

Optimal monetary delegation under fiscal uncertainty

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Abstract

Governments in a monetary union face uncertainty about their budget position. To derive their optimal fiscal policy we use the *robust control* approach as developed by Hansen and Sargent (2005, 2008). We show that budget uncertainty leads to higher tax distortions and poorer macroeconomic performances in the member states. From a normative perspective, we study how optimal monetary institutional parameters should be adjusted to taken account for the governments' uncertainty.

Keywords: budget uncertainty, robust control, monetary delegation.

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1 Introduction

Uncertainty about key relationships governing the economy is an important challenge for policymakers and substantially influences their choices. Policymakers face uncertainty in different aspects of their decision-making process. They may for instance be unsure about the state of the economy, the true model describing its structure or may have doubts about the accuracy of available data series and the impact of their actions on economic outcomes.¹

The literature mainly relates the issue of uncertainty to monetary policy-making. A series of papers has examined the central bankers' decisions in the face of uncertainty about the structural parameters of the economy. Among them, Peersman and Smets (1999), Giannoni (2002), Söderström (2002), Gros and Hefeker (2002) or Tillmann (2009a) for instance confirm Brainard's (1967) classical result which is to say that monetary authorities tend to act

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¹See Dennis (2008) for a taxonomy of the different forms of uncertainty.

more carefully if they are confronted to some model uncertainty. Other papers like Stock (1999), Onatski and Stock (2002) and Onatski and Williams (2003) challenge this view and find that uncertainty may lead to more vigorous interest rate setting.

Up to now, only few papers have linked the issue of uncertainty to fiscal policy-making. Di Bartolomeo *et al.* (2009) for instance develop a model where monetary and fiscal authorities face uncertainty about the parameters describing the fiscal policy effectiveness. Yet, when deciding fiscal policy, governments also face uncertainty as they need to anticipate a wide variety of indicators which can be altered by lots of economic, political or financial factors. In recent years in particular, uncertainty seems to have become very challenging for fiscal policy-makers, and this, especially in the European Monetary Union (EMU) member countries. The *global financial crisis* has indeed substantially deteriorated public finances so that many EMU member countries experienced a debt crisis, translating into sharp rises of their sovereign interest rates. This has not only severely deteriorated the governments' budget conditions by increasing public spending but has also confronted them with a new kind of uncertainty stemming from the uncontrollable increases of their interest rates.

In this paper, we explicitly take account of this uncertainty when considering the governments' fiscal decision-making process. To be more specific, we assume that they fear financial markets frictions that create upward pressures on their interest rates and thereby deteriorate their budget position. This issue is examined in the context of a monetary union (MU) with strategic monetary-fiscal interactions, where national governments face a balanced budget requirement as is the case in EMU member countries.

To model the governments' choice under uncertainty stemming from financial markets pressures, it seems appropriate to use the *robust control* approach. This approach consists in assuming that governments are unable to define any probability distribution to interest rate upward shocks and thus budget disturbances. To set an optimal tax rate under these circumstances, they seek to select a fiscal policy that is robust to the most pessimistic perspective, i.e. that remains optimal even under the worst possible outcome of budget disturbances.

This approach can be modeled as a min-max game between each government and a fictitious "evil agent" ; this latter symbolizes, for the government, the financial market tensions causing upward pressures on its debt interest rate and thus on its spending. The evil agent's objective is to set these spending shocks so as to maximize the government's losses, whereas this latter seeks to define a fiscal policy that minimizes its losses and is optimal even under the worst-case scenario of spending disturbances. We here assume that both, the government and the evil agent act simultaneously.² The

²The robust control approach has been introduced into economic models by Hansen *et al.* (1999) and Hansen and Sargent (2008). A number of recent papers has used this

"evil agent" may have more or less room for manoeuvre in generating interest rates disturbances, depending on the financial markets investors' confidence in the government's solvency. The lower their confidence, the higher the government's vulnerability to interest rate hikes and thus to budget uncertainty.

In our analysis, the governments' budget uncertainty affects their fiscal decisions but not only. It is also likely to interfere in the central bank's decisions and even compromise the good functioning of monetary policy institutions. A relevant example of the monetary consequences of high budget uncertainty can be given by the euro crisis in the EMU. Large fiscal interventions as a response to the *global financial crisis* has rendered some EMU member countries' public finances conditions so critical as to sharply increase their borrowing costs and put their fiscal sustainability at risk. This high uncertainty on their budgetary situation has not only questioned their ability to stay in the EMU but, through contagion effects, the existence of the monetary union as a whole. Debates about the necessity for Greece to stay in the EMU are relevant at this point.

Therefore, the objective of the paper is twofold. First, we seek to outline the consequences of the governments' budget uncertainty for their fiscal decisions and, through it, for macroeconomic outcomes in the member countries. Second, in a more normative prospect, we study the implications of this uncertainty for the optimal design of monetary institutions in the MU. More precisely, we examine how the central bank's degree of conservatism should be adjusted when the MU member countries' governments suffer from budget uncertainty due to interest rate disturbances.

Our results show that when governments fear highly adverse actions from the "evil agent", they are induced to augment taxation in order to hedge against spending rises due to higher interest rate. This exacerbated fiscal pressure translates into lower output in the member countries, obliging the central bank to set a more expansive and thus inflationary monetary policy. As a consequence, the governments budget uncertainty results into lower social welfare in the member countries.

In our analysis, we allow for asymmetries among member countries (this is typically the case with EMU member countries) by assuming that some of them may be more vulnerable to financial market turbulence and thus to interest rate hikes than the others. Our results reveal that these countries experience a diminution of their economic activity and may thereby be worse off by joining a MU with partner countries that are less exposed to financial disturbances. As for these latter, if they attach sufficiently high importance to price stability, they might be worse off in the MU as well. This is due to the fact that they will face higher inflation as a consequence of the common central bank's accommodating response to lower output in their partner

approach to determine the optimal monetary policy in the case where some uncertainty is faced by central bankers (Giannoni, 2002, 2007; Tillmann, 2009a, Woodford, 2010 among others). In Tillmann (2014), for instance, the robust control method is used by a central bank which is unsure about its estimates of potential output in the economy.

countries.

Yet, the main result of the paper concerns the more normative question of the optimal design of monetary policy institutions. It appears that if the investors' confidence in the member countries' government debt is low – so that these governments are exposed to high budget uncertainty – it may be socially optimal to reduce the central bank's degree of conservatism. Indeed, when this latter is more concerned about the member countries' real economy, governments feel less vulnerable to adverse interest rate disturbances and are thereby induced to ease their fiscal policy stance. Moreover, we show that in this case, lower central bank conservatism may not necessarily translate into higher inflation in the MU.

The rest of the paper is organized as follows. In the next section, we develop a standard Barro-Gordon MU-model with monetary-fiscal strategic interactions in which we integrate the issue of budget uncertainty. The implications of this uncertainty for the member countries' economic outcomes are discussed in section 3. Section 4 presents the normative analysis by addressing the question of the optimal choice of central bank conservatism in the presence of governments' budget uncertainty. A final section concludes.

2 The model

We consider a monetary union (MU) composed of n identical countries (indexed by i , $\forall i = 1, \dots, n$). Monetary policy is set by a common central bank (CB) whereas fiscal policies are decided at the national level by the member countries' government.

Output x_i in country i is given by:

$$x_i = \pi - \pi^e - \tau_i \tag{1}$$

where π and π^e are the actual and expected inflation rates respectively; τ_i defines the tax rate in country i . Behind this relation lies the idea that unexpected inflation, by eroding real wages, induces firms to augment their demand for labor and thus their production. Greater taxation on the firms' revenues, on the contrary, discourages production. Hence, as is common in this literature (see Beetsma and Bovenberg, 1998, 1999 among others), fiscal policy has a negative impact on aggregate supply via taxation.

The common CB cares about deviations of both, inflation and output from their respective targets which, for convenience, we assume to be equal to zero. Its loss function is given by:

$$L^{CB} = I\pi^2 + x^2 \tag{2}$$

where π and $x = \sum x_i/n$ respectively define the MU-wide inflation rate and the average output level in the monetary union. We here suppose that

the central bank perfectly controls the MU-wide inflation rate so that its monetary policy instrument is π . Parameter I measures the central bank's degree of conservatism, that is, its relative concern for inflation. Yet, the literature also refers to I as the degree of the CB's independence with respect to the national governments' preoccupation about real economy.³

These latter are concerned about both, output and public spending level in their economy. The objectives of government in country i (henceforth, government i) are summarized as follows:

$$L_i^G = x_i^2 + \alpha (g_i - \tilde{g}_i)^2 \quad (3)$$

where g_i and \tilde{g}_i respectively define the country i 's actual and targeted levels of public expenditures as shares of output. Parameter α measures the relative importance government i gives to its spending objective.⁴

When setting its fiscal decision, government i faces the following budget constraint:

$$g_i = \tau_i \quad (4)$$

This equation corresponds to a balanced budget requirement where taxation is the only source of financing public expenditures.

Government i will thus have to tolerate some tax distortions in order to finance its positive target of public expenditures \tilde{g}_i . The type of expenditures that we consider here corresponds to public consumption such as salaries of public employees and other current government expenditures. It also encompasses social security spending and the repayment of public debt (which we do not explicitly model). As it is noticeable, the spending target \tilde{g}_i is specific to each country ; for government i , it writes:

$$\tilde{g}_i = \bar{g} + \epsilon_i \quad (5)$$

where \bar{g} represents a fixed level of public spending (supposed to be identical among MU member countries). Note that \bar{g} is expressed as a share of output and might be interpreted as the level of public spending ensuring an efficient functioning of the public sector – i.e. without waste of public resources. Yet, budgets can be affected by unforeseen expenditures – due for instance to bad business cycles developments, political instability or financial market frictions putting pressure on public debt interest rates – creating uncertainty in the fiscal decision-making process. Therefore, we assume that government i fears some misspecifications ϵ_i when predicting the exact amount of expenditures it has to finance.

³For a distinction between CB conservatism and independence, see for instance Eijffinger and Hoeberichts (1998, 2008), Hughes Hallett and Weymark (2005), Weymark (2007) and Hefeker and Zimmer (2011).

⁴For convenience, we assume that member countries governments share the same weight α as well as the same output target, which is normalized at zero.

A crucial assumption about this uncertainty is that it is unmeasurable. This means that governments are unable to assign any probability distribution over alternative outcomes of ϵ_i . To hedge against this form of uncertainty, they adopt a robust control (non-Bayesian) approach which consists in setting their decision so as they are robust to the worst possible realization of ϵ_i .

More concretely, this approach can be modeled as a game between each individual government and a fictitious "evil agent" whose aim is to set misspecifications so as to maximize the government's welfare loss. Following Hansen and Sargent (2005, 2008), we assume that governments allocate a range of potential values for misspecifications to the evil agent which is constraint by χ . For government i , this can be synthesized by the following constraint:

$$\epsilon_i^2 \leq \chi \tag{6}$$

Finally, to set its robust fiscal policy, government i solves the following *minmax* program:

$$\min_{\tau_i} \max_{\epsilon_i} L^G = x_i^2 + \alpha (g_i - \tilde{g})^2 - \theta_i \epsilon_i^2 \tag{7}$$

where θ_i defines the government's preference for policy robustness or its desire for exactness in predicting its budget position. θ_i may also reflect government i 's degree of confidence in its budget estimates. It can be influenced by lots of factors. For instance, if the economy suffers from high macroeconomic instability or if it experiences financial market disturbances raising sovereign interest rate, θ_i will be rather low. Parameter θ_i is indexed by i , which implies that we allow for some asymmetry among MU-member countries.

The certainty case corresponds to $\theta_i \rightarrow \infty$. This is the common case in the literature where it is assumed that governments have a perfect control over their budget. In this paper, we allow for θ_i to have a finite value, meaning that governments are unsure about their budget position.

An alternative method to model fiscal uncertainty would be to use a Bayesian approach where budget disturbances correspond to white noise stochastic shocks and where fiscal uncertainty is given by the variance of these shocks. This method implies that governments can attach priors to budget disturbances. Yet, this is not necessarily the case. In particular, in a context of financial market instability – as EMU countries for instance have experienced with the financial turmoil in 2007 and the Euro crisis afterward – it seems reasonable to assume that it is difficult for governments to statistically measure their budget uncertainty.

The timing of the game is as follows. First, in each member country, the private sector, rationally determines inflation expectations through the

nominal wage setting process. Then, simultaneously, governments determine their tax rate τ_i using the robust control approach detailed above. Finally the common central bank selects π , the MU inflation rate. Since in practice monetary policy can be adjusted more quickly than fiscal policy, we assume that, when taking their decisions, governments anticipate the central bank's reaction and thus act as Stackelberg leaders.

The game is solved by backward induction and we begin by considering the common central bank's program. Minimizing loss function (2) with respect to π and taking the member countries' aggregate supply functions (1) as given, we have:

$$\pi = \frac{\pi^e + \tau}{1 + I} \quad (8)$$

where $\tau = \sum_i \tau_i/n$ defines the average MU-wide tax rate.

With the rationale expectations assumption ($\pi^e = \pi$), we obtain:

$$\pi = \frac{\tau}{I} \quad (9)$$

Solving the governments' program with the robust control approach and taking rational expectations (so that, $\pi^e = \pi$), we obtain the equilibrium level of tax rate in country i :

$$\tau_i = \frac{\alpha \bar{g} \theta_i (1 + I) n}{\theta_i [n(1 + I)(1 + \alpha) - 1] - \alpha [n(1 + I) - 1]} \quad (10)$$

Integrating this expression into the central bank's reaction (9), the output function (1) as well as the budget constraint (4) and considering rational expectations, we have the equilibrium values for output and public expenditures in country i , respectively: $x_i = -\tau_i$ and $g_i = \tau_i$, and also obtain the equilibrium expression for inflation in the MU: $\pi = \tau$ (with, as already specified, $\tau = \sum_i \tau_i/n$).⁵

In our model, the distortion from the first best outcome is due to the presence of a positive (fixed) spending target $\bar{g} > 0$, obliging the government to collect a positive amount of taxes ($\tau_i > 0$).⁶ This in turn reduces output ($x_i < 0$) and forces the central bank to implement an expansionary and thus inflationary monetary policy ($\pi > 0$).

As for the equilibrium spending level g , it is either higher or lower than \bar{g} , depending on whether $\theta_i < \alpha$ or $\theta_i > \alpha$. In the first case ($\theta_i < \alpha$), the government attaches great importance to its spending target whereas its capacity to correctly predict the exact amount of spending is relatively low. Its fear of not being able to attain its spending target is so strong that it overestimates the tax revenue needed to finance it. As a result, it collects too much taxes, translating into too high a spending level compared with the

⁵We assume that, for all governments, θ_i is sufficiently high for the denominator of this expression to be positive. This implies: $\theta_i > \frac{\alpha [n(1+I)-1]}{n(1+I)(1+\alpha)-1} = \underline{\theta}$.

⁶The first best outcome corresponds to a situation where: $\tau_i = x_i = \pi = 0$ and $g_i = \bar{g}$.

fixed level \bar{g} . This situation is inefficient and could be interpreted as a waste of public funds.

In the opposite case where $\theta_i > \alpha$, the government's relative concern for public spending is quite low. Moreover, as it does not worry too much about budget misspecifications either, the tax rate that it sets is too weak to secure income to finance \bar{g} , the fixed level of spending. Again, this situation can also be seen as inefficient as too few resources are invested in the public sector to ensure its optimal functioning.

3 Descriptive analysis of equilibrium outcomes

We here begin by investigating the effects of fiscal uncertainty on equilibrium outcomes. We then also consider the macroeconomic effects of monetary institutional parameters like the degree of CB conservatism and the number of MU member countries in the presence of fiscal uncertainty.

3.1 Effects of fiscal uncertainty

From expression (10), we observe that fiscal uncertainty – which in the equilibrium expressions appears through parameter θ_i , the government's trust in its estimates – exacerbates the tax distortion due to the positive spending target.⁷ This leads to the following result.

Result 1. *A decrease in θ_i , the government's degree of confidence in its budget estimates, translates into:*

- i) higher levels of taxation and public spending and into a lower level of output in country i .*
- ii) a slight increase of the MU-wide inflation rate π – proportionally to $1/n$, the country's weight in the CB's decision process.*

Proof.

i) Differentiating τ_i , the equilibrium tax rate in country i , with respect to θ_i leads to:

$$\frac{\delta\tau_i}{\delta\theta_i} = \frac{-\bar{g}\alpha^2 n(1+I)[n(1+I)-1]}{\{\theta_i[n(1+I)(1+\alpha)-1] - \alpha[n(1+I)-1]\}^2} < 0 \quad (11)$$

Consequently, we have: $\frac{\delta g_i}{\delta\theta_i} = \frac{\delta\tau_i}{\delta\theta_i} < 0$ and $\frac{\delta x_i}{\delta\theta_i} = -\frac{\delta\tau_i}{\delta\theta_i} > 0$.

⁷Note that fear of fiscal uncertainty disappears when $\theta_i \rightarrow \infty$, which means that the government can perfectly predict its budget position. By setting $\theta_i \rightarrow \infty$, equilibrium outcomes correspond to those observed in the standard case in the literature (see for instance Hefeker and Zimmer (2011) where a similar model is used with the assumption $\theta_i \rightarrow \infty$).

ii) By differentiating π , the equilibrium inflation rate in the mu, with respect to θ_i , we obtain: $\frac{\delta\pi}{\delta\theta_i} = \frac{1}{n} \frac{\delta\tau_i}{\delta\theta_i} < 0$.

When government i is less confident about its estimates, it fears higher budget misspecifications and is thereby obliged to increase taxes to be sure to collect enough fiscal revenues to cover its expenditures. As a consequence to higher taxation, the government benefits from more fiscal income and can thus expand its spending. This effect is interesting if in country i fiscal uncertainty is relatively low ($\theta_i > \alpha$) as it contributes to diminish the deviation of public spending from its target. If the country however suffers from too high a fiscal uncertainty ($\theta_i < \alpha$), the public spending level already exceeds its target. In this case, public spending deviations are exacerbated.

As for the output consequences of higher fiscal uncertainty in country i , they are necessarily negative due to the stronger fiscal pressure that it implies. The central bank reacts to this output depressing impact, according to the country's weight in its decision process ($1/n$), by implementing a more expansionary monetary policy, thereby creating inflationary pressure in the MU as a whole.

3.2 Effects of central bank conservatism

After having clarified the implications of fiscal uncertainty, we can now proceed to examine the macroeconomic effects of CB conservatism in this context.

Result 2. *An increase in the central bank's degree of conservatism I translates into :*

- i) *higher tax τ_i and public spending g_i as well as to lower output x_i in the member countries where $\theta_i < \alpha$.*
- ii) *higher inflation in the MU if member countries characterized by a relatively low θ_i , that is $\theta_i < \theta_1$, are more numerous than the others with $\theta_i > \theta_1$.*

Proof.

i) Differentiating τ_i with respect to I respectively leads to:

$$\frac{\delta\tau_i}{\delta I} = \frac{\alpha n \tilde{g} \theta_i (\alpha - \theta_i)}{\{\theta_i [n(1+I)(1+\alpha) - 1] - \alpha [n(1+I) - 1]\}^2}. \text{ This derivative is positive when: } \theta_i < \alpha.$$

As a result: $\frac{\delta g_i}{\delta I} = \frac{\delta \tau_i}{\delta I}$ and $\frac{\delta x_i}{\delta I} = -\frac{\delta \tau_i}{\delta I}$ are respectively positive and negative when $\theta_i < \alpha$.

ii) According to expression (9), we have: $\frac{\delta\pi}{\delta I} = \frac{\sum_i \partial(\tau_i/I)}{n \partial I}$.

Differentiating $\frac{\tau_i}{I}$ with respect to I yields:

$$\frac{\partial(\tau_i/I)}{\partial I} = \frac{\alpha n \theta_i \tilde{g} \{-\theta_i [n(1+I)^2(1+\alpha) - 1] + \alpha [n(1+I)^2 - 1]\}}{\{I \theta_i [n(1+I)(1+\alpha) - 1] - \alpha I [n(1+I) - 1]\}^2}. \text{ This derivative is positive}$$

for $\theta_i < \frac{\alpha[n(1+I)^2-1]}{n(1+I)^2(1+\alpha)-1} \equiv \theta_1$.⁸

Hence, if for the majority of member countries $\theta_i < \theta_1$, then $\frac{\sum_i \partial(\tau_i/I)}{n} \frac{\partial \pi}{\partial I}$ is positive, implying that $\frac{\partial \pi}{\partial I} >$ is positive too.

In the presence of high budget uncertainty in the member states (θ_i low), there is a risk that CB conservatism exerts a detrimental impact on their macroeconomic performances. Clearly, if the CB is highly inflation averse, it accommodates national tax hikes to a lesser extent, thereby rendering them more costly in terms of reduced output. This obliges national governments to adapt their fiscal behavior. Two opposite reactions are observable.

In the standard case where governments do not suffer from budget uncertainty ($\theta_i \rightarrow \infty$) or to a very low extent (θ_i very large), there is no difficulty for them to react to CB conservatism by alleviating the fiscal pressure in their economy. This in turn helps to improve their output performance and contributes to reduce inflation in the MU as a whole. Yet, there appears a detrimental impact of CB conservatism on their spending deviations ($g_i - \bar{g}$). Indeed, as has been observed earlier, in countries where budget uncertainty is low (so that $\alpha < \theta_i$), the equilibrium spending level g_i does not reach the target \bar{g} , so that the deviation ($g_i - \bar{g}$) is negative. By reducing their tax level, and thus their public spending level g_i , CB conservatism aggravates this deviation.

For governments that are more severely afflicted by budget uncertainty (θ_i small), reducing taxation in response to CB conservatism however seems more problematic as this limits their capacity to compensate for budget misspecifications. In the presence of a conservative CB, these governments may thus feel more vulnerable to budget uncertainty as their actions to hedge against it are constrained. Consequently, they may predict a larger level of budget misspecifications, leading them to increase taxation, despite its deteriorating impact on economic activity. This is the case in particular if they bear a relatively strong pressure to attain their spending objective (α large). Hence, in member countries where the government's concern for public spending is relatively higher than its concern for output (so that $\alpha/\theta_i > 1 \Rightarrow \alpha > \theta_i$), CB conservatism might translate into heavier taxation and thereby into larger public spending deviations, as well as into poorer output performance.

Moreover, if these member countries are more numerous than the ones where $\alpha < \theta_i$, the overall impact of CB conservatism on the MU-wide tax level is positive, obliging the CB to implement a more expansionary monetary policy (see Eq. (9)). This reaction to tax decisions may be so strong that it compensates the standard inflation-reducing effect of conservatism, explaining why this latter can be associated with an increase in the MU-wide inflation rate.

If this is the case, considering that society is concerned by output x_i ,

⁸Note that $\theta_1 > \underline{\theta}$; $\underline{\theta}$ being the minimum value of θ_i defined in footnote 5.

inflation π and public spending deviations $g_i - \bar{g}$, CB conservatism could prove detrimental for social welfare not only in member countries with very high budget uncertainty (so that $\alpha > \theta_i$) – as their economic performances are deteriorated – but also in the others with a low level of budget uncertainty (so that $\alpha < \theta_i$). Indeed, even though CB conservatism may contribute to boost their production, if these countries attach greater importance to their inflation and public spending objectives, CB conservatism is also welfare-reducing for them.

3.3 Effects of monetary union

We here investigate whether countries whose government suffer from budget uncertainty are better off by sharing a common monetary policy or not.

Result 3. *Participation in a monetary union:*

- i) leads to higher taxes τ_i and public spending g_i as well as to lower output x_i in countries where $\theta_i < \alpha$.*
- ii) may translate into an increase in inflation in countries having a relatively higher θ_i than their MU-partners.*

Proof.

i) The macroeconomic effects of the monetary unification process are captured by considering the transition from the case where $n = 1$ to the case $n > 1$. Hence, these effects can be determined by differentiating the equilibrium expression of τ_i , g_i and x_i with respect to n . This leads to:

$\frac{\delta \tau_i}{\delta n} = \frac{\alpha \bar{g}_i \theta_i (1+I)(\alpha - \theta_i)}{\{\theta_i [n(1+I)(1+\alpha) - 1] - \alpha [n(1+I) - 1]\}^2}$. This derivative becomes positive when: $\alpha > \theta_i$. Consequently, $\frac{\delta g_i}{\delta \theta_i} = \frac{\delta \tau_i}{\delta \theta_i}$ and $\frac{\delta x_i}{\delta \theta_i} = -\frac{\delta \tau_i}{\delta \theta_i}$ become respectively positive and negative for $\alpha > \theta_i$.

ii) We know from result 1 that countries with a high θ_i display a low level of taxation. If they join a MU with partner-countries where θ_i is relatively lower and thus taxation relatively higher, they may have to accept a more inflationary monetary policy as this latter is then set by a common CB on the basis of the average tax rate in the MU (see Eq.(9)).

The process of monetary unification triggers similar macroeconomic effects than an increase in CB conservatism. Indeed, as can be observed from expression (9), both institutional changes (increase in n and in I) contribute to moderate the CB's accommodating response to national tax decisions. This has two consequences: first, it strengthens the output-reducing impact of tax hikes and second, it exacerbates the governments' fear of budget mis-specifications. How governments adapt to these circumstances depends on θ_i , their degree of confidence in their budget estimates as well as on α , their concern for spending deviations. For governments with $\theta_i < \alpha \Rightarrow \theta_i/\alpha < 1$, consideration for output is much too low as compared to their concern for

their spending objective and their fear of not attaining it.⁹ They will focus on the fact that they feel more exposed to budget misspecifications in the MU and decide to increase taxes. Participation in the MU finally results into lower output and may thereby even contribute to reduce social welfare in these countries if the society's concern about economic activity and employment is relatively important.

Under these circumstances, these countries might be tempted by an exit from the union.¹⁰ To avoid this option and possibly a breakdown of the union as a whole, the CB would have to adapt its institutional features. One possibility would consist in being less focused on inflation and giving more attention to output in order to alleviate the pressure on national fiscal policies for this objective. Concretely, this would imply for the CB to reduce its degree of conservatism I . Indeed, as has been highlighted in result 2, lower conservatism might help countries with high budget uncertainty to attenuate tax pressure and thereby to counteract the output-deteriorating impact of their participation to the MU.

As for the member countries with a low level of budget uncertainty, even if they observe an improvement in their output performance with their entry in the MU – this effect has already been stressed by Beetsma and Bovenberg (1998), they may experience an increase in inflation due to the fact that their MU-partners suffer from relatively higher budget uncertainty. If society attaches great importance to price stability, MU may also induce a diminution of social welfare in those countries. They might then think that the solution to their problem lies in the option that MU-partners suffering from too high a budget uncertainty leave the union.

4 Optimal central bank conservatism in the presence of fiscal uncertainty

We here consider a social planner in the MU whose objective is to define an optimal design of monetary institutions – and, more precisely, of central bank conservatism – by taking account of the governments' fiscal uncertainty.

The social planner's loss function is given by:

$$L^S = x^2 + \varphi\pi^2 + \beta(g - \bar{g})^2 \quad (12)$$

where φ and β respectively define the relative weight the social planner puts on its inflation and public spending objective. We assume that its spending

⁹According to the expression of the governments' loss function Eq.(3), the relative weight that they attribute to output is normalized to 1.

¹⁰Obviously, they would have to compare the benefit of their exit with the large and hardly quantifiable cost that this would imply.

target corresponds to \bar{g} , the level of public spending enabling an optimal functioning of the public sector.

The social planner is concerned by monetary union-wide aggregates. To determine their level, it considers an average degree of uncertainty for the MU-governments, which is labeled $\bar{\theta}$, as it is difficult for it to guess each individual government's degree of uncertainty, θ_i . The MU-wide aggregates taken into account by the social planner are thus obtained by replacing θ_i with $\bar{\theta}$ in the expressions of equilibrium output, inflation and public spending.

Integrating these equilibrium values of output ($x(\bar{\theta})$), inflation ($\pi(\bar{\theta})$) and public spending ($g(\bar{\theta})$) into the social planner's loss function and minimizing with respect to I , the central bank's degree of conservatism, yields some results which are exposed in the following subsections.

4.1 How the optimal I depends on θ

Result 4. *i) It is socially optimal to reduce central bank conservatism I in response to a decrease in $\bar{\theta}$, the MU-governments' level of budget confidence, if this latter is already relatively low.*

ii) When $\bar{\theta}$ is relatively low, it is socially optimal to delegate monetary policy to a "populist" central banker, that is a central banker who cares less about inflation than society.

There exists a threshold for β above which a populist central banker proves to be optimal also for relatively high values of $\bar{\theta}$.

Proof. Integrating the equilibrium expressions for $x(\bar{\theta})$, $\pi(\bar{\theta})$ and $g(\bar{\theta})$ into (12), we obtain:

$$L^S = \frac{\bar{g}^2 \left\{ [\bar{\theta}\alpha n(1+I)]^2 (I^2 + \varphi) + \beta I^2 (\alpha - \bar{\theta})^2 [1 - n(1+I)]^2 \right\}}{\left\{ \bar{\theta}I [n(1+\alpha)(1+I) - 1] - I\alpha [n(1+I) - 1] \right\}^2} \quad (13)$$

Minimizing this loss function with respect to I , we obtain the following first order condition:

$$\frac{\partial L^S}{\partial I}(I = I^*) = \frac{2\alpha n \bar{\theta} \bar{g}^2}{\left\{ \bar{\theta}I [n(1+\alpha)(1+I) - 1] - I\alpha [n(1+I) - 1] \right\}^3} \Theta = 0 \quad (14)$$

where:

$$\begin{aligned} \Theta &= \Lambda \left\{ I^3(\alpha - \bar{\theta}) + \varphi [\alpha [n(1+I)^2 - 1] - \bar{\theta} [n(1+I)^2(1+\alpha) - 1]] \right\} \\ &+ \beta \Lambda I^3 (\alpha - \bar{\theta})^2 [n(1+I) - 1] \end{aligned}$$

with $\Lambda = \alpha n \bar{\theta} (1+I)$.

i) The determination of I^* implies to solve equation $\frac{\partial L^S}{\partial I} = 0$. Yet, our objective in this paper is not to calculate the exact value of I^* . It is rather to study how I^* should be adjusted according to different parameters, in particular to $\bar{\theta}$. In this perspective, we determine $\frac{\partial I^*}{\partial \bar{\theta}}$ using the implicit function theorem.

$$\frac{\partial I^*}{\partial \bar{\theta}} = \frac{-\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial \bar{\theta}}}{\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial I}} \quad (15)$$

The denominator $\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial I} = \frac{\partial^2 L^S}{\partial I^2}$ being always positive for $I = I^*$ – as I^* corresponds to the value of CB conservatism that minimizes L^S – the sign of $\frac{\partial I^*}{\partial \bar{\theta}}$ is given by the sign of the numerator $\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial \bar{\theta}}$.

By differentiating $\frac{\partial L^S}{\partial I}$ with respect to $\bar{\theta}$, we obtain:

$$\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial \bar{\theta}} = \frac{2n(\bar{g}\alpha)^2}{I^3 \left\{ \bar{\theta} [n(1+\alpha)(1+I) - 1] - \alpha [n(1+I) - 1] \right\}^4} \Omega(\bar{\theta})$$

where

$$\begin{aligned} \Omega(\bar{\theta}) &= \Lambda I^3 \left\{ 2[n(1+I) - 1](\bar{\theta} - \alpha) - \Lambda \right\} \\ &+ \varphi \Lambda \left\{ 2(\bar{\theta} - \alpha) [n(1+I) [n(1+I)^2 - 2 - I] + 1] + n\alpha\bar{\theta}(1+I) [2n(1+I)^2 - 3I - 2] \right\} \\ &+ \beta I^3 [n(1+I) - 1]^2 (\bar{\theta} - \alpha) \left\{ [n(1+I) - 1](\alpha - \bar{\theta}) + 2\Lambda \right\} \end{aligned}$$

$\Omega(\bar{\theta})$ becomes negative – implying that $\frac{\partial I^*}{\partial \bar{\theta}}$ is positive – for sufficiently low values of $\bar{\theta}$. Note that, for the third term of $\Omega(\bar{\theta})$, we set $\alpha > \underline{\alpha}$ so that the expression into the curly brackets is necessarily positive.¹¹ The third term is thus negative as soon as $\bar{\theta} < \alpha$.

ii) We here consider the expression $\partial L^S / \partial I$, as given by Eq.(14), for the case where $I = \varphi$, that is when the CB's degree of inflation aversion coincides with the society's one. After tedious algebra, we observe that:¹²

$\frac{\partial L^S}{\partial I} (I = \varphi)$ is positive when:

$$\bar{\theta} < \frac{2\alpha\beta I^3 [n(1+I) - 1] - \alpha^2 n(1+I) \{ \varphi [n(1+I)^2 - 1] + I^3 \} - \sqrt{\Delta}}{2\beta I^3 [n(1+I) - 1] - 2\alpha n(1+I) \{ \varphi [n(1+I)^2 (1+\alpha) - 1] + I^3 \}} \equiv \bar{\theta}_1$$

where $\Delta = \alpha^4 n^2 (1+I)^2 \left\{ [\varphi [n(1+I)^2 - 1] + I^3]^2 + 4I^3 \beta \varphi (1+I) [n(1+I) - 1] \right\}$.

¹¹For the expression into curly brackets of the third term to be positive, we must have: $\alpha [n(1+I) - 1] > \bar{\theta} \{ [n(1+I) - 1] - 2\alpha n(1+I) \}$. This condition is fulfilled in particular when the expression into curly brackets of the right-hand side is negative, which is the case for: $\alpha > \frac{n(1+I)-1}{2n(1+I)} \equiv \underline{\alpha}$. So, we retain $\underline{\alpha}$ as the lower bound for α , implying that governments' have a minimum of concern for their public spending objective.

¹²Calculations are available upon request.

In this case, social loss can be attenuated by reducing I , implying that the optimal level of I is necessarily lower than φ .

Moreover, for $\beta > \frac{\alpha n(1+I)\{\varphi[n(1+I)^2(1+\alpha)-1]+I^3\}}{I^3[n(1+I)-1]} \equiv \beta_1$, we observe that $\frac{\partial L^S}{\partial I}(I = \varphi)$ is positive either when $\bar{\theta} < \bar{\theta}_1$ or when

$$\bar{\theta} > \frac{2\alpha\beta I^3[n(1+I)-1] - \alpha^2 n(1+I)\{\varphi[n(1+I)^2-1]+I^3\} + \sqrt{\Delta}}{2\beta I^3[n(1+I)-1] - 2\alpha n(1+I)\{\varphi[n(1+I)^2(1+\alpha)-1]+I^3\}} \equiv \bar{\theta}_2$$

Consequently, when β is sufficiently large, the optimal level of I proves to be lower than φ not only for extremely low values of $\bar{\theta}$ ($\bar{\theta} < \bar{\theta}_1$) but also for extremely high values, i.e. $\bar{\theta} > \bar{\theta}_2$.

Hence, when governments are already vulnerable to fiscal uncertainty ($\bar{\theta}$ initially low), an increase in this uncertainty requires a diminution of the degree of CB conservatism. For an intuitive account of this outcome, we must recall result 1 stating that higher fiscal uncertainty (decrease in $\bar{\theta}$) deteriorates macroeconomic performances in terms of price stability, output and public spending deviations. To counter this deteriorating effect of fiscal uncertainty, we know from result 2 that CB conservatism should be reduced as this would help to improve economic outcomes in the case where $\bar{\theta}$ is relatively low.

Yet, when the society is focused on public spending deviations (β high), the CB's degree of conservatism should be reduced in response to higher uncertainty. Indeed, this helps to attenuate the public spending deviations, for member countries' with a high degree of budget uncertainty $\bar{\theta}$ as well as for the others.

Finally, it comes out from this analysis that, for relatively low values of θ and/or relatively high values of β , delegating the monetary instrument to a highly conservative CB seems not to be a good option. On the contrary, in this case, it might even prove to be optimal to appoint a central banker who cares less about inflation than society.

4.2 How the optimal I should be adjusted in a MU

We here also examine how the degree of CB conservatism should be adjusted with the monetary unification (or monetary union enlargement) in this particular context where member countries suffer from budget uncertainty.¹³

Result 5. *i) When the investors' confidence in the member countries' government bonds $\bar{\theta}$ is extremely low (below a threshold that we name $\bar{\theta}_{LOW}$), it is socially optimal to reduce the degree of CB conservatism I with the MU*

¹³Note that the monetary unification and the monetary union enlargement can both be formalized by an increase in n , the number of member countries. More specifically, in the case of a monetary unification process n raises from $n = 1$ to $n > 1$.

process.¹⁴

ii) For more standard levels of $\bar{\theta}$, i.e. $\bar{\theta} > \bar{\theta}_{LOW}$, the optimal degree of CB conservatism I should be increased with the MU process for $\bar{\theta} < \alpha$ and be reduced for $\bar{\theta} > \alpha$. Yet, when β , the society's concern for public spending, is particularly high and α , the governments' concern for public spending, is particularly low, it may be optimal to increase I with the MU process also for relatively large values of $\bar{\theta}$.

Proof. To study how I^* should be adjusted with the MU enlargement, we determine $\frac{\partial I^*}{\partial n}$ using the implicit function theorem.

$$\frac{\partial I^*}{\partial n} = \frac{-\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial n}}{\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial I}} \quad (16)$$

The denominator $\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial I} = \frac{\partial^2 L^S}{\partial I^2}$ being always positive for $I = I^*$, we have : $sign\left(\frac{\partial I^*}{\partial n}\right) = sign\left(\frac{-\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial n}\right)$.

By differentiating $\frac{\partial L^S}{\partial I}$ with respect to n , we obtain:

$$-\frac{\partial\left(\frac{\partial L^S}{\partial I}\right)}{\partial n} = \frac{2\bar{g}^2\alpha\bar{\theta}n(1+I)}{\{\bar{\theta}[n(1+I)(1+\alpha)-1]-\alpha[n(1+I)-1]\}^4} \Phi(\bar{\theta})$$

where

$$\begin{aligned} \Phi(\bar{\theta}) &= -\alpha\bar{\theta}I^4 \left\{ \bar{\theta}^2 [n(1+I)(1+\alpha)+2] - \bar{\theta}\alpha [n(1+I)(2+\alpha)+4] + \alpha^2 [n(1+I)+2] \right\} \\ &- \varphi\alpha\bar{\theta}I \left\{ \bar{\theta}^2 [\Psi(1+\alpha)-2] - \bar{\theta}\alpha [\Psi(2+\alpha)-4] + \alpha^2 [\Psi-2] \right\} \\ &- \beta I^4 (\alpha-\bar{\theta})^2 \left\{ 2\alpha [n(1+I)-1] - \bar{\theta} [2n(1+I)(1+\alpha)-3\alpha-2] \right\} \end{aligned}$$

with $\Psi = n(1+I)(2+3I)$.

Expression $\Phi(\bar{\theta})$ can be rewritten by:

$$\Phi(\bar{\theta}) = \alpha\bar{\theta}I^4 f(\bar{\theta}) \quad (17)$$

$$+ \varphi\alpha\bar{\theta}I g(\bar{\theta}) \quad (18)$$

$$+ \beta I^4 (\alpha-\bar{\theta})^2 h(\bar{\theta}) \quad (19)$$

Functions $f(\bar{\theta})$ and $g(\bar{\theta})$ are quadratic in $\bar{\theta}$ and can be represented by a parabola that opens downwards. Both functions have two positive roots:

$$\bar{\theta}_1^f = \alpha \frac{n(1+I)+2}{n(1+I)(1+\alpha)+2} \text{ and } \bar{\theta}_2^f = \alpha \text{ are the roots for } f(\bar{\theta}) \text{ and}$$

¹⁴Note that $\bar{\theta}_{LOW} > \underline{\theta}$; $\underline{\theta}$ being the minimum value for θ as defined in footnote 5.

$$\bar{\theta}_1^g = \alpha \frac{n(1+I)(2+3I)-2}{n(1+I)(2+3I)(1+\alpha)-2} \text{ and } \bar{\theta}_2^g = \alpha \text{ for } g(\bar{\theta}).$$

Function $h(\bar{\theta})$ is linear in $\bar{\theta}$, taking negative values for $\bar{\theta} < \bar{\theta}_1^h = \alpha \frac{2[n(1+I)-1]}{2(1+\alpha)[n(1+I)-1]-\alpha}$ and positive values otherwise.¹⁵

By combining functions $f(\bar{\theta})$, $g(\bar{\theta})$ and $h(\bar{\theta})$, we can deduce that $\Phi(\bar{\theta})$ and thus $(\frac{\partial I^*}{\partial n})$ are negative, for either extremely low ($\bar{\theta} < \bar{\theta}_{LOW}$) or relatively high values of $\bar{\theta}$. For intermediate levels of $\bar{\theta}$, $\Phi(\bar{\theta})$ and thus $(\frac{\partial I^*}{\partial n})$ are positive.

Yet, when β is very large, it may appear that $\Phi(\bar{\theta})$ and thus $(\frac{\partial I^*}{\partial n})$ become positive again for higher values of $\bar{\theta}$ as the positive part of $h(\bar{\theta})$ then compensates the negative part of $f(\bar{\theta})$ and $g(\bar{\theta})$. This is the case in particular when α is low ($\alpha < \bar{\theta}$) as $(\alpha - \bar{\theta})^2$ – calibrating the weight of $h(\bar{\theta})$ in the third line of expression (17) – increases with respect to $\bar{\theta}$.

For an intuitive account of this result, we must first explain how the MU process influences the impact that CB conservatism has on fiscal decisions and through it on economic outcomes. The standard mechanism is that monetary unification contributes to attenuate the macroeconomic impact of CB conservatism as, in a MU, monetary policy and its institutional parameters affect each individual member country's economic outcomes to a lesser extent ; the link between the common CB and national governments being distended.

Yet, when member countries are characterized by an extremely low level of investors' confidence on financial markets ($\bar{\theta} < \bar{\theta}_{LOW}$), MU may exacerbate the negative macroeconomic effects of CB conservatism. Indeed, when budget uncertainty is very high, governments are strongly dependent on the CB's accommodating monetary policy as it helps to attenuate the output deteriorating effect of excessive tax rates that must be implemented to hedge against large budget misspecifications. When the CB becomes more conservative, it reacts to output conditions to a lesser extent, thereby emphasizing the countries' vulnerability to budget uncertainty and aggravating its negative macroeconomic consequences (see result 2). The MU process reinforces this detrimental mechanism as the CB then cares even less about each individual country's output situation. Hence, monetary unification exacerbates the negative macroeconomic consequences of CB conservatism and requires thereby a diminution of its optimal value.

For standard levels of investors' confidence ($\bar{\theta} > \bar{\theta}_{LOW}$), the traditional mechanism applies: MU mitigates the macroeconomic effects of CB conservatism. We must here distinguish two cases depending on β , the importance

¹⁵Note that $0 < \underline{\theta} < \bar{\theta}_j^i \forall i = f, g, h$ and $\forall j = 1, 2$; $\underline{\theta}$ being the minimum value for $\bar{\theta}$ defined in footnote 5.

that society attributes to public spending.

When this later is low, the optimal choice of CB conservatism essentially depends on its effect on price stability and output. According to result 2, these effects are detrimental for relatively low – but still standard – values of $\bar{\theta}$ and becomes beneficial otherwise. As a consequence, for intermediary levels of $\bar{\theta}$ – i.e. for standard but relatively low values of $\bar{\theta}$ – MU lessens the detrimental effects of CB conservatism and can thereby be accompanied by an increase in its degree. For high levels of $\bar{\theta}$ however, it seems optimal to reduce the degree of CB conservatism as its beneficial macroeconomic effects are dampened by the monetary unification.

On the contrary, when β is high, the optimal choice of CB conservatism is mainly dictated by its impact on public spending deviations ($g_i - \tilde{g}$). This impact is always detrimental as an increase in I systematically exacerbates the deviation ($g_i - \tilde{g}$). Yet, in the case where $\bar{\theta} > \bar{\theta}_{LOW}$, the MU process contributes to alleviate this detrimental impact. The optimal degree of CB conservatism can be thus increased with the number of MU member countries. Finally, when β is sufficiently high, this effect dominates, explaining why it can be socially optimal to accompany monetary unification by an increase in the CB's degree of conservatism even for larger values of $\bar{\theta}$.

5 Conclusion

In this paper, we extend a simple MU-model with strategic monetary-fiscal interactions by considering the case where national governments fear some budget disturbances. Using a robust control approach, we model the governments' fear as the result of the decisions of a fictitious evil agent whose objective is to set the governments' spending disturbances so as to maximize their welfare losses. Different factors may impact this type of governments' budget uncertainty. We retain a financial factor, namely, the investors' confidence in the governments' debt. The lower this confidence, the higher the threat for the governments to see their debt interest rate soar. Unsurprisingly, our analysis reveals that governments that severely suffer from budget uncertainty, are induced to implement an excessively high taxation which, in turn, contributes to deteriorate performances in their real economy.

Our analysis highlights that the governments' feeling of exposure to budget disturbances is also depend on the monetary institutional environment. It appears that, for countries whose public debt benefits from a low degree of investors' confidence, higher central bank conservatism and/or monetary unification (MU), by reducing the monetary authority's concern for developments in their real economy, exacerbates their governments' feeling of vulnerability to adverse interest rates shocks, and thereby contributes to increase tax distortions. Hence, by allowing for asymmetric exposure of national governments to interest rates disturbances, we observe that the MU is likely to aggravate the heterogeneity of the member countries' economic situation:

The most-exposed countries may experiment a decrease in their already-low output level whereas the least-exposed countries may see their output level increase with the MU. Besides, it is quite possible that these latter will have to accept higher inflation ; this is the case in particular if their partner countries are extremely vulnerable to budget disturbances, obliging the common central bank's to set a very accommodating policy in response to their partner countries' poor output performances.

On the basis of these results, we investigate the more normative question of the optimal degree of central bank conservatism in the presence of government budget uncertainty. Our findings reveal in particular that when national governments' face high budget uncertainty due to low credibility in their debt sustainability, the more concerning this problem becomes, the lower should be the central bank's conservatism. More central bank concern for output and employment in the member states would indeed help to attenuate the pressure on national fiscal policies. Concretely, our results can be related to the more general debate on the EU monetary architecture that emerged in the aftermath of the euro crisis. Indeed, the two pillars of the EMU economic governance are based on the ECB's price stability objective and on the fiscal discipline constraints imposed on governments by the Stability and Growth Pact. This institutional framework implies a *de facto* clear prioritization of macroeconomic objectives, supposing that inflation stabilization is the dominant objective of public authorities and leaving little room for national objectives in terms of growth and employment. Well justified at the moment of the creation of the EMU, the EMU policy-mix organization has to adapt to the post-crisis environment by strongly taking account of the uncertainty surrounding fiscal policy-making and the difficulties it generates for national governments to simultaneously promote economic activity and ensure budget balance. This becomes even more obvious in the perspective of the Euro zone enlargement. Indeed, almost all the EU member countries should in the future join the Euro area, thereby considerably exacerbating its heterogeneity in terms of budget uncertainty. The disconnection between the centralized monetary policy focusing exclusively on aggregate price stabilization on one hand and more than twenty decentralized fiscal policies driven by different national sensitivities on the other hand may become unsustainable and could thus undermine the coherence and credibility of the whole Euro zone.

Our normative analysis focuses on the optimal institutional design of the MU's central bank, and more precisely on its degree of conservatism. Yet, monetary institutional parameters do not only consist in the central bank's conservatism, they also encompass its independence with respect to the governments' considerations. In our model, we do not explicitly model the degree of central bank independence ; it is combined with the degree of conservatism. Indeed, independence and conservatism are here treated as a unique parameter in the monetary authority's loss function, which we refer

to as *I*. An interesting extension of the paper would consist in disentangling both concepts: *Conservatism* would then be defined as the relative weight that the central bank assigns to inflation control in its loss function, while *independence* would refer to its ability to freely determine monetary policy according to its own priorities, without having to bother about the national governments' objectives and difficulties to reach them. This explicit distinction between conservatism and independence would allow us to examine their socially optimal combination in the presence of governments' budget uncertainty.

In the theoretical debate about the optimal institutional design of central banks, independence and conservatism are both considered to be crucial ingredients for a stable and successful monetary policy. The initial organization of the EMU economic governance as well relies on the idea that these parameters are complements: the ECB's institutional features have been defined so that priority is given to price stability and to ensure its large autonomy in decision-making. Yet, the ECB's decisions and behavior since the euro crisis have brought up the thought that the combination of conservatism and high independence is no longer appropriate in the current environment. In particular, we believe that the ECB's large monetary financing of government debt to prevent speculative attacks and the "Whatever it takes" speech by ECB President Draghi on 26 July 2012 have somewhat challenged its independence.¹⁶ The ECB seems to have endorsed a new responsibility for financial stability, implying some cooperation with the concerned governments and, thereby creating political pressures that may limit its *de facto* independence. Hence, in the context where some EMU governments suffer from high vulnerability to financial market turbulence, conservatism and independence no longer appear to be optimal complements. Whether, in the presence of extremely high governments' financial vulnerability, these parameters may even become substitutes – so that, in order to maintain its focus on inflation against output, the central bank is obliged to expand its "governments rescue" operations – is an interesting issue for future research.

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¹⁶See den Haan *et al.*'s discussion about the future of central bank independence.

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