Measuring the Stance of Monetary Policy for Pakistan's Economy

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Abstract

Policy concerns and measuring the stance of stabilization policy especially demand management monetary policy has been a central concern that emerges out of the incessant observance of business cycles and shocks to the aggregate economic activity. To smooth the short term fluctuation; stance of monetary policy distilled from the idea of real interest rate gap (i.e. the difference between short term real rate and natural rate of interest) has grabbed considerable focus in the recent literature. This study is an attempt to figure out the time varying natural rate of interest series for Pakistan's economy using the quarterly data of inflation and real rate of interest between 1971 Q1 to 2007 Q2. Under the framework of Kalman filter methodological design; the study seeks the determination of unobserved natural interest rate series, the resultant extracted series reveals some important features relevant to the variability of natural rate over the concerned period of study. The logic behind the selection of large sample is to increase the validity of results obtained through kalman algorithm. The acquaintance of the derived series is meant to disclose the stance of monetary policy in Pakistan over the years (especially the post reform period).The financial reforms in Pakistan are believed to be properly launched in early 90's. Though there are numerous other measures available which could depict the stance of monetary policy (i.e. Monetary Condition index has been used by different authors [Khan and Qayyum (2007)],[Fung and Yuan (2001)], [Bernanke and Minhove (1998)]) but using the real rate gap and its authenticity as a measure surpasses the other alternatives. The results thus acquired through this technique seem to declare the procyclical stance of monetary policy most of the time in the 90's decade and in the initial phases of 2000 with the exception of the period after

2005 where it remained countercyclical. The procyclicality pronounces that the policy remained loose in the periods of booms when it was supposed to be tight while it remained tight in recessions when it was supposed to be loose. The research after expounding the stance of monetary policy recommends the frequent inquiry and calculation of short term benchmark value of natural rate of interest by the central bank so that the monetary policy be made effectively operative in line with the economic conditions.

1. Introduction

Economic literature and theory has a characteristic feature that it puts no barriers to its ever changing dimensions if required by the time. Conduct of monetary policy is nevertheless a different issue, which has mostly been under different transitions keeping intact the essence of original economic theory with it. Pursuit of the price stability has always remained a desirable and most primary goal and objective of monetary policy but the intensity that has been brought in with the regimes of inflation targeting reveals a subtle commitment to the cause of economic stability. This targeting is led by the idea of output being hampered if the inflation surpasses its threshold level (Khan and Sinhadji, 2001), (Mubarik, 2005).

History has witnessed the ages of monetary policy being predominantly occupied by the quantity approach favored by Irving Fisher, but then the focus started to shift towards interest rate approach favored by Wicksell (1898). This distinction stimulated an adequate amount of literature on the issue to be considered by central banks; whether to opt for interest rate control or to go for money control. The ideological distinction among the two approaches was not quite prominent until we experienced the financial innovation, which is still continued today. The introduction of new financial instruments has weakened the role of monetary aggregates and the control of central bank in using them. Therefore the inflation targeting now a days is generally perceived to be associated with interest rate controls and bulk of economic researches are available today to fortify the truth of this perception. The mere statement, that the central bank should follow

interest rate approach does not mark an ending to the accomplishment of the objective of economic stability but the achievement of that goal demands something beyond this? At least a mark of reference (Natural rate of interest) [1], which could well depict the stance of monetary policy in lieu of the central bank's appointed targets has to be figured out. Irrespective of the predictive powers of monetary authorities on various accounts it is extremely desirable to have an account of a specific value of interest rate above or below which a central bank can examine it penalizing powers to any unfavorable economic condition faced by it.

Every article or research meant directly to the estimation of NRR castes an accompanying shadow primarily on the vital role of finding policy neutral rate for appropriate inflation targeting and smoothed economic growth, (Woodford, 2003). This argument can be verified by the quote of Woodford, "(…) inflation occurred whenever the central banks lowered interest rates without any decline in the natural rate having occurred to justify it or whenever the natural rate of interest increased (…) without any adjustment of the interest rates controlled by central banks in response (…)" (Woodford 2003, p. 49). The basic concept of NRR stems from idea presented by Wicksell (1898). Through a course of century economists agree on unanimous account to define the neutral or equilibrium real interest rate in words as follows:

"The real interest rate consistent with the level of output at its potential and inflation at its stable, primarily through the course of time over which the monetary policy is spread out"

[1] The terminologies Natural rate of interest, Neutral rate of interest and Equilibrium rate of interest used throughout this paper are being treated synonymously. NRR is referred to as Natural rate of interest.

Owing to the important role that natural rate of interest can play in providing signals to the monetary policy and its significance in serving as a guideline to it, the purpose of this research is to find out the natural rate of interest for the Pakistan's economy and using its implications for the stance of monetary policy over the period from 1971 Q1 to 2007 Q2. Not much work has been done so far in this area because of the complex nature of determination of NRR. Though other measures have remained frequently in practice to measure the stance of monetary policy including monetary aggregates, MCI index (Monetary condition index) etc but the modern theory in practice is not accommodating those measures to pin down the diagnosis of stance because of weaknesses inherent in them[2]. To avoid any misperception regarding the monetary policy stance, we are using the today's renowned measure of NRR (through its estimated value), which would keep us moving within the band of appropriateness in quoting the stance of monetary policy which prevailed over the years.

Organization of Study

The subsequent sections are organized in the following order. Literature review has been presented in the second section. A glance to Pakistan's monetary policy has been focused in the third section, introduction to data and methodology has been presented in the fourth section. Fifth section is allocated to focusing the estimation and results. Sixth section is assigned to summarize, conclude and to offer a brief review of policy recommendations.

[2] King (1997) found a weakness in MCI index inherent in its assumption of considering exchange rate to move in opposite to the movement in prices(a monetary ease), but it is possible for prices to remain stable while exchange rate would show variations(depreciation or appreciation). As far as monetary aggregates are concerned they are culpable of being highly sensitive to financial innovation.

2. Literature Review

As the gist of discussion gravitates along the measurement of the stance of monetary policy, it is necessary to focus on the concept over which this stance hinges upon. This has already being introduced before that the correct measure of natural rate of interest is critical in this regard, so in order to make true appraisals and projections about the stance it is necessary that the concept and nature of NRR be understood completely. The literature review presented below attempts to account for this dimension and is offering a detailed insight about the concept of NRR.

2.1 Backdrop

In the current literature available today, in lieu of finding out root causes of business cycles focus has been shifted dramatically to a unique concept of real rate of interest that is neutral with respect to prices and output deviations. Though it appears to have been highlighted to a large extent in the current literature and mostly thought to have been pioneered by Wicksell (1898) over a century before, but a glimpse over the history reveals that it has long ago traces back into the past, (Spiegel, 1991). The only distinction one would draw upon from the comparison is the evolution and the refinement through which, this concept has evolved over this course.

Wicksell was more concerned about the varying business cycles caused by the discrepancy between natural and the market rate of interest in the real economy and thus

regarded the determination of natural rate of interest obligatory by the monetary authorities. To him stance of monetary policy could only be figured out by finding the extent of gap between RRR (real rate of interest) and NRR prevailing in the economy and following this idea he interpreted the monetary policy mostly culpable for the business cycles. Though past did not precisely mention any thing about RRR and NRR, but the intuition of one to one correspondence between money supply and prices presented in the "Quantity theory of money" implies that the possible explanation of change in prices in response to change in money supply and the accompanying business cycles ought to have been advocated by the discrepancy of market rate relative to some standard value. As the role of rate of interest was not expounded in the earlier versions of "Quantity theory of Money", this lapse in its presentation also provoked Wicksell to present an augmented link between inflation and money supply changes by refining it through the infusion of role of the interest rate between the two, (Amato, 2005). Later on (Keynes, 1936) also inculcated the role of real interest rate to enhance exposition of the QTM but unlike Wicksell he did not hold plausibility regarding the NRR concept.

2.2 Issues relevant to time horizon

The fact that the term NRR is hard to deal with, stands on the complex and intricate concept matter which it offers. For instance in the very foundational buildup of this concept it offers a skeptic to the researchers about the time horizon. Most of the coin tossing has been made between the "medium run" and the "long run", but short run notion cannot be denied on substantial basis. Varied conflicting view points are available about this time dimension among the economists; (Friedman, 1968), (Wicksell, 1898), featured the natural rate of interest as a characteristic of long run, the New Keynesian

framework however contradicts this long run notion and perceives the NRR to be short run, period by period adjustable and flexible price real equilibrium rate preferably harmonizing with rational expectation on the part of people, (Amato, 2005). Rigidities and frictions offer appositive scenario to what seems congenial for the very determination of NRR, and short run is often found furnished with these two characteristics, thus preferably we avoid this short run abstraction, an important quote is worth mentioning here "(---)The natural rate of interest is equal to the return on capital that would be expected if there was no friction in the economy, which should also be the interest rate set by monetary policy in the absence of rigidities. (---)", (Manrique and Marque, 2004). Vanishing this abstraction out many authors have preferred to attribute this frictionless time period to medium run (Laubach and Williams, 2003), (Archibald and Hunter, 2003)

2.3 Issues relevant to time variation

Though initially formulated monetary policy rules by the New Keynesians projected a constant treatment to the value of NRR (Clarida et al., 1998) but gradually empirical evidences induced a more time varying dimension to this concept, (Neiss and Nelson, 2003), (Horvath, 2007). Recognizing the margin that can be exploited, researchers tended to seek what would have happened, if the time varying tendency of NRR had not been perceived. Mostly the logical conclusion of biasness in estimated parameters has been drawn with the fortification through empirical investigation, (Kirker, 2008). Unanimously in accord most of the economists believe that NRR is time variant not only in the short run but also in the long run. Its long run variability is generally attributed to structural changes but its short run variability is considered to be intrinsically inherent characteristic

that makes it compatible with the dynamics of period by period equilibrium, (Chananeco F and Neto, 2006). It is therefore deemed desirable that to acquire precision in the estimates of NRR and to avoid the probability of errors, fluctuation in NRR should be encountered appropriately, (Orphanides and Williams, 2002)

2.4 Estimation Techniques and their Pros and Cons

If we put attention to the momentous issue of estimating NRR, research reveals that it has been estimated through different techniques and econometric procedures, among those techniques some of most commonly used techniques are DSGE Modeling, Maximum likelihood technique, Kalman filter, SVAR, Yield Curve approximation, HPMV filter, HP filter, Band Pass filter etc. Dating back to the initial efforts of estimating NRR, we find one technique as most commonly employed in the past that is calculating the NRR through the long run average of the real interest rates. Although in calculating the estimate of NRR through the long run average of the real rate is based on the presumption that in the long run the cyclical component of interest rate averages out to zero (Archibald and Hunter, 2001) but theoretical understanding make it clear that structural changes and the persistence of business cycle over some wide range of interval calls into question the authenticity of using the historical averages for estimating the NRR, (Puflaum et al., 1997). Furthermore these long run historical averages which are employed to find the range of estimates of NRR are themselves engulfed with variability, which again reiterate the discrediting mark in using them with confidence (Manrique and Marqués, 2002).

One more simple technique in practice is the yield curve that is generally used to estimate the NRR. Although the advantage of this technique lies in the ease and convenience it offers in calculation of NRR and its trend without being indulged in sophisticated and rigorous econometric procedures but the assumptions underlying the yield curve derivation put a question mark to the validity of these estimates and their trends, (Basdevant et al., 2004). For instance yield curve is heavily dependent upon stationary time series moreover it assumes stable inflation over the relevant period of study upon which the unobservable like potential output and NRR are estimated. Another short coming candidature includes the sensitivity of the slope of yield curve to the structural changes which it does not account for; and if these changes are allowed to play their role the slope of yield curve vary drastically.[3] With the aspiration of the economists and researchers to acquire precision in the estimation of NRR, more and more sophisticated and complex techniques of estimation are witnessed today including DSGE models and Kalman filter. These techniques are frequently being employed in the current literature. Each technique has its own advantages and is also largely dependent upon model specification and assumptions i.e. whether the model is semi structural or highly structural? Whether low frequency or high frequency model is employed?[4]

DSGE models by their very name capacitates the dynamic, random and general equilibrium features of the economy, these models started to emerge in response to some

[3] For complete description of the shortcoming of using Yield curve and comparison of the estimated value of NRR with the estimates obtained through other techniques see, [Badevant et al., (2004)]

[4] For meticulous and detailed comprehension see (Laubach and Williams, 2003) and (Manrique and Marques , 2004)

weaknesses in the previous "Empirical forecasting models"[5]. Every policy implication is well versed in its own particular regime, that's implication might not be required or desired in any other regime depending on the changing scenario, (Lucas, 1976). This is the weakness which DSGE models expel out in contrast to traditional forecasting models. But one cannot set aside the other face of the coin, though DSGE models are primarily based on the New Keynesian doctrine but there are some serious pitfalls in these models which have become prime focus of the critics e.g. DSGE models exaggerate the smooth functioning of the financial markets, as classical were too optimistic about the market clearance, DSGE models are inclined to believe rather too readily on the self correcting mechanism of financial markets (Munchau, 2008). Further criticism posed in this regard was by (Buiter, 2009). Despite of all the critics on the flimsy aspects of DSGE models, their widespread application and use by the central bank and the researchers [(woodford, 2003), (Gali, 2008), (Kydland and Prescott, 1982), (Clarida et al. 1999), (Giammarioli and valla, 2004), (Neiss and Nelson, 2003), (Smets and wouters, 2003)] for economic forecasting and estimation helps DSGE models to withstand every criticism made on their use.

Finally a technique which has attained considerable familiarity and practice is the Kalman filter. Kalman filter is a discrete, recursive, linear filter its mere disadvantage which puts a restraint on the researchers in using it is the complicated methodology it posits. Another caution which the use of Kalman filter offers to its employers is its

[5] Empirical forecasting models includes models developed by Jan Tinbergen (1936), Wharton (1961), which are considered as classics in economic history for forecasting purpose even today. But the tedious and rigorous exercise required to deal hundreds of variables included in these models and lucas critique upon them made their position a bit flimsy.

sensitivity to the variance of the data series used in the estimation; the results may vary considerably with the assumptions or calibration regarding the variance of the series used. Furthermore this technique is also quite sensitive to the provision of the prior information and initial states of the unobservable variables to be estimated. But these disadvantages are surpassed by so many prolific and productive applications of this technique. It offers a unique opportunity to be accommodated and adjusted in different specifications like likelihood (Harvey, 1991), Bayesian (Harvey et al., 2005), Gaussian (Snyder, 2002) etc; furthermore it is well equipped with the modeling design which allows the simultaneous estimation of various unknowns at a time. The latter advantage is rarely criticized for limiting the degree of freedom if the time series under consideration comprises of few year data but this problem can also be accommodated by disaggregating the time series into quarterly and monthly design.

2.5 Literature on the Measures of Monetary Policy Stance

Debate has been going on throughout the recent history of literature as to what monetary policy entails. What is it all about? What are its objectives? What is its transmission mechanism? What are its prime goals and targets? These are few questions which have been occupying the literature for sometime now. Measuring monetary policy stance is easy to say than to measure. Consensus is yet to be established in this regard whether to use a single variable as an indicator of monetary policy stance or whether use a combination of relevant variables which could divulge the stance of monetary policy. Innovations and signals of a single variable might pose a reasonable projection in lieu of monetary stance according to some authors. Some authors attempt to advocate M1 among

these single variable candidates (Laidler, 1999), (Fung and Kasumovich, 1998), some contend on placing their weight on the policy rate controlled by central bank (Bernanke and Blinder, 1992), (Freedman, 1995), some prefer MCI as an indicator of monetary policy stance (Khan and Qayyum, 2007), some are more inclined to use a more composite measure in contrast to single dimensional measure for acknowledging the stance (Fung and Yuan, 2001), (Bernanke and Mihove, 1998). However all these measures remained subject to time scrutiny and criticism? MCI being regarded as a measure of overall economic condition, another allegation imposed, that limits the authenticity of MCI is its inability to incorporate the monetary aggregates to account for the monetary transmission mechanism, moreover the different relative weights assigned to the included variables in MCI are also objectionable in different situations.

3. Pakistan's Monetary Policy at a Glance[6]

3.1 A Historical Glimpse of Monetary Policy

Unlike the conventional trend prevalent all over the world regarding the focus, implementation, monitoring and scrutiny of monetary policy from the very start of financial establishment, the intensity in diverting the focus towards monetary policy management and its reforms took a while to emerge on Pakistan's economic screen. The visible posture at the background clearly provides the margin of bifurcation into two regimes. First regime comprises the prior period to 1990's and the second subsequent to it. The State bank of Pakistan which holds the soul responsibility of conducting monetary policy has been using different tools and instruments for the accomplishment of its conduct of monetary policy, including direct instruments as well as indirect instruments[7]. The use of the direct instruments was mostly observed before 1990's financial reforms (mostly in 70's and 80's) while indirect instruments started to emerge as a disguised complement of the market oriented setup.

The objectives of the monetary policy had mostly been setup in compliance with the stated realm of the SBP Act 1956[8], but remained subject to innovations with the

[6] All paraphrasing arguments and opinions in the section under discussion are extracted under the light of "History of State bank of Pakistan" Vol. I, II, III, Financial Sector assessment (1990-2000) and onward, Time to time issued bulletin of State bank etc.

[7] Direct instruments include credit ceilings, fixed margin requirements, setting credit/reserve ratio (CRR), setting credit/deposit ratio, restriction of credit to priority sectors and specific purposes etc. Indirect Instruments include changes in discount rate (3 day repo rate), Open market operations (OMO'S), T-bill Auction rate, statutory reserve requirement (SRR), statutory liquidity ratio (SLR) etc.

[8] Which holds achievement of dual cores at its prime agenda,; Economic Growth and Price stability.

upcoming changing dimension of monetary conduct all around the world. State bank of Pakistan has always been in pursuit of the ultimate targets set by the government regarding growth and inflation. Using monetary aggregates (broad money) as an intermediate target and reserve money as an operational target has been the most frequent exercise on the part of State bank[9]. To what extent these objectives were accomplished is worth consideration depending upon the working efficiency of State bank and the prevalent economic scenario. The question is whether the monetary policy prior to reforms of 1990's was in line with the stated objectives or not? The answer to this question necessarily tilts towards no; had monetary policy in the pre reform regimes been in line with the core objectives, the intensive reforms in the financial sector would need not to have been taken up as observed after 1990's.

Perhaps the most important causative proposition that can be put forth in this relevance is the question of transparency and autonomy of the state bank prior to reforms. History has revealed that the operational tool of credit ceiling and directed loans during 1970's have mostly led the monetary policy to astray from the desired path. The political dominance and control of the government especially over the interest rate (in the pre reform period) helped serving the interest of the government most of the time[10]. The preoccupation of the deficit financing in the early 1980's and the corresponding excessive government borrowing at the expense of the private sector did not reflect the realm of the projected

[9]A statement made by Dr. Shamshad Akhtar (Governor State bank of Pakistan) during the FPCCI committee on Banking, Credit and Finance held on 30th April, 2007 Karachi.

[10] The system of credit ceiling introduced in 1973 though was meant to be applicable for both government and private sectors but in reality was only practiced upon private sector exempting government from the sanctions implied most of the time. For details *see* "History of State bank of Pakistan" Vol.3. (1977-1988)

monetary policy targets of that regime but certified the observed non transparency of the state bank in that particular regime[11].

3.2 The Era of Financial Reforms

Monetary policy supposedly works efficiently only in those circumstances which provide the flexibility for instruments to operate, favorable grounds to stand on. The successive episodes of monetary conduct prior to reforms though showed some stimulus towards the reforms to improve the setup but remained hazy and vague most of the time[12]. The misevaluation and misreading regarding the lapses involved in targeting M2, the fixed and low interest rates, the uncompetitive and below market rate of return on bank lending, the sectoral misallocation of credits, the inefficient and infant process of financial intermediation, the monetary policy being subordinate to fiscal policy, the inadequate role of primary markets for the sale of government securities and debt instruments and the absence of visible secondary markets, were among those factors which impeded the proper and meaningful implication of the monetary policy. To unlock these rigid barriers and to replenish the coordination gap in making a serious attempt to make a footstep into liberal, deregulated and market oriented setup, the government for the first time launched the financial sector reforms in 1990's.

The early first half of the 1990's passed out in making transition towards structural transformation. The abolition of credit ceiling in 1992, and further of CDR (credit to

[11] The argument can be inferred from a recent research carried by Malik and Din (2008), which declared state bank of Pakistan to be the least transparent in certain aspects in comparison with advanced central banks.

[12] The banking reforms introduced in early 70's and the nationalization of banks in Bhutto's regime were also regarded as reformative steps at that time.

deposit ratio) in 1995 were the registered requisites towards change. The subsequent gradual initiatives taken were manifold, bulks of policy changes were observed to mark an end and confiscation to the inherent pitfalls of the direct control measures. The first and foremost important among the list was the ensured autonomy of the state bank. The empowerment of the state bank by amending the SBP act 1956, in 1994 was the most promising act, which provided state bank the margin to take decision regarding changes in CRR and SLR independently, formulate its own monetary objectives, and enjoy command over crucial decisions at its will. Further proceedings were carried with enormous transfiguration in the structural design of monetary policy including introduction of auctioning of T-bills (ensuring the removal of fixed yield and introducing markedly decided competitive yield), effacing the practice of discount window and replacing it with a 3 day T-bill Repo facility, transmuting the credit channel of monetary transmission by interest rate channel, replacement of dominant instrument of credit ceiling with the frequent open market operations (OMO's), replacement of the managed floating exchange rate with the free float.

3.3 The Changing Patterns of Monetary Conduct

The interest rate which was not thought to be an effective tool of the monetary conduct also got realized as a significant mean of conducting monetary policy and made effectively operational in the post reform period. Prior to reforms there were only a few and scant variations in the interest rates (showing the least confidence of monetary authority in their practical effectiveness) but post reform period well accommodated and capacitated their frequent changes (revealing a high degree of confidence on the part of

monetary authority in using them as a recognized tool). The feature of this changing preference can easily be observed in the following figures:

Fig. I

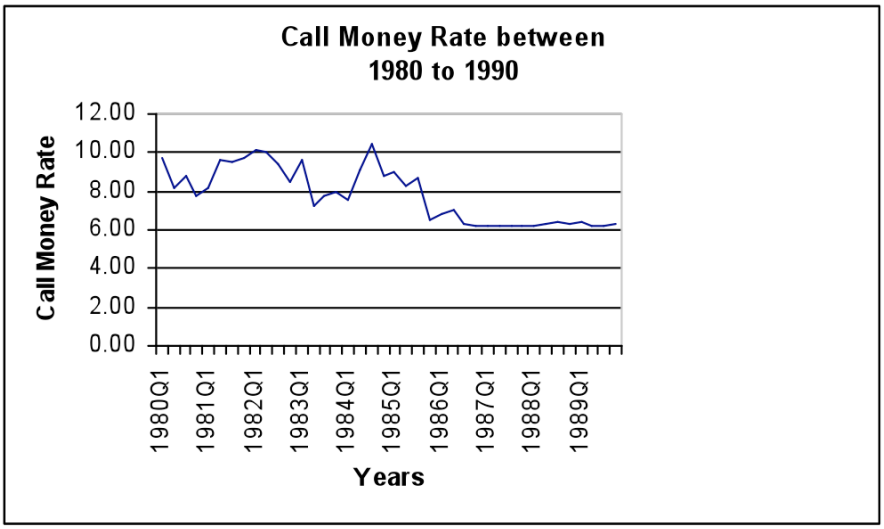


Fig. II

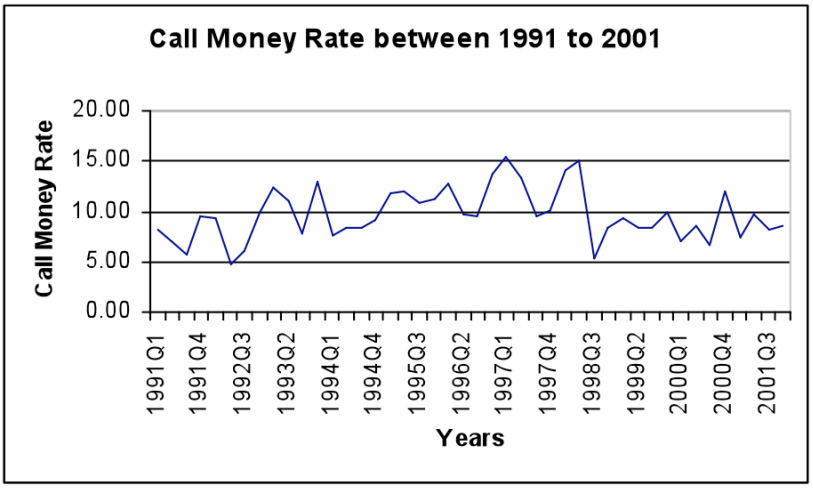


Fig. III

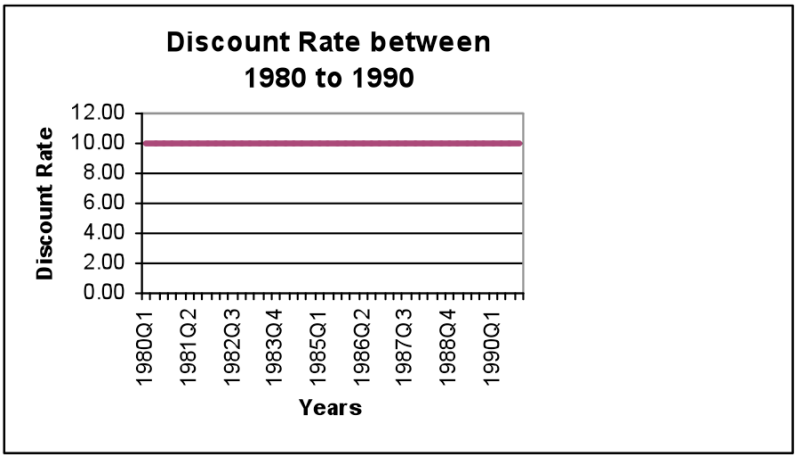


Fig. IV

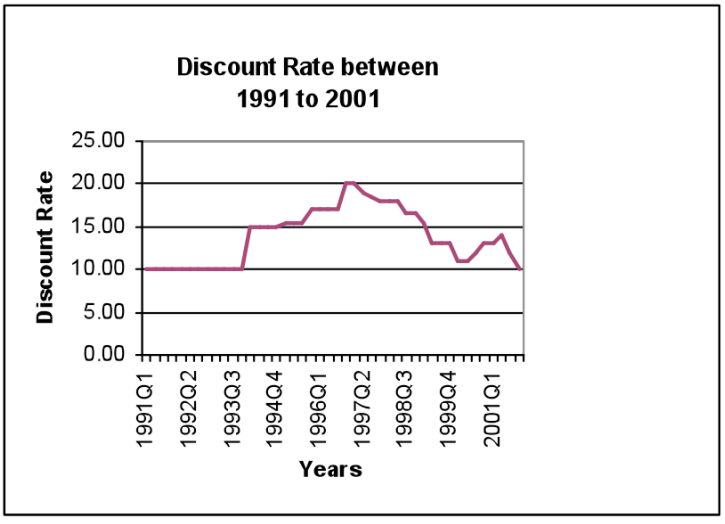


Figure I, II, III and IV display the patterns of Interest rates (Call money rate & Discount rate) over the years using Quarterly data. Fig I and Fig II make a comparison of the Call money rate prevailing in 80's and 90's, the figures well depict changing dimension of monetary conduct. Call money rates in 80's exhibit less variation as compared to 90's, the former suggesting the reluctance and in confidence of authorities to vary them as a policy tool while the later portrays the acquired confidence in using it as a useful instrument. Furthermore the former exhibits a more restrictive bandwidth while later expresses a more flexible one.

Case is not very much different for the discount rate of Central bank, which remained almost stagnant at a level of 10% in 80's (see; Fig III) but varied quite persistently in the post reform period (see; Fig IV). Thus conclusively the behavior of the interest rate is well indicative of its changing patterns in the pre and post liberalization period.

4. Data and Methodology

4.1 Description of Data

For the purpose of estimation the data regarding the variables used is taken from International Financial Statistics, IFS (2008). Quarterly data over the period of 1971 Q1 to 2007 Q2 has been utilized. For the real rate of interest generally different measures are used but most commonly used are the policy rate of the central bank e.g. For United States Federal Fund rates are used for this purpose. In case of Pakistan we have used the Call money rate, CMR as a proxy for the nominal short term interest rates. The ex post real interest is constructed by deflating the nominal call money rates with CPI, over the concerned period of study.

Inflation can be calculated in two ways [$\pi = (p_t - p_{t-1} / p_{t-1}) * 100$], this calculation formula yields us quarter to quarter inflation, while [$\pi = (p_t - p_{t-4} / p_{t-4}) * 100$] this formula yields us year on year inflation. For removing the impact or to avoid any seasonal affect in the data series of inflation we have chosen the second formula. Thus variable used for inflation is year on year inflation. Though not explicitly used in the estimation but for significant implicit comparison of the estimated results, the output gap has also been constructed. The potential output has been estimated by fitting a Quadratic trend to the actual GDP series. The resultant bifurcation results into a fitted series and a residual series counterpart. The fitted series has been taken as a proxy for the potential output and the output gap has been calculated by taking its difference from actual GDP series.

4.2 Methodology

The literature today in engulfed with the estimation carried out using Kalman filter algorithm. The advantage of using this technique is its flexibility in being specified in different specification. Following its origin usually for engineering purposes to account for the unobservable it is now expanded and distinctively used in the field of finance, economics and econometric. The reason for its widespread use is the authenticity of estimates of unobservable recovered through it. Its practical use in recovering the value of Natural rate of interest is found in the work of (Laubach and Williams, 2003), (Koiziki, 2005), (Leigh, 2005), (Plantier, 2006) etc. In this section we shall provide only a formal introduction to this recursive and iterative algorithm.

The two prime requisites on which the Kalman filter stands on are the measurement and the transition equation. Generally the measurement equation is represented in the form:

$$Y_t = \alpha + \beta_t^* X_t + \varepsilon_t \qquad \text{(a)}$$

Equation (a) can be transformed by eliminating the intercept α by assuming it equal to zero and removing the time subscript from β, equation (a) will be reduced to:

$$Y_t = \beta * X_t + \varepsilon_t \qquad \text{(b)}$$

where; X_t is state variable and ε_t is normally distributed with $(0, \sigma_t)$.Evolution or path of motion to the variable X_t is represented by transition equation as follows:

$$X_{t+1} = \delta * X_t + \xi_t \qquad \text{(c)}$$ Or alternatively we can write it as:

$$X_t = \delta * X_{t-1} + \xi_t$$ [Where; ξ_t is normally distributed with $(0, \vartheta_t)$]

This algorithm is initialized on the basis of the initial values of the state variable, thus setting the initial prior as X_0 and injecting it in equation (c) we'll get a predicted value of state variable

$$X_{1p} = \delta * X_0 + \vartheta_0 \qquad \text{(d)}$$

Equation (d) is the predicted value of the state variable, which further can be inserted into the measurement equation (a) to get a predicted value of Y, denoted by Y_{1P}. Since we have observed value of Y_1 available we can calculate the error in the following manner:

$$Y_{1E} = Y_1 - Y_{1P} \qquad \text{(e)}$$

This error can subsequently be placed in the prediction of X_1. The algorithm thus proceeds in an iterative manner. In concrete manner we may summarize this formal introduction by representing a nut shell over review of the algorithm offered by kalman filter to find the state of unobservable X.

$\hat{X}_{t/t-1} \equiv E[X_t / Y_{t-1}] and \hat{X}_{t/t} \equiv E[X_t / Y_t]$. Of course this discussion can be further extended to incorporate all the variance and covariance structures used in algorithm, forms of model, patterns of smoothed, predicted and one step ahead estimates and the information about the kalman gain but this is considered infeasible within the domain of our discussion. Those who are interested for in depth review are instructed to see (Harvey, 1989), (Arnold, 2007) and (Pasricha, 2006).

We'll simply develop a set of two equations in state space format. We employ a model similar to the model employed by (Brzezina, 2006) with the exceptions of few

assumptions regarding the variance and initial priors, we then apply kalman filter to carry out the maximum likelihood estimates. We further proceed as follows:

$$\Delta\pi = \alpha_1 \Delta\pi_{t-1} + \alpha_2 (r_{t-1} - r^*_{t-1}) + \eta_{1,t} \qquad (1)$$

Equation (1) is the measurement equation of our state space model, which is designed inline with the definition of inflation. Equation (1) simply relates the differential of inflation to its lagged differential and the lagged difference between real interest rate r_{t-1} and the natural rate of interest r^*_{t-1}. Thus this equation develops an association between observable (inflation & real interest rate) and unobservable (Natural rate of interest). The dynamics of the state variable (Natural rate of interest) is represented by the transition equation as follows:

$$r^*_t = r^*_{t-1} + \eta_{2,t} \qquad (2)$$

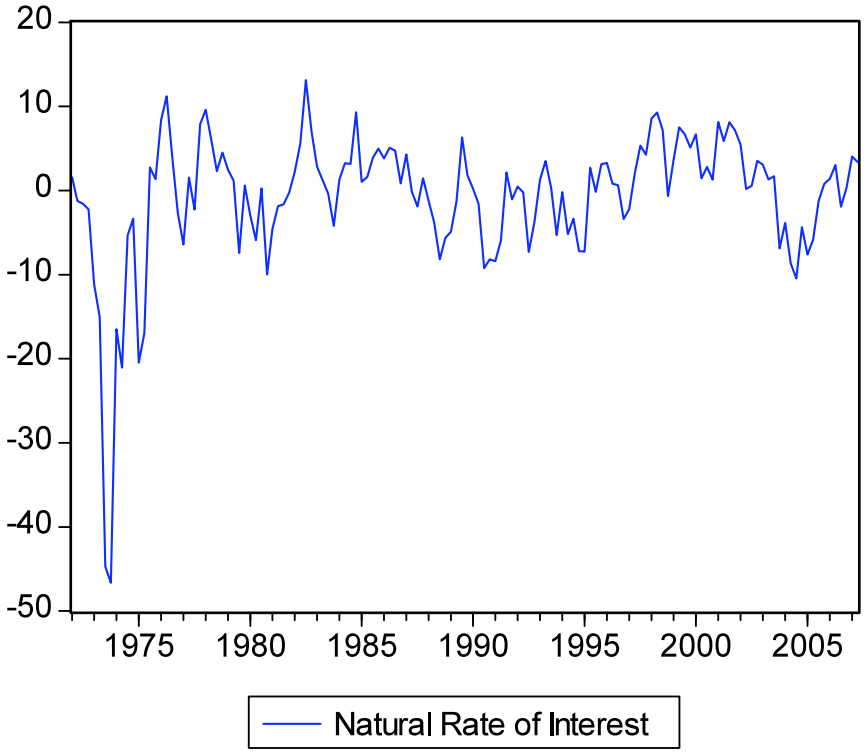
The above equation declares a path for the NRR, the NRR is assumed to follow a random walk. Moreover the residual $\eta_{1,t} and \eta_{2,t}$ are the white noise error terms, assumed to be serially uncorrelated. Kalman filter technique is quite sensitive to the provision of information about the initial priors and the residual structure. Instead of assuming the variances of the residual or calibrate them we let them to be estimated by the model.

5. Estimation and Results

5.1 Kalman Filter results

The equations (1) & (2) discussed in the methodology section have been estimated using Kalman filter and the maximum likelihood estimates have been obtained. The obtained results of the parameter coefficients are reported in the Table III of the Appendix (I). Coefficient on the real interest rate gap is found significant; the kalman filtered series of the NRR is sketched in the following graph.

Fig. V (NRR Estimates from Kalman Filter)



The derived NRR series in figure (V) appears to be quite volatile over different time periods and is showing considerable variability over different historical phases. For furthering our discussion and to extend it to scrutinize the implications of NRR for the

stance of monetary policy, we proceed by exclusively diverting our focus on the post reform period of 90's. All throughout the course of our discussion it has been made explicitly clear that monetary policy in Pakistan was not very well designed or focused prior to reforms. Furthermore interest rate structures as well as their operational capacities were not fully exploited formerly. So to have a purposeful appraisal, meaningful insights and to explore some credentials of monetary conduct we take the opportunity of diverting our whole focus to the reform period.

Of course the analysis could have been initiated straightaway by restricting the sample period of analysis within the domain period of post reforms, but our intent was to derive the estimates of Natural rate of Interest therefore we have utilized the option of selecting the long time period time series (1971 Q1 to 2007 Q2). The larger the sample period, the more robust and virtually true the time series of the derived unobservable becomes. The smoothing algorithm (as used in Kalman) better operates for large data set.[13] Thus the rest of discussion would merely focus on the nature, pattern and behavior of the natural rate over the post reform period mostly after 90's.

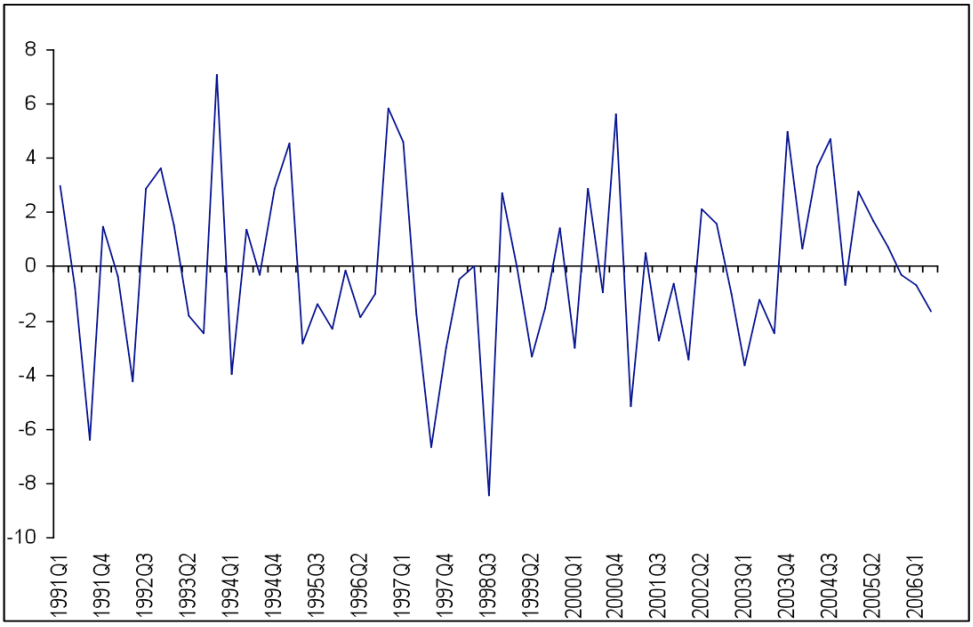
5.2 Stance of Monetary Policy

Usually the research focuses on the complex exercise of estimating the NRR because of its unique explanatory power for exploring the stance of monetary policy. Figure VI presents the behavior of the real rate gaps over the period from 1991 Q1 to 2006 Q2.[14]

[13] For detailed discussion see Stock and Watson (1999), Barnanke and Boivin (2000), who comprehensively studied the features and capacity of large data set in increasing the forecast accuracy and its implications for monetary policy. As Kalman filter is heavily based on the forecasting mechanism based on the information currently available thus use of large data sets for purpose of our estimation seems appropriate.

[14] The real rate gap has been obtained by taking the difference between the real rate of interest and our estimated Kalman filter series of NRR.

Fig VI (Real rate gaps)



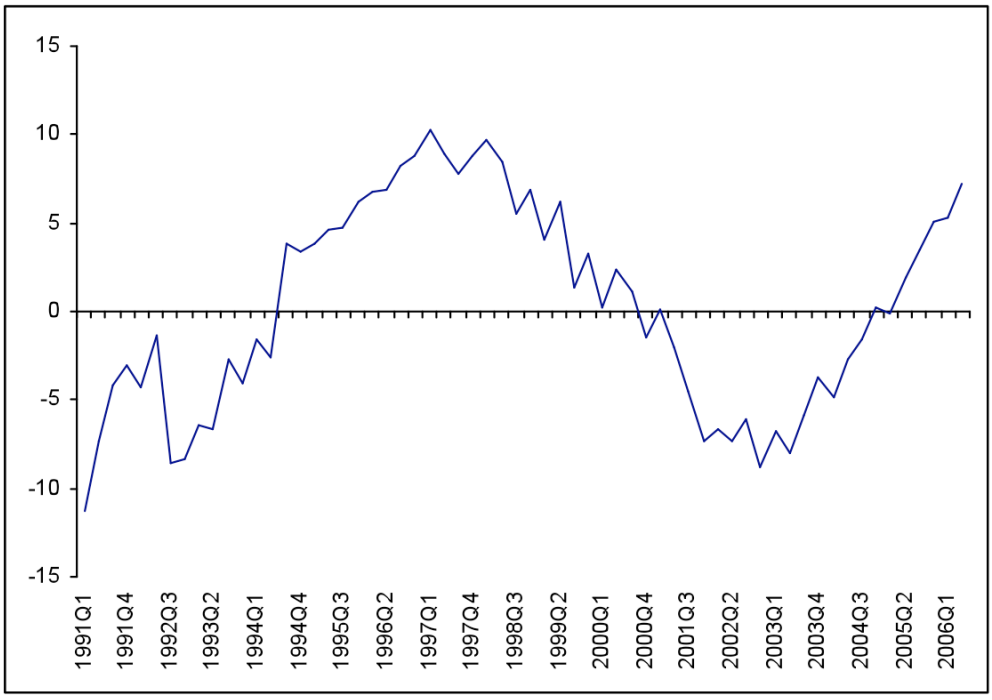
All the crests in figure VI above the zero scale line represent the tight stance of the monetary policy because these crests represent the positive values of the real interest rate gap where ($r > r^*$), while all the troughs below the zero scale line depict the loose stance of monetary conduct because ($r < r^*$). However these features of the interest rate gap without having a look on the output gaps are not of much significance so it is deemed desirable here to incorporate the behavior of the output gap in the discussion to jointly capture the pattern of both gaps in relation to each other so that countercyclical or procyclical stance of monetary policy be determined.

5.3.1 Determining Output gap over the Relevant Period

For output gap we need to determine the value of potential output y^* so that the value of output gap thus is tracked in the following way, $(y - y^*) * 100$. Though more

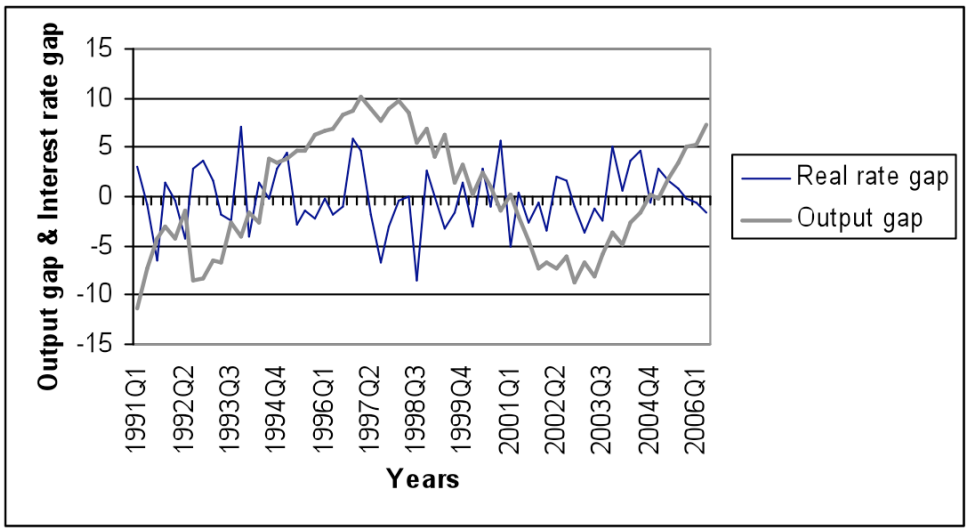
sophisticated ways are available for tracking out the value of potential output however we facilitate ourselves by fitting a quadratic trend to the actual output series. This resultantly provides us with the fitted series and its residual counterpart (cyclical component). The fitted series is a proxy of our estimate for the potential output. Figure VII outcomes the generated output gap with the help of the above mentioned prescribed method. Visibly two booms and two recessionary periods are evident from the figure. The first recession comprises of the period 1991 Q1 to 1994 Q3 and the second started to emerge from 2001 Q1 and remained in action till 2004 Q4. One complete cycle of boom is apparent from 1994 Q4 to 2000 Q4 and the second appears to emerge from 2005 Q1.

Fig VII (Output Gaps over the period 1991 Q1- 2006 Q2)



5.3.2 Output Gap and Real rate Gap in Coherence

Fig VIII (Output Gaps and Real Rate Gaps)



For a meaningful analysis or inter comparison of both the series we need to heed over their average pattern. Especially the behavior of the real interest gap in the sessions of boom and recession is worth crucial to render the monetary policy as counter cyclical or procyclical. The calculated averages in the relevant periods with the average response of monetary policy in that period are given in the table 2.

Table I (Stance of Monetary Policy)

Period	Average of Interest rate gaps	Average of Output gaps	Stance of Monetary policy
1991Q1 - 1994Q3	0.044	-4.575	Tight (Procyclical)
1994Q4 - 2000Q4	-0.319	5.477	Loose (Procyclical)
2001Q1 - 2004Q4	0.177	-4.744	Tight (Procyclical)
2005Q1 - 2006Q2	0.271	3.821	Tight (Countercyclical)

Table I; highlights some important aspects regarding the stance of monetary policy[15]. Column 2 provides the averages of real rate gaps; column 3 ridicules the calculated averages of the output gap. Column 2 and 3 in correspondence helps us to sketch a joint picture of the stance of monetary policy being procyclical or countercyclical as represented in Column 4 of the above table. The scrutiny of different boom and bust periods presents a snapshot of Pakistan's monetary policy being most of the time accommodative rather than counteracting. The periods when economy was in a sluggish mode of economic growth monetary policy was kept tight and when it was booming

[15] All the values represented in table 7 are expressed in percentages.

beyond its potential level it was allowed to flow freely without having to face the impediment or resistance through counter stance. The period of (1991 Q1-1994 Q3) and (2001 Q1-2004 Q4) were furnished with the downfall or a lumpy pattern of GDP (i.e. depicted by negative output gap). Despite of this trend the exposure of the positive interest rate gap over these periods lucidly renders the incorrect and hazy realization of the precise economic conditions prevailing at that time by the monetary authorities. Thus monetary policy remained accommodative and procyclical in these periods. Furthermore in between the period of 1994 Q4 – 2000 Q4, when the economy demanded to be controlled from heating up above its capacity, its was allowed to heat up by keeping the interest rate low below its benchmark value (i.e. as the negative real interest rate gap depicts).

Apart from these three episodes only the last period (2005 Q1- 2006 Q2) within the relevant period of study appeared to be in line with the economic intuition when the monetary policy counteracted the booming trend. The positive output gap (3.82%) was matched up with the positive interest rate gap (0.271%). Thus monetary policy in Pakistan over the years remained mostly procyclical which contradicts what the economic theory proposes. Consensus has been developed among the economists that to stabilize the economy and to dampen the affects of business cycles or shocks to the economy countercyclical monetary policy holds so much to say. However one aspect must be borne in mind that the effectiveness of the countercyclical monetary policy is heavily dependent upon the time it takes by the monetary policy to caste its impact on the economic activity. Unreasonable period of lags in monetary transmission to take affect

may stray the consequences away as projected before in hand or the countercyclical monetary policy under the influence of long lags involved may stir up the fluctuations or frictions rather than appeasing them (Willes, 1971), (Gruen et al., 1997)

5.3.3 Robustness based on Average Inflation behavior

Table II

Period	Average of real rate gap	Sample's Average Inflation	Period's Average Inflation	Average of Output gap	Stance of Monetary Poiicy	Validity
1991Q1-1994Q3	0.044	**7.887**	**10.75**	-4.575	**Tight (Procyclical)**	May or May not
1994Q4-2000Q4	-0.319	7.887	8.36	5.477	Loose (Pro cyclical)	Valid
2001Q1-2004Q4	0.177	7.887	4.19	-4.744	Tight (Pro cyclical)	Valid
2005Q1-2007Q2	0.271	7.887	8.56	3.821	Tight (Counter cyclical)	Valid

Table II is designed to present a more robust preview of what has been concluded in table I. Two additional columns (column 3 and 4) have been added in table II to examine the validity of inferences drawn from the figures of output gap and real rate gap in table I. Column 3 gives the calculated average of the inflation over the whole sample's range

(1991 Q1 to 2007 Q2), while column 4 gives the average of inflation per period. These two columns are meant either to "reinforce" or "object" the results of procyclicality or countercyclicality in the divided four periods. The first period from 1991 Q1-1994 Q3 depicts the period's average inflation (10.75 %) to be greater than sample's average inflation (7.887 %). This suggests that the previous contention of procyclicality made for this period merely based on the negative output gap against the positive real rate gap might loose some ground if this positive real interest rate gap is justified to account for the high level of period's 10.75% average inflation rate[16]. In the rest of the remaining distributed periods, monetary policy stance remained in line with the considerations of both output gaps and average inflation rate. For instance in the second period from 1994 Q4-2000 Q4 the loose stance as represented by the negative real rate gap signifies procyclical feature based on both positive output gap of (5.477%) and high period's inflation rate of 8.36% (i.e. greater than 7.887%). Following the similar comparative features the results of the remaining two periods also reinforce the inferences of table I.

[16] This inflation in the presence of negative output gap might have existed because of supply side shocks.

6. Summary, Conclusion and Policy Recommendation

6.1 Summary and Conclusion

This study intended to determine the natural interest rate series for Pakistan's economy. The inspiration for undertaking this exercise was led by the important, critical and crucial role of the bench mark level of the short term real rate in exploring the monetary policy stance. Taking into consideration the significance of the bench mark value of interest rate this study is an attempt to explore whether monetary policy responses in Pakistan remained in line with this unobservable to reap its benefits or not? Was the policy being directed under the reflection of NRR or moved randomly on the apparent signals of price, inflation and output fluctualtions?. A true forecast about the NRR helps to achieve the goals of monetary policy in a pronounced manner and may limit the chances of its misdirection.. This study unfolds the time variant series of the Natural rate of interest using Kalman filter methodology and finds some important insights regarding the stance of monetary policy

Further, for the stance of monetary policy on the basis of extracted series the composed real rate gap series is compared with the output gap series, which declares procyclical stance of monetary policy most of the time over the concerned period of examination. (i.e. Post reform period). The results suggest that the monetary policy in Pakistan did not fall true to the requisites of economic theory (i.e. pursuit of countercyclical stance for economic stability). This helps us to understand that the claims of monetary tightening

and loosening could be put to question mark; if proper concern is not shown towards finding out the true value of NRR. That appears to have been the case in Pakistan economy, monetary loosening in booms and tightening in recessions reflects the absence of complete knowledge about the true economic conditions on the part of monetary administration. Had they been in a position to incorporate the range of estimates of NRR into their policy decisions they would certainly have leaned against the wind? As this was not the case, therefore one can infer absence of frequent monitoring of NRR value and its accounting in the agenda of monetary authorities.

6.2 Policy Recommendations

This study was conducted to find out the Natural rate of interest and to signify the potential strength of Natural rate of interest in determining the stance of monetary policy. The underlying motive that led to the undertaking of this exercise was the preconceived idea of unawareness or negligence of the central bank of Pakistan in tracking out the value of NRR on frequent basis. Nothing much has been done so far in this field especially pages of research of state bank have also been left blank in this relevance thus following policy recommendations are considered worth pursuing:

- The inclusion of Natural rate of interest in the agenda of central banks of different countries as a guiding principle and as a yard stick for keeping the monetary policy within a band of accuracy is a justified evidence of significance of knowing value of NRR. Thus State bank of Pakistan should also be in a row of among those central banks which have shown commitment towards this task to make monetary policy

more vigilant towards the shocks and fluctuation and take more appropriate policy actions to lean against what is harmful for the economy.

- The experience of the world economies has justified that those economies which have taken a clear stance on their policies and which have full understanding to which course and affect their actions would take their economies to have been more successful in restricting the emerging bubbles of fluctuations. Publicly announced and transparent monetary policy worth more than hazy, vague and unclear policies. State bank of Pakistan could operate better if it would start divulging its preferences about output gaps and inflation stabilization more visibly. Directing its course of actions on apparent signals of nominal variables like growth of M2, volatile exchange rates, condition of reserves, increase in level of prices etc can be made in line properly if they are accompanied with the well known structures of natural rates.

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Appendix I

Table III

Sspace: KALMAN FILTER

Method: Maximum likelihood (Marquardt)

Sample: 1972Q1 2007Q2

Included observations: 142

Convergence achieved after 90 iterations

	Coefficient	Std. Error	z-Statistic	Prob.
α_1	-0.097178	0.070134	-1.385595	0.1659
α_2	-0.412544	0.053539	-7.705537	0.0000
	Final State	Root MSE		
r^*	-3.360795	1.654743	-2.031007	0.0423
Log likelihood	-336.9139	Akaike info criterion		4.787519
Parameters	3	Schwarz criterion		4.849966
Diffuse priors	1	Hannan-Quinn criter.		4.812895