Monetary Policy and its Informative Value*

Romain Baeriswyl

Ludwig-Maximilians Universität München

Camille Cornand†

BETA UMR 7522 CNRS - Université Louis Pasteur Strasbourg

First version: December 2005 - This version: January 2007

Abstract

This paper analyzes the welfare effects of economic transparency in a model of monopolistic competition with imperfect common knowledge on the shocks affecting the economy where the central bank has no inflationary bias. Monetary policy entails a dual role, as an action that stabilizes the economy and as a public signal that partially reveals to firms the central bank's assessment about the economy. Firms are unable to perfectly disentangle the central bank's signals responsible for the instrument: the central bank optimally balances the action and information purposes of its instrument. We derive the optimal monetary policy and central bank's disclosure.

JEL classification: E52, E58, D82.

Keywords: differential information, monetary policy, transparency.

*We thank Frank Heinemann, Gerhard Illing, Marc-Alexandre Sénégas, Hyun Shin and Carl Walsh for helpful feedbacks at various stages of the project. This paper has been written when the second author was research officer at the London School of Economics; she gratefully acknowledges financial support from the U.K. ESRC and thanks the FMG for hospitality. Remaining errors are the authors' own.

†Author in charge of the correspondance: BETA UMR 7522 CNRS - 61, avenue de la Forêt Noire - 67085 Strasbourg Cedex France - tel: ++333 90 24 20 97 - fax: ++333 90 24 20 71 - e-mail: cornand@cournot.u-strasbg.fr

1 Introduction

Over the last decades, there has been a switch in central banks' practice from secrecy to transparency. Generally speaking, central bank transparency refers to the absence of asymmetric information between the central bank and the private sector. This trend in central banking has given rise to a growing literature about the pros and cons of higher transparency. Higher transparency is usually rationalized by the economic benefits and democratic accountability required from an independent central bank.[1]

The literature mainly focuses on the impact of economic and political transparency of central banks in the Barro and Gordon (1983) framework. As central banks are presumed to systematically boost the economy above its natural level, the literature examines to what extent transparency helps to reduce the inflation bias and time-inconsistency problem and to increase the credibility and flexibility of central banks.[2]

Yet, in the current context of central bank independence and historically – and durable – low levels of inflation, many central banks have reached a high degree of credibility. On the one hand, the benefit of independence from political interferences is nowadays commonly accepted. On the other hand, central bankers are aware that boosting the output above its natural level would be inflationary and consider that the assumption of inflationary biased central banks does not capture the actual rationale for the conduct of monetary policy. In particular, Blinder (1998), King (1997), and Vickers (1998) argue that the Barro-Gordon argument is not applicable to their respective central banks.[3]

The aim of this paper is to analyze the benefits and costs of transparency for well-established and credible central banks. We concentrate on the effect of economic transparency in the case where the central bank has no inflationary bias and where

[1] These are the two main premises of the Code of Good Practices on Transparency in Monetary and Financial Policies (paragraph 4) adopted by the Interim Committee of the Board of Governors of the International Monetary Fund (IMF (1999)).

[2] See Geraats (2002) for an overview.

[3] For a discussion of this issue, see Cukierman (2002). Blinder (2000) also shows that there is a strong consensus among central bankers about the importance and benefit of credibility.

the private sector perfectly knows its preferences. Under these circumstances, the question of transparency deals with the provision of central bank's information to the private sector about its economic assessment. There is an ongoing debate about whether a central bank should explain its decisions: many central banks discuss nowadays whether they should publish their macroeconomic forecasts or the minutes of deliberations of their policy board.

Recently, the literature has raised questions about the value of having central banks provide more and better information to the public. There is a general presumption that more information enhances efficiency as economic agents make better decisions when they are better informed. Yet, in their seminal beauty contest paper, Morris and Shin (2002) – emphasizing the relevance of strategic complementarities underlying most of macroeconomic aggregates – argue that, in an environment characterized by imperfect common knowledge and strategic complementarities, more accurate public information may be detrimental to welfare because public information is attributed too large a weight relative to its face value. Their argument has received a great deal of attention in the academic literature, the financial press[4], and central banks[5]. In a closely related work, Amato et al. (2002) interpret the model by Morris and Shin (2002) as a Lucas-Phelps islands economy in which firms try to second-guess the pricing strategies of their competitors. Challenging this result, Hellwig (2005) shows in a fully micro-founded model that more accurate public information about monetary shocks is always welfare increasing because it reduces price dispersion. Angeletos and Pavan (2006a) and Angeletos and Pavan (2006b) underline that these results are sensitive to what extent coordination is socially valuable.

The present paper contributes to this debate on the welfare effects of economic transparency in the conduct of monetary policy. While Hellwig (2005) considers the case where money supply follows a stochastic process, we focuse on the optimal

[4]See The Economist (2004).
[5]See for example Kohn (2005) and Issing (2005).

monetary policy. Our analysis is based on a model of monopolistic competition with imperfect common knowledge where two shocks affect the economy, namely demand and mark-up shocks. Both the central bank and firms are uncertain about the true state of the economy. The main characteristic of our approach is to consider the instrument of the central bank not only as an action that stabilizes the economy but also as a signal that partially reveals to firms its own imperfect assessment about the state of the economy.[6] The signaling role of monetary policy has been well documented by Romer and Romer (2000). Using US data, they show that "*the Federal Reserve's actions signal its information*" and that "*commercial forecasters raise their expectations of inflation in response to contractionary Federal Reserve actions [...]*" (Romer and Romer (2000, p. 430)). So, monetary policy entails a dual role, as an action and as a vehicle for information. The central bank chooses its instrument by optimally balancing its action and information purposes. At the same time, the optimal disclosure strategy of the central bank is discussed in a framework that simultaneously accounts for the action taken by the central bank.[7]

In our set-up, an *opaque* central bank does not share its information about the state of the economy with firms. When the economy is simultaneously hit by many types of shocks, firms are unable to properly interpret the monetary instrument as they cannot disentangle the rationale behind it. For instance, the central bank may implement an expansionary instrument either because of a negative demand shock or because of a negative mark-up shock. This confusion reduces the informative value of the instrument on both fundamental shocks and on the beliefs of others about these shocks. By contrast, a *transparent* central bank discloses enough information so that it reveals to firms its assessment about fundamental shocks. A transparent central bank thus discloses an additional announcement indicating its own signals on the state of the economy.

This paper analyzes the welfare effect of economic transparency, that is the

[6] Baeriswyl and Cornand (2006), Walsh (2006), and Walsh (2007) also share this characteristic.

[7] Note that the literature in the vein of Morris and Shin (2002) addresses the value of public information when the only task of the central bank is to communicate with the private sector.

extent to which the central bank should fully reveal to firms its own assessment about fundamental shocks (namely demand and mark-up shocks). We derive the optimal monetary policy and optimal central bank's disclosure strategy. The welfare analysis of transparency is driven by three intertwined effects.

First, transparency has a positive *incentive effect* on the optimal monetary policy. As firms are unable to properly disentangle the reasons behind the instrument under opacity, the central bank balances the action and information purposes of its monetary instrument. This distorts its policy away from what would be optimal with respect to the action purpose only. By contrast, under transparency, the central bank chooses its instrument that is optimal from the perspective of its sole action purpose.

Second, transparency has a positive *uncertainty effect* with respect to demand shocks. Reducing the fundamental and strategic uncertainties about demand shocks is welfare increasing. This arises because demand shocks can be neutralized by the policy implemented by the central bank. Even if central bank's information about demand shocks is noisy, transparency is welfare increasing since it reveals the influence of monetary policy on the economy and this is part of the fundamental firms have to respond to.

Third, transparency has a negative *uncertainty effect* with respect to mark-up shocks. Mark-up shocks cannot be neutralized by the central bank as they create a trade-off between price level and output gap stabilization. Reducing the fundamental and strategic uncertainty about mark-up shocks owing to transparency is consequently detrimental to welfare since it exacerbates the response of each firm to mark-up shocks and increases the resulting loss.[8]

Overall, we show that transparency is welfare increasing (i) when the degree of strategic complementarities is low, (ii) when the economy is not too affected by mark-up shocks (relative to other shocks), (iii) when the central bank is more

[8]In a more general framework without monetary policy, Angeletos and Pavan (2006a) anticipated the fact that removing uncertainty about inefficiency shocks as mark-up shocks is welfare detrimental.

inclined towards price level rather than output gap stabilization, (iv) when firms have relatively precise private information, and (v) when the central bank has information that is relatively precise on demand shocks and relatively imprecise on mark-up shocks. Hence, our framework gives a rationale for the development of the economy over the last decades. Increasing transparency[9] seems appropriate in the current context of declining occurrence and amplitude of mark-up shocks and increasing inclination of central banks towards price stabilization.

The remaining of the paper is structured as follows. Section 2 outlines a monopolistic competition economy, in which firms' pricing decisions represent strategic complements. Section 3 considers a benchmark case under perfect common knowledge that recalls standard findings in monetary policy analysis and gives useful insights for the intuition behind our main results. Section 4 turns to the case of imperfect common knowledge and examines the optimal monetary policy and transparency. This section considers how announcements affect the optimal policy responses to demand and mark-up shocks and whether transparency is welfare increasing. Finally section 5 concludes.

2 The economy

The economy is populated by a representative household, a *continuum* of monopolistic competitive firms, and a central bank. We abstract here from the microfounded market interactions since they are very standard and focus on the optimal behaviour of firms.[10] Two types of stochastic shocks hit the economy, demand and mark-up shocks. Nominal aggregate demand is determined by both the demand shock and the monetary instrument set by the central bank.

[9]The increase in transparency in the conduct of monetary policy in recent years is studied by Eijffinger and Geraats (2006) and Dincer and Eichengreen (2006).

[10]See Adam (2006) for the derivation of the microfoundations.

2.1 Firms

The central equation of our model is given by the optimal pricing rule of firms. This is derived from an economy where the representative household consumes a composite good *à la* Dixit-Stiglitz where goods are imperfect substitutes. In such a context, the optimal price set by firm i is

$$p_i = \mathbb{E}_i[p + \xi c + u], \tag{1}$$

where $\mathbb{E}_i$ is the expectation operator of firm i conditional on its information, p the overall price level, c the output gap, and u the cost-push shock. The pricing rule (1) says that each firm sets its price according to both its own expectations about the real output gap and the cost-push shock, and its expectations about the overall price level. Per definition, the nominal aggregate demand deviation is the sum of deviations of the output gap and the price level: *i.e.* $y = c + p$. So, one can write the pricing rule as

$$p_i = \mathbb{E}_i[(1 - \xi)p + \xi y + u]. \tag{2}$$

The parameter ξ captures the impact of the real output gap on prices (through wages). A large ξ means that the representative household is highly risk averse and that output gaps imply large variations in wages and thereby in prices. We qualify such an economy as weakly extensive. ξ also describes whether prices are strategic complements or substitutes. We assume that $0 < \xi < 1$, which implies that prices are strategic complements, meaning that firms tend to raise their price whenever they expect the others to do so. This assumption seems very natural and captures the concept of beauty contest introduced by Keynes: firms base their decision not only on their own expectations of fundamentals but also on the so-called higher-order expectations, *i.e.* expectations of the average expectations of fundamentals, up to an infinite number of iterations.

2.2 The central bank

Based on its information, the central bank minimizes both the variability of the output gap c and that of the price level p owing to its monetary instrument I:

$$\min_{I} \mathbb{E}_{cb}[\lambda c^2 + p^2], \tag{3}$$

where λ is the weight assigned to the output gap variability. The monetary instrument implemented by the central bank is a linear combination of its signals on shocks: $I = \nu_1 g_{cb} + \nu_2 u_{cb}$. ν_1 and ν_2 are the policy coefficients, and g_{cb} and u_{cb} stand for the central bank's signals on demand and mark-up shocks, respectively. We assume that the monetary instrument I implemented by the central bank partially determines nominal aggregate demand. Precisely, the nominal aggregate demand y is the sum of the central bank's instrument I and of the demand shock g, *i.e.* $y = I + g$. So, the pricing rule becomes

$$p_i = \mathbb{E}_i[(1-\xi)p + \xi g + u + \xi I]. \tag{4}$$

For the sake of simplicity, we assume that both shocks affecting the economy are normally and independently distributed:

$$\begin{aligned} g &\sim N(0, \sigma_g^2) \\ u &\sim N(0, \sigma_u^2). \end{aligned}$$

3 Perfect common knowledge

Standard monetary policy analysis assumes that information is common knowledge among firms. While this paper deals with monetary policy under imperfect common knowledge, the current section derives, as a benchmark, the optimal monetary policy under perfect common knowledge.

When information is perfect and common to all firms, every firm sets the same price. The pricing rule (4) then simplifies to

$$p_i = p = I + g + \frac{1}{\xi}u.$$

Note that the impact of mark-up shocks u on the price level increases with the degree of strategic complementarities $1-\xi$. This arises because the weight assigned to mark-up shocks increases with the extensivity of the economy. As discussed above, when the economy is highly extensive (ξ small), firms assign a smaller weight to nominal aggregate demand and a relatively larger one to mark-up shocks.

When the central bank has perfect information as well, its instrument simplifies to

$$I = \nu_1 g + \nu_2 u.$$

The resulting loss under perfect information is

$$L = \lambda\Big(-\frac{1}{\xi}u\Big)^2 + \Big[(1+\nu_1)g + (\frac{1}{\xi}+\nu_2)u\Big]^2,$$

and minimizing the unconditional expected loss yields the following optimal monetary policy:

$$\begin{aligned} \nu_1 &= -1 \\ \nu_2 &= -\frac{1}{\xi}. \end{aligned}$$

The corresponding unconditional expected loss is a function of the variance of mark-up shocks and yields

$$\mathbb{E}(L) = \frac{\lambda}{\xi^2}\sigma_u^2.$$

The coefficient ν_1 indicates that the central bank perfectly offsets demand shocks. Since the monetary instrument is part of the nominal aggregate demand, the central bank is able to offset demand shocks. By closing the output gap, the central bank also gets rid of price deviations. So demand shocks are perfectly neutralized.

By contrast, mark-up shocks cannot be neutralized by the central bank as they create a trade-off between price level and output gap stabilization. Indeed, in the absence of any monetary policy action, a positive mark-up shock raises the price level and generates a negative output gap. While price level stabilization calls for a contractionary policy, output gap stabilization requires an expansionary one. Under perfect common knowledge, the optimal monetary policy coefficient ν_2 states that the central bank lowers its instrument by $-\frac{1}{\xi}$ when the mark-up shock increases by one unit (*i.e.* contractionary policy). As the price level increases because of a positive mark-up shock, the central bank contracts the nominal aggregate demand so that the price level is completely stabilized (*i.e.* $p = 0$).[11] The resulting output gap is $c = -\frac{1}{\xi}u$. The strength of the central bank's response increases with the degree of strategic complementarities.

4 Imperfect common knowledge

We now turn to the more realistic case where the state of the economy is imperfect common knowledge among firms because they have differential information.[12] In this section, we derive the optimal monetary policy as a function of the central bank transparency and then analyze the welfare effect of transparency. As information provided by the monetary instrument influences firms' reaction, the optimal policy varies according to the communication strategy adopted by the central bank.

[11] The complete stabilization of the price level arises because of the absence of frictions under perfect common knowledge.

[12] Usually, real effects of monetary policy are adduced by some frictions like price stickiness. Recently, Adam (2006), Hellwig (2002) and Woodford (2003) have shown that an economy lacking common knowledge accounts for real effects of monetary policy and persistent effects of shocks without need for additional frictions. They even show that higher-order uncertainty yields inertia not only in the price level but also in inflation what sticky-price models fail to capture.

We assume that the monetary instrument is perfectly observed by firms. This corresponds to the current practice of most central banks.[13] By setting its instrument publicly, the central bank implicitly discloses a public signal to firms. However, without additional information, firms are unable to understand the central bank's assessment about the economy. This is the reason why many central banks, additionnally to revealing the level of their instrument (*e.g.* the level of the overnight interest rate), explain their decision. A clear trend in this respect is the switch towards communication of the minutes of Monetary Policy Committee discussions. This section precisely aims at evaluating such communication strategies by considering whether the central bank should disclose additional information in the form of an explicit announcement that precisely reveals to the private sector its view about the state of the economy.

The information structure of the central bank is as follows. The central bank receives a signal on both the demand and the mark-up shocks in private. Each signal – or estimate – deviates from the true fundamental value by an error term that is normally distributed:

$$g_{cb} = g + \eta, \quad \text{with} \quad \eta \sim N(0, \sigma_\eta^2)$$
$$u_{cb} = u + \mu, \quad \text{with} \quad \mu \sim N(0, \sigma_\mu^2),$$

where η and μ are independently distributed.

The central bank chooses its instrument to minimize (3). Since both fundamental shocks and both error terms are independently normally distributed, the optimal

[13] Transparency of the monetary instrument is often rationalized by the fact that it renders monetary policy more effective as it exempts the private sector to "*waste effort inferring the stance of monetary policy from diffuse signals generated in the day-to-day implementation of policy.*" (See Greenspan (2001)). Blinder (1998) and Woodford (2005) also emphasize that central banks control only a very short-term interest rate that has virtually no economic relevance. Monetary policy however drives financial market prices only to the extent that it influences market expectations about the future development of short-term interest rates. Arbitrage requires long-term interest rates to be the cumulative combination of short-term rates expected by the market. In this context, a transparent instrument helps the central bank shaping market expectations. This effect of transparency is however ignored in our set-up since we assume that the central bank directly determines a part of the nominal aggregate demand.

instrument rule of the central bank is a linear combination of its signals and can be written as

$$I = \nu_1(g + \eta) + \nu_2(u + \mu). \tag{5}$$

We first present the case where the central bank does not announce the rationale behind its instrument (opacity) and second the case where it reveals its own signals (transparency). Then we compare and discuss the optimal disclosure policy.

4.1 No announcement (opacity)

Each firm i receives a private signal on the mark-up shock u_i that may be interpreted as a private estimate. The private signal of each firm deviates from the true mark-up shock by an error term that is normally distributed:

$$u_i = u + \rho_i, \quad \text{with} \quad \rho_i \sim N(0, \sigma_\rho^2),$$

where ρ_i are identically and independently distributed across firms.

Firms also receive a public signal in the form of the monetary policy instrument (5). By setting its instrument, the central bank gives an indication to firms of its own beliefs about the state of the economy. Yet, without announcement, firms are uncertain about the right interpretation of the monetary instrument and about how others may interpret it. Firms rationally use the monetary instrument to infer the fundamental shocks g and u, and the expectations of other firms about these shocks.

4.1.1 Equilibrium

To determine the perfect Bayesian equilibrium behavior of firms, we recall the optimal pricing rule (4) for convenience and substitute successively the average price level with higher order expectations about the demand and mark-up shocks and the monetary instrument:

$$p_i = \mathbb{E}_i[(1 - \xi)p + \xi g + u + \xi I]$$

$$= \mathbb{E}_i\Big[\xi g + u + \xi I + (1-\xi)\Big[\bar{\mathbb{E}}[\xi g + u + \xi I + (1-\xi)[\bar{\mathbb{E}}[\xi g + u + \xi I + \ldots]]]\Big]\Big].$$

We denote by $\mathbb{E}_i(.)$ the expectation operator of firm i conditional on its information and by $\bar{\mathbb{E}}(.)$ the average expectation operator such that $\bar{\mathbb{E}}(.) = \int_i \mathbb{E}_i(.)di$. With heterogeneous information, the law of iterated expectations fails and expectations of higher order do not collapse to the average expectation of degree one.[14] Thus, we rewrite the pricing rule as

$$p_i = \sum_{k=0}^{\infty}(1-\xi)^k \mathbb{E}_i\Big[\bar{\mathbb{E}}^{(k)}(\xi g + u + \xi I)\Big],$$

and averaging over firms yields

$$p = \sum_{k=0}^{\infty}(1-\xi)^k \Big[\bar{\mathbb{E}}^{(k+1)}(\xi g + u + \xi I)\Big], \tag{6}$$

where k is the degree of higher order iterations. We use the notation: $\bar{\mathbb{E}}^{(0)}(x) = x, \bar{\mathbb{E}}^{(1)}(x) = \bar{\mathbb{E}}(x)$, and $\bar{\mathbb{E}}^{(2)}(x) = \bar{\mathbb{E}}\bar{\mathbb{E}}^{(1)}(x) = \bar{\mathbb{E}}\bar{\mathbb{E}}(x)$. The price level p is a weighted average of higher order expectations of the nominal aggregate demand $g+I$ and the mark-up shock u.[15] The corresponding output gap is given by

$$c = y - p = g + I - \sum_{k=0}^{\infty}(1-\xi)^k \Big[\bar{\mathbb{E}}^{(k+1)}(\xi g + u + \xi I)\Big].$$

The output gap is the difference between the nominal aggregate demand and the weighted average of higher order expectations of the demand shock g, the mark-up shock u, and the monetary instrument I. As fundamental and strategic uncertainties about nominal aggregate demand increase, the real effect of variations in demand increases as well. In the particular case where it is common knowledge, nominal

[14] See Morris and Shin (2002).

[15] An alternative and more intuitive way to formalize the price setting of firms would be to postulate that each firm has a known individual mark-up shock (instead of a signal on the aggregate mark-up shock u) as in Walsh (2007). Such an assumption would not qualitatively affect the results since they are mainly driven by strategic rather than fundamental uncertainty.

aggregate demand has only a price effect.

In order to solve the inference problem of each firm

$$\mathbb{E}_i(g,u) = \mathbb{E}[g,u|u_i,I],$$

we define the corresponding covariance matrix $\mathbf{V}_{4\times4}$ and the relevant sub-matrices

$$\mathbf{V} = \begin{pmatrix} \mathbf{V_{uu}} & \mathbf{V_{uo}} \\ \mathbf{V_{ou}} & \mathbf{V_{oo}} \end{pmatrix}.$$

The expectation of shocks conditional on the private and public signals of firm i is given by

$$\mathbb{E}\left(\begin{array}{c|c} g & \\ u & u_i, I \end{array} \right) = \mathbf{\Omega} \begin{pmatrix} u_i \\ I \end{pmatrix} = \begin{pmatrix} \Omega_{11} & \Omega_{12} \\ \Omega_{21} & \Omega_{22} \end{pmatrix} \begin{pmatrix} u_i \\ I \end{pmatrix},$$

where $\mathbf{\Omega} = \mathbf{V_{uo}}\mathbf{V_{oo}^{-1}}$.

Using this, equation (6) becomes

$$p = \sum_{k=0}^{\infty}(1-\xi)^k \Big[\begin{pmatrix} \xi & 1 \end{pmatrix} \mathbf{\Omega \Xi^k} \begin{pmatrix} u \\ I \end{pmatrix} + \xi I \Big],$$

where

$$\mathbf{\Xi} = \begin{pmatrix} \Omega_{21} & \Omega_{22} \\ 0 & 1 \end{pmatrix}.$$

The equilibrium strategy for firm i is a linear combination of its private signal on mark-up shocks u_i and the public signal I:

$$\begin{aligned} p_i &= \gamma_1 u_i + \gamma_2 I \qquad \text{with} \\ \gamma_1 &= \frac{\xi\Omega_{11} + \Omega_{21}}{1-(1-\xi)\Omega_{21}} \end{aligned} \tag{7}$$

$$\gamma_2 = \frac{(1-\xi)\gamma_1\Omega_{22} + \xi(1+\Omega_{12}) + \Omega_{22}}{\xi}.$$

4.1.2 Optimal monetary policy

This section derives the optimal monetary policy under opacity. The central bank sets its monetary instrument (5) to minimize the expected loss (3) subject to the price rule (7). The unconditional expected loss is given by

$$\mathbb{E}(L) = \text{var}(p) + \lambda \cdot \text{var}(c).$$

First, the variance of the price level p can be written as

$$\text{var}(p) = (\gamma_2\nu_1)^2\sigma_g^2 + (\gamma_2\nu_1)^2\sigma_\eta^2 + (\gamma_1 + \gamma_2\nu_2)^2\sigma_u^2 + (\gamma_2\nu_2)^2\sigma_\mu^2.$$

Secondly, we determine the variance of the output gap. The output gap is

$$\begin{aligned} c &= I + g - p \\ &= g - \gamma_1 u + (1-\gamma_2)I. \end{aligned}$$

Therefore, the variance of the output gap yields

$$\begin{aligned} \text{var}(c) &= (1 + (1-\gamma_2)\nu_1)^2\sigma_g^2 + ((1-\gamma_2)\nu_1)^2\sigma_\eta^2 \\ &\quad + ((1-\gamma_2)\nu_2 - \gamma_1)^2\sigma_u^2 + ((1-\gamma_2)\nu_2)^2\sigma_\mu^2. \end{aligned}$$

As the monetary policy is both an action and a vehicle for information, the central bank chooses its instrument by optimally balancing its action and information purposes.

The instrument that is optimal from the perspective of its action is given by the optimal monetary policy in the case where both the central bank and firms share the same information. Indeed, when firms already know (before observing the

instrument) the assessment of the central bank about the state of the economy, the central bank has no incentive to distort its instrument in order to disguise its signals.

However, as soon as firms have imperfect information about the central bank's assessment, the central bank can reduce its loss by considering also the informative value of its instrument. As we shall see below, transparency is welfare detrimental with respect to mark-up shocks while it is welfare improving with respect to demand shocks. As a result, the information purpose of monetary policy calls for making the instrument as less informative as possible on mark-up shocks.

Figure 1 shows the optimal monetary policy as a function of σ_ρ^2, the variance of the error terms of firms' private signal on mark-up shocks. The precision of firms' information declines moving from the left to the right part of the graph. The optimal monetary policy is computed with the following parameter values: $\sigma_g^2 = 1$, $\sigma_u^2 = 1$, $\sigma_\eta^2 = 0.2$, $\sigma_\mu^2 = 0.2$, and $\lambda = 1$. Three cases can be distinguished with respect to the precision of firms' information.

First, when firms have perfect information on the mark-up shock ($\sigma_\rho^2 = 0$), the central bank implements the policy that is optimal from the perspective of its action and ignores the informative value of its instrument. Indeed, the central bank has no incentive to disguise its signal on the mark-up shock by altering its policy because firms already know the true mark-up shock. At the same time, revealing its signal on the demand shock to firms is not welfare detrimental since demand shocks can be neutralized.[16] The strength of demand shock neutralization depends on the precision of central bank's information. In the present case where the variance of the error term is one fifth of the variance of the true demand shock, the optimal neutralization becomes $\nu_1 = -\frac{\sigma_g^2}{\sigma_g^2+\sigma_\eta^2} = -0.833$. In a similar way, the response of the central bank to mark-up shocks $\nu_2 = -\frac{1}{\xi}\frac{\sigma_u^2}{\sigma_u^2+\sigma_\mu^2}$ increases (in absolute value) with the precision of its information. The response to mark-up shocks also depends on the degree of strategic complementarities. As the latter increases, mark-up shocks are

[16] Baeriswyl (2006) shows that transparency reduces the distorting effect of the monetary instrument implemented by a central bank with poorly accurate information.

given an increasing relative weight in the pricing decision of firms and the central bank responds more strongly. With higher complementarities, monetary policy is less effective because nominal aggregate demand management has a small impact on prices.

Second, when firms' private information is extremely noisy, again the central bank fully neutralizes demand shocks according to the precision of its information, *i.e.* $\nu_1 \to -\frac{\sigma_g^2}{\sigma_g^2+\sigma_\eta^2}$ as $\sigma_\rho^2 \to \infty$. However, the central bank does not respond to mark-up shocks because firms do not respond to them since they get very noisy private signals, *i.e.* $\nu_2 \to 0$ as $\sigma_\rho^2 \to \infty$. Remember that the amplitude of the impact of the mark-up shock depends on the reaction of firms.

Third, for intermediate values of information precision, the optimal monetary policy depends on both the precision of private information and the degree of strategic complementarities. We first describe the central bank's response to mark-up shocks and then its response to demand shocks.

The optimal policy can be divided into two policy regions. When $\lambda\frac{\sigma_\rho^2}{\sigma_u^2} < \xi$, the central bank responds to mark-up shocks by contracting the nominal aggregate demand whenever its signal on the mark-up shock is positive (*i.e.* $\nu_2 < 0$). The strength of the policy response to mark-up shocks ν_2 declines with σ_ρ^2. As the quality of firms' information decreases, prices react also less to firms' expected mark-up shocks and the central bank finds it optimal to respond less strongly to them as well. But when $\xi < \lambda\frac{\sigma_\rho^2}{\sigma_u^2}$, it implements a slightly expansionary instrument (*i.e.* $\nu_2 > 0$) whenever its signal on the mark-up shock is positive.[17] The sign of the policy coefficient ν_2 depends on the effectiveness of monetary policy to stabilize the price level. Under opacity, the uncertainty of firms about the policy response of the central bank to mark-up shocks is large and this reduces the impact of the policy on the price level. As discussed in section 3, mark-up shocks create a trade-off between price level and output gap stabilization. The central bank is involved either in price level

[17]Interestingly, the condition for monetary policy to be accommodating in response to mark-up shocks ($\nu_2 > 0$) is identical to that derived in Baeriswyl and Cornand (2006) under opacity even if the monetary instrument is imperfect common knowledge in that paper.

or output gap stabilization according to the effectiveness of its policy to stabilize the price level. This effectiveness is high when firms' fundamental and strategic uncertainty about the central bank's response to mark-up shocks is low. This arises either when firms' private information is highly accurate (*i.e.* private signals are good indicators for central bank's response) or when strategic complementarities are weak (*i.e.* strategic uncertainty plays only a minor role). Otherwise, as uncertainty surrounding the response to mark-up shocks is high, the central bank finds it optimal to stabilize the output gap by expanding nominal demand in response to positive mark-up shocks. It is indeed more effective at stabilizing output gap rather than price level as achieving price level stabilization is more costly in terms of output gap.

The central bank always offsets demand shocks. But the amplitude of its response also depends on whether ξ is larger than $\lambda\frac{\sigma_\rho^2}{\sigma_u^2}$.

The central bank sets its response to demand shocks in order to reduce the informative value of its instrument about mark-up shocks. There are two ways for the central bank to achieve this goal. Either could the central bank weakly respond to demand shocks so that it avoids firms to interpret the instrument as a response to mark-up shocks. Or could the central bank strongly respond to demand shocks so that firms mainly interpret the instrument as a response to demand shocks.

In the region where $\lambda\frac{\sigma_\rho^2}{\sigma_u^2} < \xi$, the central bank finds it optimal to respond more aggressively to demand shocks than it would do in the perspective of its sole action purpose. As firms have relatively precise information about mark-up shocks, the central bank strengthens its response to demand shocks to make its instrument less informative about mark-up shocks. Since the central bank strongly responds to mark-up shocks when firms' information is highly accurate, the central bank also strongly responds to demand shocks to mitigate the interpretation of its instrument. As explained above, this is precisely firms' reaction that determines the amplitude of the impact of the mark-up shock. By being less informative on the mark-up

shock, the central bank limits the degree of common knowledge about the shock and therefore attenuates overreaction of firms.

When $\lambda\frac{\sigma_\rho^2}{\sigma_u^2} = \xi$, as the central bank does not respond to mark-up shocks ($\nu_2 = 0$), the optimal response to demand shocks coincides with the policy required by a pure action motive.

And finally, when $\xi < \lambda\frac{\sigma_\rho^2}{\sigma_u^2}$, the central bank weakens its response to demand shocks. As firms' information about mark-up shocks is poorly accurate, the central bank finds it optimal to weakly respond to demand shocks so that firms do not interpret in a too large extent the instrument as a response to mark-up shocks. Compared to the policy case where the pure action purpose matters for the setting of the instrument, this policy reduces the informative value of the instrument about its mark-up shock signal.

4.2 Announcement (transparency)

Although the instrument provides information on the central bank's signals, it does not allow firms to properly understand the reason for the chosen monetary policy. As most central banks publish their instrument target, many of them are even more transparent and make the minutes of their Monetary Policy Committee deliberations available to the public. This reveals to the public the viewpoint of the central bank about the economy and rationalizes the monetary instrument.

As in the former case without announcement (opacity), each firm receives a private signal on the mark-up shocks u_i and the monetary instrument I is publicly available. With both demand and mark-up shocks hitting the economy, the sole observation of the monetary instrument does not allow firms to disentangle the extent to which each shock is responsible for the instrument. For example, the central bank may implement an expansionary instrument either because of a negative demand shock or because of a negative mark-up shock. In the current set-up, the central bank can remove uncertainty about the rationale for the instrument by explicitly

announcing (one of) its signals. This renders the informative purpose of the monetary instrument ineffective and induces the central bank to implement its instrument for its action purpose only. We qualify such a central bank as *transparent* since its announcement eliminates any information asymmetry between itself and firms. For the sake of simplicity, we assume that the central bank directly announces its signal on the demand shock g_{cb}.[18] In this context, firms rationally use their three signals to infer the fundamental shocks and other firms' expectations about them.

4.2.1 Equilibrium

This section solves the perfect Bayesian equilibrium and derives the optimal behavior of firms and of the central bank. We proceed as in the former section to solve the inference problem each firm faces

$$\mathbb{E}[g, u, I | u_i, I, g_{cb}]$$

and define the corresponding covariance matrix $\mathbf{V}_{6\times 6}$ and the relevant sub-matrices

$$\mathbf{V} = \begin{pmatrix} \mathbf{V_{uu}} & \mathbf{V_{uo}} \\ \mathbf{V_{ou}} & \mathbf{V_{oo}} \end{pmatrix}.$$

The expectation of the fundamental shocks conditional on the private and public signals of firm i is given by

$$\mathbb{E}\left(\begin{array}{c|c} g & \\ u & u_i, I, g_{cb} \\ I & \end{array} \right) = \mathbf{\Omega_T} \begin{pmatrix} u_i \\ I \\ g_{cb} \end{pmatrix} = \begin{pmatrix} \Omega_{11} & \Omega_{12} & \Omega_{13} \\ \Omega_{21} & \Omega_{22} & \Omega_{23} \\ 0 & 1 & 0 \end{pmatrix} \begin{pmatrix} u_i \\ I \\ g_{cb} \end{pmatrix},$$

[18] One may think of different types of announcement that would reveal central bank's signals to firms. In practice, the publication of inflation forecast and/or target appears to be the main form of announcement adopted by transparent central banks. Indeed, inflation is a concept firms are familiar with and is likely to be better interpreted than other measures, like output gap for example. Nevertheless, announcement of the inflation or output gap targets are equivalent in our context of rational expectations.

where $\mathbf{\Omega} = \mathbf{V_{uo}}\mathbf{V_{oo}^{-1}}$.

Using this result into the price rule (6) yields

$$p = \sum_{k=0}^{\infty}(1-\xi)^k \begin{pmatrix} \xi & 1 & \xi \end{pmatrix} \mathbf{\Omega}\mathbf{\Xi^k} \begin{pmatrix} u \\ I \\ g_{cb} \end{pmatrix}, \tag{8}$$

where

$$\mathbf{\Xi} = \begin{pmatrix} \Omega_{21} & \Omega_{22} & \Omega_{23} \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{pmatrix}.$$

The price level equation (8) is a linear combination of the mark-up shock u and of the public signals I and g_{cb}:

$$\begin{aligned} p &= \gamma_1 u + \gamma_2 I + \gamma_3 g_{cb} \qquad \text{with} \\ \gamma_1 &= \frac{\xi\Omega_{11} + \Omega_{21}}{1-(1-\xi)\Omega_{21}} \\ \gamma_2 &= \frac{(1-\xi)\gamma_1\Omega_{22} + \xi(1+\Omega_{12}) + \Omega_{22}}{\xi} \\ \gamma_3 &= \frac{(1-\xi)\gamma_1\Omega_{23} + \xi\Omega_{13} + \Omega_{23}}{\xi}. \end{aligned} \tag{9}$$

4.2.2 Optimal monetary policy

The central bank sets its monetary instrument to minimize the expected loss given the precision of its information. First, the variance of the price level p can be written as

$$\text{var}(p) = (\gamma_2\nu_1 + \gamma_3)^2\sigma_g^2 + (\gamma_2\nu_1 + \gamma_3)^2\sigma_\eta^2 + (\gamma_1 + \gamma_2\nu_2)^2\sigma_u^2 + (\gamma_2\nu_2)^2\sigma_\mu^2.$$

Secondly, we determine the variance of the output gap. The output gap is

$$c = I + g - p$$

$$= \quad g - \gamma_1 u + (1-\gamma_2) I - \gamma_3 g_{cb}.$$

Therefore,

$$\begin{aligned} \text{var}(c) \quad &= \quad (1 + (1-\gamma_2)\nu_1 - \gamma_3)^2 \sigma_g^2 + ((1-\gamma_2)\nu_1 - \gamma_3)^2 \sigma_\eta^2 \\ &\quad + ((1-\gamma_2)\nu_2 - \gamma_1)^2 \sigma_u^2 + ((1-\gamma_2)\nu_2)^2 \sigma_\mu^2. \end{aligned}$$

With the additional announcement, firms are able to perfectly disentangle the signals of the central bank. Thus the central bank cannot influence firms' beliefs by altering its instrument. The central bank does not face, unlike under opacity, the problem of optimally balancing the action and information purposes of its monetary instrument anymore. On the contrary, the central bank implements the instrument that is optimal from the perspective of its action purpose only. The corresponding coefficients of monetary policy satisfy:

$$\nu_1 \quad = \quad -\frac{\sigma_g^2}{\sigma_g^2 + \sigma_\eta^2} \tag{10}$$

$$\nu_2 \quad = \quad -\frac{1}{\xi} \frac{\sigma_u^2}{\sigma_u^2 + \sigma_\mu^2}. \tag{11}$$

As stated above, equation (10) indicates that the central bank tries to fully neutralize demand shocks according to the precision of its signal. The central bank's response to mark-up shocks (11) increases with the precision of its information. However, the response also depends on the degree of strategic complementarities since monetary policy is less effective for influencing the price level when the economy is highly extensive.

4.3 Welfare effect of transparency

This section analyzes the welfare effect of transparency. The main results are the following. First, transparency is welfare increasing with respect to demand shocks but detrimental with respect to mark-up shocks. As demand shocks can be neutralized

by the central bank, reducing uncertainty about how the central bank responds to them helps stabilizing the economy. By contrast, reducing uncertainty about mark-up shocks is detrimental as it exacerbates firms' reaction and raises the resulting loss since the central bank cannot neutralize them. Transparency is welfare improving either when mark-up shocks are not too relevant compared to demand shocks or when the degree of strategic complementarities is low as firms' pricing decision relies less on mark-up shocks. Second, transparency is particularly beneficial when the central bank is more inclined towards price stabilization. Indeed, transparency increases the effectiveness of monetary policy on the price level.

We first describe the three mechanisms that drive these results. Then, we compare the welfare level under opacity *versus* transparency, and emphasize the impact of the degree of strategic complementarities $(1-\xi)$, of the precision of firms' private information σ_ρ^2, of the variance of mark-up shocks σ_u^2, and of the preference of the central bank for output gap stabilization λ.

4.3.1 Effects at stake

Our results are driven by three effects. First, transparency has a positive *incentive effect* on the optimal monetary policy. In the absence of transparency, firms are unable to disentangle the reasons behind the monetary instrument. Monetary policy then entails a dual role, which induces the central bank to optimally balance the action and information purposes of its instrument. Transparency eliminates the informative value of the instrument (or makes it redundant) and the central bank focuses on its action purpose. The incentive effect of transparency is welfare increasing as transparency allows the central bank to choose the instrument that optimally stabilizes the economy.

Second, transparency has a positive *uncertainty effect* with respect to demand shocks on the behavior of firms. Transparency reduces both fundamental and strategic uncertainties about demand shocks and central bank's response to them. Reduc-

ing this uncertainty is welfare improving since demand shocks can be neutralized by the central bank. As discussed in Baeriswyl (2006), transparency reduces the distorting effect of a monetary instrument implemented by a central bank with poorly accurate information. This mainly departs from the conclusion by Morris and Shin (2002) because our framework additionally accounts for the action taken by the central bank.

Third, transparency has a negative *uncertainty effect* with respect to mark-up shocks. As mark-up shocks create a trade-off between price and output gap stabilization, they cannot be neutralized by the central bank. Reducing uncertainty about mark-up shocks is thus welfare detrimental because it exacerbates the reaction of firms to them. When strategic complementarities are strong, firms put a large weight on higher order expectations on mark-up shocks. Transparency reduces higher order uncertainty and induces firms to strongly react to mark-up shocks.

4.3.2 Degree of strategic complementarities and precision of private information

Figure 2 represents the ratio of the unconditional expected loss under transparency (*i.e.* with announcement) to the unconditional expected loss under opacity (*i.e.* without announcement) $\mathbb{E}(L_T/L_O)$ as a function of strategic complementarities ξ for three values of precision of firms' information σ_ρ^2. Transparency is welfare detrimental whenever the ratio is larger than one. The model is solved numerically with the following parameter values: $\sigma_g^2 = 1$, $\sigma_u^2 = 1$, $\sigma_\eta^2 = 0.2$, $\sigma_\mu^2 = 0.2$, and $\lambda = 1$.

Transparency is welfare detrimental when the negative uncertainty effect with respect to mark-up shocks dominates both the positive incentive effect and the uncertainty effect with respect to demand shocks. Removing uncertainty about mark-up shocks is highly relevant either when higher order expectations are given a large weight or when firms have very noisy information about them.

Figure 2 shows that transparency is welfare detrimental when the degree of

strategic complementarities $(1-\xi)$ is high. Price setting in an economy with a high degree of strategic complementarities is characterized by two intertwined features. First, prices are mainly determined by mark-up shocks when complementarities are high because demand shocks have a limited impact on prices as the economy is highly extensive. Second, firms are more sensitive to other firms' pricing decision. This implies that, with increasing strategic complementarities, firms put an increasing weight on higher order expectations on mark-up shocks. In this context, the detrimental effect of transparency is driven by the negative uncertainty effect related to mark-up shocks. Indeed, when strategic complementarities are strong, transparency, by reducing higher order uncertainty, induces firms to strongly react to mark-up shocks.

The precision of firms' private information strongly influences the effects at stake. In the case where firms' private information is very noisy, the detrimental uncertainty effect of transparency dominates its positive incentive effect. When firms already have precise private information, reducing uncertainty on fundamental shocks and higher order expectations has a relatively small negative effect compared to the positive incentive effect. So, transparency is welfare detrimental when complementarities are high and as long as firms' private information is not too precise.

4.3.3 Relative importance of mark-up shocks

Figures 3 and 4 represent the ratio $\mathbb{E}(L_T/L_O)$ as a function of the variance of mark-up shocks for three levels of strategic complementarities. Other parameter values are $\sigma_g^2 = 1$, $\sigma_\eta^2 = 0.2$, $\sigma_\mu^2 = 0.2\sigma_u^2$, $\sigma_\rho^2 = 0.2\sigma_u^2$, and $\lambda = 1$.

The variance of mark-up shocks σ_u^2 captures the importance of mark-up shocks in the economy. When there is no mark-up shock ($\sigma_u^2 = 0$), the question of transparency is irrelevant to welfare whatever the degree of strategic complementarities. As the central bank exclusively responds to demand shocks, firms perfectly interpret the rationale behind the monetary instrument even under opacity. So, the optimal

monetary policy and the economic outcome cannot be distinguished between opacity and transparency.

However, as soon as σ_u^2 increases, figure 3 shows that the welfare effect of transparency depends on both the degree of strategic complementarities and the importance of mark-up shocks in the economy, relative to demand shocks. As discussed in the previous section, transparency tends to improve welfare when complementarities are weak. But whatever the degree of strategic complementarities, transparency turns out to be welfare detrimental as the relative importance of mark-up shocks increases. Indeed, since mark-up shocks cannot be neutralized by the central bank, the detrimental uncertainty effect of transparency dominates as mark-up shocks become more relevant. Figure 4 allows the variance of mark-up shocks to become very large. Transparency is welfare detrimental even in the case of low complementarities ($\xi = 0.7$) when the importance of mark-up shocks is very high relative to that of demand shocks.

4.3.4 Central bank's preference for output gap stabilization

Figure 5 illustrates the ratio $\mathbb{E}(L_T/L_O)$ as a function of σ_u^2 for three levels of λ, the weight the central bank assigns to output gap variability. The parameter values used for the simulation are $\sigma_g^2 = 1$, $\sigma_\eta^2 = 0.2$, $\sigma_\mu^2 = 0.2\sigma_u^2$, $\sigma_\rho^2 = 0.2\sigma_u^2$, and $\xi = 0.5$.

It turns out that transparency is welfare improving when the central bank is more inclined towards price stabilization. Indeed, the central bank more effectively influences firms' behavior and thus the price level when it is transparent. As the central bank becomes more inclined towards price level stabilization (λ falls), the optimal central bank's response to mark-up shocks under opacity becomes stronger. As the central bank's influence on firms' behavior is limited under opacity, it finds it optimal to respond more strongly to shocks to better control the price level. In order to reduce price variability, the central bank more strongly expands or contracts nominal aggregate demand subsequent to mark-up shocks. This makes the monetary

instrument more informative about mark-up shocks and considerably reduces the negative uncertainty effect of transparency.

4.3.5 Precision of central bank's signal on mark-up shocks

Figure 6 illustrates the ratio $\mathbb{E}(L_T/L_O)$ as a function of the precision of central bank's information on mark-up shocks σ_μ^2 for three levels of ξ. The parameter values used for the simulation are $\sigma_g^2 = 1$, $\sigma_u^2 = 1$, $\sigma_\eta^2 = 0.2$, $\sigma_\rho^2 = 0.2$, and $\lambda = 1$.

This figure shows that transparency is welfare improving as the precision of central bank's signal on mark-up shocks decreases. The intuition is straightforward. Transparency is welfare detrimental when it exacerbates firms' reaction to mark-up shocks. But with poorly accurate central bank's information about mark-up shocks, the announcement does not contain much valuable information about them. As more accurate information on mark-up shocks exacerbates firms' reaction, noisy central bank's information reduces the pertinence of the announcement with respect to mark-up shocks. But, as transparency does not provide much information about mark-up shocks when σ_μ^2 is large, it provides firms with valuable information about demand shocks and central bank's response to them. The announcement however reveals to firms how the central bank perceives and responds to demand shocks, and reduces uncertainty about them.

When the economy is exclusively hit by demand shocks, transparency allows the central bank to better stabilize the economy since firms know the policy implemented by the central bank. With both demand and mark-up shocks hitting the economy and imprecise central bank's information about mark-up shocks, transparency also improves the neutralization of demand shocks without worsening the loss due to mark-up shocks.

4.3.6 Discussion

In our model, since the central bank responds to two shocks, the monetary instrument does not allow firms to disentangle the rationale behind the implemented policy. This mechanism reminds us of that in the standard literature on economic and political transparency based on the inflation bias argument. In this literature, as in our paper, the private sector is unable to disentangle two possible rationales for the observable monetary instrument. However, when central bank's preferences are unknown, firms cannot disentangle whether the rationale for the monetary instrument is the change in central bank's preferences or the response to mark-up shocks. As a result, the central bank is inclined to respond more contractively to mark-up shocks to avoid firms believing its inflation bias has risen.

However, by assuming no inflationary bias, we are able to examine the trend towards greater transparency in the conduct of monetary policy not *via* democratic accountability consideration but rather *via* some monetary policy efficiency criteria. Our framework potentially rationalizes the recent trend towards transparency in the conduct of monetary policy with respect to a couple of stylized facts. First, the occurrence and amplitude of mark-up shocks have declined over the last decades.[19] Our model suggests that economic transparency turns out to be more beneficial as the economy becomes less sensitive to mark-up shocks. Second, central banks are more inclined towards price stability today than they were in the past. Indeed, the recent switch from secrecy to transparency is clearly motivated by the will of central banks to publicly reveal their intention to stabilize prices.[20] In this respect, our model suggests that stronger price stabilization calls for higher economic transparency. Since the main aim of political transparency is better price stabilization, our result highlights that economic transparency should go along with political transparency.

[19] See Andersen and Wascher (2001) and Blanchard and Simon (2001).
[20] See Geraats (2002) and Rogoff (2003).

5 Concluding remarks

This paper analyzes the welfare effects of economic transparency in the conduct of monetary policy with imperfect common knowledge on the state of the economy. The main characteristic of our paper is to recognize that monetary policy entails a dual role: the instrument of the central bank is both an action that stabilizes the economy and a signal that partially reveals to firms the central bank's assessment about the state of the economy. We derive both the optimal monetary policy and the optimal central bank's disclosure.

The notion of transparency considered in this paper is the following. The observation of the monetary instrument does not allow firms to disentangle the central bank's opinion about each shock. A transparent central bank removes this uncertainty by disclosing an additional announcement that explains to the private sector the rationale behind its instrument. Under opacity, firms are unable to perfectly disentangle the central bank's signals responsible for the instrument. So, the central bank chooses its instrument by optimally balancing its action and information purposes. By contrast, under transparency, the central bank allows firms to identify the rationale behind the instrument and implements the policy that is optimal in the perspective of its sole action purpose.

In this context, we show that transparency is welfare increasing (i) when the degree of strategic complementarities is low, (ii) when the economy is not too affected by mark-up shocks, (iii) when the central bank is more inclined towards price stabilization, (iv) when firms have relatively precise private information, and (v) when the central bank has information that is relatively precise on demand shocks and relatively imprecise on mark-up shocks.

This result rationalizes the increase in central bank's transparency in the current context where mark-up shocks have a relatively low impact on the economic development. Since central banks that assign a large weight on price stabilization tend to be transparent with respect to their political targets, our framework suggests that

economic transparency should go along with political transparency.

References

Adam, K. (2006). Optimal monetary policy with imperfect common knowledge. *Journal of Monetary Economics*, forthcoming.

Amato, J., Morris, S., and Shin, H. S. (2002). Communication and monetary policy. *Oxford Review of Economic Policy*, 18(4):495–503.

Andersen, P. and Wascher, W. (2001). Understanding the recent behaviour of inflation: an empirical study of wage and price developments in eight countries. *BIS papers*, 3, Bank for International Settlement.

Angeletos, G.-M. and Pavan, A. (2006a). Efficient use of information and social value of information. *Econometrica*, forthcoming.

Angeletos, G.-M. and Pavan, A. (2006b). Socially optimal coordination: Characterization and policy implications. *Journal of the European Economic Association*, forthcoming.

Baeriswyl, R. (2007). Central bank's action and communication. *Munich Economics Discussion Paper*, 2007-10.

Baeriswyl, R. and Cornand, C. (2007). Can opacity of a credible central bank explain excessive inflation? *Munich Economics Discussion Paper*, 2007-08.

Barro, R. J. and Gordon, D. B. (1983). A positive theory of monetary policy in a natural rate model. *Journal of Political Economy*, 91(4):589–610.

Blanchard, O. and Simon, J. (2001). The long and large decline in US output volatility. *Brookings Papers on Economic Activity*, (1):135–164.

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

Blinder, A. S. (2000). Central-bank credibility: Why do we care? How do we build it? *American Economic Review*, 90(5):1421–1431.

Cukierman, A. (2002). Are contemporary central banks transparent about economic models and objectives and what difference does it make? *Federal Reserve Bank of St. Louis Review*, 84(4):14–45.

Dincer, N. and Eichengreen, B. (2006). Central bank transparency: Where, why, and to what effect? *mimeo*, http:// www.centrecournot.org/ pdf/ conference9/ Barry%20EICHENGREEN.pdf.

Eijffinger, S. C. W. and Geraats, P. M. (2006). How transparent are central banks? *European Journal of Political Economy*, 22(1):1–21.

Geraats, P. M. (2002). Central bank transparency. *The Economic Journal*, 112:F532–F565.

Greenspan, A. (2001). Transparency in monetary policy. *Federal Reserve Bank of St. Louis, Economic Policy Conference*, http://www.federalreserve.gov/ BOARDDOCS/ Speeches/ 2001/20011011/ default.htm.

Hellwig, C. (2002). Public announcements, adjustment delays and the business cycle. *mimeo*, http://www.econ.ucla.edu/ people/papers/ Hellwig/Hellwig208.pdf.

Hellwig, C. (2005). Heterogeneous information and the welfare effects of public information disclosures. *mimeo*, http://www.econ.ucla.edu/ people/papers/ Hellwig/Hellwig283.pdf.

IMF (1999). Code of good practices on transparency in monetary and financial policies: Declaration of principles. http://www.imf.org/ external/np/ mae/mft/code/ index.htm.

Issing, O. (2005). Communication, transparency, accountability: Monetary policy in the twenty-first century. *Federal Reserve Bank of St. Louis Review*, 87(2, pt.1):65–83.

King, M. (1997). The inflation target five years on. *Bank of England Quarterly Bulletin*, 37(4):434–442.

Kohn, D. L. (2005). Central bank communication. *mimeo*, http:// www.federalreserve. gov/boarddocs/Speeches/ 2005/20050109/ default.htm.

Morris, S. and Shin, H. S. (2002). Social value of public information. *American Economic Review*, 92(5):1521–1534.

Rogoff, K. (2003). Globalization and global disinflation. *mimeo*, http:// www.kc.frb.org/ Publicat/sympos/ 2003/pdf/ Rogoff.0910.2003.pdf.

Romer, C. D. and Romer, D. H. (2000). Federal reserve information and the behavior of interest rates. *American Economic Review*, 90(3):429–457.

The Economist (2004). It's not always good to talk. July 22nd:71.

Vickers, J. (1998). Inflation targeting in practice: the UK experience. *Bank of England Quarterly Bulletin*, 38(4):368–375.

Walsh, C. E. (2006). Transparency, flexibility, and inflation targeting. In Mishkin, F. and Schmidt-Hebbel, K., editors, *Monetary Policy under Inflation Targeting*. Central Bank of Chile, Santiago, Chile.

Walsh, C. E. (2007). Optimal economic transparency. *International Journal of Central Banking*, forthcoming.

Woodford, M. (2003). Imperfect common knowledge and the effects of monetary policy. In Aghion, P., Frydman, R., Stiglitz, J., and Woodford, M., editors, *Knowledge, Information and Expectations in Modern Macroeconomics: In Honor of Edmund S. Phelps*. Princeton University Press, Princeton.

Woodford, M. (2005). Central bank communication and policy effectiveness. *mimeo*, http://www.columbia.edu/ %7Emw2230/JHole05.pdf.

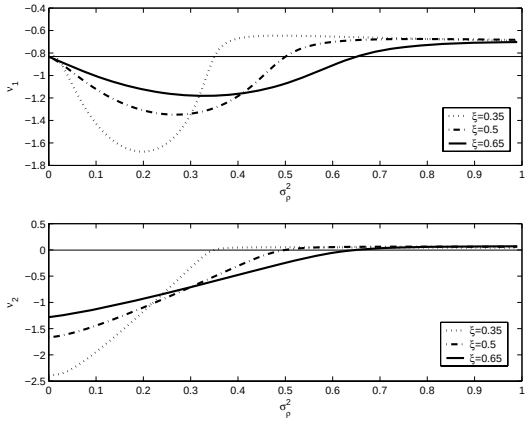

Figure 1: Optimal monetary policy under opacity

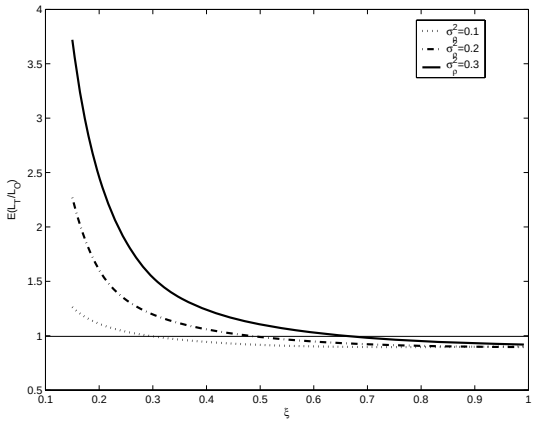

Figure 2: Welfare effect of transparency: impact of ξ

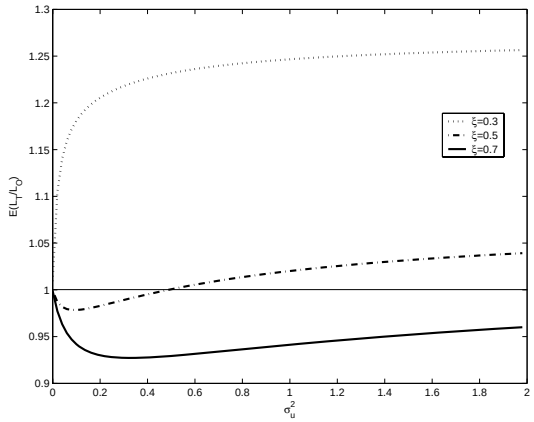

Figure 3: Welfare effect of transparency: impact of σ_u^2

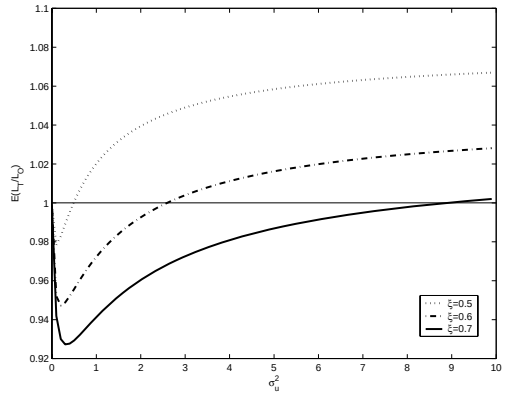

Figure 4: Welfare effect of transparency: impact of σ_u^2

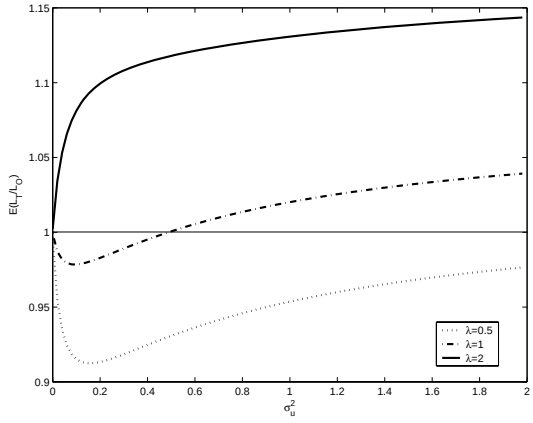

Figure 5: Welfare effect of transparency: impact of λ

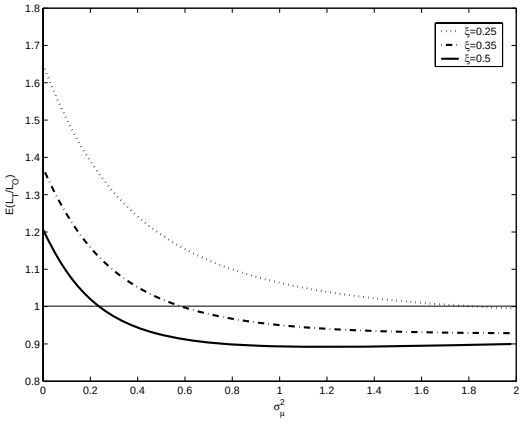

Figure 6: Welfare effect of transparency: impact of σ_μ^2