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Designed, composed, and finished at the Publications Division, PIDE.

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ABSTRACT

This paper analyzes the relative performance of inflation and price-level targeting regimes in an AS-IS-LM framework under alternative policy instruments used by the central bank. Being general in its nature, the results are further used to derive equilibrium values of the important macroeconomic variables under the two targeting regimes for two limiting cases; when LM schedule becomes vertical (Quantity Theory of Money) and when it becomes horizontal (Endogenous Money Hypothesis). Contrary to Svensson's findings, our results imply a 'free lunch' in case of inflation targeting rather than price-level targeting. Calibration results for Pakistan also support these theoretical findings and point towards inadequacy of using interest rate, rather than money supply, as a policy instrument both under the inflation and price level targeting regimes.

JEL Classification: E52, E31, E12, C63

Keywords: Monetary Policy; Inflation Targeting; Endogenous Money Hypothesis; Calibration

1. INTRODUCTION

An optimal monetary policy in its conventional meaning of aiming stable price level and output growth is essential for macroeconomic stabilisation of an economy. Kydland and Prescott (1977) and Barro and Gordon (1983) showed that policies based on discretion rather than rules are time-inconsistent and lead to adverse behavioural adjustments on behalf of private sector. Besides, Taylor (1993) asserted that monetary policy rules have greater advantage over discretion in improving economic performance of a country. Woodford (2003) added that although following rule has greater advantage over discretion yet it is not clear under what conditions and assumptions this statement holds specifically. The literature related to rules verses discretion debate distinguishes between instrument rules and targeting rules. Instrument rules are state-contingent reaction functions that link policy tools to performance indicators of the economy, e.g., McCallum Rule (1988), Taylor Rule (1993), etc. In targeting rules, due largely to Svensson (1997, 1999, 2003), the policy makers choose an appropriate variable to target, e.g., inflation rate, price level, nominal income growth rate. The choice between these two types of rules depends on simplicity, robustness, result orientation and the role of policy makers' judgment in decision making [Taylor (1993); Svensson (2003)].

The choice between price level and inflation rate as targeting variable has now been the focus of monetary authorities. The conventional wisdom [Lebow, *et al.* (1992); Fischer (1994); Haldane and Salmon (1995)] that price-level targeting leads to a lower long-run variance of the price level but at the cost of increased short-run variability in both inflation rate and output level makes inflation targeting preferable to price-level targeting. Svensson (1999), on the contrary, showed that price-level targeting is better than inflation targeting with the same output variance under both targeting regimes and lower variability of inflation rate under price-level targeting than under inflation targeting which also allows base drift of price level, thus, providing monetary authority a 'free lunch'. Vestin (2001) showed that Svensson's findings hold also in a forward looking model (as Svensson's model was a backward looking model) with Calvo (1983) and Taylor (1979) style price stickiness. Batini and Yates (2003) discussed a 'hybrid' target, which is a weighted average of an inflation target and a price-level target, for macroeconomic stabilisation.

Designing optimal rules often leads to complex rules that cannot be implemented easily [Taylor (1999)]. Models deriving optimal monetary rules or analysing the impact of monetary rules in the forward-looking macroeconomic models, e.g., Vestin (2001), Bean (2004) etc., gave results that are not robust

and are inconclusive. On the other hand, the simple macroeconomic models like the IS-LM or AS-IS-LM seem to be applicable to most of the central banking policies [Adema and Sterken (2005)] and the analytical solutions of these simple models have meaningful economic explanations.

Poole (1970) discussed a simple form of optimal monetary policy in a static stochastic IS-LM model where the objective of the central bank is to stabilise output level. He concluded that targeting interest rate is preferable to targeting money supply if the variance of the money demand disturbances is relatively larger than the variance of the goods market. Sargent and Wallace (1975) postulated that targets for inflation rate and nominal interest rate cannot be chosen independently, and controlling the short-term interest rate has important consequences for the price level. They established this result within IS-LM framework with interest rate being exogenously determined by monetary authority. McCallum and Nelson (1999a) defended the use of the IS-LM framework and argued that it could be made consistent with micro foundation. Adema and Sterken (2005) discussed an instrument rule, namely the Taylor Rule (1993), in an AS-IS-LM framework. This study will analyse inflation targeting and price-level targeting in an AS-IS-LM framework to explore as to which targeting regime might stabilise the economy in a better way under alternative instruments used by the central bank.

Besides, Svensson's model (1999), which assumes that quantity of money is set exogenously,[1] will be illustrated in an AS-IS-LM framework for simple analytical solutions. Svensson (1999) used dynamic optimisation problem to analyse targeting rules where the results are subject to a complex existence condition and the central implication of the model that price-level targeting is preferable to inflation targeting, holds only in case when central bank acts under discretion. This study would also derive theoretical results under the assumption that interest rate is set exogenously as a policy instrument by central bank of a country to determine sensitivity of Svensson's (1999) result with respect to money versus interest rate pegging regimes. The theoretical results of the AS-IS-LM models would then be calibrated for Pakistan using values for parameters of the models from empirically estimated macroeconometric model for Pakistan in the previous literature.

The remainder of this paper is organised as follows. Section 2 discusses the development of different theories related to prudent monetary policy conduct, goals and targets of monetary policy and different issues related to the effectiveness of monetary policy. Section 3 contains the analytical frameworks used for the comparison of the targeting regimes. Section 4 includes a brief discussion on both the theoretical and calibration results of the models. The final section 5 concludes this study.

[1]See, Minford and Peel (2003).

2. REVIEW OF MONETARY POLICY RULES

It has long been an interesting debate as to how monetary policy should be conducted to maintain long-run stability in terms of price level and output. Smith (1776) postulated that "a well regulated paper money" would have an advantage of improving economic growth in a country while Keynes (1923) suggested that monetary authority should control the supply of money so that "the index number of prices" does not move far away from a fixed value.[2] Besides, Wicksell (1898) gave his monetary rule that the central bank should use interest rate to stabilise price level. Friedman (1960) studied the severe monetary mistakes of the Great Depression and proposed monetary policy rule as "constant growth rate rule". Later on, Taylor (1993) suggested a feedback rule which appeared to avoid instability in every period when a shock is observed.

A consensus has been developed that there is no long-run trade-off between the rate of inflation and the rate of unemployment and only short-run trade-off exists. It means that monetary policy has effective role in changing output level in short-run only. The basic distinction in economic policy is now with regard to discretionary policy and the policy that follows a rule. Kydland and Prescott (1977) and Barro and Gordon (1983) showed that a discretionary policy results in time inconsistency problem whereby a central bank actively pursuing output goals may end up with a bias towards high inflation rate with no gains in output. Thus, even though central bank may believe to be operating in an optimal manner, yet it may end up with a suboptimal outcome. Taylor (1993) asserted that policy rules have greater advantage over discretion in improving economic performance in short-run and to achieve socially better equilibria in long run.

2.1. Monetary Policy Goals, Targets and Instruments

McCallum (1993) defined the goal of monetary policy as an ultimate but non-operational variable. The policy goal of monetary policy can be social welfare as indicated, for example, by stable output growth or low unemployment rate, etc. A target of monetary policy, contrary to goal, is an operational variable that takes preference in the conduct of monetary policy. Likely examples of targets are price level indices, inflation rate and nominal income. There are also some intermediate targets that signal news about the effectiveness of monetary transmission. Coenen, *et al.* (2001), for example, used monetary aggregates as a signal of future real economic growth. Besides, an instrument of monetary policy is a variable that a central bank frequently manipulates, e.g. interest rate, to exert indirect control over some 'target' variable [McCallum (1989)].

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[2] Cited in King (1994).

2.2. Monetary Policy Rules

Taylor (1999) defined a monetary policy rule as the description of how instruments of policy, for example discount rate, change in response to economic variables. Two well-known examples of policy rules are constant growth rate rule for money supply and the feedback rule such that interest rate changes in response to changes in output level and inflation rate. Duration of time period required to reap the benefits of stabilisation and the credibility associated with the rule are two important considerations of policy rule. There are two types of rules in the literature; instrument rules and targeting rules. In the case of targeting rule, central bank minimises a social loss function that is increasing in the deviation between the observed and desirable levels of the goal variable whereas in instrument rules; an instrument variable is expressed as an explicit reaction function of the current information on the performance indicators of the economy.

2.2.1. *Instruments Rules*

Instrument rules are state-contingent reaction functions that link policy tools (instrument variables) with performance indicators of the economy [McCallum (1988); Taylor (1993); Henderson and Mckibbin (1993)]. Instrument rules have the general advantage of being clear and easy to communicate with public. These rules are robust and technically feasible in the sense that commitment to rules is easily verifiable. A brief overview of two important instrument rules is as follow.

Taylor rule sets federal funds rate equal to the equilibrium long-run real interest rate plus current inflation rate plus a linear non-decreasing function of the deviation of output in period t from its long-run trend and the deviation of current inflation rate from its target level [Taylor (1993)].

McCallum rule sets the growth rate of monetary base equal to the target growth of nominal GDP minus the growth rate of income velocity of base money plus a linear non-increasing function of the deviation of realised nominal growth rate from the target rate (McCallum 1988). Contrary to Taylor rule, all variables in this rule are easy to measure but the disadvantage of this rule is the choice of base money variable itself as instrument because of its instability.

2.2.2. *Targeting Rules*

A targeting rule is an explicit guideline for monetary authorities to adjust monetary instruments for their objectives, e.g., a stable price level, a stable inflation rate, etc., where no ad-hoc decision are taken. Within targeting rules, a further distinction is made between ‘general targeting’ and ‘specific targeting rule’. General targeting specifies an operational loss function, increasing in the deviations between target variables and their optimal levels, which is to be minimised by the monetary authorities. In specific targeting rule, a condition for

setting the instrument is specified e.g., marginal rates of transformation and substitution between the target variables are equalised. It gives an implicit reaction function of monetary authority that needs not be announced. According to this framework, central bank collects large amount of data and uses a complex policy formulation to set the path of instruments. In this way, a target rule is directly focused on the goal of monetary policy and allows more flexibility in finding the corresponding reaction function. Therefore, Svensson (1997) argued that target rules are more stable than instrument rules and their identification and verification can easily be confirmed. A brief overview of different targeting rules is as follow.

Inflation targeting is the monetary regime where policy is formulated with an objective to stabilise inflation rate, the goal variable of central bank, directly. It had the important advantage of being easily understood by public and the resulting transparency increases the probability of promoting low inflation expectations, which helps producing a desirable inflation outcome [King (2004)]. Inflation targeting also reduces pressures on monetary authorities to pursue short-run output gains that would lead to the time inconsistency problem [Debelle and Fischer (1994); Posen (1995)]. In addition, inflation targeting can avoid the problem of 'velocity instability', which is an unreliable relationship between intermediate targets and the central bank's goal variable, because central bank through inflation targeting attempts to target the goal variable directly rather than focusing on the link between formal intermediate target and goal variable [Bernanke and Mishkin (1997)].

Price-level targeting is the monetary regime where some price index, e.g., CPI, WPI, GDP deflator, etc., is supposed to be targeted by the monetary authority with the goal of a stable price-level. Price stability is often interpreted as low and stable inflation rate but in practice price-level targeting and inflation targeting are different as the former implies a stationary price-level while the latter implies constant growth rate of price-level, allowing complete price-level drift and thus a non-stationary price level.

Price-level targeting became official goal of Sweden's monetary policy during 1931 to 1937 to capture the fall in prices after the start of the Great Depression and disorganisation of the monetary system—The Gold Standard.[3] It is in the guideline of Wicksell (1898) who viewed price-level targeting as proper guide for central bank policy and gave his monetary rule (also termed as 'cumulative process') that central bank should raise its discount rate as long as prices are rising, lower it as long as prices are falling and keep it constant when the price level is stable. The key to price stabilisation was thus found in the discount rate. Later on, Fisher (1934) started to view it as the first step towards

[3]See Berg and Jonung (1999) for a brief history of price level targeting as a monetary policy in Sweden.

recognition of price stabilisation as an alternative monetary policy to fixed exchange rate system.

A targeting price level needs not remain constant indefinitely but it can be drifted upward in a predetermined way over time [Goodhart and Vinals (1994)]. Bernanke and Mishkin (1997) demonstrated that price stability does not mean exactly zero inflation rate but something closer to a two percent annual rate of price change. Svensson (1999) showed that price-level targeting delivers better results for price stability than inflation targeting. Batini and Yates (2003) also found that some forms of price-level targeting in models with fully forward-looking inflation expectation can lower inflation variability relative to pure inflation-targeting regimes. Taylor (1996) demonstrates that price shocks should not be viewed as a reason to abandon the goal of price stability because a credible policy aimed at price stability might cause a jump in the price level but it does not require a sacrifice in the long-run goal of price stability.

Optimal hybrid inflation-price level targeting is a new perspective, which assigns weights to both the inflation and price level targets. Intermediate regimes between inflation and price-level targeting are analysed under two policies, one based on optimal control and the other on simple rules. Batini and Yates (2003) showed that under optimal control, hybrid regimes give solutions that converge to stable and unique equilibria while it is not the case under policy based on simple rule. Besides, Roisland (2006) extended this hybrid model by using New-Keynesian model with inflation persistence and showed that the optimal degree of price level drift in the hybrid model is equal to the degree of price indexation which is a weighted average of separate targets of inflation rate and price-level in the central bank's social loss function.

Monetary aggregate targeting is the policy regime where central bank targets growth path for a monetary aggregate like monetary base, M2 or M3. Goodfriend (1987) assumed nominal money stock as a direct policy instrument and showed that if velocity is relatively constant, a growth target of a monetary aggregate can keep nominal income on a steady growth path that leads to long-term price stability. Monetary aggregates can be controlled both quickly and easily by the central bank. As pointed out in Bernanke and Mishkin (1997), since a monetary aggregate is known so quickly, using it will increase transparency of monetary policy, which helps avoiding time-inconsistency problem. But, unfortunately, in many countries, velocity fluctuations have been so large and frequent that the relationship between monetary aggregates and the goal variables has broken down. As a result, the use of monetary aggregate targeting becomes highly problematic, and many countries that adopted monetary targets in the 1970s, abandoned them in the 1980s.

Exchange rate targeting is the monetary regime where central bank pegs the value of domestic currency on a predetermined path or fixes the value of the domestic currency relative to that of a developed or low-inflation country. Exchange rate targeting has the advantage of avoiding time inconsistency

problem by precommitting a country's central bank so that it cannot pursue an overly expansionary monetary policy that would lead to devaluation of its currency. With a fixed exchange rate regime, a country no longer exercises control over its own monetary policy and, hence, not only is the country unable to use monetary policy to respond to domestic shocks but it is also vulnerable to shocks emerging from the base country to which its currency is pegged [Obstfeld and Rogoff (1995)]. Furthermore, in the current environment of global capital markets, fixed exchange rate regimes are subject to breakdowns that may entail sharp changes in exchange rate producing a full scale banking and financial crisis that can tip an economy into a severe depression [Mishkin (1996)].

Nominal income targeting is the policy regime where monetary authority tries to minimise the divergence of nominal income from its full information equilibrium level or target level. It was initially suggested by Meade (1978) and Tobin (1980) who asserted that controlling nominal income should be the ultimate goal of those central banks that favoured fixed monetary targets as it can avoid undesirable fluctuations in the demand for output when velocity shifts. McCallum and Nelson (1999b) and Taylor (1985) advocated this policy because of the potential disadvantage of an inflation-targeting regime that ignores output stabilisation in face of supply-side shocks. Bean (1983) showed that in face of demand shocks, nominal income targeting is always preferable to money supply targeting while, in face of supply shocks, a condition for nominal income targeting to be preferable is that the elasticity of aggregate demand with respect to real balances be less than one.

2.3. Issues in the Design of Monetary Policy Rules

Although there are substantial differences from model to model as to which variable should be targeted yet there is some consensus in the literature on some outcomes of these targeting regimes. The policy rules that focus on exchange rate or policies that focus on money supply do not deliver as good results as policies that focus on the price level and output level directly (Taylor 1999). It means that monetary policy rules in which the short-term interest rate instrument is changed by the monetary authorities seems to work well to target price level and real income, though, by how much the interest rate should be changed is still uncertain.

Besides, there are some important issues in the design of monetary policy rules. The first issue is of robustness and simplicity; that is, central bank should be able to design simple rules that reflect optimal responses to different shocks. Woodford (2003) asserted that policy reaction functions based on forwarded-looking models were quite complicated while simple rules were easier to understand and often explained about eighty percent of the variance observed in the policy instrument. Lewis and Mizen (2000) asserted that monetary policy

rules in general should satisfy some criteria like; it should be clear and simple, its parameters could be estimated by econometric methods and it should also be able to explain the past history of monetary policy instruments. Svensson (2003) proposed that a good monetary policy should calculate various target solutions for simulated paths of instruments and should be able to pick the path that fits best into the strategy.

Friedman (1948) pointed out that monetary policy effects have long lags. As economic shocks can occur in the intervening period between a policy and its effects, monetary policy-makers must decide what time horizon is appropriate for meeting a target. Taylor (1996) explained that realised values of a target variable would not be equal to the target value exactly; rather it would tend to fluctuate around the target due to various types of shocks. Only on average, could the realisation be equal to the target. But how long a time period should the average be taken depends very much on the volatility of the targeting variable. Taylor (1985) suggested that one quarter (shorter) time period for nominal income targeting will yield a policy with little deviation from the target as the error in a forecast for nominal income next quarter is smaller on average than the error in a forecast for four or eight quarters in the future.

3. ANALYTICAL FRAMEWORK

Contrary to the conventional wisdom, Svensson's (1999) results showed price-level targeting is preferable to inflation targeting but the model concludes a very complex existence condition which has to be met for holding of results. Howitt (2000) and Mishkin (2000) pointed out that the specific assumptions necessary for holding of results in Svensson's model are hard to hold in practice. Minford and Peel (2003) graphically illustrated the resulting setup of Svensson's (1999) model in the familiar form of IS-LM and AD-AS curves. Following Minford and Peel (2003), the analytical solutions of the Svensson's model is derived under inflation targeting and price-level targeting, respectively, in AS-IS-LM model. This model though is simple but the analytical solution gives a meaningful economic interpretation.

The basic AS-IS-LM model consists of the following equations.

$$y_t = a - \alpha[i_t - (p^e_{t+1} - p_t)] + \varepsilon_t \; ; \qquad \alpha > 0, \qquad \ldots \qquad \ldots \qquad (1)$$

$$m_t - p_t = ky_t - \varphi i_t + \eta_t \qquad ; \qquad k > 0, \;\; \varphi > o, \qquad \ldots \qquad (2)$$

$$y_t = \rho y_{t-1} + \gamma(p_t - p^e_t) + v_t \; ; \qquad 0 \leq \rho < 1 \; , \; \gamma > 0 \;\; \ldots \qquad (3)$$

where y_t , i_t , p_t, p^e_t, and m_t are respectively the log of output, nominal interest rate, log or price level, the expected (log of) current price level based on current expectation and log of money stock in period *t*. The parameters α, k, φ and γ are all positive while ε_t, η_t and υ_t are mutually and serially uncorrelated shocks with zero mean and constant variances denoted by σ^2_ε, σ^2_η and σ^2_v respectively.

Equation (1) is the standard IS-equation where the term in bracket is expected real interest rate which is the nominal interest rate minus the expected rate of inflation:

$$\pi_{t+1} = p^e_{t+1} - p_t \,, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (4)$$

The private sector has rational expectations and p^e_{t+1} is the expected price-level for period *t+1* conditional upon information up to the end of period *t*. Equation (2) is the standard LM equation and Equation (3) is the short-run aggregate supply curve where monetary policy is effective due to prevalence of price rigidity so that unanticipated changes in the price-level cannot be adjusted quickly. The Period Loss Function following Svensson (1999) is given as:

$$L_t = 0.5[(\pi_t - \pi^*_t)^2 \; + \; \lambda(y_t - y^*_t)^2] \,; \;\; \lambda \; > 0 \,, \quad \ldots \quad \ldots \quad (5)$$

where π^*_t is the socially desirable inflation rate, y^*_t is the socially desirable output level and 'λ' is the relative weight on output stabilisation. The socially desirable level of output in a period *t* is obtained when actual price level equals expected price level, $p_t = p^e_t$, and putting this condition into equation (3) the expression for socially desirable output level can be written as:

$$y^*_t = \rho y_{t-1} + v_t \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (6)$$

Here v_t is the supply side shock while ρy_{t-1} shows persistence in output which implies that output in case of any shock would move to its long-run path. A positive supply-side shock increases the socially desirable level of output and vice-versa.

Now, assuming that private sector has rational expectations, we have to see how economic agents can evaluate during period *t* policy for period *t+1* because monetary authority chooses nominal rate of interest or the money supply as policy instrument at the beginning of period *t* to minimise the expected loss function (5) and that policy rate cannot be changed until the beginning of next period. Then, the current period shocks are realised and monetary authority forms expectations of the time *t+1* price level and so on. Under inflation targeting, π^*_t is fixed for all *t* and always equal π^*, the socially desirable inflation rate, because central bank targets inflation rate in every time period to the socially desirable level of inflation rate.[4] It implies that

$$\pi_{t+1} = \pi^*. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (7)$$

Putting this result (7) into Equation (1), the IS-equation under inflation targeting rule can be written as

$$y_t = a - \alpha(i_t - \pi^*) + \varepsilon_t. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (8)$$

[4]Svensson (1999) contains the full details. See also the discussion in Cover and Pecorino (2005).

In order to be consistent with an inflation-target under inflation targeting, price-level targeting takes the following form.

$$p_t^* = p_{t-1}^* + \pi^*, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (9)$$

where p_t^* is the target value of price level that central bank sets, p_{t-1}^* is a pre-determined path of prices which the monetary authority has been targeting and π^* is the average rate of inflation over time. Subtracting 'p_{t-1}' from both sides of the Equation (9) would yield:

$$\pi_t^* = \pi^* + (p_{t-1}^* - p_{t-1}). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (10)$$

If the average rate of inflation, π^*, is positive; it implies that the price-level targeting is trending upward over time. Equation (10) shows if the price-level is below its target level during period *t–1*, the target rate of inflation during period *t* would be above the average rate of inflation otherwise it will be below the average rate of inflation. This would lead central bank to set the interest rate at such a level that would lower inflation rate in the next period so that above-average inflation rate should be followed by below-average inflation rate because, in price-level targeting, *overshoots or undershoots of the target are not treated as bygones and be made up* [Svensson (1999)]. The IS equation under price-level targeting following Svensson (1999) can be written as:

$$y_t = a - \alpha[i_t - \pi^* - (p_t^* - p_t)] + \varepsilon_t. \quad \ldots \quad \ldots \quad \ldots \quad (11)$$

(A) Inflation Targeting

Solving LM Equation (2) for nominal interest rate, i_t, yields the following equation.

$$i_t = \frac{1}{\varphi}[ky_t - (m_t - p_t) + \eta_t] \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (12)$$

Putting this expression into IS Equation (8) and solving for output level would result in

$$y_t = \frac{\varphi(a+\varepsilon_t)+\alpha[(m_t-p_t)-\eta_t+\varphi\pi^*]}{\varphi+k\alpha}. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (13)$$

To find the price level at this optimal policy function, we use aggregate demand Equation (13) and aggregate supply Equation (3) to solve for price-level as a function of optimal real money supply. This results in the following equation.

$$p_t = \frac{\gamma(\varphi+k\alpha)p_t^e+\varphi(a+\varepsilon_t)+\alpha(m_t-\eta_t+\varphi\pi^*)-(\varphi+k\alpha)(\rho y_{t-1}+v_t)}{\gamma(\varphi+k\alpha)+\alpha}. \quad \ldots \quad (14)$$

From Equations (4) and (7), it can be shown that expected price-level for period *t+1* can be written as $p_{t+1}^e = p_t + \pi^*$ whereas the current inflation is defined as $\pi_t = p_t - p_{t-1}$. Therefore, we can write $(p_t - p_{t-1} - \pi^*) = (\pi_t - \pi^*)$.

Next, inserting Equations (6), (13) and (14) into social loss function (5), using Equations (4), (7) and simplifying yields the following expected loss function.

$$E_{t-1}L_t = \left\{\frac{0.5\left(1+\lambda\gamma^2\right)}{\gamma^2}\right\} E_{t-1}\left[\frac{\varphi(a+\varepsilon_t)+\alpha[(m_t-p_t)-\eta_t+\varphi\pi^*]-(\varphi+k\alpha)(\rho y_{t-1}+v_t)}{\varphi+k\alpha}\right]^2 \quad (15)$$

Setting the derivative of this expected loss function with respect to money supply equal to zero yields the optimum value of the money supply, control of which has important consequences for the aggregate output and price level. The optimal value of money supply which central bank targets under inflation targeting to minimise the social loss function is as follows.

$$(m_t - p_t) = \frac{(\varphi+k\alpha)\rho y_{t-1}-\varphi(a+\alpha\pi^*)}{\alpha}. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (16)$$

It shows that optimal value of money supply when central bank targets inflation rate depends on the optimal value of target inflation rate, π^*, and persistence in output. The positive relationship between money supply and output persistence shows the incentive for central bank to increase money supply to decrease the gap between the actual and optimal levels of output.

Inserting this optimum value into aggregate output Equation (13) and simplifying yields the optimal rule for output level.

$$y_t = \rho y_{t-1} + \frac{\varphi\varepsilon_t - \alpha\eta_t}{\varphi+k\alpha}. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17a)$$

The result shows that the output depends positively on the IS-shock, ε_t, and negatively on the LM shock, η_t. If both the shocks come to zero, the long-run equilibrium value would be achieved.

Now, we substitute Equation (17a) into Equation (3) and solve for price level to yield:

$$p_t = p_t^e + \frac{1}{\gamma}\left(\frac{\varphi\varepsilon_t - \alpha\eta_t}{\varphi+k\alpha} - v_t\right). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (18a)$$

The result shows that a positive demand shock would raise the price level while a positive supply shock would lower the current period price level. The effectiveness of any positive (demand and/or supply) shock depends on the slope of the aggregate supply curve, γ. Subtracting p_{t-1} from both sides of equation (18a) and using Equation (7), the former equation is converted into an equation for inflation rate:

$$\pi_t = \pi^* + \frac{1}{\gamma}\left(\frac{\varphi\varepsilon_t - \alpha\eta_t}{\varphi+k\alpha} - v_t\right). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (19a)$$

This result shows a zero inflation bias under inflation targeting because it depends on the new information that arrives after expectations have been formed. In the absence of any shock, inflation rate would approach its socially desirable level, π^*.

The above results for output (17a), price level (18a) and inflation rate (19a), under inflation targeting, are derived in a general framework where no restrictions have been put on the parameters of the model. Now, we can obtain different results by putting different restrictions of our interest. Here, our interest lies in the illustration of the Svensson's model in the AS-IS-LM framework. So, following Minford and Peel (2003), the analytical solutions of the Svensson's model can be derived by setting a unit income elasticity ($k = 1$) and a zero interest-elasticity of money demand, ($\varphi = 0$). This implies a vertical LM schedule where there is no role of IS shocks on output level.

Kiley (1998) also regarded Svensson's set up as 'policy ineffective' on output where no trade-off arises with output stability; i.e., a free lunch exists as price-level targeting reduces the inflation bias with no cost in output stability. It also implies central bank's behaviour of setting money supply as a policy tool to achieve its macroeconomic goals. The results for output, price level and interest rate of Svensson's (1999) model under inflation targeting can be written as:

$$y_t = \rho y_{t-1} - \eta_t, \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17b)$$

$$p_t = p_t^e - \frac{1}{\gamma}(\eta_t + v_t), \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (18b)$$

$$\pi_t = \pi^* - \frac{1}{\gamma}(\eta_t + v_t). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (19b)$$

The result shows that the output does not depend on the IS-shock, ε_t, as LM curve is vertical; whenever there is demand shock shifting the IS curve, this shock must be offset by a rise in interest rate so that output is unaffected. The result for price level shows that any positive supply shock or money-market schedule shock would decrease the current period price level. Uncertainty in LM schedule occurs because of unanticipated changes in money demand [Poole (1970)]; thus, a positive shock in the money-demand schedule shifts the aggregate demand curve backward, which for a given aggregate-supply curve, lowers price level as well as output level. Inflation rate also depends on the demand and supply shocks that occur after expectations have been formed. As in case of Equation (19a), in the absence of any shock, inflation rate approach to its target or socially desirable level, π^*.

Contrary to Svensson's illustration ($\varphi = 0, k = 1$), Cover and Pecorino (2005) analysed the case where LM schedule is horizontal which implies central bank's behaviour of setting interest rate as a policy tool to achieve its target. Cottrell (1994) argued that in a 'modern credit-money' economy a central bank is bound to accommodate the private sector credit demand as a matter of structural necessity. So, changes in the real economy, e.g., wages, employment and inventory, determine the demand for bank loans that in turn determines the supply of money. In this case, the money demand Equation (2) is redundant in the sense that central bank needs to supply all money that is demanded at certain

values of output and interest rate.[5] Thus, assuming infinite elasticity of money demand ($\varphi \to \infty$) along with finite income elasticity ($k < \infty$), yields the equilibrium values of output, price level and inflation rate under inflation targeting where central bank pegs interest rate as a policy tool.

$$y_t = \rho y_{t-1} + \varepsilon_t \,. \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (17c)$$

$$p_t = p_t^e + \frac{1}{\gamma}(\varepsilon_t - v_t). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (18c)$$

$$\pi_t = \pi^* + \frac{1}{\gamma}(\varepsilon_t - v_t). \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad \ldots \quad (19c)$$

The result shows that output depends on the IS-shock, ε_t, and is independent of the LM shock η_t and the AS shock, v_t. The result that only demand-side shock can change output reflects the state that interest rate determined by central bank causes the aggregate demand curve to be vertical (price inelastic). Any positive (negative) shock in demand side will raise (lower) the current price level while the effect of a positive (negative) supply shock on the price level is negative (positive) and it depends upon the slope of the aggregate supply curve, γ. The inflation rate does not depend on the persistence in output level which obviates the presence of inflation bias under inflation targeting.

(B) Price-Level Targeting

Now, we derive results under the assumption that central bank targets price level to achieve macroeconomic stability. Putting Equation (12) into IS function under price-level targeting (Equation 11) and solving for output level results in the following equation.

$$y_t = \frac{\varphi(a+\varepsilon_t)+\alpha\{(m_t-p_t^*)-\eta_t+\varphi[\pi^*+(p_t^*-p_t)]\}}{\varphi+k\alpha}. \quad \ldots \quad \ldots \quad \ldots \quad (20)$$

It is important to note that the output at optimal policy function under price-level targeting is different from that under optimal policy function of inflation targeting (Equation 13) because price-level targeting provides built-in stability that make up undershoots and overshoots in the next period when a shock occurs. Now, solving Equation (20) and Equation (3) for price-level as a function of optimal money supply results in the following equation.

$$p_t = \frac{[\varphi(\alpha+\gamma)+\alpha(\gamma k-1)]p_t^*+\varphi(a+\varepsilon_t)+\alpha(m_t-\eta_t+\varphi\pi^*)-(\varphi+k\alpha)\,(\rho y_{t-1}+v_t)}{\varphi(\alpha+\gamma)+\gamma k\alpha}. \quad \ldots \quad (21)$$

Substituting for y_t and p_t from Equations (20) and (21) into the social loss function (5) yields:

$$E_{t-1}L_t\left[\frac{0.5(1+\lambda\gamma^2)}{\gamma^2}\right]E_{t-1}\left[\frac{\varphi(a+\varepsilon_t)+\alpha\{(m_t-p_t^*)-\eta_t+\varphi[\pi^*+(p_t^*-p_t)]\}-(\varphi+k\alpha)\,(\rho y_{t-1}+v_t)}{\varphi+k\alpha}\right]^2 \quad (22)$$

[5]This version of the IS-LM model also coincides with Romer's (2000) view.

Optimising this expected loss function with respect to money supply, applying expectation and simplifying yields the optimum value of money supply that central bank would target under price-level targeting to minimise the social loss function. The result is as follows.

$$(m_t - p_t) = \frac{(\varphi+k\alpha)\rho y_{t-1}-\varphi(a+\alpha\pi^*)}{\alpha} \quad \dots \quad \dots \quad \dots \quad \dots \quad (23)$$

This money supply rule is exactly the same as under inflation targeting (see Equation 16). Substituting this expression into the aggregate output Equation (20) and solving it jointly with aggregate supply Equation (3) for equilibrium price level and equilibrium output yields the following results under price-level targeting.

$$p_t = p_t^* + \frac{\varphi\varepsilon_t - \alpha\eta_t-(\varphi+k\alpha)v_t}{\varphi(\alpha+\gamma)+\gamma k\alpha}; \quad \dots \quad \dots \quad \dots \quad \dots \quad (24a)$$

$$y_t = \rho y_{t-1} + \frac{\gamma(\varphi\varepsilon_t-\alpha\eta_t)+\alpha\varphi v_t}{\varphi(\alpha+\gamma)+\gamma k\alpha}. \quad \dots \quad \dots \quad \dots \quad \dots \quad (25a)$$

Contrary to inflation targeting, output is not independent of aggregate supply shock under price-level targeting. It is increasing in supply shock because a positive supply shock lowers current price level which creates an excess supply of money resulting in decline of interest rate. This decline finally causes aggregate output to rise. It is also increasing in case of demand side shock if goods-market shock is greater than money-market shock. Under price-level targeting, the optimal rule is to let price-level respond only to the new information (the demand and supply shocks); thus, inflation rate depends on the first differences of the shocks. It can be described as

$$\pi_t = \pi_t^* + \frac{\varphi(\varepsilon_t-\varepsilon_{t-1})-\alpha(\eta_t-\eta_{t-1})-(\varphi+k\alpha)(v_t-v_{t-1})}{\varphi(\alpha+\gamma)+\gamma k\alpha}. \quad \dots \quad \dots \quad (26a)$$

The equilibrium values for output, price level and inflation rate under Svensson's illustration ($\varphi = 0, k = 1$) are as follow.

$$p_t = p_t^e - \frac{1}{\gamma}(\eta_t + v_t), \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (24b)$$

$$y_t = \rho y_{t-1} - \eta_t, \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (25b)$$

$$\pi_t = \pi^* - \frac{1}{\gamma}[(\eta_t - \eta_{t-1}) + (v_t - v_{t-1})] \quad \dots \quad \dots \quad \dots \quad (26b)$$

It can be seen that equilibrium values for output, price level and inflation rate in Svensson's setup under price-level targeting are the same as under inflation targeting except variance of inflation rate which is twice the variance of price level. Therefore, variance of output would remain the same under both the targeting regimes as was the result in Svensson's (1999) model. Variations in price level and inflation rate depend on the slope of aggregate supply curve, γ, and not on the slope of demand curve, α. Under price-level targeting, the future

price-level is no longer a random walk with drift but trend stationary with finite variance around the trend. It is because price-level targeting has the advantage of reduced long-term variability of the price level; in order to stabilise price level under price-level targeting, higher than average inflation rate is followed by lower than average inflation rate. The most important feature of the results is that these are not subject to any 'stability condition' and these results hold without any restrictive assumptions. Besides, the simple results of AS-IS-LM framework can empirically be tested with ease and are interpretable and applicable to the central bank policies.

The equilibrium values of output, price level and inflation rate under price-level targeting when central bank pegs interest rate as a policy tool ($\varphi \to \infty, k < \infty$) varies from those obtained under inflation targeting. These values are as follows.

$$p_t = p_t^* + \frac{\varepsilon_t - v_t}{\alpha+\gamma}. \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (24c)$$

$$y_t = \rho y_{t-1} + \frac{\gamma\varepsilon_t + \alpha v_t}{\alpha+\gamma}. \quad \dots \quad \dots \quad \dots \quad \dots \quad \dots \quad (25c)$$

$$\pi_t = \pi^* + \frac{(\varepsilon_t - \varepsilon_{t-1}) - (\upsilon_t - \upsilon_{t-1})}{\alpha+\gamma}. \quad \dots \quad \dots \quad \dots \quad \dots \quad (26c)$$

Both the price level and output are increasing in aggregate demand shock while price level is decreasing and output is increasing in aggregate supply shock. When central bank targets price level, a positive supply shock that lowers the current price level increases future inflation rate. This increase lowers real interest rate (as central bank pegs nominal interest rate) and hence raises aggregate output. Cover and Pecorino (2005) asserted that it is this interest-led stability channel that causes price-level targeting to be superior to inflation targeting. Under price-level targeting, inflation would depend on the first difference of the demand and supply shocks.

4. COMPARISON OF INFLATION AND PRICE-LEVEL TARGETING

Given the above results, it is now possible to make a comparison between the two targeting regimes under alternative assumptions with regard to monetary policy instruments. The three cases considered are a) general AS-IS-LM framework with negative interest elasticity and positive income elasticity of money demand ($\varphi > 0, k > 0$), b) Svensson's (1999) case of money supply being used as a policy instrument as presented in AS-IS-LM model, where LM Schedule is vertical: ($\varphi \to 0, k \to 1$) and c) Cover and Pecorino's (2005) case of interest rate being used as a policy instrument, where LM schedule is horizontal: ($\varphi \to \infty, k < \infty$). The three cases can also be referred to as the liquidity preference framework, quantity theory of money framework and endogenous

money supply framework respectively. For all the three cases the variances of output, price level and inflation rate around their respective target values are derived both under the inflation targeting and price-level targeting regimes. The results are reported in Table 1.

Table 1

Variances of Output, Inflation rate and Price level under Inflation Targeting and Price-level Targeting

		Money-Supply Control as Policy Instrument		Interest-Rate Control as Policy Instrument
		Liquidity Preference Framework ($\varphi > 0, k > 0$)	Quantity Theory of Money† ($\varphi \to 0, k \to 1$)	Endogenous Money Hypothesis†† ($\varphi \to \infty, k < \infty$)
INFLATION TARGETING	$Var(y_t)$	$\frac{\varphi^2\sigma_\varepsilon^2 + \alpha^2\sigma_\eta^2}{(\varphi + k\alpha)^2} + \sigma_\upsilon^2$	$\sigma_\eta^2 + \sigma_\upsilon^2$	$\sigma_\varepsilon^2 + \sigma_\upsilon^2$
	$Var(\pi_t)$	$\frac{1}{\gamma^2}\left(\frac{\varphi^2\sigma_\varepsilon^2 + \alpha^2\sigma_\eta^2}{(\varphi + k\alpha)^2} + \sigma_\upsilon^2\right)$	$\frac{\sigma_\eta^2 + \sigma_\upsilon^2}{\gamma^2}$	$\frac{\sigma_\varepsilon^2 + \sigma_\upsilon^2}{\gamma^2}$
	$Var(p_t)$	$\frac{1}{\gamma^2}\left(\frac{\varphi^2\sigma_\varepsilon^2 + \alpha^2\sigma_\eta^2}{(\varphi + k\alpha)^2} + \sigma_\upsilon^2\right)$	$\frac{\sigma_\eta^2 + \sigma_\upsilon^2}{\gamma^2}$	$\frac{\sigma_\varepsilon^2 + \sigma_\upsilon^2}{\gamma^2}$
PRICE-LEVEL TARGETING	$Var(y_t)$	$\frac{\gamma^2(\varphi^2\sigma_\varepsilon^2 + \alpha^2\sigma_\eta^2) + \alpha^2\varphi^2\sigma_\upsilon^2}{[\varphi(\alpha+\gamma) + \gamma k\alpha]^2}$	$\sigma_\eta^2 + \sigma_\upsilon^2$	$\frac{\gamma^2(\sigma_\varepsilon^2 + \sigma_\upsilon^2)}{(\alpha+\gamma)^2}$
	$Var(\pi_t)$	$\frac{2[\varphi^2\sigma_\varepsilon^2 + \alpha^2\sigma_\eta^2 + (\varphi + k\alpha)^2\sigma_\upsilon^2]}{[\varphi(\alpha+\gamma) + \gamma k\alpha]^2}$	$\frac{2(\sigma_\eta^2 + \sigma_\upsilon^2)}{\gamma^2}$	$\frac{2(\sigma_\varepsilon^2 + \sigma_\upsilon^2)}{(\alpha+\gamma)^2}$
	$Var(p_t)$	$\frac{\varphi^2\sigma_\varepsilon^2 + \alpha^2\sigma_\eta^2 + (\varphi + k\alpha)^2\sigma_\upsilon^2}{[\varphi(\alpha+\gamma) + \gamma k\alpha]^2}$	$\frac{\sigma_\eta^2 + \sigma_\upsilon^2}{\gamma^2}$	$\frac{\sigma_\varepsilon^2 + \sigma_\upsilon^2}{(\alpha+\gamma)^2}$

Note: All variances are measured with deviation from target values.
† Svensson's (1999) model illustrated in AS-IS-LM framework
†† Cover and Pecorino (2005) results

As can be seen from the table, inflation targeting excludes any concern with output stabilisation in face of supply-side shocks and the supply-side shocks have one-to-one effect on output variance. The results for variances under liquidity preference framework show that the two demand side shocks, that is, the IS and LM shocks (ε_t and η_t) have independent and different effect on variances of output, price level and inflation rate. Contrary to Svensson's results, this model shows that variances of output and price level are not all the same under the two targeting regimes and variance of inflation rate is twice the variance of price level under price-level targeting.

Under the assumption of Quantity Theory of Money, our results partially support Svensson's results as output variance remains the same under the two targeting regimes but inflation variance is not lower (rather higher) under price-level targeting than under inflation targeting. So, the 'free-lunch' does not seem to hold; rather the result partially supports conventional wisdom where it is

believed that price-level targeting brings lower price variability at the cost of higher inflation variability. Svensson (1999) found a 'free lunch' in price-level targeting in the sense that output variance remains the same with less variability in inflation rate under price level targeting. On the contrary, our results imply a 'free lunch' in inflation targeting in the sense that variance of output and price level remains same with lower inflation variability under inflation targeting. This result is further supplemented by the observation that inflation targeting has the advantage of being easily understood by public and the resulting transparency increases the probability of promoting low inflation expectations, which helps controlling price level and producing a desirable inflation outcome [King (2004)].

Under the assumption of endogenous money hypothesis, variances of output and price level are lower under price-level targeting than under inflation targeting. It is because changes in the price level, under price-level targeting, change inflation expectations in the opposite direction which causes aggregate demand to change in such a way as to stabilise the economy (Cover and Pecorino 2005). This stabilisation effect works through interest elasticity of aggregate expenditure, α. If α becomes zero, price-level targeting would produce exactly the same results as inflation targeting. Under endogenous money hypothesis, variance of inflation rate can be lower under price-level targeting than under inflation targeting if α becomes sufficiently large such that the stability effect produce under price-level targeting becomes large enough to lower the variance of inflation rate as well.

4.1. Calibrating the Models' Results

The standard approach to judge how well the model fits the data is calibration, attributed to Kydland and Prescott (1982). Calibration is taking parameters that have been estimated for a similar model into one's own model, and solving one's own model numerically. Romer (2002) discussed two potential advantages of calibration over estimating models econometrically. First, since parameter values are selected from the actual data, a large body of information beyond that usually employed can be brought to bear, and the models can therefore be held to a higher standard. Second, the economic importance of a statistical rejection of a model is often hard to interpret.

For calibrating the models' results for Pakistan, we resort to the existing literature. Specifically, we take parameter estimates from the most recent available study, i.e., Khan and Muslehuddin (2011). The model presented in this study consists of twenty-four equations of which thirteen are behavioural equations and the rest are identities. The two step Engle-Granger cointegration technique is used to derive short run and long run elasticities of the variables. The model captures the nexus between output, aggregate demand, foreign trade, money and prices, and can be used to examine the effects of domestic and

external shocks to the economy. The estimates of the required parameters for Pakistan are presented in Table 2.

Table 2

Estimates of Parameters for Pakistan

Parameters	Short Run	Long-Run
α	0.09	0.007
φ	0.01	0.02
k	0.8	1.27
γ	0.18	0.53
σ_ε	0.06	0.09
σ_η	0.04	0.07
σ_v	0.02	0.03

Source: Khan and Muslehuddin (2011).

Following Khan and Muslehuddin's (2011) empirical findings for Pakistan, the results for variance of the output from its full–information level, variance of inflation rate and variance of price-level about target value under both the targeting regimes are presented in Table 3.

Table 3

Results of Calibration for Pakistan

		Money-Supply				Interest-Rate	
		Liquidity Preference Framework		Quantity Theory of Money		Endogenous Money Hypothesis	
Policy Instrument		Short Run	Long Run	Short Run	Long Run	Short Run	Long Run
Inflation Targeting	$Var(y_t)$	0.0024	0.0051	0.002	0.0058	0.004	0.009
	$Var(\pi_t)$	0.0735	0.0181	0.0617	0.0206	0.1235	0.0320
	$Var(p_t)$	0.0735	0.0181	0.0617	0.0206	0.1235	0.0320
Price-Level Targeting	$Var(y_t)$	0.0018	0.0041	0.002	0.0058	0.0790	0.0320
	$Var(\pi_t)$	0.1306	0.0354	0.1234	0.0413	4.8773	0.2280
	$Var(p_t)$	0.0653	0.0178	0.0617	0.0206	2.4386	0.1140

Assuming no restrictions on parameters (general liquidity preference framework) the results show that lower variance of output under price-level targeting partially negates the conventional wisdom, which states that price-level targeting results in a higher output and inflation variances. On the other hand, under price-level targeting, the variance of inflation rate is high both in short run and long run (in all models), which partially supports the conventional wisdom (as stated above). From the QTM model results, it can be stated that price-level targeting does not result in lower inflation variability; hence, monetary authority

in Pakistan cannot enjoy 'free lunch' by targeting price level. Higher variance of price level under price-level targeting than under inflation targeting when central bank uses interest rate as a policy instrument indicates the problem of price-level indeterminacy in case of Pakistan. The lower instability of inflation rate and output level under inflation targeting when central bank uses interest rate as policy instrument supports the proposition of Sargent and Wallace (1975) whereby the targets for inflation rate and nominal interest rate cannot be chosen independently. The results clearly indicate that in case of controlling interest rate as a policy instrument, the central bank of Pakistan should not target price level as it would lead to higher instability of both inflation rate and output level. The results further points towards inadequacy of using interest rate, rather than money supply, as a policy instrument both under the inflation and price level targeting regimes. This obviously means that the practice of interest rate pegging currently being followed by the State Bank of Pakistan needs reconsideration.

5. CONCLUSIONS

This paper overviewed different monetary policy rules in general where as inflation targeting and price-level targeting are compared in particular by using AS-IS-LM framework under alternative monetary policy tools set by central bank. The results with money as policy instrument are quite different from those derived assuming interest rate as policy instrument. If interest elasticity of money demand is non-zero, the money market and goods market shocks independently affect variances of output, price level and inflation rate. Under inflation targeting, output variance is vulnerable to any supply side shock and these shocks have one-to-one effect whether central bank uses money or interest rate as a policy instrument. When central bank pegs money supply as a policy instrument, variances of output, price level and inflation rate become independent of goods market demand shock under zero interest-elasticity of money demand. On the contrary, it is the money market shock that has no impact on variances of the said variables when central bank pegs interest rate as a policy instrument.

In the previous literature, it has been recognised that price-level targeting generates more variability of the output and inflation gap. Later on, Svensson (1999) demonstrated that inflation variability is lower under price-level targeting than under inflation targeting with the same output variance under the two targeting regimes; hence, providing a free lunch to monetary authority. Our results, contrary to Svensson, show that assuming zero interest elasticity of money demand with money-supply pegging as a monetary tool, inflation targeting results in lower variability of inflation rate with the same output and price level variances. Here, there is no free lunch under the price-level targeting regime as shown by Svensson. Furthermore, if interest rate is used as a policy instrument, price level targeting outperforms inflation targeting as it results in

less variability in output and price level and possibly in lower variance of inflation rate provided that the interest sensitivity of aggregate expenditure is sufficiently high because the built-in-stability effect of price-level targeting works through interest-elasticity channel.

The results of calibration for Pakistan show that price-level targeting relative to inflation targeting results in more variation in output level and inflation rate when central bank uses interest rate as a policy tool. The results further points towards inadequacy of using interest rate, rather than money supply, as a policy instrument both under the inflation and price level targeting regimes. The results suggest that the State Bank of Pakistan cannot effectively control inflation through tight monetary policy as low interest elasticity of demand does not transmit effectively this demand shock into the economy. Besides, the increased interest rate may also result in high cost of borrowing on government expenditure which further reduces aggregate expenditure causing the widening of demand-supply gap. Empirical results of svensson's model for Pakistan show that monetary authority cannot enjoy 'free-lunch' if it targets price-level as this does not result in lower inflation variance with the same output variance.

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