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"The Implications of Information Lags for the Stabilization Bias and Optimal Delegation"

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The Implications of Information Lags for the Stabilization Bias and Optimal Delegation.

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Abstract:

Many papers for example Jensen (2002) and Walsh (2003) have shown that in a New Keynesian model with a significant degree of forward-looking behaviour, policy regimes that target either the change in the output-gap (speed limit targeting) or nominal income growth can considerably reduce the size of the stabilization bias–the inefficiency that arises when a central bank conducts policy under discretion as opposed to commitment. Inflation targeting can also reduce the size of the stabilization bias but unless inflation expectations in the model are predominantly backward-looking, this targeting regime does not perform as well as speed limit or nominal income growth targeting. Jensen (2002) and Walsh (2003) obtain their results using a New Keynesian model where changes in the policy rate affect macroeconomic variables immediately. In this paper, we compare the performance of several targeting regimes by using a New Keynesian model that includes a delayed response of monetary policy as a result of information lags. We find two results that are substantially different from Jensen (2002) and Walsh (2003). First the size of the stabilization bias is considerably reduced. Second, a regime that targets inflation outperforms a regime that targets either the change in the output-gap or the growth in nominal income even when inflation expectations are very forward-looking.

JEL classification: E52, E58, E62

Keywords: Stabilization bias, Inflation Targeting, Discretion, Commitment, Information Lag

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1 Introduction

There is a general consensus among economists that the purely discretionary policy that many central banks adopted during the 1970s contributed to the poor economic performance of that period. During that time, inflation rose dramatically and was very volatile while output and unemployment were unstable. Many economists attribute the rise in inflation in the 1970s to a so-called inflation bias that resulted from central banks being too ambitious in their output and unemployment target. It is well understood now that targeting an output or an unemployment level that exceeds the full employment level is futile since rational expectations agents will realize that this policy will ultimately create inflation. As a result, they will adjust their inflation expectations accordingly. In the end, their expectations become self-fulfilling as such policy ultimately leads to an inflation rate that is above what the central bank intended but an output level that remains at full employment. This is the famous inflation bias result that is forcefully described by Kydland and Prescott (1977) and Barro and Gordon (1983) in their seminal papers.

Compared to the pure discretionary approach that characterized monetary policy in the 1970s that eventually led to the so-called inflation bias, most central banks in OECD countries are now guided by a formal objective that involves achieving a low and stable inflation rate. This is achieved either explicitly through a framework of inflation targets or implicitly through an objective of price stability. Most economists and central bankers agree that the adoption of inflation targeting as a framework has largely improved the performance of monetary policy. Inflation in these countries has declined and has remained low and stable while the volatility of output of output is smaller. Moreover, the conduct of monetary policy has become more transparent and accountable. The transparency of inflation-targeting as a framework has allowed agents to understand better how the central bank reacts to expected economic outcomes.

At the center of the inflation targeting framework is a central bank that is constrained by a commitment to low and stable inflation. This approach to monetary policy avoids the problems associated with unfettered discretion while at the same time does not force the central bank to abide to iron-clad rules that are either impossible to follow or that are likely to be abandoned. As argued by Blinder (1988, p52), "constrained discretion is the new rule" as it allows policy-makers a lot of freedom to respond to shocks and unforseen developments but at the same time forced them to be constrained by a commitment to a given objective.

The literature on rules and discretion has shown that there is another advantage to constrained discretion. It is well-known that even in the absence of an over-ambitious output target and an inflation bias, purely discretionary policies in models with forward-looking agents remain inefficient, since it leads to a stabilization bias.[1] This bias arises under pure discretion because of insufficient inertia in the policy actions of the central bank and usually manifests itself through greater inflation variability and excessive output stabilization. As Clarida, Galì, and Gertler (1999) and Woodford (1999, 2003) show in models in which expectations are important for determining inflation, optimal monetary policy under commitment (the first best outcome) exhibits a considerable degree of inertia whereas policy under pure discretion does not.

An inertial response on the part of the central bank is desirable in models with forward-looking agents since it affects the expectations of agents in a favourable manner and hence result in a better inflation—output-gap trade-off. The reason for this is intuitive; with forward-looking agents, the expected path of policy and expected inflation become more important. As a result, by making the policy response history dependent, the current actions of the central bank can appropriately affect private sector expectations of future inflation. This, in turn, improves the performance of monetary policy and the trade-off the central bank faces. Although optimal, policy under commitment may not be time-consistent. If commitment to an optimal rule is not feasible and policy under pure discretion leads to a large inefficiency, optimal delegation under discretion would be a second best solution.

In two recent papers, using a hybrid version of the New Keynesian model with no uncertainty and where changes in the policy rate affect macroeconomic variables immediately, Jensen (2002) and Walsh (2003) numerically show that a purely discretionary targeting regime leads to a large stabilization bias. More importantly, they show that the inefficiency arising from the purely discretionary can be greatly reduced if either nominal income growth or the change in the output gap is targeted. The latter which has been labelled speed limit targeting by Walsh (2003), can replicate closely the optimal precommitment outcome, in particular when expectations are predominantly forward-looking. A regime that targets inflation can reduce the size of the bias also. However, unless inflation expectations are predominantly backward-looking, it does not perform as well as the two targeting regimes

[1] In their paper, Dennis and Söderström (2002), using various calibrated and estimated closed-economy models find that the stabilization bias can be large and depends on many factors, notably on the lag structure of the model.

advocated by Jensen (2002) and Walsh (2003).

Walsh (2003) argues that a central bank concerned with stabilizing the change in the output gap and inflation is optimal since it introduces the same kind of inertia in its policy actions found under precommitment. In fact, the first-order condition under the timeless commitment outcome is very similar to a policy of speed limit targeting. Nominal income growth targeting also imparts a similar kind of persistence in the policy actions of the central bank, thereby replicating the first-best commitment outcome.[2]

One obvious shortcoming of the conventional New Keynesian framework that is used by Jensen (2002) and Walsh (2003) is the absence of realistic lags in the transmission from policy actions to macroeconomic variables. Embodied in the model is the assumption that changes in the policy actions of the central bank affects macroeconomic variables immediately. Instead, conventional wisdom among central bankers is that monetary policy affects output and inflation with long lags.[3] The typical view among central banks is that changes in the policy rate affect inflation and output after four to six quarters. This view is also widely supported by numerous studies that employ VARs. (see Christiano, Eichenbaum and Evans, 2001 for example).

One natural question that arises is whether the stabilization bias and the choice of the optimal targeting regime are different in a model that retains the same characteristics of the New Keynesian one but that also features a delayed response of macroeconomic variables to changes in the monetary policy rate. This is precisely the objective of this paper. We introduce delayed effects of monetary policy by assuming that expenditure and pricing decisions are predetermined. The model that we use is very similar to Rotemberg and Woodford (1999) and Woodford (2003) who introduce predetermined decisions through an information lag. We find that modifying the New Keynesian model to allow for lags in the transmission mechanism has important implications for both the choice of the optimal targeting regime and for the size of the stabilization bias.

When expectations are predetermined with respect to policy, this implies that current expenditures can be affected only if private agents can incorporate the central bank's most recent policy decisions in their decision making process. This is possible only if the actions of the central bank are forecastable in advance. If expectations are predetermined and the

[2]Others have proposed interest rate smoothing (Woodford, 1999), price level targeting (Vestin, 2000) and money growth targeting (Söderström, 2001) as a way of improving the pure discretionary outcome.

[3]see Friedman's (1968) well-known description of such "long and variable lags"

actions of the central bank are not forecastable in advance, then this limits the ability of the central bank to influence the decisions of private agents. As one of the main advantages of commitment is its ability to appropriately affect the expectations of private agents and hence their current expenditure decisions, the presence of the information lags, therefore reduces the value of commitment. This will have important implications for the size of the stabilization bias and the choice of the optimal targeting regime.

Another important difference between the conventional New Keynesian model and a model that features an information lag, is the ability of the central bank to perfectly insulate the economy from demand shocks. In the former case it can but not in the type of framework that we employ in this paper. Targeting regimes such as speed limit and nominal income growth are particularly efficient in improving the inflation—output-gap trade-off when the economy is predominantly hit with shocks that pose society with a trade-off, that is cost-push shocks. On the other hand, when shocks such as demand and technology—that poses no trade-off to society—become increasingly important, the need to delegate monetary policy to a central bank that targets nominal income growth or the change in the output gap becomes less attractive. [4]

Our results are fairly different from Jensen (2002) and Walsh (2003). First, we find that the size of the stabilization bias is smaller in the model with information lags. Second, we find that inflation targeting outperforms regimes that target the change in the output gap and the growth in nominal income. More importantly, we show that this result is robust irrespective of the degree of forward or backward-looking behaviour in the pricing equation. The paper is organized as follows. Section 2 describes the model and the parameter values that we use to simulate our different targeting regimes. The different targeting regimes are explained in Section 3. Our results are discussed in Section 4 and Section 5 concludes.

2 A Model with Delayed Effects

Embodied in the conventional New Keynesian framework is the assumption that policy actions affect macroeconomic variables immediately. Instead, conventional wisdom among central bankers is that monetary policy affects output and inflation with long lags.[5] The typical view among central banks is that changes in the policy rate affect inflation and

[4]This is a result that Jensen (1999) also finds in his paper. Nominal income growth targeting performs poorly when the volatility of technology shocks are high.

[5]see Friedman's (1968) well-known description of such "long and variable lags"

output after four to six quarters. This view is also widely supported by numerous studies that employ VARs (see Christiano, Eichenbaum and Evans, 2001 for example). The model with delayed effect that we use in this paper is a simple extension of the basic New Keynesian model and examples of such models can be found in Rotemberg and Woodford (1998) and Woodford (2003). We briefly describe the model below.

The economy consists of a continuum of households indexed by $j \in [0, 1]$. Expenditure decisions in the model are predetermined or are made one period in advance and can subsequently be changed only because of shocks to the economy. In this respect, the model differs from the conventional New Keynesian model since the latter assumes that expenditure decisions and stochastic shocks occur contemporaneously. This difference in timing decisions also implies that central banks can no longer perfectly insulate the economy from demand shocks as it is the case in the conventional New Keynesian model, unless these shocks are perfectly forecastable.

We follow Amato and Laubach (2003) and assume that a proportion, α of consumers are so-called rule of thumb and they choose their consumption level based on their previous consumption. Denoting the consumption of rule of thumb consumers by C^r, they set

$$C_t^r = C_{t-1} \tag{1}$$

The remaining consumers, that is $1 - \alpha$, optimizes and maximize their utility function subject to a given constraint. Denoting optimizing consumers by $\tilde{C}$, we have the following optimization problem:

$$\max_{\tilde{C}_t^o, N_t} E_{t-1} \sum_{s=t}^{\infty} \beta^{t-s} \left\{ \frac{\tilde{C}_t^{1-\eta}}{1-\eta} - \frac{N_t^{1+\varphi}}{1+\varphi} \right\} \tag{2}$$

subject to

$$P_t \tilde{C}_t + \frac{B_t}{1+R_t} \leq B_{t+1} + W_t N_t + T_t \tag{3}$$

where β denotes a discount factor, N_t hours worked from which the agent derives disutility, η^{-1} the intertemporal elasticity of substitution and φ^{-1} the labour supply elasticity. The main difference between this model and the basic New Keynesian model is that expectations are conditional upon information up to an including *t-1* and not *t*, reflecting the fact that expenditure decisions are predetermined. Expenditure decisions can be predetermined if it is costly to acquire information or simply because it takes time to plan. In our case, we assume that there is an information lag that forces these agents to take their decisions one period in advance.

Aggregate consumption in this economy is given by the standard Dixit-Stiglitz aggregate:

$$C_t = \left(\int_0^1 C_{it}^{\frac{\zeta-1}{\zeta}} di \right)^{\frac{\zeta}{\zeta-1}} \tag{4}$$

where ζ denotes the elasticity of substitution among the different goods. The associated aggregate price index is given by:

$$P_t = \left(\int_0^1 P_{it}^{1-\zeta} di \right)^{\frac{1}{1-\zeta}} \tag{5}$$

Finally, the demand function for each variety of good is:

$$C_{it} = \left(\frac{P_{it}}{P_t} \right)^{-\zeta} C_t \tag{6}$$

In our model, since there is no government expenditure, the resource constraint is $Y_t = C_t$. Hence $Y_t = C_t = \alpha C_{t-1} + (1-\alpha)\tilde{C}_t$.

Using the first-order conditions from our maximization problem and substituting the resource constraint gives the familiar Euler equation whose log-linearized version yields the following equation:

$$y_t = \theta y_{t-1} + (1-\theta)E_{t-1}y_{t+1} - \sigma[E_{t-1}i_t - E_{t-1}\pi_{t+1}] + u_t, \tag{7}$$

where $\theta = \frac{\alpha}{1+\alpha}$ and $\sigma = \frac{1-\alpha}{(1+\alpha)\eta}$. An error term, u_t has been added. This variable u_t represents a demand shock. u_t follows a stationary univariate autoregressive process and is given by $u_{t+1} = \gamma_u u_t + \eta_{t+1}$ where $\eta_{t+1} \hookrightarrow$ i.i.d $(0, \sigma_\eta^2)$ and $0 \leq \gamma_u < 1$.

This equation is a dynamic generalization of an IS function derived from consumers optimization and in the presence of rule of thumb consumers. When $\theta = 0$, this equation collapses to an "intertemporal IS" function, that is, it represents the standard log-linear approximation of the Euler equation arising from the representative agent's consumption choice.

2.1 Firms

Firms are assumed to produce a continuum of goods and operate in a monopolistically competitive market with decreasing returns to scale. The model abstract from capital and assumes that the production function is given by:

$$Y_{it} = (A_t N_{it})^{\chi} \tag{8}$$

where each firm is indexed by the subscript i. The real marginal cost of each firm is thus:

$$MC_{it} = \frac{W_t}{P_t} \frac{1}{\chi A_t^{\chi} N_{it}^{\chi - 1}} \tag{9}$$

which can be related to average marginal cost as:

$$MC_t = \frac{N_t}{\alpha Y_t} \frac{W_t}{P_t} \tag{10}$$

Using the production function, equation 6 and $Y_{it} = C_{it}$, we obtain the following condition in log-linearized form:

$$mc_{it} = mc_t - \left[\frac{\zeta(1-\chi)}{\chi} \right] (p_{it} - p_t) \tag{11}$$

Using the above and the log-linearized first-order condition for labour, real marginal cost denoted by $\hat{mc}$ is thus given by:

$$\hat{mc}_t = \left(\frac{1 - \chi + \chi\eta + \varphi}{\chi} \right) y_t - (1 + \varphi) a_t \tag{12}$$

We make the same assumption as in Amato and Laubach (2003) and assume that a fraction ω of firms use a backward-looking rule-of-thumb while the remaining firms optimize using Calvo pricing. As in Woodford (Chapter 3), we assume the optimal price chosen by these firms takes effect one period later.

The log-linearized aggregate price index is therefore given by:

$$p_t = \psi p_{t-1} + (1 - \psi) \bar{p}_t^* \tag{13}$$

where $\bar{p}_t^*$ is the log-linearized price index of prices set in period t,

$$\bar{p}_t^* = \omega p_t^b + (1 - \omega) p_t^f \tag{14}$$

where the rule-of-thumb firms are denoted by the superscript b and the optimizing firms by the superscript f. The log-linearized index of prices is thus a convex combination of the prices set by the optimizing and forward-looking firms and the remaining rule-of-thumb or backward-looking ones.

The forward-looking price as shown in Galí and Gertler (1999) and Woodford (2003) is given by:

$$p_t^f = (1 - \beta\psi) E_{t-1}(\hat{mc}_t + p_t) + \beta\chi E_{t-1} p_{t+1}^f \tag{15}$$

Note that because the price chosen takes one period to take effect, we have this different timing for expectations. The rule-of-thumb firms are assumed to set their prices according to the average price in the previous period corrected for past inflation. Thus

$$p_t^b = \bar{p}_{t-1}^* + \pi_{t-1} \tag{16}$$

where past inflation serves as the forecast for actual inflation.

Combining equations 13-16, we have the usual hybrid Phillips curve except for the expectations timing.

$$\pi_t = \gamma^f E_{t-1}\pi_{t+1} + \gamma^b \pi_{t-1} + \kappa E_{t-1} mc_t. \tag{17}$$

where $\kappa = \Omega^{-1}(1-\chi)(1-\psi)(1-\beta\psi)\Omega_1$, $\gamma^f = \frac{\beta\psi}{\Omega}, \gamma^b = \frac{\chi}{\Omega}, \Omega_1 = \frac{\psi}{1+(1-\psi)(1-\zeta)}, \Omega = \psi + \chi(1-\psi(1-\beta))$

To complete our model and to make it comparable to the model used by Jensen (2002) and Walsh (2003), we impose the restriction that the sum on the backward and forward looking coefficient sum to one and use the fact that there is a proportional relationship between the marginal cost and the output-gap. We obtain the following equation:

$$\pi_t = (1-\phi)\beta E_{t-1}\pi_{t+1} + \phi\pi_{t-1} + \kappa E_{t-1}(y_t - \bar{y}_t) + e_t. \tag{18}$$

where ϕ is the degree of backwardness and β is the discount factor. The term e_t is a cost-push shock and is defined as $e_{t+1} = \gamma_e e_t + \epsilon_{t+1}$, where $\epsilon_{t+1} \hookrightarrow$ i.i.d $(0, \sigma_\epsilon^2)$ and $0 \leq \gamma_e < 1$.

Potential output, $\bar{y}_t$, is assumed to follow an AR(1) process and is given by $\bar{y}_{t+1} = \bar{\gamma}\bar{y}_t + \xi_{t+1}$, where $\xi_{t+1} \hookrightarrow$ i.i.d $(0, \sigma_\xi^2)$ and $0 \leq \bar{\gamma} < 1$. The covariance matrix of shocks is assumed to be diagonal; i.e. shocks are independent.

2.2 Model parameters

Since obtaining analytical results are not possible here, to evaluate the size of the stabilization bias and the different targeting regimes, we follow Jensen (2002) and Walsh (2003) and resort to numerical simulations. We first evaluate the size of the stabilization bias and the performance of the different targeting regimes using similar parameter values selected by Walsh (2003). For the inflation equation, we assume, $\beta = 0.99$, $\phi = 0.5$ and $\kappa = 0.05$. For the IS equation, we have $\sigma = 1.5$ and $\theta = 0.5$. Finally, the parameters for the stochastic shocks are $\sigma_\eta = \sigma_\epsilon = 0.015$, $\sigma_\xi = 0.005$ and $\gamma_u = 0.3$, $\gamma_e = 0$, $\bar{\gamma} = 0.97$. In addition to these baseline values, we perform an important sensitivity test. Since the size of the stabilization bias and the performance of the different targeting regimes depend heavily on the value that ϕ takes–the parameter that governs the degree to which inflation expectations are either backward or forward-looking–we evaluate them by varying ϕ over the range 0 to 1..[6]

3 Alternative Targeting Regimes

The policy regimes considered in this paper are all evaluated according to a loss function. This function is given by:

$$L^T = E_0 \sum_{t=1}^{\infty} \beta^{t-1} \left(\pi_t^2 + \lambda (y_t - \overline{y}_t)^2 \right) \tag{19}$$

where L^T denotes society's loss function, β the representative agent's discount factor and π_t the deviation of inflation from a given target (assumed to be zero). The parameter λ measures society's preferences for output stabilization relative to inflation stabilization.[7] The weight society assigns to output relative to inflation stabilization can be different from the central bank. For example, the central bank can have a stronger dislike for inflation compared to society as in Rogoff (1985) and thus would assign more weight in its objective function to the stabilization of inflation relative to output. In our model, this preference is represented by a lower value for λ. As the discount factor approaches one from below, this loss function can be expressed by its unconditional expected value:

$$L_s^T = \lambda Var(y_t - \overline{y}_t) + Var(\pi_t). \tag{20}$$

We use (20) to evaluate all optimal targeting regimes and set λ to 0.25 in the baseline case.

The objective of the central bank is to choose a path for the short-term interest rate to minimise society's loss function. However, the actual conduct of monetary policy is delegated to a central bank that can independently choose a loss function that is different from society both in terms of the variables included and in terms of the relative weights on the different variables. The reason for this optimal delegation is to reduce the stabilization bias associated with purely discretionary policy.

[6]We have also performed several other sensitivity tests. We changed the relative size of the structural shocks, the proportion of rule of thumb consumers with respect to optimizing ones and the slope of the Phillips curve.

[7]This quadratic loss function is standard in the literature and is an important element of "The Science of Monetary Policy". Woodford (2001) has shown that this function (under certain conditions) represents a second order Taylor approximation of the utility of a representative agent.

In addition to the commitment case, we consider the following targeting regimes. The pure discretion regime is the case where the central banker simply implements society's loss function, and therefore corresponds to the case where a benevolent government conducts discretionary monetary policy by itself. It will mainly serve as the "worst case" scenario.[8] Second, a flexible inflation targeting regime is defined as the case where the bank is required to aim at price stability but not at all costs in terms of the output gap. The central bank implements society's objective function but is allowed to choose the optimal weight it places on output stabilization relative to inflation stabilization. A conservative central bank as in Rogoff (1985) will place more weight on inflation relative to output-gap stabilization compared to society. Third, a speed limit targeting regime consists of targeting the change in the output gap and inflation. Fourth, we consider a nominal income growth targeting regime as in Jensen (2002) where the central bank faces a trade-off between the nominal income growth and the output gap.

The single period loss functions for each targeting regimes are shown in Table 1 where x denotes the output gap.

Table 1: Alternative targeting regimes

Targeting Regimes	Loss function	Precommitment
Precommitment	$\pi_t^2 + \lambda x_t^2$	
Pure discretion	$\pi_t^2 + \lambda x_t^2$	
Inflation targeting (**IT**)	$\pi_t^2 + \widehat{\lambda}_{IT}\ x_t^2$	
Speed-Limit targeting (**SLT**)	$\pi_t^2 + \widehat{\lambda}_{SLT} \Delta x_t^2$	
Nominal Income Growth Targeting (**NIT**)	$\lambda x_t^2 + \widehat{\lambda}_{NIT2}(\pi_t + \Delta y_t)^2$	

For each and independently of the targeting regime, a grid search is performed to find the optimal value of $\widehat{\lambda}$. For example, inflation targeting involves the central bank choosing the optimal relative weight on x_t^2. In the case of inflation targeting, depending on its preferences, the central bank may attach a higher or lower value to inflation compared to society. We proceed in the same fashion for all the other targeting regimes, each time finding the optimal (relative) weight the central bank assigns to its targeting variables.

To evaluate the welfare differential between precommitment and the different targeting regimes, we use two alternative measures as in, Dennis and Söderström (2002) and Lam

[8]The commitment can be regarded as the first-best outcome, optimal delegation as second-best, a simple policy rule as third-best and the purely discretionary regime as fourth-best.

(2003). The first measure is the percentage deviation of the optimal targeting regimes from the precommitment outcome. It is calculated as:

$$L^{diff} = 100[\frac{L_{TR}}{L_C} - 1], \tag{21}$$

where L_{TR} and L_C are, respectively, the loss function value under the optimal targeting regime and precommitment.

As this measure does not have a direct economic interpretation, we follow Jensen (2002), and also calculate the permanent deviation of inflation from target (the inflation equivalent) when the central bank moves from precommitment to an optimal discretionary regime. This measure is calculated as:

$$\pi^{diff} = \sqrt{(L_{TR} - L_C)}. \tag{22}$$

This measure has a more direct economic interpretation, because it indicates how much inflation is higher on average if the central bank chooses to conduct monetary policy in a discretionary fashion.

Before evaluating the different targeting regimes, we simulate model under commitment and pure discretion and examine the nature of the stabilization bias in the standard New Keynesian model and in the model containing delayed effects. Since the parameter ϕ–that governs the degree of forward-looking price setting behaviour for the size of the stabilization bias–is important in determining the size of that bias, we compare the outcome under pure discretion and commitment for values of ϕ ranging from 0 to 1.

3.1 The stabilization bias in a model with and without information lags

In this section, we compare the dynamic response of the economy following a one-unit cost-push shock under precommitment and pure discretion using a model with and without delayed effects. We use the baseline parameters presented in Table 1 to generate our impulse response functions

Figure 1: Impulse-Response Function in the Baseline New Keynesian Model

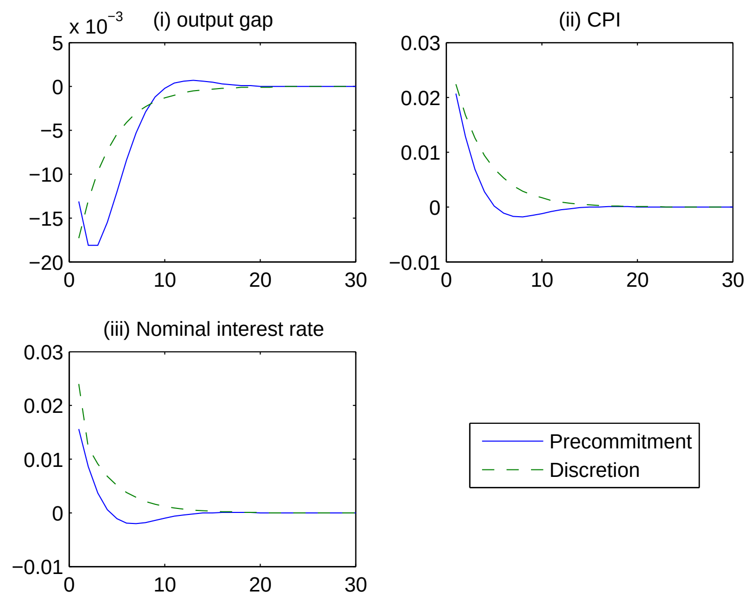
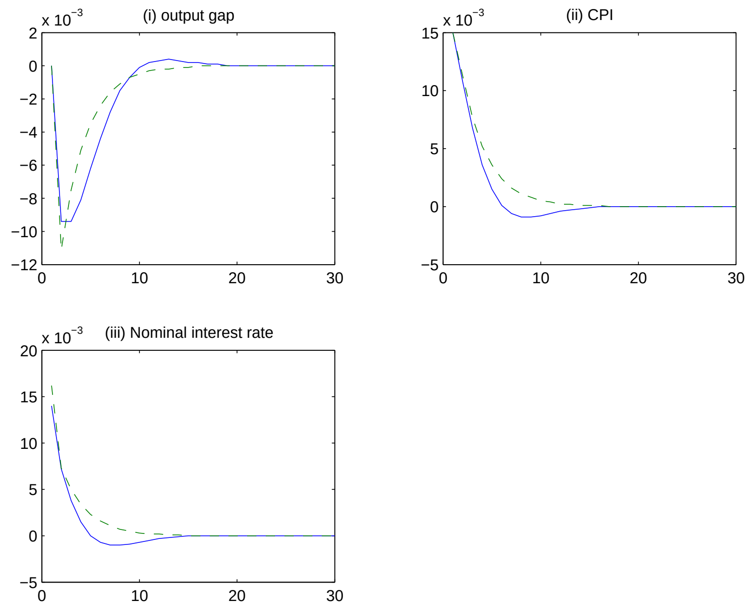


Figure 1 shows the response of the economy to a one-period cost-push shock. The unit cost-push shock leads to an increase in inflation and to a negative output gap under both discretion and precommitment. To dampen the inflationary pressures, the central bank raises interest rates under both precommitment and discretion. The policy response under the commitment is, however, less aggressive and more inertial. Under precommitment, the central bank promises to let the period of inflation be followed by a period of deflation by creating a more persistent output gap. Since inflation is forward-looking, the promise of a future deflation has a stabilizing role on actual inflation. Consequently, this results in a more favourable inflation—output-gap trade-off.

On the other hand, under discretion, the central bank has no incentive to let the contraction persist once inflation is back at its target, since the ensuing period of deflation is costly in terms of welfare. This results in a larger and less inertial policy response and hence to a less favourable inflation—output-gap trade-off.

Figure 2: Impulse-Response Function in the Model with Delayed Effects

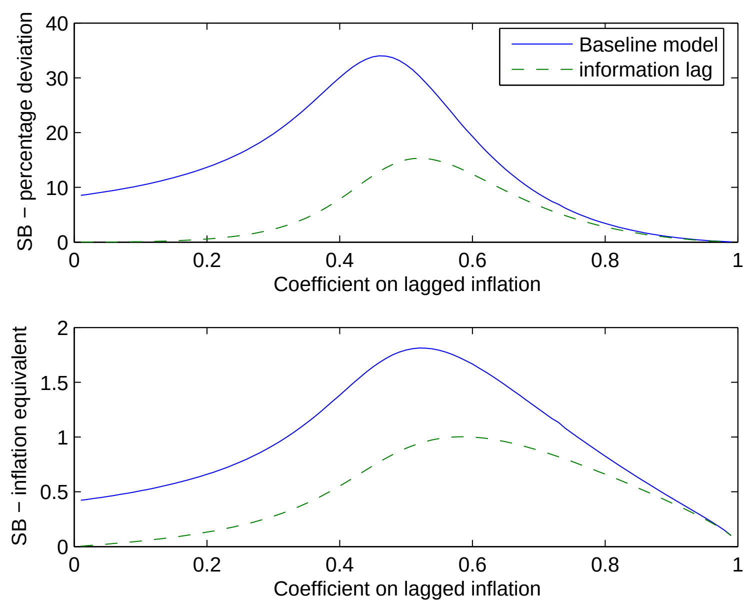


When we take into account the delayed response of the macroeconomy to changes in the policy rate of the central bank, it is seen in Figure 2 that the dynamics of the model under precommitment and discretion are closer, especially for the output gap. Although the response of the central bank under precommitment is still more inertial, the interest rate differential between precommitment and discretion is smaller in the model featuring lags. Consistent with these smaller differences in impulse-response functions, we find that the difference between precommitment and discretion—the stabilization bias—is smaller in the model featuring a delayed effect or information lag compared to the baseline closed-economy framework. Our numerical results confirm that the gains from precommitment are effectively smaller in the model featuring transmission and information lags.

3.2 The importance of ϕ for the stabilization bias

Since the size of the stabilization bias depends heavily on the degree of persistence in inflation, in Figure 3, we show how important this parameter (ϕ) is for determining the size of this inefficiency. We allow for various degrees of forward-looking price setting behaviour by varying ϕ between 0 and 1. We expect the stabilization bias to gradually disappear as ϕ tends to one—as the aggregate supply becomes completely backward-looking—and to be large when the aggregate supply is forward-looking. Figure 3 shows the implications of increasing the importance of backward-looking expectations (the value of ϕ) on the size of stabilization bias in the baseline model and the model featuring delayed effects. The first panel shows the stabilization bias in terms of percentage deviation while the second panel displays the permanent increase in inflation.

Figure 3: Size of Stabilization Bias



In both models, the size of the stabilization bias becomes increasingly smaller as the degree of backward-lookingness increases. This result is intuitive. If inflation expectations are predominantly backward-looking and expected inflation plays a very small role, the stabilization bias should disappear. This is exactly the case in both models.

As expected, the size of the stabilization bias is considerably reduced when the baseline model is modified to include an information lag. What is striking in our results is that in the model featuring an information lag, even with forward-looking expectations in the Phillips curve, the gains from commitment are very small. Since the gains from precommitment are minuscule, this suggests that a targeting regime such as inflation should perform well and the need to delegate monetary policy to a central bank that targets either the change in the output gap or nominal income growth becomes less attractive.

4 Results

Table 2 reports the results for the different targeting when the baseline parameter values are used. We present society's loss under five different monetary policy regimes. In addition, we also present the percentage deviation and the inflation equivalent of the four discretionary regimes from precommitment.

Table 2: Results with Baseline Parameters

	Baseline model			Information lag		
	Loss	L^d	π^d	Loss	L^d	π^d
COM	9.94	-	-	5.36	-	-
PD	13.16	32.41	1.79	6.16	15.03	0.90
CPI	11.76	18.32	1.35	5.81	8.49	0.67
SLT	9.97	0.30	0.17	5.81	8.41	0.67
NIT2	10.00	0.61	0.25	5.91	10.37	0.74

When the baseline model is considered, our results confirm the prior findings of Jensen (2002) and Walsh (2003). The size of the stabilization bias is fairly important. According to Table 2, a purely discretionary regime would, compared to commitment, increase the loss function by around 32% and would lead to an increase of 1.79% in inflation on average.[9] The reason, as explained in the section 2.4, is that policy under discretion leads to insufficient inertia in the policy actions of the central bank. Moving from a purely discretionary regime to a regime of inflation targeting (with a conservative manner) improves the outcome.[10] However, the welfare gain of adopting inflation targeting is fairly limited since the deviation from commitment in terms of welfare remains important.

On the other hand, delegating monetary policy to a central bank that targets the change in the output-gap (SLT) or nominal income growth (NIT2) as in Jensen (2002), results in large reductions in the loss function. Both targeting regimes, in particular, SLT, are able to replicate the precommitment outcome and are clearly superior to a regime that targets inflation. The reason, as explained in the introduction, is their ability to induce inertia in the policy response of the central bank, thereby acting more in accordance with the outcome under commitment.

[9] Inflation returns to its target of zero under all regimes. However, the transition path is very different under each targeting regime.

[10] The optimal λ is 0.15, lower than the value that society assigns to output stabilization.

Our results are however very different when the targeting regimes are evaluated in the model featuring delayed effects. First, the stabilization bias, and thus the need for optimal delegation is considerably reduced. The quantitative gain from commitment in terms of percentage deviation is now around 15%, compared to 32% in the baseline New Keynesian model. Going from pure discretion to inflation targeting leads to a further reduction in the loss function. The percentage gains from precommitment falls to 8.5%.[11]

SLT continues to perform well, but there is virtually no difference between this regime and a regime that targets inflation. The latter outperforms a regime that targets the growth in nominal income. Since the value that ϕ takes is important for determining not only the size of the stabilization bias but also how each targeting regime performs, we repeat the same exercise, but this time varying ϕ from 0 to 1. Our results are shown in Figure 3.

First inflation targeting outperforms regimes that target the change in the output-gap and the growth in nominal income when inflation expectations are predominantly backward-looking. This result is similar to Jensen (2002) and Walsh (2003). When inflation expectations are mostly backward-looking, the optimal policy for the central bank is to react quickly and avoid doing too little too late. Since inflation expectations do not matter in this case, targeting regimes that smooth interest rates too much will not perform well under these conditions. This is why the central bank should not target the change in the output-gap or the growth in nominal income when inflation expectations are backward-looking. Second we find that even when inflation expectations are forward-looking, regimes that targets inflation outperforms regimes that target the change in the output-gap and the growth in nominal income. This result is very different from those obtained by Jensen (2002) and Walsh (2003).

The introduction of an information lag reduces the benefits of precommitment. With an information lag, private agents cannot incorporate the most recent policy-makers decision and hence its likely impact on future economic outcomes. One of the main advantage of commitment is its ability to appropriately affect private agent's expectations and hence their current expenditure decisions. However, if expectations are predetermined and the actions of the central bank are not forecastable in advance, then this limits the ability of the central bank to influence the decisions and expectations of private agents, since agents cannot incorporate the latest policy decisions of the central bank in their decision-making process. As a result, the need for credible promises becomes less valuable. This is why the

[11] In this case also, it is optimal to appoint a conservative central bank.

stabilization bias and the need for optimal delegation are reduced.

Dennis and Söderström (2002) obtain a similar result when they use the model of Rudebusch (2002), that is structurally similar to our simple model. In fact, they obtain an even stronger result–there is practically no difference between precommitment and discretion in the Rudebusch (2002) framework—since the Rudebusch model embodies even more backward-looking pricing behaviour.

Moreover, in a framework with information lags, the central bank can no longer perfectly insulate the economy from demand shocks. Unless shocks are perfectly forecastable by agents, even demand shocks have an impact on the macroeconomic variables. This is not the case in the baseline New Keynesian model where policy-makers can perfectly insulate the economy from demand shocks. It is well known that precommitment is especially valuable in improving the inflation—output-gap trade-off when the economy is predominantly hit with shocks that pose society with a trade-off, such as a cost-push shock. On the other hand, when shocks such as demand and technology—that poses no trade-off to society—become increasingly important as in the framework with an information lag, the need for precommitment is greatly reduced. This is the second reason why the size of the stabilization bias is reduced in a model featuring an information lag.

This also explains why delegating monetary policy to central bank that targets nominal income growth or the change in the output gap become less attractive. A downside of targeting the change in nominal income is that it is not very efficient in dealing with shocks that pose no trade-off to society. Since the central bank cannot perfectly insulate the economy from demand shocks when an information lag is introduced, this makes a regimes of NIT growth less attractive.

5 Concluding Remarks

Using a New Keynesian framework that incorporates an explicit lag in the actions of the central bank, our results show that the size of the stabilization bias and the choice of optimal delegation can be quite different. The common belief among central bankers is that monetary policy affects the economy with a lag. Moreover, if agent's consumption and investment decisions are largely predetermined, this suggests that the stabilization bias may not be so severe after all. Obviously this deserves more attention and remains an open issue.

Moreover, optimal delegation in such a framework amounts to targeting inflation in a conservative manner. This result is very different from those obtained using a conventional

New Keynesian sticky price model. In such a framework, inflation targeting is inferior to a regime that targets either the change in the output gap or nominal income growth. Our results are robust and does not depend on the degree of forward or backward-looking behaviour of agents. Since estimates of inflation expectations vary greatly in the literature, the robustness of our result relative to this parameter is reassuring.

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Figure 4: Loss Relative to Inflation Targeting in the Baseline Model