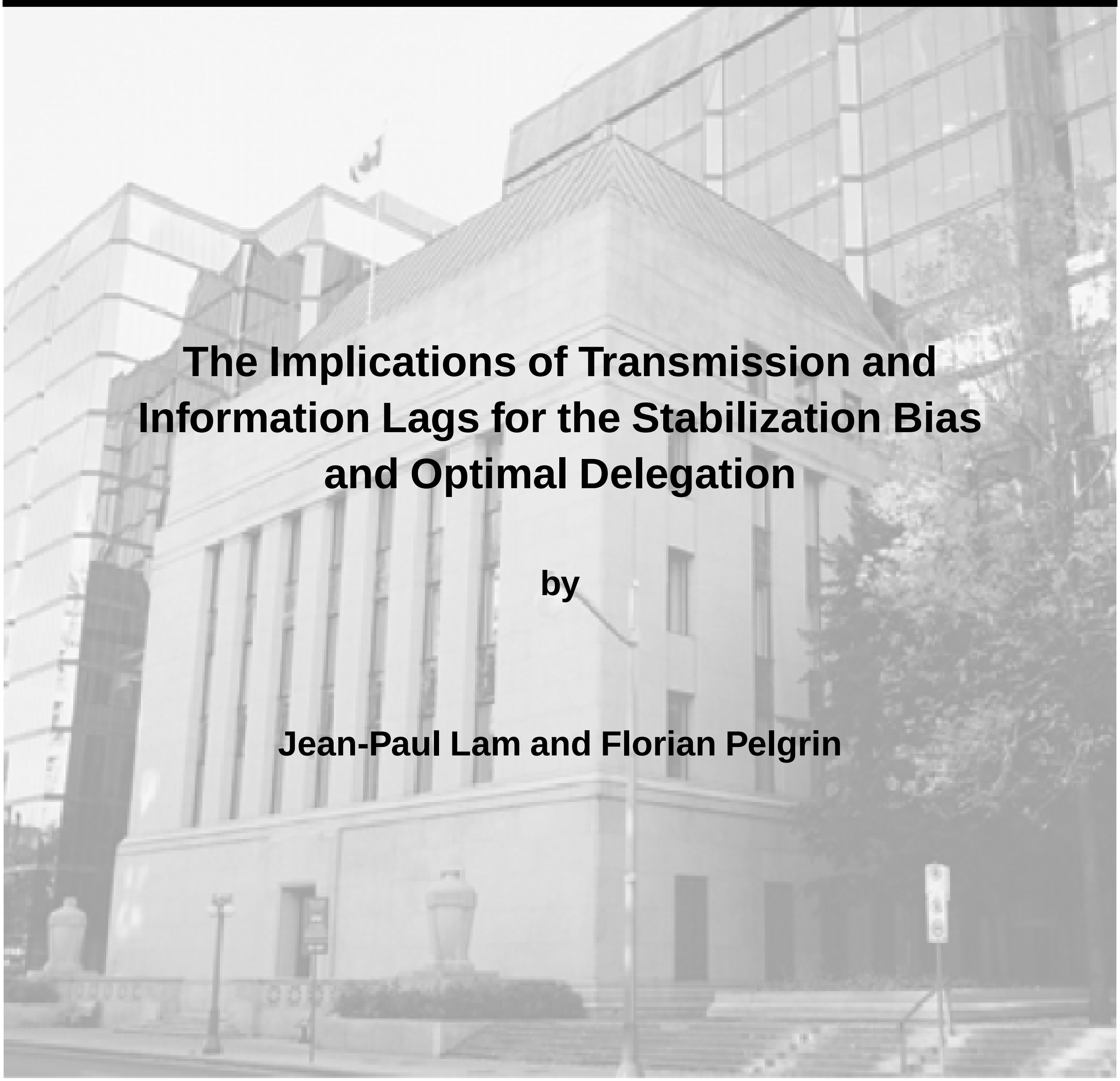
Bank of Canada   Banque du Canada

Working Paper 2004-37 / Document de travail 2004-37



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

by

Jean-Paul Lam and Florian Pelgrin

ISSN 1192-5434

Printed in Canada on recycled paper

Bank of Canada Working Paper 2004-37

September 2004

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

by

Jean-Paul Lam and Florian Pelgrin

Monetary and Financial Analysis Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
jplam@bankofcanada.ca
fpelgrin@bankofcanada.ca

Contents

Acknowledgements

Without implication, we thank the participants at the CEA meeting (May 2004, Toronto) and at the Bank of Canada seminar. All errors are our own.

Abstract

In two recent papers, Jensen (2002) and Walsh (2003), using a hybrid New Keynesian model, demonstrate that a regime that targets either nominal income growth or the change in the output gap can effectively replicate the outcome under commitment and hence reduce the size of the stabilization bias. Moreover, these two targeting regimes have been shown to outperform a regime that targets inflation, except when inflation expectations are predominantly backward looking. In this paper, the authors modify an otherwise conventional New Keynesian model to include transmission and information lags, two key problems faced by policy-makers, and they examine whether the results from the baseline model are robust to these two modifications. The authors find that the gains from commitment are considerably reduced when the model includes these two features, which implies that optimal delegation is less important. Furthermore, a regime that targets CPI inflation in a conservative manner is found to perform well and even outperforms the targeting regimes advocated by Jensen and Walsh under certain conditions.

JEL classification: E52, E58, E62
Bank classification: Transmission of monetary policy; Inflation targets

Résumé

À l’aide d’un nouveau modèle keynésien hybride, Jensen (2002) et Walsh (2003) montrent, dans deux études récentes, qu’un régime prenant pour cible soit le taux de croissance du revenu nominal soit la variation de l’écart de production permet de reproduire la solution obtenue avec une règle d’engagement et de réduire ainsi le biais de stabilisation. Par ailleurs, ces deux régimes se comportent mieux qu’un régime fondé sur la poursuite d’une cible d’inflation, à l’exception des cas où les anticipations d’inflation sont essentiellement rétrospectives. Lam et Pelgrin modifient le cadre standard du nouveau modèle keynésien pour y introduire des retards d’information et de transmission — deux caractéristiques clés pour les décideurs de la politique monétaire. Les auteurs cherchent à déterminer si les résultats de la littérature résistent à ces deux modifications. Ils constatent que les gains découlant de l’engagement des autorités monétaires sont considérablement réduits lorsque le modèle inclut ces deux caractéristiques, ce qui implique que le caractère optimal de la délégation de la politique monétaire revêt moins d’importance. Finalement, un régime qui prend pour cibles l’inflation des prix à la consommation et l’écart de production se comporte relativement bien et est parfois préférable, sous certaines conditions, aux régimes de politique monétaire décrits par Jensen et Walsh.

Classification JEL : E52, E58, E62
Classification de la Banque : Transmission de la politique monétaire; Cibles en matière d’inflation

1 Introduction

Even in the absence of an over-ambitious output target and an inflation bias, discretionary policy in models with forward-looking agents remains inefficient, since it leads to a stabilization bias.[1] This bias arises because of insufficient inertia in the policy actions of the central bank; it is usually created by greater inflation variability and excessive output stabilization. As Woodford (2003) shows in models in which expectations are important for determining inflation, optimal monetary policy under commitment exhibits considerable inertia, whereas policy under discretion does not.

An inertial response on the part of the central bank is desirable in models with forward-looking agents because it helps condition the expectations of agents, resulting in a more favourable trade-off between inflation and the output gap. 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 the expectations of the private sector regarding future inflation. This, in turn, improves the performance of monetary policy and the trade-off that the central bank faces. Although optimal, policy under commitment may not be time-consistent. If commitment to an optimal rule is not feasible and the stabilization bias can be large, how can discretion equilibrium be improved?

In two recent papers that employ a hybrid version of the New Keynesian model featuring no uncertainty, such as transmission lags, information lags, or measurement errors, Jensen (2002) and Walsh (2003) show numerically that a purely discretionary targeting regime and one that targets inflation in a flexible manner usually result in a large stabilization bias. Moreover, they show that the inefficiency that arises from a purely discretionary outcome and from a central bank that implements inflation targeting can be reduced if the central bank targets either nominal income growth or the change in the output gap. The latter, labelled as speed limit targeting by Walsh (2003), can replicate closely the precommitment outcome, particularly when expectations are predominantly forward looking.

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 found under precommitment. In fact, the first-order condition under the timeless commitment outcome

[1] 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.

is very similar to a policy of speed limit targeting. Nominal income growth targeting also imparts persistence in the policy actions of the central bank, a behaviour that results in more stable inflation than under pure discretion or inflation targeting.[2]

An obvious shortcoming of the conventional New Keynesian framework is the absence of realistic lags in the transmission from policy actions to macroeconomic variables. Embodied in the model is the assumption that policy actions affect macroeconomic variables immediately. It is conventional wisdom among central bankers that monetary policy affects output and inflation with long lags.[3] The typical view held among central banks is that changes in the policy rate affect inflation and output after 4 to 6 quarters. This view is widely supported by numerous vector autoregressive (VAR) studies (see Christiano, Eichenbaum, and Evans 2004, for example).

The main objective of this paper is to re-examine the nature of the stabilization bias and optimal monetary policy delegation by augmenting an otherwise conventional hybrid New Keynesian framework with transmission and information lags, two uncertainties commonly faced by central banks.[4] The introduction of transmission and information lags into the baseline model has important implications for optimal monetary policy delegation and the stabilization bias. When expectations are predetermined with respect to policy, this implies that current expenditures can be affected only to the extent that 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. This is important, because one of the main advantages of commitment is its ability to appropriately affect private agents' expectations and hence their current expenditure decisions. If expectations are predetermined and the actions of the central bank are not forecastable in advance, then the ability of the central bank to influence the decisions of private agents is limited, which mitigates the gains from commitment and the size of the stabilization bias.

The introduction of a transmission lag into the basic framework also has important implications for the conduct of monetary policy. Because the actions of the central bank have a delayed response on the pricing and spending decisions of firms and households, it is conceivable that, even if the promises of the central bank are credible, it could be difficult

[2] Others have proposed interest rate smoothing (Woodford 2003), 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."

[4] When the baseline model is modified to include both lags, our model resembles the Rudebusch and Svensson (1999) framework.

for it to introduce effective offsetting and to pre-empt shocks.[5] As a result, precommitment would become less attractive and important, thereby reducing the size of the stabilization bias and the need for optimal monetary policy delegation.

Moreover, in a framework that has transmission and information lags, the central bank can no longer perfectly insulate the economy from demand shocks. Targeting regimes such as speed limit and nominal income growth are particularly efficient in improving the trade-off for society between inflation and the output gap during shocks such as a cost-push disturbance. On the other hand, when shocks such as demand and technology—which pose no trade-off—become increasingly important, there is less need to delegate monetary policy to a central bank that targets nominal income growth or the change in the output gap.[6]

Using a similar framework as Jensen (2002) and Walsh (2003), but augmented with a transmission and/or information lag and using the same calibration values, we numerically quantify the stabilization bias and compare the performance of various targeting regimes. Our study is similar in spirit to that by Dennis and Söderström (2002), who compute the stabilization bias using various calibrated and estimated closed-economy models. They do not, however, compare the performance of different regimes.

Our numerical results confirm our priors. When either lag is present in the model, we find that the gains from precommitment—the size of the stabilization bias—are greatly reduced. The gains from precommitting are especially small when the model features both lags. Moreover, we find that a central bank that targets inflation in a conservative manner can effectively replicate the commitment outcome and even, in many cases, dominates (in terms of welfare measured by a widely used loss function) the targeting regimes advocated by Jensen (2002) and Walsh (2003). CPI inflation targeting performs especially well when the baseline model includes both transmission and information lags. More importantly, the resulting model, which is essentially a simplified version of the Rudebusch and Svensson (1999) framework, implies that a central bank that acts under discretion and targets inflation in a conservative manner is optimal even in versions of the model that feature a very forward-looking aggregate supply.[7]

[5]When transmission lags are present, it is optimal for the central bank to be forward looking and offset disturbances that are expected to affect output and inflation.

[6]Jensen (2002) also obtains this result. Nominal income growth targeting yields poor results when the volatility of technology shocks is high.

[7]Dennis and Söderström (2002) show that the gains from commitment in the Rudebusch and Svensson (1999) framework can be very small.

The paper is organized as follows. In section 2, we specify the main equations of our models and the values used to calibrate the models. Section 3 compares the impulse-response function of output, inflation, and the nominal interest rate in the baseline New Keynesian model and in the model augmented with the transmission and information lag. Section 4 describes our results. Section 5 concludes.

2 The Macro Models

In this section, we describe our four models. The models that include a transmission and/or information lag are a direct generalization of the common New Keynesian model with sticky prices. Each model consists of two equations that describe output and inflation and involve both forward- and backward-looking behaviour.

2.1 Baseline New Keynesian model

Our baseline model is similar to the framework employed by Jensen (2002) and Walsh (2003). For any variables, z, $z_{t+\iota|t}$ denotes expectations of $z_{t+\iota}$ conditional on the information available at time t. All variables (except the nominal interest rate) are log deviations from their long-run average, and all parameters are assumed to be positive.

Aggregate demand is represented by a hybrid IS equation:

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

where y denotes output, i the nominal interest rate, π inflation, and σ the intertemporal elasticity of substitution in consumption.

This equation is a dynamic generalization of an IS function derived from consumer optimization in the presence of habit formation. When $\theta = 0$, this equation collapses to an "intertemporal IS" function; that is, it represents the standard log-linear approximation of the Euler equation that arises from the representative agent's consumption choice. In the baseline framework, expectations are formed at time t and the policy actions of the central bank have a direct and immediate impact on output and inflation. The variable u_t represents a demand shock, and it is assumed to follow a stationary univariate autoregressive process,

$$u_{t+1} = \gamma_u u_t + \eta_{t+1}, \tag{2}$$

where η_{t+1} has a mean of zero with a standard deviation of σ_η and $|\gamma u| < 1$.

The model has an aggregate supply function that takes the following form:

$$\pi_t = (1-\phi)\beta E_t \pi_{t+1} + \phi \pi_{t-1} + \kappa(y_t - \bar{y}_t) + e_t. \tag{3}$$

In equation (3), $x_t \equiv (y_t - \bar{y}_t)$ is the output gap defined as the difference between actual output and potential output. Potential output is assumed to follow an AR(1) process and is given by:

$$\bar{y}_{t+1} = \bar{\gamma}\bar{y}_t + \xi_{t+1} \tag{4}$$

where ξ_{t+1} has a mean of zero and a variance of σ_ϵ^2 and $|\bar{\gamma}| < 1$.

The parameter $0 \le \phi_\pi \le 1$ denotes the degree of forward-looking behaviour in price-setting and κ denotes the slope of the Phillips curve. In its purely forward-looking form, this equation can be derived from a model with staggered price-setting, as in the discrete-time variant of the model proposed by Calvo (1983). In this model, a fraction of goods prices remains unchanged each period, whereas new prices are chosen for the other fraction of goods. Inflation inertia in the standard Calvo model can be introduced by assuming that the fraction of producers who do not set their prices optimally are allowed to index their prices to the most recent inflation measure. A number of authors, including Christiano, Eichenbaum, and Evans (2004) and Smets and Wouters (2003), argue that this kind of partial or full indexation of the price level results in a more realistic specification of the inflation process and improves the empirical fit of their model.

The term e_t is a cost-push shock. As with the demand shock, the cost-push shock is assumed to follow a stationary univariate autoregressive process ($|\gamma_e| < 1$). It captures any factors affecting inflation that alter the relationship between the real marginal cost and the output gap:

$$e_{t+1} = \gamma_e e_t + \epsilon_{t+1}. \tag{5}$$

The innovations to all these shocks are assumed to be white noise and have zero mean processes, with zero off-diagonal elements of the covariance matrix of shocks.

2.2 Model with transmission and information lags

In this section, we modify the baseline New Keynesian framework to introduce transmission and information lags into the model, two key features that may explain the delayed effects of monetary policy. Following Rotemberg and Woodford (1999) and Woodford (2003), we model the information lag by assuming that aggregate consumption embodies planning lags and is thus predetermined. Although simple, this mechanism nevertheless captures an important feature of expenditure decisions: the fact that consumption and investment decisions may be predetermined to a significant degree.

When a lag in the information set is introduced into the model, the baseline model is modified as follows:

$$y_t = \theta y_{t-1} + (1-\theta)E_{t-1}y_{t+1} - \sigma[E_{t-1}i_t - E_{t-1}\pi_{t+1}] + u_t, \tag{6}$$

$$\pi_t = (1-\phi)\beta E_{t-1}\pi_{t+1} + \phi\pi_{t-1} + \kappa E_{t-1}(y_t - \bar{y}_t) + e_t. \tag{7}$$

The model with the information lag is very similar to the baseline model, except that expectations at time t-1 govern the decisions of private agents. In addition, contrary to the baseline model, the central bank cannot perfectly insulate the economy from demand and potential output shocks.

The second modification to the baseline New Keynesian model is to introduce a transmission lag. A transmission lag leads to the following specification:

$$y_t = \theta y_{t-1} + (1-\theta)E_t y_{t+1} - \sigma[i_{t-1} - E_{t-1}\pi_t] + u_t, \tag{8}$$

$$\pi_t = (1-\phi)\beta E_t\pi_{t+1} + \phi\pi_{t-1} + \kappa(y_{t-1} - \bar{y}_{t-1}) + e_t. \tag{9}$$

Although our IS equation allows for lags in the transmission mechanism, monetary policy may nevertheless have immediate effects on output through expectations.

When the baseline framework is modified to incorporate both transmission and information lags, we obtain a model similar to the Rudebusch and Svensson (1999) framework.[8] Our modified framework with transmission and information lags amounts to:

$$y_t = \theta y_{t-1} + (1-\theta)E_{t-1}y_{t+1} - \sigma[i_{t-1} - E_{t-1}\pi_t] + u_t, \tag{10}$$

$$\pi_t = (1-\phi)\beta E_{t-1}\pi_{t+1} + \phi\pi_{t-1} + \kappa(y_{t-1} - \bar{y}_{t-1}) + e_t. \tag{11}$$

[8] The Rudebusch and Svensson (1999) framework is, however, more backward looking; its only forward-looking source is the term structure of interest rates.

2.3 Model parameters

To evaluate the size of the stabilization bias and the different targeting regimes, we use numerical simulations. The baseline parameters of the model (Table 1) are similar to those selected by Walsh (2003).

Table 1: Baseline Parameter Values

Inflation	Output gap	Stochastic shocks
$\beta = 0.99$	$\sigma = 1.5$	$\sigma_\eta = 0.015$, $\sigma_\epsilon = 0.015$, $\sigma_\xi = 0.005$
$\phi = 0.5$	$\theta = 0.5$	$\gamma_u = 0.3$, $\gamma_e = 0$, $\bar{\gamma} = 0.97$
$\kappa = 0.05$		

With respect to the aggregate supply function, the parameter that governs the degree of persistence in prices, ϕ, is set to 0.5 (as in Fuhrer and Moore 1995). Since this parameter is crucial in determining the size of the stabilization bias and the choice of optimal policy (and is subject to much controversy), we perform many sensitivity tests with values ranging from 0 to 1. The slope of the Phillips curve, κ, which captures both the impact of a change in real marginal cost on inflation and the co-movement of real marginal cost and the output gap, is calibrated at 0.05, midway between the estimate of 0.025 by Rotemberg and Woodford (1999) and the estimate of 0.075 by Roberts (1995). The discount factor, β, is set to 0.99, which is appropriate for interpreting the time interval as one-quarter. In the aggregate demand equation, θ, the degree of backward-looking behaviour is set to 0.5, and the intertemporal elasticity of substitution, σ, is set to 1.5. The stochastic shocks for demand, cost-push, and potential output are set, respectively, to 0.015, 0.015, and 0.005. We set the AR(1) coefficient that governs the shocks to demand and potential output, respectively, to 0.3 and 0.97, and do not allow for any serial correlation for the cost-push shock in the baseline case. We perform numerous sensitivity tests on some of these parameters.

3 Alternative Targeting Regimes

The policy regimes we consider are all evaluated according to a loss function. This function is given by:

$$L^T = E_0 \sum_{t=1}^{\infty} \beta^{t-1} \left(\pi_t^2 + \lambda (y_t - \overline{y}_t)^2 \right), \tag{12}$$

where L^T is society's loss function, β the representative agent's discount factor, π_t the deviation of inflation from its target (assumed to be zero), and λ measures society's preferences for output stabilization relative to inflation stabilization.[9] As the discount factor approaches one from below, this loss function can be expressed by its unconditional expected value:

$$L_s^T = \lambda Var(y_t - \overline{y}_t) + Var(\pi_t). \quad (13)$$

We use (13) 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 minimize society's loss function. The actual conduct of monetary policy, however, 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 optimal delegation reduces the stabilization bias associated with pure discretionary policy.

In addition to the commitment case, we consider a number of targeting regimes. First, in the purely discretionary regime, 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 mainly serves as the "worst-case" scenario.[10] Second, in the flexible inflation-targeting regime, 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 described by Rogoff (1985), will place more weight on inflation relative to output-gap stabilization compared with society. Third, in the speed limit targeting regime, the central bank aims at a change in the output gap and inflation. Fourth, we consider two nominal income growth targeting regimes: (i) the case in which the central bank faces a trade-off between the nominal income growth and inflation, and (ii) the case where there is an arbitrage between the nominal income growth and the output gap, as in Jensen (2002).

Table 2 shows the single-period loss function for each targeting regime, where x denotes the output gap.

[9] This quadratic loss function is standard in the literature and is an important element of "the science of monetary policy." Woodford (2003) shows that this function (under certain conditions) represents a second-order Taylor approximation of the utility of a representative agent.

[10] 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.

Table 2: Alternative Targeting Regimes

Targeting Regimes	Loss function
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 (NIT1)	$\pi_t^2 + \widehat{\lambda}_{NIT1}(\pi_t + \Delta y_t)^2$
Nominal income growth targeting (NIT2)	$\lambda x_t^2 + \widehat{\lambda}_{NIT2}(\pi_t + \Delta y_t)^2$

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

$$L^{diff} = 100[\frac{L_{TR}}{L_C} - 1], \tag{14}$$

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

Because this measure does not have a direct economic interpretation, we follow Jensen (2002) and 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:

$$\pi^{diff} = \sqrt{(L_{TR} - L_C)}. \tag{15}$$

This measure has a more direct economic interpretation, because it indicates how inflation is affected if the central bank chooses to renege on its promises.

4 Results

Before evaluating the different targeting regimes, we formally investigate the importance of lags and the parameter, ϕ, that governs the degree of forward-looking price-setting behaviour for the size of the stabilization bias.

4.1 The stabilization bias in a model with and without transmission and information lags

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

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

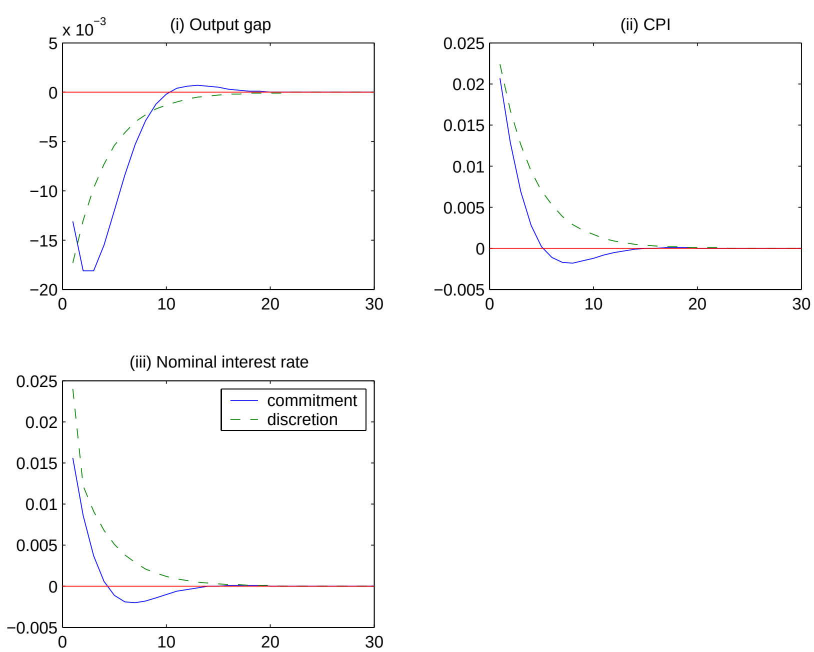
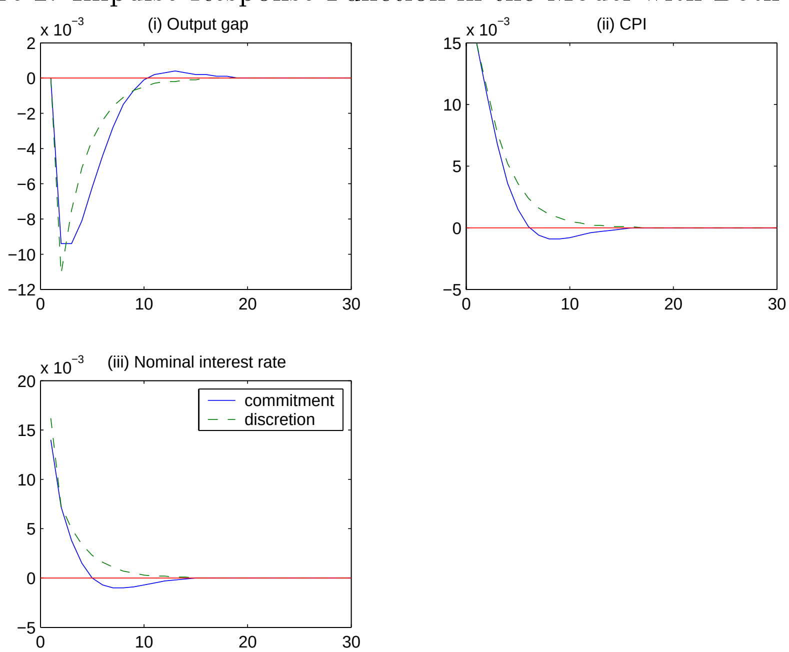


Figure 1 shows the response of the economy to a one-period cost-push shock. The unit cost-push shock leads to an increase in inflation and to a negative output gap under both discretion and precommitment. To dampen the inflationary pressures, the central bank raises interest rates under both precommitment 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 trade-off between inflation and the output gap.

Under discretion, however, 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 in a less favourable trade-off between inflation and the output gap.

Figure 2: Impulse-Response Function in the Model with Both Lags

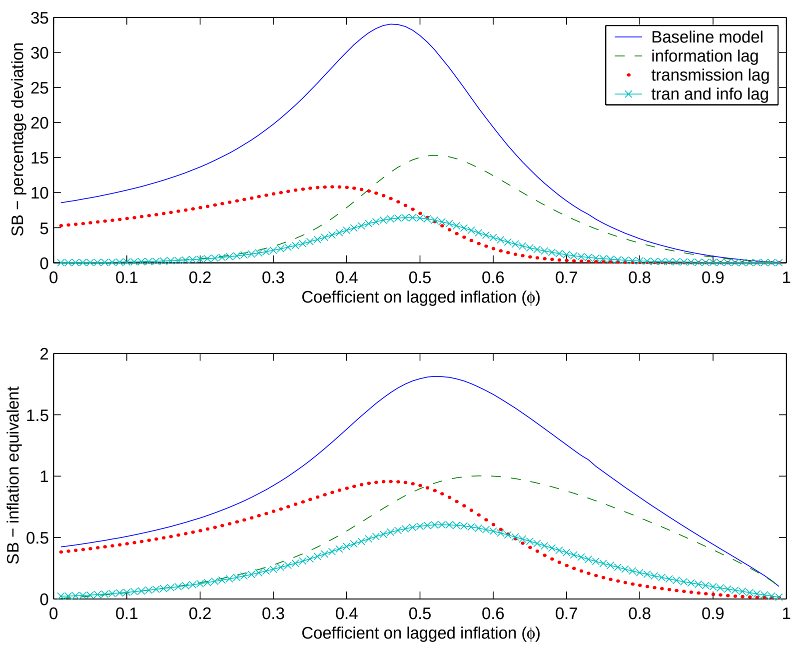


When the model features transmission and information lags (Figure 2), one striking feature is that the dynamics of the model under precommitment and discretion are closer, especially for the output gap. Although the response of the central bank under precommitment is still more inertial, the interest rate differential between precommitment and discretion is smaller in the model that features 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 that features transmission and information lags than in the baseline closed-economy model. Our numerical results confirm the fact that the gains from precommitment are effectively smaller in the model that includes transmission and information lags.

4.2 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 this section we show how important the 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 the stabilization bias in all four models. The first panel shows the stabilization bias in terms of percentage deviation, and the second panel displays the permanent increase in inflation.

Figure 3: Size of Stabilization Bias



In all four models, the size of the stabilization bias becomes increasingly smaller as the dynamics becomes increasingly backward looking. In a case where inflation is predominantly backward looking and expected inflation plays an infinitesimal role, it should not be surprising if the stabilization bias disappears.

As expected, the size of the stabilization bias is considerably reduced when the baseline model is modified to include either a transmission or an information lag. Interestingly, in the model that features an information lag or both lags, even with forward-looking expectations in the Phillips curve the gains from commitment remain minuscule. Since the gains from precommitment are small in the model that features both lags, 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 decreases.

4.3 Evaluating targeting regimes

Table 3 reports the results for the different targeting regimes when the baseline parameter values are used. We show society's loss under six different monetary policy regimes, as well as the percentage deviation and the inflation equivalent of the five discretionary regimes from precommitment.

Table 3: Results with Baseline Parameters

	Baseline model			Transmission lag			Information lag			Both lags		
	Loss	L^d	π^d	Loss	L^d	π^d	Loss	L^d	π^d	Loss	L^d	π^d
COM	9.94	-	-	12.11	-	-	5.36	-	-	5.50	-	-
PD	13.16	32.41	1.79	12.97	7.04	0.92	6.16	15.03	0.90	5.85	6.37	0.59
CPI	11.76	18.32	1.35	12.81	5.77	0.84	5.81	8.49	0.67	5.75	4.42	0.49
SLT	9.97	0.30	0.17	12.53	3.41	0.64	5.81	8.41	0.67	5.83	5.94	0.57
NIT1	11.99	20.69	1.43	13.63	12.5	1.23	6.65	24.16	1.14	6.82	23.88	1.15
NIT2	10.00	0.61	0.25	13.09	8.05	0.99	5.91	10.37	0.74	6.09	10.74	0.77

When the baseline model is considered, our results confirm the findings of Jensen (2002) and Walsh (2003). The size of the stabilization bias is fairly important. According to Table 3, a purely discretionary regime would, compared with commitment, increase the loss function by around 32 per cent and would lead to a permanent increase in inflation of 1.79 per cent: as explained earlier, 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.[11] The welfare gain of adopting inflation targeting is fairly limited, however, 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, particularly SLT, are able to replicate the precommitment outcome and are clearly superior to a regime that targets inflation: as explained in the introduction, they are able to induce inertia in the policy response of the central bank, thereby acting more in accordance with the outcome under commitment.

Our results are very different when the baseline model is extended to include transmission lags and/or information lags. The introduction of a transmission lag into the basic framework considerably reduces the stabilization bias, and thus the need for optimal delegation. The quantitative gain from commitment in terms of percentage deviation is around 7 per cent, compared with 32 per cent in the baseline case. Going from pure discretion to inflation targeting leads to a further reduction in the loss function. The percentage gain from precommitment falls to 5.8 per cent. In this case also, it is optimal to appoint a conservative central bank.

SLT continues to perform well, but the gains from adopting such a framework relative to inflation targeting are nevertheless greatly reduced. When we perform a sensitivity test on the parameter ϕ—which governs the degree of forward-looking behaviour in the aggregate supply—we find that inflation targeting, except for values of ϕ close to the baseline assumption of 0.5, outperforms SLT. There is a marked difference between these two regimes as the aggregate supply function becomes predominantly backward looking (see Table A1 in the appendix).

The introduction of a transmission lag reduces the benefits of precommitment: when monetary policy affects the economy with a lag, policy-makers are less able to make promises to offset shocks, thereby reducing the efficacy of credible commitments. Moreover, in a framework that has transmission (and information) lags, the central bank can no longer perfectly insulate the economy from demand shocks. Since precommitment is especially valuable in improving the trade-off between inflation and the output gap when the economy

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

is hit with shocks that create a trade-off for society, such as a cost-push shock. On the other hand, when shocks such as demand and technology—that pose no trade-off for society—become increasingly important, as in the framework with transmission lags, the need for precommitment is greatly reduced.

This also explains why delegating monetary policy to a central bank that targets nominal income growth (or the change in the output gap) becomes less attractive. A downside of NIT2 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 a transmission lag is introduced, this makes a regime of NIT growth less attractive. In Tables A1 and A2 in the appendix, we find that inflation targeting outperforms NIT2 even for very forward-looking specifications of the aggregate supply.

When an information lag is introduced into the baseline model, it leads to a reduction in the welfare gain from precommitment. In this variant of the baseline model, SLT continues to perform well. However, the difference between this regime and a regime that targets inflation is minuscule. For example, the quantitative difference between the two regimes in terms of loss function is less than 0.1 per cent. As in the framework that features a transmission lag only, this result is not robust when we allow for different degrees of forward-lookingness in the aggregate supply function. As we show in Table A2 of the appendix, inflation targeting is more efficient than SLT for various parameter configurations.

One of the main advantages of commitment is its ability to appropriately affect private agents' 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 important.

The model that combines transmission and information lags further reduces the welfare gain from precommitment. This result is not surprising, because the effects of a transmission lag and an information lag reinforce each other, for reasons described earlier. The impulse-response function (Figure 2), which we discussed in section 4.1, confirms that the optimal response under precommitment and discretion is not very different. It is interesting that, in this model, the purely discretionary case is very close to a regime that targets the change in the output gap, and it does better than both nominal income targeting regimes. Dennis and Söderström (2002) obtain a similar result when they use the model of Rudebusch (2002), which 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.

Even more interesting is the performance of inflation targeting relative to SLT and NIT2 in this model.[12] Our findings reveal that inflation targeting performs particularly well under various parameter configurations (see Tables A1 and A2 in the appendix). The only case in which inflation targeting does not perform well is when more persistence is introduced into the process for the cost-push shock. Although inflation targeting requires an even more conservative central banker, the case for SLT and NIT2 relative to inflation targeting is reinforced when the parameter γ_e is increased to 0.7. This result is not surprising, since the importance of precommitment to future contractions is enhanced when the shock to inflation becomes persistent.[13]

Apart from this parameter configuration, inflation targeting as a delegation scheme would be optimal. This result is robust and is very different from results obtained using the baseline model. In the baseline model, inflation targeting, except when inflation expectations are predominantly backward looking, is inferior to SLT and NIT2 under different parameter specifications (see Table A2). Figures 4 and 5 show the performance of SLT and NIT2 relative to inflation targeting. As stated earlier, except when inflation is predominantly backward looking, SLT and NIT2 are superior to inflation targeting in the baseline model. On the other hand, in the model with transmission and information lags, inflation targeting, irrespective of the degree of forward-looking pricing behaviour, outperforms both SLT and NIT2.

[12]When baseline parameter values are used, we find that targeting inflation amounts to appointing a conservative central bank, since the optimal value of λ is 0.15.

[13]This result is very robust across all models. It is somewhat of a paradox that inflation targeting becomes increasingly inferior the more persistent the effects of the shocks to inflation.

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

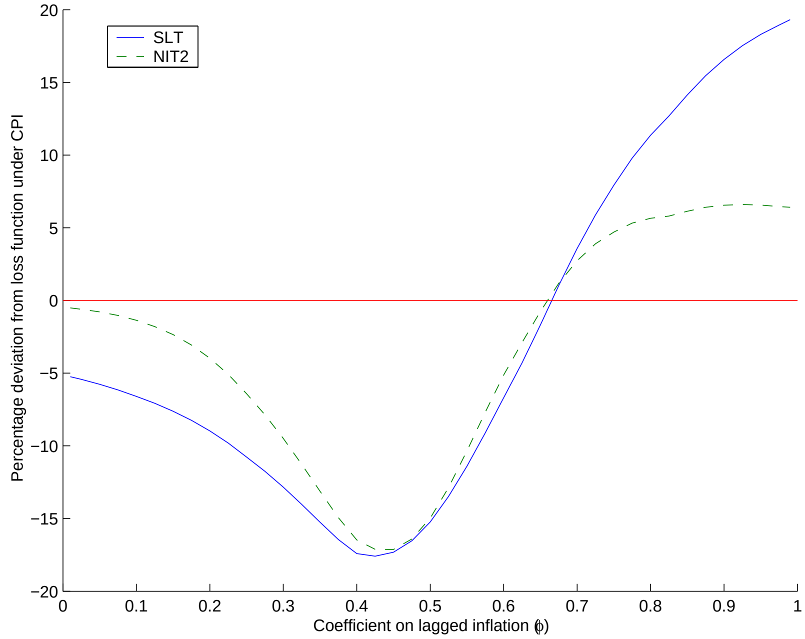
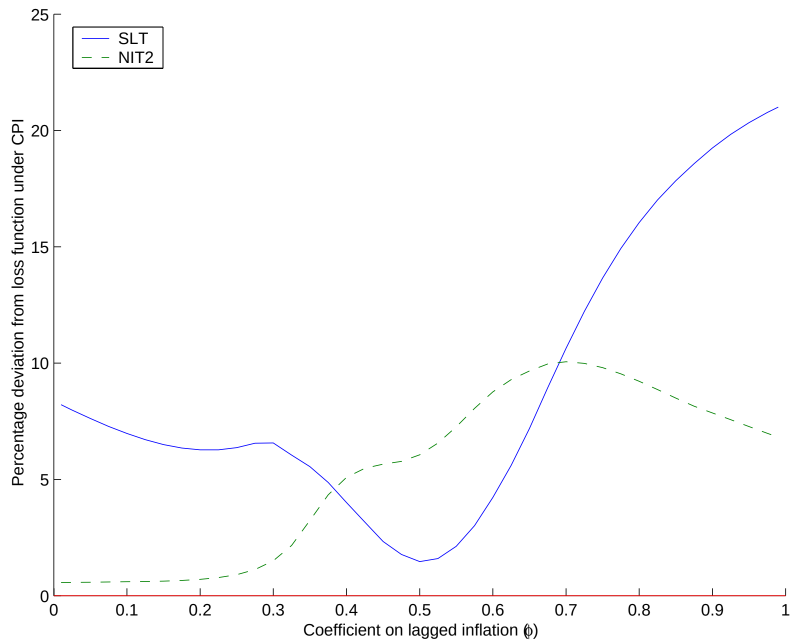


Figure 5: Loss Relative to Inflation Targeting in Models with Both Lags



5 Concluding Remarks

Using an otherwise conventional New Keynesian framework augmented with transmission and information lags, we have shown that the stabilization bias and optimal monetary policy delegation can be quite different. We have found that, in a model with predetermined expenditure and lags in the transmission mechanism, the size of the stabilization bias—the inefficiency inherent in discretionary policy-making—is greatly reduced. The common belief among central bankers is that monetary policy affects the economy with a lag. Moreover, if agents' consumption and investment decisions are largely predetermined, the stabilization bias may not be very severe after all. Obviously, this issue deserves further research.

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.

With transmission and information lags added to the model, precommitting to a given policy becomes less important, because policy-makers are less able to credibly offset and preempt shocks, even if their promises are fully credible. On the other hand, with information lags added to the model, private agents cannot incorporate the most recent decisions by policy-makers and hence its likely impact on future economic outcomes. Under both cases, the expectations channel and hence precommitment becomes less important.

Bibliography

Barro, R.J. and D.B. Gordon. 1983. "Rules, Discretion and Reputation in a Model of Monetary Policy." *Journal of Monetary Economics* 12(1): 101–22.

Blinder, A.S. 1998. *Central Banking in Theory and Practice.* Cambridge: MIT Press.

Calvo, G. 1983. "Staggered Prices in a Utility-Maximizing Framework." *Journal of Monetary Economics* 12: 383–98.

Christiano, L.J., M.S. Eichenbaum, and C.L. Evans. 2004. "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy." *Journal of Political Economy.* Forthcoming.

Clarida, R., J. Galí, and M. Gertler. 1999. "The Science of Monetary Policy: A New Keynesian Perspective." *Journal of Economic Literature* 37: 1661–1707.

Dennis, R. and U. Söderström. 2002. "How Important is Precommitment for Monetary Policy?" Sveriges Riksbank Working Paper No. 139.

Friedman, M. 1968. "The Lag in Effect of Monetary Policy." *Journal of Political Economy* 69: 447–66.

Fuhrer, J. and G. Moore. 1995. "Inflation Persistence." *Quarterly Journal of Economics* CX: 127–60.

Jensen, H. 2002. "Targeting Nominal Income Growth or Inflation?" *American Economic Review* 4: 928–56.

Kydland, F.E. and E.C. Prescott. 1977. "Rules Rather Than Discretion: The Inconsistency of Optimal Plans." *Journal of Political Economy* 85: 473–91.

Lam, J-P. 2003. "Alternative Targeting Regimes, Transmission Lags, and the Exchange Rate Channel." Bank of Canada Working Paper No. 2003-39.

Roberts, J. 1995. "New Keynesian Economics and the Phillips Curve." *Journal of Money, Credit and Banking* 27(4): 975–84.

Rogoff, K. 1985. "The Optimal Degree of Commitment to an Intermediate Monetary Target." *Quarterly Journal of Economics* 100: 1169–89.

Rotemberg, J.J. and M. Woodford. 1999. "Interest Rate Rules in an Estimated Sticky Price Model." In *Monetary Policy Rules*, edited by J. Taylor. Chicago: University of Chicago Press.

Rudebusch, G. 2002. "Assessing Nominal Income Rules for Monetary Policy with Model and Data Uncertainty." *Economic Journal* 112: 402–32.

Rudebusch, G. and L.E.O. Svensson. 1999. "Policy Rules for Inflation Targeting." In *Monetary Policy Rules*, edited by J. Taylor. Chicago: University of Chicago Press.

Smets, F. and R. Wouters. 2003. "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area." *Journal of European Economic Association* 1(5): 1123-75.

Söderlind, P. 1999. "Solution and Estimation of RE Macromodels with Optimal Policy." *European Economic Review* 41: 1111–46.

Söderström, U. 2001. "Targeting Inflation with a Prominent Role for Money." Sveriges Riksbank Working Paper No. 123.

Vestin, D. 2000. "Price-Level Targeting vs. Inflation Targeting in a Forward-Looking Model." IIES Stockholm University Working Paper.

Walsh, C.E. 1985. "Optimal Contracts for Independent Central Bankers." *American Economic Review* 85(1): 150–67.

———. 2003. "Speed Limit Policies: The Output Gap and Optimal Monetary Policy." *American Economic Review* 93(1): 265–78.

Woodford, M. 2003. *Interest & Prices.* Princeton: Princeton University Press.

Appendix A: Sensitivity Test Results

Table A1: Results with $\phi = [0.01, 0.1, ..., 0.99]$

ϕ	Disc		CPI		SLT		NIT1		NIT2	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
0.01	8.55	0.42	8.55	0.42	2.86	0.25	34.70	0.85	7.99	0.41
0.1	10.35	0.51	10.35	0.51	3.07	0.28	33.37	0.91	8.85	0.47
0.2	13.66	0.66	13.48	0.65	3.30	0.32	31.47	1.00	8.97	0.53
0.3	19.76	0.92	18.53	0.89	3.31	0.38	28.56	1.11	7.29	0.56
0.4	30.05	1.38	24.01	1.24	2.42	0.39	24.11	1.24	3.58	0.48
0.5	32.41	1.80	18.32	1.35	0.30	0.1712	20.69	1.43	0.61	0.25
0.6	19.32	1.67	8.49	1.11	1.23	0.42	29.17	2.04	2.93	0.65
0.7	8.83	1.26	2.83	0.71	6.51	1.08	49.82	2.98	5.65	1.00
0.8	3.43	0.83	0.08	0.40	12.28	1.56	73.03	3.81	6.52	1.14
0.9	0.94	0.44	0.06	0.11	16.65	1.87	94.43	4.45	6.62	1.18
0.99	0.05	0.11	0.05	0.11	19.38	2.04	111.51	4.89	6.46	1.18

Baseline Model

Table A1: Results with $\phi = [0.01, ..., 0.99]$

ϕ	Disc		CPI		SLT		NIT1		NIT2	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
0.01	5.29	0.38	5.29	0.38	18.29	0.71	27.10	0.86	6.61	0.43
0.1	6.30	0.45	6.30	0.45	15.78	0.71	21.74	0.83	8.03	0.51
0.2	7.86	0.56	7.82	0.55	13.06	0.72	16.64	0.81	10.86	0.65
0.3	9.82	0.71	9.54	0.70	10.13	0.72	12.60	0.81	12.11	0.79
0.4	10.74	0.90	9.90	0.86	6.70	0.71	10.00	0.87	9.01	0.83
0.5	7.04	0.92	5.77	0.84	3.41	0.64	12.50	1.23	8.05	0.99
0.6	2.01	0.61	1.18	0.46	5.35	0.99	29.34	2.31	10.99	1.41
0.7	0.30	0.27	0.14	0.18	11.33	1.61	53.45	3.50	10.77	1.57
0.8	0.05	0.11	0.05	0.11	15.84	2.01	73.24	4.32	9.07	1.52
0.9	0.00	0.04	0.00	0.04	18.79	2.23	89.53	4.87	7.67	1.43
0.99	0.00	0.01	0.00	0.01	20.93	2.36	102.84	5.23	6.79	1.34

Transmission Lag

Table A1: Results with $\phi = [0.01, ..., 0.99]$

ϕ	Disc		CPI		SLT		NIT1		NIT2	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
0.01	0.00	0.00	0.00	0.00	12.12	0.59	35.93	1.02	0.05	0.12
0.1	0.09	0.05	0.09	0.05	11.17	0.57	33.52	0.99	0.62	0.13
0.2	0.58	0.13	0.57	0.13	11.81	0.60	30.98	0.96	1.13	0.18
0.3	2.35	0.28	2.21	0.27	13.25	0.66	28.72	0.97	3.31	0.33
0.4	7.85	0.55	6.27	0.49	12.09	0.69	26.39	1.01	9.73	0.62
0.5	15.03	0.90	8.49	0.67	8.41	0.67	24.16	1.14	10.37	0.74
0.6	12.42	1.00	5.46	0.66	6.65	0.73	29.31	1.54	9.04	0.85
0.7	6.65	0.88	2.13	0.50	9.86	1.07	45.82	2.31	8.71	1.00
0.8	2.80	0.66	0.67	0.32	14.91	1.53	66.63	3.23	8.26	1.14
0.9	0.81	0.40	0.05	0.10	19.35	1.96	86.89	4.15	7.75	1.24
0.99	0.04	0.10	0.04	0.10	22.39	2.31	103.60	4.97	7.31	1.32

Information Lag

Table A1: Results with $\phi = [0.01, ..., 0.99]$

ϕ	Disc		CPI		SLT		NIT1		NIT2	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
0.01	0.02	0.02	0.02	0.02	8.23	0.49	31.17	0.95	0.60	12.94
0.1	0.10	0.05	0.10	0.05	7.08	0.45	28.88	0.92	0.70	0.14
0.2	0.51	0.12	0.50	0.12	6.80	0.45	26.58	0.90	1.21	0.45
0.3	1.78	0.24	1.70	0.24	8.38	0.52	24.78	0.90	3.23	0.32
0.4	4.63	0.43	3.95	0.39	8.11	0.57	23.48	0.96	9.23	0.60
0.5	6.37	0.59	4.42	0.49	5.94	0.57	23.88	1.15	10.74	0.77
0.6	3.60	0.55	1.91	0.40	6.21	0.72	33.90	1.69	10.83	0.96
0.7	1.14	0.38	0.38	0.22	11.06	1.17	53.49	2.58	10.48	1.14
0.8	0.27	0.21	0.05	0.09	16.09	1.65	73.02	3.52	9.27	1.25
0.9	0.05	0.10	0.05	0.10	19.30	2.05	89.76	4.41	7.90	1.31
0.99	0.00	0.01	0.00	0.01	21.01	2.34	102.89	5.18	6.82	1.33

Both Lags

Table A2: Results with Different Values for $\sigma_{\bar{y}}$, κ and γ_e

Regimes	$\sigma_{\bar{y}} = 0.01$		$\kappa = 0.01$		$\kappa = 0.2$		$\gamma_e = 0.3$		$\gamma_e = 0.7$	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
Disc	32.41	1.79	33.79	2.88	17.64	0.77	44.04	3.37	78.97	11.56
CPI	18.32	1.35	14.58	1.89	14.85	0.71	21.16	2.34	21.52	6.03
SLT	0.30	0.17	0.25	0.14	0.40	0.11	0.40	0.31	0.26	0.67
NIT1	23.10	1.51	103.62	5.05	5.77	0.44	17.52	2.13	9.57	4.02
NIT2	2.44	0.49	2.94	0.85	10.48	0.59	0.62	0.40	2.72	2.14

Baseline Model

Regimes	$\sigma_{\bar{y}} = 0.01$		$\kappa = 0.01$		$\kappa = 0.2$		$\gamma_e = 0.3$		$\gamma_e = 0.7$	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
Disc	6.94	0.92	12.38	1.78	3.75	0.52	9.26	1.69	14.42	5.28
CPI	5.69	0.84	7.16	1.36	3.75	0.52	7.27	1.50	8.38	4.03
SLT	4.01	0.70	5.56	1.20	2.32	0.41	2.57	0.89	13.09	5.03
NIT1	13.83	1.31	64.36	4.07	10.12	0.85	13.42	2.03	8.94	4.16
NIT2	9.60	1.09	3.02	0.88	21.48	1.24	6.13	1.37	2.72	2.14

Transmission Lag

Regimes	$\sigma_{\bar{y}} = 0.01$		$\kappa = 0.01$		$\kappa = 0.2$		$\gamma_e = 0.3$		$\gamma_e = 0.7$	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
Disc	14.52	0.90	23.05	1.44	3.98	0.38	23.81	1.35	75.09	8.14
CPI	8.20	0.67	9.94	0.95	3.35	0.35	12.33	0.97	21.19	4.32
SLT	10.23	0.75	15.34	1.18	3.70	0.37	6.48	0.71	0.97	0.92
NIT1	27.39	1.23	85.96	2.79	16.47	0.78	22.06	1.30	10.41	3.03
NIT2	12.34	0.83	7.77	0.84	17.77	0.81	8.41	0.80	3.54	1.77

Information Lag

Regimes	$\sigma_{\bar{y}} = 0.01$		$\kappa = 0.01$		$\kappa = 0.2$		$\gamma_e = 0.3$		$\gamma_e = 0.7$	
	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}	L^{diff}	π^{diff}
Disc	6.17	0.59	13.51	1.11	1.92	0.288	9.80	0.88	27.60	5.01
CPI	4.28	0.49	6.53	0.77	1.82	0.27	6.54	0.72	12.20	3.33
SLT	7.12	0.64	13.70	1.11	1.60	0.26	4.91	0.62	1.23	1.06
NIT1	26.66	1.24	82.40	2.73	16.61	0.83	23.28	1.36	15.79	3.79
NIT2	12.76	0.85	6.60	0.77	21.45	0.95	9.38	0.86	8.69	2.81

Both Lags

Bank of Canada Working Papers
Documents de travail de la Banque du Canada

Working papers are generally published in the language of the author, with an abstract in both official languages. ***Les documents de travail sont publiés généralement dans la langue utilisée par les auteurs; ils sont cependant précédés d'un résumé bilingue*.**

2004

2004-36	Optimal Taylor Rules in an Estimated Model of a Small Open Economy	S. Ambler, A. Dib, and N. Rebei
2004-35	The U.S. New Keynesian Phillips Curve: An Empirical Assessment	A. Guay and F. Pelgrin
2004-34	Market Valuation and Risk Assessment of Canadian Banks	Y. Liu, E. Papakirykos, and M. Yuan
2004-33	Counterfeiting: A Canadian Perspective	J. Chant
2004-32	Investment, Private Information, and Social Learning: A Case Study of the Semiconductor Industry	R. Cunningham
2004-31	The New Keynesian Hybrid Phillips Curve: An Assessment of Competing Specifications for the United States	D. Dupuis
2004-30	The New Basel Capital Accord and the Cyclical Behaviour of Bank Capital	M. Illing and G. Paulin
2004-29	Uninsurable Investment Risks	C. Meh and V. Quadrini
2004-28	Monetary and Fiscal Policies in Canada: Some Interesting Principles for EMU?	V. Traclet
2004-27	Financial Market Imperfection, Overinvestment, and Speculative Precaution	C. Calmès
2004-26	Regulatory Changes and Financial Structure: The Case of Canada	C. Calmès
2004-25	Money Demand and Economic Uncertainty	J. Atta-Mensah
2004-24	Competition in Banking: A Review of the Literature	C.A. Northcott
2004-23	Convergence of Government Bond Yields in the Euro Zone: The Role of Policy Harmonization	D. Côté and C. Graham
2004-22	Financial Conditions Indexes for Canada	C. Gauthier, C. Graham, and Y. Liu
2004-21	Exchange Rate Pass-Through and the Inflation Environment in Industrialized Countries: An Empirical Investigation	J. Bailliu and E. Fujii

Copies and a complete list of working papers are available from:
Pour obtenir des exemplaires et une liste complète des documents de travail, prière de s'adresser à :

Publications Distribution, Bank of Canada
234 Wellington Street, Ottawa, Ontario K1A 0G9
E-mail: publications@bankofcanada.ca
Web site: http://www.bankofcanada.ca

Diffusion des publications, Banque du Canada
234, rue Wellington, Ottawa (Ontario) K1A 0G9
Adresse électronique : publications@banqueducanada.ca
Site Web : http://www.banqueducanada.ca