Unions, fiscal policy and central bank transparency *

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Abstract

In a unionised economy with supply-side fiscal policy transparency has two contrasting effects on economic performance. Uncertainty on central bank's preferences induces unions to reduce wages but also produces a fully-anticipated expansionary fiscal policy which favours the setting of higher wages. Even if the net effect depends on the preference parameters of public entities and on the effectiveness of fiscal policy on aggregate supply: (i) the positive effects of opacity in unionised economies without fiscal policy are confirmed when the central bank is populist; (ii) if it is instead sufficiently conservative, transparency reduces inflation and the output gap, but at the cost of higher macroeconomic volatility.

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1 Introduction

The macroeconomic importance of central bank (CB from now onward) transparency is increasingly debated in the literature. According to a popular view, progressively supported by central bankers (Greesnpan, 2001), transparency allows for Pareto-improving forecasts and decisions (Blinder 1998; Blinder et al. 2001), favours cooperative behaviour (Bini-Smaghi and Gros 2001) and allows to better anticipate policy responses in the face of unexpected developments, thus speeding economic adjustments (Ferguson 2002). According to an opposite view, opacity (the opposite of transparency) allows instead CBs to use their private information strategically (in the sense of Canzoneri 1985), thus inducing wage moderation (Sorensen 1991) and in this way decreasing both the level and the variance of inflation (Grüner 2002). Some authors have also tried to demonstrate that CB's preference uncertainty is welfare enhancing because the reduction it produces in output variability dominates the higher inflation variability it brings about (Eijffinger, Hoeberichts and Shaling 2000), but other contributions have reached opposite results (Beetsma and Jensen 2003). Positions hence remain rather distant, as also shown by the available surveys on the subject matter (see, e.g., Geerats 2002; Posen 2003; Carpenter 2004).

This lack of convergence in the theoretical literature, which may help explain the existing difficulties of justifying the heterogeneous behaviour of actual CBs in information disclosure (Bini-Smaghi and Gros 2001; Eijffinger and Geraats 2002; Di Bartolomeo and Marchetti 2004; Demertzis and Hughes-Hallet 2003), is mirrored by the scanty and conflicting findings of the empirical literature. In particular, it is not clear whether transparency strongly affects the average level of inflation and of the output gap,[1] while it

[1]For example, Demertzis and Hughes-Hallet (2003) claim that this is not the case for the nine countries

remains difficult to establish its effects on output and inflation variability. According to Chortareas et al. (2003) and to Demertzis and Hughes-Hallet (2003), disclosure reduces inflation volatility at the expense of a rise in output volatility, whereas Kuttner and Posen (1999), (2000), (2001) argue that inflation targeting CBs display higher flexibility in responding to shocks without reducing their ability to respond to output volatility. Further evidence seems to instead suggest that conservative (i.e., anti-inflationary) and transparent CBs are able to reduce both levels and variances of output and inflation (Posen 2003).

Since the notion of transparency is not univocal, in this paper we restrict our attention to the so-called "contingent", or "political", view of transparency (Posen 2003; Hughes-Hallet and Viegi 2003) - i.e., that related to information asymmetries between CBs and the general public about the weight of the arguments in the monetary authorities' objective functions[2] - which relates transparency to the CB's degree of conservativeness.[3] In this context, we aim to show that the effects of transparency vary with the main institutional characteristics of the economy: degree of labour market competitiveness, degree of CB's conservativeness, constraints on fiscal policy. To this aim, we bring together two modelling set-ups recently proposed by the literature, that is:

(i) models considering the effects of monetary policy transparency in unionised economies without fiscal policy, where a reduction in transparency leads to more wage discipline (as in Sorensen 1991) and thus to lower inflation and unemployment (Grüner 2002);

(ii) models focussing on a Nash equilibrium between the CB and a government able to control a fiscal instrument, with a non unionized private sector acting as Stackelberg

for which Eijffinger and Geraats (2002) constructed their indexes.

[2]This view originated of course from Barro and Gordon (1983): in order to avoid the suboptimal outcomes of discretionary monetary policy, authorities should pre-commit to publicly announced policies, be independent and inflation averse (Rogoff 1985); in order to be accountable, their behaviour must be predictable and verifiable by the public, and to this aim they must disclose the information they possess.

[3]See, among others, Cukierman (2002), Faust and Svensson (2001), (2002), Geraats (2002), Gersbach and Hahn (2003), (2004) and Jensen (2002).

leader with respect to the public sector (Hughes-Hallett and Viegi 2003; Demertzis, Hughes-Hallett and Viegi 2004).

In our economy with endogenous supply-side fiscal policy and labour market distortions, the timing of the game (which is solved backward) is as follows: the union sets the nominal wage, then the government fixes the value of the fiscal instrument, and finally the CB chooses the value of the monetary instrument. These assumptions encapsulate the idea that wage contracts are set for a period of time which is longer than the time horizon of fiscal policy and, even more, than that of monetary policy. We adopt the sequential timing because we agree with the view that the Stackelberg equilibrium concept is the one that better captures fiscal and monetary interaction (Beetsma and Bovenberg 1998; Beetsma and Uhlig 1999).[4]

The main conclusion we reach is that CB's opacity always produces a wage restraint effect in union behaviour: as the cost of uncertainty about CB's preferences increases with inflation and unemployment, the traditional result of policy caution a là Brainard (1967) emerges. However, if fiscal policy is added to the picture the effects of transparency become more complex. In general, the positive effects of opacity documented by Grüner (2002) are confirmed if the CB is populist. Under sufficiently conservative monetary authorities, transparency reduces inflation and the output gap, but it generates higher macroeconomic volatility. Uncertainty on CB's preferences has expansionary effects on fiscal policy which are however anticipated by the union which, by increasing wages, generates higher inflation and unemployment. The tension between the wage restraint effect and this anticipation effect determines the net impact of opacity on macroeconomic outcomes. Since this depends on the exogenous preferences of all the players, our results are consistent with the empirically observed heterogeneity in CB's transparency across countries.

[4]See also Dixit and Lambertini (2003) for a general discussion.

The paper is structured as follows. In section 2 we construct a policy game between a money wage setting union, a fiscal authority and a CB, and in section 3 we solve it under a Stackelberg sequence of players' moves. In section 4 we analyze the effects of an increase in CB's transparency on the levels of inflation and output deviation from the target values, under different assumptions on the "type" of CB (more or less conservative) and on the stance of fiscal policy (fiscal authorities more or less concerned about the losses induced by fiscal expansions). Section 5 offers some insights on the effects of CB's transparency on the variances of inflation and output deviation. Section 6 concludes.

2 The model

In this section we introduce a simple policy game made up by two equations describing the economy and by three equations describing policymakers' preferences. Aggregate demand and aggregate supply are:

$$\text{AD:} \qquad x = m - p \tag{1}$$

$$\text{AS:} \qquad x = p - w + \eta b \tag{2}$$

where x is the output deviation for its non-distorted natural level, m is the money stock, p is the price level (inflation), w is the nominal wage and b is the net level of a supply-side fiscal policy. Equation (1) is a well-known and simple representation of the demand side. Equation (2) is the aggregate supply, expressed in terms of the real wage instead of price expectations, so as to introduce endogenous labour market distortions due to unionized wage setting. Equation (2) also includes the possibility for fiscal policy to influence the aggregate supply of output. This idea, which has been increasingly employed in the recent literature, can be justified in several different ways.

1. b is a fiscal surplus ($b < 0$), or deficit ($b > 0$), which has a permanent effect

on output if maintained through time (Hughes-Hallett and Viegi 2003; Demertzis, Hughes-Hallett and Viegi 2004). Equation (2) then summarizes the idea that the aggregate supply of output can be split into a private component, produced by competitive and profit-maximising firms and a public component, generated by a government producing the same (aggregate) good produced by private firms and expanding the level of output by directly purchasing labour through non-monetary budget deficits (Acocella and Ciccarone 1997).

2. b is a public investment that raises the private sector productivity, or a production subsidy to the firms that raises the supply of goods and services and reduces prices, and which can be financed by per-head taxes and/or by taxation on sales or on income (Dixit and Lambertini 2003).

3. b is a measure of social security or of non-wage costs imposed on employers, or taxes on labour, or the costs of supply side constraints, or market restrictions, or job protection legislation imposed on producers (Demertzis, Hughes-Hallett and Viegi 2004).

In any case, monetary policy operates on the demand side and fiscal policy on the supply side. We assume that $\eta > 0$: an increase in b *ceteris paribus* reduces prices, and raises output and employment, thus favouring an increase in the nominal wage set by the union. This set-up is useful, as it enables us: (a) to study the effects of transparency on output and inflation in a simple model with fiscal policy, and so to take the government's preferences (and some institutional constraints, like the *European Stability and Growth Pact*) directly into account; (b) to compare our results with those of other models already present in the literature which take on board the idea that government deficit spending does not influence the demand side of the economy.

The CB maximises the following preferences:

$$L_B = -\left[\frac{1}{2}(\beta_B - \varepsilon)\pi^2 + \frac{1}{2}(1+\varepsilon)x^2\right] \tag{3}$$

where $E[\varepsilon] = 0$, $E[\varepsilon^2] = \sigma_\varepsilon^2$, $\varepsilon \in [-1, \beta_B]$, and E is the expectation operator. We choose this specification because it avoids the arbitrary effects of CB's preference uncertainty on average monetary policy, documented by Beetsma and Jensen (2003), which are produced by objective functions such as that adopted by Grüner (2002), where a slight change in the modelling of uncertainty (e.g., the placement of the stochastic term in front of one or the other argument of the CB's objective function) can lead to radically different effects on average monetary reactions. According to equation (3), the level of uncertainty associated with CB's preferences is represented by the variance σ_ε^2. As the random variable ε takes values in a compact set and has an expected value equal to zero, σ_ε^2 must have a well defined upper bound; more precisely: $\sigma_\varepsilon^2 \in [0, \beta_B]$ (see the Appendix for details).

The Government maximises the following preferences:[5]

$$L_G = -E\left[\frac{\beta_G}{2}\pi^2 + \frac{1}{2}x^2\right] - \frac{\varphi_G}{2}b^2 \tag{4}$$

In line with the existing literature (Hughes-Hallett and Viegi 2003; Demertzis, Hughes-Hallett and Viegi 2004), we do not include an explicit budget constraint into the model, but constrain fiscal policy by placing penalties on its use through the introduction of b in the government's utility function (4), with the parameter φ_G measuring the weight of such penalties. It can be thought of as influenced, among other things, by specific institutional constraints posed on fiscal policy: when fiscal discipline becomes tight due, e.g., to international agreements (as the Stability and Growth Pact), the cost for the Government to pursue an active fiscal policy increases, and this can be represented by a higher level of φ_G.

[5]The Government has expected preferences since it does not know the CB's degree of transparency.

The justification for this approach can be split into three steps.

1. It is possible to interpret the government's present value budget constraint (the liabilities to GDP ratio at time t is equal to the surplus to GDP ratio at time t plus the expected value of future discounted surplus to GDP ratios) as a condition that must be satisfied in equilibrium. This occurs if fiscal policy generates a sequence of future surplus to GDP ratios which satisfies the condition independently of the values taken in equilibrium by the discount factors, or the initial liabilities to GDP ratio. Alternatively, if the sequence of future surplus to GDP ratios is arbitrary, the discount factors, or the initial liabilities to GDP ratio must move so as to satisfy the equilibrium condition.

2. Canzoneri, Cumby and Diba (2001) have shown that if (i) the sequence of surplus to GDP ratio is determined by the liabilities to GDP ratio (through a positive and bounded away from zero infinitely often time varying response parameter) and a bounded random variable (encapsulating political and economic factors), and (ii) the sum of the discount factors converges, then the flow budget constraint is dynamically stable, and the government's present value budget constraint is respected for any initial liabilities to GDP ratio. We do not need the fiscal response to be strong enough, but only that the discounted value of the liabilities to GDP ratio at time $t+T$ goes to zero as T goes to infinity. If the response parameter is constant, any positive value guarantees this result; in the case of a time varying fiscal response, it may be arbitrarily small and infrequent.

3. The inclusion of the fiscal deficit (or, more in general, of fiscal policy) in the government's utility function guarantees that the fiscal response will be such that the solutions of the model are both sustainable (i.e., they satisfy the long-run solvency constraint) and can be financed in advance (i.e., they satisfy the "cash in advance"

constraints): the budget constraint does not bind.

The all-encompassing monopoly union maximises:

$$L_U = E\left[\alpha(w-\pi) - \frac{1}{2}x^2\right] \tag{5}$$

The union's loss is increasing in the deviations of actual output (employment) from the natural level, but is strictly decreasing in the realized value of the real wage. Thus, the union is willing to trade departures of employment from its market clearing level against increases in the real wage. This specification, or variants of it, is common in the literature concerned with the macroeconomic implications of union wage setting.[6] It implies that, in general, equilibrium will be characterized by employment below the market-clearing level and it provides, in the present model, the source of a time inconsistency problem.

As already mentioned, the timing of the game is as follows: (i) the union sets w; (ii) the government fixes b; (iii) the CB chooses m. The game is solved backward.

3 Macroeconomic equilibrium

The solution of the CB's problem gives the following reaction function:

$$m = \frac{\beta_B - 2\varepsilon - 1}{\beta_B + 1}(\eta b - w) \tag{6}$$

where β_B is an index of the CB's degree of conservativeness: if $\beta_B > 1 + 2\varepsilon$ ($\beta_B < 1 + 2\varepsilon$) the CB follows a (non) accommodating policy with respect to wage expansion. It is worth noticing that if the CB accommodates wage increases, it cannot accommodate fiscal expansions (i.e., increase m when b increases).

[6] Properties of linear-quadratic preferences in this kind of policy games are fully discussed in Acocella and DI Bartolomeo (2004). See also Acocella and Ciccarone (1997).

Given equation (6), output, inflation and the real wage can be written as:

$$w - p = w - \frac{1+\varepsilon}{\beta_B + 1}(w - \eta b) \tag{7}$$

$$x = \frac{\beta_B - \varepsilon}{\beta_B + 1}(\eta b - w) \tag{8}$$

$$\pi = \frac{1+\varepsilon}{\beta_B + 1}(w - \eta b) \tag{9}$$

However, in setting their policy, the government and the union cannot predict these equations since they are not perfectly informed about the CB's preferences. By using equations (8) and (9), the government's expected loss can be rewritten as:

$$L_G = -\frac{1}{2}\left[\frac{\beta_G + \beta_B^2 + (1+\beta_G)\sigma_\varepsilon^2}{(1+\beta_B)^2}\right](\eta b - w)^2 - \frac{\varphi_G}{2}b^2$$

since $E\left[\beta_G(1+\varepsilon)^2 + (\beta_B - \varepsilon)^2\right] = \beta_G + \beta_B^2 + (\beta_G + 1)\sigma_\varepsilon^2$. The corresponding fiscal rule is:

$$b = \frac{\beta_G + \beta_B^2 + (1+\beta_G)\sigma_\varepsilon^2}{\eta^2(\beta_G + \beta_B^2) + \varphi_G(1+\beta_B)^2 + \eta^2(1+\beta_G)\sigma_\varepsilon^2}\eta w \tag{10}$$

The equilibrium value of the deficit depends on the variance of ε (degree of transparency), but it is unaffected by its level; thus $E[b_S] = b_S = \eta\alpha\frac{(1+\beta_B)\beta_B\varphi_G\left[\beta_G+\beta_B^2+(\beta_G+1)\sigma_\varepsilon^2\right]}{\varphi_G^2(1+\beta_B)^2\left(\sigma_\varepsilon^2+\beta_B^2\right)} + \eta\alpha\frac{\left[\beta_G+\beta_B^2+(\beta_G+1)\sigma_\varepsilon^2\right]^2\eta^2}{\varphi_G^2(1+\beta_B)^2\left(\sigma_\varepsilon^2+\beta_B^2\right)}$.

By using (6) and (10), the union's optimization problem can be written as:

$$\max_w E\left[\alpha(w-\pi) - \frac{1}{2}x^2\right]$$
$$\text{s.t.} \quad (6),\ (10)$$

The corresponding equilibrium wage w_S is a function of the model parameters: $w_S = \left[1 + 2\beta_B + \frac{\beta_G+\beta_B^2+(\beta_G+1)\sigma_\varepsilon^2}{1+\beta_B}\eta^2\right]\frac{\beta_G+\beta_B^2+(1+\beta_G)\sigma_\varepsilon^2}{\varphi_G^2(1+\beta_B)\left(\sigma_\varepsilon^2+\beta_B^2\right)}\eta$.

The equilibrium outcomes are:

$$\pi_S = \alpha \frac{\left[\left(1+\beta_G\right)\eta^2\sigma_\varepsilon^2 + \left(\beta_G+\beta_B^2\right)\eta^2 + \beta_B\left(1+\beta_B\right)\varphi_G\right]}{\varphi_G\left(1+\beta_B\right)\left(\sigma_\varepsilon^2+\beta_B^2\right)}\left(1+\varepsilon\right) \tag{11}$$

$$x_S = -\alpha \frac{\left[\left(1+\beta_G\right)\eta^2\sigma_\varepsilon^2 + \left(\beta_G+\beta_B^2\right)\eta^2 + \beta_B\left(1+\beta_B\right)\varphi_G\right]}{\varphi_G\left(1+\beta_B\right)\left(\sigma_\varepsilon^2+\beta_B^2\right)}\left(\beta_B-\varepsilon\right) \tag{12}$$

Equations (11)-(12) immediately clarify that, in this context, the issue of transparency is relevant only if the wage distortion introduced by α is significantly high.[7] The higher is α, the higher are inflation and unemployment, as in this economy the only distortion is due to the presence of unions and wage bargaining. At the same time, an increase in β_B increases unemployment but decreases inflation, in line with the traditional view introduced by Rogoff (1985). Finally, since the effects of CB's opacity are either positive or negative on both unemployment and inflation, we focus only on the latter variable.

Before analyzing the effects of opacity on macroeconomic outcomes it is useful to briefly discuss the full transparency case (i.e. $\sigma_\epsilon^2 = 0$). If the Government is inactive, we face the traditional Barro-Gordon model and the related well-known *inflation bias problem*. By contrast an active Government produces an additional bias: as it attempts to increase output trough expansionary fiscal policy, the union raises the nominal wage, since the marginal cost of output (employment) is lower when fiscal policy is expansionary. This *wage anticipation effect* leads to a *fiscal bias*: the more the Government is populist (i.e. β_G is low), the higher are inflation and unemployment. In order to mitigate union claims, a fiscal policy oriented to stabilizing inflation is required.

[7] This is true also for the equilibiurm value of b.

4 Transparency, inflation and unemployment

After some algebra, it turns out that the effect of transparency on the expected level of inflation is determined by the following inequalities:

$$\begin{aligned} \frac{\partial \pi}{\partial \sigma_{\varepsilon}^2} &> 0 \Longleftrightarrow \frac{\varphi_G}{\beta_G} < \frac{\eta^2 (\beta_B - 1)}{\beta_B} \\ \frac{\partial \pi}{\partial \sigma_{\varepsilon}^2} &< 0 \Longleftrightarrow \frac{\varphi_G}{\beta_G} > \frac{\eta^2 (\beta_B - 1)}{\beta_B} \end{aligned} \tag{13}$$

Since the influence of transparency on the output gap goes in the same direction as that on inflation (see equations (11), (12)), the first of conditions (13) says that more opacity generates an increase in both inflation and output gap iff $\frac{\varphi_G}{\beta_G} < \frac{\eta^2(\beta_B - 1)}{\beta_B}$.

The economic interpretation of condition (13) is straightforward. The effects of transparency depends on the fiscal stance of the Government (φ_G) relative to its preference parameter over inflation (β_G). When the government is active in stabilizing inflation (i.e., for low values of φ_G and high values of β_G), a transparent CB reduces average inflation and unemployment; when the government faces a tight fiscal constraint (i.e., for high values of φ_G), an opaque CB will be associated with lower average inflation and unemployment.[8]

The rationale of the result summarized by inequalities (13) can be explained by Brainard's (1967) approach to uncertainty: as uncertainty increases so do the expected marginal gains associated with more expansionary fiscal policies and with wage restraints. On the other hand, the wage is raised by the union anticipating larger fiscal deficits. Thus, the more the government is active (a low φ_G), the more the anticipation effect of expansionary fiscal policy tends to offset the wage restraint effect due to uncertainty. Also β_B and β_G affect the wage anticipation effect: the Government responds to uncertainty more (or less) strongly according to the size of these two parameters. In particular, the role

[8] In a traditional Barro-Gordon model augmented with preference uncertainty, higher opacity implies lower average inflation and unemployment. This result can be easily verified by considering $\varphi_G \to \infty$ (inactive Government); in this case, only inequality $\frac{\varphi_G}{\beta_G} > \frac{\eta^2(\beta_B - 1)}{\beta_B}$ holds.

played by CB's conservativeness should be highlighted. According to (13), when the union and the Government expect to face a populist CB on average (i.e. when $\beta_B < 1$), more opacity always implies a reduction in average inflation and in the output gap. Summing up, inequalities (13) derive from the interaction between:

(UN): the *uncertainty* effects on wage and fiscal policy and

(WA): the *wage anticipation* of fiscal policy.

The relative size of the **UN** and **WA** effects determines the final impact of σ_ε^2 on the macroeconomic equilibrium (x_S, π_S). As for the **UN** effect, greater uncertainty leads to wage moderation and more expansionary fiscal policy, i.e., more prudent policies (Brainard's principle). As far as fiscal policy is concerned, the **UN** effect can be easily observed by considering the Government's reaction function (10); the elasticity of b to an increase in σ_ε^2, for a given level of nominal wage w, is equal to:[9]

$$\frac{db}{d\sigma_\varepsilon^2}\frac{\sigma_\varepsilon^2}{b} = \frac{\varphi_G\left(1+\beta_B\right)^2\left(1+\beta_G\right)\sigma_\varepsilon^2}{\eta^2\left[\beta_G+\beta_B^2+\left(1+\beta_G\right)\sigma_\varepsilon^2\right]^2+\left[\beta_G+\beta_B^2+\left(1+\beta_G\right)\sigma_\varepsilon^2\right]\varphi_G\left(1+\beta_B\right)^2} > 0$$

The "moderation" effect of greater uncertainty on w_S cannot be checked in the same way, as it incorporates the other players' best responses. Yet, when the Government is inactive ($\varphi_G \to \infty$) the optimal response by the union collapses to:

$$w_{S(\neg G)} = \frac{\beta_B\left(1+\beta_B\right)}{\sigma_\varepsilon^2+\beta_B^2}\alpha$$

In this case, the only mechanism at work is a "wage moderation effect" (analogous to that of Grüner 2002): $\frac{dw_{S(\neg G)}}{d\sigma_\varepsilon^2} < 0$. As for the **WA** effect, more expansionary fiscal policy stimulates a wage increase because it reduces its marginal cost (in terms of employment) for the union.

[9]More uncertainty does not imply in general a greater b_S, since it increases with uncertainty *given the nominal wage*, which is however an endogenous variable.

Thus, the **UN** and the **WA** effects go in the opposite direction and their relative importance determines the sign of the final impact of greater uncertainty on the macroeconomic equilibrium. The net result between **UN** and **WA** is summarized by inequalities (13). The relative strength of the two effects depends upon the ratio φ_G/β_G: a low value (an active Government concerned with inflation) means a reduced **UN** effect; the **WA** effect then prevails, inducing the union to rise the wage. The opposite happens (the moderation effect prevails) when φ_G/β_G is high enough, i.e., when the Government is inactive/populist.

Finally, consider the role played by CB's conservatorism. According to (13), when the union and the Government expect to face a populist CB on average (i.e. when $\beta_B < 1$), greater opacity always implies a reduction in average inflation (and in the output gap), but the effects of wage moderation due to opacity are weak, since the expected marginal benefit (for the union) of such behaviour are small. Under a populist CB, inflation tends to be high and the output gap low. The cost of reducing expected loss variability by wage restraint is high: wage reduction becomes more costly as the output gap gets closer to zero.[10] In this situation, wage effects are small relative to fiscal policy, and the fiscal expansion due to uncertainty prevails in determining the effects of opacity on inflation and the output gap. Summing up, if the CB is populist, b increases while the wage may increase or decrease, but the effect of the former always prevails on the latter. This explains why inflation and the output gap fall with opacity.

5 Transparency and macroeconomic instability.

In order to fully evaluate the impact of transparency in economic performance, it is also necessary to study its impact on the economy's volatility, here synthesized by the variances

[10]The union's preferences imply second-order losses in output gap/real wage; furthermore, a zero output gap is not optimal for the union.

of the equilibrium levels of x_S and π_S.

This variance is computed from equations (11) and (12):

$$\sigma^2_{x,\pi} = \alpha^2 \frac{\left[\left(1+\beta_G\right)\eta^2\sigma^2_\varepsilon + \left(\beta_G+\beta_B^2\right)\eta^2 + \beta_B\left(1+\beta_B\right)\varphi_G\right]^2}{\varphi_G^2\left(1+\beta_B\right)^2\left(\sigma^2_\varepsilon+\beta_B^2\right)^2}\sigma^2_\varepsilon \tag{14}$$

As the effect of σ^2_ε on the variances of x_S and π_S is the same, equation (14) accounts in an unambiguous way for the impact of opacity on macroeconomic volatility. We can obtain some insights on this impact by analyzing the derivative:

$$\begin{aligned}
\frac{\partial\sigma^2_{x,\pi}}{\partial\sigma^2_\varepsilon} &= \frac{\alpha^2\left[\left(1+\beta_G\right)\left(\eta^2\sigma^2_\varepsilon+\beta_B\varphi_G\right)+\left(\beta_G+\beta_B^2\right)\eta^2\right]}{\varphi_G^2\left(1+\beta_B\right)^2\left(\sigma^2_\varepsilon+\beta_B^2\right)^3}\left[\Theta_1(\sigma^2_\varepsilon)^2+\Theta_2\sigma^2_\varepsilon+\Theta_3\right] \\
\Theta_1 &= \left(1+\beta_G\right)\eta^2 > 0 \\
\Theta_2 &= \eta^2\left[(2+3\beta_G)\beta_B^2-\beta_G\right]-\beta_B\left(1+\beta_B\right)\varphi_G \\
\Theta_3 &= \beta_B^2\left[\left(\beta_G+\beta_B^2\right)\eta^2+\beta_B\left(1+\beta_B\right)\varphi_G\right] > 0
\end{aligned} \tag{15}$$

Equations (14) and (15) suggest two remarks. First, as σ^2_ε approaches zero, also the macroeconomic volatility, $\sigma^2_{x,\pi}$, tends to disappear; this is straightforward, as the only source of uncertainty in the model is the one related to the CB's preferences. Were the levels of π_S and $-x_S$ always increasing in opacity, there would be no real trade-off between equilibrium levels and volatility with respect to the degree of transparency: the most desirable situation would be to have a fully transparent CB ($\sigma^2_\varepsilon = 0$). But, as shown in section 4, the response $\partial\pi/\partial\sigma^2_\varepsilon$ (and, equally $\partial\pi/\partial\sigma^2_\varepsilon$) can be either negative or positive according to parameter values. If $\partial\pi/\partial\sigma^2_\varepsilon < 0$ and $\partial\sigma^2_{\pi,x}/\partial\sigma^2_\varepsilon > 0$, there exists a trade off between variances and levels: an increase in opacity would yield lower equilibrium inflation (and output gap), but it would also imply greater macroeconomic instability.

Second, the sign of (15) depends on the sign of the parabola $\Theta_1(\sigma^2_\varepsilon)^2+\Theta_2\sigma^2_\varepsilon+\Theta_3$. As $\Theta_1, \Theta_3 > 0$, $\partial\sigma^2_{\pi,x}/\partial\sigma^2_\varepsilon$ is positive for a large set of parameter values. A sufficient condition

to have $\partial\sigma^2_{\pi,x}/\partial\sigma^2_{\varepsilon} > 0$ is $\Theta_2 > 0$, which implies:

$$0 < \eta^2\left[(2+3\beta_G)\beta_B^2 - \beta_G\right] - \beta_B\left(1+\beta_B\right)\varphi_G \Longrightarrow \frac{\partial\sigma^2_{x,\pi}}{\partial\sigma^2_{\varepsilon}} > 0$$

or equivalently:

$$\frac{\eta^2\left[(2+3\beta_G)\beta_B^2 - \beta_G\right]}{\beta_B\left(1+\beta_B\right)} > \varphi_G \Longrightarrow \frac{\partial\sigma^2_{x,\pi}}{\partial\sigma^2_{\varepsilon}} > 0 \tag{16}$$

Condition (16) differs from the first of inequalities (13). The latter says that when β_B is greater than one and φ_G is relatively low, π_S increases with opacity (an opposite effect to that highlighted by Grüner 2002). According to condition (16), the same parameter values would also bring about an increase in macroeconomic volatility. In such case there would not be a trade off between levels and variances.

A crucial parameter in condition (16) is β_B; a numerical example shows that when β_B is high enough - even if lower than 1 - then $\sigma^2_{\pi,x}$ monotonically increases with opacity; in order to have a more complex behaviour of macroeconomic volatility, a rather low value of β_B is needed (see Figure 1).

This result extends that obtained by Grüner (2002), who envisages a non-monotonic relationship between opacity and macroeconomic volatility: σ^2_{π} increases with σ^2_{ε} for low values of CB's preference uncertainty, and then decreases after reaching a maximum. In our model this occurs when the CB is strongly populist on average (β_B is small enough), but a positive monotone relationship between σ^2_{π} and σ^2_{ε} arises when the CB's is conservative (or mildly populist).

6 Conclusions

In this paper we developed a model of CB's transparency in a unionized economy with endogenous fiscal policy. In this economy, opacity always produces a wage restraint effect in union behaviour, as the cost of uncertainty about CB's preferences increases with

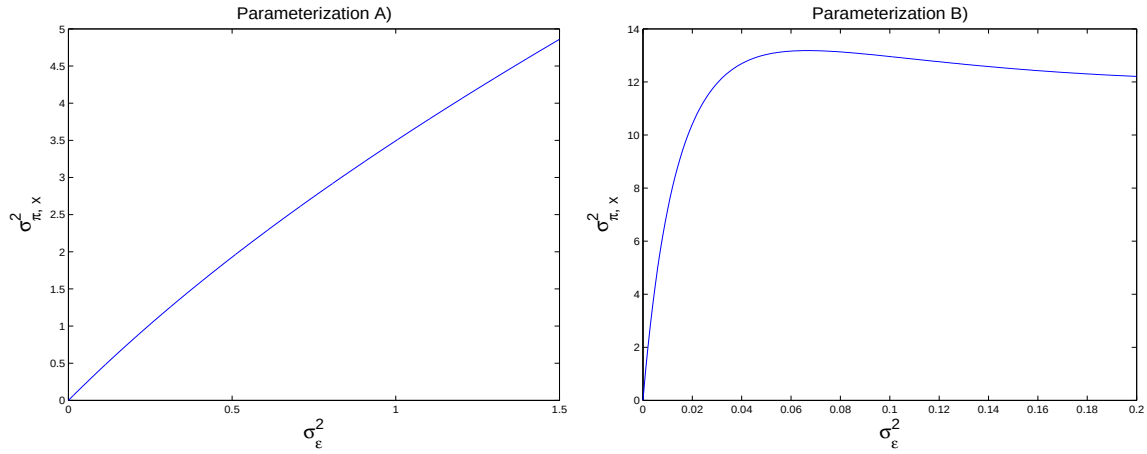

Figure 1: Macroeconomic volatility $\sigma^2_{x,\pi}$ as a function of opacity σ^2_ϵ, for two different parameterisations: A) $\beta_B = \alpha = \eta = \varphi_G = 1.5$, $\beta_G = 0.5$; and B) $\beta_B = 0.25$, $\alpha = \eta = \varphi_G = 1.5$, $\beta_G = 0.5$. Note that for both parameterizations it is $\frac{\partial \pi}{\partial \sigma^2_\varepsilon} < 0$, thus in both cases there exists a trade off between levels and variance. Under parameterization B), $\sigma^2_{\pi,x}$ is increasing in opacity for low values of the latter, and reaches a maximum when σ^2_ε is equal to 0.068.

inflation and unemployment. However, this source of uncertainty has also an expansionary effect on fiscal policy which is however anticipated by the union, leading to increased wages and thus to higher inflation and unemployment.

The tension between the wage restraint effect and the anticipation effect determines the net impact of opacity on macroeconomic equilibrium. The relative strength of the two factors depends on the fiscal stance of the Government relative to its degree of inflation aversion. When the Government is active and concerned with inflation, the wage anticipation effect prevails, inducing the union to rise the wage; in this case, a transparent CB reduces average inflation and unemployment. When a populist government faces a tight fiscal constraint, the moderation effect prevails and an opaque CB brings about lower average inflation and unemployment. The role played by CB's conservatorism is also relevant. When the union and the Government expect to face a populist CB on average, the wage restraint effect is weak relative to fiscal expansion, and greater opacity implies a reduction in average inflation and in the output gap.

As CB's opacity is the only source of uncertainty, macroeconomic volatility disappears with full transparency, and increases, in general, with opacity. This relationship is however humped-shaped when the CB is strongly populist.

Our analysis qualifies the results documented by Grüner (2002). When fiscal policy is considered, the positive effects of opacity on macroeconomic outcomes and the non-monotonic relationship between opacity and macroeconomic volatility occur if the CB is strongly populist on average. If the CB is sufficiently conservative, transparency can instead reduce inflation and the output gap, but it generates higher macroeconomic volatility.

Appendix

The problem of characterizing the moments of a generic random variable subject to specific constraints (e.g., to take values in a compact set, or else) has been extensively debated in mathematical statistics (see, e.g., Kemperman 1968).

Although a general demonstration is out of the scope of the paper, a sketchy argument can help to grasp the general idea of why σ_ε^2 has an upper bound which is equal or lower than β_B. The probability distribution of ε ensuring the highest variance is the one that assigns positive probability values to the extrema of ε, -1 and β_B, and zero elsewhere, according to the following chart:

$$\begin{array}{lll} \varepsilon \rightarrow (\varepsilon_1 = -1) \sim p & & \text{(probability of } -1) \\ \searrow & & \\ \qquad (\varepsilon_2 = \beta_B) \sim 1 - p & & \text{(probability of } \beta_B) \end{array}$$

The distribution p is subject to the following constraint on the expected value:

$$E(\varepsilon) = p(-1) + (1-p)\beta_B = 0$$

We can now state the problem of finding the distribution p which maximises the variance of ε:

$$\max_p \ \sigma_\varepsilon^2 = E(\varepsilon - 0)^2 = p + (1-p)\beta_B^2$$

$$\text{s.t.} \ \ (1-p)\beta_B - p = 0$$

From the first order conditions it is immediate to obtain: $p_{\max} = \frac{\beta_B}{1+\beta_B}$. It follows that the maximum value for the variance is: $\sigma^2_{\varepsilon,\,\max} = \frac{\beta_B}{1+\beta_B} + \left(1 - \frac{\beta_B}{1+\beta_B}\right)\beta_B^2 = \beta_B$.

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