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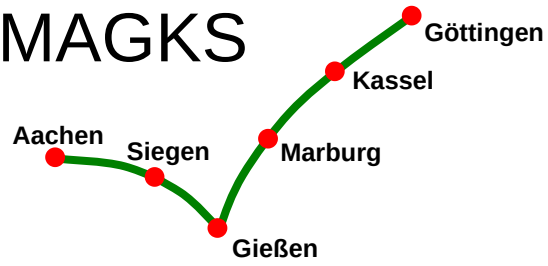

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Uncertainty and fiscal policy in an asymmetric monetary union*

Carsten Hefeker† and Blandine Zimmer‡

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Abstract We examine monetary and fiscal interactions in a monetary union model with uncertainty due to imperfect central bank transparency. It is first shown that monetary uncertainty discourages excessive taxation and may thus reduce average inflation and output distortions. However, as countries enter the monetary union, this tax-restraining effect of uncertainty is mitigated. The monetary union may hence lead to higher fiscal distortions in some member countries, depending on governments' spending targets and on the change in the degree of uncertainty implied by common monetary policy.

Keywords Monetary union · fiscal policy · transparency of monetary policy · asymmetries.

JEL Classification E 58 · E 63 · F 36.

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1 Introduction

Recent years have seen a strong and nearly universal increase in central bank transparency (Dincer and Eichengreen 2009). Many central banks, such as the European Central Bank (ECB), are nonetheless criticized for their low transparency, being unfavorably compared with the US Federal Reserve or the Bank of England (Blinder et al. 2001). Most of the literature considers transparency as crucial for monetary policymaking because it helps the private sector to better understand the intentions of the central bank and thereby renders monetary policy more effective and credible (Blinder 1998). Yet, there are also approaches in the literature which argue that maximum transparency may be suboptimal. In particular, it is shown that some "creative ambiguity" (Cukierman and Meltzer 1986) can discipline the private sector, such as wage setters, and induce governments to pursue more employment friendly policies.

This paper contributes to this debate and provides new theoretical arguments based on the implications of central bank transparency for fiscal policymaking in a monetary union. Our objective in this paper is two-fold. First, we aim at investigating the effects of transparency on tax decisions. Second, considering the case of a common monetary policy, we offer some insights on how its creation or enlargement may affect national fiscal policies in the presence of imperfect central bank transparency. This latter issue could be of particular interest for the Economic and Monetary Union (EMU) which will experience important changes due to further enlargements. We will therefore often refer to the case of EMU, but it should be understood that our approach is fairly general and could also be applied to other planned monetary unions in different regions of the world, such as in Africa, Latin America or Asia (Kenen and Meade (2008) discuss such plans).

In developing our arguments, we complement earlier studies in two different strands of literature. First, our analysis is related to the huge literature on monetary policy uncertainty. A series of papers in this literature has investigated the influence of uncertainty on central bank behaviour (Brainard 1967; Söderström 2002; Dennis 2007). They show in particular that monetary authorities tend to act more carefully if there is uncertainty about the transmission of monetary policy (Gros and Hefeker 2002; Benigno 2004). The focus in this paper however is on how domestic agents react to uncertainty about the central bank's behaviour.[1] In this line of research, Sorensen (1991), Grüner (2002), Grüner et al. (2005) and Hefeker (2008) demonstrate that greater uncertainty about monetary policy may discipline wage setters and thereby improve labour market performance.

A player that has so far received relatively little attention in the literature is the fiscal authority, and only a few contributions have combined the issue

[1] This literature is much too broad to be completely referenced here. See Eijffinger and Hoeberichts (2000), Winkler (2000), Geraats (2002) and Eijffinger and van der Cruijsen (2007) for surveys.

of central bank transparency with fiscal policymaking. Hughes Hallett and Viegi (2003) develop a monetary-fiscal policy game to investigate the effects of transparency, depending on whether it corresponds to *political* transparency – where the central bank's preferences or priorities are clearly defined – or *economic* transparency – where conditioning information, shocks or target values are made clear.[2] Ciccarone, Di Bartolomeo and Marchetti (2007) focus on political transparency in a framework with supply-side fiscal policy and strategic wage setting. However, none of these papers has explicitly examined how fiscal policymakers react to central bank transparency. Our contribution aims to fill this void and to show how this reaction is transformed in a monetary union.

The second literature our analysis is linked to is the broad discussion about monetary and fiscal interactions in a monetary union.[3] We make use of the framework developed by Beetsma and Bovenberg (1998) to study how the formation or the enlargement of a monetary union affects tax decisions and macroeconomic outcomes in the member countries. Beetsma and Bovenberg have demonstrated that tax distortions decrease with the monetary unification as the strategic position of each individual fiscal player vis-à-vis the larger central bank is weakened. We analyse the robustness of this result with respect to two important assumptions.

First, we assume that the central bank is not fully transparent about its preferences, so that the monetary reaction to taxation is to some degree uncertain for governments.[4] The issue of uncertainty is particularly relevant when examining the context of a monetary union because the decisions of a common central bank reflect all kinds of interactions among different member countries and may therefore be less predictable than those of a national central bank. As shown by Goldberg and Klein (2005) for instance, the perception of the European Central Bank's reaction parameters has changed over time, suggesting that markets have refined their view of its characteristics and objectives over time.

Second, we allow for cross-country asymmetries in fiscal policymaking. More precisely, we assume that governments in the member countries have different public spending targets. These assymetries may have an impact on the common monetary policy and therefore feedback on the optimal national fiscal policies. Such asymmetries could for instance reflect different spending targets due to catch-up processes in infrastrucure, preferences for more or less generous social policies, or differences between richer and poorer states.

It appears from this set up that monetary uncertainty forces governments to moderate taxation, thereby reducing average inflation and output distor-

[2] A similar distinction can be found in Geraats (2002) and Demertzis and Hughes Hallett (2007).

[3] This literature includes seminal contributions by, for instance, von Hagen and Süppel (1994), Beetsma and Bovenberg (1998, 1999), Beetsma and Uhlig (1999), Dixit and Lambertini (2001, 2003) and Uhlig (2003).

[4] Hence, the concept of uncertainty used here refers to political transparency.

tions. Hence, maximum transparency seems not optimal from this point of view. The moderating effect of uncertainty however is mitigated with the move to a common monetary policy. Monetary unification may translate into greater tax distortions in some member countries, depending on their governments' spending targets and on the potential change in uncertainty that accompanies the change of monetary regime. A possible response to these adverse effects could be to deliberately increase uncertainty via lower transparency in the larger currency area. This solution should nevertheless be used cautiously as it could prove to be counterproductive for countries with a high public spending target.

The remainder of this paper is organised as follows. The next section analyses the effects of uncertainty on fiscal decisions in a closed economy. Section 3 extends this analysis to a monetary union and derives the effects of a change in the monetary regime on macroeconomic outcomes. Two cases are considered: The benchmark case of a symmetric monetary union and the more complex case of a monetary union with heterogeneous fiscal policies. Section 4 concludes.

2 Policy choices in the closed economy

2.1 The model

This section presents a model in line with Beetsma and Bovenberg (1998), extended to allow for imperfect political transparency of the central bank as in Ciccarone et al. (2007).

We begin by considering a closed economy consisting of three players: the central bank, the government and the private sector.[5] The timing of the game is as follows. First, inflation expectations are determined rationally.[6] Then, the government sets taxes and finally the central bank selects the inflation rate. Since in practice monetary policy can be adjusted more quickly than fiscal decisions, we assume that the government, when setting taxes, takes account of the central bank's expected reaction. Accordingly, the government acts as a Stackelberg leader vis-à-vis the central bank.

The output supply function is described by:

$$x = \pi - \pi^e - \tau \tag{1}$$

where π and π^e are the actual and expected inflation rates respectively; τ

[5] Alternatively, one might think about this as the current monetary union, to be expanded later to new member states.

[6] As in Alesina and Tabellini (1987), the private sector can be thought of either as populated by small uncoordinated agents or by a centralised trade union. If the union pursues a real wage target only, both assumptions lead to the same results. For an analogous study to ours (in the closed economy set up) but where the monopoly union aims at stabilising both real wages and output, see Ciccarone et al. (2007).

defines the tax rate.[7] As can be seen from this relation, unexpected inflation, by eroding real wages, induces firms to augment their demand for labour and thus their production. Greater taxation of the firms' revenues, on the contrary, discourages production. Hence, as in Beetsma and Bovenberg (1998, 1999) for instance, fiscal policy has a negative impact on aggregate supply via taxation. In line with most literature, we thus assume that taxation is used for consumption only and has no productive effect on supply.[8]

The government's objectives are summarised in the following loss function:

$$L_G = \alpha\pi^2 + x^2 + \beta\left(g - \tilde{g}\right)^2 \tag{2}$$

where g and $\tilde{g}$ respectively denote the actual and targeted levels of public expenditures as shares of output. The government wishes to minimise the deviations of inflation, output and public spending from their respective targets. For convenience, we normalise the target levels of inflation and output at zero. The public spending target $\tilde{g}$, however, is positive which is crucial for our analysis. This implies that the government will tolerate some tax distortions in exchange for a positive amount of public spending. Since expenditures correspond to public consumption – such as public sector wages and other current government spending – the target $\tilde{g}$ could reflect the government's view of the optimal size of the public sector, or political economic aspects such as the government's interest in boosting expenditures to increase reelection chances (Brender and Drazen 2005). Parameters α and β respectively measure the weights of the inflation and spending objectives relative to the weight of the output objective.

In setting public expenditures, the government faces the following budget constraint:

$$g = \tau \tag{3}$$

This equation can be interpreted as a long-run balanced budget requirement where taxation is the only source of financing public expenditure. Hence, we abstract from the issues of debts and deficits, as in Beetsma and Bovenberg (1998) for instance, and we also exclude seignoriage as a source of finance.[9] Hence, our perspective is a long to medium term analysis. In the European context this is reflected in the Stability and Growth Pact which mandates a balanced budget over the cycle.

The central bank cares about deviations of inflation and output from their respective targets (set equal to zero). We assume that the central bank

[7] A complete derivation of this output equation can be found in, e.g., Alesina and Tabellini (1987) or Beetsma and Bovenberg (1998).

[8] The variable τ could also be interpreted as the tax rate net of public investment so as to capture the productivity enhancing role of public expenditures. See for instance Ismihan and Ozkan (2004) who explicitly consider the composition of public spending by distinguishing between public sector consumption and investment.

[9] For an intertemporal budget constraint where government expenditures can also be financed by public debt, see for instance Beetsma and Bovenberg (1999), Beetsma and Uhlig (1999) or Beetsma and Debrun (2007).

is independent from the government so that it does not take account of the government's spending target. To specify the central bank's loss function that encompasses the issue of monetary uncertainty, we draw on Ciccarone et al. (2007):

$$L_{CB} = (I - \epsilon)\,\pi^2 + (1 + \epsilon)\,x^2 \tag{4}$$

where I measures the central bank's dislike of inflation. It seems realistic to suppose that it attaches a higher priority to price stability than national governments do, as many central banks, like the ECB, have been explicitly given a mandate for price stability. More formally, this means that: $I > \alpha$. Monetary uncertainty arises as the central bank may not fully be transparent in terms of its preferences. This idea is captured by the presence of a random variable ϵ, with $\epsilon \in [-1, I]$, $E(\epsilon) = 0$ and $E(\epsilon^2) = \sigma^2$.[10] The government and the private sector are on average able to predict the monetary authority's preferences but there is some uncertainty around them. This is measured by the parameter σ^2, which we refer to as the degree of monetary uncertainty. An increase in σ^2 means the central bank becomes more opaque and that its behavior is therefore harder to predict.

The solution of the central bank's problem is derived from Eqs. (1) and (4) as:

$$\pi = \frac{1 + \epsilon}{1 + I}\,(\pi^e + \tau) \tag{5}$$

As usually in this type of analysis, inflation is increasing in expected inflation and taxation because the central bank aims to compensate their negative output effects. Inflation is also increasing in $(1 + \epsilon)$, the stochastic weight the bank puts on its output objective, but decreasing in its aversion to inflation I.

The government determines fiscal decisions by minimising its expected loss function $E(L_G)$ subject to the budget constraint (3) and the central bank's reaction (5). This yields the following tax rate :

$$\tau = \frac{\tilde{g}\; I\,(1 + I)\,\beta}{\alpha\,(1 + \sigma^2) + \sigma^2 + I\,(I + \beta + I\beta)} \tag{6}$$

Clearly, taxation is increasing in the spending target $\tilde{g}$ as well as in β, the relative importance the government gives to its spending objective. A higher weight, α, attributed to the price stability objective, however, leads the government to reduce taxes so as to limit the central bank's inflationary reaction.

The equilibrium values for inflation, output and public expenditure devi-

[10] Note that $\sigma^2 \in [0, I]$ as the random variable ϵ is defined in a compact set and has an expected value of zero. See the Appendix of Ciccarone et al. (2007) for further details.

ations are respectively given by:

$$\pi = \frac{\tilde{g}\ (1+I)\,\beta}{\alpha\,(1+\sigma^2)+\sigma^2+I\,(I+\beta+I\beta)}\,(1+\epsilon) \tag{7}$$

$$x = \frac{-\ \tilde{g}\ (1+I)\,\beta}{\alpha\,(1+\sigma^2)+\sigma^2+I\,(I+\beta+I\beta)}\,(I-\epsilon) \tag{8}$$

$$g-\tilde{g} = \frac{-\ \tilde{g}\ [\alpha\,(1+\sigma^2)+\sigma^2+I^2]}{\alpha\,(1+\sigma^2)+\sigma^2+I\,(I+\beta+I\beta)} \tag{9}$$

As can be seen from Eqs. (7) through (9), average inflation is above its target (zero) while average output and public expenditures are below their targets (respectively zero and $\tilde{g}$). As a response to higher taxation, firms reduce their production and the central bank implements an expansive monetary policy. Yet, taxes remain insufficient to finance the desired level of public spending, as the government trades off the utility gain from increased expenditures with the losses from higher average inflation and output distortions.

2.2 The effects of monetary uncertainty

After having determined the equilibrium outcomes, we proceed to examine the effects of monetary uncertainty on the average level and the variability of economic performances. Our results are summarised in the following propositions.

Proposition 1. *Monetary uncertainty reduces taxes, average inflation and output distortions but increases deviations of public expenditures from their target level.*

Proof. Taxes and average inflation decline in σ^2 as can be seen respectively from Eqs. (6) and (7) while, according to Eq. (8), average output increases with σ^2.

Concerning the impact of uncertainty on public expenditure deviations, we obtain:

$$\frac{\partial(g-\tilde{g})}{\partial\sigma^2} = \frac{-\tilde{g}\ I(1+I)(1+\alpha)\beta}{\left[\alpha\,(1+\sigma^2)+\sigma^2+I\,(I+\beta+I\beta)\right]^2} < 0$$

Proposition 1 can be explained by Brainard's (1967) principle of policy caution. When there is great uncertainty about the central bank's preferences, the government can not rely on the monetary response to its fiscal decisions. Too strong a reaction of the central bank would exacerbate the costs of a given increase in taxes in terms of inflation, whereas too weak a reaction would exacerbate the costs in terms of reduced output. The government therefore acts more carefully and abstains from raising taxes. This, in turn, brings about lower output distortions and lower average inflation.

However, as taxes decrease, so does the public expenditure level, pushing the government further away from its desired level of spending.

Central bank opacity could eventually prove to be desirable for governments provided they are not too concerned about their spending objective (β low).[11] This also suggests that, if society is assumed to share the government's objectives, maximum transparency is not optimal from a social point of view.

Proposition 2. ***Inflation and output variability will increase with monetary uncertainty if the central bank is sufficiently inflation averse.***

Proof. Using $V(\pi) = E[\pi - E(\pi)]^2$ and $V(x) = E[x - E(x)]^2$, we get $V(\pi) = V(x) = \tau^2 \cdot \sigma^2 / I^2$. Differentiating $V(\pi)$ and $V(x)$ with respect to σ^2 yields:

$$\frac{\partial V(\pi)}{\partial \sigma^2} = \frac{\partial V(x)}{\partial \sigma^2} = \frac{\tilde{g}^2 (1+I)^2 \beta^2 \ [\alpha - \sigma^2 (1+\alpha) + I(I+\beta+I\beta)]}{\{\alpha(1+\sigma^2) + \sigma^2 + I(I+\beta+I\beta)\}^3}$$

This derivative is positive if:

$$\frac{\alpha + I(I+\beta+I\beta)}{1+\alpha} > \sigma^2 \tag{10}$$

Given that $\sigma^2 \in [0, I]$ (see footnote 11), the condition is likely to hold.[12]

Hence, uncertainty about central bank preferences may translate into higher variability of output and inflation if uncertainty is not too high. The intuition of this result is as follows. Opacity of monetary policy triggers two countervailing effects on macroeconomic volatility: a direct positive effect as less transparency is associated with greater uncertainty in the monetary reaction; and an indirect negative effect due to the fact that opacity leads to lower taxation and in this way contributes to reduce macroeconomic variability. If the degree of monetary uncertainty, σ^2, is not extremely high, the direct positive effect prevails.

Moreover, from rewriting condition (10) as $f(I, \beta) \equiv \frac{\alpha + I(I+\beta+I\beta)}{1+\alpha} > \sigma^2$, we observe that $\frac{\partial f}{\partial I} > 0$. The greater the degree of central bank conservatism, I, the more uncertainty is likely to increase macroeconomic variability. If the bank is highly concerned about price stability, the consequences of its opacity on inflation are relatively low. Accordingly, the decreasing impact of uncertainty on taxe decisions, and thus on macroeconomic volatility, is mitigated.

[11] In integrating Eqs. (7), (8) and (9) into the government's expected loss function and differentiating with respect to σ^2, we observe that $\frac{\partial E(L_G)}{\partial \sigma^2}$ is negative for $\beta < \frac{(1-I)[\alpha(1+\sigma^2)+\sigma^2+I^2]}{I(1+I)^2}$.

[12] A sufficient condition for it to hold is $I > 1$.

Besides, we also observe that: $\frac{\partial f}{\partial \beta} > 0$. The more the government cares about its spending objective (β large), the less prone it is to reduce taxes in response to monetary uncertainty. This means that a higher β is associated with a lower 'tax-decreasing' effect of uncertainty and thus with a higher probability that uncertainty increases macroeconomic variability.

3 Policy choices in the monetary union

We now shift our attention to the interactions between uncertainty and fiscal policymaking in a monetary union. It latter is composed of two countries (indexed by i, $\forall i = 1, 2$) which may either be identical (as for instance the founding members of the EMU) or present differences in their economic and institutional development (this might be thought of as the enlargement of the present EMU to new member states).

In the latter case, we also allow for cross-country asymmetries in the public spending targets. As argued above, this could reflect differences in the member countries' need for public investment, their preferences over the size of the welfare state, or political economic considerations.[13]

In addition, we assume that the monetary union may induce changes in the members' degree of central bank transparency. As Dincer and Eichengreen (2009) show, degrees of transparency differ widely across countries, including those that aim at joining the EMU or plan for other regional monetary unions. It is hence possible that the move to a larger currency area may create additional uncertainty in countries where the national central bank has been highly transparent. This assumption seems realistic at least for an initial period where the public and the governments need some time to assess the preferences of the larger monetary authority. Alternatively, other member states may see their degree of uncertainty fall with their entry in the union. This idea could be justified by the fact that, during a transitional period, candidates for an entry to the union experience some extra uncertainty due to their adjustment to the new monetary regime which is resolved upon entry. Another interpretation would be that the well-established central bank of the monetary union is more predictable than the entering member's national central banks with, for instance frequently changing governors.

With the monetary union (superscript U), monetary policy is centralised in the hands of a larger central bank which is independent from national governments. The common central bank sets a common rate of inflation, π^U, prevailing in the whole monetary area since the member countries' good markets are assumed to be perfectly integrated. Its loss function reflects its concern about price stability (the inflation target is assumed to be zero) and

[13] Note that the relative weights attributed by governments to inflation and public spending deviations (respectively denoted by parameters α and β in the governments' loss function) are assumed to be identical across countries. Allowing for different spending targets suffices to derive asymmetric fiscal policy choices.

average output, x^U, in the union:

$$L_{CCB} = \left(I - \epsilon^U\right)\left(\pi^U\right)^2 + \left(1 + \epsilon^U\right)\left(x^U\right)^2 \tag{11}$$

where ϵ^U is a random variable with $\epsilon^U \in [-1, I]$, $E(\epsilon^U) = 0$ and $E(\epsilon^U)^2 = \sigma_U^2$; $x^U = (x_1 + x_2)/2$ represents the average output in the union.[14] The presence of the random variable ϵ^U indicates that there is some uncertainty surrounding the common central bank's preferences as well. This uncertainty is measured by the variance σ_U^2.

In minimising Eq. (11) subject to the member countries' output function (1), we obtain the central bank's reaction:

$$\pi^U = \frac{1+\epsilon}{1+I}\left(\pi^{Ue} + \bar{\tau}\right) \tag{12}$$

where π^{Ue} is the expected common inflation rate and $\bar{\tau} = (\tau_1 + \tau_2)/2$, the average tax rate in the union.

Like the national central bank, the common central bank reacts to the fiscal authorities' behaviour. Although it is independent from governments, national tax policies still affect its decisions via their impact on average output.

As before, when setting its tax rate, each government in the union faces the budget constraint represented by Eq. (3)**.** Hence, the government in country i ($i = 1, 2$) chooses the tax rate to minimise its expected losses $E(L_{G,i})$ (with $L_{G,i}$ defined in Eq. (2)) subject to (3) and (12), taking the other government's fiscal decision as given. Its resulting tax rate can be written:

$$\tau_i^U = \frac{\beta(1+I)\left\{(\tilde{g}_i - \tilde{g}_j)\left[\alpha\left(1+\sigma_U^2\right) + \sigma_U^2\right] + 2\tilde{g}_i I\phi^U\right\}}{\phi^U\left[\alpha\left(1+\sigma_U^2\right) + \sigma_U^2 + I\phi^U\right]} \tag{13}$$

where $\phi^U = 1 + 2(I + \beta + I\beta) > 0$. The index j refers to country i's partner in the union.

This expression reveals that taxes are increasing in the domestic spending target but falling in the partner country's spending target. In particular, tax rates turn out to be *strategic substitutes* since higher taxation abroad triggers pressures on the common inflation that force the domestic government to lower its own tax rate.

3.1 The symmetric case

The simple case of a symmetric monetary union implies that both member countries have identical public spending targets: $\tilde{g}_1 = \tilde{g}_2 = \tilde{g}$. Furthermore, our aim in this benchmark case is to highlight the *direct* effect of monetary

[14] In an earlier version of the paper, we have considered asymmetries in the member countries' relative economic weight. This does not substantially modify the results.

integration. This effect is 'direct' in the sense that all relevant monetary parameters are assumed to be unaffected by the regime change. In particular, we suppose that the move to a larger currency area has no repercussion on the degree of uncertainty in the participating countries: $\sigma_U^2 = \sigma_i^2 = \sigma^2$, $\forall i = 1, 2$.

In substituting these parameter values into (13), we obtain the equilibrium tax rate in the symmetric case ($\tau_1^U = \tau_2^U = \tau^U$):

$$\tau^U = \frac{2\tilde{g}\ I\,(1+I)\,\beta}{\alpha\,(1+\sigma^2) + \sigma^2 + I\,[1 + 2(I + \beta + I\beta)]} \tag{14}$$

We can now derive the implications of the union for fiscal policy decisions and, through it, for macroeconomic performances in the participating countries. Formally, this is done by examining the difference $(\tau^U - \tau)$, $\forall i = 1, 2$. Once this difference is known, it is straightforward to derive the effects of the union on the average levels of output and inflation as well as on public spending.

The comparison of expression (14) with the equilibrium tax rate observed before monetary union (6) leads to the following propositions.

Proposition 3. *Under the assumption of symmetric countries, the monetary union increases taxes, average inflation, output distortions and public spending if:*
i) uncertainty, σ^2, is high
ii) the central bank's aversion to inflation, I, is low
iii) the relative weight that governments attribute to their inflation objective, α, is high.

Proof. The comparison of Eq. (6) with (14) reveals that the union has a positive impact on taxes and thus on average inflation, output distortions and public expenditures if the following condition holds:

$$\sigma^2 > \frac{I - \alpha}{1 + \alpha} \tag{15}$$

Proposition 3 qualifies the main result obtained by Beetsma and Bovenberg (1998) who demonstrate that the monetary union may encourage national fiscal authorities to reduce taxation. According to result *i)*, this scenario only occurs for sufficiently low degrees of uncertainty but disappears when the central bank's opacity, σ^2, is high enough.

To understand the intuition underlying Proposition 3, we note that the overall impact of the monetary union on fiscal policies (and thereby on economic outcomes) is the consequence of two opposite mechanisms. The first has already been highlighted by Beetsma and Bovenberg (1998). It hinges on the assumption that central banks care more about price stability than governments do ($I > \alpha$). In this case, the latter are induced to set high taxes since they know that the central bank will respond by raising inflation

so as to counteract the adverse effects of excessive taxation on output. Yet, in the monetary union, governments' fiscal choices have a smaller impact on monetary policy. The union indeed reduces the inflationary consequences of individual tax increases, thereby rendering them more costly in terms of reduced output. Consequently, governments are forced to moderate taxation. Through this mechanism – which we label the 'conventional mechanism' – monetary union translates into lower average inflation, output distortions and public expenditures.

However, taking account of the fact that the central bank's reaction may not be fully predictable, we find an additional mechanism through which monetary union is likely to increase taxes. In the union, governments perceive the uncertainty surrounding monetary decisions to a lesser extent, and the moderating impact of uncertainty on fiscal decisions is accordingly mitigated. This in turn encourages higher taxation. The strength of this second mechanism – which we refer to as the 'uncertainty mechanism' – is calibrated by the degree of uncertainty, σ^2. Hence, for sufficiently high values of σ^2, the 'uncertainty mechanism' prevails, and monetary union raises average inflation, output distortions and public expenditures. This mechanism will also prevail when the central bank is rather populist (I small) and/or when the governments' concern for output relative to price stability is not too high (i.e. α large).

This result allows us to briefly touch on the issue of the welfare effects of a monetary union. Proposition 3 also suggests that a union characterised by a relatively opaque central bank could make governments and society – if one assumes that governments incorporate social preferences – worse off. This is likely to happen if they attach great importance to price and output stability so that the gain from the increased expenditure level is more than compensated by the losses due to higher inflation and output distortions. In this case, it could be beneficial to reduce transparency as a response to monetary integration. This would allow to counteract the reduction in the governments' perception of uncertainty that results from monetary union.

3.2 The asymmetric case

We now turn to the asymmetric case where we allow for cross-country differences in the targeted level of public expenditures, so that: $\tilde{g}_1 \neq \tilde{g}_2$. Moreover, in this section we also consider the possibility that the monetary union may induce changes in the countries' degree of uncertainty. As argued above, we suppose that some members will experience an increase in uncertainty whereas others see their degree of uncertainty fall. Formally, this implies: $\sigma_i^2 \gtrless \sigma_U^2$ $(\forall i = 1, 2)$.

Taking account of these asymmetries, we can examine how the effects of the union vary across the different member countries, depending on their spending target and on the change in monetary uncertainty that they exper-

ience. Comparison of the tax rate (13) with the one observed in country i ($\forall i = 1, 2$) before monetary union (Eq. (6)) delivers the following proposition.

Proposition 4. *The monetary union may increase taxes, output distortions and public spending in country i if:*
i) it is associated with a reduction in the degree of uncertainty in country i
ii) country i has a relatively higher spending target than its partner in the union.

Proof. For country i, it appears that $\tau_i^U - \tau_i > 0$, $E(x_i^U - x_i) < 0$ and $g_i^U - g_i > 0$ (where variables without superscript U refer to the situation before the monetary union) if the following expression is positive:

$$\begin{aligned} &-\tilde{g}_i I(I-\alpha)\left[1+2(I+\beta+I\beta)\right] \\ &+\tilde{g}_i I(1+\alpha)\left[1+2(I+\beta+I\beta)\right]\left(2\sigma_i^2-\sigma_U^2\right) \\ &+\left(\tilde{g}_i-\tilde{g}_j\right)\left[\alpha(1+\sigma_U^2)+\sigma_U^2\right]\left[\alpha(1+\sigma_i^2)+\sigma_i^2+I^2+I\left(1+I\right)\beta\right] \end{aligned} \tag{16}$$

This expression is composed of three terms. The first is negative if $I > \alpha$, i.e. when the central bank is more inflation averse than governments. The two last terms, nonetheless, are positive when respectively: $\sigma_i^2 - \sigma_U^2 > 0$ and $\tilde{g}_i - \tilde{g}_j > 0$. If these differences are sufficiently large, the whole expression may be positive.

Proposition 4 states that countries characterized by a relatively high spending target and for which the union is likely to imply less uncertainty may experience greater tax distortions, but also attain a higher spending level. On the contrary, in countries which have a relatively modest spending target and where uncertainty increases, taxes and output distortions will fall. There is hence a polarization between countries in the sense that those with a conservative fiscal policy will further reduce taxation and vice versa.

For an intuitive account of this result, we must look at the three different mechanisms underlined in expression (16). The first term has already been explained above and referred to as the 'conventional mechanism'. It implies that the monetary union favours tax moderation provided central banks are sufficiently more concerned about price stability than governments ($I > \alpha$). This conventional tax-decreasing effect of the union, however, may be offset by the two other mechanisms operating in the opposite direction.

The second term in expression (16) suggests an increase in taxes if the monetary unification implies a reduction of uncertainty. Since the larger central bank runs a much more transparent and predictable monetary policy than the national banks did, the moderating influence from uncertainty is reduced and governments are encouraged to raise taxation.

The third term in (16) implies an increase in tax distortions in countries with a substantially higher spending target than their partners. This hap-

pens because tax rates are strategic substitutes. Governments with a high spending target take advantage of their partners' tax moderation, and thus of the resulting lower inflationary pressure (on average and in terms of variance) to set higher taxes. Moreover, the strength of this effect is positively related to the degree of uncertainty in the union. The higher is σ_U^2, the greater is the governments' perception of the decline in inflation variability due to the tax moderation of their partners and the stronger is their tax increase. Hence, greater uncertainty does not necessarily prove to be beneficial for countries characterised by a large spending target. This observation somewhat qualifies our earlier result (section 3.1) about the tax reducing effect of lower transparency.

At last, we turn to the effects of the union on inflation. Under the assumption of asymmetric national fiscal policies, the equilibrium inflation rate observed in the enlarged currency area is given by:

$$\pi^U = \frac{(\tilde{g}_1 + \tilde{g}_2)\ (1+I)\,\beta}{\alpha\,(1+\sigma_U^2) + \sigma_U^2 + I\,[1+2(I+\beta+I\beta)]}\left(1+\epsilon^U\right) \tag{17}$$

Not surprisingly, π^U positively depends on the public spending targets in both countries. Comparing π^U with the inflation rate observed in country i ($\forall i = 1, 2$) before its entry into the monetary union delivers the following proposition.

Proposition 5. *Country i may experience an increase in the average inflation rate due to the union if its partner country has a relatively high spending target.*

Proof. Comparison of the expected values of (17) and (7) yields:

$$E(\pi^U - \pi_i) = (1+I)\,\beta\left[\frac{\tilde{g}_i + \tilde{g}_j}{\alpha\,(1+\sigma_U^2) + \sigma_U^2 + I\phi^U} - \frac{\tilde{g}_i}{\alpha\,(1+\sigma^2) + \sigma^2 + I\phi}\right] \tag{18}$$

where $\phi = I + \beta + I\beta > 0$; π_i, defined in Eq. (7), corresponds to the inflation rate observed in country i before monetary union.

From this expression, it is easy to see that $E(\pi^U - \pi_i)$ is increasing in $\tilde{g}_j$. Hence, the greater the spending target in country j, the more the union is likely to raise inflation in country i. The intuition underlying this result is simple. Countries with a large spending target are characterised by high taxation. As a response the common central bank then conducts a rather inflationary policy, harmful to other countries in the union.

4 Conclusion

This paper has demonstrated that uncertainty about the monetary authorities' relative preferences for output and inflation has a systematic influence

on the optimal fiscal policies of governments. In particular, we showed that monetary uncertainty encourages tax moderation and thereby helps to reduce average inflation and output distortions. This result hence makes a case for some ambiguity in the central bank's preferences and behaviour. We next extended this analysis to the case of a monetary union, considering first symmetric member countries. In the monetary union, governments internalise the effects of monetary uncertainty to a lesser extent and are therefore likely to pursue a more aggressive tax policy. It thus appears to be an appropriate response by the central bank to become less transparent in a larger currency area.

However, we do not argue that such a deliberate increase in uncertainty constitutes a systematically efficient solution to the potential tax-increasing impact of a monetary union. By considering cross-country asymmetries in the governments' objectives, we observed that the enlargement may lead to higher taxation in countries with a relatively large spending target as they take advantage of their partners' fiscal conservatism. Higher uncertainty in the union then even strengthens this effect.

Finally, our analysis does not provide any clear-cut argument to the debate about the desirability of central bank transparency. On the contrary, it underlines the crucial implications of asymmetric fiscal policies in the monetary union for the appropriate choice of central bank transparency.

There are several interesting issues we have not incorporated here. First, we have not allowed for deficits and debt. Extending our setup to a multi-period model would allow to take account of these issues and to see how the incentives to run up debt are influenced by uncertainty. Second, one can take the model to the data and see if our postulated relation between uncertainty and fiscal policy can be confirmed empirically. These points should be the subject of further research.

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