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The Effects of Corruption in a Monetary Union

Judit Garcia*

Abstract

Many countries around the world suffer from corruption. In a monetary union, corruption varies from one country to another. It is possible corruption in one country may affect another country in a monetary union. We demonstrate that this feature has important implications in a monetary union with two asymmetric countries. Country 1 has a corrupted government while country 2 does not. Within this framework, we determine under which conditions corruption damages or benefits both countries. We find that corruption in country 1 may have a positive or negative effect on country 2. In particular, when the government of country 1 is much more concerned about public spending than output, corruption damages both countries. In addition, we investigate how country 1 could compensate country 2 for the negative externality.

JEL classification: D60, D73, E52, E58, E62.

Keywords: Corruption; Fiscal Policy; Monetary Policy; Monetary Union.

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1. Introduction

The last anti-corruption report from the European Commission shows that corruption costs around 120 billions euros per year to the European economy. Additionally, it reflects that corruption varies from one Member State to another. According to the Corruption Perception Index from Transparency International, in the European Monetary Union (EMU), Finland was the cleanest country in 2014. By contrast, Italy and Greece were the most corrupt countries. Apart from them, Cyprus, Portugal, Spain and Slovakia, among others, were below the EMU average. Concretely, Italy and Greece were below the global world average.[1] Scientific papers do not usually analyse the effects of corruption in one country on another country. Therefore, our research question here is the following: does it matter whether a corrupt country affects other Member State in a monetary union? In this paper, we study how the degree of corruption in one country would affect its own economy as well as that of the other country. From our knowledge, the consequence of this feature has not been examined. This paper aims to fill this void.

This work is related to the literatures on corruption and on monetary and fiscal policy interactions in a monetary union and on how corruption may favour or damage countries. In the monetary union presented here, there are two countries. Country 1 has a corrupted government while Country 2 does not. In this context, we explore (i) how corruption affects both countries, (ii) and more importantly, how the corrupt country may compensate the other country for its negative externality.

This paper is linked to three literatures. The first one focuses on corruption in a monetary union, and the closest paper to ours is Hefeker's (2010). However, we allow for more asymmetries between countries since in our framework all the authorities have different preferences, there are different output goals between countries and there is only one corrupt country. Besides, we consider corruption as a share of tax revenue and our purpose is to analyse the effects of corruption on both countries. The second strand of related literature deals with how we model corruption, we follow Huang and Wei (2006). Although these authors focus on the effects of institutional quality, they do not analyse the effects in a monetary union. The third branch of literature looks at asymmetries between countries as Dixit and Lambertini (2001) and Beetsma and Giuliodori (2010). By contrast to them, we include corruption and we consider that fiscal authorities are concerned about their public spending stabilisation. Dixit and Lambertini (2001) study the interaction of monetary and fiscal policies in a monetary union. They find that if there is an agreement about ideal output and inflation, a monetary-fiscal symbiosis is created. Beetsma and Giuliodori (2010) study the macroeconomic costs and

[1] See Fig. 4.1 in the Appendix.

benefits of monetary unification. They explore, among other things, how conflicts between the fiscal authorities and the European Central Bank about the macroeconomic objectives may produce a race among the policymakers.

We obtain several interesting results from the analysis. First, an increase in the degree of corruption always leads to a decrease in the public spending of country 1 (the corrupt country). Moreover, corruption may increase or decrease the output growth rate of country 1 and it may increase or decrease the monetary authority's desire to inflate; it will depend on how far the government of country 1 is concerned about stabilising its public spending. However, corruption has no effect on the output nor public spending of country 2. Second, depending also on how far the government of country 1 is concerned about public spending stabilisation, both countries may be better off or worse off with an increase in the level of corruption. In particular, if the government of country 1 is very concerned about public spending stabilisation, both countries are worse off with corruption. Third, as country 2 may be damaged by the degree of corruption, country 1 could be forced to decrease its public spending goal in order to compensate country 2 for the negative externality. In this case, country 2 would be better off but country 1 may be worse off if country 1 is very concerned about stabilising its public spending.

The paper proceeds as follows. Section 2 sets up the model. Section 3 studies the effects of corruption. Concluding remarks are presented in Section 4 and proofs are gathered in the Appendix.

2. The Model

In this section we extend the analysis of Hefeker (2010) to allow for more asymmetry between countries, i.e., different preferences on the authorities' objectives and different output goals among countries.

We assume that there are two member countries and a common central bank in the monetary union. Each country i has a fiscal authority who selects the fiscal policy variable in each country, the tax rate. Besides, the common central bank chooses a monetary policy variable, the inflation rate. Inflation is equal across the monetary union.

The output function for country i, $i = 1, 2$, is a simplified Lucas supply function and it is described by

$$x_i = \pi - \pi^e - \tau_i, \tag{2.1}$$

where x_i denotes output in country i and π is the actual common inflation rate. Moreover, π^e is the expected inflation rate and τ_i represents the taxes levied on output in country i.[2]

The fiscal authorities face the following budget constraints

$$g_1 = \phi\tau_1 \text{ and} \tag{2.2}$$

$$g_2 = \tau_2, \tag{2.3}$$

where g_i denotes the ratio of public expenditures over output in country i. Note that the only source of financing the public spending of both countries is by their taxes as in Acocella et al. (2007a).[3] Moreover, the degree of corruption is represented by the parameter ϕ $(0 \leq \phi \leq 1)$. In contrast to Hefeker (2010) and following Huang and Wei (2006), the degree of corruption is modelled as follows: the private sector pays taxes, τ_i, but only $\phi\tau_1$ is collected by the government of country 1. Thus, when $\phi = 0$, there is full corruption in the economy in country 1 and the tax revenues are "eaten up", whereas when $\phi = 1$, there is no corruption and all tax revenues are collected as in country 2. Therefore, country 1 has a weaker institution than country 2 since there is a leakage of tax revenue in country 1. In consequence, we assume also asymmetry between countries through their public spending.

We consider that both fiscal authorities wish to minimise the deviations of inflation, output and public spending from their targets (0, $\bar{x}_i$ and $\bar{g}_i$, respectively). Moreover, as in Beetsma and Bovenberg (1998), Beetsma and Bovenberg (2001) and Acocella et al. (2007b), the common central bank is concerned with avoiding the deviation of inflation and stabilising the average output growth in the union.[4] Thus, the fiscal authority in country i and the monetary authority CCB want to minimise their respective loss functions defined by

$$L_i = \frac{1}{2}\left[\pi^2 + \delta_i\left(x_i - \bar{x}_i\right)^2 + \gamma_i\left(g_i - \bar{g}_i\right)^2\right], \tag{2.4}$$

where δ_i, $\gamma_i > 0$ and $\bar{x}_i$, $\bar{g}_i \geq 0$, and

$$L_{CCB} = \frac{1}{2}\left[\pi^2 + \delta_{CCB}\left(zx_1 + (1-z)\,x_2 - (z\bar{x}_1 + (1-z)\,\bar{x}_2)\right)^2\right], \tag{2.5}$$

[2] A complete derivation of Expression (2.1) can be found in Alesina and Tabellini (1987) or in Beetsma and Bovenberg (1997).

[3] However, Acocella et al. (2007a) assume that all countries do not suffer from revenue leakage.

[4] Following the related literature, - see Alesina and Tabellini (1987), Debelle and Fischer (1994), Alesina and Stella (2010), among others - we assume that the inflation target ($\bar{\pi}$) of the authorities has been normalised to zero since e.g., the ECB's inflation target is below 2%. The results would not be qualitatively altered by assuming a positive inflation target.

where $\delta_{CCB} > 0$ and $0 < z < 1$. Countries in the monetary union have a relative share, z for country 1 and $1 - z$ for country 2. The parameters $\delta's$ and $\gamma's$ measure the weights of the output and public spending objectives relative to the weight of the inflation objective. Following Dixit and Lambertini (2001) and Beetsma and Giuliodori (2010),[5] we allow that the three authorities disagree about their relative weights. Specifically, the disagreement is among countries ($\delta_1 \neq \delta_2$ and/or $\gamma_1 \neq \gamma_2$) and between countries and the monetary authority ($\delta_i \neq \delta_{CCB}$).

In the previous loss functions, the parameters $\bar{x}_i$ and $\bar{g}_i$ represent the output and public spending goals in country i, respectively. Allowing different output and spending targets reflect heterogeneity between countries as in Dixit and Lambertini (2001) and Hefeker and Zimmer (2011). In what follows, we will assume that $\frac{\bar{x}_1}{\bar{g}_1} < \frac{\phi\gamma_1}{\delta_1}$ and $\frac{\bar{x}_2}{\bar{g}_2} < \frac{\gamma_2}{\delta_2}$ given that these inequalities guarantee that the values of public spending rates, in equilibrium, are positive.

The sequence of events is as follows:

1. Expectations are formed.

2. The fiscal and monetary authorities choose simultaneously their policy variables, τ_i and π, respectively.

The model is solved by minimising the loss functions of the three authorities, holding π^e constant and then imposing rational expectations. The solutions of the authorities' problems are derived from the output (Expression 2.1) and budget constraints (Expression 2.2 and 2.3) as

$$\tau_1 = \frac{\bar{g}_1}{\phi} - \frac{\frac{\delta_1}{\gamma_1}}{\phi\left(\phi^2 + \frac{\delta_1}{\gamma_1}\right)}\left(\phi\bar{x}_1 + \bar{g}_1\right) + \frac{\frac{\delta_1}{\gamma_1}}{\phi^2 + \frac{\delta_1}{\gamma_1}}\left(\pi - \pi^e\right),$$

$$\tau_2 = \bar{g}_2 - \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}}\left(\bar{x}_2 + \bar{g}_2\right) + \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}}\left(\pi - \pi^e\right) \text{ and}$$

$$\pi = \frac{\delta_{CCB}}{1 + \delta_{CCB}}\left(\pi^e + z\left(\tau_1 + \bar{x}_1\right) + (1 - z)\left(\tau_2 + \bar{x}_2\right)\right). \tag{2.6}$$

Imposing rational expectations and, then, solving the system of three equations and three unknowns (τ_1, τ_2 and π), we obtain the following proposition:

Proposition 1. *In equilibrium, the tax and inflation rates are as follows:*

[5] Both papers consider that fiscal authorities are not worried about their public spending. However, we follow Alesina and Tabellini (1987), Beetsma and Bovenberg (1997) and Huang and Wei (2006), among others, who assume that fiscal authorities take into account their public goods provision.

	$\bar{x}_1$	$\bar{x}_2$	$\bar{g}_1$	$\bar{g}_2$	δ_{CCB}	δ_1	γ_1	δ_2	γ_2
Inflation	$+$	$+$	$+$	$+$	$+$	$-$	$+$	$-$	$+$
Output$_1$	$+$	0	$-$	0	0	$+$	$-$	0	0
Output$_2$	0	$+$	0	$-$	0	0	0	$+$	$-$
Gov. Spending$_1$	$-$	0	$+$	0	0	$-$	$+$	0	0
Gov. Spending$_2$	0	$-$	0	$+$	0	0	0	$+$	$-$

Table 2.1: Effects of preference changes in inflation, output and public spending for both countries.

$$\tau_1^* = \frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1 + \phi\bar{g}_1}{\phi^2 + \frac{\delta_1}{\gamma_1}}, \tag{2.7}$$

$$\tau_2^* = \frac{-\frac{\delta_2}{\gamma_2}\bar{x}_2 + \bar{g}_2}{1 + \frac{\delta_2}{\gamma_2}}, \; and \tag{2.8}$$

$$\pi^* = z\frac{\phi\delta_{CCB}}{\phi^2 + \frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1 + \bar{g}_1\right) + (1-z)\frac{\delta_{CCB}}{1 + \frac{\delta_2}{\gamma_2}}\left(\bar{x}_2 + \bar{g}_2\right). \tag{2.9}$$

Moreover, using the Expressions (2.7) and (2.8), it follows that, in equilibrium, the values of output and public spending rates are given by

$$x_1^* = \frac{\frac{\delta_1}{\gamma_1}\bar{x}_1 - \phi\bar{g}_1}{\phi^2 + \frac{\delta_1}{\gamma_1}}, \tag{2.10}$$

$$x_2^* = \frac{\frac{\delta_2}{\gamma_2}\bar{x}_2 - \bar{g}_2}{1 + \frac{\delta_2}{\gamma_2}}, \tag{2.11}$$

$$g_1^* = \phi\frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1 + \phi\bar{g}_1}{\phi^2 + \frac{\delta_1}{\gamma_1}}, \text{ and} \tag{2.12}$$

$$g_2^* = \frac{-\frac{\delta_2}{\gamma_2}\bar{x}_2 + \bar{g}_2}{1 + \frac{\delta_2}{\gamma_2}}. \tag{2.13}$$

The following table captures the effects of preference changes in inflation, output and public spending for both countries.

Note that an increase in $\bar{x}_i$ creates more incentives for the central bank to inflate (see Expression 2.9). Besides, the fiscal authority of country i decreases its tax rate in order to be closer to its output target (see Expressions 2.7 and 2.8). As a result, the reduction in tax rates gives rise an increase in the output level of country i and a decrease in its public spending. It is important to point out that an increase in $\bar{x}_i$ has no effect on the behaviour of the other fiscal authority (see Expressions 2.7 and 2.8). Hence, the changes in $\bar{x}_i$ do not affect the output and public spending of the other country.

Moreover, an increase in $\bar{g}_i$ means that taxes in country i are increased and, thus, its output decreases and its public spending increases. The behaviour of the fiscal authority of country i of raising its taxes leads to an increase in the incentives of the central bank to inflate.

Now, we want to derive the implications of preference changes for the monetary and fiscal authorities (δ_{CCB}, δ_i and γ_i, respectively) on the equilibrium. Firstly, we examine the effects of the monetary authority's preferences. Inflation depends positively on the common central bank's weight on output, i.e., δ_{CCB}. The central bank faces a trade-off between stabilisation inflation and output: the higher the relative weight given to output stabilisation by the common central bank, the greater the incentives to inflate by the central bank. However, the output and public spending rates of both countries are not affected by the changes in δ_{CCB} (see Expressions 2.7 and 2.8).

Secondly, we study how changes in δ_i affect the strategic behaviours of the three authorities. If δ_i is higher, which means that the fiscal authority of country i gives relatively much more weight to its output stabilisation, then this fiscal authority decreases its tax rate in order to be closer to its output target, and hence, its output increases and its public spending decreases. From the point of view of the common central bank, if the output rate of country i increases, the monetary authority has less incentives to inflate.

Thirdly, we analyse the effects of γ_i on the strategic behaviours of the authorities. If γ_i is higher, which means that the fiscal authority of country i gives relatively much more weight to its public spending stabilisation, this fiscal authority raises its tax rate to be closer to its public spending target, and hence, its output decreases and its public spending increases. As the output rate of country i is decreasing, the monetary authority has more incentives to inflate.

3. The Effects of the Degree of Corruption

After determining the equilibrium outcomes and studying the effects of target and preference changes, we now examine how the degree of corruption affects the main variables of this model. Therefore, the impact of a change in ϕ on growth, public spending and inflation rates is summarised in the following corollary:

Corollary 3. *In equilibrium:*

a) as the degree of corruption rises, the output of country 1 decreases and the inflation rate increases if and only if $\gamma_1 > \bar{\gamma}_1$*, where* $\bar{\gamma}_1 = \frac{\delta_1(2\phi\bar{x}_1+\bar{g}_1)}{\phi^2\bar{g}_1}$*,*

b) as the degree of corruption rises, the public spending of country 1 always decreases, and

c) the output and public spending of country 2 are not affected by the level of corruption.

This corollary indicates that the effects of corruption on both the output rate of country 1 and the inflation rate depend on how far the fiscal authority of country 1 is concerned about stabilising its public spending (γ_1). Specifically, when the fiscal authority of country 1 attaches a high relative weight to public spending stabilisation ($\gamma_1 > \bar{\gamma}_1$), the output of country 1 decreases and the inflation rate increases in the degree of corruption. On the other hand, the opposite result holds whenever $\gamma_1 < \bar{\gamma}_1$. In addition, the second part of this corollary suggests that an increase in the degree of corruption always leads to a decrease in the public spending of country 1. Finally, Corollary 3c shows that the output and public spending of country 2 are not affected by changes in corruption.

The rationale behind Corollary 3 is as follows. When the fiscal authority of country 1 gives much relative weight to public spending stabilisation ($\gamma_1 > \bar{\gamma}_1$), an increase in the degree of corruption causes an increase in the tax rate of country 1. This rise in the tax rate increases the incentive to inflate by the central bank, as shown in Expression (2.6). As the increase in the inflation rate is predicted by price-setters, the output of country 1 is only affected by the change in tax rate and, therefore, the output of country 1 decreases in the degree of corruption. Despite the increase in the tax rate due to an increase in the degree of corruption, the public spending of country 1 always decreases in the degree of corruption. This shows that the increase in the level of corruption more than compensates for the increase in the tax rate of country 1. On the other hand, if the fiscal authority of country 1 is little concerned about public spending stabilisation ($\gamma_1 < \bar{\gamma}_1$), it has an incentive to decrease its tax rate when the level of corruption increases. In this case, the output rate of country 1 increases and its public spending decreases. Therefore, the increase in output reduces the incentive to inflate by the central bank. Finally, as we saw in the previous section, parameter changes in one country do not affect the other and so, the degree of corruption has no impact on the tax rate of country 2, as shown in Expression (2.8). Therefore, the output and public spending rates of country 2 are independent of the degree of corruption.

The following figure summarises the effects of corruption on the main variables:

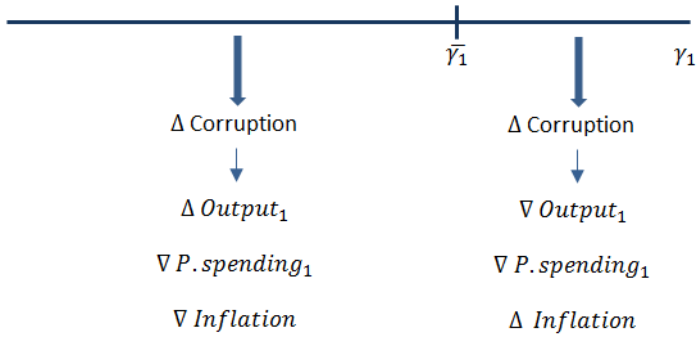

Figure 3.1: The effects of the degree of corruption according to the relative weight on public spending of country 1.

3.1. Welfare Implications

What is the effect on welfare of both countries if the degree of corruption of country 1 increases? To answer this question, we assume that there are no political distortions, i.e., the government's losses coincide with society's losses. This is because if the government has been elected by society, its preferences will be much closer to the society's in order to be re-elected (Beetsma and Bovenberg, 1998 and Dixit and Lambertini, 2003). It is important to point out that even if the degree of corruption has no impact on output or public spending in country 2, it will affect the losses of country 2 through its impact on the inflation rate.

In the next corollary, we show that the effect of corruption on losses generally depends on how far the fiscal authority of country 1 is concerned about public spending stabilisation (γ_1). If the fiscal authority of country 1 is little concerned about public spending stabilisation ($\gamma_1 < \tilde{\gamma}_1$), corruption favours both countries, whereas the reverse result holds if $\gamma_1 > \bar{\gamma}_1$.

Corollary 4. *In equilibrium:*
a) the losses in country 1 increase as the degree of corruption increases if and only if $\gamma_1 > \tilde{\gamma}_1$, *where* $\tilde{\gamma}_1$ *is characterised in the Appendix, with* $\tilde{\gamma}_1 < \bar{\gamma}_1$,[6] *and*
b) the losses in country 2 increase as the degree of corruption increases if and only if $\gamma_1 > \bar{\gamma}_1$.

To intuitively understand the impact of corruption on losses in both countries, notice that when institutional quality worsens (a decrease in ϕ) and the fiscal authority of country 1 gives much relative weight to public spending stabilisation ($\gamma_1 > \bar{\gamma}_1$), Corollary 3 shows that the inflation rate goes up and, hence, we can conclude that the losses in country 2 increase. Moreover, this corollary also points out that the output and public spending rates of country

[6] In the Appendix, $\tilde{\gamma}_1$ is implicitly determined. This is the reason why we cannot give the explicit expression of this threshold.

1 decrease in inflation, and therefore, the deviations from their respective targets increase. Thus, we can also conclude that, in this case, the losses in country 1 also increase and, hence, this leads to conclude that both countries are worse off with corruption. However, if the fiscal authority of country 1 is little concerned about public spending stabilisation ($\gamma_1 < \tilde{\gamma}_1$), a rise in the degree of corruption causes a decrease in both the inflation rate and public spending of country 1 and an increase in the output rate of country 1. This brings to the conclusion that, in this case, corruption positively affects both countries. Finally, for intermediate values of γ_1 (i.e., $\tilde{\gamma}_1 < \gamma_1 < \bar{\gamma}_1$), the decrease in the public spending of country 1 due to the increase in the level of corruption more than compensates for the decrease in the inflation rate and the increase in output rate. In this case, we have that country 1 is worse off with an increase in the level of corruption, but country 2 is better off.

To sum up, the following figure illustrates the effects of corruption on losses in both countries in equilibrium:

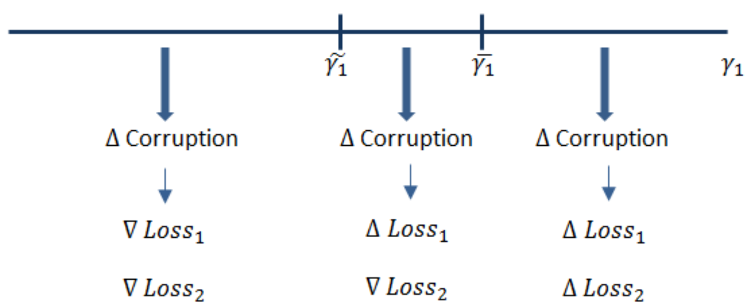

Figure 3.2: Relationship between corruption and losses in equilibrium.

As indicated in Fig. 3.2, when the losses in country 2 increase in the level of corruption and this holds when $\gamma_1 > \bar{\gamma}_1$, the losses in country 1 also increase. However, when $\gamma_1 < \bar{\gamma}_1$, the losses in country 2 decrease as the level of corruption increases. In this range, corruption may increase or decrease the losses in country 1. Therefore, we can see that there are more cases where corruption damages country 1 but benefits country 2.

Note that, we can analyse how $\bar{\gamma}_1$ may increase. This implies having fewer cases in which both countries are worse off with an increase in the level of corruption.

Remark. *Notice that* $\bar{\gamma}_1$ *increases if:*

a) the degree of corruption increases,

b) the fiscal authority of country 1 is strongly concerned about its output,

c) the public spending target of country 1 decreases, or

d) the output target of country 1 increases.

Roughly speaking, if one of the previous conditions is satisfied, the government of country 1 is more interested in output. This makes it more likely that country 1 decreases its tax rate when the level of corruption increases and, consequently, the inflation rate decreases. This means that $\bar{\gamma}_1$ becomes higher.

3.1.1. Negative Externality and Compensation

The previous analysis suggests that country 2 may be negatively affected by corruption in country 1. To determine under which conditions corruption causes a harmful effect on country 2, we study when the difference between the losses in country 2 under corruption and without corruption is positive, i.e., $L_2^*(\phi) - L_2^*(1) > 0$.[7] Combining the expression of the losses in country 2 and Corollary 3, it follows that

$$L_2^*(\phi) - L_2^*(1) = \frac{1}{2}\left[\left(\pi^*\left(\phi\right)\right)^2 - \left(\pi^*\left(1\right)\right)^2\right].$$

Hence, $L_2^*(\phi) - L_2^*(1) > 0$ if and only $\pi^*\left(\phi\right) > \pi^*\left(1\right).$ Using (2.9), it follows that corruption in country 1 generates a negative externality in country 2 if and only if $\gamma_1 > \delta_1 \frac{(1+\phi)\bar{x}_1 + \bar{g}_1}{\phi \bar{g}_1}$. In what follows, we assume that this inequality holds.[8] In such a case, it could be interesting to analyse how country 1 might compensate country 2 for the increase in its losses. Notice that, for achieving this goal, policies that reduce inflation would be effective. By virtue of (2.9), one could conclude that the implementation of some austerity measures could compensate country 2 for corruption. One easy way to model such measures would be to require a reduction in the public spending target of country 1.[9] In this new framework, the fiscal authority of country 1 selects the tax rate that minimises the losses of country 2, assuming that now the public spending target is the required level of public spending target of country 1, denoted by $\bar{g}_1^R$. The following corollary explicitly characterises the value of $\bar{g}_1^R$ that fully compensates country 2 for corruption:

Corollary 5. *Country 2 is fully compensated for the negative externality caused by country 1 (corruption) if* $\bar{g}_1^R = \bar{g}_1 - \Psi$, where $\Psi = (1-\phi)\,\frac{\gamma_1 - \delta_1 \frac{(1+\phi)\bar{x}_1 + \bar{g}_1}{\phi \bar{g}_1}}{\delta_1 + \gamma_1}\bar{g}_1.$

[7] $L_2^*(\phi)$ denotes the optimal losses of country 2 as a function of the degree of corruption, ϕ. In particular, $L_2^*(1)$ means the optimal losses of country 2 without corruption.

[8] As a possible extension, one might study corruption as a positive externality.

[9] A similar analysis could be performed assuming a reduction in the relative weight associated to public spending of country 1.

Notice that the expression of the reduction in the public spending target of country 1, denoted by Ψ, suggests that when there is no corruption (i.e., $\phi = 1$) or when the negative externality vanishes (i.e., $\gamma_1 = \delta_1 \frac{(1+\phi)\bar{x}_1 + \bar{g}_1}{\phi \bar{g}_1}$), this reduction is null.

Next, we wonder whether the present austerity measure harms or benefits country 1. To answer this question, we study the optimal losses of country 1 as a function of the reduction in its public spending target, denoted by $L_1^*(\Psi)$. Direct computations yield that

$$\begin{aligned} L_1^*(\Psi) = \; & \frac{1}{2}\Bigg(\Bigg(z\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}(\phi\bar{x}_1+\bar{g}_1-\Psi) \\ & +(1-z)\frac{\delta_{CCB}}{1+\frac{\delta_2}{\gamma_2}}(\bar{x}_2+\bar{g}_2)\Bigg)^2 \\ & +\delta_1\left(\frac{\frac{\delta_1}{\gamma_1}\bar{x}_1-\phi(\bar{g}_1-\Psi)}{\phi^2+\frac{\delta_1}{\gamma_1}}-\bar{x}_1\right)^2 \\ & +\gamma_1\left(\phi\frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1+\phi(\bar{g}_1-\Psi)}{\phi^2+\frac{\delta_1}{\gamma_1}}-\bar{g}_1\right)^2\Bigg) \text{ and} \end{aligned} \tag{3.1}$$

where $L_1^*(\Psi)$ indicates that country 1 is forced to have its required public spending target.

Comparing the Expressions $L_1^*(\Psi)$ and $L_1^*(0)$, we can see that the inflation rate and the output deviation decrease in Ψ, while the public spending deviation increases in Ψ. Thus, we can conclude that this austerity measure, if adopted, will negatively affect country 1 provided that this country is sufficiently concerned about the stabilisation of public spending (i.e., γ_1 is high enough). This result is formalised in the following corollary:

Corollary 6. *If the fiscal authority of country 1 is little concerned about public spending stabilisation ($\gamma_1 < \widehat{\gamma_1}$), country 1 is better off with the required public spending target. By contrast, if the fiscal authority of country 1 gives much relative weight to public spending stabilisation ($\gamma_1 > \widehat{\gamma_1}$), this country is worse off with such a measure.*[10]

Assuming that $\gamma_1 > \widehat{\gamma_1}$, it is interesting to study under which conditions country 1 will accept the austerity measure and remain in the monetary union and under which conditions country 1 prefers to exit the monetary union. To perform this analysis, we assume that in case of leaving the monetary union the new central bank has similar preferences to the initial common central bank. After some algebra, we have that, if country 1 decides to leave the monetary union, its loss is given by:

[10] $\widehat{\gamma_1}$ is implicitly determined in the Appendix.

$$
\begin{aligned}
L_1^{NM*} \quad = \quad & \frac{1}{2}\left(\left(\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1+\bar{g}_1\right)\right)^2\right. \\
& \left. +\delta_1\left(\frac{\frac{\delta_1}{\gamma_1}\bar{x}_1-\phi\bar{g}_1}{\phi^2+\frac{\delta_1}{\gamma_1}}-\bar{x}_1\right)^2+\gamma_1\left(\phi\frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1+\phi\bar{g}_1}{\phi^2+\frac{\delta_1}{\gamma_1}}-\bar{g}_1\right)^2\right),
\end{aligned} \tag{3.2}
$$

where the superscript NM refers to the fact that country 1 does not remain in the monetary union.

Therefore, notice that country 1 has incentives to leave the monetary union if and only if $L_1^*(\Psi) > L_1^{NM*}$. From Expressions (3.1) and (3.2), it follows that inflation is lower if country 1 remains in the union provided that $\frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}}$ is low enough $\left(\text{i.e., } \frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}} < \frac{\phi}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1+\bar{g}_1+\frac{z}{1-z}\Psi\right)\right)$, the output deviation is lower if country 1 remains in the union, while the public spending deviation is lower if country 1 leaves the union. This leads us to the following conclusion:

Corollary 7. *Country 1 benefits from leaving the monetary union if country 1 is very concerned about stabilising its public spending (i.e., γ_1 is high enough). However, the opposite result holds whenever inflation is lower if country 1 remains in the monetary union and country 1 appreciates a lot this fact (i.e., γ_1 and $\frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}}$ are low enough).*

3.1.2. The Greek Case

In the last years, news about the Greek crisis have drawn attention around the world. Being aware that our model does not capture all that is happening in Greece (such as debt, international trade, alternating right and left parties in office, among others), our results may make an interesting comparison with the current situation in Greece. Notice that, according to the 2014 Corruption Perception Index drawn up by Transparency International, Greece is the most corrupt country in the European Monetary Union. Further, the Troika (the European Central Bank, the European Commission and the International Monetary Fund) has recommended the implementation of fiscal consolidation measures for Greece in order to receive a third bailout.[11] One of these measures includes a cut in its public spending.

There are two opposing opinions on the introduction of this measure. Paul Krugman and Joseph E. Stiglitz recommend to reject these measures and leave the Eurozone, while Christopher Pissarides and several Economics professors at Universities in Greece agree with these measures and with the position of remaining in the union. According to our model, a cut in public spending could be interpreted as a lower public spending target (see Table 2.1).

[11] According to the 2014 Corruption Perception Index drawn up by Transparency International, Greece is the most corrupt country in the European Monetary Union.

Thus, Corollary 6 suggests that if Greece is little concerned about public spending stabilisation, this country would be better off with a reduction in its public spending target. By contrast, if Greece gives much relative weight to its public spending stabilisation, Greece is worse off with its required target. In this last case, it would be interesting to study if Greece has incentives to leave the monetary union and, from our study, Corollary 7 provides the following intuitions. If (i) Greece gives little relative weight to its public spending stabilisation, (ii) the output and public spending targets of other countries of the EMU are low, and (iii) these countries are very concerned about output stabilisation (or not very concerned about public spending stabilisation), the optimal decision for Greece would be to remain in the union. Otherwise, if Greece is very concerned about stabilising its spending, 'Grexit' from the Eurozone would be the optimal decision and the reduction in public spending would not be implemented.

4. Conclusions

In this paper, we examine the effects of corruption in a monetary union with two countries. To do so, we extend the model of Hefeker (2010) to consider more asymmetry between countries, i.e., different preferences on the authorities' objectives and different output goals among countries. However, we focus on the effects of corruption on both countries. Additionally, we model a monetary policy game, where corruption negatively affects tax revenue (as in Huang and Wei, 2006) only in one country, and we obtain some interesting results.

First, we find that as the degree of corruption rises, the public spending of country 1 always decreases and its output and the inflation rate may increase or decrease, depending on how far the fiscal authority of country 1 is concerned about stabilising its public spending. Concretely, if the degree of corruption increases and the fiscal authority of country 1 gives much relative weight to public spending stabilisation, it raises the tax rate. The rise in the tax rate increases the incentives to inflate by the central bank. By contrast, the opposite result may hold if the fiscal authority of country 1 is little concerned about public spending stabilisation. However, the output and public spending of country 2 are not affected by changes in corruption.

Second, we show that losses in both countries also depend on the relative weight of public spending assigned by the fiscal authority of country 1. Specifically, if the fiscal authority of country 1 is not very concerned about public spending stabilisation, corruption favours both countries, whereas the reverse result may hold if the fiscal authority of country 1 gives much relative weight to public spending stabilisation.

Third, we argue that country 2 could impose a public spending target on country 1 in order to make country 2 indifferent about the externality from country 1. Additionally, if country 1 is forced to decrease its public spending goal, country 2 is always better off. However, country 1 may be worse off with this change if this country is very concerned about stabilising its public spending. The case of Greece is a good illustration of how a cut in public spending may affect a corrupt country. Greece, according to the Corruption Perception Index, was the most corrupt country in the European Monetary Union in 2014. This country has been required to implement fiscal consolidation measures in order to receive a third bailout. One of these measures consists in cutting its public spending. According to our model, a cut in public spending target favours Greece if the Greek government is relatively less interested in stabilising its public spending. However, if Greece gives much relative weight to its public spending stabilisation, Greece would be worse off and, in this case, '*Grexit*' might be a good decision. Concretely, if Greece is relatively very interested in stabilising its public spending, leaving the Eurozone may be an optimal decision.

Several extensions are left for future research. In order to illustrate the effect of corruption in one country on another country in a monetary union, we started supposing that there is only one country with a corrupted government. Once this analysis is made, an interesting extension would be to consider two corrupt countries. This analysis could also be extended to include seigniorage revenues as another source of financing for governments. Another extension would be to analyse the effects of corruption in a monetary union with a fiscal union.

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Appendix

Appendix A: Figure

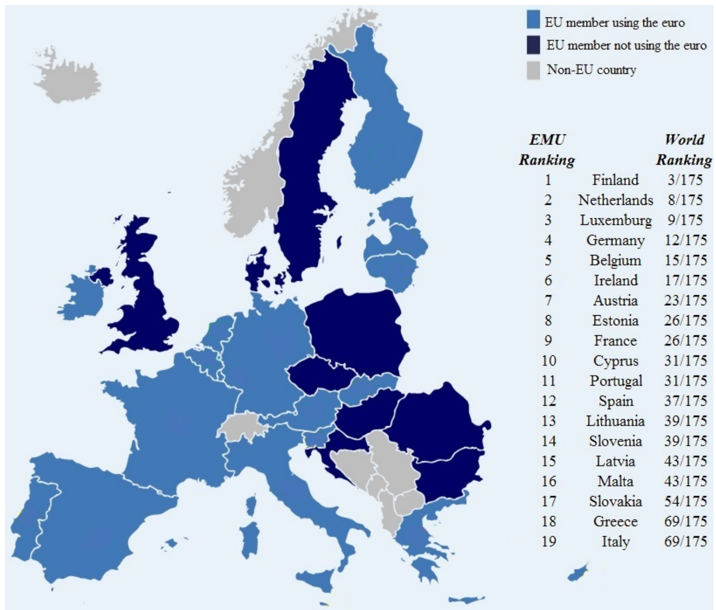

Figure 4.1: The Corruption Perception Index in the European Monetary Union.

Appendix B: Proofs

Proof of Proposition 1. Substituting (2.1), (2.2) and (2.3) into (2.4) and (2.5), it follows that

$$\begin{aligned} L_1 &= \frac{1}{2}\left[\pi^2 + \delta_1 (\pi - \pi^e - \tau_1 - \bar{x}_1)^2 + \gamma_1 (\phi\tau_1 - \bar{g}_1)^2\right] \\ L_2 &= \frac{1}{2}\left[\pi^2 + \delta_2 (\pi - \pi^e - \tau_2 - \bar{x}_2)^2 + \gamma_2 (\tau_2 - \bar{g}_2)^2\right] \text{ and} \end{aligned}$$

$$\begin{aligned} L_{CCB} &= \frac{1}{2}\Big[\pi^2 + \delta_{CCB} \big(z (\pi - \pi^e - \tau_1) \\ &\quad + (1-z)(\pi - \pi^e - \tau_2) - (z\bar{x}_1 + (1-z)\bar{x}_2)\big)^2\Big]. \end{aligned}$$

The first-order conditions of the fiscal authorities' optimisation problems are given by

$$\begin{aligned} \frac{\partial L_1}{\partial \tau_1} &= -\delta_1 (\pi - \pi^e - \tau_1 - \bar{x}_1) + \phi\gamma_1 (\phi\tau_1 - \bar{g}_1) = 0 \text{ and} \\ \frac{\partial L_2}{\partial \tau_2} &= -\delta_2 (\pi - \pi^e - \tau_2 - \bar{x}_2) + \gamma_2 (\tau_2 - \bar{g}_2) = 0. \end{aligned}$$

Hence,

$$\tau_1 = \frac{\bar{g}_1}{\phi} - \frac{\frac{\delta_1}{\gamma_1}}{\phi\left(\phi^2 + \frac{\delta_1}{\gamma_1}\right)}(\phi\bar{x}_1 + \bar{g}_1) + \frac{\frac{\delta_1}{\gamma_1}}{\phi^2 + \frac{\delta_1}{\gamma_1}}(\pi - \pi^e) \text{ and} \tag{4.1}$$

$$\tau_2 = \bar{g}_2 - \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}}(\bar{x}_2 + \bar{g}_2) + \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}}(\pi - \pi^e). \tag{4.2}$$

For the central bank, the first-order condition of its optimisation problem implies that

$$\begin{aligned} \frac{\partial L_{CCB}}{\partial \pi} &= \pi + \delta_{CCB} (z (\pi - \pi^e - \tau_1) + (1-z)(\pi - \pi^e - \tau_2) \\ -(z\bar{x}_1 + (1-z)\bar{x}_2)) &= 0. \end{aligned}$$

Thus,

$$\pi = \frac{\delta_{CCB}}{1 + \delta_{CCB}}(\pi^e + z(\tau_1 + \bar{x}_1) + (1-z)(\tau_2 + \bar{x}_2)). \tag{4.3}$$

Plugging (4.1) and (4.2) into (4.3), it follows that

$$\pi = \frac{z\frac{\phi^2}{\phi^2+\frac{\delta_1}{\gamma_1}} + (1-z)\frac{1}{1+\frac{\delta_2}{\gamma_2}}}{\Delta}\pi^e + z\frac{\phi}{\left(\phi^2+\frac{\delta_1}{\gamma_1}\right)\Delta}(\phi\bar{x}_1+\bar{g}_1) + (1-z)\frac{1}{\left(1+\frac{\delta_2}{\gamma_2}\right)\Delta}(\bar{x}_2+\bar{g}_2), \tag{4.4}$$

where $\Delta = \frac{1}{\delta_{CCB}} + z\frac{\phi^2}{\phi^2+\frac{\delta_1}{\gamma_1}} + (1-z)\frac{1}{1+\frac{\delta_2}{\gamma_2}}$.

Using rational expectation hypothesis, we know that $\pi = \pi^e$. Therefore, from (4.4), it follows that

$$\pi = z\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}(\phi\bar{x}_1+\bar{g}_1) + (1-z)\frac{\delta_{CCB}}{1+\frac{\delta_2}{\gamma_2}}(\bar{x}_2+\bar{g}_2). \tag{4.5}$$

Substituting (4.5) in (4.1) and (4.2), and after some algebra, we obtain (2.7) and (2.8). ■

Proof of Corollary 3. We differentiate the expressions for the output (2.10 and 2.11), public spending (2.12 and 2.13) and inflation (2.9) rates with respect to ϕ. Therefore, we obtain the following expressions:

$$\frac{\partial}{\partial\phi}x_1^* = -\frac{2\phi\frac{\delta_1}{\gamma_1}\bar{x}_1 + \left(\frac{\delta_1}{\gamma_1}-\phi^2\right)\bar{g}_1}{\left(\phi^2+\frac{\delta_1}{\gamma_1}\right)^2},$$

$$\frac{\partial}{\partial\phi}g_1^* = \frac{\delta_1}{\gamma_1}\frac{\left(\phi^2-\frac{\delta_1}{\gamma_1}\right)\bar{x}_1 + 2\phi\bar{g}_1}{\left(\phi^2+\frac{\delta_1}{\gamma_1}\right)^2},$$

$$\frac{\partial}{\partial\phi}\pi^* = z\delta_{CCB}\frac{2\phi\frac{\delta_1}{\gamma_1}\bar{x}_1 + \left(\frac{\delta_1}{\gamma_1}-\phi^2\right)\bar{g}_1}{\left(\phi^2+\frac{\delta_1}{\gamma_1}\right)^2}, \text{ and}$$

$$\frac{\partial}{\partial\phi}x_2^* = \frac{\partial}{\partial\phi}g_2^* = 0.$$

Hence, $\frac{\partial}{\partial\phi}x_1^* > 0$ and $\frac{\partial}{\partial\phi}\pi^* < 0$ if and only if $\gamma_1 > \bar{\gamma}_1$, where the expression of $\bar{\gamma}_1$ is given in the statement of this corollary. Finally, taking into account the assumption that $\frac{\bar{x}_1}{\bar{g}_1} < \frac{\phi\gamma_1}{\delta_1}$, we can conclude that $\frac{\partial}{\partial\phi}g_1^* > 0$. ■

Proof of Corollary 4. a) Substituting the Expressions (2.9), (2.10) and (2.12) into (2.4) for country 1 and deriving the resulting expression with respect to ϕ, we have

$$\frac{\partial L_1^*}{\partial \phi} = \gamma_1 \frac{p(\gamma_1)}{\left(\delta_1 + \phi^2 \gamma_1\right)^3 \left(\frac{\delta_2}{\gamma_2} + 1\right)},$$

where

$p(\gamma_1) = p_2 \gamma_1^2 + p_1 \gamma_1 + p_0$, with

$p_2 = -\left(z\,(1-z)\,\phi^4 \delta_{CCB}^2 \bar{g}_1\,(\bar{x}_2 + \bar{g}_2) + \phi^3\left(z^2 \delta_{CCB}^2 + \delta_1\right)\left(1 + \frac{\delta_2}{\gamma_2}\right)(\phi \bar{x}_1 + \bar{g}_1)\,\bar{g}_1\right),$

$p_1 = 2z\,(1-z)\,\phi^3 \delta_1 \delta_{CCB}^2 \bar{x}_1\,(\bar{x}_2 + \bar{g}_2)$

$+\phi \delta_1 \left(\delta_1\,(\phi \bar{x}_1 - \bar{g}_1) + z^2 \delta_{CCB}^2\,(2\phi \bar{x}_1 + \bar{g}_1)\right)\left(1 + \frac{\delta_2}{\gamma_2}\right)(\phi \bar{x}_1 + \bar{g}_1)$ and

$p_0 = z\,(1-z)\,\delta_1^2 \delta_{CCB}^2\,(2\phi \bar{x}_1 + \bar{g}_1)\,(\bar{x}_2 + \bar{g}_2) + \delta_1^3\left(1 + \frac{\delta_2}{\gamma_2}\right)(\phi \bar{x}_1 + \bar{g}_1)\,\bar{x}_1.$

Notice that $p_2 < 0$ and $p_0 > 0$. This allows us to guarantee that there exists a unique positive root of the polynomial $p(\gamma_1)$, denoted by $\tilde{\gamma}_1$. Hence, we can conclude that $\frac{\partial L_1^*}{\partial \phi} < 0$ if and only if $\gamma_1 > \tilde{\gamma}_1$. Moreover, in order to show that

$$\bar{\gamma}_1 > \tilde{\gamma}_1 \tag{4.6}$$

it suffices to prove that $p(\bar{\gamma}_1) < 0$. Direct computations yield

$$p(\bar{\gamma}_1) = -2\delta_1^3 \frac{1 + \alpha_2}{\phi \bar{g}_1}\,(\phi \bar{x}_1 + \bar{g}_1)^3 < 0 \text{ and,}$$

hence, (4.6) is satisfied.

b) Taking into account that the output and public spending of country 2 are not affected by the level of corruption of country 1, we have that $\frac{\partial L_2^*}{\partial \phi} = \pi^* \frac{\partial \pi^*}{\partial \phi}$. Combining the positiveness of π^* and Corollary 3, it follows that $\frac{\partial L_2^*}{\partial \phi} < 0$ if and only if $\gamma_1 > \bar{\gamma}_1$. ■

Proof of Corollary 5. To study how can country 1 compensate country 2 for its negative externality (corruption), we will take into account the Expression (2.4) for country 2. Therefore, in equilibrium

$$\begin{aligned} L_2^* \;=\; & \frac{1}{2}\left(\left(z \frac{\phi \delta_{CCB}}{\phi^2 + \frac{\delta_1}{\gamma_1}}\,(\phi \bar{x}_1 + \bar{g}_1) + (1-z)\,\frac{\delta_{CCB}}{1 + \frac{\delta_2}{\gamma_2}}\,(\bar{x}_2 + \bar{g}_2)\right)^2\right. \\ & \left. + \delta_2 \left(\frac{\frac{\delta_2}{\gamma_2}\bar{x}_2 - \bar{g}_2}{1 + \frac{\delta_2}{\gamma_2}} - \bar{x}_2\right)^2 + \gamma_2 \left(\frac{-\frac{\delta_2}{\gamma_2}\bar{x}_2 + \bar{g}_2}{1 + \frac{\delta_2}{\gamma_2}} - \bar{g}_2\right)^2\right). \end{aligned} \tag{4.7}$$

Note that country 2 has the same losses whether there is corruption or not if $L_2^*(\phi) - L_2^*(1) = 0$, this is equivalent to

$$\frac{1}{2}\left(\pi^*\left(\phi\right)\right)^2 - \frac{1}{2}\left(\pi^*\left(1\right)\right)^2 = 0.$$

Hence, the value of $\bar{g}_1^R$ that satisfies the previous expression is given by

$$\bar{g}_1^R = \bar{g}_1 - \Psi,$$

where the expression of Ψ is given in the statement of this corollary. ■

Proof of Corollary 6. Using the expression of Ψ, we get that

$$L_1^*\left(\Psi\right) - L_1^*\left(0\right) = \frac{\phi\gamma_1\Psi}{2\left(\delta_1+\gamma_1\right)\left(\delta_1+\phi^2\gamma_1\right)^2\left(\delta_2+\gamma_2\right)}l(\gamma_1),$$

where

$$\begin{aligned}
&l(\gamma_1) = \left(1-\phi\right)\phi^3\left(\delta_2+\gamma_2\right)\bar{g}_1\gamma_1^3\\
&+\phi\left(\left(\left(1-\phi\right)^2\delta_1\bar{g}_1 - \left(1+\phi\right)z^2\delta_{CCB}^2\bar{g}_1 - \left(\left(1-\phi^2\right)\delta_1 + 2z^2\delta_{CCB}^2\right)\phi\bar{x}_1\right)\left(\delta_2+\gamma_2\right)\right.\\
&\quad\left.-2\phi z\left(1-z\right)\gamma_2\delta_{CCB}^2\left(\bar{x}_2+\bar{g}_2\right)\right)\gamma_1^2\\
&-\delta_1\left(\left(\left(1-\phi\right)\left(\left(1+\phi\right)\bar{x}_1+\bar{g}_1\right)\delta_1 + z^2\delta_{CCB}^2\left(\left(1+\phi^2\right)\bar{x}_1 + \left(1+\phi\right)\bar{g}_1\right)\right)\left(\delta_2+\gamma_2\right)\right.\\
&\quad\left.+2\left(1+\phi^2\right)z\left(1-z\right)\gamma_2\delta_{CCB}^2\left(\bar{x}_2+\bar{g}_2\right)\right)\gamma_1\\
&-2z\left(1-z\right)\delta_1^2\gamma_2\delta_{CCB}^2\left(\bar{x}_2+\bar{g}_2\right).
\end{aligned}$$

Note that

$$l\left(\delta_1\frac{\left(1+\phi\right)\bar{x}_1+\bar{g}_1}{\phi\bar{g}_1}\right) < 0 \text{ and}$$
$$\lim_{\gamma_1\to\infty} l(\gamma_1) > 0.$$

Moreover, applying the Descartes' rule, we can conclude that there exists a unique value of γ_1, denoted by $\widehat{\gamma_1}$, that satisfies $L_1^*\left(\Psi\right) - L_1^*\left(0\right) = 0$. Moreover, we know that $\widehat{\gamma_1} \in \left(\delta_1\frac{(1+\phi)\bar{x}_1+\bar{g}_1}{\phi\bar{g}_1}, \infty\right)$. Therefore, if $\gamma_1 < \widehat{\gamma_1}$, country 1 is better off with its required public spending target. Otherwise, if $\gamma_1 > \widehat{\gamma_1}$, country 1 is worse off with its required target. ■

Proof of Corollary 7. Using the expression of Ψ, it follows that the inequality $L_1^*(\Psi) > L_1^{NM*}$ is equivalent to

$$\frac{\phi^2(1-\phi)^2\gamma_1^2\bar{g}_1^2}{\left(\delta_1+\phi^2\gamma_1\right)(\delta_1+\gamma_1)^2}\left(\gamma_1-\delta_1\frac{(1+\phi)\bar{x}_1+\bar{g}_1}{\phi\bar{g}_1}\right)^2 >$$
$$\frac{\phi^2\delta_{CCB}^2}{\left(\phi^2+\frac{\delta_1}{\gamma_1}\right)^2}\left(\phi\bar{x}_1+\bar{g}_1\right)^2-\left(z\frac{\delta_{CCB}}{1+\frac{\delta_1}{\gamma_1}}\left(\bar{x}_1+\bar{g}_1\right)+(1-z)\,\delta_{CCB}\frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}}\right)^2.$$

Note that if γ_1 is high enough the previous inequality is satisfied and, consequently, in this case country 1 prefers to leave the monetary union. By contrast, if $\gamma_1 = \widehat{\gamma_1}$, then $L_1^*(\Psi) = L_1^*(0)$. It is easy to see that this value is lower than L_1^{NM*} whenever $\frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}} < \frac{\phi}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1+\bar{g}_1\right)$. ■

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