Price Level vs. Nominal Income Targeting and the Cost Channel of Monetary Policy Transmission

Hamza Ali Malik
Department of Economics
955 Oliver Road
Lakehead University
Thunder Bay, Ontario, P7B 5E1
Canada
hamza.malik@lakeheadu.ca
Phone: (807) 343-8638
Price Level vs. Nominal Income Targeting and the Cost Channel of Monetary Policy Transmission

Abstract

This paper incorporates both the traditional aggregate demand-interest rate channel and the cost channel of monetary policy in a baseline ‘new Keynesian’ model and study two targeting regimes --- price-level targeting and nominal income targeting. In light of empirical considerations, alternative specifications for the aggregate demand side of the economy and for the aggregate supply side of the economy are also considered. The main result is that the cost channel matters; with the cost channel operating the volatility of real output increases under both price-level and nominal income targeting. The paper also finds that nominal income targeting performs better than price level targeting in bringing down the volatility of real output in almost all the specifications of the macro models used in the analysis.

JEL Classification: E30, E32, E52

Keywords: the cost channel, price level targeting, nominal income targeting
1- Introduction

While there is broad understanding regarding the overall monetary policy strategy that central banks should primarily focus on policies that promote price stability in the economy and that a rule-based monetary policy is superior to discretion-based monetary policy actions, the channels through which monetary policy affects the real economy are not completely understood. The traditional interest rate channel operates by affecting the spending decisions of households and firms and thus works through the aggregate demand side of the model. An alternative view, often termed as the bank lending channel (or the cost channel), operates by affecting the cost of production of firms and thus the aggregate supply. Most of the literature has, so far, concentrated mainly on the traditional channel of monetary policy while assessing alternative targeting regimes. However, several researchers such as Christiano and Eichenbaum (1992), Christiano, Eichenbaum and Evans (1997) and Barth and Ramey (2001) have emphasized the cost channel as a powerful collaborator in the transmission of short run effects of monetary policy. By analyzing both the traditional and the cost channel of monetary policy in one unified framework, this paper is an attempt to bridge the gap between these two strands of literature.

Distinguishing the relative importance of the traditional and the cost channel is useful for various reasons. First, it improves our understanding of the link between the financial and real sectors of the economy. Second, it provides alternative indicators to help gauge the stance of monetary policy and thus increases its ability to offset particular types of adverse shocks. Third, a clear understanding of the transmission mechanism has the potential to give more information regarding the choice of intermediate targets. Informed by these observations, especially the last one, the objective of this paper is to assess the robustness of policy recommendations for a closed economy in the presence of the cost channel of monetary policy. In particular, I study two interest rate based monetary policy rules --- price-level targeting and nominal income targeting in a ‘new Keynesian model’ that incorporate both the traditional interest rate channel and the cost channel of monetary policy transmission mechanism.

\[1\] For a detailed discussion see Kashyap and Stein (1994)
The highlighting features of the model(s) used in this paper are as follows. First, a continuous-time modeling approach is used instead of the more conventional discrete-time approach. Apart from the advantage in terms of analytical simplicity, continuous-time models avoid the unappealing problems regarding the model properties being dependent on small changes in assumptions concerning information availability. I explain this point further while explaining the structure of the model below. Second, rather than deriving the optimal policy this paper makes use of the Taylor-type interest rate based monetary policy rules which have become quite popular in policy circles in recent years. More specifically, two such rules --- price-level targeting and nominal income targeting are used in a continuous-time version of the ‘new Keynesian model’ that incorporate both the traditional interest rate channel and the cost channel of monetary policy transmission mechanism. Third, the paper also studies alternative specifications for the aggregate demand side of the economy --- the IS-type relationship and for the aggregate supply side of the economy --- a Phillips curve type relationship that has been proposed recently in the literature in light of empirical considerations. Since the results in favour of or against a price level target are very model specific, especially regarding the specification of the Phillips curve, therefore, this consideration adds robustness in assessing the role of the cost channel. Fourth, instead of the nominal interest rate, the real interest rate appears in the Phillips curve relationships to represent the cost channel.\footnote{In a recent paper Walsh and Ravenna (2004) assumed that firms needed to pay the hired workers before the receipt of the sales revenues. For this purpose, they borrowed from banks at the nominal interest rate \( i \). Thus, there was a payment lag involved and the relevant ‘cost of borrowing’ was represented by the nominal interest rate. On the other hand, following the assumption employed by Mitchell (1984) and Myatt (1985), in this paper I assume that firms borrow from banks to pay for the wage-bill before the production process begins. Thus, there is a production lag involved here and the relevant ‘cost of borrowing’ is represented by the real interest rate.} Fifth, it is assumed that the two targeting regimes generate the same outcome regarding long-term inflation. Thus, the criterion for evaluating the performance of a monetary regime is its ability to minimize the volatility in real output in response to aggregate demand shocks.

The main result of the paper is that the cost channel matters in the sense that the volatility of real output increases under both price-level and nominal income targeting when the cost channel is included in the model(s). However, the inclusion of the cost channel does not say much on the choice between the
two regimes. It appears that nominal income targeting performs better than price-level targeting in bringing down the volatility of real output in almost all the specifications of the macro models used in the analysis regardless of the cost channel.

1.1- Comparison of Price-level Targeting and Nominal Income Targeting

Although price-level targeting is quite similar to inflation targeting and it shares many of its benefits, the two regimes have a fundamental difference. If there is an unexpected increase in prices then according to price level targeting the monetary authority will attempt to tighten monetary policy so as to restore the price level back to the target in order to prevent the base drift in the price level. Under inflation targeting no action will be taken and the new level of prices would be maintained. Thus, price-level targeting offers the potential benefit of delivering greater certainty of the level of prices through time and may provide greater prospects for maintaining price stability in the longer run than under an inflation targeting regime. However, short-term price volatility (and thus output volatility) may be higher under price-level targeting because unexpected rises in the price level will be followed by attempted reductions in the price level.

The conventional literature (e.g., Fischer (1994) and Haldane and Salmon (1995)) focus on this alleged increased output-gap volatility under price-level targeting to argue against it. Kiley (1998) has also reached a similar conclusion using a new Keynesian Phillips curve. However, Dittmar, Gavin and Kydland (1999) and Svensson (1999) have challenged this conventional wisdom and, employing a neo-classical Phillips curve, shown the price-level targeting to be preferred over inflation targeting. Svensson (1999) finds that price-level targeting results not only in lower variability in the price-level but also delivers lower inflation variability in the presence of output persistence. More recently, Dittmar and Gavin (2000) and Vestin (2003) have confirmed this result using the new Keynesian Phillips curve by demonstrating that price-level targeting provides a better inflation-output-gap variability trade-off compared to inflation targeting with discretionary policy making regardless of the degree of importance of past levels of output for current output. Thus, the debate over the relative benefits of price-level
targeting is far from being settled. As Mishkin (2000) has correctly pointed out, the results in favour of or against a price level target are very model specific, especially regarding the specification of the Phillips curve. In particular, the assumptions about private sector’s inflation expectations entering the Phillips curve, amount of persistence in the output gap and whether policy is conducted under a commitment rule or in a discretionary fashion play important roles in determining the desirability of price level targeting. In this paper, I add one more consideration; namely, the cost channel of monetary transmission.

Nominal income targeting is another desirable strategy for monetary policy as it shares many positive features of inflation targeting. But, the most attractive feature of nominal income targeting is that it is closely related to both real output and prices --- the two variables that central bank seem to care about most. In addition, nominal income targeting allows the monetary policy to adjust to offset disturbances to both aggregate demand and aggregate supply. For example, in case of an adverse demand shock (that would cause both real output and prices to go below target), policymakers would ease monetary policy that would return nominal income (the product of real income and prices) to target. Similarly, an adverse supply shock results in falling real output and rising price levels. This could pose a dilemma if central bank is pursuing price level targeting. Stabilizing the price level would mean further decline in real output. Nominal income targeting would help policy makers resolve the dilemma as it places equal emphasis on stability of both real output and price level.

Recently, several contributions in the literature have been made that study the stability properties of the nominal income-targeting regime. Two key papers in this regard are Ball (1999) and McCallum (1997). Using a backward looking macro model, Ball (1999) has forcefully argued that nominal income targets are not merely inefficient, but also disastrous: they imply that output and inflation have infinite variances. Svensson (1997) replicates Ball’s instability result and suggest that it is the stylized fact that policy affects real output before inflation which Ball builds into his model that lies at the heart of the instability.

---

3 For an in-depth analysis of the conditions under which price level targeting would be preferred over inflation targeting see Barnett and Engineer (2000).

4 The case in favour of nominal income targeting has been well documented in Hall and Mankiw (1994).

5 The paper first came out in 1997 as a working paper of Reserve Bank of New Zealand, G-97/3.
instability result. Challenging the negative assessment of nominal income targeting, McCallum (1997) has shown that Ball’s instability result is not robust; it critically depends on the specification of the Phillips curve relationship. Using a forward-looking model McCallum demonstrates that nominal income targeting does not generate instability. Using a Phillips curve with mixed expectations, Dennis (2001) has shown that nominal income targeting will not generate instability as long as inflation expectations contain some forward-looking component. More recently Rudebusch (2002), however, has shown that nominal income targeting performs poorly after taking into account of the range of model and data uncertainty that policy makers face.

It is evident from the above discussion that the case for or against price level targeting and nominal income targeting relies critically on how inflation expectations are formed in the Phillips curve or more generally on the specification of the model. For this reason, I evaluate the performance of price-level targeting and nominal income targeting in a series of macroeconomic models with different specifications for the IS relationship and Phillips curve relationship. In addition, I also explore the implications of adding the supply side effects --- the cost channel --- of interest rates to each specification. It has been argued in the literature that such effects can be significant in evaluating the performance of monetary policy (e.g., Myatt and Scarth (2003)). These considerations provide an additional and comprehensive contribution to the ongoing debate between choosing an appropriate targeting regime. Thus, the analysis not only allows for a direct comparison between price-level and nominal income targeting in a range of macroeconomic models, but also highlights the importance of the transmission mechanism of monetary policy.

2- The Baseline Continuous-time ‘new Keynesian’ Model

The model is defined by equations (1) through (4). These equations define (respectively) the “new” IS relationship (aggregate demand), the “new” Phillips curve (aggregate supply), monetary policy, and

---

\[\text{Equations (1) through (4).}\]

---

6 The issue of the importance of Phillips curve or the supply side of the economy for the performance of nominal income targeting is not new; it has been previously highlighted by Bean (1983) and West (1986).
and the exogenous cycle in autonomous spending. The definition of variables and a more detailed description of the structure are given following the equations.

\[ \dot{y} = \alpha (r - \bar{r}) + \beta \dot{a} \]  
\[ \dot{p} = -\lambda (y - \bar{y}) + \psi (a - \bar{a}) - \kappa (r - \bar{r}) \]  
\[ p + \mu y = 0 \]  
\[ a = \bar{a} + \delta \sin(t) \]

All variables except the interest rate \( r \) and the time index \( t \) are the natural logarithms of the associated variable. Dots and bars above a variable denote (respectively) the time derivative, and the full-equilibrium value of that variable. All coefficients (the Greek letters) are positive. The variables are: \( a \) – autonomous spending, \( p \) – the general price level, \( r \) – the real interest rate, and \( y \) – the level of real output.

Before discussing each equation in turn, I discuss the continuous-time specification. Discrete-time specifications are more common, but following this practice can involve model properties being dramatically dependent on small changes in assumptions concerning information availability. For example, consider the original “policy relevance” paper by Sargent and Wallace (1976). The central conclusion in this study does not emerge if it is assumed that the information available to agents when deciding how much to spend is the same as what is now usually assumed (that is, when the assumption involved in McCallum and Nelson (1999) is invoked). Also, if the McCallum and Nelson analysis (p. 309) is reworked with the information-availability assumption used by Sargent and Wallace, the entire undetermined coefficients solution procedure breaks down (with restrictions on structural, not reduced form, coefficients being called for).\(^7\) A continuous-time specification precludes such unappealing problems from developing.

Equation (1) is the “new” IS relationship which states that the rate of change of real output depends positively on the real interest rate and on the rate of change of autonomous spending. The motivation for such a relationship can be appreciated by referring to a dynamic general equilibrium macro

\(^7\) See, Lam and Scarth (2002).
model with optimizing economic agents. I start with a log-linear approximation of the economy’s resource constraint: \( y = \alpha c + \beta a \), where ‘\( c \)’ is the log of consumption expenditure, ‘\( a \)’ is the log of the autonomous spending. The parameters ‘\( \alpha \)’ and ‘\( \beta \)’ are the steady-state ratios of household spending and autonomous spending to total real output respectively. The Ramsey model is used to model forward-looking domestic households. If the instantaneous utility function involves separable terms, log consumption and the square of labour supply, the first-order conditions are \( \dot{c} = r - \bar{r} \), and (ignoring constants) \( n = w - p - c \). ‘\( n \)’ and ‘\( w \)’ denote the log of employment and the nominal wage. Equation (1) follows by taking the time derivative of the resource constraint and substituting in the Euler equation for consumption.\(^8\) The labour supply function is used below.

Equation (2) is the “new” Phillips curve that relates the rate of change of inflation to the output gap, autonomous-spending gap and the real rate of interest gap. This relationship essentially captures the supply side of the economy and can be derived by incorporating nominal price rigidities using Calvo’s (1983) model of sluggish price adjustment and imperfect competition a la Dixit and Stiglitz (1977) in a dynamic general equilibrium macro model. Many authors have shown that if we assume that firms minimize the undiscounted present value of the squared deviations between the log of marginal cost (\( mc \)) and price (\( p \)), optimal behaviour at the individual firm level leads to \( \ddot{p} = -[(1 - \tau) / \tau](mc - p) \) at the aggregate level. (1 - \( \tau \)) is the fraction of firms that can change prices at each point in time. To represent this price-adjustment process in a format that resembles the traditional Phillips curve, I follow King (2000) and replace real marginal cost with the output gap (and any other term that emerges as relevant given that I have autonomous spending and supply-side effects of interest rate in the model). In order to incorporate the cost channel I assume that firms borrow from banks to pay for the wage-bill before the production process begins. Thus, there is a production lag involved here and the relevant ‘cost of borrowing’ is represented by the real interest rate \( r \). This assumption allows me to explicitly analyze the supply-side effects (the cost channel) of monetary policy. The cost channel makes firms’ marginal costs

---

\(^8\) For detailed derivation and discussion, see Clarida, Gali and Gertler (1999), McCallum and Nelson (1999), and Walsh (2003)
depend directly on the rate of interest. I assume a standard Cobb-Douglas production function of the form \( Y = N^\theta \). Thus, in log terms, \( y = \theta n \) and the marginal product of labour, \( MPL \), equals \( \theta Y/N \). Now, the marginal cost is defined as \( MC = W(1 + r)/MPL \); we can (ignoring constants) approximate the log of real marginal cost by \( mc - p = w - p + r - y + n \). Equation (2) is then derived in three more steps. Use the labour supply function, the production function and the resource constraint to eliminate \( (w - p) \), \( n \) and \( c \) by substitution; define units so that, in full equilibrium, all prices are unity (so that \( mC - \bar{p} = 0 \)); and substitute out the deviation of real marginal cost from its full-equilibrium value. The coefficients in (2) have the following interpretations: \( \lambda = (1 - \tau)^2 ((2/\theta) + (1/\alpha) - 1)/\tau \), \( \psi = (1 - \tau)^2 \beta / \alpha \tau \), and \( \gamma = (1 - \tau)^2 / \tau \). Thus parameters \( \lambda \), \( \gamma \) and \( \psi \) are functions of “deep” parameters like the fraction of firms adjusting their prices, labour’s exponent in the production function and \( \alpha \) and \( \beta \). The parameter \( \kappa \) is introduced to capture the cost channel of monetary transmission. By setting \( \kappa = 0 \), I can close this channel.

Equation (3) defines monetary policy and encompasses both price-level targeting, \( \mu = 0 \) and nominal income targeting, \( \mu = 1 \). Equation (4) depicts the anticipated ongoing cycles in exogenous spending defined by the sine curve. Since the focus of the paper is on the role of the cost channel in affecting the volatility of output under alternative monetary policy regimes, the simplest way to introduce fluctuations in output is to assume that these are caused by exogenous variations in the autonomous spending.

Before analysing the model and discussing the results I briefly talk about the parameter values that are used in calibrating the model(s) below. Consumption is 80% of the total output, that is, \( \alpha = 0.8 \).

---

9 A more general monetary policy rule would take the form: \( i = \bar{i} + \Omega(p + \mu \nu - 0) \). According to this rule, the central bank adjusts the nominal interest rate above its steady-state value whenever either the price level is above its target (assumed to be zero, with \( \mu = 0 \)), or the nominal income is above its target (also assumed to be zero, with \( \mu = 1 \)). With this rule we can consider various degrees of ‘leaning against the wind’ in both cases. For example, \( \Omega = 1 \) depicts the case when the central bank conducts monetary policy in a ‘modest’ manner. On the other hand, \( \Omega \) approaching infinity would give us equation (3) of the paper where central bank responds in an ‘aggressive’ manner. For ease of exposition, I have only reported the results for the latter case.
This implies that $\beta = 0.2$. The other summary coefficients for the baseline Phillips curve relationship can be calculated by referring to the corresponding values of the ‘deep’ parameters. For example, if labour’s exponent in the Cobb-Douglas production function is two-thirds ($\theta = 0.67$) and the fraction of firms that are able to adjust their prices once a year is approximately one-fourth ($1 - \tau = 0.27$), then $\lambda = 0.33$, $\psi = 0.03$ and $\gamma = 0.10$. The parameter $\delta$ in equation (4) is taken as 1.

3- Analysis

In this section I derive the reduced form for real output to see how the cost channel affects the amplitude of the cycle in $y$, and to see the relative performance of price-level and nominal income targeting in this context. I explain this derivation in the baseline case only. The reader can use similar steps to verify the results that I report for other cases in the following sections.

First, take second time derivative of equation (3) and use the result to eliminate $\ddot{p}$ in equation 2. Also, use equation (1) to eliminate $r - \bar{r}$ from equation 2. The result is:

$$- \mu \ddot{y} = -\lambda(y - \bar{y}) + \psi(a - \bar{a}) - (\kappa \gamma / \alpha) \dot{y} + (\kappa \gamma \beta / \alpha) \dot{a}$$

Using the undetermined coefficient solution procedure as described in Chiang (1984), the solution for output can be written as:

$$y = \bar{y} + B[\cos(t)] + C[\sin(t)]$$

where $B$ and $C$ are arbitrary constants that must be related to the underlying parameters of the model. To solve for $B$ and $C$, first take the time derivatives of (6), $\dot{y} = -B \sin(t) + C \cos(t)$ and $\ddot{y} = -B \cos(t) - C \sin(t)$ along with the time derivative of (4), $\dot{a} = \delta \cos(t)$ and then substitute these results and equation (4) and (6) in equation (5). The resulting coefficient-identifying restrictions are:

---

10 In order to ensure that my results are not dependent on particular values of these parameters, I have considered a range of other parameter values as well. For example, if we assume that the fraction of firms with sticky prices is two-thirds 0.67 rather than 0.73 than the values of all summary parameters change accordingly. In particular, they are: $\lambda = 0.55$, $\psi = 0.05$ and $\gamma = 0.18$. However, the results are not sensitive to these alternative values for various parameters.
\[ B = \frac{\kappa \gamma (\beta \delta - C)}{\alpha (\lambda + \mu)} \] (7)

\[ C = \frac{\alpha^2 \psi (\lambda + \mu) + \beta \delta (\kappa \gamma)^2}{(\kappa \gamma)^2 + \alpha^2 (\lambda + \mu)^2} \] (8)

The amplitude of the cycles in real output that correspond to the ongoing cycles in autonomous spending can be examined by substituting the calibrated expressions for B and C in equation (6).

Note that if \( \kappa = 0 \), that is, if the cost channel is not operating, \( B = 0 \). Thus, only the reduced-form parameter \( C \) represents the amplitude of the cycle in real output. It is straightforward to verify that the amplitude of the cycle in real output decreases as \( \mu \) increases, that is, changes from zero to one. This is the first main result of this paper: In a baseline ‘new Keynesian’ model, nominal income targeting performs better as compared to price-level targeting in terms of reducing the volatility of real output in the face of demand shocks.

To investigate the role of the cost channel, I set \( \kappa = 1 \). The results are reported in table 1.

**Table 1: Output Effects --- Baseline ‘new Keynesian’ Model**

<table>
<thead>
<tr>
<th>Amplitude of ongoing cycle in real output</th>
<th>Cost channel closed (( \kappa = 0 ))</th>
<th>Cost channel operating (( \kappa = 1 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-level targeting (( \mu = 0 ))</td>
<td>0.061</td>
<td>0.123</td>
</tr>
<tr>
<td>Nominal Income targeting (( \mu = 1 ))</td>
<td>0.016</td>
<td>0.036</td>
</tr>
</tbody>
</table>

Looking at table 1, it is clear that the volatility of real output goes up in the presence of cost channel irrespective of the monetary policy regime. This result is consistent with the claims of many empirical papers like Barth and Ramey (2001) that there are important supply side effects of monetary...
policy. In addition, table 1 also demonstrates that nominal income targeting performs better than price-level targeting with or without the cost channel. Thus, we have our second result: In a baseline ‘new Keynesian’ model with the cost channel the volatility of real output is larger than in a baseline ‘new Keynesian” model without the cost channel. However, nominal income targeting still performs better in terms of reducing the volatility of real output.

The intuition for this is simple. In response to an autonomous ongoing demand cycle, the central bank adjusts the nominal interest rate to manipulate the aggregate demand (and thus the aggregate price level) in order to keep resulting output volatility at a minimum. In the presence of the cost channel, however, adjustments in the real interest rate directly affect the aggregate supply side of the model as well; thereby increasing output volatility. As a result, with price-level targeting, the central bank would have to manipulate the aggregate demand by a large magnitude that would ensure the achievement of the original level of prices at the cost of an increased volatility in output. On the other hand, with nominal income targeting it would adjust aggregate demand just enough to reach a targeted level of nominal income with slightly higher level of prices but a lower volatility in output. Since the metric used to evaluate the performance of a targeting regime is the minimization of real output volatility, nominal income targeting is preferred to price-level targeting.

4- Extension I: Alternative Specifications of the Phillips Curve

It has been pointed out by many researchers that ‘the new Keynesian Phillips curve’ based on Calvo’s (1983) sticky price model generates inertia in the price level and not the inflation rate and that this is inconsistent with stylized facts on inflation dynamics. The empirical evidence (for example, Nelson (1998)) indicates that inflation responds sluggishly to economic shocks. The ‘new Keynesian Phillips curve’ implies that inflation is determined by the current output gap and current expectations of future inflation. Inflation is, therefore, very flexible and responds immediately to monetary policy shocks and hence does not accord with stylized facts. In order to capture the inflation persistence found in the data, it
is common to augment the basic forward-looking inflation adjustment equation with the addition of lagged inflation. Fuhrer and Moore (1995) is one such example. Mankiw and Reis (2002) suggest an alternative approach, which departs from the assumption of sticky prices and replaces it with that of sticky information. According to their model of price adjustment firms gather and process the information about the state of the economy slowly over time. Unlike the sticky price model, prices are always changing but firms are slow to update their pricing strategies in response to new information. Empirical research of Gali and Gertler (1999) and Fuhrer (1997) have generally found that when lagged inflation is added to the basic ‘new Keynesian Phillips curve’, its coefficient is statistically and economically significant. Since the debate over the relative benefits of price-level and nominal income targeting rests critically on the specification of the Phillips curve, it is a worthwhile exercise to redo the analysis with these more general specifications for the Phillips curve.

If the weight on the lagged inflation term is assumed to be 0.5, then the Fuhrer and Moore (1995) type Phillips curve can be written as follows:

\[ \ddot{p} = -2\lambda(y - \bar{y}) + 2\varphi(a - \bar{a}) - 2\kappa\gamma(r - \bar{r}) \quad (2a) \]

Following a similar solution procedure as outlined in the previous section I can derive the coefficient-identifying restrictions. The quantitative results for the calibrated version of the model are reported in table 2.

**Table 2: Output Effects: ‘new’ IS relationship with Fuhrer-Moore’s Phillips curve**

<table>
<thead>
<tr>
<th>Amplitude of ongoing cycle in real output</th>
<th>Cost channel closed ($\kappa = 0$)</th>
<th>Cost channel operating ($\kappa = 1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-level targeting ($\mu = 0$)</td>
<td>infinity</td>
<td>0.178</td>
</tr>
<tr>
<td>Nominal Income targeting ($\mu = 1$)</td>
<td>0.021</td>
<td>0.067</td>
</tr>
</tbody>
</table>
It is clear for table 2 that both of our previous results carry over to this more general case. In fact, the cost channel is more potent in effecting the volatility of real output. Another point to note is that volatility of output goes to infinity when the cost channel is not operating. This result can be interpreted as being consistent with the observation made by Barnett and Engineer (2000): “….. price-level targeting is desirable only for a purely forward looking specification of the Phillips curve”.

Mankiw and Reis’ (2002) specification of the supply side of the economy can be described by the following set of equations:

\[
\begin{align*}
\ddot{p} &= \lambda'(y - \bar{y}) - \psi'(a - \bar{a}) + \kappa \dot{r}^* + \dot{p}^* + \eta \ddot{y}^* - \nu \ddot{a}^* + \kappa \dot{r}^* \\
\ddot{p}^* &= \phi(\dot{p} - \dot{p}^*) \\
\ddot{y}^* &= \phi(\dot{y} - \dot{y}^*) \\
\ddot{a}^* &= \phi(\dot{a} - \dot{a}^*) \\
\ddot{\dot{r}}^* &= \phi(\dot{r} - \dot{r}^*)
\end{align*}
\]  

(2b)

The three new parameters '\(\phi\)', '\(\eta\)' and '\(\nu\)' respectively represent the fraction of firms that obtain new information, the coefficient of rate of change of output in the Phillips curve and the coefficient of the rate of change of autonomous expenditure. Khan and Zhu (2002) have estimated the key structural parameters of Mankiw and Reis’ paper. Accordingly, I pick \(\phi\) and \(\eta\) to be 0.25 and 0.37 respectively. Parameter \(\nu\) is assumed to be 0.03.

A similar solution procedure is used to derive the coefficient-identifying restrictions, but I report only the quantitative results for the calibrated version of the model in table 3.
Table 3: Output Effects --- ‘new’ IS relationship with Mankiw - Reis’ Phillips curve

<table>
<thead>
<tr>
<th></th>
<th>Amplitude of ongoing cycle in real output</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cost channel closed ((κ = 0))</td>
</tr>
<tr>
<td>Price-level targeting ((μ = 0))</td>
<td>0.080</td>
</tr>
<tr>
<td>Nominal Income targeting ((μ = 1))</td>
<td>0.072</td>
</tr>
</tbody>
</table>

Once again the volatility of real output increases under both price-level and nominal income targeting when the cost channel is operating. This time the difference between the performance of nominal income targeting regime and price-level targeting regime is more pronounced in the presence of the cost channel; nominal income targeting performs far better in keeping the volatility of output low. Comparing the results of table 2 and 3, a point can be made (with some caution) that it is the structure of the model regarding how the backward looking behaviour is introduced that is important and not just the backward looking behaviour itself.

5- Extension II: Alternative Specification of the IS Relationship

In all the three models discussed above, I have studied various specifications for the Phillips curve relationship combined with the ‘standard’ Ramsey type specification of the aggregate demand relationship or the IS curve. In this section I consider the change in the specification of the aggregate demand relationship and then combine it with the three different specifications of the Phillips curve. This exercise is useful in shedding more light on the robustness of the results derived above. In particular, I introduce a lag output term in the IS function. The motivation for doing this modification is taken from the works of Fuhrer (2000) and Amato and Laubach (2003).
Fuhrer (2000) and Amato and Laubach (2003) have pointed out that the standard Ramsey type Euler Equation for consumption (which gives rise to an IS-type relationship) fails to capture the dynamics of the aggregate output. Fuhrer (2000) allow for habit formation in preferences while maintaining the assumption of optimal consumption choice on the part of consumers. Amato and Laubach (2003), on the other hand, introduce the ‘rule of thumb’ behaviour on the part of a fraction of the household; the remaining fraction of the household is able to optimize their consumption in a usual fashion. Their modification to the standard consumer problem is justified on the grounds that it is costly to reoptimize every period. Both these modifications, introducing habit persistence and incorporating ‘rule of thumb behaviour’, leads to a lagged output gap term with some positive weight in the IS equation. Thus, it can be considered as the ‘hybrid’ version used by Ball (1999) and McCallum (1997).

If the weight on the lagged output term is taken as 0.5, then the ‘hybrid’ IS relationship can be written in continuous time as:

\[ \dot{y} = 2\alpha (r - \bar{r}) + 2\beta \dot{\hat{a}} \]  

(1a)

The quantitative results for the calibrated version of the models that combine this hybrid IS relationship with the three specifications of the Phillips curve discussed above are reported in table 4, 5 and 6.

**Table 4: Output Effects --- ‘hybrid’ IS with ‘new Keynesian’ Phillips curve**

<table>
<thead>
<tr>
<th>Amplitude of ongoing cycle in real output</th>
<th>Cost channel closed ((\kappa = 0))</th>
<th>Cost channel operating ((\kappa = 1))</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-level targeting ((\mu = 0))</td>
<td>0.061</td>
<td>0.226</td>
</tr>
<tr>
<td>Nominal Income targeting ((\mu = 1))</td>
<td>0.015</td>
<td>0.039</td>
</tr>
</tbody>
</table>
Table 5: Output Effects --- ‘hybrid’ IS with Fuhrer-Moore’s Phillips curve

<table>
<thead>
<tr>
<th></th>
<th>Cost channel closed ($\kappa = 0$)</th>
<th>Cost channel operating ($\kappa = 1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-level targeting ($\mu = 0$)</td>
<td>infinity</td>
<td>infinity</td>
</tr>
<tr>
<td>Nominal Income targeting ($\mu = 1$)</td>
<td>0.62</td>
<td>0.606</td>
</tr>
</tbody>
</table>

Table 6: Output Effects --- ‘hybrid’ IS with Mankiw and Reis’ Phillips curve

<table>
<thead>
<tr>
<th></th>
<th>Cost channel closed ($\kappa = 0$)</th>
<th>Cost channel operating ($\kappa = 1$)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Price-level targeting ($\mu = 0$)</td>
<td>0.080</td>
<td>0.111</td>
</tr>
<tr>
<td>Nominal Income targeting ($\mu = 1$)</td>
<td>0.070</td>
<td>0.101</td>
</tr>
</tbody>
</table>

A stark difference between the results reported in table 2 and table 5 is that now the volatility of output is infinite under price level targeting and much higher under nominal income targeting in the presence of the cost channel. Moreover, the performance of nominal income targeting regime is not much different with or without the cost channel. Thus, the initial results do not hold completely when an alternative specification of the IS relationship is considered. This contradicts the claim made by McCallum (1997) that it is only the specification of the Phillips curve that is important: “…replacement of the Ball-Svensson Phillips curve with the mentioned alternative (new Keynesian Phillips curve) results in a model in which both output and inflation are dynamically stable under nominal income targeting whether or not the IS relationship is re-specified”. This point is strengthened even more when results of
table 6 are compared with the results of table 3; the amplitude of output is quite different under price-level targeting in the presence of the cost channel.

6- Concluding Remarks

This paper studied the main developments in the macroeconomic theory regarding the specifications for the aggregate demand and aggregate supply side of the model and the transmission mechanism of monetary policy in the context of two rule-based monetary policy regimes: price-level targeting and nominal income targeting. Comparing the results presented in the series of macroeconomic models indicate that analysing both the traditional and the cost channel of monetary policy in one unified framework has been worthwhile. They confirm the results of earlier theoretical and empirical research on the potency of supply side effects of monetary policy (the cost channel) in effecting the real economy. Moreover, the paper also finds strong support for a case in favour of nominal income targeting when compared with price-level targeting as it keeps the volatility of real output low. There is a growing literature that studies and compares the performance of these targeting regimes and a consensus has not been reached yet. Thus, the results of this paper can be considered as an addition to this debate. An important point in this regard is that the specification of both the demand side and the supply side of the model are crucial while analysing various monetary policy targeting regimes.

However, I agree with McCallum (1997) when he concluded while comparing the performance of inflation targeting and nominal income targeting: “This demonstration does not establish that nominal income targeting is preferable to inflation targeting or to other rules for monetary policy. To reach such a conclusion would require an extensive combination of theoretical and empirical analyses, conducted in a manner that gives due emphasis to the principle of robustness to model specification, plus attention to concerns involving policy transparency and communication with the public”. The point of this paper was not to attempt any such ambitious undertaking. However, the results can be considered as a small step in that direction.
References


