NEW KEYNESIAN MONETARY MODEL: EVIDENCE FROM PAKISTAN

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ABSTRACT

In this study, we specified and estimated a New Keynesian model (NKM) with the aim to support inflation targeting for the Pakistan economy describing the relationships among the main variables relevant to the transmission mechanism of monetary policy. The model encompasses three structural equations – inflation, the output gap, and the exchange rate – and an interest rate rule. The theory underlying the model is broadly in line with the current monetary theory prevailing in academics and central banks. We take three types of interest rate rule: standard, backward looking and forward looking rule that describes how the interest rate should be adjusted. We use FMOLS and ECM approach to monthly data ranging from January 2001 to December 2010. The results indicate that NKM performed quite well in Pakistan and paved a way to adopt inflation targeting because output and inflation have desired sign in Taylor type interest rate rule although the real exchange rate and depreciation in exchange rate are also statistically significant to effect inflation and output in Pakistan.

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1. INTRODUCTION

Inflation targeting (IT) is one of the most debated topics of recent economic research. For example Johnston (2002), Newman and von Hagen (2002) and Ball and Sheridan (2005), are among the studies that empirically assess the effects of IT on price stability across industrial countries. Fraga *et al.*, (2004), Lin and Ye (2008) and Gonçalves and Salles (2008) examined the IT in emerging markets. While there are also studies that assess the impact of inflation targeting on emerging and industrial economies together (Vega and Winkerlried 2005), while Mishkin and Schmidt-Hebbel, (2007) examined both groups separately and jointly. Mollick *et al*., (2008) conclude that IT has been effective on achieving price stability in emerging market economies. Nonetheless, according to its supporters, the potential benefits of inflation IT are not limited to price stability. For instance, once a low, and stable inflation is achieved and credibility is enhanced, IT could lead to a reduction of the output losses associated with disinflation.[1] This apparent success of industrialized inflation targeting countries has attracted the attention of many developing countries and the success story of Chile in controlling inflation boost the confidence among developing economies, as its experience indicated another path available to central banks of developing countries. Brazil, Mexico, Colombia, Peru, the Republic of Korea, Thailand, Philippines, the Czech Republic, Hungary, Poland, and South Africa adopted inflation targeting policy. The latest additions are Slovakia, Indonesia, Romania, Turkey, and Ghana (see Appendix A).

Pakistan, in recent years has been in the grip of high inflation due to structural weakness arising from energy shortage, along with hike in the international commodity prices, particularly oil and extremely volatile security situation. Moreover upward adjustment in the electricity tariffs, the rupee devaluation against the US dollar and increasing government borrowing from the State Bank of Pakistan (SBP) which stood at Rs. 3 trillion at the end of fiscal year 2011 aggravated inflationary pressures in Pakistan. During the last five years average yearly inflation stood at 12.9% against average GDP growth rate of mere 2.9%. It is the first time in the country's history that we observe double digit inflation for five years straight.

[1] *Mollick et, al., (2008) supported by Mishkin (1999) argue that inflation targeting promotes real economic growth in addition to controlling inflation.*

The deplorable situation of inflation in Pakistan raises the need to explore new insights for price stability in Pakistan. The increasing popularity of inflation targeting policy attracts the attention of monetary policy makers in Pakistan. SBP held its 3rd international conference in May 2010 on the topic under discussion. Most of the literature in Pakistan is concerned with examining whether Pakistan should adopt inflation targeting policy or not.

Felipe (2009) argues that though Pakistan meets the basic technical requirements to implement some version of IT, the SBP should take into consideration that there is no overwhelming empirical evidence that short-term interest rates are inversely related with inflation. Moinuddin (2007) concluded that money demand function is unstable so monetary aggregate targeting is not feasible and, consequently IT may be an option for SBP. Akbari and Rankaduwa (2006) evaluated whether Pakistan fulfils the major requirements to establish an IT regime and concluded that the lack of exchange rate pass through is weak which stands in favor of inflation targeting.

Khalid (2006) argued that SBP should think about IT after reviewing the experience of other developing nations with IT. While Khan and Schimmelfening (2006) recommended IT with a target of 5%. On the other hand Choudhry and Choudhry (2006) opposed IT to adopt as a policy by State Bank of Pakistan because according to them the main determinant of inflation in the country is the growth rate of import prices. Malik and Ahmad (2007) estimated Taylor rule for Pakistan and found that there are other objectives of monetary policy other then output and inflation due to very low value of R^2 and DW statistics of Taylor rule equation. Consequently Malik (2007) investigated the objectives of monetary policy and concluded that output gap, inflation, lagged interest rate, exchange rate and trade deficit as monetary policy objectives.

The overall consensus built in the 3rd conference of SBP on the topic of inflation targeting was that deeper investigation is needed to adopt inflation targeting policy as an alternate policy and to explore the important issues which must be considered while adopting inflation targeting. Moinuddin (2009) raised another issue by saying that a monthly or quarterly model-based forecast can provide sound arguments regarding pro-active monetary policy. Moreover, publication of model-based forecasts establishes credibility about the working and policy formulation process in the central bank. Another important issue, which is neglected by the researchers, is the transmission mechanism of monetary policy. While Moinuddin (2009) concluded that understanding, transmission mechanism is important for the conduct and

implementation of monetary policy to achieve specific inflation target as a primary responsibility.

Monetary models based on the New Keynesian theory have been developed in the majority of central banks in the Western world during the last decade. Many papers have estimated different versions of the NKM model for many purposes. For instance, Rotemberg and Woodford (1997) and Galí and Gertler (1999) analyze inflation dynamics and evaluate monetary policy. More recently, Lubik and Schorfheide (2004) estimate the model for testing for indeterminacy using U.S. data. Boivin and Giannoni (2003) and Canova (2004) also estimate the model but they test the stability of monetary policy parameters and the transmission mechanism of policy shocks. Finally, Smets and Wouters (2003) derive and estimate an expanded version of the standard NKM model of the Eurozone. The global financial crisis and "great" recession has led to a re-examination of the role of monetary policy. Cúrdia and Woodford (2009) found that in a simple new Keynesian model with time-varying credit (arising because of financial frictions) the optimal target criterion (the optimal monetary policy) remains the same as in the basic New Keynesian model, which is the central bank should seek to stabilize a weighted average of inflation and output gap.

An interesting set of research questions naturally arises with reference to Pakistan that how do we evaluate the effectiveness of the current monetary policy framework in Pakistan with the help of new Keynesian monetary model? Are we able to indicate some specific basic characteristics of the Pakistani economy from estimation? How we will analyze the reactions behavior of the Pakistani economy to specific type of shocks? Which type of Taylor rule is more effective keeping in view the objectives of monetary policy? Does our model allows to explain long-run relationships as well as short-run dynamic restrictions from economic theory? Is there any deterministic role of inflation expectation in the model and what determines the expected inflation in Pakistan? Is there any role of the exchange rate in managing economic overheating in the current round of economic stabilization?

A number of issues motivate our analysis. In the first instance, we are interested to search out the answers of the above questions. An additional motivation is to develop a practical model-based policy analysis framework (new Keynesian monetary model) to support inflation targeting. This paper extends previous research on the feasibility of a simple inflation targeting policy in

Pakistan. The study, basically, is timely because Pakistan economic system is in need of an appropriate monetary model based on strong theoretical foundations with accurate predicting properties and consistent with specific characteristics of Pakistan economy.

The paper is organized as follows. Section 2 gives a brief and comprehensive review of related literature. Section 3 discusses the methodology and data while section 4 explains the estimation results. Conclusions are given in section 5.

2. Literature Review

Lui and Zhang (2007) adopted a three-equation New Keynesian model to assess whether the current monetary policy framework in Mainland China is appropriate. The three-equation model includes a forward-looking Phillips curve, and IS curve, and a monetary policy reaction function based on a monetary policy rule. Model simulations show that the hybrid rule has the lowest volatilities in the processes of inflation and output. Therefore, it should be preferable to the alternative rules such as an interest rate rule and a quantity of money rule when implementing monetary policy in China. Simulation analysis also has important policy implications. Although the exchange rate policy may have a limited role in helping decelerate rapid economic growth, it is effective in helping curb inflation. The authorities could thus take advantage of this feature of the exchange rate policy by adjusting the pace of the renminbi appreciation when facing rising inflationary pressures.

Dib, Gammoudi and Moran (2008) developed New Keynesian model for Canada. This model in particular computed out of sample forecasts and compares its forecasts with those arising from VAR models. It shows that the forecasts are favorably valid with that of the benchmark, particularly as the forecasting horizon increases. Thus, the study deduces that the model could become a useful forecasting tool for Canadian economy. This study includes the sample of 1981:1 to 2004:4. Since the model drove by four shocks, thus it is estimated using data for four series. The variables are output in terms of real domestic demand, inflation, a short-term interest rate, and real money balances. This study uses slightly different estimation strategy as compared with others for estimating DSGE models. For example, it points out that this estimation shows an advantage of estimating and forecasting for the log levels of the data, rather than forecasts for detrended series. The method of estimation is Maximum likelihood. It also describes about the impulse response drawn from the estimates. Through this aspect of model, building study

shows with sure that the out of sample forecasts are relatively more appealing than any other model in comparison. For some of the variables such as interest rate and output in fact have very good level of accuracy in forecasting. The forecasting power however for inflation is not so strong yet it is not significantly less than those of the benchmark VARs. In the last this study introduces several dimensions for improvements in the model for future work.

Nimark (2007) built up and estimated a structural model of Australia as a small open economy using Bayesian techniques with the data sample 1991:Q1 to 2006:Q2. Unlike other recent studies, the paper shows that a small micro-founded model can capture the open economy dimensions quite well. Specifically, the model attributes a substantial fraction of the volatility of domestic output and inflation to foreign disturbances and matches the evidence from reduced-form studies. In addition, the model relies much less than other estimated models on a persistent shock to the risk premium to explain changes in the nominal exchange rate. The paper also investigates the effects of various exogenous shocks on the Australian economy.

Argov and Elkayam (2007) formulated and estimated a small New Keynesian model for the Israeli economy. The goal is to construct a small but still realistic model, which can support the inflation targeting process. The model contains three structural equations: An open economy Phillips curve for CPI inflation (excluding the housing component), an aggregate demand curve for the output gap, an interest parity condition for the nominal exchange rate and an interest rate reaction function (Taylor-type rule). In the specification of the model, they had to pay special attention to the crucial role of the exchange rate in the transmission of monetary policy in Israel, which has a direct effect on almost 60 percent of the CPI. The model is estimated by the GMM method, using quarterly data for the period 1992: I to 2005:IV. In the estimation of the structural equations they tried to remain, as close as possible to the theoretical formulation by restricting the dynamics to one lag at most and use the model to characterize an "optimal" simple interest rate rule. They concluded, the monetary authority should respond to a hybrid backward-forward looking rate of inflation and does not benefit from direct reaction to exchange rate measures.

Sadeq (2008)'s paper uses a small open economy model for central Europe Transition economies, EU-15: Czech Republic, Hungary, Poland, Slovakia, and Slovenia. The objective is to analyze the general model convergence issues. Quarterly data for the sample range 1996:2 to 2007:2 has been used for empirical analysis. Variables from each country selected, include real GDP, household consumption, nominal wages, CPI Inflation, and nominal short-term interest

rates. This model is estimated by utilising the Bayesian techniques utilizing information from the previous studies as priors. The estimation results of this illustrate some differences from the Euro area results in structural parameters. However, the results exhibit some similarities across countries, notably in some shocks volatilities and high habit formation of consumption. The results illustrate also an important degree of rigidity of imported goods prices, which implies a low pass-through of the exchange rate fluctuations. Finally, we study the Ramsey optimal allocation, in a timeless perspective, of the estimated model for each country in order to analyse the convergence criteria of entrance in the European exchange rate mechanism.`

Dolores and Vazquez (2006) estimated a standard version of the New Keynesian monetary (NKM) model under alternative specifications of the monetary policy rule using U.S. and Euro zone data from 1970Q1 to 2004Q3. The estimation procedure implemented is a classical method based on the indirect inference principle. An unrestricted VAR is considered as the auxiliary model. On the one hand, the estimation method proposed overcomes some of the shortcomings of using a structural VAR as the auxiliary model in order to identify the impulse response that defines the minimum distance estimator implemented in the literature. On the other hand, by following a classical approach we can further assess the estimation results found in recent papers that follow a maximum-likelihood Bayesian approach. The estimation results show that some structural parameter estimates are quite sensitive to the specification of monetary policy. Moreover, the estimation results in the U.S. show that the fit of the NKM under an optimal monetary plan is much worse than the fit of the NKM model assuming a forward-looking Taylor rule. We also find, in contrast to the literature, evidence of indeterminacy under the best fitting monetary policy rule under the Greenspan era. In contrast to the U.S. case, in the Euro zone, the best fit obtained assuming a backward-looking Taylor rule and determinacy holds, but the improvement is rather small with respect to assuming either a forward-looking Taylor rule or an optimal plan.

A few attempts have been undertaken to build Macroeconomic models for Pakistan economy. First is PIDE Macro Model (1986) which reflects both the Keynesian and the supply side consideration. It was designed to provide a quantitative framework for an economy wide planning exercise. It comprises 97 equations, consisting of 45 behavioral and 52 definitional equations with 86 exogenous variables.

Second is ISPM (Integrated Social Policy Macroeconomic Model) which explicitly recognize the interdependence between macro economy and social sector development comprises 321 equations out of which 159 are behavioral equations. It can be used as an effective planning tool for social sector development to address poverty and income distribution as well as social service delivery. Third model developed by Chishti *et al*., (1992) comprises ten key macroeconomic variables. It empirically analyzes the strength of short run and long-run impact of anticipated and unanticipated monetary and fiscal policies; and external resources and remittances shocks on the economy. Hanif *et al.*, (2010) estimated a macro econometric model comprising 17 equations to foresee the effects of monetary policy through forecasting and simulations. They used OLS method to estimate the equations by using annual data from FY73-FY06. The study concluded that the government investment has a crowding-in impact on private investment in Pakistan not a crowding-out effect, which implies that credit channel is effective in transmitting monetary policy in Pakistan. They have not found any stable specification for nominal money demand function of broad definition (M_2), however, demand for narrow money (M_1) found stable, and US output and exchange rate are the most important determinants of Pakistan's exports of goods and services while relative prices are although statistically significant but with a small estimated coefficient. They also found that income elasticity of imports is higher than income elasticity of exports in Pakistan, which indicates that imports increase higher relative to Pakistan's GDP.

Saleem (2010) in the first step assessed the pre requites for inflation targeting in Pakistan and argued the case for inflation targeting in Pakistan as a policy option to achieve price stability. Then in the second step, applying the VAR technique to data sample 1970 to 2009 periods, inflation was shown to be adaptive in nature, leading us to reject the accelerationist hypothesis. The Lucas critique holds as people found to use forward-looking models in forming expectations about inflation. The paper also sheds some light on the State Bank of Pakistan's level of preparedness for the possibility of adopting inflation targeting, for which transparency and autonomy are prerequisites and concluded that the interest rate channel can play the role of a nominal anchor in the long run.

3. Methodology and Data

We take Argove and Elkayam (2007) model, which is based on Svensson (2000), Adolfson (2001) and Linde et al. (2004). At several stages, we deviate from other formulations, in order to adjust the model to the special characteristics of the Pakistani economy. The model presented below belongs to the class of New Keynesian models. In these models, under an inflation-targeting regime, the role of monetary policy is clearly defined: to provide the economy with an anchor for inflation and for inflation expectations. In these models, if monetary policy functions properly the economy converges to an equilibrium in which real variables converge to their potential values, inflation converges to its target, and the other nominal variables adjust in accordance with the inflation target.

$$\pi^{c}_{t} = a_{ld}\,\pi^{c}_{t+1} + (1 - a_{ld})\,\pi^{c}_{t-1} + (1 - w^{f})\,a_{y}\,(0.5\,y_{t} + 0.5\,y_{t-1}) + a_{z}\,(q_{t}-q_{t-1}) + a_{f}\,(1 - w_{f})\,up^{*zf}_{t}] + w^{f}\,[\alpha_{d}\,(dep^{*f}_{t})] \quad \text{I}$$

$$y_{t} = b_{yld}\,y_{t+1} + (1 - b_{yld})\,y_{t-1} - b_{r}\,[0.5\,(r_{t} - r^{n}_{t}) + 0.5\,(r_{t-1} - r^{n}_{t-1})] + b_{q}\,(q_{t} - q_{t+1}) + b_{y*}\,(y^{*}_{t} - y^{*}_{t+1}) \quad \text{II}$$

$$e_{t} = c_{ld}\,e_{t+1} + (1 - c_{ld})e_{t-1} + [c_{i}\,(i^{*}_{t} - i_{t}) - (1 - c_{i})\,(i^{*}_{t-1} - i_{t-1})] + [c_{p}(rpt) - (1 - c_{p})\,rp_{t-1}] \quad \text{III}$$

$$I_{t} = (1 - d_{lag})\,\{r^{n}_{t} + \pi^{target}_{t} + d_{\pi}\,(E\pi^{c}_{t} - \pi^{target}_{t}) + d_{y}\,y_{t}\} + d_{lag}\,i_{t-1} \quad \text{IV.1}$$

$$I_{t} = (1 - d_{lag})\,\{r^{n}_{t} + \pi^{target}_{t} + d_{\pi}\,(E\pi^{c}_{t+1} - \pi^{target}_{t}) + d_{y}\,y_{t+1}\} + d_{lag}\,i_{t-1} \quad \text{IV.2}$$

$$I_{t} = (1 - d_{lag})\,\{r^{n}_{t} + \pi^{target}_{t} + d_{\pi}\,(E\pi^{c}_{t-1} - \pi^{target}_{t}) + d_{y}\,y_{t-1}\} + d_{lag}\,i_{t-1} \quad \text{IV.3}$$

Where;

π^{c}_{t} - Rate of change in the consumer price index and source of the data is SBP monthly Statistical bulletin.

y_t- Output gap. Monthly LSM index has been taken as a proxy for monthly output data. output gap is computed by HP Filter

q_t - Gap is computed by HP Filter for Real Effective Exchange Rate (REER) and is expected to affect both inflation and output positively. Source is IFS-CD 2010.

up^{*zf}_{t}- Imported inflation. Gap of the ratio between world price index of imported inputs and

price index of imported consumer goods. The gap was computed by HP Filter. It is hypothesized that it has positive impact on inflation. Source FBS statistical yearbook (various issues) and IFS-CD 2010.

Δdep_t- Depreciation. Change in nominal exchange rate and is expected to have a positive relationship with CPI. Source is Monthly statistical bulletin SBP.

r_t- Ex-ante real interest rate. Nominal interest rate adjusted by inflation in next period and is computed by author.

r^n_t- Natural real interest rate. Interest rate on 6 month T-bill has been used a proxy for natural real interest rate. Source SBP monthly statistical bulletin, various issues.

y^*_t- World output. Imports of the industrialized countries in constant prices (Y*) is used as proxy for world output. The world ouput gap was computed by HP Filter.

It is expected to have a positive impact on domestic output. Source: IFS-CD 2010.

e_t- Exchange rate. Log of the nominal exchange rate. Source is IFS-CD 2010 and monthly statistical bulletin of SBP.

i_t- Nominal interest rate. SBP discount rate used as a proxy for Nominal interest rate. source SBP monetary policy statements, various issues.

i^*_t- Interest rate abroad. Interest rate in US has been taken as a proxy for interest rate abroad. Source: IFS-CD 2010.

rp_t- Exchange rate risk premium. Depreciation in exchange rate in next time period is taken as a proxy for risk premium and hypothesized to positively related to nominal exchange rate.

π_t^{target}- *Inflation target, (*annualized). We have taken 9 percent as an inflation target because As estimated by Khan and Senhadji (2001), threshold level of inflation for developing countries ranges from 7 percent to 11 percent and by Mubarik (2005), this level for Pakistan is 9 percent.

$E\pi^c_t$- *Average inflation.* Four months moving Average inflation is computed by the author.

The model consists of above four equations from which the first is hybrid Phillips curve which include expected as well adaptive expectation[2], second shows the IS curve relationship, third is uncovered interest parity equation, while in the end is a standard Taylor-type monetary rule. At this stage, we are going to estimate three different types of interest rate rule. Malik and Ahmad (2007) in their seminal work used a simple Taylor rule for Pakistan. Here we are going to extend their work while estimating a standard, backward-looking, and forward-looking interest rate rule also, the lagged interest rate is also included, and the difference between them is whether the current interest rate reacts to current, expected or lagged values of inflation and output gap.

In estimating the model, we used three types of data: gaps, rates of change and interest rates. In general, rates of change and interest rates are annualized, while the gaps are expressed in ordinary monthly terms. This is the case for estimation, simulation, and calculation of the impulse response functions.

All the gaps were estimated using the HP filter[3]. In what follows, we denote the trend of series X calculated using the HP filter as HP(X). The gap of the original series Z (for example, business output) is denoted by z (the output gap) and is estimated as follows:

$$z = (\log(Z) - HP(\log(Z)) * 100$$

The term in brackets is the rate of deviation of Z from its trend. Multiplying by 100 expresses the gap in percent. Following is a description of the gaps included in the model:

In inflation equation, w^f is the weight of the import component in the consumer price index. The data about the proportion of direct imports of consumer goods in total private consumption is not available for Pakistan. So this weight is derived from the effect of exchange rate depreciations on the consumer price index of inflation. However, there are other import components such as certain energy components and overseas travel, which have the weights of 7.29 and 7.32 % in overall CPI. There is another important contributor in import components of CPI is non-perishable food which has a weight of 35.20% in overall CPI. Similarly, the housing component (which accounts for about 23.43 percent of the index) is heavily affected by the exchange rate of the rupee against the dollar and that is why it probably belongs to the component of imported products. According to the above facts the weight of the imported goods and services in the

[2] Adaptive (backward-looking) models have gained some popularity in a number of papers that formulate policy rules, such as Rudebush and Svensson (1999). According to Blinder (1998, p:44) central bankers consider it obvious that expectations of inflation are closer to adaptive than rational

[3] Adnan and Bukhari (2008) estimated output gap for pakistan using six different methods and concluded that HP Filter is the most appropriate method out of all six for Pakistan for the estimation of output gap.

general index (w^f) obtained is 0.40. The detailed description and source of data is discussed in the following table. This study aims to restrict the analysis to monthly data from January 2001 to December 2010.

Econometric Methodology

The Augmented Dickey and Fuller (ADF) (1979, 1981) test is used in order to infer the number of unit roots (if any) or non-stationarity in each of the variables. Engle and Granger (1987) discussed that, a set of economic series is not stationary, there may have to exist some linear combination of the variables that is stationary. Now, when all the variables are non-stationary at their level but stationary in their 1st difference, this allows proceeding further for the implementation of Johansen co-integration technique. Economically speaking, two variables will be co-integrated if they have a long-term relationship between them. Thus, co-integration of two series suggest that there is a long integration tests and of course, the system approach developed by Johansen (1991,1995) can also applied to a set of variables containing possibly a mixture of I(0) and I(1) (Pesaran and Pesaran, (1997) and Pesaran *et al*., (2001, 315).

Do not use square-brackets.

FMOLS was originally designed first time by [Philips and Hansen, (1990); Pedroni, (1995, 2000); and, Philips and Moon, (1999)] to provide optimal estimates of Co-integration regressions (Bum and Jeon, 2005). This technique employs kernal estimators of the Nuisance parameters that affect the asymptotic distribution of the OLS estimator. In order to achieve asymptotic efficiency, this technique modifies least squares to account for serial correlation effects and test for the endogenouity in the regressors that result from the existence of a Co-integrating Relationships. To apply the FMOLS for estimating long-run parameters, the condition that there exists a Co integration relation between a set of variable is satisfied. Therefore, we have to confirm the presence of the unit root and test the Co-integrating relation.

The acceptance of cointegration between two series implies that there exists a long run relationship or an error-correction model (ECM) which combines the long-run relationship with the short-run dynamics of the model. Based on Engle and Granger (1987) representation theorem, the error correction model of equations is formulated. The parameter Ψ is the error correction coefficient that measures the response of the regressand in each period to departures from equilibrium. The presence of error correction term reflects the presumption that dependent

variable does not adjust instantaneously to its long-run determinants. Therefore, in the short-run an adjustment is made to correct any disequilibrium in the long-run, while lagged explanatory variables represent short- run impact.

4. Empirical Results

In this section, we analyze time series properties of the data during the period 2001:M1-2010:M12.The ADF tests results in Table-1 shows that the existence of unit root for all the variables that are included in the four models. However, the first differences of these variables are stationary under the test. Hence, we conclude that these six variables are integrated of order 1 or I(1).

The preliminary step in this analysis is concerned with establishing the order of integration of each variable. For this purpose, to get reliable results of equation 1, the implicit assumption is that variables are *I(1)* and Co-integrated. We employed the test for the existence of a unit root in the level and first difference of each of the variables in our sample using the Augmented Dickey Fuller (ADF) test.

Table 1: ADF Unit root Test Results

	Variable	Level	1st dif
Model I	π^{c}_{t}	0.60392	7.92885
	Y_t	-2.1124	9.573932
	q_t	-1.9135	-10.536
	Up^{*zf}_{t}	-11.0861	---
	dep_t	-13.9194	---
Model II	y_t	1.73881	9.724051
	r^{*}_{t}	-9.8888	---
	q_t	-1.9135	-10.536
	Y^{*}_{t}	-10.393	---
Model III	e_t	0.1329	-4.4177
	^{lct}	-9.781	---
	rp_t	-11.120	---

Model IV	I_t	-0.7350	-10.434
	y_t	-2.1124	9.573932
	$E\pi^*_t$	-1.585775	-8.475839
	R^e_t	-1.085085	-9.206079
		1% level	-3.487550
		5% level	-2.886509
		10% level	-2.580163

According to the results given in table 2 , the dependent variables of all the models π^c_t , y_t , e_t and I_t are non-stationary at level and have the integrated order I(1), it means these will be stationary at first difference. The variables q_t, up^{*zf}_t, dep_t, Y^*_t and rp_t are stationary at level and at second difference, having integrated order of I(0).

Table 2: Johansen Maximum Likelihood Test for Co-integration

Model I				Model II			
H_0	**H_1**	**Trace Statistic**	**0.05 Critical Value**	**H_0**	**H_1**	**Trace Statistic**	**0.05 Critical Value**
r =0	**r ≥ 1**	104.8807*	69.81889	**r =0**	**r ≥ 1**	141.8004*	47.85613
r≤ 1	**r ≥ 2**	65.31725*	47.85613	**r≤ 1**	**r ≥ 2**	84.17865*	29.79707
r ≤ 2	**r ≥ 3**	31.85817*	29.79707	**r ≤ 2**	**r ≥ 3**	38.38271*	15.49471
r≤ 3	**r ≥ 4**	15.05793	15.49471	**r≤ 3**	**r ≥ 4**	6.189916*	4.841466
Model III				**Model IV**			
H_0	**H_1**	**Trace Statistic**	**0.05 Critical Value**	**H_0**	**H_1**	**Trace Statistic**	**0.05 Critical Value**

r =0	**r ≥ 1**	88.14068*	29.79707	**r =0**	**r ≥ 1**	51.52767*	29.79707
r≤ 1	**r ≥ 2**	32.29742*	15.49471	**r≤ 1**	**r ≥ 2**	7.457441*	15.49471
r ≤ 2	**r ≥ 3**	0.017977	3.841466	**r ≤ 2**	**r ≥ 3**	2.256654	3.841466

* denotes rejection of the hypothesis at the 0.05 level while considering MacKinnon-Haug-Michelis (1999) p-values

The results obtained from the Johansen Maximum Likelihood Test for Co-integration test presented for four models in the Table-2. Starting with the null hypothesis of no co integration (r =0) among the variables the trace statistic is (104.8807) which above the critical value of (69.81889). Hence it rejects the null hypothesis r =0 at 5% level of significance in the favor of specific alternative that there is co-integrating vector **r ≥ 1.** As is evident in Table-2 the null hypothesis of r ≤ 1, r ≤ 2 and r ≤ 3 can also rejected at a 5% level of significance and the r ≤ 4 and r ≤ 5 cannot be rejected at 5% level of significance in model I. Similarly, in model II the null hypothesis of r ≤ 1, r ≤ 2, r ≤ 3 and r ≤ 4 can also be rejected at a 5% level of significance and the r ≤ 5 cannot be rejected at 5% level of significance in model II. Thus, we conclude that there are three, four two and two co integrating relationship among the six variables in model I, II, III.

It is found that the long-run relationship exists between the inflation, output, exchange rate and interest rate, and their determinants; in this section, our goal is to estimate long-run relationship. We achieve this through by using, Phillips and Hansen (1990) fully modified ordinary least squares (FMOLS) because Fully Modified OLS (FMOLS) estimator is asymptotically unbiased and has fully efficient mixture normal asymptotic allowing for standard Wald tests using asymptotic Chi-square statistical inference.

Table:3 Long Run Results

Model I dependent var: π^c_t			**Model II dependent var:** y_t			**Model III dependent var:** e_t		
Variable	Coefficient	T-Stat	Variable	Coefficient	T-Stat	Variable	Coefficient	T-Stat

π^{c}_{t+1}	0.22*	3.39	y_{t+1}	0.50*	*29.66*	e_{t+1}	*0.90**	*46.84*
π^{c}_{t-1}	0.775*	-11.78	y_{t-1}	-0.49*	*-30.71*	e_{t-1}	*0.10**	*5.43*
C	6.67	2.74	c	-0.75	*-0.29*	*C*	*-0.37*	*-1.03*
y_t	0.0034*	2.16	R^{n}_{t}	*0.21**	*2.93*	I^{c}_{t}	*-0.71**	*-6.31*
q_t	0.07*	-2.61	q_t	*-0.0026*	*-0.88*	rp_t	*0.022***	*1.15*
Up^{*zf}_{t}	0.0004	0.46	Y^{*}_{t}	0.77*	*2.81*			
dep_t	0.42*	-2.96						
R-sq	0.44		R-sq	0.56		R-sq	0.995	
Adj R-sq	0.41		Adj R-sq	0.54		Adj R-sq	0.994	
D-W stat	2.50		D-W stat	2.82		D-W stat	1.34	

** denotes rejection of the hypothesis at the 0.05 level and ** at 10% level of significance*

The results of our first three models depicted in table 3. A linear restriction is checked that sum of all autoregressive terms is equal to one through Wald test all three models. The result of hybrid Phillips curve (model I) confirms the theory that inflations is both adaptive and rational in Pakistan. It shows that inflation is persistence in Pakistan in the last decade but expected inflation is also statistically significant with the lower coefficient of 0.22. The relationship between inflation and output gap is positive which confirm the theory[4] and the positive coefficient of depreciation is according to Goldfajn and Werlang (2000).

While The IS curve (model II) confirms that in determining aggregate demand, the rational expectations hypothesis holds with equal force. The impact of real exchange rate is significant in first model but insignificant in second model. The exchange rate strongly affected by the expected exchange rate (90%) and remaining 10% by lagged exchange rate. Another important result is that the difference between Rupee interest rate and dollar interest rate is significantly affected the exchange rate while exchange rate risk premium is insignificant, but exchange rate is insignificant. The fourth model (interest rate rule) has three cases so we presented the results of fourth model in a separate table (table 4)

Table: 4 Long Run Results Taylor rule results

[4] The actual relationship between output gap and inflation is positive; see for instance Sbordone (2001) for U.S, Satti, Malik and Saghir(2007) for Pakistan.

Model IV.1			Model IV.2			Model IV.3		
Variable	Coefficient	T-Statistic	Variable	Coefficient	T-Statistic	Variable	Coefficient	T-Statistic
I_{t-1}	0.98	78.51	I_{t-1}	-0.034	-2.76	I_{t-1}	-0.017	
C	1.39	2.25	C	2.84	4.76	C	2.56	
y_t	0.007	7.42	y_{t+1}	-0.002	-5.64	y_{t-1}	0.004	
$E\pi^c_t$	0.02	2.06	$E\pi^c_{t+1}$	0.07	5.38	$E\pi^c_{t-1}$	0.04	
Adj R-sq = 0.18 D.W stat = 1.93			Adj R-sq = 0.12 D.W stat = 2.01			Adj R-sq = 0.11 D.W stat = 2.02		

The results of standard interest rate rule, forward interest rate rule, and backward interest rate rule is presented in table four. All inflation and output is positively related to interest rate as proposed by Taylor (1993) but magnitude of both the coefficient is very small because SBP has not adopted the inflation targeting policy. The coefficient of inflation substantially less than one implies pro-cyclical response of monetary policy to the business cycle. Again, this may be due to the external shocks in the economy and the factors affecting inflation other than those in the monetary sector.

Our results can be compare with (Malik 1997) who found a negative relationship of output with interest rate, which is against the Taylor principle. Secondly The value of (R^2) in all three cases is low which requires the addition of other variables.

Error Correction Results

To apply error correction model it is imperative to determine the optimal lag length and also the stability condition of the VAR. We used FPE (final prediction error), AIC (Akaike information criterion), and SC (Schwarz criterion] criteria to determine the lag length and these criteria supported lag 2 as the optimal lag order for VAR.

Table 5: Error Correction Model Results

Model I dependent var: π^c_t			**Model II dependent var: y_t**			**Model III dependent var: e_t**		
Variable	Coefficient	T-Statistic	Variable	Coefficient	T-Statistic	Variable	Coefficient	T-Statistic
$\Delta \pi^c_t(-1)$	0.38	-2.604	$\Delta y_t(-1)$	0.93	40.17	$\Delta e_t(-1)$	2.19	11.92
$\Delta \pi^c_t(-2)$	-0.14	-1.69	$\Delta y_t(-2)$	-0.94	-40.72	$\Delta e_t(-2)$	-1.19	-6.41
Δy_t	-0.001	-0.85	ΔR^n_t	0.21	4.27	ΔI^c_t	-0.59	-5.00
Δq_t	-0.005	2.13	Δq_t	-0.01	-6.52	Δrp_t	0.02	2.17
ΔUp^{*zf}_t	-0.002	0.87	ΔY^*_t	-0.9	-4.81	Ψ	-0.94	-0.94
Δdep_t	-0.008	-0.39	Ψ	-0.84	-54.81			
Ψ	-0.34	-2.21						
Adj R-sq = 0.36 D.W stat = 2.01			Adj R-sq = 0.96 D.W stat = 2.17			Adj R-sq = 0.99 D.W stat = 1.90		

Error correction results show that the error correction term Ψ has the correct negative sign and is significant for inflation, output gap and exchange rate and indicate the long-run equilibrium between the foresaid variables. An estimate of –0.34 for inflation indicates that 16% of the preceding month disequilibrium is eliminated in the current month. The depreciation negatively related to inflation both in FMOLS model and in ECM.

Table 6: Error Correction Model Results for Taylor rule :

Model IV.1			**Model IV.2**			**Model IV.3**		
Variable	Coefficient	T-Statistic	Variable	Coefficient	T-Statistic	Variable	Coefficient	T-Statistic
$\Delta I_t(-1)$	0.91	2.95	$\Delta I_t(-1)$	0.98	2.476	$\Delta I_t(-1)$	1.17	2.25
$\Delta I_t(-2)$	-0.91	-2.95	$\Delta I_t(-2)$	-0.97	-2.43	$\Delta I_t(-2)$	-1.18	-2.24
Δy_t	0.14	0.79	Δy_{t+1}	0.01	1.36	Δy_{t-1}	0.001	0.176
$\Delta E\pi^c_t$	0.15	4.81	$\Delta E\pi^c_{t+1}$	0.02	5.38	$\Delta E\pi^c_{t-1}$	0.004	0.008
Ψ	-0.98	-2.09	Ψ	-1.25	-2.49	Ψ	-1.17	-2.24
Adj R-sq = 0.09 D.W stat = 2.06			Adj R-sq = 0.09 D.W stat = 2.01			Adj R-sq = 0.05 D.W stat = 2.005		

After establishing the long run relationship between nominal interest rate, inflation and output in the case of Pakistan as discussed in Table 4. Table 6 reports the short-run coefficient estimates obtained from the ECM. The coefficient of Ψ is equal to (-0.98) for the standard interest rate short run model and imply that disequilibrium in the previous month is corrected by (98%) percent in the current month. The coefficient of error correction term in forward and backward looking rule is greater than one which implies that model are divergent in the short run. However, the output is statistically insignificant in forward and backward looking rule.

5. Conclusions

In this study, we specified and estimated a New Keynesian model for the Pakistan economy. One of the main findings of the study is the importance of the exchange rate in the Pakistani economy's transmission mechanism. The exchange rate affects inflation both directly and through its influence on the output gap. In addition, the direct influence of the exchange rate on inflation, and its effect on the output gap, are stronger than in other economies. The sensitivity of inflation and the output gap to the exchange rate, and to the exogenous shocks that characterize it, is manifested in their relatively large fluctuations, and as a result also in the fluctuations of the nominal interest rate (through the interest rate rule) and the real interest rate.

Also in the case of the output gap equation, it was found that the world output has a significant effect on domestic output, which is further evidence of the Pakistani economy's degree of openness and its sensitivity to exogenous global shocks. The estimation of the inflation equation shows that there is inertia in the inflation process, A relatively significant coefficient for inflation expectations (in the inflation equation) indicates that monetary policy has an effect on inflation via expectations.

In most economies, a relatively long lag is found in the influence of the interest rate on inflation. In contrast, our study found that the transmission mechanism from the interest rate to inflation in the Pakistani economy is rapid, even in comparison to other small open economies. This finding is a result of two factors: the first is the immediate effect of the interest rate on the exchange rate and the strong and rapid effect of a depreciation on inflation; and the second is the high coefficients obtained for the expectation variables in the equations for inflation and the output gap. The strong influence of expectations in these two equations is consistent with the New

Keynesian theory, which emphasizes the importance of the public's expectations in the transmission mechanism.

In the end, we are now in a position to conclude that new Keynesian monetary model performed quite well in Pakistan. Estimation of three alternative Taylor rule paved a way to adopt inflation targeting to control double-digit inflation in Pakistan with the hope that with the adoption of inflation targeting the interest rate rule will perform well in future not only to control inflation but also to increase output and subsequently decrease unemployment.

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Appendix A:

Individual countries' inflation targets

Country	Target set by	Target measure	Target 2012	Target type	Multiple target	Target horizon
Armenia	G and CB	H CPI	4% ±1.5 pp	P+T	-	Medium term
Australia	G and CB	H CPI	2%–3%	P+T	-	Medium term
Brazil	G and CB	H CPI	4.5% ±2 pp	P+T	2012 and 2013	Yearly target
Canada	G and CB	H CPI	2% (mid-point of 1%–3%)	P+T	-	Six-eight quarters extend to dec 2016
Chile	CB	H CPI	3% ±1 pp	P+T	-	Around two years
Colombia	CB	H CPI	2%–4%	Range	-	Medium term
Czech republic	CB	H CPI	2% ±1 pp	P+T	-	Medium term
Ghana	G and CB	H CPI	8.7% ±2 pp	P+T	End 2012 and 2013	18-24 months
Guetemala	CB	H CPI	4.5% ±1 pp	P+T	2012 and 2013	End of year
Hungary	CB	H CPI	3%	Point	-	Medium term
Ice land	G and CB	H CPI	2.5%	Point	-	On average
Indonesia	G and CB	H CPI	4.5% ±1 pp	P+T	-	Medium term
Israel	G and CB	H CPI	1%–3%	Range	-	Within two years
Mexico	CB	H CPI	3% ±1 pp	Point	-	Medium term
New Zealand	G and CB	H CPI	1%–3%	P+T	-	Medium term

Norway	G	H CPI	2.5%	P+T	-	Medium term
Peru	CB	H CPI	2% ±1 pp	P+T	-	At all times
Philippines	G and CB	H CPI	4.0% ±1 pp	P+T	-	Medium term
Poland	CB	H CPI	2.50% ±1 pp	P+T	-	Medium term
Romania	G and CB	H CPI	3% ±1 pp	P+T	-	Medium term
Serbia	G and CB	H CPI	4.0% ±1.5pp	P+T	-	Medium term
South Africa	G	H CPI	3%-6%	Range	-	On a continous basis
Three years	CB (with G)	H CPI	3% ±1 pp	P+T	-	Three years
Sweden	CB	H CPI	2%	Point	-	Two years
Thialand	G and CB	H CPI	3% ±1.5 pp	P+T	-	eight quarters
Turkey	G and CB	H CPI	5.0% ±2 pp	P+T	2012 and 2013	Multi year
United kingdom	G	H CPI	2%	point	-	At all times

Source: centre for central banking studies, Handbook No 29, Bank of England.

Note: CB = Central bank. G = Government. H CPI = Headline CPI. P + T = Point with tolerance band.

pp = percentage point.