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Monetary Policy Objectives in Pakistan: An Empirical Investigation

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ABSTRACT

The Taylor rule (1993) focuses only on two objectives: output and inflation. In practice, the central bank's loss function (especially in developing countries) contains objectives other than these two, like the interest rate smoothing, exchange rate stabilisation, etc. In this study, the monetary policy reaction function has been estimated, including five objectives for monetary policy as well as controlling for the effect of three other factors. Whereas the results confirm the counter-cyclical response of monetary policy to the factors in the loss function, the response of interest rate to changes in the foreign exchange reserves and the government borrowing has been negative. Variance decomposition shows that most of the variation in the interest rate is explained by its own lagged values. Other variables, in explaining variation in the interest rate, can be ranked as inflation, government borrowing, exchange rate, output gap, trade deficit, and, finally, the foreign exchange reserves.

JEL classification: E52, E52, E58

Keywords: Monetary Policy Objectives, Variance Decomposition, Call Money Rate

1. INTRODUCTION

Since the seminal work by Taylor (1993) on using monetary policy rules in a practical way, researchers have been trying to explore the policy reaction function for different countries. One practical issue in the Taylor rule is the monetary policy objectives considered in the rule. According to this rule there are only two objectives of monetary policy: output and inflation.[1] In practice central banks have objectives other than these two like interest rate smoothing and exchange rate stabilisation. This issue becomes more important in developing countries where exchange rate is not flexible and governments depend heavily on seignorage revenues due to limited effort to generate revenues from other sources and heavy budget deficits. So if these countries use Taylor rule as practical guide for monetary policy then the rule would be incomplete in the sense that it does not address the issues faced by the monetary authorities. So the point here is that before suggesting any rule to a central bank, one should be very clear on monetary policy objectives in the country.

In estimating monetary policy reaction function, researchers have included variables other than the output and inflation in their estimation procedure like the interest rate smoothing factor, exchange rate, stock prices, government debt, foreign interest rate and foreign exchange reserves.[2] Another point is worth discussing here. In estimating response of the central banks to different variables, researchers miss-specify the reaction function. The problem arises because of not including the variables in the reaction function that have important information about the variable used as monetary policy instrument. This issue is important if instrument (for which central banks set operational

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[1]One may think that these other variables/objectives are included in the Taylor rule by many researchers. Of course it is the case, but weights on these other variables have not been yet decided in the literature. So unless we are able to decide on these weights, Taylor rule can be used only in its original form. Also as stated earlier, the Taylor rule has only two objectives; so the equations specifying interest rate as a function of some other variables are reaction functions and not the Taylor rules.

[2]See, for instance, Hsing and Lee (2004), Chang (2000), Bernanke and Gertler (1999), Rigobon and Sack (2003), Shortland and Stasavage (2004), and Sheehan (1985), among others, for including different variables in the reaction function.

target) of monetary policy is determined in the market. Deviation of policy rate from the target is possible because of factors affecting the instrument but they are not the monetary policy objectives. For instance, foreign exchange reserves and the government borrowing from the central bank explain the behaviour of interest rate, though they are not the policy objectives[3]. Hence the reaction function would be miss-specified if estimated without these variables. These other factors serve as control variables in estimating reaction function.

The present study focuses on the estimation of monetary policy reaction function for Pakistan to find the monetary policy objectives. Another objective is to find variables, other than monetary policy objectives, that affect the behaviour of interest rate. These factors are indicators of control errors as they cause deviation of interest rate from the operational target. The motivation behind this study is estimation of the Taylor rule for Pakistan in Malik and Ahmed (2007). In that study, we have estimated the Taylor rule and found that SBP had not been following such a rule. There we have found very low values of R^2 and DW statistics: both show that there are missing variables in the equation. It means there are certain objectives of monetary policy, other than output and inflation that the SBP focuses on. So, present study deals with identifying these other objectives of monetary policy in Pakistan.

We have estimated monetary policy reaction function including five objectives for monetary policy: output, inflation and exchange rate stabilisation, interest rate smoothing, and reducing the trade deficit. As for as the variables other than policy objectives are concerned, we have included two variables in the reaction function: foreign exchange reserves and government borrowing from the central bank. Regarding the policy variable, we have used the short term interest rate (inter bank offered rate) as the monetary policy instrument.[4] This is consistent with most of the empirical literature on the issue at hand including Taylor (1993).[5] In estimation, foreign interest rate has been used as exogenous factor.

We have estimated the impulse response functions and variance decomposition by estimating VAR. Estimated impulse response functions show that if there is a positive shock in the interest rate, output, inflation, exchange rate and/or in trade deficit, interest rate would respond positively but the direction of change in interest rate is reversed when shock occurs in foreign exchange reserves or government borrowing. Variance decomposition shows

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[3]It should be noted here that these two variables could be included in monetary policy objective function. But normally it is not the case because the objective of foreign exchange reserves is indirectly captured by exchange rate and inclusion of the second variable is mismatched with the central bank independence.

[4]Inter bank offered rate, also known as the call money rate is equivalent to federal funds rate in U.S.

[5]There is evidence in Agha, *et al*. (2005) that interest rate channel works in monetary policy transmission mechanism in Pakistan.

that most of the variation in interest rate is explained by its own lagged values. Other variables, in explaining variation in interest rate, can be ranked as inflation, government borrowing, exchange rate, output gap, trade deficit and finally the foreign exchange reserves.

Remaining portion of the study is organised as follows. Section 2 deals with the choice of variables and theoretical framework. In Section 3 some preliminary statistics and historical facts regarding monetary policy instrument and objectives and other variables included in the model are presented. Data issues and methodology have been discussed in Section 4. Section 5 includes results and finally Section 6 concludes the study.

2. THE CHOICE OF VARIABLES AND THE THEORETICAL FRAMEWORK

In estimating monetary policy reaction function researchers included variables other than output and inflation in their estimation procedure. Two of them, exchange rate and interest rate smoothing variable-lagged interest rate are more widely used [see for instance, Hsing and Lee (2004); Chang (2000) for both and Assane and Malamud (2002); Gerlach and Smets (2000); Amonde (2006); Setlhare (2004) for exchange rate, among others for recent review].[6] Another potential variable that is included in the monetary policy reaction function is asset prices. Central banks respond to stock market indicators by including deviation of asset prices from the normal trend in their policy reaction function [see for example Bernanke and Gertler (1999); Rigobon and Sack (2003) among others for including stock prices in the reaction function]. Debt accumulated by the government and government borrowing from the central bank are also included in the response function of central bank. We have found single study for each, Sheehan (1985) for debt and Shortland and Stasavage (2004) for government borrowing. The latter study also includes foreign reserves in the response function of central bank. If capital mobility is important for an economy then monetary policy, while setting interest rate, focuses on foreign interest rate as well [for example Shortland and Stasavage (2004)].

We have used the short interest rate (inter bank offered rate or call money rate, CMR) as monetary policy instrument.[7] The main reason for using this variable instead of using the discount rate is the fact that discount rate is only a policy tool to achieve operational target for the instrument that can also be achieved by other policy tools like open market operations and changes in the required reserve ratio. This is consistent with most of the empirical literature on

[6]Romer (2001), while discussing possible changes in Taylor rule, suggests inclusion of exchange rate and lagged interest rate in the rule.

[7]Inter bank offered rate also known as call money rate is equivalent to federal funds rate in U.S.

the issue at hand including Taylor (1993); Goodfriend (1993); Clarida, *et al*. (1998; 2000) among others.[8]

As for as the objectives of monetary policy are concerned, we have included in our estimation the inflation (Inf), output gap (Y-Gap), interest rate smoothing variable (lagged interest rate), exchange rate deviation from the trend (ERD) and trade deficit (TD). It is well established in the literature on monetary policy that price stability is the prime objective of any central bank. This has been taken as one of the objectives in the Taylor (1993) rule and all empirical studies on the estimation of monetary policy objective function. High and variable inflation creates uncertainty making it harder to interpret the message conveyed by the price changes. This uncertainty creates problem for consumers and investors in making optimal decisions. So price stability is the prime target of monetary policy in almost all of the countries. The second most important objective that enters the loss function of most of the central banks is the output stability around the potential or the normal level as the central banks are not, according to King (1997), 'inflation nutters'. So, even the inflation targeting countries do care about output fluctuations in conducting monetary policy. Again this variable has been included in almost all of the empirical studies on the central bank's reaction function. This objective is important to keep unemployment on the natural rate.

Other than variables in the Taylor rule, interest rate smoothing has been widely accepted as monetary policy objective and is included in estimation of policy reaction function in a number of studies. Interest rate stability is important because it creates the stable demand for investment. Too high interest rate discourages investment resulting in higher unemployment. High interest rate also reduces public support for the central bank independence if people perceive high interest rate as a result of too tight monetary policy [Mishkin (2001), Chapter 14)].[9] In open economies, especially with the fixed or managed floating exchange rate regime, exchange rate stabilisation becomes important for both exports as well as for domestic monetary objectives like inflation. Low exchange rate makes domestic products less competitive in the world market.[10] This results in lesser exports demand and ultimately in the slow economic growth. On the other hand, high exchange rate makes terms of trade against the home country and increases inflation in the domestic economy.

[8]Shortland and Stasavage (2004) and Chang (2000) estimated response of discount rate to other variables. Some other studies included monetary aggregates as policy instrument in estimating the policy reaction function, [see for instance, Barro (1978); Mishkin (1981); Melvin (1983); Chochrane (1989); and more recently Fung (2000)].

[9]However high interest rate might be good if it results from higher demand for investment and not because of the tight monetary policy [Poole (1999)].

[10]This is true if we define exchange rate as the domestic currency price of the foreign currency.

Continuous trade deficit can create problem, if the exchange rate is either fixed or managed floating, by depleting foreign exchange reserves, which creates problems both for currency valuation as well as for the imports. However, to our knowledge we are first time using this variable and we could not found this in the empirical studies on the present issue. Nevertheless, it is an important factor for monetary policy setting, especially for developing countries like Pakistan. Stock price stabilisation is important because it has the wealth effect that changes private consumption and investment [for instance, Mishkin (1995) and Bernanke and Gertler (1995)].[11]

As control variables, we have taken two variables, other than the policy objectives, that may affect interest rate in any period. These are government borrowing from the central bank (GB) and the foreign exchange reserves (FER). In developing countries, where governments have to spend on development projects with increasing fiscal deficit, seignorage is an important source of revenues and governments rely heavily on borrowing from the central banks.[12] Similarly changes in foreign exchange reserves have important implications for developing countries. In fixed exchange regime any attempt by the central bank to stabilise exchange rate results in changing foreign exchange reserves that have important implication for domestic monetary policy. Finally, the foreign interest rate (FI) has been taken as an exogenous variable that has important implications for domestic policy setting.

Theoretical Framework

Monetary policy objectives are often summarised by a monetary authority's loss function. Then depending on the monetary policy framework, policy instrument is characterised by either explicit reaction function like the Taylor type rule or by an implicit reaction function in inflation targeting rules.[13] But whatever is the policy framework, the objective of the monetary policy remains to minimise the loss function defined over certain variables. In the literature, loss function is normally defined over two main objectives: inflation and output [e.g. Romer (2001)] as,

$$L_t = f(y_t, \pi_t - \pi^*) \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad \ldots \qquad (1)$$

where y_t is deviation of output from potential level and π_t and π^* are current and target level of inflation, respectively.

[11]Initially we have included the stock price index in the estimation. But as its effect on the interest rate was negligible we have excluded it from the final estimation. Similarly we did not find indication of focus of monetary policy in Pakistan on the stock market performance in the reports and documents of State Bank of Pakistan.

[12]This is also a result of partial autonomy of central banks in these countries.

[13]See Taylor (1993) and Svensson (2003) for reference.

However, in practice, central banks have more than two objectives. For instance, Mishkin (2001) states six objectives of monetary policy: employment, economic growth, price stability, interest rate stability, financial sector stability, and exchange rate stabilisation. So a number of researchers, when estimating the Taylor rule or monetary policy reaction function, have included different variables/targets in the reaction function. So if we take all of the objectives of monetary policy in the loss function then it becomes:

$$L_t = L(y_t, \pi_t - \pi^*, i_t - i_{t-1}, er_t - er_t^t, td_t, i_t - i_t^f \quad \ldots \quad \ldots \quad (2)$$

Where i_t is policy instrument rate, *er* and er^t are exchange rate and trend value of exchange rate, td is trade deficit and i^f is the foreign interest rate.

In this case the reaction function will depend on all these variables, i.e.

$$i_t = i(y_t, \pi_t - \pi^*, i_t - i_{t-1}, er_t - er_t^t, td_t, i_t - i_t^f \quad \ldots \quad \ldots \quad \ldots \quad (3)$$

An important point is worth discussing here. Although this function explains how interest rate would change when any of the variables in the loss function changes, complete modelling of the short interest rate requires inclusion of other variables in the reaction function that significantly explain variation in the interest rate. This is important in estimation process as two variables might be correlated because of their joint correlation with a third variable that is missing. In this case, one may find significant impact of a variable because of another missing variable. So the effect of variables (monetary policy objectives) on interest rate makes sense only if we control for the effect of certain other variables. As discussed above, we have included two such variables in our estimation of determinants of the reaction function: government borrowing from the central bank and the foreign exchange reserves.

In this case the reaction function becomes

$$i_t = i(y_t, \pi_t - \pi^*, i_t - i_{t-1}, er_t - er_t^t, td_t, i_t - i_t^f, gb_t, fer_t) \quad \ldots \quad \ldots \quad (4)$$

Where *gb* is government borrowing from the central bank and *fer* is the foreign exchange reserves.

Now we briefly explain the theory on how changes in the monetary policy instrument—the short interest rate affect the monetary policy objectives and how the other factors in the reaction function 4 affect the interest rate.

Increase in the short interest rate induces bank lending rate to be high. Assuming that private investment is interest sensitive, there would be lesser investment demand inducing aggregate demand to be lower. Now if inflation depends on lagged output demand, this action lowers the inflation, though after some lag. This mechanism can be explained from the following equation.

$$i \uparrow \rightarrow i_L \uparrow \rightarrow I \downarrow \rightarrow AD \downarrow \rightarrow Inf \downarrow$$

Lowering policy instrument rate makes commercial banks decrease the lending rate. This promotes investment and hence the aggregate demand. If the output is demand determined then output would increase by the loose monetary policy.

$$i \downarrow \rightarrow i_L \downarrow \rightarrow I \uparrow \rightarrow AD \uparrow \rightarrow Inf \uparrow$$

Increase in the domestic interest rate attracts foreign investment, thereby increasing foreign exchange reserves. This capital inflow strengthens the domestic currency.

$$i \uparrow \rightarrow CapitalInflow \uparrow \rightarrow FER \uparrow \rightarrow ER \downarrow$$

By increasing short interest rate, central bank can increase bank lending rate. This would lower domestic demand for foreign goods thereby lowering the trade deficit. It also has an indirect effect by lowering inflation that makes domestic goods more competitive in the world market and hence increases exports. These two relations are explained by the following two equations.

$$i \uparrow \rightarrow i_L \uparrow \rightarrow D_f \downarrow \rightarrow TD \downarrow$$

$$i \uparrow \rightarrow i_L \uparrow \rightarrow Inf \downarrow \rightarrow Ex \uparrow \rightarrow TD \downarrow$$

Where D_f is domestic demand for foreign goods.

Monetary policy can affect stock prices in a number of ways. If stock prices are decreasing, central bank can lower interest rate to provide loans to the stock investors. Lower interest rate also has another effect: it discourages bank deposits and provides funds for alternative assets like the stocks. On the other hand if stock market is facing a bubble, central bank can tight monetary policy thereby increasing bank deposit rates. Following two equations explain these two effects.

$$i \downarrow \rightarrow i_D \downarrow \rightarrow D_S \uparrow \rightarrow SP \uparrow$$

$$i \downarrow \rightarrow i_L \downarrow \rightarrow D_S \uparrow \rightarrow SP \uparrow$$

Where i_D is the bank deposit rate and D_s is the demand for stocks.

Changes in government borrowing from the central bank and foreign exchange reserves affect the monetary base and hence the interest rate.

$$GB \uparrow \rightarrow MB \uparrow \rightarrow i \downarrow$$

$$FER \uparrow \rightarrow MB \uparrow \rightarrow i \downarrow$$

Increased interest rate in the domestic country attracts foreign exchange reserves, adding to the capital account of balance of payment, which has important implications for investment in the home country, for domestic currency valuation and for inflation.[14] It should be noted here that keeping the interest rate equal to foreign interest rate is not the objective of monetary policy. However it is targeted to achieve some other domestic objectives.

3. SOME BASIC STATISTICS

In this section we briefly discuss some basic statistics (mean, measures of dispersion and correlation of short interest rate with one period lagged values of all other variables) over the period taken in the study. The results are summarised in Table 1 (and the actual behaviour of variables by simple plot is given in Appendix C). Regarding these statistics, there are some important points to be discussed here. In the period 1993–2005, output gap and exchange rate deviation from the trend remained zero, on average. This indicates that, on average, monetary policy remained successful in bridging the gap of output and exchange rate from their respective trends. Inflation in this period was on average 7.5 percent, which is an indication of SBP's long run inflation target as well as the optimal level of inflation. Another interesting point is that domestic average interest rate in this period was almost double than the foreign interest rate in the same period. Not only this, the volatility of domestic interest rate was also high than that in the foreign interest rate. The highest correlation of monetary policy instrument has been found with the foreign interest rate followed by that with the foreign exchange reserves. Interest rate smoothing seems another objective of monetary policy as the short interest rate is strongly correlated with its own lagged values.[15] Interestingly, short interest rate is highly correlated with inflation but not with the output gap, showing that monetary policy in Pakistan seems to have a focus on inflation but not on the output.

Table 1

Basic Statistics (1993–2005)

	Average	Variance	St. Dev	Maximum	Minimum	Correlation*
CMR	8.34	13.06	3.61	15.42	1.05	0.72
Y-Gap	–0.32	6.37	2.52	8.54	–4.40	0.05
Inf	7.51	12.64	3.56	13.14	2.65	0.68
ERD	–0.01	8.05	2.84	5.21	–5.69	0.21
TD	14.25	115.69	10.76	51.35	–3.97	0.29
GB	2.04	316.41	17.79	31.51	–42.05	0.37
FER	3.88	14.41	3.80	11.40	0.21	–0.73
FI	4.71	1.77	1.33	6.46	2.28	0.79

* Correlation is calculated between short interest rate and lagged values of the other variable.

[14]But we need here the assumption of capital mobility, as interest rate is not the only factor affecting capital flight. Other factors like political stability, investment opportunities, risk etc. are important factors attracting capital in a country.

[15]This has not remained the case however, when we controlled for other variables as shown in Section 5.

3.1. Shift in Mean Values

If we see history of all the variables, the whole sample can easily be divided into two sub-samples; one with the mean of most of the variables above the long run average and the other with below it. So in terms of inflation and output, one period can be considered as boom and the other as recessionary phase of the economy. So we split the sample into two sub-samples, 1993–1997 and 1998–2004 and mean values over these periods are given in Table 2. Last year is omitted as most of the variables have steep increasing trend in that year.

Table 2

Shift in Mean Values

	Average Values		
	1993-1997	1998-2004	1993-2004*
CMR	10.88	6.75	8.47
Y-Gap	0.02	–1.40	–0.81
Inf	11.29	4.60	7.39
ERD	0.11	–0.08	–0.01
TD	15.19	10.18	12.27
GB	4.10	–2.01	0.53
FER	1.56	4.64	3.36
FI	5.47	4.27	4.77

Wit respect to inflation and output gap, the period 1993-1997 can be termed as boom as both of these variables, on average, were above their long run average. However after reaching the peak in mid of this sub-sample, inflation, output gap and interest rate started declining. It can be seen from the Figure 2 in the appendix that output gap started declining before the inflation, which is according to Keynesian hypothesis that inflation is affected by the changes in aggregate demand, [for example Svensson (1997)].[16] Interestingly, monetary policy was tight (on average) in the same period as average short interest rate was 10.88 percent, higher than the long run average of 8.47 percent. This relation remained also stable in the next sub-sample where monetary policy was, on average, expansionary with the economy being in recessionary phase.

Trade deficit has followed the same pattern in this period and its correlation with interest rate was also exactly the same as was of output gap. Exchange rate, on average, was negatively correlated with interest rate in that period as it was on average below the long run average. But this result might be

[16]In a Lucas type transmission mechanism, output is affected by unanticipated inflation, [see for instance, Cukierman (2001)].

misleading as most of the changes in exchange rate occurred in the period 2000Q3-2002Q1 that have influenced long run average thereby making it biased upward. Similarly average value of government borrowing does not make sense here as most of the fluctuation in it came after the first period and in the second sub-sample there is no average trend. In the first period foreign exchange reserves were below the long run average so the relation between them and interest rate, on average, was according to the theory. It is worth discussing here that interest rate started declining in the second period before the increase in foreign exchange reserves as the latter started increasing only after 2001Q2. So increasing foreign exchange reserves just added to interest rate decline and was not the only driving force behind interest rate change. Foreign interest rate movement was also correlated with the domestic interest rate and the timing of change was exactly the same as was with foreign exchange reserves.

All that comes out of this discussion is that short interest rate responds counter cyclically to output and inflation in Pakistan if we take the average behaviour and not the period to period movements. So despite focusing on other objectives in the short run, SBP focuses on two primary objectives, inflation and output, in the long run.

4. DATA ISSUES AND ESTIMATION METHODOLOGY

We have estimated monetary policy reaction function for Pakistan for the period 1993Q1-2005Q4. Data on all the variables except GDP are taken from International Financial Statistics (IFS) while that on GDP are taken from Kemal and Arby (2005).[17] The output gap has been constructed by fitting linear trend in seasonally adjusted real GDP and then calculating percentage deviation from this linear trend.[18] Inflation has been calculated as the percentage change in Consumer Price Index (CPI) over the last quarter and then taking four quarters moving average to get an annualised average inflation rate over the four quarters including the current one.

Exchange rate deviation from the trend has been calculated by fitting the trend in the nominal exchange rate. However the trend in this variable is discontinuous; in the period 1993Q1-2001Q4 there is linear trend in exchange rate while after that period it fluctuated around a constant mean of 60. So we have used 'Quadratic Spline' to handle this issue. Data on trade deficit is taken from IFS in U.S. dollars, which has been converted into Pak rupees by multiplying with the nominal exchange rate. It has been adjusted for the seasonal pattern, divided by seasonally adjusted GDP and multiplied by 100 to

[17]As the data on GDP is available only for 1972-2003Q2, the last ten observations have been constructed by taking averages of quarters' weights over the whole period and then multiplying these weights to annual real GDP of the last three years.

[18]To have deviation from the long run trend we have taken data for the period 1987Q1-2005Q4 for detrending.

have a measure of trade deficit as a percent of GDP.[19] Data on government borrowing have been taken as quarterly change in claims of central bank on the government. It is then made as a percentage of GDP and finally four quarters average is calculated to have average claims of central bank on government over the previous four quarters including the current one. Foreign exchange reserves have been taken in billion U.S. dollars. Finally the data on foreign interest rate have been taken as the average of U.S. 6-months Treasury bill rate and 6-months LIBOR.

The reaction function in Equation 4 can be estimated by ordinary least square (OLS), two stage least square (TSLS), generalised method of moment (GMM), vector auto regression (VAR), vector error correction method (VECM), probit and logit models etc.[20] The most frequently used technique is the vector autoregression (VAR) approach, with which the analysis of monetary policy is done by estimating impulse response functions and variance decomposition of forecast error of policy instrument rate, [see for instance, Amonde (2006); Chang (2000); Hsing and Lee (2004) among others for recent studies]. Some studies estimated Taylor rule by simple OLS and recursive OLS techniques, [see for example Judd and Rudebusch (1998); Plantier and Scrimgeour (2002)]. Shen and Chen (1996) applied binary non-linear models on time series data by making dependent variable binary by some categorisation. Following Shen and Chen (1996), Shortland and Stasavage (2004) estimated reaction function by multinomial logit. Following Romer and Romer (1989), Boschen and Mills (1995); Shen, Hakes and Brown (1999) estimated monetary policy reaction function by binary probit models, making narrative index for policy stance. Clarida, Gali and Gertler (1998) used generalised method of moment (GMM) technique for estimating forward looking monetary policy reaction function for six countries.

Although some studies have estimated Taylor rule by simple OLS, it is not the appropriate technique if contemporaneous values of variables on right hand side are taken. However there are estimation techniques that deal with endogeniety issues like two stage least squares (TSLS) or generalised method of moments (GMM). But finding instruments and classifying variables into endogenous and exogenous variables is not an easy job. So we have estimated monetary policy reaction function for Pakistan with the VAR model, which is more frequently used in estimation of the reaction function and takes care of endogeniety issue in the estimation.

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[19]Trade deficit has been multiplied by minus one for direct interpretation and convenience as we used trade deficit instead of trade balance in estimation.

[20]Different estimation techniques are based on different assumptions regarding the model and data. Probit and/or logit models can estimate the reaction function by making dependent variable comparable with these techniques. For example, we can classify interest rate change into two categories as: positive and negative change.

To model the reaction function, consider the following eight variables structural VAR,

$$BX_t = B_0 + \sum_{i=1}^{p} C^i X_{t-i} + \sum_{i=1}^{p} D^i i^f_{t-i} + \xi_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (5)$$

Where X_t is a vector of endogenous variables given by,

$$X_t = \left[i_t, y_t \;\; \pi_t \;\; er^*_t \;\; td_t \;\; gb_t \;\; fer_t \right]'$$

Where

i_t is the short interest rate (call money rate taken as central bank's operational target),

y_t is the real output gap,

π_t is four quarters average CPI inflation,

er^*_t is deviation of exchange rate from the long run trend

gb_t is government borrowing from the central bank as a percent of GDP,

fer_t is the log of foreign exchange reserves,

td_t is trade deficit as a percent of real GDP.

i^f_{t-i} is a scalar; the only variable that has been assumed to be exogenous in the system is the foreign interest rate.

B is a matrix of coefficients with one on the diagonal and capturing the contemporaneous effects of variables on each other. B_0 is a vector of constant terms. C^i are the matrices of coefficients measuring the lagged effects of variables on each other. ξ_t is a vector of error terms that contains zero mean, constant variance and serially as well as cross uncorrelated innovations, i.e. these elements represent pure structural shocks. System of Equations 5 can be converted into standard reduced form VAR with only lagged variables on the right hand side.

$$X_t = A_0 + \sum_{i=1}^{p} A_i X_{t-1} + \sum_{i=1}^{p} D_i i^f_{t-i} + e_t \qquad \ldots \qquad \ldots \qquad \ldots \qquad (6)$$

Where, $A_0 = B^{-1} B_0$

$A_i = B^{-1} C^i$

and $e_t = B^{-1} \xi_t$

Here e_t contains the elements that have zero mean, constant variance and are serially uncorrelated. However, these errors may be cross correlated, i.e.

$$E(e_{jt}) = 0 ,$$

$$Var(e_{jt}) = \sigma^2_j ,$$

$$Cov(e_{jt}, e_{jt-1}) = 0 ,$$

but $Cov(e_{jt}, e_{kt})$ may or may not be equal to zero.

Now the objective is to estimate the system 6 and then using these estimated parameters to identify the structural parameters and to recover structural shocks from the system 5 by imposing appropriate restrictions on the structural parameters. System of equations in 6 can be estimated by OLS because right hand side variables of all equations are same.

Next we have identified the structural shocks to estimate the impulse response functions and variance decomposition of short interest rate to one standard deviation shock in all the endogenous variables. To identify the structural shocks, we have used Choleski decomposition with the assumption that monetary policy responds to endogenous variables with at least one lag. However the appropriate number of restrictions to make model exactly identified is $\left(\frac{n^2-n}{2}\right)$, where n is the number of variables in the VAR, [Enders (2004)]. Here the monetary policy shocks are estimated residuals from the first equation in system 5.

5. EMPIRICAL RESULTS

As all of the variables in our analysis are stationary at level (integrated of order zero), we have estimated VAR in level. Also it has been estimated by OLS as it gives efficient parameter estimates as long as the right hand side variables are same in all equations [e.g. Enders (2004)]. We have selected one lag on the basis of Schwarz Criterion. This lag length is also appropriate practically, as we assume monetary policy responds to variables after one quarter and some of the variables are already previous four quarters averages. As we are primarily concerned with the estimation of monetary policy reaction function, here we present results of only the first equation in reduced form VAR – the estimated policy reaction function, (Detailed results from the VAR are given in Appendix B.

$$i_t = 2.28 - 0.17i_{t-1} + 0.33y_{t-1} + 0.18\pi_{t-1} + 0.24er^*_{t-1} - 0.03gb_{t-1} - 0.44\,fer_{t-1} + 0.07td_{t-1} + 1.47i^f_t$$

(0.94) (–1.26) (1.93) (1.67) (2.18) (–1.55) (–2.83) (1.66) (2.90)

Adjusted R^2: 0.78, S.E: 1.69

Here all parameters except for the intercept and lagged interest rate are significant, though the effect of output gap, inflation and exchange rate on interest rate is significant only at 10 percent level of significance. These results indicate that the State Bank of Pakistan target all of the variables in our model but does not smooth the interest rate. If output gap is positive, i.e. current output is above trend then SBP tights monetary policy by increasing the interest rate and vice versa. It should be noted however that the coefficient of output is not exactly the same as Taylor (1993) proposes but anyhow it is not significantly different from that, as shown by the Wald coefficient restriction test in Table 3.[21]

[21] Taylor (1993) proposed coefficient of current output but we have estimated the reaction function using lagged values of all variables.

Table 3

The Wald Test

Hypothesis	Chi-square stats	P-value
Coefficient of Output Gap = 0.5	0.96	0.33
Coefficient of Inflation = 1.5	142.51	0.00
Coefficient of Inflation = 1.0	54.81	0.00

Inflation has statistically significant and positive effect on short interest rate but the magnitude of its coefficient is problematic. According to the Taylor principle this coefficient must be at least greater than one; otherwise the system would become unstable.[22] Coefficient of exchange rate shows that the SBP acts to tight monetary policy whenever the domestic currency depreciates. Trade deficit induces interest rate to be high to discourage the aggregate demand. This result is statistically significant but again like the government borrowing the magnitude of coefficient is quite small. Finally, monetary policy in Pakistan seems more dependent on exogenous (foreign) factors as our results show more than one for one movement of policy rate with the foreign interest rate.

Coefficient of government borrowing is negative and statistically significant. It is also according to the theory as increased government borrowing from the central bank increases monetary base, which reduces interest rate. However the magnitude of coefficient is quite small. Same is the case with the variable of foreign exchange reserves; the effect of foreign exchange reserves on interest rate is negative and significant. We should keep in mind here that these two variables, government borrowing and foreign reserves are not in the monetary authority's loss function so they explain variation in the interest rate that is not explained by the variables in the loss function.

5.1. Impulse Response Functions

As stated in the introduction our primary focus in this study is to estimate the impulse response function of short interest rate due to changes in any of the endogenous variables we have taken. For this we have identified structural shocks by Choleski decomposition by imposing the restriction that monetary policy does not respond to any of the variables contemporaneously. With the help of these shocks, we have estimated response of interest rate to one standard deviation shock in each of the endogenous variables in the VAR. Results are give in Figure 1 below (detailed results are given in Table 5 in the Appendix).

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[22]It is because the coefficient is less than one only if central bank procyclically responds to inflation deviation from the target.

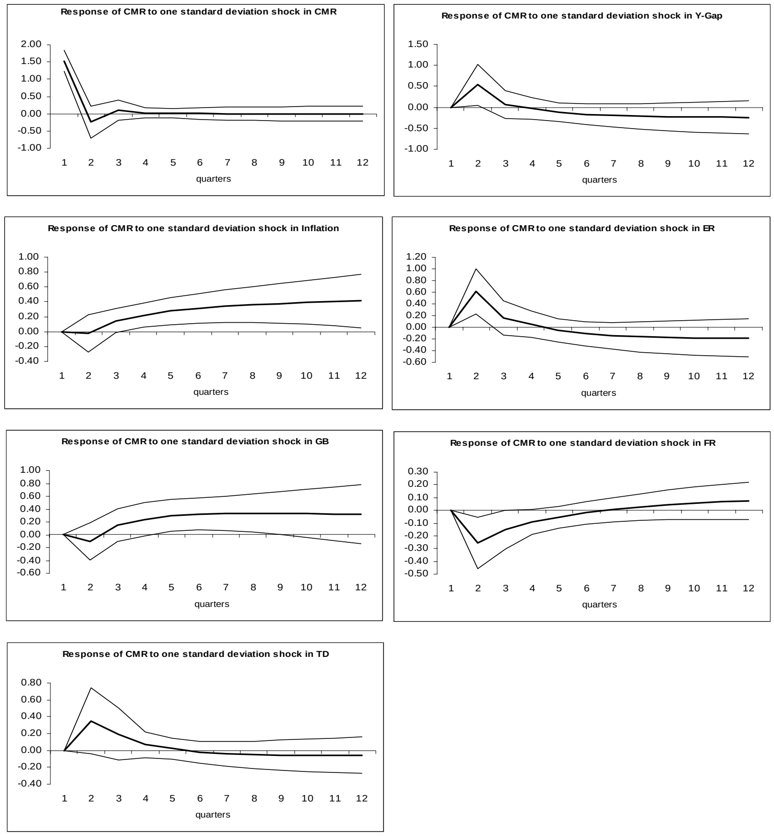
Our results show that shock in the interest rate transmits into interest rate immediately and positively and this effect dies out to zero just after one quarter as only first quarter's response is statistically significant. This behaviour confirms the result we have discussed above for monetary policy reaction function. If there is a shock in the output gap then monetary policy responds positively but after one quarter. Interestingly the effect starting in the second quarter reaches at the peak in the same quarter and dies out to zero in the third period. Monetary policy responds to inflation positively but only after two quarters. The effect starts in the third quarter and then gradually and slowly dies out to zero after two years. So inflation induces monetary authority to change stance of policy for longer time period. Shock in the exchange rate transmits into policy interest rate with a lag of one quarter and just like the case of output, the effect approaches to zero in the third quarter.[23] In case of trade deficit, a shock in this variable causes interest rate to increase—tight monetary policy. Like many other variables, this effect starts and reaches at peak in the second quarter and then dies out to zero in the third quarter.

If there is a positive shock in foreign exchange reserves in the country then interest rate responds negatively to this shock after one quarter. The effect starts and then reaches at peak in the second quarter but approaches zero (statistically) in the fifth quarter. The effect of government borrowing from the central bank on interest rate is ambiguous. Interest rate responds negatively to government borrowing after one quarter. However this effect becomes positive in the first quarter of the second year and approaches zero in the second last quarter of the same year. This change in direction after some period might be due to inflation resulting from monetary policy accommodation of government borrowing. So we can say that the effect of government borrowing on interest rate is negative and direct in the short run but it is positive and indirect in the long run.

In nutshell, we conclude here that monetary policy counter cyclically responds to output, inflation, exchange rate and trade deficit and the foreign exchange reserves and government borrowing from the central bank have also significant but negative impact on the short interest rate. All these results are in accordance with what the economic theory predicts. It should be noted however that the results in VAR somehow depend on the choice of lag length. But we have found that the direction of effect did not change even when we included two lags in the VAR. Nevertheless, the assumption of one lag is quite appropriate in the monetary policy analysis.

[23]Although the effect becomes negative after fourth quarter, it remains insignificant.

Fig. 1. Impulse Response Functions (± 2 S.E.)



5.2. Variance Decomposition

Finally we have decomposed the forecast error variance of interest rate to have an idea on the percentage explanation of interest rate by each of the endogenous variables. We have kept the same Choleski ordering as was in the case of impulse response functions. We have found that much of the variation in the interest rate is explained by its own lagged values, (about 73 percent in the first quarter). The second variable that explains much of the variation in the policy rate is the inflation rate. It explains about 18.57 percent of the variation in the interest rate. After this, three variables that explain more variation in the interest rate are respectively, the government borrowing from the central bank, exchange rate and the output gap. Their magnitudes are respectively, 15.69 percent, 11.62 percent and 10.62 percent. Finally the trade deficit explains about 4.71 percent of the variation in interest rate followed by the last variable, the foreign exchange reserves with a value of 2.74 percent. One important point to note is that as the time passed variation explained by interest rate itself is decreasing, while that by inflation and government borrowing is increasing.

Table 4

Variance Decomposition of Interest Rate

Quarters	CMR (–1)	Y-Gap	Inf	ERD	GB	FER	TD
1	100.00	0.00	0.00	0.00	0.00	0.00	0.00
2	73.59	8.90	0.02	11.38	0.32	2.01	3.78
3	70.79	8.64	0.64	11.62	1.01	2.60	4.71
4	68.35	8.36	1.95	11.30	2.62	2.74	4.67
5	64.99	8.32	3.88	10.80	4.87	2.69	4.45
6	60.98	8.51	6.13	10.44	7.23	2.53	4.19
7	56.81	8.84	8.44	10.22	9.38	2.36	3.94
8	52.82	9.23	10.71	10.10	11.21	2.21	3.72
9	49.16	9.62	12.86	10.04	12.71	2.09	3.53
10	45.87	9.98	14.88	9.98	13.92	2.01	3.36
11	42.93	10.32	16.78	9.92	14.89	1.96	3.20
12	40.29	10.62	18.57	9.85	15.69	1.93	3.06

In summary, we have found the ordering of variables in explaining the highest variation in interest rate as: lagged interest rate, inflation, government borrowing, exchange rate, output gap, trade deficit and the foreign exchange reserves. The important result here is that inflation has more explanatory power for the interest rate than the output gap has. Similarly the government borrowing from the central bank and exchange rate can explain interest rate variation more than what the output gap can do.

6. CONCLUSION

We have estimated monetary policy reaction function for Pakistan for the period 1993-2005 to identify the objectives of monetary policy in Pakistan. For this purpose we have included in our reaction function: the output gap, inflation, lagged interest rate, exchange rate and trade deficit as monetary policy objectives, while to overcome the issue of miss-specification, two more variables have been included in the reaction function that are not the policy objectives; foreign exchange reserves and government borrowing from the central bank. For the analysis we have used VAR to estimate impulse response functions and variance decomposition.

Our results confirm that the State Bank of Pakistan does care about both inflation and output. However the policy has also been focused on other factors as all of the objectives we included in the estimation significantly affect the behaviour of monetary policy instrument. The important result is that the trade deficit that is not taken as monetary policy objective in the empirical literature has significant impact on the central bank (SBP)'s actions. Two variables that we have included other than objectives (government borrowing and foreign exchange reserves) and the exogenous factor (foreign interest rate) also explain significantly the variation in interest rate.

We suggest here that one should take into account these other objectives when modifying Taylor-type rule for a country like Pakistan. Simple Taylor rule that focuses on inflation and output may be incomplete for the developing countries. But including too many objectives into the rule looses the simplicity of these rules—an important characteristic of the instrument rules. Similarly there are not agreed upon parameter values for the variables, other than inflation and output that are more frequently included in modified Taylor rule. A potential area for research in this regard is that whether the inclusion of other variables in the reaction function would reduce the loss to the society or it is better to just focus on two objectives in the Taylor rule.

APPENDIX A

Table 5

*Response of Interest Rate to One Standard Deviation Shock in Each Variable**

Quarters	CMR	Y-Gap	Inf	ERD	GB	FER	TD
01	1.53	0.00	0.00	0.00	0.00	0.00	0.00
	(10.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
02	–0.24	0.54	–0.03	0.61	–0.10	–0.26	0.35
	(–1.07)	(2.23)	(–0.21)	(3.19)	(–0.70)	(–2.56)	(1.80)
03	0.10	0.06	0.15	0.16	0.16	–0.15	0.19
	(0.72)	(0.37)	(1.81)	(1.08)	(1.23)	(–1.97)	(1.26)
04	0.02	–0.03	0.22	0.05	0.24	–0.09	0.07
	(0.33)	(–0.22)	(2.68)	(0.47)	(1.89)	(–1.91)	(0.87)
05	0.02	–0.12	0.28	–0.05	0.30	–0.05	0.02
	(0.21)	(–1.04)	(3.07)	(–0.48)	(2.39)	(–1.31)	(0.32)
06	0.01	–0.17	0.31	–0.11	0.33	–0.02	–0.02
	(0.10)	(–1.38)	(3.16)	(–1.07)	(2.62)	(–0.48)	(–0.29)
07	0.00	–0.20	0.34	–0.15	0.34	0.00	–0.04
	(0.03)	(–1.43)	(3.12)	(–1.27)	(2.55)	(0.10)	(–0.55)
08	0.00	–0.22	0.36	–0.17	0.34	0.03	–0.05
	(0.00)	(–1.40)	(3.01)	(–1.30)	(2.29)	(0.48)	(–0.63)
09	0.00	–0.23	0.38	–0.18	0.33	0.04	–0.06
	(–0.01)	(–1.35)	(2.85)	(–1.25)	(2.00)	(0.72)	(–0.63)
10	0.00	–0.23	0.39	–0.18	0.33	0.06	–0.06
	(0.00)	(–1.29)	(2.67)	(–1.20)	(1.75)	(0.87)	(–0.60)
11	0.00	–0.23	0.40	–0.18	0.33	0.07	–0.06
	(0.00)	(–1.24)	(2.47)	(–1.14)	(1.55)	(0.96)	(–0.57)
12	0.00	–0.24	0.41	–0.18	0.32	0.07	–0.06
	(0.01)	(–1.19)	(2.27)	(–1.09)	(1.40)	(1.02)	(–0.53)

* *t*-stats in the parenthesis.

APPENDIX B

Table 6

Vector Autoregression Results

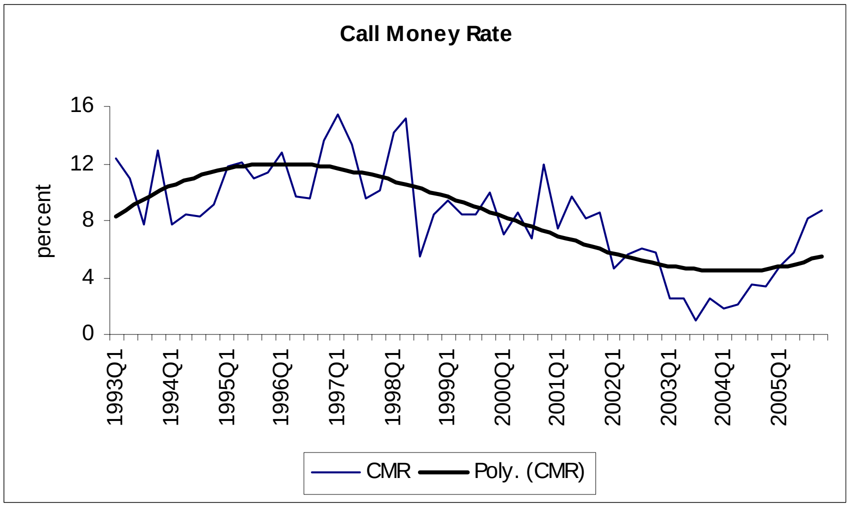
	CMR	Y-Gap	Inf	ERD	GB	FER	TD
	–0.172438	–0.039928	0.003073	0.032469	0.075475	–0.025598	0.496732
CMR(–1)	(0.13720)	(0.12566)	(0.04924)	(0.17034)	(0.69578)	(0.03737)	(0.52555)
	(–1.25683)	(–0.31774)	(0.06242)	(0.19062)	(0.10848)	(–0.68490)	(0.94518)
	0.332071	0.296446	–0.107986	–0.078352	–0.369580	0.026082	0.486715
Y-Gap(–1)	(0.17182)	(0.15737)	(0.06166)	(0.21331)	(0.87133)	(0.04680)	(0.65814)
	(1.93269)	(1.88377)	(–1.75124)	(–0.36731)	(–0.42416)	(0.55726)	(0.73953)
	0.183629	0.212984	1.078031	0.064288	0.245068	–0.050346	0.627770
Inf(–1)	(0.11027)	(0.10100)	(0.03957)	(0.13690)	(0.55920)	(0.03004)	(0.42238)
	(1.66529)	(2.10885)	(27.2413)	(0.46961)	(0.43825)	(–1.67606)	(1.48627)
	0.240692	–0.138124	–0.040542	0.413996	–0.750489	0.041016	0.372120
ERD(–1)	(0.11032)	(0.10104)	(0.03959)	(0.13696)	(0.55946)	(0.03005)	(0.42258)
	(2.18176)	(–1.36700)	(–1.02400)	(3.02270)	(–1.34146)	(1.36484)	(0.88060)
	–0.033811	0.004667	0.020956	–0.001215	0.834429	–0.015713	0.271041
GB(–1)	(0.02175)	(0.01992)	(0.00781)	(0.02700)	(0.11030)	(0.00592)	(0.08331)
	(–1.55453)	(0.23428)	(2.68471)	(–0.04501)	(7.56516)	(–2.65203)	(3.25330)
	–0.444884	0.162382	–0.003314	–0.534578	0.937174	0.859010	2.034125
FER(–1)	(0.15719)	(0.14397)	(0.05641)	(0.19516)	(0.79716)	(0.04282)	(0.60212)
	(–2.83018)	(1.12786)	(–0.05874)	(–2.73925)	(1.17564)	(20.0606)	(3.37826)
	0.069862	0.078254	0.001791	0.103468	0.078602	0.016887	0.134374
TD(–1)	(0.04206)	(0.03852)	(0.01509)	(0.05222)	(0.21329)	(0.01146)	(0.16110)
	(1.66106)	(2.03143)	(0.11867)	(1.98155)	(0.36853)	(1.47390)	(0.83408)
	2.283534	–1.380956	1.841413	7.101295	–12.70220	2.415067	–9.925850
C	(2.42945)	(2.22514)	(0.87189)	(3.01617)	(12.3203)	(0.66181)	(9.30594)
	(0.93994)	(–0.62061)	(2.11198)	(2.35441)	(–1.03100)	(3.64921)	(–1.06661)
	0.734554	–0.188908	–0.271052	–0.753003	0.632217	–0.136897	0.585514
FI	(0.25301)	(0.23174)	(0.09080)	(0.31412)	(1.28309)	(0.06892)	(0.96916)
	(2.90322)	(–0.81519)	(–2.98509)	(–2.39721)	(0.49273)	(–1.98622)	(0.60415)
R-squared	0.816716	0.692645	0.976055	0.517614	0.812154	0.987726	0.706537
Adj. R-squared	0.780953	0.632674	0.971383	0.423490	0.775501	0.985331	0.649276
S.E. Equation	1.694681	1.552164	0.608192	2.103948	8.594104	0.461647	6.491428
F-statistic	22.83702	11.54954	208.9064	5.499272	22.15799	412.4237	12.33887
Akaike AIC	4.054415	3.878726	2.004897	4.487057	7.301579	1.453517	6.740391
Schwarz SC	4.398579	4.222890	2.349061	4.831221	7.645743	1.797681	7.084555
Determinant Residual Covariance			1090.979				
Akaike Information Criteria			29.37997				
Schwarz Criteria			31.78912				

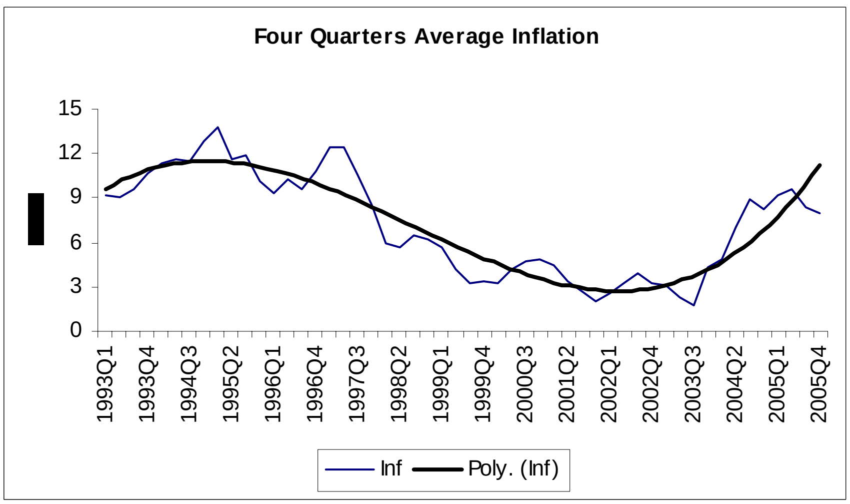
* Standard errors and *t*-statistics in parentheses.

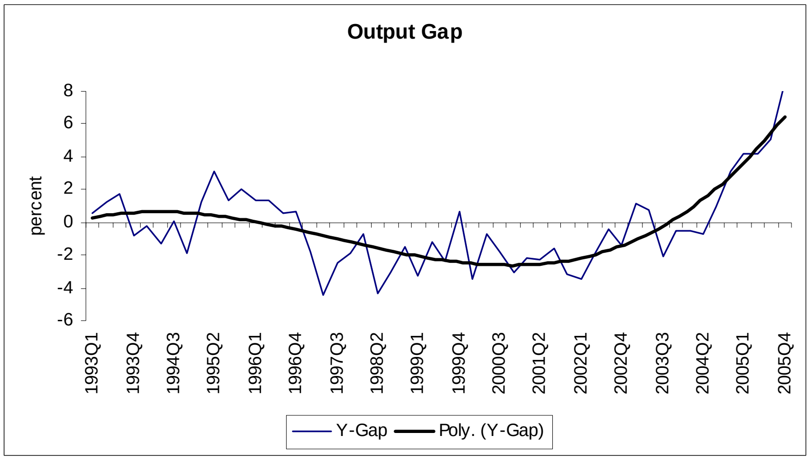
APPENDIX C

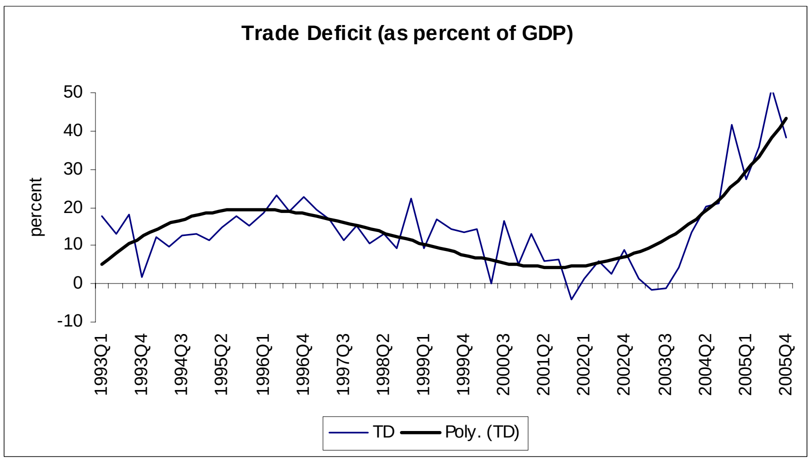
All of the series have been plotted with cubic trend to compare the average behaviour of a particular series with that of the short interest rate. It can easily be seen that interest rate, output gap, inflation and trade deficit follow almost the same trend. Trend in foreign interest rate is also same but the timing of curves is moderately different. Exchange rate, foreign reserves and government borrowing do not follow the same pattern as other series do. A simple result we can draw from here is that SBP focuses on output gap, inflation and trade deficit in the long run while other variables are correlated with interest rate only in the short run. Also, the monetary policy in Pakistan is much influenced by foreign interest rate.

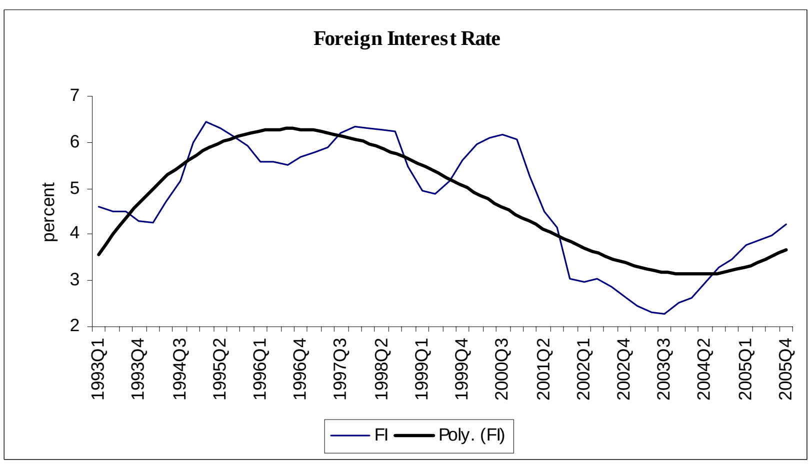
Fig. 2. Simple Graphs of the Variables

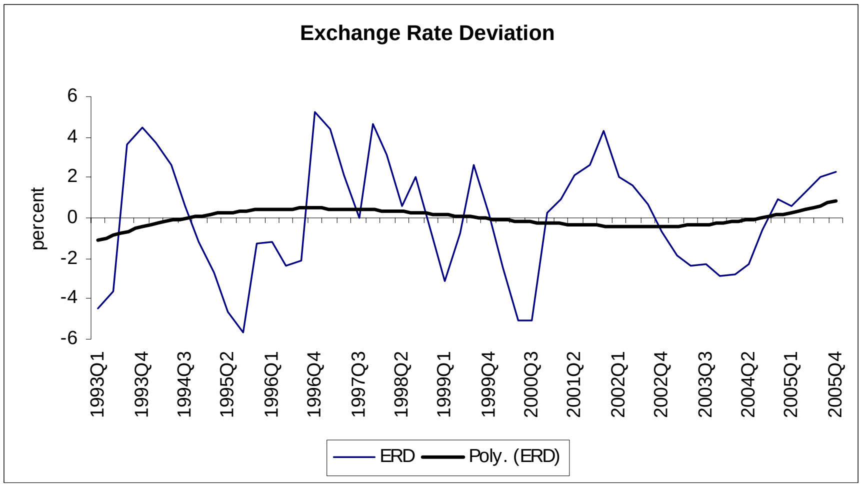


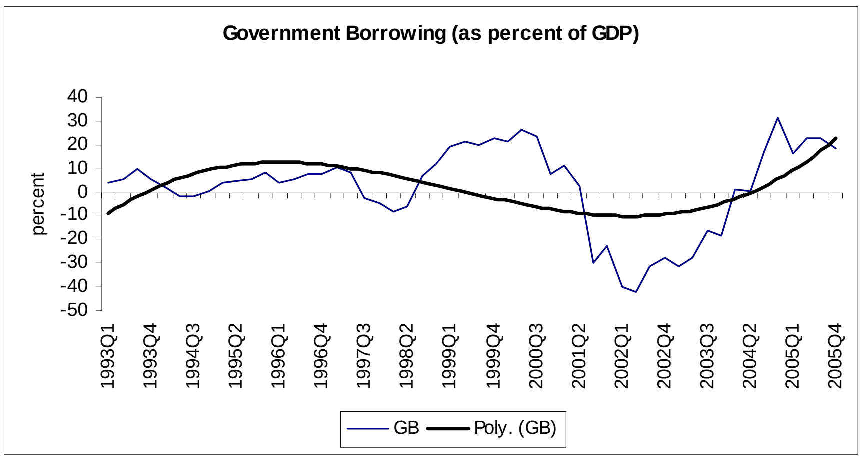


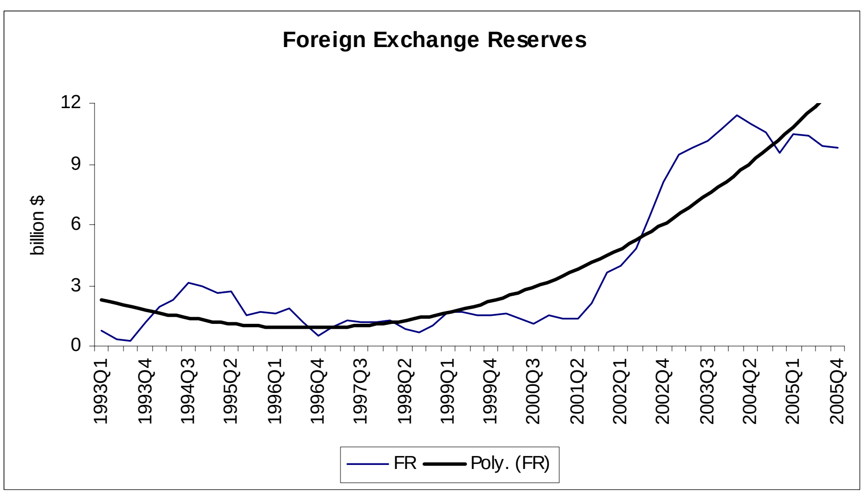

Output Gap
percent
8
6
4
2
0
-2
-4
-6
1993Q1
1993Q4
1994Q3
1995Q2
1996Q1
1996Q4
1997Q3
1998Q2
1999Q1
1999Q4
2000Q3
2001Q2
2002Q1
2002Q4
2003Q3
2004Q2
2005Q1
2005Q4
Y-Gap
Poly. (Y-Gap)


Trade Deficit (as percent of GDP)
percent
50
40
30
20
10
0
-10
1993Q1
1993Q4
1994Q3
1995Q2
1996Q1
1996Q4
1997Q3
1998Q2
1999Q1
1999Q4
2000Q3
2001Q2
2002Q1
2002Q4
2003Q3
2004Q2
2005Q1
2005Q4
TD
Poly. (TD)


Foreign Interest Rate
percent
7
6
5
4
3
2
1993Q1
1993Q4
1994Q3
1995Q2
1996Q1
1996Q4
1997Q3
1998Q2
1999Q1
1999Q4
2000Q3
2001Q2
2002Q1
2002Q4
2003Q3
2004Q2
2005Q1
2005Q4
FI
Poly. (FI)


Exchange Rate Deviation
percent
6
4
2
0
-2
-4
-6
1993Q1
1993Q4
1994Q3
1995Q2
1996Q1
1996Q4
1997Q3
1998Q2
1999Q1
1999Q4
2000Q3
2001Q2
2002Q1
2002Q4
2003Q3
2004Q2
2005Q1
2005Q4
ERD
Poly. (ERD)


Government Borrowing (as percent of GDP)
percent
40
30
20
10
0
-10
-20
-30
-40
-50
1993Q1
1993Q4
1994Q3
1995Q2
1996Q1
1996Q4
1997Q3
1998Q2
1999Q1
1999Q4
2000Q3
2001Q2
2002Q1
2002Q4
2003Q3
2004Q2
2005Q1
2005Q4
GB
Poly. (GB)


Foreign Exchange Reserves
billion $
12
9
6
3
0
1993Q1
1993Q4
1994Q3
1995Q2
1996Q1
1996Q4
1997Q3
1998Q2
1999Q1
1999Q4
2000Q3
2001Q2
2002Q1
2002Q4
2003Q3
2004Q2
2005Q1
2005Q4
FR
Poly. (FR)

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