The Role of Uncertain Government Preferences for Fiscal and Monetary Policy Interaction[1]

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Abstract

This paper explores the role of uncertain government preferences in a standard linear-quadratic model of fiscal and monetary policy interaction. We show that the effects of preference uncertainty are fastened on uncertainty about the policy multipliers. If the fiscal and monetary multipliers are known, preference uncertainty does not alternate the symbiosis result of policy interaction. In this case, inflation and output are equal to their targets irrespective of the central bank and the government preferences. Uncertainty about the fiscal multiplier creates the inflation bias, and preference uncertainty deteriorates it by lowering output and rising inflation up. Uncertainty about the monetary multiplier creates either standard inflation bias or negative inflation bias with output higher than the target and inflation lower than the target. In this case, preference uncertainty enlarges the absolute value of output gap, while the effect on inflation gap depends on the extent of uncertainty about the monetary multiplier. If both the multipliers are uncertain, the impact of preference uncertainty depends not only on the extent of multiplicative uncertainty, but also on the inflation and output targets.

Keywords: *fiscal and monetary policy interaction, uncertain government preferences, multiplicative uncertainty, symbiosis result*

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1 Introduction

Trump's inauguration has provoked the extensive debates among economists about the future fiscal policy stance in the U.S. Many analysts worry about the macroeconomic effects of this 'Trump's uncertainty'. It is too early to estimate the real economic effects, but it is already obvious, that the Fed's policy may change in response to this uncertainty. The implicit proof can be found, for example, in the speech of the Fed Governor Lael Brainard on January 17, 2017 [1]:

'There are many sources of uncertainty affecting... the appropriate path of monetary policy. In particular, there has been speculation about significant changes to fiscal policy of late, although the magnitude, composition, and timing of any fiscal changes are as yet unknown and will depend on the incoming Administration and the new Congress as well as the vicissitudes of the budgeting process... It thus seems possible that monetary policy could be affected for some time by uncertainty surrounding fiscal policy and its effects on the economy'.

Starting from the famous paper by Sargent and Wallace (1981), fiscal and monetary policy interaction has been always in the center of attention in academic literature. One of the most important issues in this literature is whether the central bank and the government can achieve the target values of output and inflation. And yet, there is no consensus in this question.

Dixit and Lambertini (2003b) show that fiscal and monetary policy achieve the target values of output and inflation if the government and the central bank share their targets. This result holds for all the forms of policy interaction and for all the weights in the loss functions. This conclusion is known as the symbiosis result. However, Dixit and Lambertini (2003a) show that if fiscal policy creates deadweight loss and the targets of central bank and government are different, the non-cooperative equilibrium is characterized by inflation bias. This inflation bias with inflation higher than the target and output lower than the target arises because of too restrictive fiscal policy and too expansionary monetary policy.

Two papers of Di Bartolomeo et al. show that the symbiosis result also does not hold in case of multiplicative uncertainty. Di Bartolomeo et al. (2009) investigate the role of uncertainty about fiscal multiplier for policy interaction. They show that even if the government and the central bank share output and inflation target levels, fiscal multiplicative uncertainty does not allow them to achieve these targets. This uncertainty

[1] Governor Lael Brainard 'Monetary Policy in a Time of Uncertainty' At the Brookings Institution, Washington, D.C.

forces the government to become more cautious. As a result, fiscal policy becomes less expansionary and output drops. The central bank faces time inconsistency problem and tries to raise output with too expansionary policy, which leads to an increase in inflation, and the inflation bias arises. Di Bartolomeo and Giuli (2011) analyze uncertainty about monetary policy multiplier and come to the same result: multiplicative uncertainty causes ineffective levels of output and inflation in equilibrium. In their model, uncertainty about the impact of monetary policy on the economy forces the monetary authority to lower the absolute value of his intervention. This leads to a gap between the equilibrium inflation and its target. This effect could be neutralized by the change in fiscal policy, which can be done at sake of the gap between the equilibrium output and the target level. Obviously, the government is reluctant to change considerably the policy and none of the targets is achieved.

In our paper, we examine these results in the model the uncertain government preferences. To our knowledge, there are no other studies of fiscal and monetary policy interaction with uncertain government preferences. The role of uncertain central bank preferences has been already studied in economic literature. Ciccarone et al. (2007), Hefeker and Zimmer (2011) show that uncertainty about the central bank preferences could reduce the macroeconomic volatility due to the fiscal disciplining effect, which will be expressed in reduction of taxes, inflation and output distortions. Dai and Sidiropoulos (2011), however, note that such result can be achieved only under the Stackelberg interaction, where the government acts as a leader and the central bank acts as a follower. Dai and Sidiropoulos (2011) argue that the fiscal disciplining effect of uncertain central bank preferences could be insignificant if the government and the central bank interact in a Nash game. Oros and Zimmer (2015) analyze the monetary transmission mechanism in a monetary union with uncertain central bank preferences. They show, that the private agents expect the central bank to be more conservative to compensate the uncertainty of the central bank preferences. This could lead to a decrease in inflation and better macroeconomic outcomes not because of a disciplinary effect, but because of the central bank's communication channel.

So, as we have seen, economic literature elaborates a number of implications of uncertainty about the central bank preferences for strategic interaction between fiscal and monetary policy. However, the existing research does not deal with uncertainty about the government preferences. Meanwhile, uncertainty about the central bank preferences seems to be less significant than uncertainty about the government preferences at least in developed countries. For example, the targets of the European Central Bank are clearly defined: inflation below and close to 2 percent. Moreover, Blinder et al. (2008) show that in recent years transparency of monetary policy has considerably increased all other the world. This means that the assumption of uncertain central bank preferences might be unjustified. At the same time, the inclusion of uncertain government preferences seem to be promising. Firstly, the government preferences are exposed to considerable changes in the election period. Moreover, information policies of fiscal authorities have not demonstrated positive changes in recent years. Almost everywhere, the governments are much less transparent than the central banks.

The goal of our paper is to study the effects of uncertain government preferences on fiscal and monetary policy interaction. We show that uncertainty about the government preferences does not change the interaction result if the policy multipliers are certain. However, uncertain government preferences matter in case of multiplicative uncertainty. Below we show how uncertainty about the government preferences affect macroeconomic equilibrium under fiscal and/or monetary multiplicative uncertainty.

The paper is organized as follows. In Section 2 we describe a benchmark model of fiscal and monetary policy interaction. Section 3 analyzes the equilibrium in the model with certain preferences. In Section 4 we discuss the impact of uncertain government preferences on the equilibrium. Section 5 concludes.

2 Benchmark Model

We start our analysis with a benchmark model with certain preferences and random policy multipliers. This model is described by two equations: aggregated supply (1) and aggregated demand (2):

$$y = \overline{y} + b(\pi - \pi^e) + a\tau \tag{1}$$

$$\pi = \varphi m + \rho c\tau \tag{2}$$

$$a > 0, b > 0, c > 0,$$

where π is the rate of inflation, π^e is the expected rate of inflation, y is the level of real output, $\overline{y}$ 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). Monetary policy multiplier is equal to φ, which is a random variable with mean 1 and variance σ_φ^2. Fiscal policy multiplier is equal to ρc, where ρ is a random variable with mean 1 and variance σ_ρ^2. Thus, parameter σ_ρ^2 characterizes the degree of fiscal multiplicative uncertainty, while σ_φ^2 characterizes the degree of monetary multiplicative uncertainty. Our model generalizes two papers: Di Bartolomeo et al. (2009), which studies fiscal multiplicative uncertainty, and Di Bartolomeo and Giuli (2011), which studies monetary multiplicative uncertainty. The results of the both papers can be easily replicated in our model by putting the corresponding variance to zero. Moreover, our model allow us to study the additional effects which arise only if both the multipliers are certain.

Losses of the central bank and the government are defined by the gap between inflation rate and the target inflation π^* and by the gap between output and the target output y^*:

$$L_{CB} = E[\frac{1}{2}(\pi - \pi^*)^2 + \frac{1}{2}\theta_B(y - y^*)^2] \tag{3}$$

$$L_G = E[\frac{1}{2}(\pi - \pi^*)^2 + \frac{1}{2}\theta_G(y - y^*)^2] \tag{4}$$

$$\theta_B > 0, \theta_G > 0,$$

where θ_B and θ_G characterize the preferences of the central bank and the government for output. To stay in line with the broad consensus in the literature [2], we assume that the central bank is more conservative than the government: $\theta_G \geq \theta_B$. Minimization of losses (3) and (4) with constraints (1) and (2) gives the following reaction functions:

$$\tau(\theta_G) = \frac{-c(\overline{m} - \pi^*) + \theta_G(a + bc)(y^* - \overline{y} + b\pi^e - b\overline{m})}{c^2(1 + \sigma_\rho^2) + \theta_G(\sigma_\rho^2 b^2 c^2 + (a + bc)^2)} \tag{5}$$

$$m(\theta_B) = \frac{\pi^* - c\overline{\tau} + b\theta_B(y^* - \overline{y} + b\pi^e - (a + bc)\overline{\tau})}{(1 + \sigma_\varphi^2)(1 + \theta_B b^2)}, \tag{6}$$

where (5) is the reaction function of the government with preferences θ_G, (6) is the reaction function of the central bank with preferences θ_B, $\overline{m}$ is the expected value of monetary instrument and $\overline{\tau}$ is the expected value of fiscal instrument. As we can see from (5) and (6), the equilibrium values of the both policy instruments depend positively on the inflation target π^*, the expected inflation π^e and the gap between target and natural output $(y^* - \overline{y})$. The impact of the output gap on a policy instrument depends positively on the weight of output in a policymaker's loss function. According to (6), the absolute value of monetary instrument chosen by the central bank depends negatively on the variance of monetary multiplier σ_φ^2. This phenomenon corresponds to the standard attenuation affect in policy: uncertainty about the policy instrument forces the policymaker to become more cautious and to decrease the extent of intervention. The same attenuation effect is true for the government. According to (5), the absolute value of fiscal instrument τ decreases with the extent of fiscal multiplicative uncertainty, measured by σ_ρ^2.

[2] See, for example, Rogoff (1985).

3 Equilibrium with certain preferences

In this section we look for the equilibrium with certain preferences. We assume that the parameter of monetary preferences θ_B is equal to $\tilde{\theta}_B$ and the government preferences are characterized by $\theta_G = \tilde{\theta}_G$, θ_G, $\tilde{\theta}_G$ are given. As the preferences of the both policymakers are known by all the agents, the expected values of their policy instruments coincide with their actual values: $\overline{m} = m(\tilde{\theta}_B)$ and $\overline{\tau} = \tau(\tilde{\theta}_G)$.

In order to analyze the effects of multiplicative uncertainty, we firstly compute the equilibrium with certain multipliers, which corresponds to the model of Dixit and Lambertini (2003b). Substituting $\sigma_\rho^2 = 0$, $\sigma_\varphi^2 = 0$ into reaction functions (5) and (6), we obtain the following equilibrium values of fiscal and monetary instruments:

$$\tau_0 = \frac{y^* - \overline{y}}{a} \tag{7}$$

$$m_0 = \pi^* - c\tau_0 \tag{8}$$

As the target output is higher than the natural level, the equilibrium of fiscal policy is expansionary. The value of the fiscal instrument (7) is chosen in a such way that the equilibrium level of output coincides with the target value: $y_0 = y^*$. Expansionary fiscal policy would lead to an increase in the inflation rate, equal to $c\tau_0$. Nevertheless, the central bank can react to this inflationary pressure by decreasing the monetary instrument by the same value. The sign of equilibrium m_0 depends on the value of inflation target. If inflation target is sufficiently high, such that $\pi^* > \frac{c}{a}(y^* - \overline{y})$, monetary policy is expansionary and $m_0 > 0$. If inflation target is low, monetary policy is contractionary, $m_0 < 0$. As a result, the equilibrium inflation rate is equal to the target: $\pi_0 = \pi^*$. Thus, the model with certain multipliers replicates the symbiosis result of Dixit and Lambertini (2003b): irrespective of their preferences, the central bank and the government achieve their inflation and output targets. For this purpose, the government conducts expansionary fiscal policy.

If the multipliers are both uncertain, given taken the intersection of (5) and (6) for given $\tilde{\theta}_G$ and $\tilde{\theta}_B$, the equilibrium values of fiscal and monetary instruments:

$$\tilde{\tau} = \tau_0 - \frac{\tilde{W}_\tau}{\tilde{W}}\tau_0 - \frac{\tilde{W}_\tau \Lambda_B}{\tilde{W}}\tau_0 + \frac{\tilde{W}_m - \Lambda_B \tilde{\theta}_G a(a+bc)}{\tilde{W}}\frac{m_0}{c} \tag{9}$$

$$\tilde{m} = m_0 - \frac{\tilde{W}_m}{\tilde{W}}m_0 - \frac{\tilde{W}_\tau \Lambda_B}{\tilde{W}}m_0 + (c + ab\tilde{\theta}_B)\frac{\tilde{W}_\tau}{\tilde{W}}\tau_0, \tag{10}$$

where $\Lambda_G = \sigma_\rho^2(\tilde{\theta}_G b^2 + 1)$, $\Lambda_B = \sigma_\varphi^2(\tilde{\theta}_B b^2 + 1)$, $\tilde{W}_\tau = c^2\Lambda_G$, $\tilde{W}_m = \Lambda_B(c^2 + \tilde{\theta}_G a(a+bc))$, $\tilde{W} = W + \tilde{W}_\tau + \tilde{W}_m + \Lambda_G\Lambda_B c^2$ and $W = a(\tilde{\theta}_G a + (\tilde{\theta}_G - \tilde{\theta}_B)bc)$.

According to (9) and (10), the equilibrium values of policy instruments $\tilde{\tau}$ and $\tilde{m}$ are affected by multiplicative uncertainty about both the multipliers. We can distinguish three effects: the direct effect of fiscal multiplicative uncertainty, the direct effect of monetary multiplicative uncertainty and the mutual effect which arise only if both uncertainties are present.

The direct effect of fiscal multiplicative uncertainty corresponds qualitatively to the process described in Di Bartolomeo et al. (2009). Uncertainty about the fiscal multiplier forces the government to attenuate its policy and to decrease τ. This attenuation effect is equal to $\frac{\tilde{W}_\tau}{\tilde{W}}\tau_0$ and depends positively on the uncertainty extent σ_ρ^2. Moreover, the size of the attenuation effect depends negatively on $\tilde{\theta}_G$. More the government prefers output, less is the decrease in τ in response to uncertainty. The fiscal attenuation leads to a decrease in both output and inflation, which drops lower than their desired levels. In response to a decrease in τ, the central bank starts to stimulate economy with a more expansionary policy. An increase in monetary instrument equal to $c\frac{\tilde{W}_\tau}{\tilde{W}}\tau_0$ would be enough to compensate the drop in inflation rate due to the attenuation effect of fiscal policy. Nevertheless, similarly to the famous paper Kydland and Prescott (1977), an inflation bias arises. The central bank takes inflation expectations as given and tries to push output up. With this goal, the central bank raises monetary instrument more than necessary to stabilize inflation.

As we can see from (10), the excess response of monetary policy to fiscal multiplicative uncertainty is equal to $ab\tilde{\theta}_B\frac{\tilde{W}_\tau}{\tilde{W}}\tau_0$. This excess increase in monetary instrument depends positively on the monetary preferences of output, $\tilde{\theta}_B$. Due to this excess increase in monetary instrument, the expected inflation becomes higher than the optimal level. This, nevertheless, cannot overcome the output drop which is caused by the decrease in fiscal instrument, as only fiscal policy can affect the output in equilibrium.

Thus, the direct effect of fiscal multiplicative uncertainty is the inflation bias, which corresponds to the Di Bartolomeo et al. (2009). Nevertheless, as the ratio $\frac{\tilde{W}_\tau}{\tilde{W}}$ depends negatively on the variance of monetary multiplier, σ_φ^2, we can conclude that the presence of monetary uncertainty decreases the inflation pressure of fiscal attenuation. The intuition is straightforward: as the central bank is unsure about the monetary multiplier, monetary policy also becomes more cautious. Thus, the central bank allows a lower excess increase in monetary instrument and the increase in inflation is lower.

The direct effect of monetary multiplicative uncertainty on monetary policy is equal to $-\frac{\tilde{W}_m}{\tilde{W}}m_0$ and corresponds qualitatively to the effect described in Di Bartolomeo and Giuli (2011). Uncertainty about the monetary multiplier leads to the attenuation effect in monetary policy and the absolute value of monetary instrument drops. The government reacts to the attenuation effect in monetary policy by the opposite change in fiscal instrument. The change in τ equal to $\frac{\tilde{W}_m}{\tilde{W}}\frac{m_0}{c}$ would be enough to overcome the effect of attenuation effect on inflation. Nevertheless, this would influence the output and the government varies fiscal instrument less. The change in τ is proportional to $\frac{\tilde{W}_m - \Lambda_B\tilde{\theta}_G a(a+bc)}{\tilde{W}}$. The stronger preferences of output $\tilde{\theta}_G$, the less change in fiscal instrument.

The influence of monetary multiplicative uncertainty on expected output and inflation depends on the sign of m_0. If $m_0 > 0$, uncertainty about monetary multiplier forces the central bank to decrease m and monetary policy becomes more contractionary. The government responds to this by an increase in fiscal instrument. This, in turn leads to an increase in output. In order to prevent output from the excess increase, the government raises its instrument to a less extent than is necessary to overreact the influence on inflation. Moreover, the equilibrium fiscal instrument decreases with $\tilde{\theta}_G$. As a result, a negative inflation bias arises with expected inflation less than π^* and expected output greater than y^*.

On the contrary, if $m_0 < 0$, uncertainty about monetary multiplier makes monetary policy more expansionary. The government reacts by a decrease in τ. This decrease is less than necessary to overreact inflationary impact of monetary policy. As a result, expected inflation is higher than π^*, while output is lower than y^*. In other words, inflation bias arises.

As we already noted, the direct effects of fiscal and monetary uncertainty correspond qualitatively to the conclusions of Di Bartolomeo et al. (2009) and Di Bartolomeo and Giuli (2011). Nevertheless, the simultaneous presence of the both sources of uncertainty creates additional effects. These affects are proportional to the product of Λ_G and Λ_B. First of all, simultaneous uncertainty about the both multipliers decrease the response of any policymaker to uncertainty about the other multiplier. This follows directly from (9) and (10) if we remember that $\tilde{W}$ depends positively on the product $\Lambda_B\Lambda_G$. On the other hand, the mutual uncertainty influence the direct effects of the both sources. For example, the presence of monetary uncertainty aggravates the attenuation effect which is caused by fiscal uncertainty. Fiscal instrument drops by additional amount of $\frac{c^2\Lambda_G\Lambda_B}{\tilde{W}}\tau_0$. Moreover, this decrease is not compensated by an increase in a monetary instrument. Thus, the mutual effect strengthens the negative effect of fiscal uncertainty on the output and weakens the upward shift in inflation. The mutual effect also strengthens the attenuation in monetary policy by the amount of $\frac{c^2\Lambda_G\Lambda_B}{\tilde{W}}$. This change in monetary instrument is not compensated by a corresponding response of fiscal authority. Thus, the mutual uncertainty weakens the effect of monetary uncertainty on inflation.

The overall effect of uncertainty on the equilibrium depends on the comparative strength of all the effects. Expected levels of output and inflation can be obtained from (1), (2) together with (9), (10) and are as follows:

$$\tilde{\pi}^e = \pi^*(1 - \frac{c^2\Lambda_G\Lambda_B}{\tilde{W}}) + \frac{a\tilde{\theta}_B b\tilde{W}_\tau}{\tilde{W}}\tau_0 - \frac{\Lambda_B\tilde{\theta}_G a(a+bc)}{\tilde{W}}m_0 \quad (11)$$

$$\tilde{y}^e = y^* + \frac{ac^2\Lambda_B}{\tilde{W}}\frac{m_0}{c} - \frac{a\tilde{W}_\tau(1+\Lambda_B)}{\tilde{W}}\tau_0 \quad (12)$$

According to (11), the gap between expected inflation and its target depends on the direct effects of multiplicative uncertainty and the mutual effect described above. The direct effect of fiscal uncertainty is equal to $\frac{a\tilde{\theta}_B b\tilde{W}_\tau}{\tilde{W}}\tau_0$. This effect is explained by the overreaction of the central bank to the attenuation in fiscal policy. The underreaction of the government to the attenuation in monetary policy leads to the change in inflation equal to $-\frac{\Lambda_B\tilde{\theta}_G a(a+bc)}{\tilde{W}}m_0$. As we discussed earlier, this effect is positive if m_0 is negative and vice versa. The coexistence of the both sources of uncertainty leads to the additional attenuation of the policies. This forces a further decrease in inflation, equal to $\frac{c^2\Lambda_G\Lambda_B}{\tilde{W}}\pi^*$.

The attenuation effect of fiscal policy leads to a decrease in the output, equal to $\frac{a\tilde{W}_\tau}{\tilde{W}}\tau_0$. The presence of monetary multiplicative uncertainty strengthens this attenuation effect and causes a further decrease in output, equal to $\frac{a\tilde{W}_\tau\Lambda_B}{\tilde{W}}\tau_0$. The underreaction of the government to the attenuation in monetary policy leads to the change in output equal to $\frac{ac^2\Lambda_B}{\tilde{W}}\frac{m_0}{c}$. This amount is positive if m_0 is positive. If m_0 is negative, all the effects of uncertainty on output are negative.

With the use of (11) and (12) we arrive at Proposition 1. The following Proposition 1 summarizes these findings.

Proposition 1. For given ($\tilde{\theta}_B$, $\tilde{\theta}_G$, σ_ρ^2, σ_φ^2), there exist $\lambda_2 \geq \lambda_1$, such that in equilibrium with certain preferences:

i) $\pi^e \geq \pi^*$ if and only if $\frac{m_0}{\tau_0} \leq \lambda_1$;

ii) $y^e \geq y^*$ if and only if $\frac{m_0}{\tau_0} \geq \lambda_2$;

where $\lambda_1 = \frac{c^2\Lambda_G(ab\tilde{\theta}_B - c\Lambda_B)}{\Lambda_B(c^2\Lambda_G + \tilde{\theta}_G a(a+bc))}$, $\lambda_2 = \frac{c\Lambda_G(1+\Lambda_B)}{\Lambda_B} \geq 0$.

Proposition 1 indicates that there can be three different economic situations in equilibrium. If $\frac{m_0}{\tau_0} \leq \lambda_1$, there is the inflation bias problem in equilibrium: the expected rate of inflation exceeds its target level ($\pi^e \geq \pi^*$), while the expected rate of output is below its target level ($y^e \leq y^*$). If $\lambda_1 < \frac{m_0}{\tau_0} \leq \lambda_2$, there is the deflation bias problem: both the expected rate of inflation and output are below their target levels ($\pi^e \leq \pi^*, y^e \leq y^*$). If $\frac{m_0}{\tau_0} > \lambda_2$, there is negative inflation bias problem in equilibrium: the expected rate of output exceeds its target level ($y^e \geq y^*$), while the expected level of inflation is below its target level ($\pi^e \leq \pi^*$).

We can also note that if we set $\sigma_\varphi^2 = 0$, we automatically replicate the results of Di Bartolomeo et al. (2009). In this case both the thresholds λ_1, λ_2 go to infinity and for any possible $\frac{m_0}{\tau_0}$ the economy faces the inflation bias problem. If σ_ρ^2 increases, the inflation bias problem aggravates.

If we let $\sigma_\rho^2 = 0$, we get the result of Di Bartolomeo and Giuli (2011). In this case, both the thresholds $\lambda_1 = \lambda_2 = 0$. This means that if $\frac{m_0}{\tau_0} < 0$, there is the inflation bias problem in the economy. If $\frac{m_0}{\tau_0} > 0$, there is negative inflation bias. The simultaneous presence of monetary and fiscal multiplicative uncertainty makes the third type of equilibrium possible. This equilibrium is characterized by both inflation and output lower than their targets and is achieved for intermediate values of $\frac{m_0}{\tau_0} \in (\lambda_1, \lambda_2)$. It is easy to show that $\frac{\partial \lambda_1}{\partial \sigma_\rho^2} > 0$, $\frac{\partial \lambda_1}{\partial \sigma_\phi^2} < 0$, $\frac{\partial \lambda_2}{\partial \sigma_\rho^2} > 0$ and $\frac{\partial \lambda_2}{\partial \sigma_\phi^2} < 0$. Moreover, λ_1 is positive if and only if $\sigma_\phi^2 > \frac{ab\tilde{\theta}_B}{1 + b^2\tilde{\theta}_B^2}$, while λ_2 is always positive. After characterizing the equilibrium with certain preferences we now proceed to the search for the equilibrium with preference uncertainty.

4 Uncertain government preferences

In this Section, we relax the assumption of certain preferences and assume that parameter θ_G is a random variable with mean $\tilde{\theta}_G$ and cumulative distribution function $F(\theta_G)$. Thus, we can rewrite the reaction function of the government with preferences θ_G (5) in the following way:

$$\tau(\theta_G) = \tau(\tilde{\theta}_G) - \Phi_G \omega(\theta_G), \tag{13}$$

where $\tau(\tilde{\theta}_G)$ is the value of fiscal instrument chosen by the government with preferences $\tilde{\theta}_G$, $\Phi_G = \frac{c^2(1+\sigma_\rho^2)(a+bc)(y^* - \overline{y} + b\pi^e - c\pi^*) + ac(a + bc(1-\sigma_\rho^2))(m - \pi^*)}{c^2(1+\sigma_\rho^2) + \tilde{\theta}_G(\sigma_\rho^2 b^2 c^2 + (a+bc)^2)}$ and $\omega(\theta_G) = \frac{\tilde{\theta}_G - \theta_G}{c^2(1+\sigma_\rho^2) + \theta_G(\sigma_\rho^2 b^2 c^2 + (a+bc)^2)}$ characterizes the distance between the actual government preferences θ_G and the mean preferences $\tilde{\theta}_G$, with $\frac{\partial \omega}{\partial \theta_G} < 0$ and $\frac{\partial^2 \omega}{(\partial \theta_G)^2} > 0$.

The central bank does not know the true distance between government preferences and their mean, so the monetary policy is conducted according to equation (6), which is the reaction of the central bank to the expected value of fiscal instrument, $\overline{\tau}$. The expected value of fiscal instrument can be computed with the help of (13):

$$\overline{\tau} = \tau(\tilde{\theta}_G) - \Phi_G \Omega_G, \tag{14}$$

where $\Omega_G = \int_{\underline{\theta_G}}^{\overline{\theta_G}} \omega(\theta_G)\,\mathrm{d}F(\theta_G)$ is the average value of $\omega(\theta_G)$. As function $\omega(\theta_G)$ is decreasing and convex, Ω_G is higher than the value $\omega(\tilde{\theta}_G)$, which is equal to zero. Obviously, the value of Ω_G depends on the extent of uncertainty about the government preferences. Due to convexity of function $\omega(\theta_G)$, the higher variance of θ_G the higher value of Ω_G.

To compute the equilibrium, we firstly find the intersection of reaction functions (6) and (14). After that, we compute the expected inflation in the intersection point and substitute it into the reaction functions. The equilibrium values of the average value of fiscal instrument and the monetary instrument are as follows:

$$\hat{\overline{\tau}} = \tau_0 - \frac{\hat{W}_\tau(1+\Lambda_B)}{\hat{W}}\tau_0 + \frac{\hat{W}_m - \Lambda_B a(a+bc)\tilde{\theta}_G - ac^2\Omega_G\Lambda_B(bc\sigma_\rho^2 - (a+bc))}{\hat{W}}\frac{m_0}{c} \tag{15}$$

$$\hat{m} = m_0 - \frac{\hat{W}_m + c^2\Lambda_B\Lambda_G}{\hat{W}}m_0 + (c + ab\tilde{\theta}_B)\frac{\hat{W}_\tau}{\hat{W}}\tau_0, \tag{16}$$

where (15) is the average fiscal policy in equilibrium, (16) is the equilibrium monetary policy, $\hat{W}_\tau = \tilde{W}_\tau + \Omega_G\sigma_\rho^2 c^2 a(a+2bc)$, $\hat{W}_m = \tilde{W}_m + \Lambda_B bc^3(a+bc)\Omega_G(1+\sigma_\rho^2)$, $\hat{W} = \tilde{W} - \Omega_G c(a(a+bc)(b(a+bc)\tilde{\theta}_B + c) + \sigma_\rho^2 abc^2(b^2\tilde{\theta}_B - 1) - bc^2(a+bc)\Lambda_B - \sigma_\rho^2 bc^2(a+bc)\Lambda_B)$.

If we compare (15) and (16) with the equilibrium policies with certain preferences (9) and (10), we will see that the main effects created by uncertainty are the same. These are the fiscal attenuation effect equal to $-\frac{\hat{W}_\tau(1+\Lambda_B)}{\hat{W}}\tau_0$ in (15) and the monetary attenuation effect equal to $-\frac{\hat{W}_m + c^2\Lambda_B\Lambda_G}{\hat{W}}m_0$ in (16). The reaction of the central bank to the fiscal attenuation effect is given by $-(c + ab\tilde{\theta}_B)\frac{\hat{W}_\tau}{\hat{W}}\tau_0$ in (16), while the average reaction of fiscal policy to the monetary attenuation effect is given by $\frac{\hat{W}_m - \Lambda_B a(a+bc)\tilde{\theta}_G - ac^2\Omega_G\Lambda_B(bc\sigma_\rho^2 - (a+bc))}{\hat{W}}\frac{m_0}{c}$ in (15). These effects define the equilibrium expected inflation and output:

$$\hat{\pi^e} = \pi^* + \frac{\Lambda_B((c^2 + a(a+bc)\tilde{\theta_G} + c^2\Lambda_G) + bc^3(a+bc)\Omega_G(1+\sigma_\rho^2))}{\hat{W}} m_0 + \\ + \frac{\hat{W}_\tau(ab\tilde{\theta}_B - c\Lambda_B)}{\hat{W}}\tau_0 \tag{17}$$

$$\hat{y^e} = y^* + \frac{ac^2\Lambda_B(1+\Omega_G((a+bc)^2 + b^2c^2\sigma_\rho^2)}{\hat{W}}\frac{m_o}{c} - -\frac{\hat{W}_\tau(1+\Lambda_B)}{\hat{W}}\tau_0 \tag{18}$$

As we can see, the equilibrium values of monetary and fiscal instruments are given by the cumbersome equations. Thus, we start our analysis of the equilibrium from the polar cases when either σ_ρ^2 or σ_φ^2 is equal to zero. After that, we describe the equilibrium in the generalized model with both σ_ρ^2 and σ_φ^2 positive.

4.1 Certain multipliers and uncertain fiscal preferences

We start to analyze the effects of preference uncertainty in the model with $\sigma_\rho^2 = \sigma_\varphi^2 = 0$. Substiting these values into (15-18) gives the following Proposition:

Proposition 2. In equilibrium with uncertain government preferences and without multiplicative uncertainty, $m = m_0$, $\tau(\theta_G) = \tau_0$ for any θ_G. Thus, for any Ω_G equilibrium output and inflation are equal to their target levels: $y = y^*$, $\pi = \pi^*$.

Proposition 2 indicates that in the absence of multiplicative uncertainty the government preference uncertainty does not affect the equilibrium. Irrespective of his preferences, the government with any θ_G chooses τ_0. Thus, the average fiscal policy is also equal to τ_0. The optimal reaction of the central bank to the average τ_0 is equal to m_0. As a result, in this case the uncertainty about the government preferences is not relevant and the symbiosis result of Dixit and Lambertini (2003b) holds: the government and the central bank are able to achieve both inflation and output targets.

4.2 Uncertain fiscal multiplier and uncertain fiscal preferences

We proceed with the model with fiscal multiplicative uncertainty. The equilibrium in this model can be computed from (15-18) with $\sigma_\varphi^2 = 0$ and is described in the following Proposition:

Proposition 3. The equilibrium with fiscal multiplicative uncertainty and government preference uncertainty ($\sigma_\rho^2 > 0, \Omega_G > 0, \sigma_\varphi^2 = 0$) is such that:

i) For any $\frac{m_0}{\tau_0}$, there is the inflation bias problem: the expected rate of inflation exceeds its target level ($\pi^e > \pi^*$), while the expected rate of output is below its target level ($y^e < y^*$).

ii) Government preferences uncertainty aggravates the inflation bias problem. With higher Ω_G, the inflation gap and the output gap become larger: $\frac{\partial|\pi - \pi^e|}{\partial \Omega_G} > 0$, $\frac{\partial|y - y^e|}{\partial \Omega_G} > 0$.

Part i) of Proposition 3 states that the equilibrium with uncertain fiscal multiplier and uncertain government preferences is characterized by inflation bias. The intuition is straightforward. The fiscal multiplicative uncertainty leads to the attenuation fiscal effect. The central bank does not know the true preferences of the government and has to rely on the average fiscal attenuation effect, which is given by the term $\frac{\hat{W}_\tau}{\hat{W}}\tau_0$ in (15). The attenuation fiscal effect leads to a decrease in both inflation and output. An increase in monetary instrument equal to $c\frac{\hat{W}_\tau}{\hat{W}}\tau_0$ would be enough to compensate the average decrease in inflation due to fiscal multiplicative uncertainty. Nevertheless, the central bank takes expectations as given and raises its instrument more in order to stimulate output. The value of the excess increase in monetary instrument is proportional to $ab\tilde{\theta}_B\frac{\hat{W}_\tau}{\hat{W}}$. This excess increase in monetary instrument pushes in inflation above the target level, while the expected output stays below the target.

Part ii) of Proposition 3 states that an increase in the dispersion of fiscal preferences leads to the higher inflation bias. To understand this, note that the gap between the expected output and the target is proportional to the average attenuation fiscal effect. From (14) the value of the average fiscal instrument $\overline{\tau}$ is lower than $\tau(\tilde{\theta}_G)$. Thus, the average attenuation effect is higher than the attenuation of the policy by the government with preferences $\tilde{\theta}_G$. With higher preference uncertainty, measured by Ω_G, the difference between the average attenuation and the attenuation of the government with average preferences becomes larger. Consequently, the absolute value of expected output gap also increases. Thus, the willingness of the central bank to stimulate output with the excessive increase in monetary instrument enlarges. As a result, the gap between expected inflation and the target inflation becomes larger.

Thus, the effects of fiscal multiplicative uncertainty in the model with uncertain government preferences coincide with the effects in the model with certain preferences qualitatively and are larger quantitatively. In the next subsection we analyze the effects of preference uncertainty in the model with uncertain monetary multiplier.

4.3 Uncertain monetary multiplier and uncertain fiscal preferences

Now we proceed to the model with monetary multiplicative uncertainty. The equilibrium in this model can be derived from (15-18) with $\sigma_\rho^2 = 0$ and is described in the following Proposition 4:

Proposition 4. The equilibrium with monetary multiplicative uncertainty and government preference uncertainty ($\sigma_\rho^2 = 0, \Omega_G > 0, \sigma_\varphi^2 > 0$) is such that:

i) If $m_0 > 0$, there is negative inflation bias problem in the economy: the expected rate of output exceeds its target level ($y^e \geq y^*$), while the expected level of inflation is below its target level ($\pi^e \leq \pi^*$). If $m_0 < 0$, there is the inflation bias problem in the economy: the expected rate of inflation exceeds its target level ($\pi^e \geq \pi^*$), while the expected rate of output is below its target level ($y^e \leq y^*$).

ii) $\dfrac{\partial|\pi - \pi^e|}{\partial\Omega_G} \geq (\leq) 0$ if and only if $\sigma_\varphi^2 \leq (\geq) \dfrac{ab\tilde{\theta}_B}{c(1 + b^2\tilde{\theta}_B)}$. If $\sigma_\varphi^2 > \dfrac{ab\tilde{\theta}_B}{c(1 + b^2\tilde{\theta}_B)}$, an increase in Ω_G lowers inflation gap. If $\sigma_\varphi^2 < \dfrac{ab\tilde{\theta}_B}{c(1 + b^2\tilde{\theta}_B)}$, an increase in Ω_G enlarges inflation gap.

iii) For any m_0, uncertain government preferences aggravate the gap between the expected output and its target level: $\dfrac{\partial|y - y^e|}{\partial\Omega_G} > 0$.

Part i) of Proposition 4 states that there is either inflation bias or negative inflation bias in equilibrium. The logic is similar to the model with certain preferences. Uncertainty about monetary multiplier causes the attenuation monetary effect, equal to $\dfrac{\hat{W}_m}{\hat{W}}$. Similar to the case of certain preferences, to change the average fiscal instrument by $\dfrac{\hat{W}_m}{\hat{W}}\dfrac{m_0}{c}$ would be enough to compensate the influence of monetary attenuation effect on inflation. Nevertheless, the government with any preferences has a competing target of output. As the government does not want to change considerably the output level, there is the under-reaction to the monetary attenuation effect. The average size of this under-reaction is given by the term $\dfrac{-\Lambda_B a(a + bc)\tilde{\theta}_G - ac^2\Omega_G\Lambda_B(-(a + bc))}{\hat{W}}\dfrac{m_0}{c}$ in (15). This under-reaction gives rise to the gap between expected inflation and its target, while the equilibrium average change in fiscal instrument gives rise to the gap between expected output and the target output. The sign of inflation and output gaps, which are given by (19), depend on the sign of m_0. If m_0 is positive, the negative inflation bias with low inflation and high output arises. If m_0 is negative, uncertainty leads to a standard inflation bias:

$$\tilde{y}^e = y^* + \frac{ac^2\Lambda_B(1+\Omega_G(a+bc)^2)}{\hat{W}}\Bigg|_{\sigma_\rho^2=0} \frac{m_0}{c} \tag{19}$$

Parts ii) and iii) of Proposition 4 characterize the effects of preference uncertainty on the absolute values of output and inflation gaps. To better understand these findings, let us firstly note that the size of monetary attenuation effect, $\frac{\hat{W}_m}{\hat{W}}$, depends positively on Ω_G. This means that an increase in preference uncertainty aggravates the attenuation effect of monetary policy. The explanation is as follows. As we have seen in Section 3, if $m_0 > 0$ and preferences are certain, the equilibrium fiscal instrument is decreasing and convex function of government type. This means that under uncertain preferences the average fiscal instrument is higher than the policy of the government with the average preferences. Thus, the central bank decreases m in accordance with its reaction function. This signifies an aggravation of attenuation effect in comparison with certain preferences. If $m_0 < 0$, the fiscal instrument under certain preferences is increasing concave function of the government preferences. Thus, the average fiscal instrument is lower than the policy chosen by the government with the average preferences. The central bank reacts to this by an increase in m. As the attenuation effect in this case implies the rise of m, we can conclude that uncertainty about preferences again aggravates attenuation effect.

The gap between expected output and target output is defined by the government reaction to this attenuation affect. The change in the fiscal instrument is proportional to the size of attenuation effect. From here we can conclude, that the absolute value of the output gap is also proportional to the attenuation effect. Thus, we can conclude that an increase in preference uncertainty always aggravates the output gap which is caused by uncertainty about monetary multiplier.

The gap between expected inflation and its target is defined by the average fiscal under-reaction to the monetary attenuation effect. The under-reaction of the government with preferences θ_G is proportional to $\Lambda_B(\tilde{\theta}_G - c^2\omega(\theta_G))a(a+bc)$. As there is no uncertainty about fiscal multiplier, the following equation holds:

$$\tilde{\theta}_G - c^2\omega(\theta_G) = \theta_G \frac{c^2 + (a+bc)^2\tilde{\theta}_G}{c^2 + (a+bc)^2\theta_G} \tag{20}$$

Thus, from (20) we can see that the coefficient $\tilde{\theta}_G - c^2\omega(\theta_G)$ is non-negative and depends positively on θ_G. This means that the stronger government preferences for output the less reaction to the monetary attenuation effect. Moreover, $\tilde{\theta}_G - c^2\omega(\theta_G)$ is concave function of θ_G. The average underreaction of the government to the monetary attenuation effect, $\left.\frac{\Lambda_B(\tilde{\theta}_G - c^2\Omega_G)a(a+bc)}{\hat{W}}\right|_{\sigma_\rho^2=0}$, defines the gap between expected inflation and inflation target.The size of this gap depends on the variance of government preferences, Ω_G. The sign of this dependence is defined by the extent of monetary uncertainty. If the uncertainty about monetary multiplier is strong and $\sigma_\varphi^2 > \frac{ab\tilde{\theta}_B}{c(1+b^2\tilde{\theta}_B)}$, a decrease in Ω_G leads to an increase in the underreaction. This means that more uncertain preferences lower the gap between expected inflation and the inflation target. On the contrary, if monetary uncertainty is weak and $\sigma_\varphi^2 < \frac{ab\tilde{\theta}_B}{c(1+b^2\tilde{\theta}_B)}$, an increase in uncertainty about government preferences leads to an increase in the gap between the expected and target inflation rates.

4.4 Uncertain policy multipliers and uncertain fiscal preferences

After discussion of the polar cases in Sections 4.1-4.3, we now proceed to the most general framework. The characteristics of the equilibrium with uncertain preferences when both the multipliers are also uncertain are summarized in the following Proposition:

Proposition 5. For given $(\sigma_\rho^2, \sigma_\varphi^2, \Omega_G)$, there exist $\lambda_2^* \geq \lambda_3^* \geq \lambda_1^*$, such that:

i) $\pi^e \geq \pi^*$ if and only if $\frac{m_0}{\tau_0} \leq \lambda_1^*$;

ii) $y^e \geq y^*$ if and only if $\frac{m_0}{\tau_0} \geq \lambda_2^*$;

iii) $\frac{\partial(y-y^e)}{\partial\Omega_G} \geq 0$ if and only if $\frac{m_0}{\tau_0} \geq \lambda_3^*$, and
$\frac{\partial(\pi-\pi^e)}{\partial\Omega_G} \geq 0$ if and only if $\left(\frac{m_0}{\tau_0} - \lambda_3^*\right)\left(\sigma_\varphi^2 - \frac{ab\tilde{\theta}_B}{c(1+b^2\tilde{\theta}_B)}\right) > 0$;

where
$$\lambda_1^* = \frac{c^2(\Lambda_G + a\sigma_\rho^2\Omega_G(a+2bc))(ab\tilde{\theta}_B - c\Lambda_B)}{\Lambda_B(c^2\Lambda_G + \tilde{\theta}_G a(a+bc) + ac^2\Omega_G(bc(\sigma_\rho^2-1)-a))},$$
$$\lambda_2^* = \frac{c(1+\Lambda_B)}{\Lambda_B}\frac{(\Lambda_G + a\sigma_\rho^2\Omega_G(a+2bc))}{(1+\Omega_G((a+bc)^2 + b^2c^2\sigma_\rho^2))} \geq 0,$$
$$\lambda_3^* = \frac{c\sigma_\rho^2(a^2 + abc(1+\theta_B b^2) + \Lambda_B(a(a+bc) - b^2c^2))}{\Lambda_B(a(a+bc) + \sigma_\rho^2 b^2c^2)}.$$

Parts i) and ii) of Proposition 5 states that if both the multipliers are uncertain, there are three possible economic situations: inflation bias, deflation bias or negative inflation bias. If $\frac{m_0}{\tau_0} \leq \lambda_1^*$, there is the inflation bias problem in the economy: the expected rate of inflation exceeds its target level ($\pi^e \geq \pi^*$), while the expected rate of output is below its target level ($y^e \leq y^*$). If $\lambda_1^* < \frac{m_0}{\tau_0} \leq \lambda_2^*$, there is the deflation bias problem in the economy: the expected rate of inflation and output are below their target levels ($\pi^e \leq \pi^*, y^e \leq y^*$). If $\frac{m_0}{\tau_0} > \lambda_2^*$, the expected rate of output exceeds its target level ($y^e \geq y^*$), while the expected level of inflation is below its target level ($\pi^e \leq \pi^*$), which means that there is negative inflation bias problem in the economy. Similar to the model with certain preferences, the deflation bias is possible only if both the multipliers are uncertain and $\frac{m_0}{\tau_0} \in (\lambda_1^*, \lambda_2^*)$.

Uncertainty about government preferences influences the thresholds λ_1^* and λ_2^*. It is easy to show that $\frac{\partial \lambda_2^*}{\partial \Omega_G} < 0$. This means that an increase in uncertainty about government preferences lowers λ_2^*. The effect of preference uncertainty on the value of λ_1^* depends on the sign of this value. If λ_1^* is positive, an increase in Ω_G leads to a further increase in λ_1^*. If λ_1^* is negative, an increase in Ω_G leads to a further decrease in λ_1^*.

Part iii) of Proposition 5 defines the effect of preference uncertainty on the equilibrium output and inflation. The effect of preference uncertainty on the expected output is positive if $\frac{m_0}{\tau_0} > \lambda_3^*$ and negative if $\frac{m_0}{\tau_0} < \lambda_3^*$. This means that if $\frac{m_0}{\tau_0} < \lambda_1^*$ and the equilibrium is characterized by inflation bias with negative output gap, an increase in preference uncertainty leads to the further increase in the absolute value of this gap. If $\frac{m_0}{\tau_0} > \lambda_2^*$ and the equilibrium is characterized by the negative inflation bias with positive output gap, an increase in preference uncertainty also leads to the further increase in the absolute value of this gap. If $\frac{m_0}{\tau_0} \in (\lambda_1^*, \lambda_2^*)$, there might be non-monotonous effect of preference uncertainty on the output gap.

The effect of preference uncertainty on expected inflation depends not only on the value of $\frac{m_0}{\tau_0}$, but also on the extent of monetary multiplicative uncertainty. For example, if $\frac{m_0}{\tau_0} > \lambda_3^*$, equilibrium is characterized by the negative gap between the expected inflation and its target. The effect of Ω_G depends on the value of σ_ϕ^2. If $\sigma_\varphi^2 > \frac{ab\tilde{\theta}_B}{c(1+b^2\tilde{\theta}_B)}$, an increase in Ω_G leads to an increase in expected inflation and consequently, to a decrease in the absolute value of inflation gap. Similarly, if $\sigma_\varphi^2 < \frac{ab\tilde{\theta}_B}{c(1+b^2\tilde{\theta}_B)}$, an increase in Ω_G leads to a decrease in expected inflation and consequently, to an increase in the absolute value of the inflation gap.

5 Conclusion

This paper contributes to the existing literature on monetary and fiscal policy under uncertainty. In particular, we study the role of uncertain government preferences for policy interaction.

We show, that if the fiscal and monetary multipliers are known, uncertainty about the government preferences do not affect the equilibrium. If any of multipliers are uncertain, the results change. Uncertainty about the government preferences lowers output, increases inflation and thereby aggravates the inflation bias problem, which could be created by fiscal multiplicative uncertainty. Monetary multiplicative uncertainty can create either the inflation bias problem or negative inflation bias problem. Uncertain government preferences aggravate the problem by enlarging the absolute value of output gap, while the effect on inflation gap depends on the extent of uncertainty about the monetary multiplier. If both the multipliers are uncertain, the impact of uncertain government preference depends not only on the extent of multiplicative uncertainty, but also on the inflation and output targets.

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 under various forms of strategic interaction is a promising avenue for further research.

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