Documents de travail

« Does Model Uncertainty Lead to Less Central Bank Transparency ? »

Auteurs
Li QIN, Elefterios SPYROMITROS, Moïse SIDIROPOULOS

Document de travail n° 2006–22

Octobre 2006
Does Model Uncertainty Lead to Less Central Bank Transparency?

Li Qin, Elefterios Spyromitros, Moïse Sidiropoulos

University Louis Pasteur of Strasbourg and BETA-Theme
61, Avenue de la Forêt Noire, 67000 Strasbourg, (France)

October 4, 2006

Abstract

This paper discusses the problem of monetary policy transparency in a simple static robust control framework. In this framework, we identify two sources of monetary policy uncertainty. First, we identify the uncertainty about the central bank’s inflation stabilization preferences, which affects the private sector’s inflation expectations and therefore the realized inflation and output. On the other hand, uncertainty means that central bank is unsure about its model, in the sense that there is a group of approximate models that it also considers as possibly true and its objective is to choose a rule that will work under a range of different model specifications. We find that robustness reveals the emergence of a precautionary behaviour of the central bank in the case of unstructured model uncertainty, reducing thus central bank’s willingness to choose a high degree of monetary policy transparency.

Keywords: central bank transparency, min-max policies, model uncertainty, robust control.

JEL classification: E50, E52, E58

Corresponding author: spyro@cournot.u-strasbg.fr (Elefterios Spyromitros)
1 Introduction

Central bank transparency has become one of the main features of monetary policymaking during the last decade. However, despite the recognized academic literature on the central bank independence, research in favour of transparency of monetary policy is relatively new (Eijffinger, Hoeberichts and Shaling, 2000; Cukierman, 2001; Geraats, 2002, 2004 and Demertzis and Hughes Hallet, 2003) and the findings of the transparency literature seem to be not irrefutable. There appears also to be an inconsistency between the effects emphasized in the theoretical literature and the motives for central bank transparency in practice (Geraats, 2002). Indeed, theoretical models show that transparency has the potential to reduce uncertainty and to enhance the credibility of monetary policy. In addition, transparency may affect the incentives that policymakers face to manipulate private sector beliefs through signaling and reputation building. In other words, when monetary policy decisions are intended to offset economic shocks, private information gives the central bank greater flexibility to stabilize the economy.

These theoretical considerations on central bank transparency often rely on uncertainty effects generated by asymmetric information and are likely to depend on the specific context of uncertainty. Transparency refers to the absence of information asymmetries between monetary policymakers and the private sector. Perfect transparency corresponds to a situation of symmetric information. This does not imply that monetary policymakers and the private sector have complete information about the economy and economic disturbances. Thus, to understand the optimal choice of the degree of transparency and his economic consequences, it is helpful to look, first, at the uncertainty generated by asymmetric information and second, at the uncertainty about the true structure of the economy.

There is currently a wide consensus that, subject to the constraints inherent in the structure of the economy, the central bank should minimize an appropriately discounted value of expected losses where the period loss function is given by a weighted average of the output and inflation deviations from their targets. Transparency about the policy process aimed at achieving this objective requires clarity about the structure of the economy (Cukierman, 2005). In this context, uncertainty about the structure of the economy has some interesting implications for the optimal transparency. However, in previous studies on central bank transparency, policymakers are assumed to know the true model of the economy and observe accurately all relevant macroeconomic variables. Uncertainty arises from the unknown future realisations of the supply shocks, assumed to be modeled according to some stochastic process whose properties is known. Unfortunately, the reality is much more complex. The policymaker’s choice is made in the fare of tremendous uncertainty about the true structure of the economy, the impact policy actions have on the economy, and even about the current state of the economy. This complexity means that a certain degree of subjectivity enters into the actual decision making when deciding upon optimal monetary policy. In other words, the policymaker is unsure about his model, in the sense that there is a group of approximate models that he also considers as possibly true.
This raises the question of how a monetary policy rule should be selected in the face of uncertainty about the correct model of the economy. In fact, solutions to the expected value problem by standard optimal control methods do not deliver the best average performance if they are applied to an incorrect model. Because uncertainty is pervasive, it is important to understand how alternative policies work when the policymaker employs a model of the economy that is incorrect in unknown ways. Therefore, the resulting problem is one of robust control, in the sense of Hansen and Sargent (2003, 2004), where the objective is to choose a rule that will work under a range of different model specifications. The notion that policy decisions may be more robust if based on systematically distorted model of the economy is a key implication of the recent research on robustness control or uncertainty aversion literature (Onatski and Williams, 2003; Kilponen, 2003; Giordani and Söderlind, 2004; Leitemo and Söderström, 2004; Walsh, 2004).

This paper adapts robust control approach to the problem of the central bank transparency in a simple one-period positive theory monetary policy framework developed originally by Kydland and Prescott (1977) and Barro and Gordon (1983) in order to illustrate the basic intuition behind this new approach to uncertainty. In this framework, we identify two sources of uncertainty. First, the uncertainty concerning the central bank preferences (lack of transparency) affecting the private sector inflation expectations and thus inflation and output and second, the model uncertainty affecting the macroeconomic variables and the degree of transparency. In this context, it is particularly important to give an answer to the question whether model uncertainty affects the transparency of monetary policy as well as the welfare and the macroeconomic performance.

The rest of the paper is organised as follows. Section 2 sets up a one-period model of monetary policy. Section 3 derives the discretionary equilibrium under robust control. Section 4 derives the link between robustness and the degree of central bank transparency. Section 5 and 6 derives the macroeconomic performance and the welfare effects of central bank transparency. Section 7 summarises the main conclusions.

2 The model

In this section, we apply the basic idea of robust control to a simple one-period model of monetary policy developed originally in the seminal papers of Kydland and Prescott (1977) and Barro and Gordon (1983), in which policymaker sets inflation according to the following aggregate supply function:

\[ x = \pi - \pi^e + \epsilon + h \]  

(1)

where \( x \equiv y - y^* \) is the output gap between the real aggregate output \( y \) and the natural rate of output \( y^* > 0 \), \( \pi \) is the inflation rate, \( \pi^e \) is the rationally expected inflation rate, \( \epsilon \) is a random variable with mean zero and variance 1, and \( h \) is an additional deterministic disturbance component which introduce ambiguity of the
model. The two disturbances terms and have different properties. The term $\epsilon$ is assumed to be a random error with a prior known stochastic properties, whilst $h$ represents in the spirit of robust control (Hansen and Sargent, 2004) a totally ambiguous model misspecification error, in the sense that the policymaker is not able to assign any prior probability distribution to $h$. The model with $h = 0$ represents the reference model, while the models with $h \neq 0$ represent candidate models surrounding the reference model. The size of the distortion term $h$ must be bounded as the policymaker has some information on the process. Hence, we assume that the magnitude of the square of the specification error verifies:

$$h^2 \leq \eta^2$$  \hspace{1cm} (2)

where the parameter $\eta^2$ bounds the square of the government’s specification error $h^2$.

Restriction (2), together with equation (1), define a set of models that the central bank considers as being possible outcomes in the sense that the policymaker does not know exactly the position of the aggregate supply in the space $(x, \pi)$.

The central bank’s preferences are described by the following standard quadratic loss function:

$$L_{cb} = \frac{1}{2} \left[ (x - \hat{x})^2 + \lambda (\pi - \hat{\pi})^2 \right]$$  \hspace{1cm} (3)

where central bank is assumed to stabilize output $y$ and inflation $\pi$ around their target values $\hat{x} > 0$ and $\hat{\pi}$, which is for simplicity fixed to zero. $\lambda > 0$ is the inflation aversion parameter of the central bank.

The issue of transparency arises when the public’s perception about the bank’s preferences on inflation $\hat{\lambda}$ differs from the values that the bank itself actually considers $\lambda^1$. Equation 4 specifies the stochastic behavior of the parameter $\lambda$ as follows:

$$\lambda = \hat{\lambda} - \mu, \quad \text{with} \quad E_{t-1} (\mu) = 0, \quad \text{Var} (\mu) = \sigma^2_{\mu}$$  \hspace{1cm} (4)

This implies that the public is correct on average, but may be mistaken when making guesses about the central bank preferences in individual cases or at certain points in time. $\sigma^2_{\mu}$ measures the degree of opacity of the central bank’s inflation stabilization preferences. If the variance of the preference shock $\sigma^2_{\mu}$ goes up (goes down), the central bank becomes less (more) transparent respectively.

### 3 Discretionary equilibrium

According to the robust control approach, in order to hedge against the model ambiguity, the policymaker makes a particular subjective assessment of $h$. In other words, he chooses the worst case ($h \neq 0$) at any given $\pi^e$ and then designs corresponding monetary policy rule $\pi$ which maximizes the utility at given $h$. In

\footnote{In the transparency literature, misunderstandings about the true value of the preference parameters $\lambda$ can be identified as political transparency in line with Hughes Hallet and Viegi (2001) or Geraats (2002).}
order to introduce such subjective assessment of \( h \) into the decision making problem, we replace the standard quadratic utility function (4) by an “uncertainty aversion” utility function and we seek a solution to the following problem:

\[
\min_{\pi} \max_{h} L'_{cb} = \frac{1}{2} \left[ (x - \hat{x})^2 + \lambda (\pi - \hat{\pi})^2 \right] - \frac{\theta}{2} h^2 \quad (5)
\]

The design of a robust policy rule becomes now a min-max problem, where the optimal level of inflation is found by minimizing \( L'_{cb} \), with \( h \) being chosen to maximize \( L'_{cb} \) subject to the linear constraint (1). \( \theta \) is a fixed penalty parameter which reflects the central banker’s desired degree of robustness. \( \theta > 1 \) can be interpreted as a Lagrangian multiplier on constraint (2). The value \( \theta = 1 \) is the breakdown point to be discussed later. The value for \( \theta \) would be endogenous in the constrained Lagrangian, and it would be associated to the specific \( \eta \) value used in the constraint (2). The way the problem is written here, \( \theta \) is chosen directly and the constraint is adapted accordingly. Note also that larger values of \( \theta \) imply smaller sets of models so that \( \theta \) is an indicator of the precautionary behaviour of the authorities. In other words, the more \( \theta \) is close to one, the more the central bank is insuring about the accuracy of the model it uses. In the opposite case, as \( \theta \to +\infty \), the central bank believes that its model is a good approximation of the true model of the economy. In the limit case where \( \theta = +\infty \), there is no misspecification and the central bank is convinced that the model it uses is the true one.

From the first order conditions for \( \pi \) and \( h \) in the problem (5), we obtain respectively the following solutions for the central bank robust policy rule and the nature (evil agent) worst-case shock:

\[
\pi(h) = \frac{\pi^e + \hat{x} - \varepsilon - h}{1 + \lambda} \quad (6)
\]

\[
h(\pi) = \frac{\pi - \pi^e + \varepsilon - \hat{x}}{\theta - 1} \quad (7)
\]

and then solving the system of equations (6) and (7), we obtain:

\[
\pi(\theta) = \frac{\theta}{\theta + \lambda(\theta - 1)} (\pi^e - \varepsilon + \hat{x}) \quad (8)
\]

\[
h(\theta) = -\frac{\lambda}{\theta + \lambda(\theta - 1)} (\pi^e - \varepsilon + \hat{x}) \quad (9)
\]

where \( \pi(\theta) \) gives the central bank’s (robust) best reaction function for setting \( \pi \) as a function of \( \pi^e \), while \( h(\theta) \) determines the worst case model, given \( \pi^e \) and the central bank’s setting \( \pi(\theta) \). Then, using equation (8) and assuming rational expectations of the private sector yields:

\[
E(\pi) = E \left[ \frac{\theta}{\theta + \lambda(\theta - 1)} \right] (\pi^e + \hat{x}) \quad (10)
\]
Using $E(\pi) = \pi^e$ and a second order Taylor approximation, we write (10) as

\[
\pi^e = \frac{[\theta + \bar{\lambda}(\theta - 1)]^2 + (\theta - 1)\sigma^2_\mu}{[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu} \hat{x}
\]

(11)

where the expected inflation is positive $\pi^e > 0$ because there is a source of a positive inflation bias in the model ($\hat{x} > 0$). Then, given (11), we can solve for the equilibrium. Inserting inflation expectations (11) into equations (8) and (9) and solving the resulting system delivers the inflation, the output gap and the worst-case shock in discretionary equilibrium as follows:

\[
\pi = \frac{\theta}{\theta + \lambda(\theta - 1)} \left[ \frac{[\theta + \bar{\lambda}(\theta - 1)]^3 \hat{x}}{[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu} - \varepsilon \right]
\]

(12)

\[
x = \hat{x} - \frac{\theta \lambda}{\theta + \lambda(\theta - 1)} \left[ \frac{[\theta + \bar{\lambda}(\theta - 1)]^3 \hat{x}}{[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu} - \varepsilon \right]
\]

(13)

\[
h = -\frac{\lambda}{\theta + \lambda(\theta - 1)} \left[ \frac{[\theta + \bar{\lambda}(\theta - 1)]^3 \hat{x}}{[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu} - \varepsilon \right]
\]

(14)

### 4 Robustness and transparency

In this model uncertainty framework, the robust policy rule is designed to perform reasonably well across a range of alternative models, but it has not been designed to be optimal relative to any particular model. In this context, it is particularly important to give an answer to the question whether model uncertainty affects the transparency of monetary policy. In order to highlight this question, it is useful to find a relation between the degree of model robustness $\theta$ and the variance of the central bank preference shock $\sigma^2_\mu$. For this reason, we use the expected inflation equation (11), where $\pi^e > 0$ because a positive inflation bias ($\hat{x} > 0$) is assumed in this model. To be consistent with $\pi^e > 0$, the condition

\[
[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu > 0
\]

is required. By arranging the terms of this condition, we get the inequality:

\[
\sigma^2_\mu < \frac{[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}}{\theta(\theta - 1)}
\]

(15)

This inequality (15) can be used to generate a link between the degree of model robustness $\theta$ and the variance of the central bank preference shock $\sigma^2_\mu$. The intuition behind this link is that there is an upper limit for the degree of central bank opacity.
(lack of transparency) \( \sigma_n^2 \), which is a function of the degree of model robustness \( \theta \). In this perspective, we verify the monotonicity of the function

\[
f(\theta) = \frac{[\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}}{\theta(\theta - 1)}
\]

(16)

by taking the following first order condition:

\[
f'(\theta) = -\frac{[\theta + \bar{\lambda}(\theta - 1)] [\theta - \bar{\lambda}(\theta - 1)]}{\theta^2(\theta - 1)^2}
\]

(17)

Equation (17) reveals that monotonicity of \( f'(\theta) \) depends crucially on the sign of the term \([\bar{\lambda}(\theta - 1) - \theta]\). To provide a further clarification of the sign of this term, we can determine the relation between the degree of model robustness and the degree of central bank opacity. In this respect, the expression \([\bar{\lambda}(\theta - 1) - \theta]\) can be illustrated in the Figure 1:

![Figure 1: The monotonicity of \((\bar{\lambda}(\theta - 1) - \theta)\)](image)

where the curve in this figure represents all the points satisfying the condition: \([\bar{\lambda}(\theta - 1) - \theta] = 0 \) (with \( \bar{\lambda} = 1 \) and \( \theta = 1 \) being two asymptotes). Here, we just take into account the region A delimited by \( \bar{\lambda} \geq 1 \) and \( \theta > 1 \). Our discussion here focuses solely on the region A which represents generally the most of possible cases where an independent central bank has a rather high degree of model robustness. It becomes also obvious that the area bordered by the above three lines is negligible in the whole region A. For this region, we verify the following relation:

\[
f'(\theta) > 0
\]

(18)

This result represents the more realistic condition on the current central banking practice. In fact, the majority of central banks presently attach a more important
weight to inflation stabilization than to the output gap. On the other hand, though the central bank’s reference model could be misspecified to some extend, the extent of specification error is restricted (see equation 2), which implies that the degree of model robustness $\theta$ is usually to a large extent higher than the break point 1. From this result, we derive the following proposition.

**Proposition 1** There are a positive relationship between the degree of model robustness, $\theta$, and the degree of central bank opacity (lack of transparency) $\sigma^2_{\mu}$. In other words, the limits within which the central bank may assign alternative values in $\sigma^2_{\mu}$, enlarge with the increase in the degree of model robustness, $\theta$, meaning that central bank’s monetary policy can be less transparent.

**Proof.** According to equation (18), we obtain the following result $\partial f(\theta)/\partial \theta > 0$. This result imply a less restrictive condition on $\sigma^2_{\mu}$ according to equation $\sigma^2_{\mu} < f(\theta)$ (15). This imply an enlargement of the limits within which the uncertainty of central bank preferences, $\sigma^2_{\mu}$, may take higher values than before an increase in the degree of model robustness, $\theta$.

The intuition behind this result is that the less a central bank believes in the robustness of the model of the economy, the more it could be reluctant to reveal information on its preferences about inflation stabilization.

## 5 Macroeconomic effects

The discretionary equilibrium solutions permit as to investigate now how the degree of central bank opacity, $\sigma^2_{\mu}$, affects the optimal values of the macroeconomic variables. Considering equations (19), (12) and (13), and differentiating with respect to the degree of central bank opacity $\sigma^2_{\mu}$, we obtain respectively for expected inflation, inflation and output gap the following results:

$$
\frac{\partial \pi^e}{\partial \sigma^2_{\mu}} = \left[ \frac{\theta A^2 + \theta(\theta - 1)^2 \sigma^2_{\mu} (\theta - 1)^2}{\bar{\lambda}(\theta - 1) A^2 - \theta(\theta - 1)^2 \sigma^2_{\mu}} \right] \hat{x} + \frac{\theta(\theta - 1)^2}{\bar{\lambda}(\theta - 1) A^2 - \theta(\theta - 1)^2 \sigma^2_{\mu}}
$$

$$
\frac{\partial \pi}{\partial \sigma^2_{\mu}} = \frac{\theta^2(\theta - 1)^2 A^3 \hat{x}}{(\lambda(\theta - 1) + \theta) (A^2 \bar{\lambda}(\theta - 1) - (\theta - 1)^2 \theta \sigma^2_{\mu})^2}
$$

$$
\frac{\partial |x - \hat{x}|}{\partial \sigma^2_{\mu}} = \frac{\lambda \theta^2(\theta - 1)^2 A^3 \hat{x}}{(\lambda(\theta - 1) + \theta) (A^2 \bar{\lambda}(\theta - 1) - (\theta - 1)^2 \theta \sigma^2_{\mu})^2}
$$

From the above results, we derive the following propositions concerning the effects of transparency on macro variables.

**Proposition 2** The more the central bank’s opacity $\sigma^2_{\mu}$ is important, the higher the inflation expectations $\pi^e$, the inflation $\pi$ and the output gap $x$ will be.
Proof. From equations (19), (20) and (21) it is straightforward to find that:

\[
\frac{\partial \pi}{\partial \sigma^2_\mu} > 0, \quad \frac{\partial \pi}{\partial \sigma^2_\mu} > 0 \quad \text{and} \quad \frac{\partial |x - \hat{x}|}{\partial \sigma^2_\mu} > 0.
\]

The intuition behind this proposition is that as the central bank opacity about its preferences increases, private agents tend to move up their inflationary expectations because of the risk to underestimate the inflation. On the other hand, to realize the output objective, central bank should raise more the inflation rate subsequent to the move up of the inflationary expectations. Consequently, the level of the output gap will be higher when the change on the central bank opacity (lack of transparency) becomes more important.

Concerning now the inflation and output gap volatility due to the change on the central bank transparency, equations (12) and (13) give as respectively the variances of the inflation and the output gap as:

\[
\text{Var}(\pi) = \frac{\theta^2(\theta - 1)^2}{[\lambda(\theta - 1) + \theta]^4} \sigma^2_\mu \quad (22)
\]

\[
\text{Var}(x) = \frac{\theta^2\lambda^2}{[\lambda(\theta - 1) + \theta]^2} \left[ \frac{\theta - 1}{\lambda(\theta - 1) + \theta} - \frac{1}{\lambda} \right]^2 \sigma^2_\mu \quad (23)
\]

Proposition 3 The more the central bank’s opacity \( \sigma^2_\mu \) is important, the more the volatility of the output gap and the inflation will be important.

Proof. Differentiating equations (22) and (23) with respect to \( \sigma^2_\mu \) gives respectively:

\[
\frac{\partial \text{Var}(\pi)}{\partial \sigma^2_\mu} = \frac{\theta^2(\theta - 1)^2}{[\lambda(\theta - 1) + \theta]^4} > 0 \quad (24)
\]

\[
\frac{\partial \text{Var}(x)}{\partial \sigma^2_\mu} = \frac{\theta^2\lambda^2}{[\lambda(\theta - 1) + \theta]^2} \left[ \frac{\theta - 1}{\lambda(\theta - 1) + \theta} - \frac{1}{\lambda} \right]^2 > 0 \quad (25)
\]

Finally, we consider the interaction between the uncertainty about the central bank preferences \( \sigma^2_\mu \) and the model uncertainty which is characterized by the mis-specification term \( h \). We derive the following proposition.

Proposition 4 The misspecification doubts of the central bank about the true structure of the economy, \( h \), are positively related to the central bank’s opacity \( \sigma^2_\mu \).

Proof. From the derivation of equation (21) with respect to \( \sigma^2_\mu \), we obtain:

\[
\frac{\partial |h|}{\partial \sigma^2_\mu} = \frac{\lambda\theta(\theta - 1)^2A^3\hat{x}}{(\lambda(\theta - 1) + \theta) \left( A^2\lambda(\theta - 1) - (\theta - 1)^2\theta\sigma^2_\mu \right)^2} > 0 \quad (26)
\]

\(^2\text{We assume here} \hat{x} = 0, \text{for simplifying the calculate.}\)
The preceding results reveal that a larger degree of central bank opacity requires that central bank will act more aggressively. This brings better economic stability performance, but it does not come without costs. On the other hand, the possible misspecification doubts of the central bank will be negatively related to the monetary policy transparency.

6 Welfare effects

We consider in this section how the central bank’s expected loss function $L'_cb$ varies with the degree of model robustness $\theta$ and the degree of central bank’s opacity $\sigma^2$. In this respect we insert the equilibrium values of $\pi$, $x$ and $h$ in the central bank’s expected loss function (5) and we obtain the following result:

$$L'_cb = \frac{1}{2} \left[ \left( \frac{\theta \lambda}{\theta + \lambda(\theta - 1)} \right)^2 \left( \frac{\theta + \bar{\lambda}(\theta - 1)}{\theta + \bar{\lambda}(\theta - 1)} \right)^3 \tilde{x} - \bar{\varepsilon} \right]^2$$

Taking into account that $E(\lambda) = \lambda$ and $\sigma^2 = 1$, we get:

$$L'_cb = \frac{\theta \lambda}{2[\theta + \lambda(\theta - 1)]} \left[ \frac{[\theta + \bar{\lambda}(\theta - 1)]^6 \tilde{x}^2}{([\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu)^2} + 1 \right]$$

We examine, first, the impact of the uncertainty concerning the central bank’s opacity on the central bank’s expected losses and we derive the following proposition.

Proposition 5 The greater the central bank opacity is, the higher the expected losses of central bank will be.

Proof. From equation (28), we derive with respect to $\sigma^2_\mu$ and we easily obtain:

$$\frac{\partial L'_cb}{\partial \sigma^2_\mu} = \frac{\lambda \theta^2 (\theta - 1)^2 [\theta + \bar{\lambda}(\theta - 1)]^6 \tilde{x}^2}{[\theta + \lambda(\theta - 1)] \left\{ [\theta + \bar{\lambda}(\theta - 1)]^2 \bar{\lambda}(\theta - 1) - \theta(\theta - 1)^2\sigma^2_\mu \right\}^3} > 0$$

It is not surprising that this increase of uncertainty of the central bank preferences will induce a further higher loss. Indeed, as has been demonstrated in the previous section, an increase of the uncertainty about the central bank’s preferences generates a higher volatility of inflation and the output gap.

Finally, we consider the effect of the model uncertainty on the central bank’s expected loss function. Given the imprecise interaction between the of model uncertainty, the central bank’s opacity and the central bank’s expected losses, we consider
two particular cases. First, the case where there is no uncertainty on central bank’s preferences, (i.e. the case of full transparency) and second, the case where there is a certain degree of uncertainty on central bank’s preferences (i.e. relative opacity).

In the first case, since \( \sigma^2 = 0 \), we put \( \lambda = \bar{\lambda} \) and then the expected loss function becomes

\[
L'_{cb} = \frac{1}{2} \left[ \frac{\bar{\lambda} \theta}{\theta + \bar{\lambda}(\theta - 1)} + \frac{A \bar{x}^2}{(\theta - 1)^2 \bar{\lambda}} \right]
\]  

(30)

Then, we derive (30) with respect to \( \theta \) and we obtain:

\[
\frac{\partial L'_{cb}}{\partial \theta} = -\frac{1}{2} \left[ \frac{\bar{\lambda}(\theta - 1) + 2 \bar{\lambda} \theta \bar{x}^2 + \bar{\lambda}}{\lambda(\theta - 1)^3} \right]
\]

(31)

Equation (31) reveals that the more the model is robust, the less the central bank expected loss will be. This result is in line with the corresponding literature. Moreover, in the case where there is no model misspecification (i.e. \( \theta \to \infty \)), the central bank’s expected loss receives its minimum value (the certainty equivalence case).

However, it becomes more interesting to re-evaluate this relation in the second case, in which opacity on the central bank preferences occurs. Unfortunately, analytical derivation in this case for the expected loss function with respect to \( \theta \) is complicated. Nevertheless, using numerical simulations, we show that when the model used by the central bank becomes more accurate, the central bank’s losses augment for any given degree of monetary policy transparency.

Figure 2: The central bank’s losses

In Figure 2 we report the results of our numerical simulations and we illustrate a negative relationship between the degree of model robustness \( \theta \) and the central bank’s losses \( L'_{cb} \). Finally, using the results of these two cases, we can derive the following proposition:
Proposition 6  For any given degree of transparency, the central bank’s expected loss decreases with the degree of model robustness.

Proof. From equation (31) and the simulation results reported in Figure 2, it is straightforward to find that: \[ \frac{\partial L_{cb}}{\partial \theta} < 0 \]

In this framework, the expected loss is affected by two underlying sources of uncertainty. For any given degree of central bank transparency, central bank can always benefit from the improvement of the model robustness improving thus the macroeconomic performances.

7 Conclusions

In this paper, we adapt the robust control approach on uncertainty in a simple static one-period monetary policy game framework to study the problem of the monetary policy transparency. In this framework, we identify two sources of uncertainty: the uncertainty about the central bank preferences (central bank’s opacity or transparency) and the model uncertainty concerning the true structure of the economy. In this context, it is particularly important to give an answer to the question whether model uncertainty affects the transparency of monetary policy as well as the welfare and the macroeconomic performance.

In this environment, we show that robustness or ”uncertainty aversion” reveals the possibility of a precautionary behaviour of the central bank in the case of potential specification errors surrounding the model, reducing thus central bank’s willingness to choice a high degree of monetary policy transparency. More precisely, there appears that the limits within which the central bank may assign different values in preference uncertainty enlarge with the increase in the degree of model robustness, meaning that central bank’s monetary policy may potentially be less transparent.

On the other hand, we show also that the more the central bank’s opacity is important, the higher the inflation expectations, the inflation, the output gap and their volatility will be important. These results reveal that a larger degree of central bank opacity requires that central bank will act more aggressively, generating thus a better economic stability performance. Finally, we show that the central bank expected loss is affected by two underlying sources of uncertainty. For any given degree of central bank transparency, central bank can always benefit from the improvement of the model robustness improving thus the macroeconomic performances.
References


## Documents de travail du BETA

<table>
<thead>
<tr>
<th>Numéro</th>
<th>Titre</th>
<th>Auteur(s)</th>
<th>Date de publication</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000–01</td>
<td>Hétérogénéité de travailleurs, dualisme et salaire d’efficience.</td>
<td>Francesco DE PALMA</td>
<td>janvier 2000</td>
</tr>
<tr>
<td>2000–04</td>
<td>Une analyse cognitive du concept de « vision entrepreneuriale ».</td>
<td>Frédéric CRÉPLET, Babak MEHMANPAZIR</td>
<td>février 2000</td>
</tr>
<tr>
<td>2000–05</td>
<td>Common knowledge and consensus with noisy communication.</td>
<td>Frédéric KŒSSLER</td>
<td>mars 2000</td>
</tr>
<tr>
<td>2000–08</td>
<td>Knowledge and Expertise : Toward a Cognitive and Organisational Duality of the Firm.</td>
<td>Frédéric CRÉPLET, Olivier DUPOUET, Francis KERN, Francis MUNIER</td>
<td>mai 2000</td>
</tr>
<tr>
<td>2000–13</td>
<td>Turning Box–Cox including Quadratic Forms in Regression.</td>
<td>Marc GAUDRY, Ulrich BLUM, Tran LIEM</td>
<td>septembre 2000</td>
</tr>
<tr>
<td>2000–14</td>
<td>Pour une approche dialogique du rôle de l’entrepreneur/manager dans l’évolution des PME : l’ISO comme révélateur ...</td>
<td>Frédéric CRÉPLET, Blandine LANOUX</td>
<td>septembre 2000</td>
</tr>
<tr>
<td>2000–16</td>
<td>Can we consider the policy instruments as cyclical substitutes ?</td>
<td>Sylvie DUCHASSAING, Laurent GAGNOL</td>
<td>décembre 2000</td>
</tr>
</tbody>
</table>


2001–03 Développement durable et Rapports Nord–Sud dans un Modèle à Générations Imbriquées:  
interroger le futur pour éclairer le présent.  

2001–04 Modeling Behavioral Heterogeneity in Demand Theory.  
Isabelle MARET, mars 2001.

2001–05 Efficient estimation of spatial autoregressive models.  

2001–06 Un modèle de stratégie individuelle de primo–insertion professionnelle.  

2001–07 Endogenous Fluctuations and Public Services in a Simple OLG Economy.  

2001–08 Behavioral Heterogeneity in Large Economies.  


2001–10 Dépendance spatiale sur données de panel: application à la relation Brevets–R&D au  
niveau régional.  

Laurent GAGNOL, Jean–Alain HÉRAUD, mai 2001.

2001–12 Diversity of innovative strategy as a source of technological performance.  


Frédéric KŒSSLER, juin 2001.


2001–16 The Performance of German Firms in the Business–Related Service Sectors: a Dynamic  
Analysis.  

2001–17 Why Central Bank Independence is high and Wage indexation is low.  

2001–18 Le mélange des ethnies dans les PME camerounaises: l’émergence d’un modèle  
d’organisation du travail.  
Raphaël NK AKLEU, octobre 2001.

2001–20 Profils d'identité des dirigeants et stratégies de financement dans les PME camerounaises. 
Raphaël NKA Luxe, octobre 2001.

2001–21 Concurrence Imparfaite, Variabilité du Taux de Marge et Fluctuations Endogènes. 

2001–22 Determinants of Environmental and Economic Performance of Firms : An Empirical Analysis 
of the European Paper Industry. 

2001–23 The policy mix in a monetary union under alternative policy institutions and asymmetries. 


2002–01 Strategic Knowledge Sharing in Bayesian Games : A General Model. 
Frédéric KŒSSLER, janvier 2002.

2002–02 Strategic Knowledge Sharing in Bayesian Games : Applications. 
Frédéric KŒSSLER, janvier 2002.

2002–03 Partial Certifiability and Information Precision in a Cournot Game. 
Frédéric KŒSSLER, janvier 2002.

2002–04 Behavioral Heterogeneity in Large Economies. 
Gael GIRAUD, Isabelle MARET, janvier 2002. 

2002–05 Modeling Behavioral Heterogeneity in Demand Theory. 
Isabelle MARET, janvier 2002. 

2002–06 Déforestation, croissance économique et population : une étude sur données de panel. 
Phu NGUYEN VAN, Théophile AZOMAHOU, janvier 2002.

Claudia KESER, Marc WILLINGER, janvier 2002.

2002–08 Principe de précaution et comportements préventifs des firmes face aux risques 
environnementaux. 
Sandrine SPÆTER, janvier 2002.

Phu NGUYEN VAN, janvier 2002.

2002–10 Dualité cognitive et organisationnelle de la firme au travers du concept de communauté. 
Frédéric CRÉPLET, Olivier DUPOUËT, Francis KERN, Francis MUNIER, février 2002.

2002–11 Comment évaluer l’amélioration du bien—être individuel issue d’une modification de la qualité 
du service d’élimination des déchets ménagers ? 
Valentine HEINTZ, février 2002.
<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Authors</th>
<th>Date</th>
</tr>
</thead>
</table>
2003–04  Strategic Market Games with a Finite Horizon and Incomplete Markets.  
Gaël GIRAUD et Sonia WEYERS, avril 2003.

2003–05  Exact Homothetic or Cobb–Douglas Behavior Through Aggregation.  

2003–06  Relativité de la satisfaction dans la vie : une étude sur données de panel.  
Théophile AZOMAHOU, Phu NGUYEN VAN, Thi Kim Cuong PHAM, juin 2003.

2003–07  A model of the anchoring effect in dichotomous choice valuation with follow–up.  
Sandra LECHNER, Anne ROZAN, François LAISNEY, juillet 2003.

Giuseppe DIANA, Moïse SIDIROPOULOS, juillet 2003.

Julien PÉNIN, juillet 2003.

Isabelle MARET, août 2003.

Nicolas CARAYOL, septembre 2003.

2003–12  The ‘probleme of problem choice’: A model of sequential knowledge production within scientific communities.  
Nicolas CARAYOL, Jean–Michel DALLE, septembre 2003.

Phu NGUYEN VAN, décembre 2003.

2004–01  Utilité relative, politique publique et croissance économique.  
Thi Kim Cuong PHAM, janvier 2004.

2004–02  Le management des grands projets de haute technologie vu au travers de la coordination des compétences.  
Christophe BELLEVAL, janvier 2004.

2004–03  Pour une approche dialogique du rôle de l’entrepreneur/manager dans l’évolution des PME : l’ISO comme révélateur …  
Frédéric CRÉPLET, Blandine LANOUX, février 2004.

Gaël GIRAUD, Céline ROCHON, février 2004.

Gaël GIRAUD, Céline ROCHON, février 2004.

2004–06  Dualité cognitive et organisationnelle de la firme fondée sur les interactions entre les communautés épistémiques et les communautés de pratique.  
Frédéric CRÉPLET, Olivier DUPOUËT, Francis KERN, Francis MUNIER, février 2004.

2004–07  Les Portails d’entreprise : une réponse aux dimensions de l’entreprise « processeur de connaissances ».  
Frédéric CRÉPLET, février 2004.
<table>
<thead>
<tr>
<th>Year</th>
<th>Title</th>
<th>Authors</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004–09</td>
<td>Les CIFRE : un outil de médiation entre les laboratoires de recherche universitaire et les entreprises.</td>
<td>Rachel LÉVY</td>
<td>avril 2004</td>
</tr>
<tr>
<td>2004–14</td>
<td>Insurance and Financial Hedging of Oil Pollution Risks.</td>
<td>André SCHMITT, Sandrine SPAETER</td>
<td>septembre 2004</td>
</tr>
<tr>
<td>2004–16</td>
<td>Du paradoxe libéral–parétien à un concept de métaclassement des préférences.</td>
<td>Herrade IGERSHEIM</td>
<td>novembre 2004</td>
</tr>
<tr>
<td>2005–01</td>
<td>Les collaborations Université Entreprises dans une perspective organisationnelle et cognitive.</td>
<td>Frédéric CRÉPLET, Francis KERN, Véronique SCHAEFFER</td>
<td>janvier 2005</td>
</tr>
<tr>
<td>2005–02</td>
<td>The Exact Insensitivity of Market Budget Shares and the ‘Balancing Effect’.</td>
<td>Gaël GIRAUD, Isabelle MARET</td>
<td>janvier 2005</td>
</tr>
<tr>
<td>2005–06</td>
<td>Is Monetary Union Necessarily Counterproductive ?</td>
<td>Giuseppe DIANA, Blandine ZIMMER</td>
<td>mars 2005</td>
</tr>
</tbody>
</table>

*Note: The dates are in the format of the year followed by the month.*
Laurent BUISSON, mai 2005.

2005–09  Coordination des négociations salariales en UEM : un rôle majeur pour la BCE.
Blandine ZIMMER, mai 2005.

2005–10  Open knowledge disclosure, incomplete information and collective innovations.
Julien PÉNIN, mai 2005.

Giovanni DOSI, Patrick LLERENA, Mauro SYLOS LABINI, juillet 2005.

André SCHMITT, Sandrine SPAETER, novembre 2005.

Stéphane BERTRAND, Kene BOUN MY, Alban VERCHÈRE, novembre 2005.


2006–01  Demand and Technology Determinants of Structural Change and Tertiarisation : An Input–Output Structural Decomposition Analysis for four OECD Countries.
Maria SAVONA, André LORENTZ, janvier 2006.

2006–02  A strategic model of complex networks formation.
Nicolas CARAYOL, Pascale ROUX, janvier 2006.

2006–03  Coordination failures in network formation.
Nicolas CARAYOL, Pascale ROUX, Murat YILDIZOGLU, janvier 2006.

2006–04  Real Options Theory for Lawmaking.
Marie OBIDZINSKI, Bruno DEFFAINS, août 2006.

2006–05  Ressources, compétences et stratégie de la firme : Une discussion de l’opposition entre la vision Porterienne et la vision fondée sur les compétences.
Fernand AMESSE, Arman AVADIKYAN, Patrick COHENDET, janvier 2006.

2006–06  Knowledge Integration and Network Formation.
Müge OZMAN, janvier 2006.

Müge OZMAN, février 2006.

2006–08  A.K. Sen et J.E. Roemer : une même approche de la responsabilité ?
Herrade IGERSHEIM, mars 2006.

2006–09  Efficiency and coordination of fiscal policy in open economies.
Gilbert KOENIG, Irem ZEYNELOGLU, avril 2006.

Guillaume HORDRY, avril 2006.

2006–12  *Customary versus Technological Advancement Tests.*
Bruno DEFFAINS, Dominique DEMOUGIN, avril 2006.

Bruno DEFFAINS, Dominique DEMOUGIN, avril 2006.

2006–14  *How does leadership support the activity of communities of practice?*
Paul MULLER, avril 2006.

2006–15  *Do academic laboratories correspond to scientific communities? Evidence from a large European university.*
Rachel LÉVY, Paul MULLER, mai 2006.

Nicolas CARAYOL, Pascale ROUX, mai 2006.

Tapas K. MISHRA, juin 2006.

2006–18  *A regional typology of innovation capacities in new member states and candidate countries.*
Emmanuel MULLER, Arlette JAPPE, Jean–Alain HÉRAUD, Andrea ZENKER, juillet 2006.

2006–19  *Convergence des contributions aux inégalités de richesse dans le développement des pays européens.*

2006–20  *Channel Performance and Incentives for Retail Cost Misrepresentation.*
Rabah AMIR, Thierry LEIBER, Isabelle MARET, septembre 2006.

Antoine BURETH, Julien PÉNIN, Sandrine WOLFF, septembre 2006.

2006–22  *Does Model Uncertainty Lead to Less Central Bank Transparency?*
Li QIN, Elefterios SPYROMITROS, Moïse SIDIROPOULOS, octobre 2006.

La présente liste ne comprend que les Documents de Travail publiés à partir du 1er janvier 2000. La liste complète peut être donnée sur demande.

*This list contains the Working Paper written after January 2000, 1rst. The complete list is available upon request.*