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THE ROLE OF UNCERTAIN GOVERNMENT PREFERENCES FOR FISCAL AND MONETARY POLICY INTERACTION

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THE ROLE OF UNCERTAIN GOVERNMENT PREFERENCES FOR FISCAL AND MONETARY POLICY INTERACTION[3]

This paper explores the role of uncertain government preferences for fiscal and monetary policy interaction. Our analysis shows that the uncertainty about government preferences does not affect the macroeconomic equilibrium if the fiscal multiplier is known. In the case of multiplicative uncertainty, uncertain government preferences make fiscal policy more contractionary, while monetary policy becomes more expansionary. This leads to higher expected inflation and lower expected output, which means a stronger inflation bias.

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1. Introduction

Uncertainty is an inherent feature of any economic system. Therefore, macroeconomic agents, such as governments and central banks, should take uncertainty into account. This is emphasized in the economic literature (Estrella, Mishkin (1999), Soderstrom (2002), Lane (2003), De Grauwe, Senegas (2006)).

In this paper we explore the role of uncertain government preferences for fiscal and monetary policy interaction. The economic impact of uncertainty depends on its origins. As Tinbergen (1952) and Theil (1958) show in the case of additive uncertainty, certainty equivalence holds. This means that this type of uncertainty does not change agent behaviour. However, if uncertainty affects the loss function of the agent or the channels of policy transmission, an agent's optimal behaviour is not certainty equivalent. For example, for multiplicative uncertainty, agents do not have complete information about the magnitude of macroeconomic policy effects. As Brainard (1967) shows, in this situation the policymaker becomes less active in reacting to macroeconomic shocks. This phenomenon was called the Brainard conservatism principle by Blinder (1998).

There is no consensus in the economic literature about the welfare effect of multiplicative uncertainty. Swank (1994) and Pearce, Sobue (1997) find that multiplicative uncertainty reduces inflation bias and, therefore increases social welfare. Kobayashi (2003) shows that even in the absence of inflation bias, multiplicative uncertainty leads to an increase in social welfare. Ciccarone, Marchetti (2009) emphasize that the findings of Kobayashi (2003) are correct only if the preferences of society and the central bank coincide.

Without doubt, multiplicative uncertainty should affect the interaction of the government and the central bank. A considerable part of the economic literature is devoted to fiscal and monetary policy interactions. Starting from Sargent, Wallace (1981) this topic has become especially popular. Tabellini (1986), and Alesina, Tabellini (1987) developed a formal description of the strategic interaction of fiscal and monetary policy. Beetsma, Bovenberg (1999) consider a conflict of interest between the government and the central bank, namely the regulation of public debt and inflation. They show that all macroeconomic policy targets are achievable irrespective of whether the central bank is independent or not.

Another issue concerns the idea that both fiscal and monetary authorities can use their instruments to influence aggregate demand finding a compromise between output and inflation. For example, Andersen, Schneider (1986) note that two independent authorities do not automatically guarantee the achievement of the target level of output. Blinder (1982) questions the idea that macroeconomic targets can be achieved under fiscal and monetary policy coordination. Dixit, Lambertini (2003a) also show that in equilibrium with the coordination of fiscal and monetary authorities, output is lower than the target level, while inflation is higher. Dixit, Lambertini (2003b), however, show that fiscal and monetary policy can achieve macroeconomic targets if the government and the central bank share output and inflation targets. This result holds even if the weight coefficients in the loss functions of the fiscal and monetary authorities are different.

While research on fiscal and monetary policy interaction is well-established, at present the role of uncertainty in this literature is limited. As a rare exception, Di Bartolomeo, Giuli, Manzo (2009) incorporate the uncertainty about the fiscal multiplier into the model by Dixit, Lambertini (2003b). They show that even if the government and the central bank share output and inflation target levels, multiplicative uncertainty does not allow them to achieve these targets. In equilibrium output is too low and inflation is too high. In other words, inflation bias is present. Di Bartolomeo, Giuli (2011) analyse the uncertainty about the monetary policy multiplier and come to the same conclusion: in equilibrium multiplicative uncertainty causes ineffective levels of output and inflation. To our knowledge, there are no other studies about policy interactions under uncertainty. The literature neglects the role of uncertain preferences in policy interactions. Although several studies focus on uncertain preferences under different economic frameworks, they do not raise the question of policy interactions.

For example, Sibert (2002) analyses the design of optimal monetary policy in a multi-period model, when society does not know the central bank preferences. Sibert (2002) shows that due to the reputation motive of central bankers, average inflation decreases. Hefeker, Zimmer (2011) point out that under uncertain monetary authority preferences, central bank independence is no longer a sufficient condition for achieving macroeconomic targets. Hefeker, Zimmer (2011) instead emphasize the primary role of the central bank's conservatism. In turn, Sorge (2013) also questions the efficiency of delegating monetary policy to an independent and conservative central bank in the case of severe model uncertainty. He shows that in some cases it could be optimal to delegate monetary policy to the central bank, which is less conservative than society.

The economic literature describes a number of implications for the uncertainty about policymaker preferences. Nevertheless, none of these studies considers the strategic interaction between fiscal and monetary policy. Further, the existing research does not deal with uncertain government preferences. In developed countries the problem of uncertain central bank preferences is less significant than uncertain government preferences. For example, the targets of the European Central Bank are clearly defined: inflation less than 2%. Moreover, Blinder et al. (2008) confirm that in recent years the transparency of monetary policy has considerably increased all over the world. This means that the assumption of certain central bank preferences is relevant. At the same time, the transparency of fiscal policies has not significantly changed, although government preferences are exposed to considerable changes in election periods.

Our paper fills this gap. We modify the model of Di Bartolomeo, Giuli, Manzo (2009) by adding the uncertainty about government preferences. As a result, we show that uncertain government preferences do not change the characteristics of macroeconomic policy if the fiscal multiplier is certain. In the case of multiplicative uncertainty, uncertain government preferences lead to a more expansionary monetary policy and a more contractionary fiscal policy.

The paper is organized as follows. In Section 2 we describe the model of fiscal and monetary policy interaction. In Section 3 we analyse the impact of uncertain government preferences on macroeconomic equilibrium. Section 4 discusses the main findings and future directions for research.

2. Model

2.1. Model framework

We modify the model of Di Bartolomeo, Giuli, Manzo (2009) by introducing uncertain government preferences. The economy is described by the standard aggregate demand and aggregate supply functions:

$$y = \bar{y} + b\left(\pi - \pi^e\right) + a\tau , \tag{1}$$

$$\pi = m + \rho c \tau , \qquad a, b, c > 0 , \tag{2}$$

where π is the rate of inflation, π^e is the expected rate of inflation, y is the level of real output, $\bar{y}$ is the natural level of real output, τ is the instrument of fiscal policy (for example, transfers), m is the monetary policy instrument (for example, the growth rate of the money supply). Following the traditional macroeconomic approach (see Kydland, Prescott (1977)), the target level of output exceeds the natural level of output: $y^* > \bar{y}$. Following Di Bartolomeo, Giuli, Manzo (2009), we assume that fiscal multiplier ρ is a random variable with mean 1 and variance σ_ρ^2. Thus, σ_ρ^2 characterizes the degree of multiplicative uncertainty.

The losses of the government and the central bank are given by the following functions:

$$L_i = E\left[\frac{1}{2}(\pi - \pi^*)^2 + \frac{1}{2}\theta_i(y - y^*)^2\right], \qquad (3)$$

where $i \in \{CB, G\}$, E is the expectation operator.

The loss functions of the central bank (L_{CB}) and the government (L_G) depend on the deviations of inflation (π) and output (y) from their target levels π^* and y^*. Parameter θ_{CB} is the central bank preference regarding the stabilization of output and inflation, while θ_G is the corresponding characteristic of the government.

Contrary to Di Bartolomeo, Giuli, Manzo (2009), we assume that θ_G is a random variable. It has a unimodal and symmetric distribution over the interval $[\underline{\theta_G}; \overline{\theta_G}]$ with a cumulative distribution function $F(\theta_G)$. Following Rogoff (1985) we assume that the central bank is more conservative than the government, $\theta_{CB} \le \underline{\theta_G}$. Because of the symmetry of the distribution of θ_G, the expected government type equals to $\frac{\underline{\theta_G} + \overline{\theta_G}}{2}$ for all $F(\theta_G)$. The variance of θ_G varies for different distribution functions.[4] Consequently, the variance of θ_G measures the uncertainty about government preferences.

We assume that the government and the central bank simultaneously and independently choose their policies after the expectations have been formed. Minimizing the government loss function under constraint (1) and (2), we obtain the optimal action τ_G for the government of type θ_G:

$$\tau_G = \frac{A_1 + A_2\theta_G}{A_3 + A_4\theta_G}, \qquad (4)$$

where $A_1 = -c(m - \pi^*)$, $A_2 = (a + bc)(y^* - \bar{y} + b\pi^e - bm)$, $A_3 = c^2(1 + \sigma_\rho^2) > 0$, $A_4 = \sigma_\rho^2 b^2 c^2 + (a + bc)^2 > 0$.

Thus, (4) represents the function of the government response to central bank action. From (4) it follows that $\frac{\partial \tau_G}{\partial m} = \frac{-c - b(a + bc)}{A_3 + A_4\theta_G} < 0$. This means that the government responds to an

[4] The special case with uniformly distributed θ_G is presented in Kuznetsova, Merzlyakov (2015).

increase of m with a contractionary policy (for example, by reducing transfers). It should be noted that this effect weakens with a rise of multiplicative uncertainty ($\frac{\partial^2 \tau_G}{\partial m \partial \sigma_\rho^2} > 0$).

Using the government response function (4) we obtain the average government action $\bar{\tau} = \int_{\underline{\theta_G}}^{\overline{\theta_G}} \tau_G(\theta_G) dF(\theta_G)$:

$$\bar{\tau} = \frac{A_2}{A_4} + \frac{A_1 A_4 - A_2 A_3}{A_4} \Phi , \qquad (5)$$

where $\Phi = \int_{\underline{\theta_G}}^{\overline{\theta_G}} \frac{dF(\theta_G)}{A_3 + A_4 \theta_G}$ is the implicit characteristic of the distribution of θ_G. Due to the concavity of function $\frac{1}{A_3 + A_4 \theta_G}$, its expected value depends positively on the variance of θ_G. Note that for two different cumulative distribution functions $F_1(\theta_G)$ and $F_2(\theta_G)$, such that $\int_{\underline{\theta_G}}^{\overline{\theta_G}} (\theta_G - E\theta_G)^2 dF_1(\theta_G) < \int_{\underline{\theta_G}}^{\overline{\theta_G}} (\theta_G - E\theta_G)^2 dF_2(\theta_G)$, we have $\Phi(F_1(\theta_G)) < \Phi(F_2(\theta_G))$. Thus, for the distribution of θ_G with higher variance Φ is higher. In other words, Φ characterizes the uncertainty about government preferences.

Minimizing the central bank losses, we obtain the central bank response function:

$$m = \frac{\pi^* + b^2 \theta_B \pi^e + (y^* - \bar{y}) b \theta_B - (c + b\theta_B (a + bc)) \bar{\tau}}{1 + b^2 \theta_B} . \qquad (6)$$

The optimal monetary action m decreases with an increase in $\bar{\tau}$. After finding the intersection of the response functions (5) and (6) we define the level of inflation expectations:

$$\pi^e = m + c\bar{\tau} . \qquad (7)$$

Next, we substitute the inflation expectations at the intersection point and define the parameters of equilibrium.

2.2.Equilibrium

The equilibrium values of monetary action $\tilde{m}$, government action $\tilde{\tau}_G$ and the average government action $\tilde{\bar{\tau}}$ depend on all the parameters of our model including the characteristic of uncertainty Φ:

$$\tilde{m} = \pi^* + c(y^* - \bar{y}) \left(\frac{B_1 + B_2 \Phi}{B_3 - B_4 \Phi} \right), \qquad (8)$$

$$\tilde{\tau}_G = (y^* - \bar{y})\left(\frac{B_1^G - B_2^G \Phi}{B_3 - B_4 \Phi}\right)\frac{1}{\theta_G A_4 + A_3}, \qquad (9)$$

$$\tilde{\tilde{\tau}} = (y^* - \bar{y})\left(\frac{B_1^X - B_2^X \Phi}{B_3 - B_4 \Phi}\right), \qquad (10)$$

where $B_1 = \theta_B b^3 c \sigma_\rho^2 - (a + bc)$, $B_2 = c(1 + \sigma_\rho^2)(a + bc)(\theta_B b(a + bc) + c) \geq 0$, $B_3 = A_4 - bc(a + bc) \geq 0$, $B_4 = ac(b\theta_B A_4 + c(a + bc(1 - \sigma_\rho^2)))$, $B_1^G = A_4 \theta_G (a + bc) - c^2 B_1 \geq 0$, $B_2^G = c(a + bc)(b(a + bc)\theta_B + c)(\theta_G A_4 + c^2(1 + \sigma_\rho^2)) \geq 0$, $B_1^X = a + bc \geq 0$, $B_2^X = bc\theta_B A_4 + (a + bc)A_3 \geq 0$.

We start the analysis of equilibrium (8–10) by characterizing the function of government action $\tilde{\tau}_G$. For all possible distributions of θ_G, Proposition 1 is true.

Proposition 1. For all distributions of θ_G over interval $\left[\underline{\theta_G}; \overline{\theta_G}\right]$ and for any $\theta_b < \underline{\theta_G}$ the equilibrium transfers $\tilde{\tau}_G$ are positive for any government type θ_G. Moreover, $\frac{\partial \tilde{\tau}_G}{\partial \theta_G} > 0$ and $\frac{\partial^2 \tilde{\tau}_G}{(\partial \theta_G)^2} < 0$.

Proof. See Appendix 1.

In other words, Proposition 1 states that in any equilibrium fiscal policy is expansionary. Furthermore, the stronger the government preference with respect to the stabilization of output, the more expansionary fiscal policy. At the same time due to concavity of function $\tilde{\tau}_G(\theta_G)$ the average government action ($\tilde{\tilde{\tau}}$) is less than the action of the average government type

$$\tilde{\tau}_G\left(\frac{\overline{\theta_G} + \underline{\theta_G}}{2}\right) = (y^* - \bar{y})\left(\frac{B_1^G - B_2^G \Phi}{B_3 - B_4 \Phi}\right)\frac{1}{A_3 + \frac{\overline{\theta_G} + \underline{\theta_G}}{2} A_4}.$$

Using (8–10) we can derive the equilibrium expected output and inflation:

$$\tilde{\pi}^e = \pi^* + c(y^* - \bar{y})\theta_b \sigma_\rho^2 bc\left(\frac{b^2 + (a + 2bc)\Phi}{B_3 - B_4 \Phi}\right), \qquad (11)$$

$$\tilde{y}^e = y^* - (y^* - \bar{y})\sigma_\rho^2 c^2\left(\frac{b^2 + a(a + 2bc)\Phi}{B_3 - B_4 \Phi}\right). \qquad (12)$$

With the use of (11) and (12) we arrive at Proposition 2.

Proposition 2. For all distributions of θ_G over interval $\left[\underline{\theta_G};\overline{\theta_G}\right]$ and for any $\theta_b < \underline{\theta_G}$, equilibrium is characterized by inflation bias: the expected rate of inflation exceeds its target level π^*, while the expected level of output is below its target level y^*.

Proof. See Appendix 1.

This result is in line with Di Bartolomeo, Giuli, Manzo (2009), who show that for multiplicative uncertainty the government and the central bank cannot achieve their targets even if they share them. Thus, we demonstrate that preference uncertainty aggravates the inflation bias problem. We analyse in detail the origins of this effect in Section 3.

3. Uncertain government preferences

As stated earlier, the variance of θ_G characterizes the uncertainty about government preferences. Comparing equilibria for different distributions we come to the following results.

Proposition 3. Let $(\tilde{m}(F_i);\tilde{\tau}_G(F_i);\tilde{\bar{\tau}}(F_i))$ denote the equilibrium under the symmetric unimodal distribution of θ_G over interval $\left[\underline{\theta_G};\overline{\theta_G}\right]$ with CDF $F_i(\theta_G)$. Then for any $\sigma_\rho^2 > 0$ and for any $F_1(\theta_G)$ and $F_2(\theta_G)$, such that $\int_{\underline{\theta_G}}^{\overline{\theta_G}}(\theta_G - E\theta_G)^2 dF_1(\theta_G) < \int_{\underline{\theta_G}}^{\overline{\theta_G}}(\theta_G - E\theta_G)^2 dF_2(\theta_G)$:

i) $\tilde{m}(F_1) < \tilde{m}(F_2)$ and $\tilde{\tau}_G(F_1) > \tilde{\tau}_G(F_2)$ for all θ_G,

ii) $\tilde{\pi}^e(F_1) < \tilde{\pi}^e(F_2)$ and $\tilde{y}^e(F_1) > \tilde{y}^e(F_2)$.

Proof. See Appendix 2.

The first part of Proposition 3 states that the uncertainty about government preferences forces the central bank to be more expansionary, while the policy of the government with any θ_G becomes more contractionary. The explanation is straightforward. Due to Proposition 1, in equilibrium government action $\tilde{\tau}_G(\theta_G)$ is an increasing concave function. So if the variance of θ_G rises, the average government action $\tilde{\bar{\tau}}$ decreases. A decrease in $\tilde{\bar{\tau}}$ leads to an increase in central bank action $\tilde{m}$. This in turn forces the government to decrease its action $\tilde{\tau}_G$ in accordance with the response function (4). As a result, the average government action $\tilde{\tilde{\tau}}$ goes down. The process continues until a new equilibrium is achieved.

The second part of Proposition 3 states that for a distribution with higher variance the expected level of inflation is higher, while the expected level of output is smaller. In other words, the uncertainty about government preferences aggravates the problem of inflation bias, described in Proposition 2. This result complements the main finding of Di Bartolomeo, Giuli, Manzo (2009), who show that multiplicative uncertainty also causes this problem. Moreover, in our model multiplicative uncertainty is a necessary condition for inflation bias. It can be easily shown that if $\sigma_\rho^2 = 0$, Proposition 4 is correct.

Proposition 4. If $\sigma_\rho^2 = 0$, for any cumulative distribution function $F(\theta_G)$:

i) $\tilde{m} = \pi * - \frac{c}{a}(y * - \bar{y})$ and $\tilde{\tau}_G = \tilde{\tilde{\tau}} = \frac{(y * - \bar{y})}{a}$,

ii) $\tilde{\pi}(F) = \pi^*$ and $\tilde{y}(F) = y^*$.

Proof. See Appendix 2.

Proposition 4 (i) indicates that in the absence of multiplicative uncertainty the preference uncertainty does not affect equilibrium. For any distribution function $F(\theta_G)$ the governments of all types choose the same amount of transfers $\tilde{\tau}_G = \tilde{\tilde{\tau}} = \frac{(y * - \bar{y})}{a}$, so the average government action does not depend on the distribution of θ_G. Consequently, monetary action is also constant. As a result, the uncertainty about government preferences is no longer relevant. Thus, the main findings of Dixit, Lambertini (2003b) hold, and the government and the central bank are able to achieve both inflation and output targets, as shown in Proposition 4 (ii). In other words, without multiplicative uncertainty, inflation bias disappears despite uncertain government preferences.

4. Conclusion

This paper contributes to the existing literature on macroeconomic policy under uncertainty. Although various implications of uncertainty have been well studied, considerable gaps in this area still remain. For instance, the problem of uncertain government preferences deserves more attention and requires further analysis.

In this paper we consider the impact of uncertain government preferences on the main characteristics of macroeconomic policy. Our analysis shows that if the fiscal multiplier is known, uncertain government preferences do not affect macroeconomic equilibrium. In the case of multiplicative uncertainty, uncertain government preferences make fiscal policy more contractionary, while monetary policy becomes more expansionary. As a result, expected inflation rises and expected output drops. Thus, the inflation bias problem worsens.

The problem of different forms of strategic interaction is beyond the scope of our paper: we consider that the government and the central bank conduct their policies simultaneously and independently. The analysis of the influence of uncertain government preferences on macroeconomic policy for various forms of strategic interaction is a promising avenue for further research.

Appendix 1

Proof of Propositions 1 and 2.

From (4) we can see that the influence of θ_G on government action τ_G depends on the sign of expression $\left(A_1A_4 - A_2A_3\right)$:

$$\frac{\partial \tau_G}{\partial \theta_G} = -\frac{A_1A_4 - A_2A_3}{(A_3 + A_4\theta_G)^2}, \qquad \text{(A1.1)}$$

$$\frac{\partial^2 \tau_G}{\left(\partial \theta_G\right)^2} = \frac{A_1A_4 - A_2A_3}{(A_3 + A_4\theta_G)^3} A_4. \qquad \text{(A1.2)}$$

Substituting the equilibrium values (8–10) into expression $\left(A_1A_4 - A_2A_3\right)$ we obtain:

$$\left(A_1A_4 - A_2A_3\right)\Big|_{\substack{m=\tilde{m}(F_i)\\ \bar{\tau}=\tilde{\bar{\tau}}(F_i)}} = \frac{\sigma_\rho^2 c^2 (y^* - \bar{y})(\theta_b cb^3 + a + bc)A_4}{B_4\Phi(F_i) - B_3}. \qquad \text{(A1.3)}$$

As $(y^* - \bar{y})$ is positive, the sign of (A1.3) coincides with the sign of denominator $\left(B_4\Phi(F_i) - B_3\right)$. $\Phi(F_i)$ and B_3 are always positive. If $B_4 < 0$, $\left(B_4\Phi(F_i) - B_3\right) < 0$ automatically. For $B_4 > 0$ some further derivations are needed. By assumption $\theta_b < \underline{\theta_G}$, thus $\frac{1}{A_3 + A_4\theta_G} < \frac{1}{A_3 + A_4\theta_b}$ for all $\theta_G \in \left[\underline{\theta_G}; \overline{\theta_G}\right]$. Consequently, for any cumulative distribution function $F_i(\theta_G)$ the following holds:

$$\Phi(F_i) \equiv \int_{\underline{\theta_G}}^{\overline{\theta^G}} \frac{dF_i\left(\theta_G\right)}{A_3 + A_4\theta_G} < \int_{\underline{\theta_G}}^{\overline{\theta^G}} \frac{dF_i\left(\theta_G\right)}{A_3 + A_4\theta_b}. \qquad \text{(A1.4)}$$

The right-hand side of (A1.4) can be further rewritten as:

$$\int_{\underline{\theta_G}}^{\overline{\theta^G}} \frac{dF_i\left(\theta_G\right)}{A_3 + A_4\theta_b} = \frac{1}{A_3 + A_4\theta_b}\int_{\underline{\theta_G}}^{\overline{\theta^G}} dF_i\left(\theta_G\right) = \frac{1}{A_3 + A_4\theta_b}, \qquad \text{(A1.5),}$$

where we use $\int_{\underline{\theta_G}}^{\overline{\theta^G}} dF_i\left(\theta_G\right) = 1$, as we assume that θ_G is distributed over interval $\left[\underline{\theta_G}; \overline{\theta_G}\right]$. So, using (A1.4) and (A1.5), we conclude that

$$\Phi(F_i) < \frac{1}{A_3 + A_4\theta_b}. \qquad \text{(A1.6)}$$

Thus, for $B_4 > 0$, $B_4\Phi(F_i) - B_3 < \frac{B_4}{A_3 + A_4\theta_b} - B_3 = -\frac{\sigma_\rho^2 c^2 A_4}{A_3 + A_4\theta_b} < 0$. As a result:

$$\left(A_1 A_4 - A_2 A_3\right)\Big|_{\substack{m=\tilde{m}(F_i) \\ \bar{\tau}=\tilde{\bar{\tau}}(F_i)}} < 0\,. \qquad \text{(A1.7)}$$

Using (A1.1), (A1.2) and (A1.7), we get that $\frac{\partial \tilde{\tau}_G}{\partial \theta_G} > 0$ and $\frac{\partial^2 \tau_G}{\left(\partial \theta_G\right)^2} < 0$.

Moreover, as $B_4\Phi(F_i) - B_3 < 0$, we conclude that

$$\tilde{\pi}^e = \pi^* + c\left(y^* - \bar{y}\right)\theta_b \sigma_\rho^2 bc\left(\frac{b^2 + (a + 2bc)\Phi}{B_3 - B_4\Phi}\right) > \pi^*, \qquad \text{(A1.8)}$$

$$\tilde{y}^e = y^* - \left(y^* - \bar{y}\right)\sigma_\rho^2 c^2\left(\frac{b^2 + a(a + 2bc)\Phi}{B_3 - B_4\Phi}\right) < y^*. \qquad \text{(A1.9)}$$

Q.E.D.

Appendix 2

Proof of Propositions 3 and 4.

As we have seen, the distribution of higher variance is characterized by a higher value of Φ:

$$\int_{\underline{\theta_G}}^{\overline{\theta_G}} (\theta_G - E\theta_G)^2 dF_1(\theta_G) < \int_{\underline{\theta_G}}^{\overline{\theta_G}} (\theta_G - E\theta_G)^2 dF_2(\theta_G) \Leftrightarrow \Phi(F_1(\theta_G)) < \Phi(F_2(\theta_G)). \tag{A2.1}$$

With (A2.1) and definitions (8–12) from the main text, Proposition 3 follows directly.

If $\sigma_\rho^2 = 0$, from (A1.3) $\left(A_1 A_4 - A_2 A_3\right)\Big|_{\substack{m=\tilde{m}(F_i) \\ \bar{\tau}=\tilde{\bar{\tau}}(F_i)}} = 0$. Taking into account (A1.1) we can conclude that in this case $\frac{\partial \tau_G}{\partial \theta_G} = 0$. This means that governments of any type choose the same level of transfers $\tilde{\tau}_G = \left(\frac{A_2}{A_4}\right)\Big|_{\sigma_\rho^2} = \frac{(y^* - \bar{y})}{a}$. If all government types choose the same action, the average action also equals this level. Substituting the average government action into (6), (1) and (2), we immediately arrive at Proposition 4.

Q.E.D.

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