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The Estimation and Evaluation of Monetary Reaction Function: An Empirical Study for Pakistan

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The present study has used simple Taylor Rule in order to explore whether it is followed by State Bank of Pakistan (SBP) while formulating its monetary policy or otherwise? In the study, the Monetary Policy Reaction function has been estimated for the period of about 27 years i.e. 1981-2007, keeping in view the objectives of monetary policy. The study also aimed at assessing the behavior of monetary authorities against different shocks hitting the economy including both internal and external. The stationarity of the variables has been estimated by using augmented Dickey Fuller test. The result shows that all the variables are stationary at the level of 1st difference. Further, Co-integration technique has been applied for the OLS estimation of the modified Taylor rule. The results of the study indicate that State Bank of Pakistan has not been following the Taylor Rule. It means that the actual monetary policy is highly deviating from it. The study reveals that SBP has focused on the exchange rate smoothness; despite the traditional targeted variables of the Taylor Rule i.e. inflation and output gap. It depicts that the response of monetary authorities against shocks to the economy is procyclical. It reveals that SBP set its policy rule in response to cyclical movements of macroeconomic variables rather than following the Taylor rule.

Field of Research: Monetary & Financial Economics, Taylor Rule, Pakistan

1. Introduction

Economic policy aims at minimizing an objective function that is defined over two bads; unemployment and inflation. One of the branches of the government namely the monetary branch is supposed to minimize the loss function defined over inflation and output gap. To achieve the objectives of price stability along with the real stabilization, monetary authority has different instruments, like interest rate and monetary base that are changed in response to changing economic scenario. These changes in instrument can be done either by committing to a rule or by discretionary actions. In either case changes in monetary policy instrument remains state contingent. The only difference

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lies in the policy consistency for the fact that discretionary policies may be time inconsistent especially when agents are assumed to form expectations rationally.

In Pakistan State Bank of Pakistan (SBP) affects its policy variables by using the short term interest rate, which is controlled through OMO's, as it is easy to control interest rate and to assess the effect of interest rate variations on the other macro variables of the economy i.e. price level, money growth, exchange rate, GDP growth rate, output level etc. within this perspective, the primary focus of this study is to estimate monetary reaction function for the case of Pakistan with a special focus on open economy variables. An important issue regarding monetary policy is that how the reaction of interest rate to inflation and output gap does affect exchange rate variations. Researchers have used the Taylor rule (1993) for different countries to estimate the policy reaction function of central bank. The main issue, which is faced in estimation of Taylor type reaction function, is the estimation of output gap. Researchers have used different techniques in its estimation. The methods include Linear trend, Hodrick-Prescott (HP filter) method, Band-Pass (BP) of Baxter-King method, Structural Vector Autoregressive (SVAR) method, Production Function (PF) method, and the Unobserved Component (KALMAN filter) method. It is controversial that which method is the best to approximate the potential level of output that can be used to calculate output gap for the loss function.

Despite of these estimation issues there are also issues on the inclusion of other variables instead of using simple Taylor rule that focuses only on two objectives of the central bank[1]. In estimating monetary reaction function researchers have added other variables as well which should also be included in the objectives of central bank. Moreover most of the countries' banks also focus on these objectives either directly or indirectly. As for as SBP is concerned, it also focuses on the variables other than these two. The reason why other variable should be included when such a simple rule exists is that as each country has different economic and political conditions, it cannot be applied to all the economies. Moreover exclusion of these other important variables also causes mis-specification of the reaction function. The present study focuses on the estimation of monetary policy reaction function for Pakistan to find the objectives of the monetary policy as well as to assess the magnitude of coefficients of variables in the reaction function. Monetary reaction function for the period 1985 – 2007 has been estimated, including variables like inflation, output gap, exchange rate changes, foreign exchange reserves, trade deficits and dummy has been assigned to capture the effect of devaluation on interest rate. The short term interest rate (call money rate) has been used as the monetary policy instrument. For the case of Pakistan's economy, State Bank of Pakistan (SBP) sets its target to achieve handsome growth rate of GDP, low inflation and increased employment. To achieve these targets discretionary policy has been used instead of any type of interest rate rule.

The reaction function has been estimated using OLS. The stationarity of the variables has been checked using Dickey-Fuller stationary test. We find that all the variables are stationary at first difference. To test for the consistency of estimates we applied stationarity test on error term. Error term has to be stationary at level for consistent

estimates. The estimation shows that interest rate responds positively to its own lagged rate, inflation, trade deficit and devaluation of currency. but the direction of change in interest rate is negative for the case of foreign exchange reserves. SBP also responds negatively to changes in output gap, which cannot be supported by simple Taylor type rule but this has been found by other researchers. The results for the estimation of monetary policy reaction function depicts that central bank's policy is highly deviating from simple Taylor rule. Although it is bit countercyclical in case of controlling the inflation but it has not been minimizing the output gap. Moreover the study also shows that central bank also targets other variables besides inflation and output. The organization of the study is as follow; Section 1 covers the review of related literature, Section 2 deals with the theoretical framework for the model and rules to be used for estimation on theoretical grounds, it also provides rational for the use of simple Taylor rule for this study. Section 3 consists on the methodology used for the estimation and data manipulation procedures. Section 4 gives the final results of the estimation and the results has been explained in light of theoretical background and variables relationship. Section 5 covers the conclusion of this study and give some policy recommendations.

2. Literature Review

Taylor (2000) shows that the use of monetary policy rules in emerging market economies has many of the same benefits that have been found in research and in practice in developed economies. For those emerging market economies that do not choose a policy of "permanently" fixing the exchange rate-perhaps through a currency board or dollarization, the only sound monetary policy is one based on the trinity of a flexible exchange rate, an inflation target, and a monetary policy rule. In his study he further discussed about the instrument rule that either it should be exchange rate or interest rate. He further put stress on it that there is need for modification in such monetary policy rules either in the choice of the instrument, in the variables in the rule, or in the size of the response of the instruments to economic events.

Svensson (2001) discusses how current inflation targeting should be modeled, and argues that it is better characterized as a commitment to a targeting rule , than as a commitment to a simple instrument rule(like a Taylor Rule). He introduced the concept of general and specific targeting in his study. These concepts are designed to provide a discussion of monetary rules that are fully consistent with the optimizing and forward looking nature of the modern monetary policy. General targeting rules essentially specify operational objectives for monetary policy, and specific targeting rules essentially specify operational Euler conditions for monetary policy. An optimal targeting rule expresses the equality of the marginal rates of transformation and the marginal rates of substitution between the target variables in an operational way.

Svensson (2003) argued that inflation targeting is best understood as a commitment to a targeting rule rather than an instrument rule. The paper bridge the gap between the recent literature's focus on simple interest rate rule and the actual monetary policy

practice by inflation targeting central banks. The simple instrument rules, like variants of the Taylor rule may to some extent serve as very rough benchmark for good monetary policy, they are very incomplete rules, because they don't specify when the central bank should or should not deviate from the simple instrument rule. While the targeting rules allow the use of judgment and extra model information. The model has been solved for backward looking, forward looking, and forecasting and discretion cases. In conclusion the study states that central target its rule for forecasting the future inflation and the judgment of previous time periods, that's why it deviates from the simple Taylor Rule. According to this study by setting target rules, there are few good reasons to deviate from them, since they allow the use of judgment and extra model information.

Bukhari and Khan (2008) reviewed six commonly used methods and attempted to estimate potential output and the output gap for Pakistan economy. These methods categorized as statistical and structural Estimation techniques include linear time trends, Hodrick-Prescott filters, Band-Pass filter, Production Function, the Structural Vector Autoregressive, and Unobserved Component methods. The performance of these methods has been discussed critically in terms of its limitations and advantages as well. However, the results suggest that the measures of the output gap produced different outcomes that are not identical to each other. But there has been some association among the results achieved from these methods. In addition a high degree of correlation was observed within the statistical and structural methods. Therefore, all of the six methods were divided into the classification of statistical and structural to measure the composite output gaps for each group. However, they observed a low degree of correlation between these two composite output gaps. Therefore, a bench mark output gap has been calculated by combining the outcome of each method. The benchmark output gap demonstrates a cyclical episode of demand pressure corresponding with excess supply, implying different degree of slack in the economy over a time period. In the recent past, since financial year (FY) 20005, it has been observed that the demand pressures are overriding in the Pakistan economy. As a part of these concluding remarks, there has been observed a high degree of temporal cross correlation between inflation and the composite measures of output gap. Furthermore, a common composite of structural and statistical output gap measure has shown highest degree of correlation with inflation during 2001-07.the results propose a considerable caution when constructing output gaps and using them for policy analysis in developing countries such as Pakistan.

According to Taylor (1999b) "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*". In modern economics, macroeconomists has established an acceptance of commitment on a rule rather than following a discretionary policy. As lags are involved in the monetary policy transmission, therefore to evaluate the desired results, the rule should be labeled along reasonable span of time. The literature related to rules versus discretion debate distinguishes between simple rules attributed by McCallum (1988); Taylor (1993), targeting rules that is duly proposed by Svensson (1997, 2002 and 2003)

and monetary committee rate (Svensson, 2005). I would like to create concise review of these policy rules here.

Taylor (1993) proposed the instrument rules. Instrument rules are simple and they are easy to follow. Simple instrument rules spell out monetary policy instrument as a function of the state of the economy that is formed on the available information to the central bank. These rules are simple to follow as it require little amount of information. These are robust. They are also technically feasible due to their provable commitment. Taylor (1993) offered an instrument rule to conduct monetary policy operations where he proposed to set the target for federal funds rate (interest rate/discount rate in Pakistan) equal to an "equilibrium" real funds rate with the collaboration of current inflation plus the weighted average of monetary authority's response to its deviations from the targeted inflation and percentage deviation of the real GDP from its potential level. The proposed rule by Taylor is as follow:

$$I_t = r + \pi_t + a_1 y_t + a_2 (\pi_t - \pi^*) \qquad \ldots\ldots\ldots\ldots \quad (1)$$

Where r is the long run equilibrium real interest rate, π_t is the current inflation rate, π* is the target inflation rate and y_t is the deviation of output in period t from its long run trend. It is pertinent to confer here that coefficient should fulfil the parametric requirements set by Taylor that coefficients of inflation and output gap should be greater than zero for having macroeconomic stability. As it can be assessed, if the inflation coefficient be let to less than zero, it would lead to further interest rate cut resultantly causing increased spending. The increased spending would cause high pressure of aggregate demand and pushes the prices up, consequently moves the economy towards unstable equilibrium.Taylor 1999a).Whereas Taylor has assigned the coefficient values 0.5 to both inflation and output gap.

However, Taylor do not use the exchange rate channel, the reasons he puts in Taylor (2000) is as;"*Simulation of multicounty models led me to believe that if the central bank reacted too strongly to the exchange rate then inflation – output performance would deteriorate. It was for the reason that I omitted the exchange rate in Taylor rule for United States. However, it is clear that same conclusion would not be reached, especially for small open economies. A country's size, openness, capital mobility and degree of exchange market development would matter*" However, Ball (1999) proposed a rule with the improvement on the Taylor rule (1993) by including exchange rate for small open economies.

Targeting rule (proposed by Svensson, 2000), central banks sets a single digit of inflation to target or gives a range of targeted values. Then monetary authorities legislate their directive for achieving that inflation target along with his discretionary

power of implementation. In order to process this rule, a high degree of transparency and accountability of the authorities is required that cannot be achieved in case of Pakistan. As a technical staff would be required to assemble data for this complex rule. These targeting rules are further classified into two types of rules known as, "general targeting rule" and "specific targeting rule". A general targeting rule specifies an operational loss function, which the monetary policy is committed to minimise. In specific targeting rule, a condition for setting the instrument is specified, e.g. marginal rate of transformation and substitution between the target variables is equalised. In this specific targeting rule, Monetary authorities does not announce any rule or range of numeric values to targets rather It gives an implicit reaction function of the monetary policy. In accordance with this type of framework central banks assemble large amount of data and then devise the policy.

However Woodford (2005) and Svensson (2003 and 1999) advocate the more structural demonstration of targeting rule in the following words: "an optimal targeting rule is a first order condition for optimal monetary policy. It corresponds to the standard efficiency condition of equality between the marginal rates of substitution and the marginal rates of transformation between target variables". So a simple targeting rule gives practical representation of robust and strong monetary policy that performs reasonably well under different circumstances. So it would be right to say that the optimal instrument rate is the rate that results in an optimal projection of the target variables that would not only minimize the intertemporal loss function of the central bank but also tends to maximize the welfare function of the society. According to Svensson (2005) interest rates adjusted according to market expectations are more realistic than constant instrument rate (Taylor rule), as they are based on the market's understanding and prediction of future interest rate. A recent trend he included in his study is the use of monetary policy committee rate. According to Svensson(2005) "*suppose that the central bank staff presents the monetary policy committee with two different instrument rate plans with two different projections of inflation and the output gap . It should simply choose the instrument plan that results in the inflation and output gap projection with the lowest loss*". Mishkin (2003). argues that it is too difficult for a monetary policy committee to agree on a path rather than a current instrument rate decision.

2.1 Instruments Rule in Pakistan's perspective:

There has been a large debated literature on the instrument rule that should be used for the accomplishment of targeted variables. Poole (1970) presented a debate on choice between a policy rule with the interest rate as the instrument and a policy rule with the money base/monetary aggregates. According to Taylor (2000) "if there is too much uncertainty in measuring the real interest rate or if there are relatively big shocks to investment or net exports, then a monetary aggregate is the preferred instrument; the same is true if it is difficult to measure the equilibrium real interest rate. In contrast, if velocity shocks are big then the interest rate is the better instrument". The commonly

used rule in monetary policy is Taylor rule (1993) that is used as a bench mark for policy rules.

Malik and Masood (2007) listed the five identified fundamental institutions problems of developing countries: weak fiscal institutions, weak financial institutions, low credibility of monetary institutions, currency substitution and liability dollarization and finally the vulnerability of the developing countries to sudden stops in capital flows (originally proposed by Calvo and Mishkin (2003). As Pakistan is also a developing country and also facing the same fundamental institutions problems. In such kind of scenario, simple rule is easy for any country to follow rather than complex structured rules. They also have the constraint of human capital, which is highly used in the formulation of second type of rule (targeting rule), where they have to formulate implicit policy reaction function and assemble large amount of data in order to devise a policy rule. So any kind of wrong judgment by the policy authorities leads them to unstable situation that may cause for adverse effects on economic variables. It is easy for Pakistan to follow simple interest rate rule as it is robust and all kind of data is easily available on it.

3. Methodology and Research Design

The mathematical form of the model is simple linear form

$$Y = f(x)$$

Where y represents the dependent variable and x represents the independent variable. Although the number of independent variable is not one in the model, so the estimated model is of the form as follow

$$Y = f (x_1, x_2, x_3 \ldots\ldots\ldots\ldots\ldots)$$

As the study is concerned with the estimation of Taylor Type reaction function, the statistical form of the base model is as follow

$$i_t = \prod_{t+} r^* + 0.5 (\Pi_t \_ \Pi^*) + 0.5 (Y_t \_ Y^*)$$

Where i_t is the rate of interest, $\Pi_t \_ \Pi^*$ is the deviation of inflation rate from its targeted level, $Y_t \_ Y^*$ is the output gap. Whereas .5 are the coefficients assigned by Taylor to the respected variables. So according to Taylor central sets only two objectives in its loss function to minimize it, where the central bank loss function is of quadratic form. Considering the central bank loss function

$$Lt = \alpha (\prod t - \prod^*)^2 + bx_t^2$$

Where α represent the coefficient for inflation deviations from its targeted inflation level, while x_t denotes a measure of the output gap in period t; b>0 denotes the relative weight on output stabilization relative to inflation stabilization. The objective of central bank is to minimize the deviations sum of square. Now if coefficient of output gap is zero it implies

that central bank is strictly having only inflation target variable, but if it is greater than zero, it implies that central bank is adopting flexible inflation targeting. So keeping this common practice in consideration Taylor developed this rule. But if we look at the common practices any central bank does not only target the output or the inflation level, it also targets other objectives like the exchange rate, trade balances etc. so considering it the model for this study has been modified by adding other variables as well. The model specified for this study is as follow

$$i_t = B_0 + \theta\, i_{t-1} + B_1 (e_m - e_0) + B_2 (\Pi_t - \Pi^*) + B_3 (Y_t - Y^*) + \lambda D + B_4 Dtb + B_5 RES + \xi t$$

Where variable on the left side is dependent variable and variables on the right side are the exogenous variables. The interpretation of the variables is as under

i_t = the rate of interest; call money rate has been taken for the study

i_{t-1} = the one year lagged value of call money rate

$e_m - e_0$ = the deviation of exchange rate from the trend values

$\Pi_t - \Pi^*$ = the deviation of inflation from the targeted level

$Y_t - Y^*$ = output gap

D = the dummy assigned for devaluation, 1 for the period in which dev

Has occurred and 0 otherwise

Dtb = deficit in trade balances

RES = foreign exchange reserves

The hypothesized relationship between interest rate and other regressors, as found in the literature, is tested by applying t test statistics. The usual hypothesis regarding the regressors' relationship is

Null hypothesis H0**:** B's= 0

Alternate hypothesis **H_1:** B's ≥ 0 except $B_5 \leq 0$

3.1 Data sources and manipulation

Secondary data has been used for the estimation of monetary reaction function for Pakistan for the period 1981-2007. Data on all the variables has been taken from IFS in U.S dollars. Inflation rate has been calculated from the consumer price index (CPI), whereas data on CPI for year 1981 is available on 1960 bas year while after 2000 the CPI is based on 2000 prices, so first the data has been converted on the 2000 prices.

The purpose of this method is to convert data on one base so as it would be easy to interpret the results by using recent base year. Moreover, numerous structural and economical changes have occurred in the last 20 years. Therefore, the inflation rate based on 1980 base year CPI is no more presentable to interpret the true picture of the economy. As due to inflation, the economy is depicting growth if it is compared on the basis of 1980's prices. Therefore, the whole exercise was done to waive off this inflationary growth. In this way all the series has been converted on 2000 prices, after that the inflation rate has been calculated by subtracting the last year prices from the recent year and divided it by last year price and then multiplying by 100.

The exchange rate gap has also been calculated by fitting the trend, and then subtracting the exchange rate from the trended values. The exchange rate gap from 1981 to 2000 has been calculated by this formula

$$\text{ERGAP 1981} = \frac{\text{nominal exchange rate} - \text{trended value}}{\text{Trended value}} * 100$$

As after the 2000, due to the incident of 9/11 Pakistan reserves has increased which causes to stable the exchange rate, moreover state bank also adopted the policy of pegged exchange rate system, that's why there is no more deviations in the data that's makes the trended line horizontal, due to this the exchange rate adjustments has been made by using this formula for the last years values

$$\text{ERGAP} = \frac{\text{nominal exchange rate} - 60}{60} * 100$$

The output gap has also been constructed by fitting linear trend and then calculating percentage deviation from this linear trend, as the same have been done for the exchange rate gap. The data on trade deficit and foreign exchange reserves has also been taken from the IFS. Data on call money rate has been used instead of short term and long term interest rate. As the central uses discount rate to effect the interest rate, banks lending rates, stock prices and investment. As in case of Pakistan discount rate is not changed yearly, so for call money rate has been taken for the analysis.

3.2 Estimation Techniques

For the estimation of Taylor type reaction function different techniques have been employed like generalized method of moments (GMM), ordinary least square (OLS), vector autoregressive regression (VAR) and two stage least square (2SLS). As Mehra (1999) estimated the short run reaction functions by using GMM technique for two sample periods. Abrams et al (1980) estimated the reaction function to check the stability of reaction function by using random-coefficient regression technique (RCR). The same Taylor function for Pakistan economy has been estimated by Malik (2007) by using VAR technique.

The present study intends to use OLS technique for the estimation of reaction function. OLS technique is used as it is simple and it is easy to satisfy all of its assumptions ~ (0, σ^2)

$$\text{Mean } (\varepsilon) = 0$$

$$\text{Var } (\varepsilon) = \sigma^2$$

$$\text{Cov } (\varepsilon_t, \varepsilon_{t-1}) = 0$$

As lagged value of interest rate is used in the function, so the Durbin Watson statistic has been used to test the problem of autocorrelation. Although it is not a matter of autocorrelation rather it is the requirement of model that its lagged value be added in the model. The stationarity of the variables has been checked by using the Dickey Fuller test of stationarity. If the variables are not stationary at the level or stationary at different levels then co-integration is used to apply the OLS* in order to explore the long run relationship to be found among the variables used in the study.

3.3 Unit Root Test (Stationarity)

Unit root testing is used to check the stationarity of a series. In time series models in econometrics, a linear stochastic process has a unit root if 1 is a root of the process's characteristic equation. The process will be non-stationary if the other roots of the characteristic equation lie inside the unit circle, then the first difference of the process

variable	ADF Statistic	1% level of significance	5% level of significance	Durbin Watson statistic
Interest rate	-1.840284	-3.7497	-2.9969	1.9381
Lagged interest rate	-0.581939	-3.7497	-2.9969	2.130
Inflation rate	-1.785416	-3.7497	-2.9969	1.936
Output gap	-2.183251	-3.8877	-3.0521	1.2886
Exchange rate gap	-3.4328	-3.7497	-2.9969	2.044
Foreign reserves	-0.4964	-3.7497	-2.9969	1.69
Trade deficit	0.35275	-2.6819	-1.9583	2.026

will be stationary. There is a need to test stationarity because stationarity of a series can strongly influence its behavior and properties. Moreover, in presence of non stationarity the usual “t statistic” values will not follow ‘t’ distribution that can cause for invalid hypothesis test of regression parameters.

3.3.1 Augumented Dicker Fuller (ADF) Test at Level

The stationarity of the series has been tested by employing ADF test on level first. The Results have been shown in Table 3.1. It clearly indicates that none of the series is stationary at level.

Table 3.1 Results of Augmented Dicker Fuller Test Statistic At Level

The usual hypothesis for unit root is as follow:

Ho = 0 (Unit Root: non stationery)

H1 ≠ 0 (stationer)

variable	ADF Statistic	1% level of significance	5% level of significance
Interest rate			
Lagged interest rate	-4.149870	-3.7667	-3.0038

The test shows that ADF statistics for all variables is greater than the critical value at 1% and 5% level of significance that leads to accept the null hypothesis of unit root which means that series is non stationery. Moreover, if a series is stationary at level but it's Durbin Watson Statistic is not equal to 2, it shows that the series is having problem of autocorrelation. The usual interpretation of the variables from these results is not clear and reliable. Therefore the ADF test is again applied at first difference

3.3.2 Augumented Dicker Fuller (ADF) Test at 1st Difference

The stationarity of all the variables was checked by using Augmented Dickey - Fuller test at level which showed that all the series have unit root problem and are non stationer.

Table 3.2 Results of Augmented Dicker Fuller Test Statistic At 1st Difference

Inflation rate	-3.121603	-3.7667	-3.0038
Output gap	-4.404180	-3.9228	-3.0659
Exchange rate gap	-3.234878	-3.7497	-2.9969
Foreign reserves	-3.1329	-3.7667	-3.0038
Trade deficit	-2.0686	-2.6889	-1.9592

Therefore taking the first difference or deter ending of the series generates the stationarity.The usual hypothesis for unit root is again followed

Ho = 0 (Unit Root: non stationery)

H1 ≠ 0 (stationer)

It shows Reserves, trade deficit, inflation and exchange rate gap are stationary at 1st difference on 5% level of significance, as their ADF statistic is less than the critical value at 5%, while other variables are also stationary at 1st difference on 1% level of significance.

4. Discussion of Findings

The stationarity of all the variables has been checked by using Augmented Dickey - Fuller test. It shows Reserves, trade deficit, inflation and exchange rate gap are stationary at 1st difference on 5% level of significance, while other variables are also stationary at 1st difference on 1% level of significance.

We cannot estimate equation by OLS if all of the variables are non-stationary. However Engle – Granger (1987) put forward that OLS give super consistent results even in case of non-stationary variables if the residual from the estimated regression is stationary at level. In this regard the stationarity of fitted residuals has also been checked. The test shows the stationarity of residuals of OLS at level. The estimated equation of OLS by using Eviews package is, (t-stats in parentheses)

$$i_t = 2.097 + 2.59\, i_{t-1} + 0.459\, \Pi_t - 0.54\, y_t + 0.054\, e_t + 1.61\, td - 8.63\, res + 0.214\, D$$

(1.52) (2.48) (4.05) (-3.99) (0.58) (3.03) (-4.36) (0.31)

Adjusted $R^{2:}$ 0.77 F-statistic: 12.58

S.E: 1.18 D.W statistic: 2.24

The estimated value for R^2 and F statistic is 0.77 and 12.58 respectively. Which shows that the regression is overall good fitted on 1% level of significance (as the $F > F_{.01}$: n-I, n-k), which means that we can reject the null hypothesis that the regressors have no impact on the interest rate.

Significance of the regressions parameters is tested by the usual t statistic. The t statistics are given in parentheses, which show that all the parameters except for the intercept, exchange rate deviations and dummy are significant, though the effect of lagged interest rate, inflation, output gap, trade deficit and foreign exchange reserves is significant at 5% level of significance. The results show that SBP target all the variables in our model but do not smooth the exchange deviations and devaluation of currency rate. Despite the fact of devaluation, there is one other major cause that causes for exchange rate deviation, which is the trade deficit. As the data shows that trade deficit is continuously increasing which means that our imports are more than domestic exports, which causes for a thrust in exchange rate. This rise in exchange rate not only cause for the loss of foreign exchange but also for the origin of imported inflation that entered in the CPI through the exchange rate.

Marshal Lerner has given conditions for the devaluation, that devaluation will only be successful if the sum of elasticity's of imports and exports is greater than one, while in case of Pakistan the elasticity of imports is more than the exports that causes the sum less than one, that is also the reason that in spite of devaluing currency, the deficit is widening as well as the exchange rate deviations are not being smoothened. It is due to the devaluation and constant rise in imports that causes for the violation of smoothness in exchange rate deviations. The different studies conducted by Ball (1999), Svensson (2000) and Taylor (1999b) estimated the exchange rate reaction coefficient of -.37, -.25, -.45 where as in this study the coefficient is .054 which is highly deviating from the literature and is not significant in this study as well.

The output gap coefficient is exactly the same as proposed by Taylor (1993) but having negative sign. As it has been said by different economist that Taylor's output gap coefficient is ideal but it's not necessary that it will remain alike for the economies of different countries. The appearance of negative magnitude of output gap is not only the single case of Pakistan's economy. The same kind of results has been found for Turkish economy as well (Çağrı Sarıkaya et al 2005). The purpose of the output gap measurement is to separate out the role of demand from supply-side shocks in affecting output movements, and inform policy about the trade-off between output and inflation. As the concept of output gap is driven from the Philips curve approach

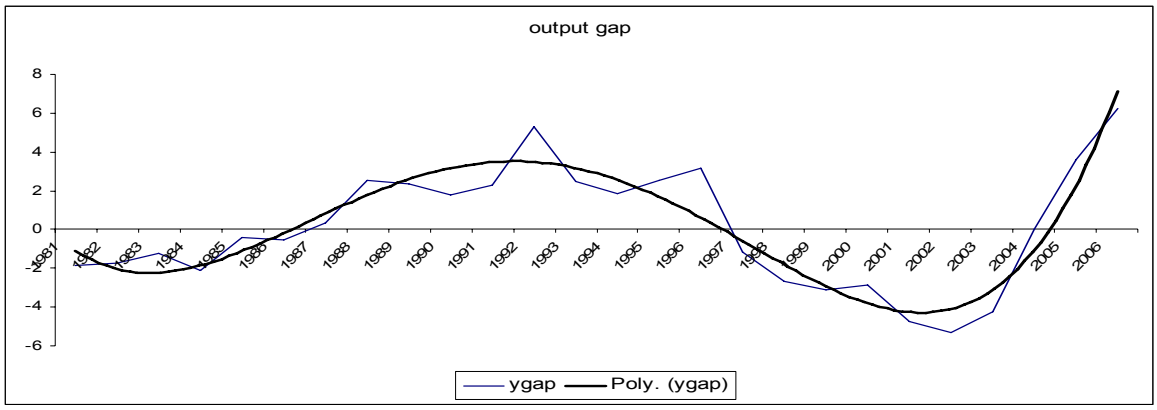
$$p_t = p_{t-1} + b(y_t - y^*) + e$$

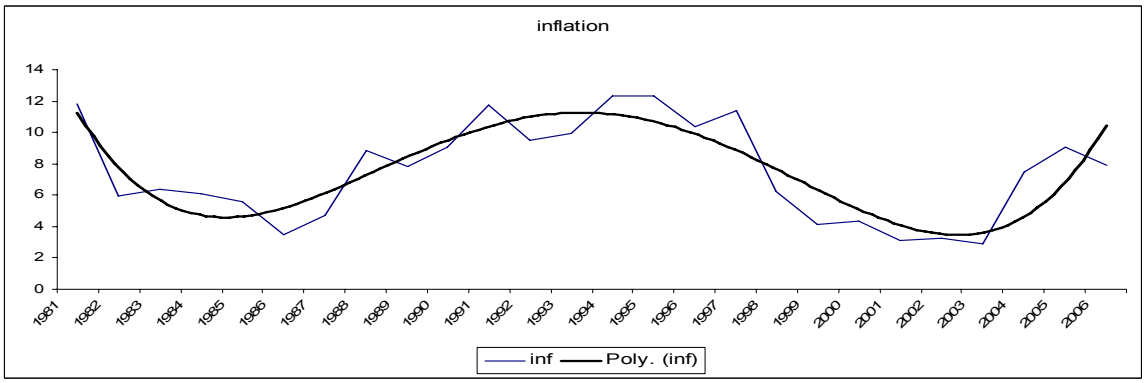
A comprehensive review on the estimation of output gap clears that the change in signs is also due to employing different techniques of estimation of potential output like HP filter, extended kalman filter, standard kalman filter etc. if the monetary authorities using HP filter for output gap it may give different sign if it is employing extended kalman filter. The output gap for Pakistan economy has also been estimated by S. Adnan H. A. S.

Bukhari and Safdar Ullah Khan (2008) by employing different estimation techniques. The study of the researcher is showing that Pakistan economy is under high pressure of demand. The same results has been in this study as well which means that output is less than the demand in the economy and the monetary policy could not boost up the investment to decrease these production shock as well.

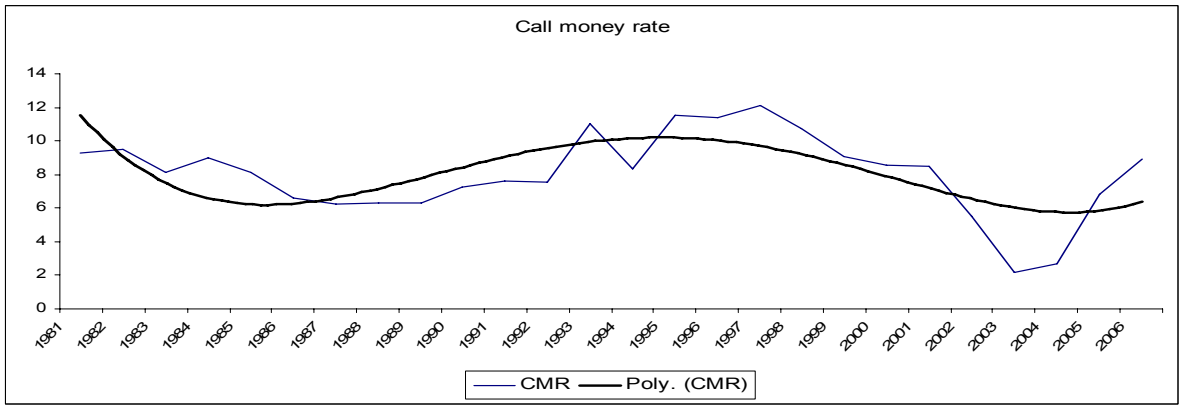
As the trade cycle's theories state that when there is fall in prices the supply also falls as it reduces the benefits of the producers. After this period price level tends to rise till it reaches to peak in 1994 and so is the output gap. So the relationship of inflation and output gap is procyclical. On the supply side of economy, an increase in interest rate means a higher cost of output produced and, therefore, a rise in price level. But as suggested by Ball (1990) an increase in interest rate has an intertemporal substitution effect on labor supply. Workers prefer to increase their working time in present period in order to increase their saving on higher interest rates. The increased labor supply will increase the output level and hence to decrease the prices. While on the demand side of economy, an increase in interest rate affect the aggregate demand by decreasing the net present value of expected return on invest as well as increases the cost of credit funds. This in turn reduces the investment, incomes of the laborers. The trend shows that price level is increasing which would cause to raise the interest rates level. As suggested by Ball, on supply side as investment is more sensitive to rise in interest rates, it causes to decrease the investment level as well as raise the cost of investment through lending channel, output level will fall and the output gap will increase more. The figure depicts that monetary authorities are successful in bridging supply shocks of the output gap after the period of 2004.while the SBP was following the easy monetary policy to decrease the supply shocks in the economy. Moreover inflation is also following the same pattern; there is not aggressive violation in the inflation rate which means that monetary authorities also concerned to one digit inflation rate.

On the other hand, being aware of numerous shortcomings of the output gap measures, most central banks acknowledge that output gap is just one variable in the information set of the policy maker among many indicators for forecasting future inflationary pressures, and thus, interpretation of the output gap measures along with the information provided by other indicators will improve the overall quality of assessing inflationary pressure.





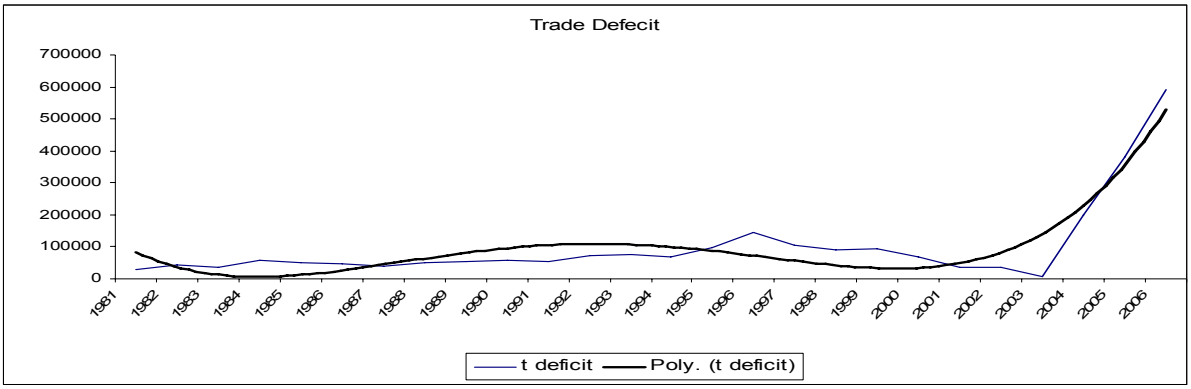
The effect of lagged interest is also statistically significant. This is showing that the lagged interest rate also matters in the determination of policy rate for the next year.

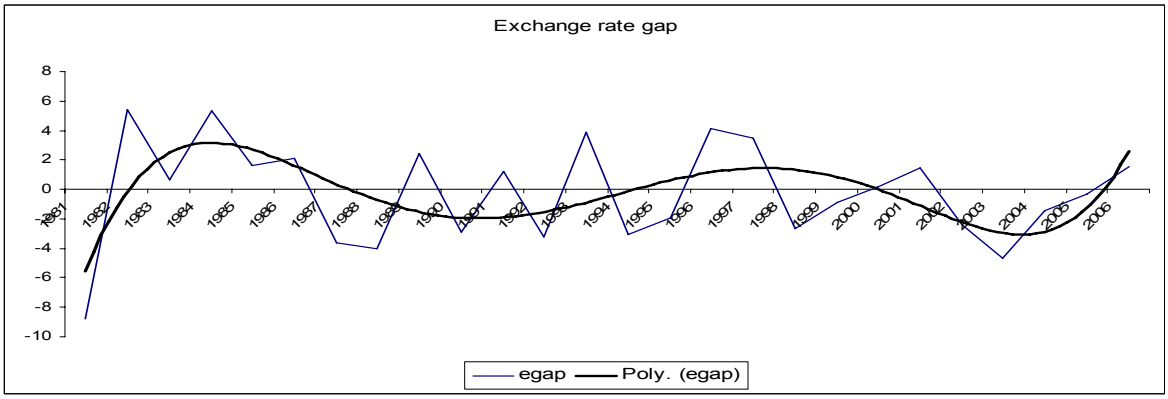


The figure depicts the movement of short term interest rate along the long trended interest rate. As long term interest rate depends on the short term interest rate and risk premia that is formulated on the future expectations of interest rate. As central bank set the short term interest rate but the private sector built his expectations on the past trend

of interest rate as well as the inflation factor is also corporate in it. Inflation also has statistically significant and positive effect on interest rate that is also supporting the Fisher identity that nominal interest rate is equal to real interest rate and inflation level, so if the inflation rises it would also cause to increase the interest rate.

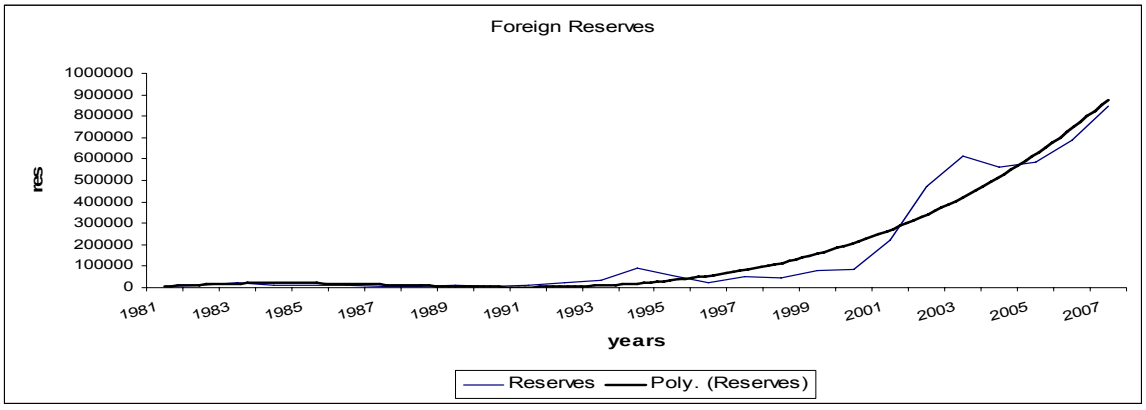
The coefficient of trade deficit is also significant statistically and is supported by the literature. As its slope coefficient is positive which shows that for rise in deficit would lead to increase the interest rate that would indirectly affect the aggregate demand by decreasing the transaction demand for money on the assumption that there is no change in international interest rate to affect the domestic interest rate and no outflow of physical capital. The magnitude of the coefficient shows that SBP gives large weight to decrease trade deficits that would eventually smooth the exchange rate itself. The relationship of exchange rate gap and trade deficit can be explained in figures. There is a considerable debate on implications of trade deficits on interest rates, rate of growth of money supply and in price level that in turn will affect the exchange rate of the economy. As far as Pakistan economy is considered, it is having the pressure of both domestic and imported inflation. It can be assessed due to continuous increase in goods prices that causes to appreciate the exchange rate. This in turn results to deteriorate the balance of payments, being our exports less than imports. Any country having deficit in trade means it is losing its foreign reserves which would cause to lower the value of its currency





The same picture has been depicted in the above figures. As the deficit was low in eighties with violation in exchange rate gap which falls in mid nineties and rise slightly after 1994. While trade deficit remains low till that period. When exchange gap rises after that period the trade deficit also shoot during the corresponding period that also causes for devaluation in our currency as well as losing of more reserves. As figure is showing negative exchange rate gap after 2002 which keep on falling till 2004 and then start rising, looking at trade deficit graph will also show a sharp decline in trade deficit of Pakistan. This happens due to the 9/11 incident which causes to raise the level of reserves in the economy and stabilizing the exchange rate level. Moreover this period is also showing that trade deficit has fallen historically in Pakistan. This causes to save the foreign reserves and surplus in current account. Foreign exchange rate reserves also showing the same pattern of other variables.

The coefficient of foreign reserves is significant. As increase in reserves would cause to increase the monetary base that would lead to increase the money supply remaining the money multiplier unchanged. As advocated by Fisher increased money level will raise price level. While the SBP aims to controls the price levels so as to stabilize the exchange rate value domestically. In order to decrease the aggregate demand level by decreasing transaction demand of money, the SBP would raise the interest rate level. Though, foreign reserves are not included in SBP loss function so it only explains variations in interest rate that is not explained by the variables in loss function.



As dummy has been assigned in this study to see the behavior of interest rate, it takes value of 1 in which year devaluation has occurred and 0 otherwise. In which year devaluation has occurred the mean change in interest rate is equal to (2.097+0.214) times while the mean change would be 2.097 in absence of devaluation. As Devaluation of currency lowers its own value and resultantly affects the purchasing power of

consumers through increased goods prices. As Keynes believed that people want to hold the same real amount of money. So, as nominal prices for goods and services increase, people want to hold larger nominal money balances. The demand for transactional demand for money will rise and interest will rise with the money supply remaining the same. So, although the dummy results are insignificant but it is verified by the literature and theory.

4. Conclusion

The study has been inducted to evaluate and estimate the Taylor type reaction function for the policy formulation by monetary authorities in Pakistan (State Bank of Pakistan). Monetary policy reaction function has been estimated for the period 1981-2007 to recognize the objectives of monetary policy in Pakistan as well to assess the behavior of monetary authorities against different shocks hitting the economy. For this purpose the output gap, inflation rate, exchange rate gap, lagged interest rate, trade deficit and foreign exchange reserves have been included in our estimated reaction function to modify the simple Taylor rule. For the analysis we have used the simple linear regression to estimate the function and other statistical estimation to compare the results and analyze the behavior of changes in variables.

The resulted coefficient values of inflation and output gap denotes the relative weight on output stabilization relative to inflation stabilization. As the coefficient value of output gap is less than zero which is implying that State Bank is neither fully targeting to output nor inflation. Rather it is trying to adopt flexible inflation targeting policy. Moreover SBP is more concerned to inflation than output stabilization. As monetary policy has transmission lags that's why affect of policy actions cannot be seen in the same period. As interest rate changes directly by changes in inflation rate and money supply. While investment and output level changes with lags of one or two years.

Considering the main objective of policy function i.e. inflation, output gap, exchange rate smoothness, the study shows that monetary authorities care more for the inflation rate than output gap stabilization. The results are also significant statistically. Like the other researchers Malik (2007), Bukhari & Safdar (2008), the findings of this study is same for the output gap. The output gap demonstrates a cyclical episode of demand pressure corresponding with excess supply, implying different degree of slack in the economy over a time period.

However, the policy has also been focused on other objectives that have been included in the estimation significantly. The important result is that the trade deficit, that is not included in simple Taylor rule as well as in monetary policy objectives, does have significant impact on central bank's actions. It means that trade deficit also causes to change the interest rate but on minor level as the correlation between interest rate and trade deficit is the lowest among all other variables. It shows that it affects monetary authorities' policy decision but it has lower weight. But looking from the other side of the picture as trade deficit does affect the exchange rate changes, so as long as the deficit

will increase, it would also cause to deteriorate the exchange rate. While in our estimations exchange rate correlation coefficient is much stronger than that trade deficit. The reason behind is that monetary authorities focuses on inflation, output gap and exchange rate smoothness. Our findings also depict the same kind of results that monetary authorities do change interest rate with the exchange rate deviations.

The study recommends that State bank of Pakistan should follow the Taylor rule. Any wrongly opted policy will lead to diverge from their targeted goals i.e. to minimize inflation and output gap. Although, there is tradeoff between inflation and output gap. The achievement of one does on the cost of sacrificing the other. However, now a days, it is need of SBP to control the inflation rate which is going on the path of hyper inflation. Moreover, the study also reveals that most of economic variables are affected through exchange rate channel. Therefore, the monetary authorities should also consider the option of exchange rate as policy variable.

There are some others that should also be added in the study to assess the true picture of reaction function, but that has not been included in this study to avoid for the problem of multicollinearity. The variables that should be added by the other researchers are govt budget deficit or Govt borrowings and foreign interest rate. As the addition of Govt borrowings creates new dimension of discussion of twin deficit that itself is a big issue to be dealt with, that can be left for the further research.

End Notes

1. The central bank's two objectives in simple Taylor rule are inflation and output gap

2. Marginal rate of substitution is given by the monetary policy loss function and marginal rate of transformation is given by the transmission mechanism of monetary policy.

3. svensson use monetary policy committee as the generic term for the monetary policy decision-making body of the central bank, including when the bank has single decision maker.

4. Considering the residual as a linear combination of all the variables in the model, this procedure is called the Co integration approach

5. EKF and SKF has been used in estimating for Turkish economy by Çağrı Sarıkaya et al (2005), both the results shows different policy recommendations due to different sings of coefficient.

6. The researcher has given the correlation coefficient between different estimation technique of potential output, where there exist high correlation in linear trend and Hp filter that is commonly employed in estimation

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