be noted however that none of the central banks, even the inflation targeting ones, practically do this, as inflation targeting is flexible in the sense that central banks put some weight on output stabilisation too, [Svensson (1997) and Ball (1999)].

equal weights to output and inflation stabilisation in the reaction function and targets inflation at 8 percent with zero real interest rate.[18] The rule with this set of parameter values is given in Equation 13. This roughly indicates the optimal level of inflation for Pakistan and the results are consistent with earlier findings of Mubarik (2005) and Khan and Senhadji (2001).

$$i_t = 0 + \pi_t + 0.5y_t + 0.5(\pi_t - 8) \text{ or } i_t = -4 + 0.5y_t + 1.5\pi_t \quad \ldots \quad \ldots \quad (13)$$

The results for the measures of macroeconomic performance by the rule (both in case of historical as well as stochastic simulation) with the first best set of parameter values are given in Table 4. The procedure adopted here for comparison is the same as discussed above for the actual Taylor rule. It is clear that the variability in output gap and inflation decreases as we move from discretionary policy towards the Taylor rule when the first best set of parameter values for Pakistan are used. However the average values of the variables are somewhat greater. To confirm these results, and to find the probability of standard deviation of output and inflation in simulated series being greater than that in the actual series, we have used stochastic simulation by re-sampling the estimated shocks. The results indicate that the variability of both the variables has been lower, even in repeated simulation and the probability is also quite low.[19]

Table 4

Simulation with the First Best Set of Parameter Values

			First Best Set		
		Actual	Historical	Stochastic*	p-value**
Interest Rate	Average	8.28	8.08		
	St Deviation	3.53	3.11		
Output Gap	Average	–0.24	0.3		
	St Deviation	2.47	1.67	1.72 (0.24)	0.05
Inflation	Average	7.36	7.88		
	St Deviation	4.31	3.49	3.91 (0.47)	0.2

* Average of 1000 values of standard deviations in bootstrap simulation.
** Probability of standard deviation of a variable with rule being greater than that of actual data.

The second best set of parameter values was found when the central bank assigned one-hundred percent weight to output stabilisation with no response to inflation deviation from the target. The implication is that it does not matter what level of inflation is optimal to target. Regarding macroeconomic performance by the Taylor rule, the parameter values given below in Equation 14 were used.

$$i_t = 0 + \pi_t + y_t + 0(\pi_t - \pi^*) \text{ or } i_t = \pi_t + y_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (14)$$

[18]The coefficient values are same as proposed by Taylor but inflation target is different.

[19]Comparison of actual and simulated data on inflation, output gap and interest rate using this proposed rule is given in Appendix A, Figure 3.

It can be seen from Table 5 that variability in interest rate, output gap and inflation decreased as one moved away from discretionary policy towards the proposed Taylor rule for Pakistan. [20,21] The average values of all the three variables are found to be slightly greater when the rule is followed. To confirm these results further and to find out whether or not the probability of standard deviation of output and inflation in simulated series turns out to be greater than that in the actual series, stochastic simulation was used to resample the estimated shocks. The outcome confirmed that the variability remained lower even in the repeated simulations. It was also found that the probability of standard deviation of output and inflation being greater in simulated series than that in the actual data, with the rule as monetary policy strategy was quite low.[22]

Table 5

Simulation with the Second Best Set of Parameter Values

			Second Best Set		
		Actual	Historical	Stochastic*	p-value**
Interest Rate	Average	8.28	8.17		
	St Deviation	3.53	2.58		
Output Gap	Average	–0.24	0.25		
	St Deviation	2.47	1.55	1.70 (0.20)	0.03
Inflation	Average	7.36	7.84		
	St Deviation	4.31	3.62	4.18 (0.48)	0.2

* Average of 1000 values of standard deviations in bootstrap simulation.

** Probability of standard deviation with rule being greater than that of actual data.

Loss Function and Comparison of Parameter Values

Besides minimising the variability in output and inflation, one can also calculate and compare loss to society associated with each set of parameter values as an attractive alternative. The loss function not only includes both the objectives, it also takes care of the trade off between them. In this respect it can do a better job of finding out the optimal parameter values.

For estimating the loss function, expression 6 has been used. In an effort to ensure comparability, the assumption that society assigns equal weight to inflation and output has been maintained. Using expressions 11 and 12, the economy has been back-casted for 21 sets of parameters discussed above, one at a time and the best set of parameters was chosen which minimised the loss function.

The results presented in Table 6 show that the loss is minimum when inflation target is set at 8 percent and equal coefficients of output and inflation in the reaction function are adopted. The second best set of parameter values has been found exactly the same as was proposed by Taylor. The third best option is found when the entire weight is given to real stabilisation in the reaction function. The results of stochastic simulation exercise given in Table 6 confirm these findings. It can be seen that the performance of

[20]By the proposed Taylor rule we mean the rule with parameter values found optimal for Pakistan.

[21]Detailed comparison of actual and simulated data on inflation, output gap and interest rate with this proposed rule is given in Appendix A, Figure 4.

[22]However this probability is higher in case of inflation.

the rule (with either set of parameters) is, on average, better than that in case of actual policy. The results show that there is very low probability (0.02 in all cases) of loss, associated with the rule, being greater than that with actual policy setting. Interestingly, Taylor's proposed parameter values give better results than the second best possibility when historical simulation is undertaken but the opposite is true in the case of stochastic simulation.

Table 6

Loss Associated with Different Parameter Values for the Rule

	Variance		Loss to Society		
	Output	Inflation	Historical	Stochastic*	p-value**
Actual Data	6.10	18.54	12.32		
First Best	2.80	12.15	7.48	7.82	0.02
				(1.92)	
Second Best	2.40	13.11	7.76	8.10	0.02
				(1.78)	
Taylor Rule	2.94	12.25	7.60	8.26	0.02
				(1.72)	

* Standard error in parenthesis.

** Probability of loss associated with rule being greater than that of actual data.

5. SUMMARY AND CONCLUDING REMARKS

In this study the Taylor rule for Pakistan has been estimated for the period 1991-2006 and for the sub-samples covering the period of three former Governors of SBP. One of the important findings of the study is that monetary policy has been generally conducted through discretionary measures rather than adopting a rule. This could have been due to the SBP's concentration on policy objectives other than inflation and output stabilisation. Through historical and stochastic simulation, the study has concluded that commitment to the Taylor-type rule would have significantly improved the macroeconomic performance, especially in terms of less variability of output and inflation. Regarding parameter values in the rule, it has been found that targeting inflation at 8 percent and treating output and inflation equally in the policy reaction function would have yielded an optimal scenario for the SBP.[23]

The key messages that emerges from the study are as follows:

First, notwithstanding the fact that the pre-requisites for more elaborate policy rules are lacking and the institutional capacity is also quite weak in Pakistan, yet there is ample scope to reap benefits by committing to simple instrument rules with a clear understanding of the warning issued by McCallum (2000). It is proposed that adoption of simple instrument rules may be regarded as a first step for Pakistan and other developing countries to move from discretionary policy to a more elaborate inflation targeting framework. Second, although there is a need for having an elaborate range of targets in the monetary policy framework (including output and inflation), the study is not putting any restrictions on these possibilities, i.e., incorporating other objectives in the simple

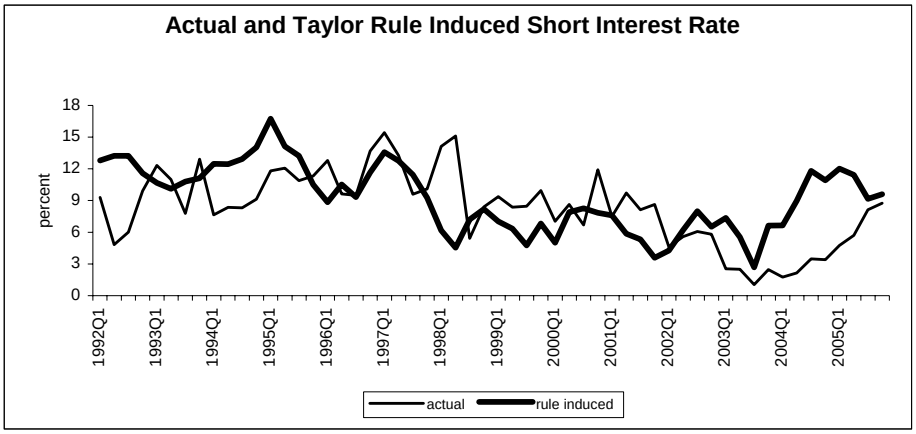
[23]These results are based on the assumption of zero real interest rate.

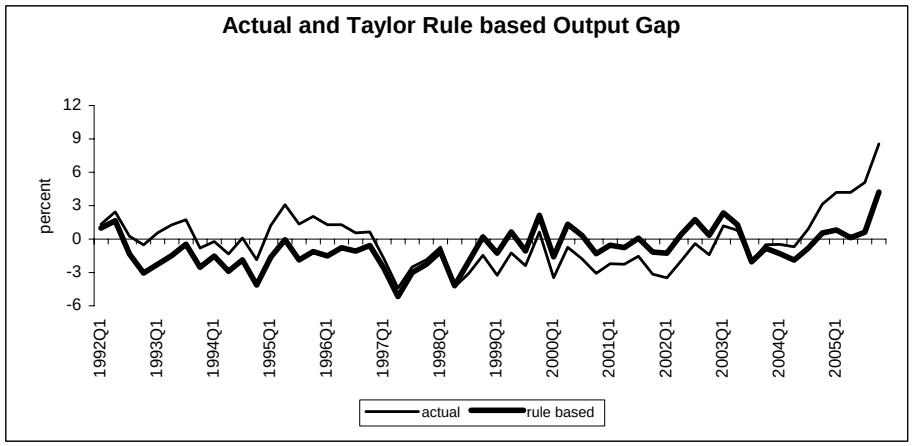
rules. However, we recommend a humble beginning as it allows better understanding of ground realities. Third, it is also advisable to adjust the parameters in the rule (especially the inflation target) according to the economic conditions prevalent in the economy.

Finally, it may be added that currently this is a passionately pursued area of research in macroeconomics. Thus, there is ample scope for further research. To start with, the inconclusiveness of literature on the Taylor rule, especially the coefficients of variables other than output and inflation in the policy reaction function, can provide further insights for developing countries, including Pakistan. There is also a possibility for exploring ways and means for adopting a more elaborate inflation targeting framework. In this regard the research can focus on the pre-requisites such as central bank independence, and transparency and accountability of its actions. These three notions might be the outcome of elaborate policy rules and not just the pre-requisites for it. Research in this area would be quite beneficial for developing countries where institutions are not yet strong and the focus on issues like monetary policy transparency and accountability is generally quite weak.

APPENDIX - A

Fig. 2. Actual and Taylor Rule-induced Short Interest Rate, Output Gap and Inflation





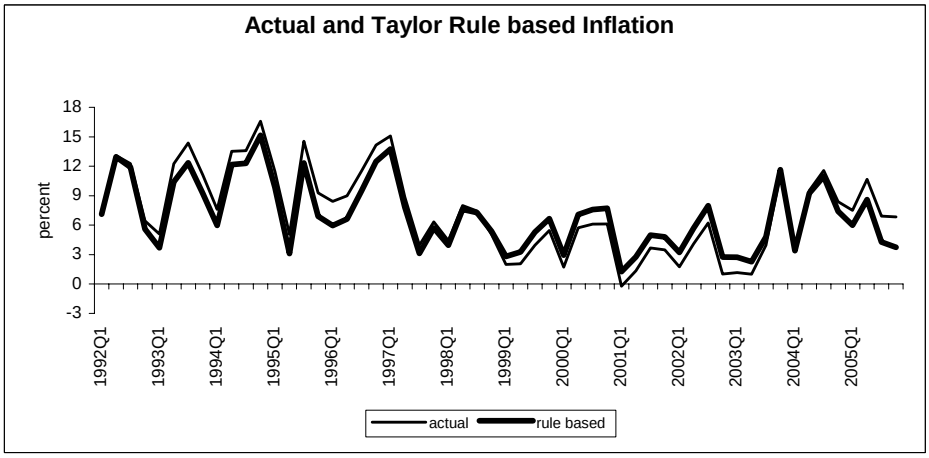


Fig. 3. Actual and First Best Rule-induced Short Interest Rate, Output Gap and Inflation

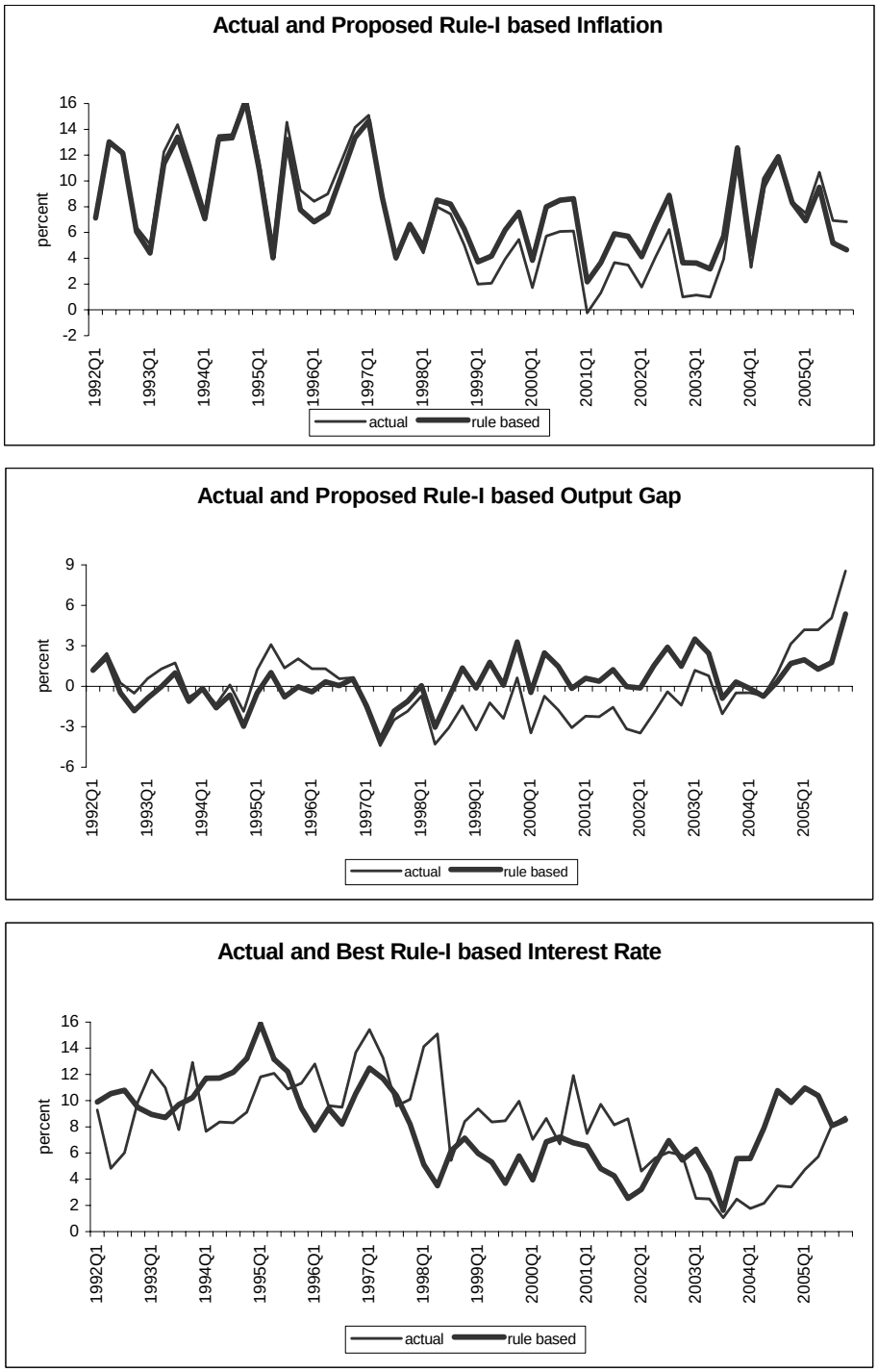
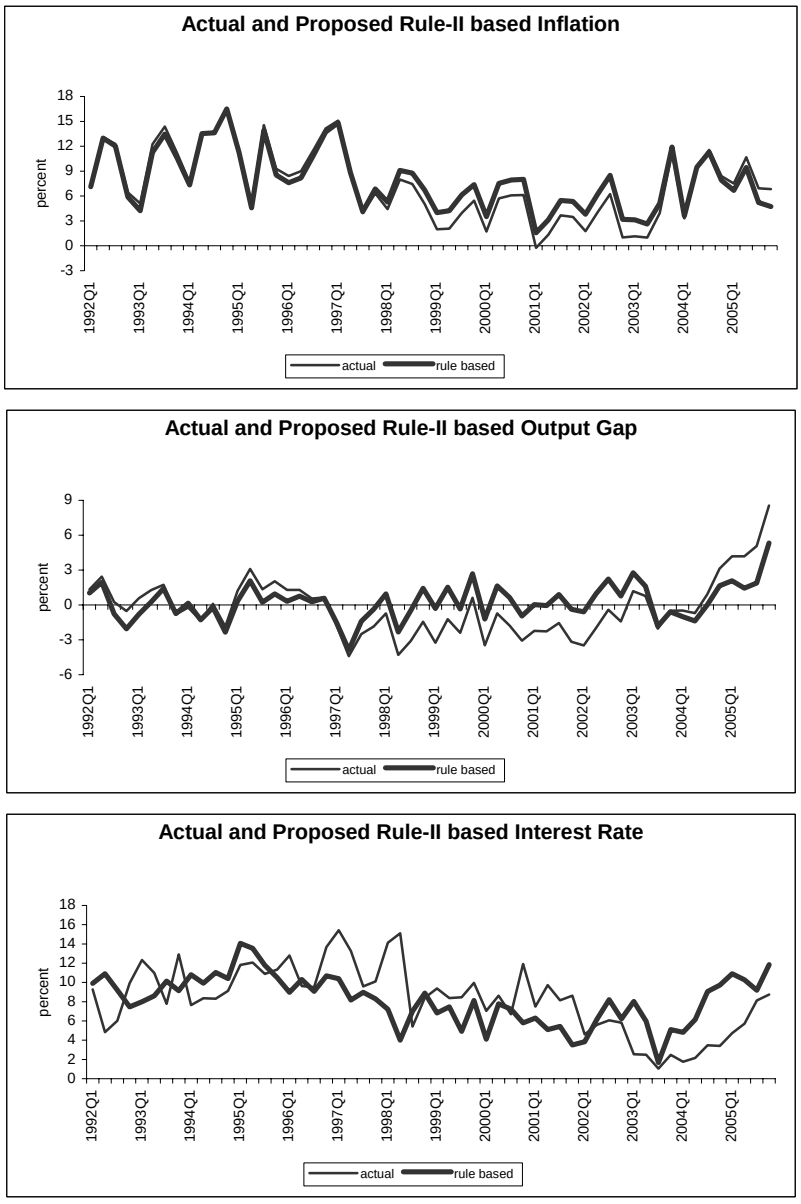


Fig. 4. Actual and Second Best Rule-induced Short Interest Rate, Output Gap and Inflation



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