

Monetary Policy and its Informative Value*

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Abstract

This paper analyzes the welfare effects of economic transparency in the conduct of monetary policy. We propose a model of monopolistic competition with imperfect common knowledge on the shocks affecting the economy where the central bank has no inflationary bias. In this context, monetary policy entails a dual role. The instrument of the central bank is both an action that stabilizes the economy and a public signal that partially reveals to firms the central bank's assessment about the state of the economy. Yet, firms are unable to perfectly disentangle the central bank's signals responsible for the instrument and the central bank optimally balances the action and information purposes of its instrument. We derive the optimal monetary policy and the optimal central bank's disclosure. We define transparency as an announcement by the central bank that allows firms to identify the rationale behind the instrument. It turns out 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

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central bank's information is relatively precise on demand shocks and relatively imprecise on mark-up shocks. These results rationalize the increase in transparency in the current context of relative low sensitivity of the economy to mark-up shocks and of strong central bank's preference for price stability.

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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.³ 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.⁴

The aim of this paper is to analyze the benefits and costs of transparency for well-established and credible central banks. 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

¹These 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)).

²See Geraats (2002) for an overview.

³For example, as politicians gave their opinion (and disagreement) about the conduct of monetary policy by the European Central Bank, its president at that time, Wim Duisenberg, stated that it was a “*normal phenomenon*” to observe suggestions from politicians but that “*it would be very abnormal if those suggestions were to be listened to*” (The Economist (1998)).

⁴For 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.

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 press⁵, and central banks⁶. 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.

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 focus on the optimal monetary policy. Our analysis is based on a model of monopolistic competition with imperfect common knowledge and 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. Our approach has two main characteristics. First, we concentrate on the effect of economic transparency in the case where the central bank has no inflationary bias and where the private sector perfectly knows its preferences. Second, following Walsh (2005), we 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. 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,

⁵See The Economist (2004).

⁶See for example Kohn (2005) and Issing (2005).

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.

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 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.

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 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 transparency⁷ seems appropriate in the current context of declining occurrence and amplitude of mark-up shocks⁸ 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 model is derived from an economy with flexible prices, populated by a representative household, a *continuum* of monopolistic competitive firms, and a central bank. 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. The baseline framework is close to Adam (2006).

⁷The increase in transparency in the conduct of monetary policy in recent years is studied by Eijffinger and Geraats (2006).

⁸See Andersen and Wascher (2001) and Blanchard and Simon (2001).

2.1 Representative household

The representative household chooses its aggregate composite good C and labor supply H in order to maximize its utility subject to its budget constraint,

$$gU(C) - V(H)$$

$$\text{s.t. } WH + \bar{\Pi} = PC.$$

The parameter g is a stochastic demand shock with $E(g) = 1$, that induces variations in the efficient level of output. The utility function has the following usual properties: $U' > 0$, $U'' < 0$, $\lim_{C \rightarrow \infty} U'(C) = 0$, $V' > 0$, $V'' < 0$, and $V'(0) < U'(0)$. C is the composite good defined by the Dixit-Stiglitz aggregator

$$C = \left[\int_0^1 (C_i)^{\frac{\theta-1}{\theta}} di \right]^{\frac{\theta}{\theta-1}}$$

where $\theta > 1$ is the parameter of price elasticity of demand and where C_i is the good produced by firm i . θ is stochastic with $E(\theta) = \bar{\theta}$ and induces variations in the desired mark-up of firms. W denotes the competitive wage and $\bar{\Pi}$ the profits the household gets from firms. P is the appropriate price index which solves $PC = \int_0^1 P_i C_i di$ and satisfies

$$P = \left[\int_0^1 P_i^{1-\theta} di \right]^{\frac{1}{1-\theta}}.$$

Given the overall level of consumption, the household allocates its expenditure across goods according to

$$C_i = \left(\frac{P_i}{P} \right)^{-\theta} C \tag{1}$$

and optimizing the consumption-labor decision leads to the real wage

$$\frac{W}{P} = \frac{V'(H)}{gU'(C)}. \tag{2}$$

2.2 Firms

Each firm i produces a single differentiated good C_i with one unit of labor H_i according to the simple production function

$$H_i = C_i. \tag{3}$$

The profit maximization problem of firm i is given by

$$\max_{P_i} \mathbb{E}[P_i C_i(P_i) - W H_i(P_i) | I_i], \quad (4)$$

where I_i is the information set of firm i . Using (1), (2), and (3), the first order condition of (4) becomes

$$\mathbb{E} \left[(1 - \theta) \left(\frac{P_i}{P} \right)^{-\theta} + \theta \left(\frac{P_i}{P} \right)^{-\theta-1} \frac{V'(C)}{gU'(C)} | I_i \right] = 0. \quad (5)$$

Linearizing (5) around the steady state delivers

$$p_i = \mathbb{E}_i[p + \xi c + u], \quad (6)$$

where small letters indicate percentage deviation from the steady state and where

$$\begin{aligned} \xi &= -\frac{U''(\bar{C})\bar{C}}{U'(\bar{C})} + \frac{V''(\bar{C})\bar{C}}{V'(\bar{C})} \\ u &= \frac{1}{1 - \bar{\theta}} \frac{\theta - \bar{\theta}}{\bar{\theta}}. \end{aligned}$$

\bar{C} and $\bar{\theta}$ are the real output and the price elasticity of demand at their steady state level, respectively.

The pricing rule (6) states that firms set their price as a function of their expectations of the overall price level p , the real output gap c , and the mark-up shock u . This captures the strategic nature of price setting as the price level is the average price set by all firms. So, each firm sets its price according its expectation about the price of others.

The parameter ξ determines to what extent the optimal price responds to the output gap. Firms' prices strongly respond to the output gap when it has a strong impact on the competitive real wage. This occurs when ξ is large, *i.e.* when the household's utility and disutility functions are very concave and convex, respectively. Then the real wage required for additional production is high (since the household derives a low utility from additional consumption while it suffers a high disutility from additional work) and firms strongly adjust their price to the output gap. We qualify as "weakly extensive" an economy with a high value of ξ and as "highly extensive" an economy with a low value of ξ .

In this context, ξ captures the effectiveness of monetary policy for influencing the price level. As we assume below, the central bank partially determines the nominal

aggregate demand through its monetary instrument. In the case where the economy is highly extensive, output gap deviations have a small impact on the competitive real wage and thus on the price level. The monetary instrument is consequently weakly effective for influencing the price level.

ξ also determines whether prices are strategic complements or substitutes. Using the fact that the nominal aggregate demand (deviation) y can be expressed as $y = c + p$, we rewrite the pricing rule (6) as

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

In the whole paper, we realistically assume that prices are strategic complements, *i.e.* $0 < \xi \leq 1$.

2.3 Central bank

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 :

$$\min_I \mathbb{E}_{cb}[\lambda c^2 + p^2], \tag{7}$$

where $c = y - p$ is the output gap and λ the weight assigned to the output gap variability. The monetary instrument I partially determines nominal aggregate demand. The nominal aggregate demand y is the sum of the central bank's instrument and of the demand shock g , *i.e.* $y = I + g$. So, the pricing rule becomes

$$p_i = \mathbb{E}_i[(1 - \xi)p + \xi g + u + \xi I]. \tag{8}$$

For the sake of simplicity, we assume that the two 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 (8) 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

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

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

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

This result is consistent with standard optimal monetary policy analysis.⁹ 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

⁹See Clarida et al. (1999) for an overview on standard New Keynesian monetary policy.

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.* $p = 0$). 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. Contracting aggregate demand whenever mark-up shocks are positive is a standard result in monetary policy and is known as the *lean against the wind* principle.¹⁰

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.¹¹

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.

We assume that the monetary instrument is perfectly observed by firms. This corresponds to the current practice of most central banks.¹² By setting its instru-

¹⁰As we shall see below, this standard principle does not necessarily hold under imperfect common knowledge.

¹¹Usually, 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.

¹²Note that the 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

ment 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, additionally 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:

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

where η and μ are independently distributed.

The central bank chooses its instrument to minimize (7). Since both fundamental shocks and both error terms are independently normally distributed, the optimal instrument rule of the central bank is a linear combination of its signals and can be written as

$$I = \nu_1(g + \eta) + \nu_2(u + \mu). \tag{9}$$

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

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.

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 (9). 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 (8) for convenience and substitute successively the average price level with higher order expectations about the demand and mark-up shocks and the monetary instrument

$$\begin{aligned} p_i &= \mathbb{E}_i[(1 - \xi)p + \xi g + u + \xi I] \\ &= \mathbb{E}_i \left[\xi g + u + \xi I + (1 - \xi) \left[\bar{\mathbb{E}}[\xi g + u + \xi I + (1 - \xi) \bar{\mathbb{E}}[\xi g + u + \xi I + \dots]] \right] \right]. \end{aligned}$$

We denote by $\mathbb{E}_i(\cdot)$ the expectation operator of firm i conditional on its information and by $\bar{\mathbb{E}}(\cdot)$ the average expectation operator such that $\bar{\mathbb{E}}(\cdot) = \int_i \mathbb{E}_i(\cdot) di$. With heterogeneous information, the law of iterated expectations fails and expectations of higher order do not collapse to the average expectation of degree one.¹³ Thus, we rewrite the pricing rule as

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

and averaging over firms yields

$$p = \sum_{k=0}^{\infty} (1 - \xi)^k \left[\bar{\mathbb{E}}^{(k+1)}(\xi g + u + \xi I) \right], \quad (10)$$

¹³See Morris and Shin (2002).

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. The corresponding output gap is given by

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

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 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 $\mathbf{V}_{4 \times 4}$ 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

$$\mathbb{E} \begin{pmatrix} g \\ u \end{pmatrix} \Bigg| u_i, I = \mathbf{\Omega} \begin{pmatrix} u_i \\ I \end{pmatrix} = \begin{pmatrix} \Omega_{11} & \Omega_{12} \\ \Omega_{21} & \Omega_{22} \end{pmatrix} \begin{pmatrix} u_i \\ I \end{pmatrix},$$

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

Using this, equation (10) becomes

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

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 :

$$\begin{aligned} p_i &= \gamma_1 u_i + \gamma_2 I && \text{with} && (11) \\ \gamma_1 &= \frac{\xi \Omega_{11} + \Omega_{21}}{1 - (1 - \xi) \Omega_{21}} \\ \gamma_2 &= \frac{(1 - \xi) \gamma_1 \Omega_{22} + \xi(1 + \Omega_{12}) + \Omega_{22}}{\xi}. \end{aligned}$$

4.1.2 Optimal monetary policy

This section derives the optimal monetary policy under opacity. The central bank sets its monetary instrument (9) to minimize the expected loss (7) subject to the price rule (11). 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.

When central bank's and firms' information is symmetric, the monetary instrument reflects its action purpose only.

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. The information purpose of the monetary policy calls for making the instrument as less informative as possible on mark-up shocks (and as informative as possible on demand 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 shock¹⁴ ($\sigma_\rho^2 = 0$), 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 are neutralized. 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 given an increasing 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 when the economy is "highly extensive".

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.* $\nu_1 \rightarrow -\frac{\sigma_g^2}{\sigma_g^2 + \sigma_\eta^2}$ as $\sigma_\rho^2 \rightarrow \infty$. 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.* $\nu_2 \rightarrow 0$ as $\sigma_\rho^2 \rightarrow \infty$.

¹⁴With perfect information, the mark-up shock is common knowledge among 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 $0 < \lambda \frac{\sigma_p^2}{\sigma_u^2} < \xi$, the central bank responds to mark-up shocks according to the so-called *lean against the wind* principle by contracting the nominal aggregate demand whenever its signal on the mark-up shock is positive (*i.e.* $\nu_2 < 0$). And when $\xi < \lambda \frac{\sigma_p^2}{\sigma_u^2} < \infty$, it implements a slightly expansionary instrument whenever its signal on the mark-up shock is positive. 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 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.¹⁵ 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.

By doing so, the central bank reduces the informative value of its instrument about mark-up shocks. As complementarities increase, the weight put on the monetary instrument in the pricing rule increases because of its focal role. The informative value of the instrument becomes more relevant and the informative purpose of the monetary policy more effective. The incentive to reduce the response to mark-up shocks is thus larger when the degree of strategic complementarities is high.

The response of the central bank to demand shocks also depends on whether ξ is larger than $\lambda \frac{\sigma_p^2}{\sigma_u^2}$. In the region where $0 < \lambda \frac{\sigma_p^2}{\sigma_u^2} < \xi$, the central bank finds it optimal to respond more aggressively to demand shocks than it would do in the

¹⁵Baeriswyl and Cornand (2006) address more carefully this issue.

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. When $\lambda \frac{\sigma_p^2}{\sigma_u^2} = \xi$, 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 $\xi < \lambda \frac{\sigma_p^2}{\sigma_u^2} < \infty$, the central bank weakens its response to demand 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 and increases its value about its demand 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} .¹⁶ In this context, firms rationally use their three signals

¹⁶One 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.

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

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

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

Using this result into the price rule (10) yields

$$p = \sum_{k=0}^{\infty} (1-\xi)^k \begin{pmatrix} \xi & 1 & \xi \end{pmatrix} \mathbf{\Omega} \mathbf{\Xi}^k \begin{pmatrix} u \\ I \\ g_{cb} \end{pmatrix}, \quad (12)$$

where

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

The price level equation (12) is a linear combination of the mark-up shock u and of the public signals I and g_{cb} :

$$\begin{aligned} p &= \gamma_1 u + \gamma_2 I + \gamma_3 g_{cb} && \text{with} \\ \gamma_1 &= \frac{\xi \Omega_{11} + \Omega_{21}}{1 - (1-\xi) \Omega_{21}} \end{aligned} \quad (13)$$

$$\begin{aligned}\gamma_2 &= \frac{(1-\xi)\gamma_1\Omega_{22} + \xi(1 + \Omega_{12}) + \Omega_{22}}{\xi} \\ \gamma_3 &= \frac{(1-\xi)\gamma_1\Omega_{23} + \xi\Omega_{13} + \Omega_{23}}{\xi}.\end{aligned}$$

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

$$\begin{aligned}c &= I + g - p \\ &= g - \gamma_1u + (1 - \gamma_2)I - \gamma_3g_{cb}.\end{aligned}$$

Therefore,

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

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:

$$\nu_1 = -\frac{\sigma_g^2}{\sigma_g^2 + \sigma_\eta^2}g_{cb} \quad (14)$$

$$\nu_2 = -\frac{1}{\xi}\frac{\sigma_u^2}{\sigma_u^2 + \sigma_\mu^2}u_{cb}. \quad (15)$$

As stated above, equation (14) 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 (15) 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 strate-

gic uncertainties about demand shocks. Reducing this uncertainty is welfare improving since demand shocks can be neutralized by the central bank. 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.

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 the positive incentive and uncertainty effects 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. Indeed, 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

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.¹⁷ 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.¹⁸ 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.

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

¹⁷See Blanchard and Simon (2001) and Andersen and Wascher (2001).

¹⁸See Geraats (2002) and Rogoff (2003).

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.

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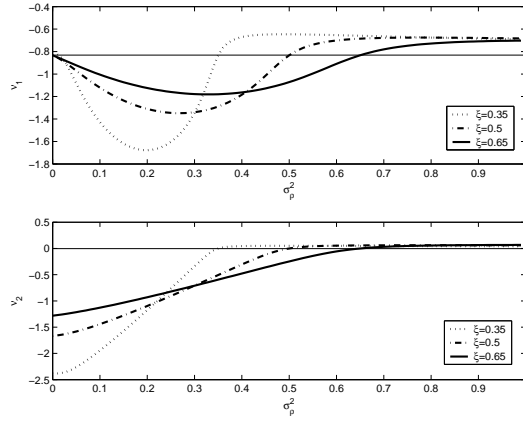


Figure 1: Optimal monetary policy under opacity

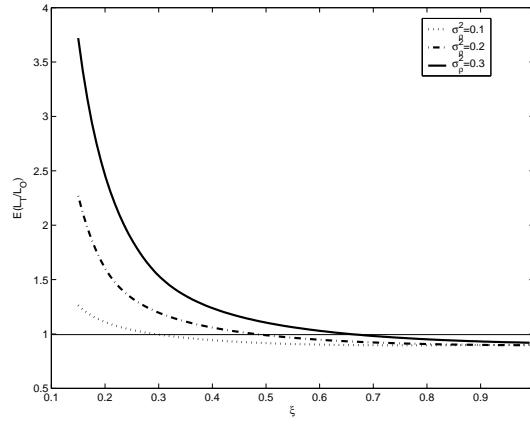


Figure 2: Welfare effect of transparency: impact of ξ

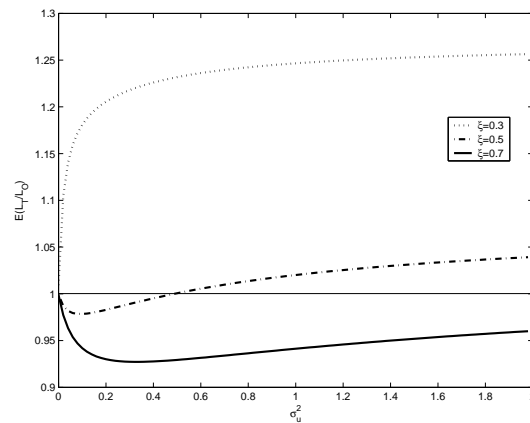


Figure 3: Welfare effect of transparency: impact of σ_u^2

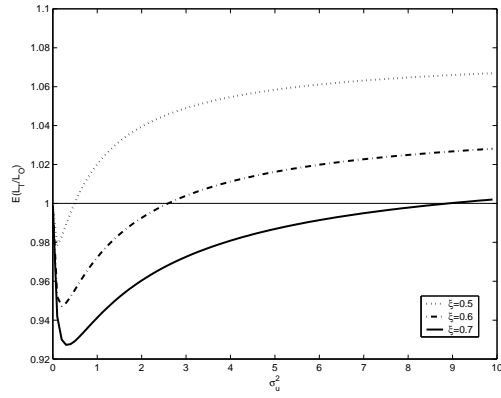


Figure 4: Welfare effect of transparency: impact of σ_u^2

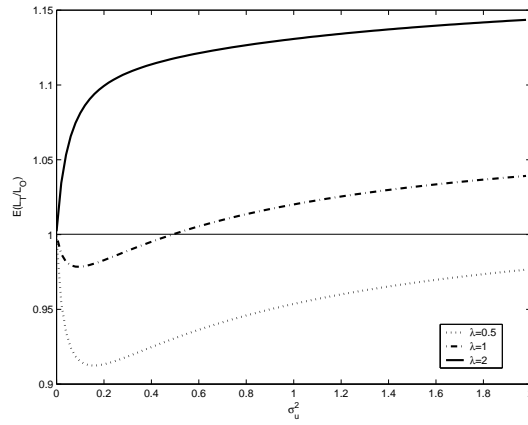


Figure 5: Welfare effect of transparency: impact of λ

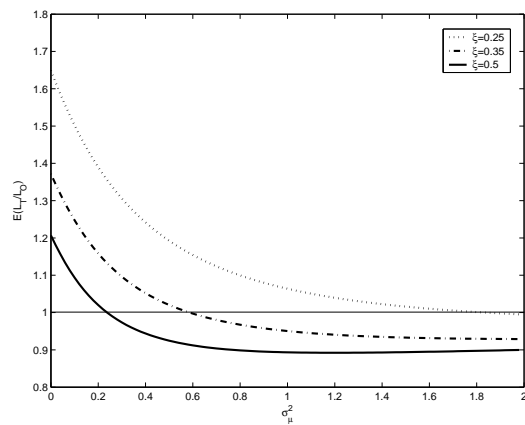


Figure 6: Welfare effect of transparency: impact of σ_μ^2