Ph.D. Dissertation

UNIVERSITAT ROVIRA I VIRGILI

Judit Garcia Fortuny

Essays on Corruption, Seigniorage and Economic Policies

Universitat Rovira i Virgili

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Dipòsit Legal: T 1678-2015

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Supervised by Dra. Montserrat Ferré and Dra. Carolina Manzano

Department of Economics

Grup de Recerca en Organització i Decisió Econòmiques

UNIVERSITAT ROVIRA I VIRGILI

Reus 2015

A la meva família

UNIVERSITAT
ROVIRA I VIRGILI
DEPARTAMENT D'ECONOMIA

Avinguda de la Universitat, 1 • 43204 REUS
Tel. 977 759 811 - Fax 977 300 661 / 977 758 907
E-mail: sde@urv.cat

We STATE that the present study, entitled "Essays on Corruption, Seigniorage and Economic Policies", presented by Judit Garcia Fortuny for the award of the degree of Doctor of Philosophy in Economics, has been carried out under our supervision at the Department of Economics of this university.

Reus, 1st September 2015

Doctoral Thesis Supervisors

Dra. Montserrat Ferré Carracedo   Dra. Carolina Manzano Tovar

Acknowledgments

It has been a pleasure and a privilege to be a student of Prof. Montserrat Ferré and Prof. Carolina Manzano. I have enormously enjoyed the intellectual exchange and the depth of learning from their knowledge, vision and values. I would like to thank them for their time and patience they have devoted to my academic development. I thank Montserrat for her advice and readiness even when she was away. I also thank Carolina for her great support and for giving me advice as a psychologist. I will be forever grateful for continuously pushing me in the correct direction and teaching me to do a good research. I wish to continue learning from them in the future.

This thesis probably would not have been possible if Prof. Antonio Quesada had not informed about the Research Master of Industrial Organisation in his lessons of "Microeconomia Superior". Moreover, I would like to thank him for many interdisciplinary conversations and for reading my documents. I have benefitted from his creative suggestions.

I would also like to thank all members of the Economics Department for many useful discussions at the seminars and at the GRODE's meetings. I am proud for been a student of the Economics Department for its nice and friendly atmosphere. I would also like to thank the administrative staff for helping me with all the procedures.

I gratefully acknowledge the funding provided by Universitat Rovira i Virgili to pursue this Ph.D. I would like to acknowledge the financial support from CREIP, project ECO2013-42884-P and project 2014 SGR 631.

A special thanks goes to my colleagues of my office from whom I have had many stimulating conversations. I would also like to thank my GRODE's colleague: Dr. Sebastian Cano.

This thesis would not be the same without the companionship of my personal friends, in particular: Mònica and Jessica.

Finally, I would especially like to thank my family. Gràcies papes, *Mama* i *Papa*, per haver-me donat la oportunitat, la llibertat i el suport necessari per haver estudiat durant les diferents fases de la meva vida. Espero que estigueu orgullosos del resultat d'aquesta tesi. Gràcies germans, *Verònica* i *Oriol*, per haver estat sempre al meu costat en qualsevol circumstància. Gràcies cunyat, *Juli*, perquè des de que tinc vuit anys t'has convertit com un germà per mi. Gràcies nebot i fillol, *Jan*, per mostrar interès pel que feia la teva padrina, "escriure en xinès". Gràcies *Tiet Pep* per sempre estar atent en les notícies de premsa relacionades amb la meva tesi. En memòria dels meus avis, gràcies *àvia Maria*, *yaya Carmen*, *yayo Tomás* i *avi Domènech*, els quals d'alguna manera han influenciat sobre la meva personalitat. Gràcies, en memòria també, al meu gat *Kuki* el qual sempre estava al meu costat quan estudiava. *And last but not least*, gràcies *Eloi* per donar-me suport i ànims, aguantar els meus alts i baixos, escoltar els assajos de les meves presentacions en anglès i per la paciència en aquesta recta final.

September, 2015 *Judit G. F.*

Contents

Abstract

This thesis examines theoretically the impact of corruption and/or seigniorage on some of the main macroeconomic variables (such as output, public spending and inflation rates) and on central bank conservativeness. This thesis is divided into four chapters.

Chapter 1 is devoted to introduce the issues discussed in this thesis, to do a review of the literature and to present the principal findings of the following chapters.

In the second chapter, I analyse how corruption and seigniorage affect output and inflation rates, in contexts where there are a government and an independent central bank. I find under which conditions corruption has a positive (negative) impact on output and inflation rates. I also show under which conditions the inflation rate increases (decreases) as the degree of seigniorage increases. Finally, I obtain that seigniorage always has a positive effect on output.

In the third chapter, I analyse how conservative should an independent central bank be in an economy with corruption and seigniorage. I propose a new indicator of the degree of conservativeness of an independent central bank and then I characterise its optimal value. I show that, when the government's preferences represent those of the society, the central bank has to be more conservative than the government, except with complete corruption. In this particular case, the central bank

should be as conservative as the government. Further, I obtain that the relationship between corruption and the optimal relative degree of conservativeness of the central bank is affected by the volatility of supply shocks. Finally, I find that if seigniorage decreases, the central bank should be more conservative.

In the fourth chapter, I explore the effects of corruption in a monetary union with a common central bank and two asymmetric countries. Country 1 has a corrupt government while country 2 does not. Within this framework, I determine under which conditions corruption affects output, public spending and inflation rates and I obtain that it depends on how far the government of country 1 is concerned about stabilising its public spending. I also determine under which conditions corruption in country 1 generates a negative effect on country 2. In such a case, I investigate how country 1 could compensate country 2 for the negative externality.

Finally, concluding remarks and several extensions for future research are presented in Chapter 5.

List of Figures

List of Tables

Glossary

x	output
x_i	output in country i
π	inflation rate
π^e	expected inflation rate
τ	tax rate
τ_i	tax rate in country i
ε	a supply shock
g	public spending rate
g_i	public spending rate in country i
ϕ	the degree of corruption
k	the degree of seigniorage
L_G	the government's loss function
L_i	the government's loss function in country i
L_{CB}	the central bank's loss function
L_{CCB}	the common central bank's loss function
L_S	the society's loss function
δ_G	the weight of output objective relative to the weight on inflation for the government
δ_i	the weight of output objective relative to the weight on inflation for the government of country i

δ_{CB}	the weight of output objective relative to the weight on inflation for the central bank
δ_{CCB}	the weight of output objective relative to the weight on inflation for the common central bank
δ_S	the weight of output objective relative to the weight on inflation for the society
γ_G	the weight of public spending objective relative to the weight on inflation for the government
γ_i	the weight of public spending objective relative to the weight on inflation for the government of country i
γ_{CB}	the weight of public spending objective relative to the weight on inflation for the central bank
γ_S	the weight of public spending objective relative to the weight on inflation for the society
α_G	$\frac{\delta_G}{\gamma_G}$
$\bar{x}_i$	the output target in country i
$\bar{g}$	public spending target
$\bar{g}_i$	the public spending target in country i
z	the relative share for country 1 in the monetary union
L_t	labour in period t
P_t	price level in period t
W_t	nominal wage in period t
λ	output elasticity
X_t	real output in period t
w^*	target real wage
G_t	public spending in period t
M_t	nominal money supply in period t
$\bar{X}$	output level

Chapter 1

Introduction

1.1 Motivation

Corruption is capturing a lot of attention around the world. In May 2015 US prosecutors disclosed cases of corruption by FIFA (Fédération Internationale de Football Association) officials and associates. In July 2015, Romanian prosecutors indicted the prime minister as part of a corruption investigation. At the same time, thousands of protesters marched in Guatemala City demanding the resignation of the country's corruption-plagued president. Thus, corruption is a particular feature prevalent in many economies whose pervasiveness reaches many spheres, both in developed and developing countries. According to the corruption perception index from Transparency International, in 2014, the global average score was 43 and the European Monetary Union average score was 66.[1]

The concept of seigniorage refers to the difference between the face value of a note or coin and its costs of production and mintage (Buiter, 2007). Developing countries tend to have more inefficient institutions than developed countries. Therefore, developing countries rely more on getting finance through seigniorage revenues and less through tax revenues. Gros (2004) exposes that seigniorage represents less than one-half of 1 per cent of government revenues for the Euro Area. This author points out that low independence of the central bank, high seigniorage and high regime instability are likely to appear together. Vergote et al.

[1] On a scale from 0 (highly corrupt) to 100 (very clean).

(2010) show that seigniorage income is a reliable income in the long run for the European Central Bank and its distribution to all the Member States of the Eurozone depends on their relative weight on GDP in the Euro Area. Sotiropoulos et al. (2014) discuss the sovereign debt in the Euro Area. They present several alternative scenarios to suspend the debt burden for five years and they estimate that if the average of the Euro Area is stabilised above the level of interest rates, in the very long run the losses of the European Central Bank could be compensated by seigniorage profits.

The aim of this thesis is to study the impact of corruption and seigniorage on fiscal and monetary instruments and on central bank conservativeness. Fiscal and monetary policies constitute the main concerns in macroeconomic theory since they are the primary macroeconomic instruments on the control of the authorities. An understanding of these issues is crucial for the design of more efficient and effective economic policies.

A crucial assumption that I make in this thesis is a connection between the fiscal capacity of the governments and its quality. Specifically, weak institutions cause a leakage of the tax revenue and I focus on corruption as the main reason for tax leakage. I develop corruption as in Huang and Wei (2006). Specifically, the private sector pays taxes, but only a proportion of this amount is used to finance public spending. Thus, when there is complete corruption, tax revenues are "eaten up". Moreover, I model seigniorage as in Beetsma and Bovenberg (1998) and Hefeker (2010), the revenue from inflation that it is transferred from the central bank to public spending of each government.

1.2 Literature Review

1.2.1 Corruption

Corruption is a debatable topic not only for the press but also for academic researchers. One of the difficulties of studying this topic lies in defining corruption. Since it is not easy to agree with a precise definition, I follow Jain (2001) who refers corruption as acts in which the power of public office is used for personal gain.

To the best of my knowledge, causes and consequences of corruption have been discussed since the 1960s. In this thesis, I focus only on consequences of corruption. Beginning with Leff (1964) and Huntington (1968), some authors have exposed that corruption may benefit economic growth. The main reasons are as follows: (i) corrupt practices such as "speed money" may help in reducing bureaucratic delay, and (ii) government employees who receive bribes may work harder. By contrast, Shleifer and Vishny (1993) argue that corruption tends to lower economic growth. In this line, Mauro (1995) finds a negative association between corruption and investment and hence, corruption is detrimental to economic growth. Tanzi and Davoodi (1997) and Mauro (1997) indicate that corruption causes misallocations of public expenditures.

In the last decade, some papers have explored the effects of corruption in frameworks where there are interactions between fiscal and monetary policies (Huang and Wei, 2006; Hefeker, 2010; Faure, 2011; Dimakou, 2013; among others). In what follows, I summarise their main results.

The first study in my overview is Huang and Wei (2006). These authors examine the consequence of weak public governance (e.g., corruption) on the design of monetary policy with complete seigniorage revenues. They find that developing countries with lower institutional quality should have less conservative central bankers.

Hefeker (2010) is interested in the connection between institutional quality, the fiscal system and the choice of the exchange rate regime in diverse frameworks: a monetary autonomy, a hard peg and a full monetary union with two countries. In contrast to Huang and Wei (2006), Hefeker (2010) allows for different degrees of seigniorage and the government sets the institutional quality. He obtains that when a monetary autonomy moves to a full monetary union, the level of corruption can increase or decrease. This result depends mainly on the choice of partner countries for the monetary union. Hefeker (2010) also shows that a credibly fixed exchange rate to a low inflation country may reduce the degree of corruption.

Faure (2011) investigates the consequences of institutional deficiencies regarding public debt on welfare. He considers an extension of the Huang and Wei's (2006) framework since Faure (2011) assumes that the government benefits from complete seigniorage revenues, taxes and newly issued debt. Besides, the government controls the tax and inflation rates. He finds that corruption can make a country better off if the government is more worried about output than inflation stabilisation.

Dimakou (2013) explores the interactions among the decisions of delegating monetary policy to more conservative central bank and combating bureaucratic corruption. She finds that these decisions are strategic complementarities and she identifies a set of structural determinants that affect the decisions of the government to enhance economic institutions.

1.2.2 Seigniorage

Regarding the seigniorage's literature, one of the first studies on the revenue from inflation is Friedman (1971). He argues that a government monopoly of fiat money issue can not produce at zero cost because there are two different relevant prices to issue money: the goods and services that are given up to get a dollar and the number of cents per dollar that the money holder needs to keep his real balances constant (per year).

Seigniorage revenue has been a source of government finance for most of the countries. In modern fiat money economies, the central banks have the power to print money. The importance of seigniorage revenue as another source of government revenue differs across countries. Cukierman et al. (1992) show empirically that countries with a more unstable and polarised political system have more inefficient tax structures and, hence, they rely more on seigniorage. Furthermore, they suggest that high seigniorage, low independence of central bank and high regime instability are likely to appear together. Gros (2004) states that poorer member states in the European Union are benefited by the distribution of seigniorage because its share in the monetary income of the European Central Bank is calculated on population shares instead of the GDP per capita. Leen (2011) studies if seigniorage can be a solution to the reform of the EU budget. He concludes that seigniorage is as a financial transaction tax and an European Union VAT.

There are few studies that focus on the effects of seigniorage on fiscal and monetary instruments. Huang and Wei (2006) show that, under commitment, a Laffer curve effect on seigniorage revenue can lower the inflation rate and raise the tax rate. Hefeker (2010) finds that the tax rate is falling in an increase in the degree of seigniorage. Thus, seigniorage may have positive output effects. Myles and Yousefi (2015) explore if the correlation between the level of corruption and the rate of inflation can be a consequence of a government exploiting seigniorage as a compensation for revenue lost because of corruption. They provide that a rational policy response to the existence of corruption may be the cause of excessive inflation.

There is one paper, Beetsma and Bovenberg (1998), which includes seigniorage in a model of a monetary union. They analyse the social welfare of a monetary union in two types of arrangements: making the common central bank more conservative and imposing an inflation target. They find that an optimally designed conservative common central bank is typically preferred to an optimal inflation target. They demonstrate that monetary unification reduces inflation, taxes and public spending with benevolent policymakers and fiscal leadership. Besides, if the number of participants in the union increases, these disciplining effects become stronger and they are likely to raise social welfare. They also conclude that fiscal coordination is prejudicial to social welfare if money holdings are low and social benefits from seigniorage are small.

1.3 Contribution to the Literature

The contribution of this thesis to the literature is explained specifically in the following paragraphs.

In the second chapter, I examine the effects of corruption and seigniorage on the output growth and inflation rates assuming that there are a government and a central bank. This chapter builds on the static Alesina and Tabellini (1987) and Huang and Wei (2006) frameworks allowing for different degrees of seigniorage. Alesina and Tabellini (1987) analyse the effects of different degrees of independence of the central bank and if the coordination between monetary and fiscal policies are welfare improving. I depart from Alesina and Tabellini (1987) since in my study tax revenues are affected by institutional quality. Although Huang and Wei (2006) focus on studying the implications of weak public institutions for the design of monetary policymaking institutions, they also compare how corruption affects tax and inflation rates between commitment and discretion cases. I extend Huang and Wei's framework allowing more diversity in the policymakers' preferences (i.e., the government and central bank) and different degrees of seigniorage. Further, I do a review of the literature about corruption, output growth and inflation rates, I contrast my results with the literature and I give intuitions about my findings.

The third chapter contains joint work with Montserrat Ferré and Carolina Manzano. We bring together the literatures on central bank conservativeness, seigniorage and corruption considering also one government and one central bank. Therefore, we analyse how conservative should an independent central bank be in an economy with corruption and seigniorage. We introduce a new indicator of the conservativeness of the central bank that will depend on the relative importance attributed to output and public spending stabilisation with respect to inflation, as well as on the level of corruption and seigniorage. Our model departs from Huang and Wei (2006) and Dimakou (2013) in four important ways. First, we include shocks. Second, we allow the authorities to have different relative interest in output over spending stabilisation. Third, we allow for different degrees of seigniorage. Fourth, we propose an indicator of the degree of conservativeness.

In the fourth chapter, I study how corruption affects monetary and fiscal policy interactions in a monetary union with two countries. There are some works that analyse the interaction of monetary and fiscal policies and my work is related to three of them. Hefeker (2010) models corruption as an endogenous variable in a framework with a monetary union. My chapter differs from him in many respects, but most notably in three: (i) I allow for more asymmetries between countries since in my framework, all the authorities have different preferences on the authorities' objectives, different output target levels between countries and there is only one country with a corrupt government, (ii) my purpose is to analyse the effects of corruption on both countries, and (iii) I assume corruption as a share of tax revenue, as in Huang and Wei (2006).[2] My work is also related to Dixit and Lambertini (2001) and Beetsma and Giuliodori (2010), who look at monetary unions with asymmetric countries since targets and preferences between countries may differ. Dixit and Lambertini (2001) analyse the interaction of monetary and fiscal policies in a monetary union and Beetsma and Giuliodori (2010) investigate the macroeconomic costs and benefits of monetary unification, e.g., how conflicts between the fiscal authorities and the European Central Bank about the macroeconomic objectives may produce a race among policymakers. In their analysis, they do not consider corruption and the fiscal authorities are only concerned about inflation and output stabilisation. Hence, my chapter differs from them in two aspects: (i) I include corruption, and (ii) I assume that fiscal authorities are concerned about public spending stabilisation. To sum up, according to different studies in this literature, I propose to analyse the effect of corruption in a new setup.

1.4 Relationship between Chapters

There are two underlying themes which connect the frameworks of the chapters of this thesis. The first is corruption. In the following chapters, it is assumed that the quality of institutions is poor, in the sense that governments are inefficient collecting taxes. Therefore, in all three chapters there is corruption. However, it is important to point out that, in the fourth chapter, only one country has an inefficient tax system while the other country does not.

The second theme is based on the monetary income, known as seigniorage. In the second and third chapters, public expenditures can be financed by tax and seigniorage revenues, while in the fourth chapter both governments finance their spending only through taxes.

[2] Although Huang and Wei (2006) analyse the effects of institutional quality, they do not study these effects in a monetary union.

Moreover, positive and normative aspects of the theory are examined in these chapters. Concretely, the economic outlook of the positive theory of economics is examined in the second and fourth chapters since I explore the economy of "what is". In the third and fourth chapters, I concentrate on the normative facet of the discipline since I am interested in "what ought to be" in economic matters. Therefore, both positive and normative facets are examined in Chapter 4.

1.5 Results

Let me finish the introduction with the main results found in my thesis.

In the second chapter, I analyse four aspects. First, I examine the effects of corruption on output growth rate. Second, I study the relationship between corruption and the inflation rate. I find under which conditions an increase in the degree of corruption has a positive (negative) impact on output and the inflation rate. Specifically, for poor levels of institutional quality, an increase in the level of corruption increases output growth rate and decreases the incentives to inflate. However, for high levels of institutional quality, these results are reversed. Third, I study the effect of seigniorage on output and I show that there is always a positive relationship between them. Fourth, I analyse the connection between seigniorage and the inflation rate. I find under which conditions seigniorage has a positive (negative) effect on the inflation rate. Concretely, for low (high) levels of seigniorage, the increase in the degree of seigniorage increases (decreases) the incentives to inflate. According to the literature, Huang and Wei's (2006) assumptions favour the positive (negative) relationship between corruption and the growth (inflation) rate with respect to my framework.

In the third chapter, we study the connection between seigniorage, institutional quality of the government and the design of an independent and conservative central bank. We find that the relationship between the optimal relative degree of conservativeness of the central bank and the degree of corruption is affected by the volatility of supply shocks. Concretely, when these shocks are not important, the central bank should be less conservative if the degree of corruption increases. However, this result may not hold when the shocks are relevant. Finally, if seigniorage decreases, the central bank should be more conservative. According to this literature, our results are in line with the results derived by Huang and Wei (2006) and Dimakou (2013), when the shocks are not important, and hence, we can conclude that their results are robust since they are obtained in a more general framework. In contrast, when the shocks are relevant, we may find an opposite result that the literature has found. It is worth mentioning that I have not found any study about the effects of seigniorage on central bank conservativeness.

In the fourth chapter, I extend the model from one country to two countries and I examine how corruption in one country may affect both the corrupt and the efficient country in a monetary union. I demonstrate that this feature has important implications in a monetary union with two asymmetric countries. Country 1 has a corrupt government while country 2 does not. Within this framework, I determine under which conditions an increase in the degree of corruption damages or benefits both countries. I find that an increase in the level of corruption in country 1 may have a negative effect on country 2. In particular, when the government of country 1 is more concerned about public spending than output, an increase in corruption damages both countries. Hence, the main research question is to answer how country 1 could compensate country 2 for the negative externality. These findings may have some implications for the Greek case, concretely in the austerity measures that the European Central Bank, the European Commission and the International Monetary Fund have been ordered.

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Chapter 2

The Effects of Corruption and Seigniorage on Growth and Inflation

2.1 Introduction

Corruption is capturing a lot of attention around the world. It is one particular feature that is prevalent in developing economies. However, developed countries are not immune to this problem, even though it is less common than in many developing countries. The therm corruption encompasses different meanings such as bribery, the sale of public property by government officials, kickbacks in public procurement, and misuse of government funds (Reinikka and Svensson, 2005). In our chapter, we define corruption as the abuse of public office for private gain (Jain, 2001).

Doubts have arisen as to whether corruption is detrimental or beneficial for the economy. Thus, a number of related questions on this topic have evoked genuine interest among economists. How can corruption impact on output growth rate? What are the effects of corruption on inflation? If we consider the empirical studies that focus on the relationship between corruption and growth, it is surprising to find out that they offer mixed results (see Leff, 1964; Mauro, 1995; Aidt et al., 2008; among others). On the other hand, it is found that the relationship between corruption and inflation is positive in the literature (Al-Marhubi, 2000; and Haider et al., 2011).

The following two graphs illustrate the relationship between the annual percentage growth rate of GDP and the annual percentage of inflation (the consumer price index) with the corruption perception index for a sample of 38 countries around the world.[1] The corruption perception index shows how public sectors are perceived to be corrupt. Higher values of the index correspond to less corruption. The corruption perception index is on a scale whose maximum is 100. The data covers the period between 2000 and 2014. We use the Database of Worldbank to select GDP growth and the annual percentage of inflation. Moreover, we have used the Database of Transparency International to select the corruption perception index. In Fig. 2.1, there does not seem to be a clear relationship between growth and corruption. Notice, however, that the tendency for inflation presented in Fig. 2.2 seems to be positive.

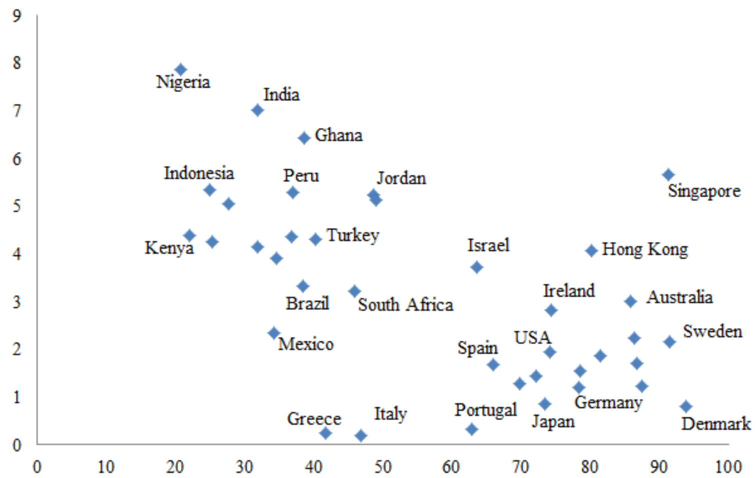

Figure 2.1: Relationship between the annual percentage of GDP growth (vertical axes) and the corruption perception index between 2000 and 2014 for a sample of 38 countries.

[1]Following Mauro (1995), we have chosen the following countries according to the available data: Australia, Austria, Belgium, Brazil, Canada, Colombia, Denmark, Ecuador, Egypt, France, Germany, Ghana, Greece, Hong Kong, India, Indonesia, Ireland, Israel, Italy, Japan, Jordan, Kenya, Malaysia, Mexico, Netherlands, Nigeria, Norway, Peru, Philippines, Portugal, Singapore, South Africa, Spain, Sweden, Thailand, Turkey, United Kingdom and United States.

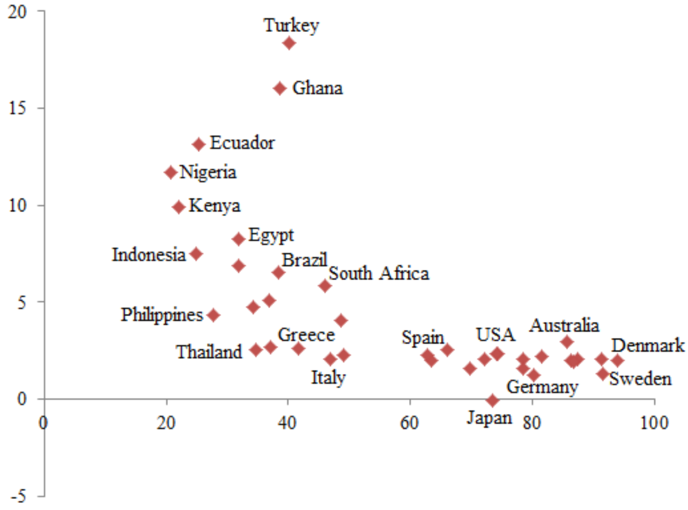

Figure 2.2: Relationship between the annual percentage of inflation (vertical axes) and the corruption perception index between 2000 and 2014 for a sample of 38 countries.

In this chapter we present a theoretical model that attempts to explain the impact of corruption and seigniorage on output growth and inflation rates. To this end, we extend the framework developed by Huang and Wei (2006) in two ways: first, we allow different degrees of seigniorage, and second, we permit different preferences among the authorities. Concretely, we assume different degrees of seigniorage given that we focus on countries with different levels of development. The concept of seigniorage refers to the difference between the face value of a note or coin and its costs of production and mintage (Buiter, 2007). Allowing different preferences among the authorities in the model indicates two facts: the governing body of the central bank is not the outcome of elections and the central bank tends to assign a greater weight to inflation relative to output and public expenditures than the government.

The model developed in this chapter captures the public financing of developed and developing countries through seigniorage and/or tax revenues. Developed countries have governments which are able to finance their expenditures mainly through taxes. However, developing countries tend to have inefficient institutions and hence, they get more finance through seigniorage and less through taxes than developed countries. In this area, corruption can play an important role as it lowers tax revenues (Ghura, 1998; Mokhtari and Grafova, 2007; Ajaz and Ahmad, 2010; among others). The reliance of many developing countries on seigniorage is a reality, often due to an inefficient tax system. Although seigniorage is more relevant in developing economies, Vergote et al. (2010) expose that seigniorage income is a reliable income source in the long run for the European Central Bank. The distribution of seigniorage income to all the Member States of the Eurozone depends on their relative weight on the GDP in the Euro Area. However, the Governing Council of the European Central Bank can retain all the European Central Bank's seigniorage to, for example, cover expenses (Krsnakova and Oberleithner, 2012).

In this chapter, we will show that the impact of corruption on growth is ambiguous since it depends on the level of institutional quality. Concretely, for poor levels of institutional quality, an increase in the degree of corruption favours the growth rate, whereas the reversal result may hold for high levels of institutional quality. Thus, our results could provide a rationale for the mixed empirical findings. Moreover, we find that the effects of corruption and seigniorage on inflation rate are also ambiguous. Specifically, the impact of corruption on the inflation rate also depends on the level of institutional quality. In addition, we obtain that an increase in the level of seigniorage always enhances output growth rate.

The remainder of the chapter is organised as follows. Section 2.2 surveys the related literature on the linkage between corruption, seigniorage, output growth rate and the inflation rate. Section 2.3 describes our model. Section 2.4 discusses the effects of corruption and seigniorage. Section 2.5 presents some numerical cases. Section 2.6 concludes. Finally, the proofs of the main results are included in the Appendix.

2.2 Literature Review

This section surveys the empirical and theoretical literature on the effects of corruption and seigniorage on some economic variables such as economic growth and inflation.

In the empirical literature on corruption, the most frequently used measures of institutional quality are those of Business International, International Country Risk Guide, Transparency International and the World Bank.[2]

First of all, we discuss the relationship between corruption and economic growth given that this has been a major concern for academics. The empirical literature indicates that this relationship is ambiguous. Economists' reflections have been divided between those who find that corruption produces prejudicial effects on economic performance and those who see that corruption could accelerate economic growth.

The negative relationship between corruption and economic growth has been identified in numerous empirical studies (for instance, Mauro, 1995; Del Monte and Papagni, 2001; Aidt et al., 2008; Adewale, 2011; among others).[3] These investigations have indicated various ways in which corruption damages economic growth, such as lowering investment (Mauro, 1995; Del Monte and Papagni, 2001), inciting the people who live in countries with high quality institutions to search employment in the informal sector (Aidt et al., 2008), and causing capital flight in illegal deposits abroad (Adewale, 2011).

By contrast, other researchers have found that corruption may be beneficial around the world, e.g., Rock and Bonnett (2004) in the large East Asian newly industrialised countries, Méon and Weill (2010) in countries where institutions are extremely ineffective and Dreher and Gassebner (2013) in highly regulated economies.[4] One of the most popular justifications of this relationship relies on the fact that corruption could be beneficial in a second best world because of the distortions caused by bad functioning institutions (Leff, 1964; Huntington, 1968). It is argued that if the governmental procedures or regulations that hinder economic activity for private agents are allowed, corruption may act to "grease" the economy.

In the last fifteen years, empirical studies have also analysed the

[2] Jain (2001), Johnston (2001) and Salinas and Salinas (2007) give a summary of the different institutional quality measures used in the empirical literature.

[3] Mo (2001) and Ibraheem et al. (2013) also report this result.

[4] Other authors point out this result such as Vial and Hanoteau (2010) and Dzhumashev (2014), among others.

impact of corruption on inflation, finding a positive relationship (Al-Marhubi, 2000; Abed and Davoodi, 2000; Haider et al., 2011).[5] In this sense, Al-Marhubi (2000) is the first who analyses the relationship between corruption and inflation around the world. He finds that higher corruption is associated with higher inflation. Abed and Davoodi (2000) find a positive impact of corruption on inflation in some transition countries. By contrast, they find that corruption is not significant when a structural reform index is included. The paper of Haider et al. (2011) shows that lower corruption is associated with lower inflation in democratic regimes since weak governments with high corruption rely more on seigniorage to finance their public expenditures, which affects inflation.

There seems to be little empirical research on seigniorage. Bose et al. (2007) find that the growth effect is large and significantly negative in developing countries. An increase in the seigniorage revenue alters the relative rate of return between a nonproductive liquid asset and a productive illiquid asset since financial intermediaries shift their portfolios in favour of the liquid asset and thus, it causes a detrimental effect on the economic growth. In contrast, Adam and Bevan (2005) show that seigniorage-financing appears to be significantly growth-enhancing below the threshold of 1.25% of GDP when it is used to finance productive expenditure (expenditure on health, education, infrastructure, public order and safety and public administration). From our knowledge, the effects of seigniorage on inflation have not yet been empirically developed.

Once the empirical literature has been analysed, it is also important to review the theoretical literature. Huang and Wei (2006), Faure (2011) and Dimakou (2013) assume complete seigniorage in order to analyse the effect of corruption on their main variables. Huang and Wei (2006) consider that weak institutions (e.g., corruption) cause a leakage of tax revenue and examine the effects of institutional quality on inflation targeting and exchange rate fixing. They further study the implications for the design of several other monetary frameworks, including a currency board, dollarisation and a Rogoff-type conservative central banker. The main result derived in Huang and Wei (2006) is that more corruption leads the

[5] These findings are consistent with Rahmani and Yousefi (2009).

central bank to be less conservative. Faure (2011) provides a new insight into the lack of incentive from authorities to curtail corruption. He assumes corruption as in Huang and Wei (2006). The main finding is that corruption can make a country better off if its government is unable to make binding commitments and assigns a larger weight to output than to inflation stabilisation. Dimakou (2013) analyses the interactions among the decisions of delegating monetary policy to more conservative central bank and combating bureaucratic corruption. Her study also builds on Huang and Wei's framework (2006) allowing for borrowing and systematically assessing the incentives to improve economic institutions. She identifies a set of structural determinants that affect the decisions of the government to enhance economic institutions. Finally, Hefeker (2010) is interested in the connection between corruption, the fiscal system and the choice of the exchange rate regime in diverse frameworks: a monetary autonomy, a hard peg and a monetary union. Unlike Huang and Wei (2006), he allows for different degrees of seigniorage and he supposes corruption as an absolute sum that can even be larger than tax revenue. He finds that in a country with low inflation, a credibly fixed exchange rate can reduce corruption and improve the fiscal system. He also obtains that a high tax revenue leads government to allow more corruption and vice-versa, and lower seigniorage implies higher taxes and may have negative output effects.[6]

2.3 The Model

The model we use expands the model of Huang and Wei (2006) to allow for different degrees of seigniorage and different preferences on the authorities' objectives. We assume a modified Lucas supply function in which the level of output, x, depends positively on unexpected inflation, $\pi - \pi^e$. Besides, output depends negatively on the tax rate, τ.[7] To be more precise, output is given by

[6] Basu (2001) finds that, for low levels of bank reserves, seigniorage has a growth-enhancing effect. For him, imposing a reserve requirement on the banking sector generates seigniorage.

[7] All variables are expressed in logarithms.

$$x = \pi - \pi^e - \tau. \tag{2.1}$$

The model includes two policies, fiscal and monetary policy. Fiscal policy is controlled by the government and monetary policy is controlled by the central bank. We also assume that there could be corruption in the government, as in Huang and Wei (2006). Following these authors, the private sector pays a tax rate in the amount of τ, but only a portion of it, ϕ, will be used for public spending. Hence, the government's public spending function is described by

$$g = \phi\tau + k\pi, \tag{2.2}$$

where g denotes the ratio of public expenditures over output, $0 \leqslant \phi \leqslant 1$ and $0 \leqslant k \leqslant 1$. Hence, there are two sources of finance: tax and seigniorage revenue. On the one hand, $\phi\tau$ represents the tax revenue, where ϕ indicates the degree of institutional quality. Specifically, when $\phi = 1$ there is no corruption, whereas $\phi = 0$ means that the collection system collapses as there is full corruption. On the other hand, $k\pi$ measures the seigniorage revenue where k represents the degree of seigniorage. Thus, when $k = 1$ there is complete seigniorage, whereas $k = 0$ is the case where there are no benefits through seigniorage revenue.

The sequence of events is such that expectations are set and afterwards the government and central bank, simultaneously, choose the tax and inflation rates, respectively.

The government and central bank optimise, respectively, the following loss functions:

$$L_G = \frac{1}{2}\left(\pi^2 + \delta_G x^2 + \gamma_G \left(g - \bar{g}\right)^2\right), \tag{2.3}$$

where $\delta_G, \gamma_G > 0$, $\bar{g} \geq 0$ and the subscript G represents the government, and

$$L_{CB} = \frac{1}{2}\left(\pi^2 + \delta_{CB} x^2 + \gamma_{CB} \left(g - \bar{g}\right)^2\right), \tag{2.4}$$

where $\delta_{CB} > 0$, $\gamma_{CB} \geq 0$ and the subscript CB represents the central bank.

Note that the government and central bank aim at stabilising inflation, output and public spending. The parameters δ_i and γ_i $(i = G, CB)$ represent the relative weights on output and public spending stabilisation with respect to inflation for each authority. In the literature, there does not seem to be an agreement about the particular values of the weights in the loss functions. Alesina and Tabellini (1987) argue that the two policymakers can differ in the weights attributed to output and public spending relative to inflation. As these authors point out, an independent central bank is not subject to elections and, in most industrial countries, it enjoys various degrees of independence from the fiscal authority. Hence, we assume that the relative weights of both authorities are different ($\delta_G \neq \delta_{CB}$ and $\gamma_G \neq \gamma_{CB}$). In addition, the target levels for inflation and output are normalised to zero and the target level for public spending is denoted by $\bar{g}$. Following Dixit and Lambertini (2003), we assume that fiscal and monetary authorities have identical targets.

Substituting the Expressions (2.1) and (2.2) into (2.3) and (2.4), the loss functions of both authorities can be rewritten as follows

$$L_G = \frac{1}{2}\left(\pi^2 + \delta_G\left(\pi - \pi^e - \tau\right)^2 + \gamma_G\left(\phi\tau + k\pi - \bar{g}\right)^2\right) \text{ and} \tag{2.5}$$

$$L_{CB} = \frac{1}{2}\left(\pi^2 + \delta_{CB}\left(\pi - \pi^e - \tau\right)^2 + \gamma_{CB}\left(\phi\tau + k\pi - \bar{g}\right)^2\right). \tag{2.6}$$

The Nash equilibrium is obtained by minimising the government's and central bank's loss functions, the Expressions (2.5) and (2.6), with respect to tax and inflation rates, respectively. Hence, the corresponding optimisation problems are

$$\min_{\tau} L_G \text{ and}$$

$$\min_{\pi} L_{CB}.$$

The following proposition provides the optimal tax and inflation rates:

Proposition 1. *The tax and inflation rates in equilibrium are given by*

$$\tau^* = \frac{\phi}{\phi^2 + \alpha_G + k\eta}\bar{g} \text{ and} \tag{2.7}$$

$$\pi^* = \frac{\eta}{\phi^2 + \alpha_G + k\eta}\bar{g}, \tag{2.8}$$

where $\eta = \phi\delta_{CB} + k\alpha_G\gamma_{CB}$ *and* $\alpha_G = \frac{\delta_G}{\gamma_G}$.

This proposition shows that the higher is the public spending target, the higher tax and inflation rates are set. An increase in the public spending target requires more tax financing. Moreover, an increase in the spending target requires more seigniorage financing and hence, the inflation rate depends positively on the public spending target.

Moreover,[8] it follows that public spending and output deviations are

$$\bar{g} - g^* = \frac{\alpha_G}{\eta}\pi^* \text{ and} \tag{2.9}$$

$$0 - x^* = \frac{\phi}{\eta}\pi^*. \tag{2.10}$$

Note that these deviations are increasing in the inflation rate, meaning that a higher inflation rate induces more public spending and output deviations. In particular, the higher the need to finance the public spending (i.e., an increase in $\bar{g}$), the higher inflation, output and public spending deviations. In addition, from the Expressions (2.9) and (2.10), it follows that the average levels of public spending and output fall short of their targets, showing the trade-off the fiscal authority faces between spending and output.

2.4 Comparative Statics

In the next two subsections we will present some comparative static results. In particular, we analyse the effects of corruption and seigniorage on the levels of growth and inflation rates.

[8] Notice that the Expressions (2.9) and (2.10) make sense when $\eta \neq 0$.

2.4.1 Institutional Quality

In this part, we analyse how corruption affects the growth and inflation rates.

Corollary 2. *In equilibrium:*
a) the growth rate increases with corruption if and only if $\phi < \bar{\phi}_x$*, and*
b) the inflation rate decreases with corruption if and only if $\phi < \bar{\phi}_\pi$*, where*

$$\bar{\phi}_x = \sqrt{\alpha_G(k^2\gamma_{CB}+1)} \text{ and } \bar{\phi}_\pi = \alpha_G\left(\sqrt{\frac{k^2\gamma_{CB}^2}{\delta_{CB}^2}+\frac{1}{\alpha_G}}-\frac{k\gamma_{CB}}{\delta_{CB}}\right),$$

with $\bar{\phi}_x > \bar{\phi}_\pi$.

Corollary 2a shows that, in general, the effect of corruption on the growth rate depends on the level of institutional quality. For poor levels of institutional quality $\left(\phi < \bar{\phi}_x\right)$, corruption favours growth, whereas the opposite result may hold if $\phi > \bar{\phi}_x$. It is worth mentioning that if the fiscal authority is more concerned about the output objective than the public spending objective ($\alpha_G > 1$), then $\bar{\phi}_x > 1$. Consequently, we can conclude that in this case a positive relationship between corruption and growth always arises. However, when α_G is low enough, corruption has a negative effect on growth at moderate levels of institutional quality $\left(\phi > \bar{\phi}_x\right)$.

To intuitively understand the impact of corruption on the growth rate, notice first that an increase in corruption lowers tax revenues $\left(\frac{\partial}{\partial\phi}\phi\tau > 0\right)$. As the institutional quality worsens, *ceteris paribus*, the fiscal authority has incentives to increase the tax rate in order to compensate the reduction in public spending financing. However, the increase in the tax rate negatively affects the output rate. When $\phi < \bar{\phi}_x$ $\left(\phi > \bar{\phi}_x\right)$ the cost of increasing the tax rate overcomes (does not overcome) the corresponding benefit and, consequently, the government prefers to reduce (rise) its tax rate resulting in an increase (decrease) in output.

Corollary 2b indicates that, in general, the impact of corruption on inflation depends on the level of institutional quality.[9] Bear in mind that

[9] In another framework, neither do Myles and Yousefi (2015) find a direct relationship between corruption and the inflation rate.

the central bank will set inflation of corruption taking into account two effects: the impact of lower institutional quality on tax revenues (spending effect) and the impact of a higher or lower tax rate on output (output effect). Whenever $\phi > \bar{\phi}_x$, an increase in the degree of corruption leads to lower tax collection and higher tax rates, so the central bank will have more incentives to inflate. When $\phi < \bar{\phi}_x$, the spending effect and the output effect will work in opposite directions: as the degree of corruption increases, there will be lower tax collection and the government will set lower taxes. According to the first effect, the central bank will have more incentives to inflate, but the second effect will lead the central bank to set a lower inflation. Whenever $\bar{\phi}_\pi < \phi < \bar{\phi}_x$, the spending effect dominates and the inflation rate will be higher. For high levels of corruption $\left(\phi < \bar{\phi}_\pi\right)$, the output effect dominates and the central bank will set a lower inflation rate. Further, it can be seen that when the government is relatively very interested in stabilising output over spending (i.e., α_G is high enough) and the central bank places a high relative weight on the output objective (i.e., $\frac{k\gamma_{CB}}{\delta_{CB}}$ is low enough), $\bar{\phi}_\pi > 1$: in this case, a reduction in the degree of institutional quality will always reduce the inflation rate.

To sum up, Figure 2.3 illustrates the effect of corruption on the average levels of growth and inflation.

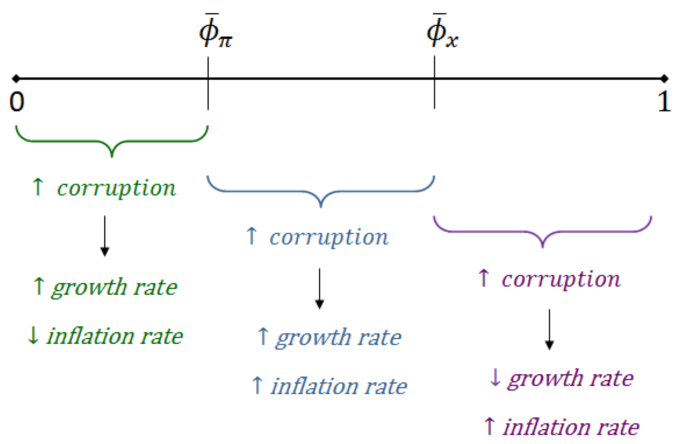

Figure 2.3: Relationship between output, the inflation rate and corruption.

The existing empirical literature points out that corruption leads to higher inflation. Looking at Fig. 2.3, this would indicate that $\phi > \bar{\phi}_\pi$ and this could suggest that, in fact, $\bar{\phi}_\pi$ is probably the minimum level of corruption that we would find. Notice that in this area, corruption can enhance or damage the growth rate. This is in line with the mixed results found related to the effect of corruption on the growth rate as discussed in Section 2.2. From this analysis we can conclude that the assumptions made in Huang and Wei (2006) favour the positive (negative) relationship between corruption and the growth (inflation) rate with respect to our framework.

2.4.2 Seigniorage

We now derive some comparative static results for the case of seigniorage. Given that seigniorage, as a source of revenue, tends to be smaller as the monetary and fiscal institutions of a country become more sophisticated, we will study the effects of a reduction in seigniorage. Thus, the following corollary provides the effects of seigniorage on the equilibrium values of growth and inflation rates:

Corollary 3. *In equilibrium:*
a) the growth rate always increases with the degree of seigniorage, and
b) the inflation rate increases with the degree of seigniorage if and only if $k < \bar{k}$,
where $\bar{k} = \frac{\sqrt{(\phi^2+\alpha_G)\alpha_G\gamma_{CB}}-\phi\delta_{CB}}{\alpha_G\gamma_{CB}}$.[10]

The rationale intuition behind Corollary 3a is as follows. When the degree of seigniorage decreases, the total revenue through inflation decreases ($\frac{\partial}{\partial k}k\pi^* > 0$). This implies that the fiscal authority has more incentive to increase its tax rate to get more tax financing.[11] Hence, a lower degree of seigniorage damages output growth rate.

[10] Notice that $\bar{k}$ decreases if the central bank attaches more relative weight to output and so, there are more cases in which an increase in seigniorage leads central bank to have less incentive to inflate.

[11] Hefeker (2010) and Caballé and Hromcová (2011) also obtain a negative relationship between seigniorage and the tax rate (in expected terms).

In addition, Corollary 3b indicates that Corollary 3a has two effects on the behaviour of the central bank: on the one hand, taking into account the objective of output, the increase in the tax rate increases the incentives to inflate; on the other hand, given the objective of public spending, the increase in tax rate decreases the incentives to inflate. Notice that the reduction in seigniorage revenue leads to an increase in the inflation rate whenever the central bank prioritises considerably more the stabilisation of output over public spending, so $\frac{\delta_{CB}}{\gamma_{CB}}$ is high enough. In this case, $\bar{k} < 0$ and therefore, $k > \bar{k}$. However, when $\frac{\delta_{CB}}{\gamma_{CB}}$ is low enough, the opposite could be true.

2.5 Numerical Cases

In this section, we visualise the theoretical results stated in Subsections 2.4.1 and 2.4.2. To this end, we replicate the relationship identified in the theoretical model between corruption, seigniorage, growth and inflation rates.

The parameters of the model are depicted in Table 2.1. The relative weight on the output gap deviation for the government has been observed in several studies. Jensen (2002) and Tillmann (2008) set $\delta_G = 0.25$. Walsh (2003) varies δ_G until 1 and Dimakou (2013) until 1.2. Following Dimakou (2013), we set $\delta_G = 0.75$ and $\gamma_G = 1.2$ as the mean values of Dimakou's (2013) ranges. Moreover, following Alesina and Tabellini (1987), we assume that $\delta_G > \delta_{CB}$ and $\gamma_G > \gamma_{CB}$ since the government does not assign a greater weight to inflation relative to output and public spending than the central bank. Further, we assume that $\delta_{CB} > \gamma_{CB}$ since some authors point out that the central bank is not worried about stabilising the public spending (Debelle and Fischer, 1964; Beetsma and Bovenberg, 2001; Hefeker, 2010). Hence, we assume that $\delta_{CB} = 0.65$ and $\gamma_{CB} = 0.15$. Moreover, the degrees of institutional quality and of seigniorage are set to vary within its full range, $0 \leq \phi \leq 1$ and $0 \leq k \leq 1$, respectively. Finally, we set the value of the government spending target, $\bar{g} = 0.28$, extracted also from the mean range of Dimakou (2013).

Parameter		Value
δ_G	Government's weight on output gap relative to inflation	0.75
γ_G	Government's weight on public spending gap relative to inflation	1.2
δ_{CB}	Central bank's weight on output gap relative to inflation	0.65
γ_{CB}	Central bank's weight on public spending gap relative to inflation	0.15
ϕ	Degree of institutional quality	0.1-0.9
k	Degree of seigniorage	0.002-0.8
$\bar{g}$	Public spending target	0.28

Table 2.1: Parameter values

Our analysis includes four sets of comparative static exercises divided into two subsections, corruption and seigniorage. Concretely, in each subsection, we simulate for output growth and inflation rates. Thus, in the first subsection, we compare the optimal output growth and inflation rates for different levels of corruption and, in the second subsection, we analyse the optimal output growth and inflation rates under different degrees of seigniorage.

2.5.1 Corruption

We start off presenting our two first specifications where we compare two cases in which the only difference lies on the degree of seigniorage. In one case (red line), we assume that $k = 0.8$ and in the other case (blue line) $k = 0.002$,[12] while growth or inflation vary for different institutional quality parameters. The high seigniorage simulation case would attempt to represent developing countries (red line). By contrast, the low seigniorage simulation case would depict developed economies (blue line). Remember that institutional quality is inversely related to the level of corruption.

[12] Following Gros (2004), we will represent seigniorage for developed countries less than one quarter of 1 per cent.

2.5.1.1 Growth and Institutional Quality

Fig. 2.4 depicts the optimal growth rate for two different seigniorage degrees at different levels of corruption. We can see that higher levels of corruption ($\phi < 0.83$ for developing countries and $\phi < 0.79$ for developed countries) have a positive effect on the growth rate. Hence, in this case, our results are in line with the point of view that an increase in the degree of corruption may be beneficial for growth as Leff (1964), Rock and Bonnett (2004) and Méon and Weill (2010), among others. However, at the point where $\phi > 0.83$ for developing countries (red line) and $\phi > 0.79$ for developed countries (blue line), an increase in the degree of corruption lowers growth, similarly to the empirical evidence found by Mauro (1995) and Aidt et al. (2008). Note that more cases may be found where an increase in the degree of corruption promotes the growth rate in developing countries since their threshold (0.83) is higher than in developed countries (0.79).

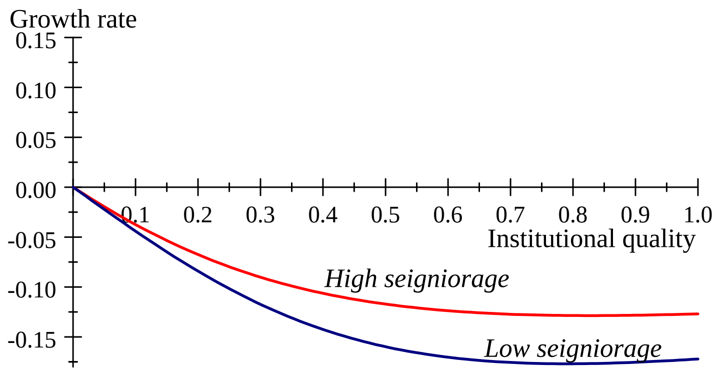

Figure 2.4: Relationship between institutional quality and the growth rate when δ_G=0.75, γ_G=1.2, δ_{CB}=0.65, γ_{CB}=0.15 and $\bar{g}$=0.28.

2.5.1.2 Inflation and Institutional Quality

Fig. 2.5 indicates that higher levels of corruption ($\phi < 0.68$ for developing countries and $\phi < 0.79$ for developed economies) lower the inflation rate, and thus, $\frac{\partial}{\partial \phi}\pi^* > 0$. Above these thresholds (i.e., $\phi > 0.68$ for developing countries and $\phi > 0.79$ for developed countries), an increase in the degree of corruption leads to an increase in the inflation rate, $\frac{\partial}{\partial \phi}\pi^* < 0$, as found by Al-Marhubi (2000), Abed and Davoodi (2000) and Haider et al. (2011). Notice that the countries identified by the blue line appear to be more sensitive to changes in corruption. Further, the threshold for developed countries (0.79) is higher than for developing countries (0.68). Hence, there are more cases where an increase in the degree of corruption reduces the inflation rate in developed countries than in developing countries.

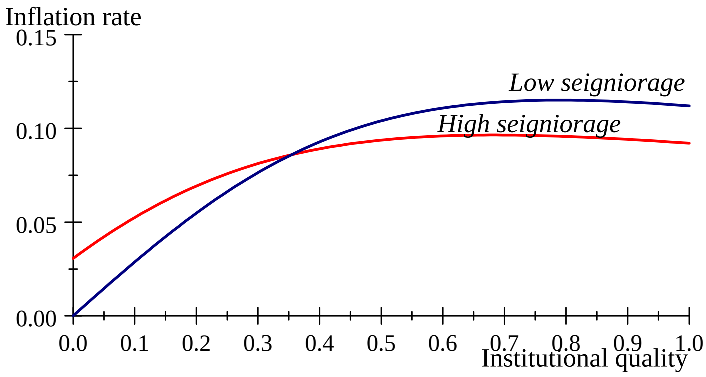

Figure 2.5: Relationship between institutional quality and the inflation rate when δ_G=0.75, γ_G=1.2, δ_{CB}=0.65, γ_{CB}=0.15 and $\bar{g}$=0.28.

2.5.2 Seigniorage

In the two following specifications, we focus on the impact of seigniorage changes on the growth and inflation rates in which the only difference lies on the levels of corruption. In the red line, the economy suffers from a very high level of bureaucratic corruption, $\phi = 0.1$. In contrast, the blue line represents an economy with high institutional quality, $\phi = 0.9$.

2.5.2.1 Growth and Seigniorage

Fig. 2.6 illustrates the previous theoretical result between seigniorage and the growth rate, $\frac{\partial}{\partial k}x^* > 0$. Hence, seigniorage has a positive effect on the growth rate for both levels of corruption.

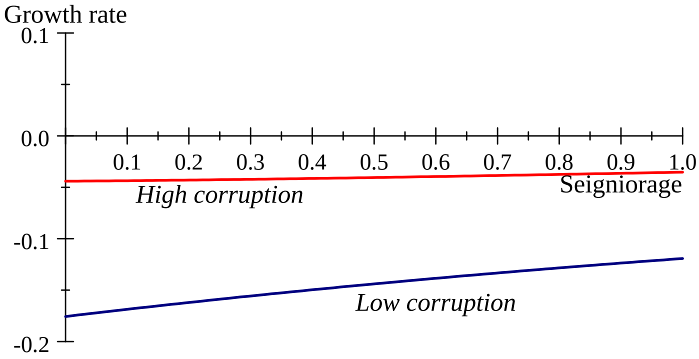

Figure 2.6: Relationship between seigniorage and the growth rate when δ_G=0.75, γ_G=1.2, δ_{CB}=0.65, γ_{CB}=0.15 and $\bar{g}$=0.28.

2.5.2.2 Inflation and Seigniorage

Finally, we analyse the effects of different degrees of seigniorage on the inflation rate. Fig. 2.7 reveals that for countries with low institutional quality (red line), an increase in the degree of seigniorage increases the inflation rate. In that case, $\bar{k} = 1.91$ and hence, $\frac{\partial}{\partial k}\pi^* > 0$.[13] However, for countries with high institutional quality, the blue line shows that an increase in the degree of seigniorage reduces the inflation rate since, in that case, $\bar{k} = -2.33$ and thus, $\frac{\partial}{\partial k}\pi^* < 0$. Therefore, according to our particular values, we do not find that $0 \leq \bar{k} \leq 1$. However, if $0.25 \leq \phi \leq 0.42$, we will obtain $0 \leq \bar{k} \leq 1$.

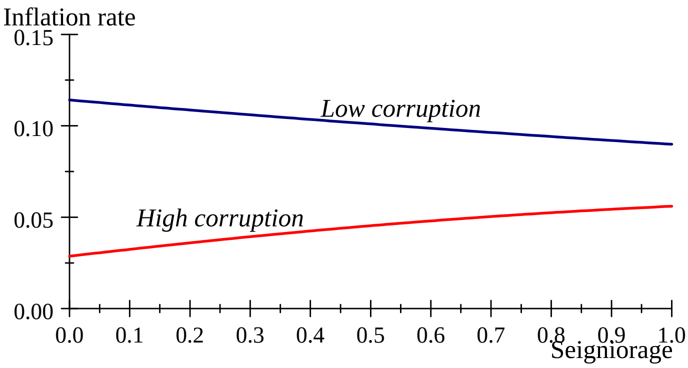

Figure 2.7: Relationship between seigniorage and the inflation rate when δ_G=0.75, γ_G=1.2, δ_{CB}=0.65, γ_{CB}=0.15 and $\bar{g}$=0.28.

[13] See Subsection 2.4.2.

2.6 Conclusions

The literature about corruption has given the impression that the world is divided in two types of people: the 'sanders' and the 'greasers'. The 'sanders' consider that corruption is detrimental to development, while the 'greasers' think that corruption may enhance development. The purpose of this chapter is to study the relationship between corruption, seigniorage, output growth and inflation rates.

We extend the model of Huang and Wei (2006) allowing different preferences among the authorities and permitting different degrees of seigniorage. This chapter provides three contributions to the literature. The first one is to provide a theoretical underpinning for the mixed empirical results found in the literature on the relationship between output growth and corruption. The second one is to give a theoretical foundation on the positive effect of corruption on the inflation rate. The third one is to provide a rationale for the impact of seigniorage on output growth and inflation rates.

This chapter concludes that the effects of corruption on output growth and inflation rates are not straightforward. Thus, our results are in line with Mauro (1995), Del Monte and Papagni (2001) and Adewale (2011) who consider that corruption lowers growth and with Leff (1964), Méon and Weill (2010) and Dreher and Gassebner (2013) who support the 'greasing' effect of corruption. Moreover, we show that in some cases, the degree of seigniorage increases the inflation rate and in other circumstances, seigniorage decreases the inflation rate. Besides, we find that seigniorage always has a positive effect on output growth rate. Finally, we have performed a set of comparative static exercises employing numerical simulations.

Several extensions are left for future research. A first one is to develop the model in a Stackelberg game with, for example, the government as the leader. It may be more realistic since monetary policy can be adjusted more quickly than fiscal policy. A second one is to consider that the government can get finance through public debt with a two period dynamic environment. A third one is to examine the difference between developed and developing countries on the issue of central banks independence with corrupt governments. Finally, a fourth one is to introduce the cost in fighting corruption and to study the optimal level of corruption.

Acknowledgments

We are grateful to all comments received during the 28th Annual Congress of the European Economic Association and 67th European Meeting of the Econometric Society in Gothenburg (2013), during the 8th Portuguese Finance Network in Vilamoura (2014), and during the seminars at Universitat Rovira i Virgili in Reus (2013 and 2014). We would like to thank Sabine Flamand for her useful comments in the 3rd PhD Workshop on Industrial and Public Economics in Reus (2015). Financial support from project ECO2013-42884-P, project 2014 SGR 631, and from the fellowship granted by Universitat Rovira i Virgili are also gratefully acknowledged.

Appendix

Derivation of Expression (2.1). Following Alesina and Tabellini (1987), the Expression (2.1) is derived from the following optimisation problem of a competitive firm in period t:

$$max_{L_t} \quad (1-\tau_t)P_t X_t - W_t L_t$$

$$s.t. \;\; X_t = L_t^{\lambda}, \;\; 0 < \lambda < 1,$$

where L_t is the labour, τ_t represents the tax rate on the total revenue of firms, P_t is the price level, X_t denotes the real output and W_t is the nominal wage (upper case letters denote antilogs). Thus, output is produced by labour, where λ indicates the output elasticity.
Solving for the firm's optimisation problem, the first-order condition is given by

$$\lambda(1-\tau_t)P_t L_t^{\lambda-1} = W_t.$$

Using the production function and taking logs (lower case letters denote logs), we get

$$x_t = \frac{\lambda}{\lambda-1}\left(w_t - \ln\lambda - p_t - \ln(1-\tau_t)\right).$$

Workers set wage (w_t) to achieve a target real wage w^*: $w_t = w^* + p^e$, where the e superscript denotes expected values. We will assume $w^* = 0$ since it is assumed that monetary policy inconsistency arises solely from distortionary taxation. Finally, approximating $\ln(1-\tau_t)$ by $-\tau_t$ yields

$$x_t = a\left(\pi_t - \pi^e - \tau_t\right) + b,$$

where $a = \frac{\lambda}{1-\lambda}$, π_t and π^e are the actual and expected inflation rates respectively, with $\pi_t \approx p_t - p_{t-1}$, and $b = \frac{\lambda}{1-\lambda}\ln\lambda$. For simplicity and following Debelle and Fischer (1964), we set $\lambda = 0.5$, so that $a = 1$. Moreover, we set $b = 0$ as in Alesina and Tabellini (1987), so the expression for output becomes (2.1). ■

Derivation of Expression (2.2). The Expression (2.2) has been obtained as follows. The government budget constraint in nominal terms is given by

$$P_t G_t = \phi \tau_t P_t X_t + M_t - M_{t-1},$$

where G_t denotes the public spending, ϕ is the degree of corruption and M_t the nominal money supply. We will assume that $\frac{M_t}{P_t} = k\bar{X}$ as in Beetsma and Bovenberg (1997), where k is the degree of seigniorage and $\bar{X}$ denotes an output level.
Dividing the government budget constraint by nominal income, $P_t X_t$, yields

$$\frac{G_t}{X_t} = \phi \tau_t + \frac{M_t - M_{t-1}}{P_t X_t}.$$

Taking into account the money demand function and approximating X_t to $\bar{X}$ as in Dimakou (2013), we get

$$\frac{G_t}{X_t} = \phi \tau_t + k \frac{P_t - P_{t-1}}{P_t}. \tag{2.11}$$

Finally, approximating π_t to $\frac{P_t - P_{t-1}}{P_t}$ in the Expression (2.11), the government budget constraint can be rewritten in real terms as the Expression (2.2). ■

Proof of Expressions (2.7) and (2.8). Remember that the government and central bank solve the following problems:

$$\min_{\tau} L_G \text{ and}$$

$$\min_{\pi} L_{CB}.$$

Using the Expressions (2.5) and (2.6), and considering π^e constant in the problems, the first-order conditions are given by

$$\frac{\partial L_G}{\partial \tau} = -\delta_G\left(\pi - \pi^e - \tau\right) + \phi\gamma_G\left(\phi\tau + k\pi - \bar{g}\right) = 0 \text{ and}$$

$$\frac{\partial L_{CB}}{\partial \pi} = \pi + \delta_{CB}\left(\pi - \pi^e - \tau\right) + k\gamma_{CB}\left(\phi\tau + k\pi - \bar{g}\right) = 0.$$

Hence, it follows that

$$\tau = \frac{\left(\delta_G - \phi k\gamma_G\right)\pi - \delta_G\left(\pi^e\right) + \phi\gamma_G\bar{g}}{\delta_G + \phi^2\gamma_G} \text{ and} \quad (2.12)$$

$$\pi = \frac{\delta_{CB}\left(\pi^e + \tau\right) - k\gamma_{CB}\left(\phi\tau - \bar{g}\right)}{1 + \delta_{CB} + k^2\gamma_{CB}}. \quad (2.13)$$

Plugging the Expression (2.12) into (2.13) yields

$$\pi = \frac{\left(\bar{g} + \phi\pi^e\right)\eta}{\phi^2 + \alpha_G + \left(\phi + k\right)\eta}, \quad (2.14)$$

where $\eta = \phi\delta_{CB} + k\alpha_G\gamma_{CB}$ and $\alpha_G = \frac{\delta_G}{\gamma_G}$. Solving the Expression (2.14) for π^e, we get

$$\pi^e = \frac{\eta}{\phi^2 + \alpha_G + k\eta}\bar{g}. \quad (2.15)$$

Using the Expression (2.15) in (2.12) and (2.13), and after some algebra, we obtain the Expressions (2.7) and (2.8). ■

Proof of Corollary 2. Imposing rational expectations and using the Expressions (2.1), (2.7) and (2.8) it follows that

$$x^* = -\frac{\phi}{\phi^2 + \alpha_G + k\eta}\bar{g} \text{ and} \tag{2.16}$$

Differentiating the Expressions (2.16) and (2.8) with respect to the degree of institutional quality (ϕ), we get

$$\frac{\partial}{\partial \phi}x^* = \frac{\phi^2 - \alpha_G - k^2\alpha_G\gamma_{CB}}{\left(\phi^2 + \alpha_G + k\eta\right)^2}\bar{g} \text{ and}$$

$$\frac{\partial}{\partial \phi}\pi^* = -\frac{\left(\phi^2 - \alpha_G\right)\delta_{CB} + 2\phi k\alpha_G\gamma_{CB}}{\left(\phi^2 + \alpha_G + k\eta\right)^2}\bar{g}.$$

Therefore, $\frac{\partial}{\partial \phi}x^* < 0$ if and only if $\phi < \bar{\phi}_x$ and $\frac{\partial}{\partial \phi}\pi^* > 0$ if and only if $\phi < \bar{\phi}_\pi$, where the expressions of $\bar{\phi}_x$ and $\bar{\phi}_\pi$ are given in the statement of this corollary. ■

Proof of Corollary 3. Differentiating the Expressions (2.16) and (2.8) with respect to the degree of seigniorage (k), we obtain

$$\frac{\partial}{\partial k}x^* = \phi\frac{\phi\delta_{CB} + 2k\alpha_G\gamma_{CB}}{\left(\phi^2 + \alpha_G + k\eta\right)^2}\bar{g} \text{ and}$$

$$\frac{\partial}{\partial k}\pi^* = \frac{\left(\phi^2 + \alpha_G\right)\alpha_G\gamma_{CB} - \eta^2}{\left(\phi^2 + \alpha_G + k\eta\right)^2}\bar{g}.$$

Hence, $\frac{\partial}{\partial k}x^* > 0$ and $\frac{\partial}{\partial k}\pi^* < 0$ if and only if $k > \bar{k}$, where the expression of $\bar{k}$ is provided in this corollary. ■

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Chapter 3

Corruption, Seigniorage and Central Bank Conservativeness

3.1 Introduction

In the last two decades, cases of corruption have been unveiled in different countries, raising public awareness and reinforcing a trend in which society expects more from their leaders. In general, corruption involves inappropriate use of political power and reflects a failure of the political institutions within a society (Jain, 2001).

Another trend that characterises the last two decades in all countries is the greater independence granted to central banks, which has been particularly marked for developing and emerging market economies (Crowe and Meade, 2008). In fact, after a series of influential articles by, among others, Rogoff (1985), Alesina and Tabellini (1987) and Debelle and Fischer (1994), a majority of countries have adopted independent and conservative central banks in order to lower inflation. Acemoglu et al. (2008), study whether such central bank independence is associated with significant declines in inflation. According to the authors, the right functioning of an independent and conservative central bank is affected by the quality of political institutions and the presence of political constraints, like corruption.

In this chapter, we aim to study the connection between seigniorage, institutional quality of the government and the design of an independent and conservative central bank. To this end, we will extend the framework developed by Alesina and Tabellini (1987) to allow different degrees of seigniorage and to include corruption, in a similar way to Huang and Wei (2006) and Dimakou (2013), who develop a framework to study the design of monetary policy in developing economies. Our framework extends the model of Huang and Wei (2006) and Dimakou (2013) in three important ways: (i) we include shocks, (ii) we allow the authorities to have different relative interest in output over spending stabilisation and, (iii) we allow for different degrees of seigniorage. With the introduction of shocks, we can ascertain the effects of external perturbations in the model that might affect the behaviour of the central bank. By allowing the monetary and fiscal authorities to have different preferences on their objectives, our model allows for a more general specification of their preferences, encompassing but also extending previous models in the literature. Finally, we include seigniorage in the form of inflation financing. In the developing country literature, less efficient tax collection, among other factors, tends to increase dependence on the inflation tax (Catao and Terrones, 2005). It is worth mentioning that corruption is not only present in developing and transition economies, it also affects developed economies. The 2013 corruption perception index of Transparency International, which measures the perceived levels of public sector corruption for 177 countries, ranks OECD countries like Mexico, Greece, Italy and the Slovak Republic in the middle third of the sample. Such countries, however, generally enjoy an environment of price stability and seigniorage represents a small percentage of government revenues. For the Eurosystem, seigniorage income is referred to as monetary income and it is accruing to the individual national central banks (Handig and Holzfeind, 2007). In order to develop a model that is also applicable to developed economies, we will allow for seigniorage revenue to take different proportions.

We will introduce an indicator of the conservativeness of the central bank that will depend on the relative importance attributed to output and public spending stabilisation with respect to inflation, as well as on the levels of corruption and seigniorage. We will show that the optimal degree of conservativeness of the central bank should increase with institutional quality when shocks are not significant. If the institutional quality is poorer, the government has less resources through taxes and thus, it is necessary to collect resources through seigniorage. Therefore, the central bank should be less conservative. This result is in line with the result derived by Huang and Wei (2006) and we can conclude that their results are robust since it is obtained in a more general framework. However, when the variability of shocks affecting the economy is important (such as in a major financial crisis), this result may not hold. The reason is that deviations of output and public spending and the variance of inflation are higher and, this, in some instances, leads the central bank to be more conservative. We will also prove that the optimal degree of conservativeness is negatively related to seigniorage. Therefore, if the variability of shocks is not important, then economies with higher levels of corruption and seigniorage should not design central banks that are too conservative.

The chapter is organised as follows. Section 3.2 introduces the model. Section 3.3 studies how conservative the central bank should be when there is some degree of corruption. The conclusions are presented in the last section and proofs are gathered in the Appendix.

3.2 The Model

In this section, we will extend Alesina and Tabellini's model (1987) to allow for different levels of seigniorage and for corruption, in a similar way to Huang and Wei (2006). Following Alesina and Tabellini (1987), Debelle and Fischer (1994) and Beetsma and Bovenberg (2001), among others, we assume that workers are represented by trade unions whose objective is to achieve a target real wage, the logarithm of which is normalised to 0. Hence, the (log of the) nominal wage (w) is equal to the expected (log of the) price level, p^e.

Output of a representative firm is given by $X = L^{\lambda} e^{\varepsilon/2}$, where X denotes the real output, L represents labour, λ indicates the output elasticity and ε represents a supply shock. We assume that ε is independently and identically distributed with mean zero and variance σ_ε^2. Distortionary taxes are levied on production. The firm maximises profit, given by: $(1-\tau)PL^\lambda e^{\varepsilon/2} - WL$, where τ denotes the tax rate on total revenue of firms. Solving for the firm's labour demand, assuming it can hire the labour it demands at the given nominal wage, taking logs, and after some algebra, it follows that output supply is $x = a(\pi - \pi^e - \tau) + b + \frac{\varepsilon}{2(1-\lambda)}$, where x denotes the (log of) real output, $a = \frac{\lambda}{1-\lambda}$, π is the inflation rate, π^e is the expected inflation rate and $b = \frac{\lambda}{1-\lambda}\ln\lambda$. Following Debelle and Fischer (1964), for simplicity, we set $\lambda = 0.5$, so that $a = 1$ and we approximate $\ln\lambda$ to 0. Thus, output is given by

$$x = \pi - \pi^e - \tau + \varepsilon. \tag{3.1}$$

We will introduce corruption in the model by assuming that there is a connection between the government's fiscal capacity and the quality of institutions. In this way, we will follow Huang and Wei (2006), where the private sector pays a tax to the government, but only a proportion of this amount, ϕ, is accrued. Thus, the government budget constraint is

$$g = \phi\tau + k\pi, \tag{3.2}$$

where g represents public spending (as a share of non-distortionary output), ϕ is the degree of institutional quality ($0 \leq \phi \leq 1$) and k denotes the degree of seigniorage ($0 \leq k \leq 1$).[1] The right-hand side of the Expression (3.2) represents the two sources to finance public spending: tax revenues ($\phi\tau$) and seigniorage revenues ($k\pi$). A low value of $\phi\tau$ indicates that the resources obtained through taxes are small. Thus, institutional quality will be inversely related to corruption: $\phi = 1$ will indicate absence of corruption, whereas complete corruption will occur when $\phi = 0$. Therefore, the lower ϕ is, the greater will be the leakage of tax revenues, indicating a less effective tax system. Thus, a low value of $k\pi$ implies that public spending is mainly financed through tax revenues, as in developed

[1] Gros (2004) shows that for the Euro area as a whole, seigniorage represents less than one quarter of 1 per cent of GDP. He puts forward a methodology to assess the fiscal implications for the new EU members from central and eastern Europe of joining the Euro area.

countries.

We assume that there are two policies, fiscal and monetary policy, which are controlled by the government and an independent central bank, respectively. Concretely, the government chooses the tax rate and the independent central bank chooses the inflation rate, in order to minimise the following loss functions, respectively:

$$L_G = \frac{1}{2}\left(\pi^2 + \delta_G x^2 + \gamma_G (g - \bar{g})^2\right), \tag{3.3}$$

where $\delta_G, \gamma_G > 0$ and $\bar{g} \geq 0$, and

$$L_{CB} = \frac{1}{2}\left(\pi^2 + \delta_{CB} x^2 + \gamma_{CB} (g - \bar{g})^2\right), \tag{3.4}$$

where $\delta_{CB} > 0$ and $\gamma_{CB} \geq 0$.

We assume that both policymakers wish to minimise the deviations of inflation, output and public spending from some targets, i.e., 0, 0 and $\bar{g}$, respectively. Without loss of generality, the inflation target is normalised to zero. The output target level is also normalised to zero, which is the natural output level reached in the absence of tax distortions and shocks whenever the price level is correctly anticipated by the private sector. Even though the targets are identical for both authorities, -as suggested by Dixit and Lambertini (2003), their weights may differ.

The weights in the loss functions adopt different values in the literature. For instance, some authors like Debelle and Fischer (1994), Berger et al. (2001) and Hefeker (2010), assume that $\gamma_{CB} = 0$. Alesina and Tabellini (1987) assume that $\delta_{CB} < \delta_G$ and $\gamma_{CB} < \gamma_G$. In Huang and Wei (2006) and Dimakou (2013), the weights for both authorities are identical, except the weight attributed to inflation. Concretely, Huang and Wei (2006) assume the following loss functions:

$$L_G = \frac{1}{2}\left[\pi^2 + \delta_G x^2 + \gamma_G (g - \bar{g})^2\right] \text{ and}$$

$$L_{CB} = \frac{1}{2}\left[S\pi^2 + \delta_G x^2 + \gamma_G (g - \bar{g})^2\right].$$

Thus, in their model $\delta_{CB} = \frac{\delta_G}{S}$ and $\gamma_{CB} = \frac{\gamma_G}{S}$, where S denotes the weight on the inflation rate placed by the central banker. In particular, in their model $\frac{\delta_G}{\gamma_G} = \frac{\delta_{CB}}{\gamma_{CB}}$. This means that both authorities have the same relative interest in output over spending stabilisation. The general framework presented in this chapter encompasses all the models in this literature.

The timing of events will be as follows. First of all, expectations and thus, wages, are set. Afterwards, the shock ε occurs. Finally, the monetary and fiscal instruments will be simultaneously chosen. The model is solved by minimising the loss function of the policymakers, holding π^e constant and then imposing rational expectations.

It is shown in the Appendix that with rational expectations and minimising the government's and central bank's loss functions, the tax and inflation rates are given by

$$\tau^* = \phi \frac{\gamma_G}{\delta_G + \phi^2 \gamma_G + k\eta} \bar{g} + \frac{\delta_G + k\eta}{\delta_G + \phi^2 \gamma_G + (\phi + k)\eta} \varepsilon \text{ and} \tag{3.5}$$

$$\pi^* = \frac{\eta}{\delta_G + \phi^2 \gamma_G + k\eta} \bar{g} - \phi \frac{\eta}{\delta_G + \phi^2 \gamma_G + (\phi + k)\eta} \varepsilon, \tag{3.6}$$

where $\eta = \phi \gamma_G \delta_{CB} + k \delta_G \gamma_{CB}$. Moreover, it follows that

$$\bar{g} - g^* = \frac{\delta_G}{\eta} \pi \text{ and} \tag{3.7}$$

$$0 - x^* = \frac{\phi \gamma_G}{\eta} \pi. \tag{3.8}$$

Taxes and the inflation rate depend positively on the target for public spending, but are affected in opposite ways by the shocks. The presence of a positive supply shock on output will lead the fiscal authority to raise the tax rate and the monetary authority to have less incentive to inflate. Further, output and public spending will be negatively affected by inflation. In equilibrium, output and public spending are below their targets (0 and $\bar{g}$, respectively). The higher the need to finance the public spending (i.e. an increase in $\bar{g}$), the further away are inflation, output and public spending from their respective targets.

3.3 Central Bank Conservativeness with Corruption and Seigniorage

In this section, we will define a measure of the relative conservativeness of the central bank with respect to the government when there is corruption and seigniorage. We will also study the design of the monetary institution such that social welfare is maximised.

3.3.1 Conservativeness Indicator

The term conservativeness refers to the degree of a central bank's inflation aversion. In the literature, different measures of conservativeness have been used. Rogoff (1985) defines a "conservative" central banker as one that would care relatively more about inflation and less about output than the fiscal authority. For Alesina and Tabellini (1987), the central bank is conservative when $\delta_{CB} < \delta_G$ and $\gamma_{CB} < \gamma_G$ in the Expressions (3.3) and (3.4). Berger et al. (2001), Huang and Wei (2006), and Dimakou (2013) assume that the central banker is more averse to inflation than the government when (s)he places a greater weight on price stability than does the government, whereas the remaining weights of the loss functions coincide for both authorities. Huang and Wei (2006) and Dimakou (2013) measure the degree of conservativeness of the central banker by the excess weight he or she places on the inflation term relative to the government's.

We will introduce an indicator of the conservativeness of the central bank in the presence of corruption and seigniorage, which will encompass all the measures of conservativeness previously mentioned.

Definition. *The relative degree of conservativeness of the central bank with respect to the conservativeness of the government, c, is defined as:*

$$c = \frac{\phi + k}{\phi \frac{\delta_{CB}}{\delta_G} + k \frac{\gamma_{CB}}{\gamma_G}}. \tag{3.9}$$

Remark 1. *This indicator is the weighted harmonic mean of the relative weights of the central bank with respect to the weights of the government in their loss functions. Moreover, note that whenever c is higher than 1 (c lower than 1), the central bank is relatively more (less) conservative than the government.*

The following cases will clarify the possible values that the indicator of the relative degree of conservativeness can take:

1) When both authorities have the same preferences, $\delta_{CB} = \delta_G$ and $\gamma_{CB} = \gamma_G$, then $c = 1$.[2] Thus, in this case both authorities have the same degree of conservativeness, i.e., the central bank is as conservative as the government.

2) If $\delta_{CB} \leq \delta_G$ and $\gamma_{CB} \leq \gamma_G$ and at least one of the previous inequalities is strict, then the central bank is more conservative than the government in Alesina and Tabellini's sense. In this case, $c > 1$, i.e., the central bank is more conservative than the government.

3) If $\gamma_{CB} = \gamma_G$, then $c > 1$ is equivalent to $\delta_{CB} < \delta_G$, and in this case, the indicator of conservativeness we consider and the one proposed by Rogoff coincide.

4) If $\delta_{CB} = \frac{\delta_G}{S}$ and $\gamma_{CB} = \frac{\gamma_G}{S}$ (as in Huang and Wei's model, 2006), then $c = S$. Huang and Wei (2006) propose as a measure of conservativeness $S-1$. Thus, both indicators are equivalent.

5) If $\phi = 0$, i.e., there is complete corruption, then $c = \frac{\gamma_G}{\gamma_{CB}}$. Notice that when $\phi = 0$, as the government does not obtain any revenue through taxes, it will set a tax rate such that the output deviation is null. In this case, conservativeness will be determined by the public spending weights, which will determine whether inflation will be high or low.

Proposition 1. *Delegation of monetary policy to an independent and "conservative enough" authority (c >1) reduces the expected inflation and*

[2] This case would also coincide with the government being in control of monetary policy, as the central bank would be minimizing the government's loss function.

the variance of inflation, but increases the expected value and the variance of the deviations of output and public spending from their targets.

The results derived in Proposition 1 are in line with the related literature (see, among others, Rogoff, 1985; Debelle and Fischer, 1994). In addition, this proposition shows that the proposed measure of conservativeness of the central bank is effective in the sense that a higher degree of c lowers both the expected value and the variability of inflation.

3.3.2 Welfare Analysis under Corruption and Seigniorage

In this subsection we will study how conservative should an independent central bank be from the society's welfare point of view. In order to study the optimal degree of conservativeness of the central bank, we will consider, as in Debelle and Fischer (1994),[3] the following general loss function for the society:

$$L_S = \frac{1}{2}\left(\pi^2 + \delta_S x^2 + \gamma_S \left(g - \bar{g}\right)^2\right), \tag{3.10}$$

where $\delta_S > 0$ and $\gamma_S \geq 0$.

The problem consists in finding δ_{CB} and γ_{CB} that minimise the society's expected loss function. Therefore, we have

$$\min_{\delta_{CB},\gamma_{CB}} E\left[L_S^*\right].$$

In the Appendix it is shown that

[3] Debelle and Fischer (1994), in a model similar to Alesina and Tabellini's, analyse how conservative should a central bank be. They show that the optimal degree of conservatism of the central bank depends on the society's aversion to inflation and output fluctuations.

$$E\left[L_S^*\right] = \Omega\left(\left(\frac{1}{D_1(c)}\bar{g}\right)^2 + \left(\frac{\phi}{D_2(c)}\right)^2\sigma_\varepsilon^2\right) \left(1+\delta_S\left(\frac{\phi c}{(\phi+k)\,\delta_G}\right)^2 + \gamma_S\left(\frac{c}{(\phi+k)\,\gamma_G}\right)^2\right), \quad (3.11)$$

where $\Omega = \frac{1}{2}(\phi+k)^2\gamma_G^2\delta_G^2$, with

$$\begin{aligned} D_1(c) &= c\left(\delta_G + \phi^2\gamma_G\right) + (\phi+k)\,k\delta_G\gamma_G \text{ and} \\ D_2(c) &= c\left(\delta_G + \phi^2\gamma_G\right) + (\phi+k)^2\,\delta_G\gamma_G. \end{aligned}$$

This expression indicates that the parameters δ_{CB} and γ_{CB} affect the society's welfare through c. Therefore, the problem of finding the optimal relative weights, i.e., δ_{CB} and γ_{CB}, that maximise the society's welfare is reduced to obtaining the optimal relative degree of conservativeness of the central bank. Formally,

$$\min_c E\left[L_S^*\right]. \quad (3.12)$$

Proposition 2. *There exists a unique value of c, denoted by c^*, that maximises society's welfare. When $\phi > 0$, $c^* \in \left(\beta, \frac{\phi+k}{k}\beta\right)$ where $\beta = \frac{\delta_G\gamma_G\left(\delta_G+\phi^2\gamma_G\right)}{\delta_G^2\gamma_S+\phi^2\gamma_G^2\delta_S}$ and, when $\phi = 0$, $c^* = \frac{\gamma_G}{\gamma_S}$.*

Remark 2. *The extremes of the interval stated in Proposition 2 are achieved when σ_ε^2 takes an extreme value. Concretely, when $\sigma_\varepsilon^2 \to \infty$, then $c^* \to \beta$ and when $\sigma_\varepsilon^2 = 0$, then $c^* = \frac{\phi+k}{k}\beta$. Notice that this proposition provides a generalisation of Huang and Wei's results (2006), since these authors focus on the case $\sigma_\varepsilon^2 = 0$. Huang and Wei (2006) show that $S^* = \phi + 1$. Using this optimal value and taking into account that in their model $\delta_{CB} = \frac{\delta_G}{S}$ and $\gamma_{CB} = \frac{\gamma_G}{S}$, the optimal values obtained by these authors result in a degree of relative conservativeness equal to $\phi + 1$, which coincides with the one derived in Proposition 2 (since in their model $k = 1$). Therefore, this analysis shows the robustness of the results derived by Huang and Wei (2006). Notice however that by allowing for incomplete seigniorage, the degree of conservativeness derived* *here is higher than theirs as long as $k < 1$. However, it is important to point out that there are other alternative values that achieve the same degree of conservativeness and, therefore, our result is more general. For instance, we could consider the case where $\gamma^*_{CB} = 0$ and $\delta^*_{CB} = \frac{k}{\phi}\delta_G$.*

Proposition 2 shows that the optimal degree of conservativeness of the central bank is bounded, in a similar way as in Rogoff (1985), where the central bank could not be infinitely conservative. Further, it depends on parameter values that represent the preferences of the government and society over inflation, output and public spending stabilisation. Notice that, contrary to Rogoff's findings, there will be parameter values for which it will be optimal to design a central bank that is less conservative than government. For instance, this will occur when $\phi > 0$, whenever $\frac{\phi+k}{k}\beta < 1$, i.e., whenever δ_S or γ_S are high enough. Moreover, when there is complete corruption ($\phi = 0$) and society places a higher weight on public spending stabilisation than the government ($\gamma_G < \gamma_S$), the central bank should be less conservative than the fiscal authority. Given that under complete corruption $c = \frac{\gamma_G}{\gamma_{CB}}$ and $c^* = \frac{\gamma_G}{\gamma_S}$, then, it follows that in the optimal $\gamma_{CB} = \gamma_S$. Nonetheless, when $\phi = 0$ and when the government's and society's preferences coincide, Proposition 2 implies that $c^* = 1$, i.e., the central bank has to be as conservative as society when there is full corruption.

In what follows we focus on $\phi > 0$ and we assume that the fiscal authority shares the same preferences as society (i.e., $\delta_G = \delta_S$, $\gamma_G = \gamma_S$). This has been justified in the literature given that the government has been elected by society and would be representing society's preferences. In the following corollary, we show how the optimal degree of conservativeness varies with some parameter values.

Corollary 3. *When the government shares the same preferences as society, then the optimal relative degree of conservativeness of the central bank satisfies that $c^* \in \left(1, \frac{\phi+k}{k}\right)$. Moreover, the following comparative static results hold:*
a) c^* is decreasing in σ^2_ε,
b) c^* is increasing in $\bar{g}$,
c) c^* is decreasing in k, and

d) c^* is increasing in ϕ whenever σ_ε^2 is low enough. The opposite result may arise when σ_ε^2 is high enough.

Corollary 3 shows that when the government's and society's preferences coincide and there is a certain degree of corruption, the central bank should be at least as conservative as the government. Moreover, we have derived several comparative statics results. In particular, the higher the volatility of supply shocks (σ_ε^2), the less conservative should the central bank be in order to stabilise output. Further, the higher the public spending target ($\bar{g}$), the higher the expected inflation and, thus, the more conservative the central bank would have to be.

In addition, if seigniorage decreases, the central bank should be more conservative. The intuition behind this result is that, in economies with little seigniorage, the effect of an increase in conservativeness on the deviations of output and spending will be negligible. On the other hand, when seigniorage is important, the trade off between a reduction of expected inflation and the increase in the deviations of output and spending becomes relevant. Consequently, the central bank should be more conservative when seigniorage is not important.

Finally, when shocks are not significant and there is more corruption (i.e., a decrease in ϕ), the central bank should be less conservative. Intuitively, if the institutional quality is poorer, there will be less resources available for the government through taxes. Thus, the government will need to collect financing resources through seigniorage and for that reason the central bank should be more accommodative and less conservative. However, the opposite result may arise when σ_ε^2 is high enough. Notice that the higher the volatility of shocks, not only the variance of deviations of output and public spending will be higher, but also the variance of inflation. This will lead to some instances (for instance, when $k > \phi$) where the central bank will need to be more conservative. Following Alesina and Stella (2010), a high value of σ_ε^2 is an alternative way of thinking of a major financial crisis. Therefore, in the case of a major crisis, there are some instances that the central bank should be more conservative when the level of corruption increases.

Next, we are interested, from a normative point of view, in finding the optimal relative weights of the central bank's preferences. By solving the optimisation problem stated in (3.12), we look for the relationship that the optimal values of δ_{CB} and γ_{CB} must satisfy. Therefore, without any loss of generality, as the relevant variable in the optimisation problem of society's welfare is c, we can interpret that we have a degree of freedom when choosing the optimal values of δ_{CB} and γ_{CB}. Consequently, we can suppose that $\gamma_{CB} = 0$, like Debelle and Fischer (1994) and Berger et al. (2001).[4] In this case, the following corollary applies:

Corollary 4. *If the government's and society's preferences coincide and public spending is not included in the preferences of the central bank* ($\gamma_{CB} = 0$)*, the optimal relative weight of output satisfies* $\delta^*_{CB} \in \left(\frac{k}{\phi}\delta_G, \frac{\phi+k}{\phi}\delta_G\right)$.

In this case, in economies where institutional quality is particularly low (i.e., $k > \phi$), the central bank should be less conservative than the government and society in the Rogoff sense (i.e., the central bank should give more importance to output stabilisation than the government). However, we cannot conclude that the central bank should be less conservative in this case, since $c^* > 1$ as Corollary 3 shows. From a normative point of view, we could then justify that public spending does not need to be included in the loss function of the monetary authority, but the consequence of this is that the socially optimal value of δ_{CB} has to be higher than $\frac{k}{\phi}\delta_G$.

3.4 Conclusions

This chapter has studied the effect of institutional quality and seigniorage on the design of an independent and conservative central bank. To that end, Alesina and Tabellini's model (1987) has been extended to include corruption by postulating a connection between the government's fiscal

[4]The advantage of the general model presented here over models that impose restrictions on the parameters is that it allows to study many configurations of preferences. For instante, Huang and Wei's model could not handle the case $\gamma_{CB} = 0$.

capacity and the quality of institutions and to allow different degrees of seigniorage.

In terms of the optimal design of an independent and conservative central bank, we have carried out a welfare analysis by introducing a measure of the degree of conservativeness of the central bank with respect to the government and we have characterised its optimal social value. It is shown that one can design a central bank that cares about public spending, besides output and inflation. A central bank could equally not care about public spending, but then the optimal weight on output stabilisation would have to be higher. Moreover, when the preferences of the government and society coincide, then the central bank should be more conservative than the government, except in the case of complete corruption. In this case, both policymakers should be equally conservative.

Finally, when the shocks affecting the economy are not very significant, the optimal value of conservativeness decreases in the level of corruption. Notice, however, that this result may reverse when the economy is affected by volatile shocks, as in crisis times. Besides, if the degree of seigniorage decreases, the central bank should be more conservative. Therefore, if the variability of shocks is not important, then economies with higher levels of corruption and seigniorage should not design central banks that are too conservative. Two further extensions can be made: first, we could empirically estimate the parameters of the model and test the implications presented here and second, we could endogenise corruption and study the reverse connection, from conservativeness to corruption.

Acknowledgments

We are grateful to all comments received during the 28th Annual Congress of the European Economic Association and 67th European Meeting of the Econometric Society in Gothenburg (Sweden, 2013), during the 8th Portuguese Finance Network in Vilamoura (Portugal, 2014), and during the seminars at Universitat Rovira i Virgili in Reus (Spain, 2013 and 2014). We also acknowledge the financial support from the Spanish Ministry of Science and Innovation (ECO2013-42884-P) and the Generalitat de Catalunya (2014 SGR 631), and from the predoctoral fellowship awarded by Universitat Rovira i Virgili.

Appendix

Proof of Expressions (3.5) and (3.6). If we substitute the Expressions (3.1) and (3.2) into (3.3) and (3.4), we obtain

$$L_G = \frac{1}{2}\left(\pi^2 + \delta_G\left(\pi - \pi^e - \tau + \varepsilon\right)^2 + \gamma_G\left(\phi\tau + k\pi - \bar{g}\right)^2\right) \text{ and}$$

$$L_{CB} = \frac{1}{2}\left(\pi^2 + \delta_{CB}\left(\pi - \pi^e - \tau + \varepsilon\right)^2 + \gamma_{CB}\left(\phi\tau + k\pi - \bar{g}\right)^2\right).$$

The first-order condition of the government's optimisation problem is given by

$$\frac{\partial L_G}{\partial \tau} = -\delta_G\left(\pi - \pi^e - \tau + \varepsilon\right) + \phi\gamma_G\left(\phi\tau + k\pi - \bar{g}\right) = 0,$$

and hence,

$$\tau = \frac{\left(\delta_G - \phi k\gamma_G\right)\pi - \delta_G\left(\pi^e - \varepsilon\right) + \phi\gamma_G\bar{g}}{\delta_G + \phi^2\gamma_G}. \tag{3.13}$$

For the central bank, the first-order condition implies that

$$\frac{\partial L_{CB}}{\partial \pi} = \pi + \delta_{CB}\left(\pi - \pi^e - \tau + \varepsilon\right) + k\gamma_{CB}\left(\phi\tau + k\pi - \bar{g}\right) = 0,$$

or equivalently,

$$\pi = \frac{\delta_{CB}\left(\pi^e + \tau - \varepsilon\right) - k\gamma_{CB}\left(\phi\tau - \bar{g}\right)}{1 + \delta_{CB} + k^2\gamma_{CB}}. \tag{3.14}$$

Plugging the Expression (3.13) into (3.14), it follows that

$$\pi = \frac{\left(\bar{g} + \phi\left(\pi^e - \varepsilon\right)\right)\eta}{\delta_G + \phi^2\gamma_G + \left(\phi + k\right)\eta}, \tag{3.15}$$

where $\eta = \phi\gamma_G\delta_{CB} + k\delta_G\gamma_{CB}$. Taking expectations in the previous equality and solving for π^e, we get

$$\pi^e = \frac{\eta}{\delta_G + \phi^2\gamma_G + k\eta}\bar{g}. \tag{3.16}$$

Substituting the Expression of π^e given in (3.16) into (3.15), we have

$$\pi^* = \frac{\eta}{\delta_G + \phi^2\gamma_G + k\eta}\bar{g} - \phi\frac{\eta}{\delta_G + \phi^2\gamma_G + (\phi + k)\,\eta}\varepsilon. \tag{3.17}$$

Using the Expressions (3.16) and (3.17) in (3.13), and after some algebra, we obtain

$$\tau^* = \phi\frac{\gamma_G}{\delta_G + \phi^2\gamma_G + k\eta}\bar{g} + \frac{\delta_G + k\eta}{\delta_G + \phi^2\gamma_G + (\phi + k)\,\eta}\varepsilon. \blacksquare$$

Proof of Expressions (3.7) and (3.8). The first-order condition of the government's optimisation problem can be rewritten as

$$x = -\frac{\phi\gamma_G}{\delta_G}\left(\bar{g} - g\right). \tag{3.18}$$

Analogously, for the central bank, we have

$$\pi + \delta_{CB}x + k\gamma_{CB}\left(g - \bar{g}\right) = 0.$$

Using the Expression (3.18), it follows that

$$\bar{g} - g^* = \frac{\delta_G}{\eta}\pi^*. \tag{3.19}$$

Hence,

$$0 - x^* = \frac{\phi\gamma_G}{\eta}\pi^*. \blacksquare \tag{3.20}$$

Proof of Expression (3.11). Substituting the Expressions (3.7) and (3.8) into (3.10), we get

$$L_S = \frac{1}{2}\left(\pi^2 + \delta_S\left(\frac{\phi\gamma_G}{\eta}\pi\right)^2 + \gamma_S\left(\frac{\delta_G}{\eta}\pi\right)^2\right),$$

or equivalently,

$$L_S = \frac{1}{2}\pi^2\left(1 + \delta_S\left(\frac{\phi c}{(\phi+k)\,\delta_G}\right)^2 + \gamma_S\left(\frac{c}{(\phi+k)\,\gamma_G}\right)^2\right),$$

since

$$\eta = \frac{(\phi+k)\,\delta_G\gamma_G}{c}. \tag{3.21}$$

Taking expectations, we get

$$E\left[L_S\right] = \frac{1}{2}E\left(\pi^2\right)\left(1 + \delta_S\left(\frac{\phi c}{(\phi+k)\,\delta_G}\right)^2 + \gamma_S\left(\frac{c}{(\phi+k)\,\gamma_G}\right)^2\right).$$

Moreover, using the Expression(3.21) in (3.6), we obtain

$$\pi = \frac{(\phi+k)\,\delta_G\gamma_G}{D_1(c)}\bar{g} - \frac{\phi\,(\phi+k)\,\delta_G\gamma_G}{D_2(c)}\varepsilon,$$

where

$$\begin{aligned} D_1(c) &= c\left(\delta_G + \phi^2\gamma_G\right) + (\phi + k)\, k\delta_G\gamma_G \text{ and} \\ D_2(c) &= c\left(\delta_G + \phi^2\gamma_G\right) + (\phi + k)^2\, \delta_G\gamma_G. \end{aligned}$$

Hence,

$$E\left(\pi^2\right) = \left(E\left(\pi\right)\right)^2 + var\left(\pi\right) = \left(\frac{(\phi + k)\,\delta_G\gamma_G}{D_1(c)}\bar{g}\right)^2 + \left(\frac{\phi\,(\phi + k)\,\delta_G\gamma_G}{D_2(c)}\right)^2 \sigma_\varepsilon^2.$$

Using this expression in the last formula for $E\left[L_S\right]$, direct computations yield

$$\begin{aligned} E\left[L_S\right] &= \Omega\left(\left(\frac{1}{D_1(c)}\bar{g}\right)^2 + \left(\frac{\phi}{D_2(c)}\right)^2 \sigma_\varepsilon^2\right) \\ &\quad \left(1 + \delta_S\left(\frac{\phi c}{(\phi + k)\,\delta_G}\right)^2 + \gamma_S\left(\frac{c}{(\phi + k)\,\gamma_G}\right)^2\right), \end{aligned}$$

where $\Omega = \frac{1}{2}\left(\phi + k\right)^2 \gamma_G^2\delta_G^2$. ■

Proof of Proposition 1. Recall that $E(\pi) = \frac{(\phi+k)\delta_G\gamma_G}{c\left(\delta_G+\phi^2\gamma_G\right)+(\phi+k)k\delta_G\gamma_G}\bar{g}$ and $var\left(\pi\right) = \left(\frac{\phi(\phi+k)\delta_G\gamma_G}{c\left(\delta_G+\phi^2\gamma_G\right)+(\phi+k)^2\delta_G\gamma_G}\right)^2 \sigma_\varepsilon^2$. Moreover, taking into account the Expressions (3.19), (3.20) and (3.21), it follows that

$$E\left(0 - x\right) = \frac{c\phi\gamma_G}{c\left(\delta_G + \phi^2\gamma_G\right) + (\phi + k)\, k\delta_G\gamma_G}\bar{g},$$

$$var\left(0 - x\right) = \frac{c^2\phi^4\gamma_G^2}{\left(c\left(\delta_G + \phi^2\gamma_G\right) + (\phi + k)^2\,\delta_G\gamma_G\right)^2}\sigma_\varepsilon^2,$$

$$E\left(\bar{g} - g\right) = \frac{c\delta_G}{c\left(\delta_G + \phi^2\gamma_G\right) + (\phi + k)\, k\delta_G\gamma_G}\bar{g} \text{ and}$$

$$var\left(\bar{g} - g\right) = \frac{c^2\phi^2\delta_G^2}{\left(c\left(\delta_G + \phi^2\gamma_G\right) + (\phi + k)^2\,\delta_G\gamma_G\right)^2}\sigma_\varepsilon^2.$$

Differentiating these expressions, we have that $\frac{\partial}{\partial c}E(\pi) < 0$, $\frac{\partial}{\partial c}var(\pi) < 0$, $\frac{\partial}{\partial c}E\left(0 - x\right) > 0$, $\frac{\partial}{\partial c}E\left(\bar{g} - g\right) > 0$, $\frac{\partial}{\partial c}var\left(0 - x\right) > 0$ and $\frac{\partial}{\partial c}var\left(\bar{g} - g\right) > 0$. ■

Proof of Proposition 2. Let's minimise the expected value of the loss function for society

$$\min_{c} E\left[L_S\right].$$

The first-order condition of this optimisation problem is given by

$$\frac{\partial E\left[L_S\right]}{\partial c} = \frac{2\Omega\left(\phi^2\gamma_G^2\delta_S + \delta_G^2\gamma_S\right)}{\left(\phi + k\right)\delta_G\gamma_G}\left(\frac{kc - \left(\phi + k\right)\beta}{\left(D_1(c)\right)^3}\bar{g}^2 + \phi^2\left(\phi + k\right)\frac{c - \beta}{\left(D_2(c)\right)^3}\sigma_\varepsilon^2\right) = 0, \tag{3.22}$$

where

$$\beta = \frac{\delta_G\gamma_G\left(\delta_G + \phi^2\gamma_G\right)}{\delta_G^2\gamma_S + \phi^2\gamma_G^2\delta_S}.$$

Thus, we can distinguish two cases:

Case A: $\phi = 0$. In this case, from the Expression (3.22) we get that $c^* = \beta = \frac{\gamma_G}{\gamma_S}$.

Case B: $\phi > 0$. Note that if $c > \frac{\phi+k}{k}\beta$, then $\frac{\partial}{\partial c}E\left[L_S\right] > 0$. Otherwise, if $c < \beta$, then $\frac{\partial}{\partial c}E\left[L_S\right] < 0$. Hence, we know that there exists a value of c belonging to the interval $\left(\beta, \frac{\phi+k}{k}\beta\right)$ that satisfies the first-order condition.

In relation to the second-order condition note that

$$\frac{\partial^2 E[L_S]}{\partial^2 c} = -\frac{2\Omega\left(\phi^2\gamma_G^2\delta_S + \delta_G^2\gamma_S\right)}{(\phi+k)\delta_G\gamma_G}\left(\frac{\left(\delta_G+\phi^2\gamma_G\right)(2ck-3(\phi+k)\beta)-(\phi+k)k^2\delta_G\gamma_G}{(D_1(c))^4}\bar{g}^2 + \right.$$
$$\left. +\phi^2\left(\phi + k\right)\frac{\left(\delta_G+\phi^2\gamma_G\right)(2c-3\beta)-(\phi+k)^2\delta_G\gamma_G}{(D_2(c))^4}\sigma_\varepsilon^2\right).$$

In a value of c that satisfies the first-order condition, it holds that

$$\bar{g}^2 = -\phi^2\left(\phi + k\right)\frac{\left(c - \beta\right)\left(D_1(c)\right)^3}{\left(kc - \left(\phi + k\right)\beta\right)\left(D_2(c)\right)^3}\sigma_\varepsilon^2. \tag{3.23}$$

Using the Expression (3.23) in the expression of $\frac{\partial^2 E[L_S]}{\partial^2 c}$, we get

$$\frac{\partial^2 E\left[L_S\right]}{\partial^2 c} = \frac{2\Omega\phi^3\left(\phi^2\gamma_G^2\delta_S + \delta_G^2\gamma_S\right)p(c)}{\left(\left(\phi+k\right)\beta - kc\right)\delta_G\gamma_G\left(D_1(c)\right)\left(D_2(c)\right)^4}\sigma_\varepsilon^2,$$

where $p(c) = p_2c^2 + p_1c + p_0$, with

$$\begin{aligned} p_2 &= \left(\delta_G + \phi^2\gamma_G\right)\left(\beta\left(\delta_G + \phi^2\gamma_G\right) - 3\left(\phi+k\right)k\delta_G\gamma_G\right), \\ p_1 &= 4\left(\phi+k\right)\left(\phi+2k\right)\beta\delta_G\gamma_G\left(\delta_G+\phi^2\gamma_G\right) \text{ and} \\ p_0 &= \left(\phi+k\right)^2\beta\delta_G\gamma_G\left(-3\beta\left(\delta_G+\phi^2\gamma_G\right) + \left(\phi+k\right)k\delta_G\gamma_G\right). \end{aligned}$$

Now, we distinguish two cases:

Case 1: If $\left(\beta\left(\delta_G + \phi^2\gamma_G\right) - 3\left(\phi+k\right)k\delta_G\gamma_G\right) < 0$, then we conclude that $p(c)$ has a root strictly higher than $\frac{\phi+k}{k}\beta$ and another root strictly smaller than β since $p(\beta) > 0$ and $p(\frac{\phi+k}{k}\beta) > 0$.

Case 2: If $\left(\beta\left(\delta_G + \phi^2\gamma_G\right) - 3\left(\phi+k\right)k\delta_G\gamma_G\right) \geq 0$, then $p(c)$ is increasing in the interval $\left(\beta, \frac{\phi+k}{k}\beta\right)$. Moreover, in this case it also holds $p(\beta) > 0$.

Therefore, in both cases we conclude that $p(c) > 0$ whenever $c \in \left(\beta, \frac{\phi+k}{k}\beta\right)$. Consequently, it follows that in a value of c that satisfies the first-order condition, $\frac{\partial^2}{\partial^2 c}E\left[L_S\right] > 0$. This guarantees that the value c that solves the first-order condition is unique and it is a minimum. ■

Proof of Corollary 3. a) When the preferences of the government and society coincide $\beta = 1$. In this case, from the first-order condition, we know that c^* satisfies

$$F(c^*, \sigma_\varepsilon^2) = 0,$$

where

$$F(c, \sigma_\varepsilon^2) = \left(\frac{kc - \left(\phi+k\right)}{\left(D_1(c)\right)^3}\bar{g}^2 + \phi^2\left(\phi+k\right)\frac{c-1}{\left(D_2(c)\right)^3}\sigma_\varepsilon^2\right).$$

In addition, from the second-order condition, it follows that $\frac{\partial F}{\partial c}(c^*, \sigma_\varepsilon^2) > 0$. Applying the Implicit Function Theorem, we get

$$\text{sign}\left(\frac{\partial c^*}{\partial \sigma_\varepsilon^2}\right) = -\text{sign}\left(\frac{\partial F}{\partial \sigma_\varepsilon^2}(c^*, \sigma_\varepsilon^2)\right).$$

Moreover, notice that

$$\frac{\partial F}{\partial \sigma_\varepsilon^2}(c^*, \sigma_\varepsilon^2) = \phi^2 (\phi + k) \frac{c^* - 1}{(D_2(c^*))^3}.$$

As $c^* > 1$, we can conclude that $\frac{\partial F}{\partial \sigma_\varepsilon^2}(c^*, \sigma_\varepsilon^2) > 0$, and hence, $\frac{\partial c^*}{\partial \sigma_\varepsilon^2} < 0$.

b) In this case, from the first-order condition, we know that c^* satisfies

$$F(c^*, \bar{g}) = 0,$$

where

$$F(c, \bar{g}) = \frac{kc - (\phi + k)}{(D_1(c))^3}\bar{g}^2 + \phi^2 (\phi + k) \frac{c - 1}{(D_2(c))^3}\sigma_\varepsilon^2.$$

Besides, from the second-order condition, it follows that $\frac{\partial F}{\partial c}(c^*, \bar{g}) > 0$. Combining this result and the Implicit Function Theorem, we get

$$\text{sign}\left(\frac{\partial c^*}{\partial \bar{g}}\right) = -\text{sign}\left(\frac{\partial F}{\partial \bar{g}}(c^*, \bar{g})\right).$$

In addition, after some algebra, it follows that

$$\frac{\partial F}{\partial \bar{g}}(c^*, \bar{g}) = 2\frac{kc^* - (\phi + k)}{(D_1(c^*))^3}\bar{g},$$

As $1 < c^* < \frac{\phi + k}{k}$, it follows that $\frac{\partial F}{\partial \bar{g}}(c^*, \bar{g}) < 0$. This allows us to conclude that $\frac{\partial c^*}{\partial \bar{g}} > 0$.

c) Note that, from the first-order condition, we know that c^* satisfies

$$F(c^*, k) = 0,$$

where

$$F(c,k) = \left(\frac{kc - (\phi + k)}{(D_1(c))^3} \bar{g}^2 + \phi^2 (\phi + k) \frac{c-1}{(D_2(c))^3} \sigma_\varepsilon^2 \right).$$

In addition, from the second-order condition, it follows that $\frac{\partial F}{\partial c}(c^*, k) > 0$. Applying the Implicit Function Theorem, we get

$$\text{sign} \left(\frac{\partial c^*}{\partial k} \right) = -\text{sign} \left(\frac{\partial F}{\partial k}(c^*, k) \right).$$

Furthermore, after some algebra, it follows that

$$\frac{\partial F}{\partial k}(c,k) = \left(\frac{\left(\delta_G + \phi^2\gamma_G\right)c^2 - \left(\delta_G + \phi^2\gamma_G + (2\phi+5k)k\delta_G\gamma_G\right)c + (\phi+k)(3\phi+5k)\delta_G\gamma_G}{(D_1(c))^4} \bar{g}^2 + \right.$$
$$\left. (c-1)\,\phi^2 \frac{\left(\delta_G + \phi^2\gamma_G\right)c - 5(\phi+k)^2\delta_G\gamma_G}{(D_2(c))^4} \sigma_\varepsilon^2 \right),$$

and from the Expression (3.23), $\sigma_\varepsilon^2 = -\frac{(ck-(\phi+k))(D_2(c))^3}{\phi^2(\phi+k)(c-1)(D_1(c))^3}\bar{g}^2$. Substituting this formula in the previous equality and operating

$$\frac{\partial F}{\partial k}(c^*, k) = \frac{\phi \left(\delta_G + \phi^2\gamma_G\right)^2 q\left(\frac{\delta_G\gamma_G}{\delta_G+\phi^2\gamma_G}\right)}{(\phi+k)\,(D_1(c^*))^4\,(D_2(c^*))} \bar{g}^2,$$

where

$$q(z) = (\phi+k)^3 \left(3(\phi+k) - 2c^*k\right) z^2 + (\phi+k)\left(-3(\phi+k)c^* + (\phi+5k)\right) c^* z + c^{*3}.$$

Next, we distinguish two cases: $k \geq \phi$ and $k < \phi$.

Case 1: $k \geq \phi$. In this case, $1 \geq \frac{3(\phi+k)}{\phi+5k}$. Using the expression of $q(z)$, for all $c \geq 1 \geq \frac{3(\phi+k)}{\phi+5k}$ $q(z) > 0$ whenever $z > 0$, which implies that $\frac{\partial F}{\partial k}(c^*) > 0$.

Case 2: $k < \phi$. In this case, $1 < \frac{3(\phi+k)}{\phi+5k} < \frac{\phi+k}{k}$. First, doing a similar reasoning as in Case 1, we conclude that $\frac{\partial F}{\partial k}(c^*) > 0$ whenever $c \geq \frac{3(\phi+k)}{\phi+5k}$. Now, suppose that $1 \leq c < \frac{3(\phi+k)}{\phi+5k}$. From direct computations, the minimum of $q(z)$ is $\overline{z} = \frac{-c(\phi+k)(-3(\phi+k)+c(\phi+5k))}{2(\phi+k)^3(3(\phi+k)-2ck)}$ and $q(\overline{z}) > 0$, as $k < \phi$ and $1 \leq c < \frac{3(\phi+k)}{\phi+5k}$. Consequently, in this case it is also true that $q(z) > 0$ whenever $z > 0$ and, hence, $\frac{\partial F}{\partial k}(c^*, k) > 0$.

d) Finally, we rewrite the first-order condition as follows:

$$F(c^*, \phi) = 0,$$

where

$$F(c, \phi) = \left(\frac{kc - (\phi + k)}{(D_1(c))^3} \bar{g}^2 + \phi^2 (\phi + k) \frac{c - 1}{(D_2(c))^3} \sigma_\varepsilon^2 \right).$$

Besides, from the second-order condition, it follows that $\frac{\partial F}{\partial c}(c^*, \phi) > 0$. Applying the Implicit Function Theorem, we get

$$\text{sign}\left(\frac{\partial c^*}{\partial \phi}\right) = -\text{sign}\left(\frac{\partial F}{\partial \phi}(c^*, \phi)\right).$$

Moreover, after some algebra, it follows that

$$\frac{\partial F}{\partial \phi}(c, \phi) = \left(-\frac{6\phi k c^2 \gamma_G + \left(\delta_G - \phi(5\phi+6k)\gamma_G + 3k^2 \delta_G \gamma_G\right)c - 2(\phi+k)k\delta_G\gamma_G}{(D_1(c))^4} \bar{g}^2 + \right.$$
$$\left. \phi\,(c-1) \frac{\left((3\phi+2k)\delta_G - \phi^2(3\phi+4k)\gamma_G\right)c - \left((\phi+k)^2(3\phi-2k)\delta_G\gamma_G\right)}{(D_2(c))^4} \sigma_\varepsilon^2 \right),$$

and from the Expression (3.23), $\sigma_\varepsilon^2 = -\frac{(ck-(\phi+k))(D_2(c))^3}{\phi^2(\phi+k)(c-1)(D_1(c))^3}\bar{g}^2$. Substituting this formula in the previous equality and operating

$$\frac{\partial F}{\partial \phi}(c^*, \phi) = \frac{q(c^*)}{\phi\,(\phi + k)\,D_2(c^*)\,(D_1(c^*))^4} \bar{g}^2, \tag{3.24}$$

where

$$q(c) = q_3 c^3 + q_2 c^2 + q_1 c + q_0,$$

with

$$\begin{aligned}
q_3 &= -(3\phi + 2k)\, k \left(\delta_G + \phi^2 \gamma_G\right)^2, \\
q_2 &= (\phi + k) \Big(2(\phi + k)\left(\delta_G + \phi^2\gamma_G\right)^2 \\
&\quad - k\delta_G\gamma_G \left(\left(5\phi k - 3\phi^2 + 4k^2\right)\delta_G + \phi^2\left(11\phi k + 3\phi^2 + 4k^2\right)\gamma_G\right)\Big), \\
q_1 &= (\phi + k)^2 \delta_G \gamma_G \Big((3\phi + 4k)\, k\delta_G + 2\phi^2\left(\phi^2\gamma_G - 2\delta_G\right) \\
&\quad + k\left(\phi^2(9\phi + 4k) - 2(\phi + k)\, k^2 \delta_G\right)\gamma_G\Big) \text{ and} \\
q_0 &= (\phi + k)^4 (2k - \phi)\, k\delta_G^2 \gamma_G^2.
\end{aligned}$$

Note that

$$q\left(\frac{\phi + k}{k}\right) < 0 \text{ and}$$

$$\begin{aligned}
q(1) = {} & 3\phi^2\left(\delta_G^2 + \phi^4\gamma_G^2 + 2\phi^2\delta_G\gamma_G + 8\phi^4\delta_G\gamma_G^2\right) + \\
& \phi(k - \phi)\Big((\phi + k)^3 k\delta_G^2\gamma_G^2 + 2\phi^2\left(6\phi k + 11\phi^2 + k^2\right)\delta_G\gamma_G^2 \\
& + \phi^4\gamma_G^2 + 2(\phi + k)(2\phi + k)\,\delta_G^2\gamma_G + 2\phi^2\delta_G\gamma_G + \delta_G^2\Big).
\end{aligned}$$

Combining these results and the Expression (3.24), we can conclude that if σ_ε^2 is low enough, as c^* is close to $\frac{\phi+k}{k}$, then $\frac{\partial F}{\partial \phi}(c^*, \phi) < 0$, and hence, $\frac{\partial c^*}{\partial \phi} > 0$. In contrast, if σ_ε^2 is high enough, then c^* is close to 1. Notice that there are parameter configurations (for instance, $k > \phi$) such that $q(1) > 0$, which implies that $\frac{\partial F}{\partial \phi}(c^*, \phi) > 0$, and hence, $\frac{\partial c^*}{\partial \phi} < 0$. Consequently, we show that $\frac{\partial c^*}{\partial \phi} < 0$ may hold when σ_ε^2 is high enough. ■

Proof of Corollary 4. This is omitted since it immediately follows from Corollary 3. ■

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Chapter 4

The Effects of Corruption in a Monetary Union

4.1 Introduction

The last anti-corruption report from the European Commission shows that corruption costs around 120 billion euros per year to the European Union 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]

Academic 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, in an economic sense, whether a corrupt country affects other Member State in a monetary union? In this chapter, we study how the degree of corruption in one country would affect its own economy as well as that of the other country. To the best of our knowledge, the consequence of this question has not been examined. This chapter aims to fill this void.

[1]See Fig. 4.3 in the Appendix.

In the monetary union presented here, there are two countries. We denote by *country 1* the country with a corrupt government and by *country 2* the country with a completely efficient government. In this context, we explore (i) how corruption in country 1 affects the main macroeconomic variables in both countries, and more importantly, (ii) how country 1 may compensate the other country in case that corruption generates a negative externality to country 2.

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 the 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 sufficiently 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 by country 2 to decrease its public spending target 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.

This chapter 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 target levels between countries and there is only one country with a corrupt government. Besides, we model corruption as a share of tax revenue and our purpose is to analyse the effects of corruption on both countries. Hefeker (2010) focuses on the implications of a move from a national autonomy to a monetary union. He finds that, under some conditions, taxes decrease and inflation, output and public spending increase. Besides, he obtains that if the new member country brings a large finance gap and a high level of corruption into the monetary union, the common central bank sets a higher inflation.

The second strand of related literature deals with how corruption is modeled. In that regard, we follow Huang and Wei (2006). They find that corruption can make a country better off if its government is unable to make binding commitments and assigns a larger weight to output than to inflation stabilisation. Although these authors focus on the effects of institutional quality on monetary and fiscal policies in only one country, they do not set their analysis in a monetary union.

The third branch of literature looks at asymmetries between countries, as in 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 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.

The chapter is organised as follows. Section 4.2 sets up the model. Section 4.3 studies the effects of corruption on the main macroeconomic variables of both countries. Concluding remarks are presented in Section 4.4 and proofs are gathered in the Appendix.

4.2 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 target levels among countries.

We assume that there are two member countries and a common central bank in a monetary union. Each country i, $i = 1, 2$, 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 is a simplified Lucas supply function and it is described by

$$x_i = \pi - \pi^e - \tau_i, \tag{4.1}$$

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

The fiscal authorities face the following budget constraints:

$$g_1 = \phi\tau_1 \text{ and} \tag{4.2}$$

$$g_2 = \tau_2, \tag{4.3}$$

where g_i denotes the ratio of public expenditures over output in country i.[2] 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 modeled 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.

[2]The derivation of Expressions (4.1), (4.2) and (4.3) is omitted since it is analogous to the derivation of Expressions (2.1) and (2.2) in Chapter 2 (included in the Appendix).

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

We assume 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

$$L_i = \frac{1}{2}\left[\pi^2 + \delta_i\left(x_i - \bar{x}_i\right)^2 + \gamma_i\left(g_i - \bar{g}_i\right)^2\right], \tag{4.4}$$

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

$$L_{CCB} = \frac{1}{2}\left[\pi^2 + \delta_{CCB}\left(zx_1 + (1-z)\,x_2 - \left(z\bar{x}_1 + (1-z)\,\bar{x}_2\right)\right)^2\right], \tag{4.5}$$

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), we allow disagreement among the authorities regarding their relative weights. Specifically, the disagreement is between countries ($\delta_1 \neq \delta_2$ and/or $\gamma_1 \neq \gamma_2$) and between countries and the monetary authority ($\delta_i \neq \delta_{CCB}$). It is worth mentioning that both papers presume 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.

[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.

In the previous loss functions, the parameters $\bar{x}_i$ and $\bar{g}_i$ represent the output and public spending targets in country i, respectively. Allowing different output and spending targets reflects 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 equilibrium values of public spending rates are positive.

The sequence of events is as follows:

1. Rational expectations are formed.

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

The model is solved by backward induction. From the first-order conditions of the authorities' optimisation problems, we obtain the following reaction functions:

$$\tau_1 = \frac{\bar{g}_1}{\phi} - \frac{\frac{\delta_1}{\gamma_1}}{\phi\left(\phi^2 + \frac{\delta_1}{\gamma_1}\right)}\left(\phi\bar{x}_1 + \bar{g}_1\right) + \frac{\frac{\delta_1}{\gamma_1}}{\phi^2 + \frac{\delta_1}{\gamma_1}}\left(\pi - \pi^e\right), \tag{4.6}$$

$$\tau_2 = \bar{g}_2 - \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}}\left(\bar{x}_2 + \bar{g}_2\right) + \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}}\left(\pi - \pi^e\right) \text{ and} \tag{4.7}$$

$$\pi = \frac{\delta_{CCB}}{1 + \delta_{CCB}}\left(\pi^e + z\left(\tau_1 + \bar{x}_1\right) + (1 - z)\left(\tau_2 + \bar{x}_2\right)\right). \tag{4.8}$$

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:*

$$\tau_1^* = \frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1 + \phi\bar{g}_1}{\phi^2 + \frac{\delta_1}{\gamma_1}}, \tag{4.9}$$

$$\tau_2^* = \frac{-\frac{\delta_2}{\gamma_2}\bar{x}_2 + \bar{g}_2}{1 + \frac{\delta_2}{\gamma_2}}, \textit{ and} \tag{4.10}$$

$$\pi^* = z\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1+\bar{g}_1\right)+(1-z)\frac{\delta_{CCB}}{1+\frac{\delta_2}{\gamma_2}}\left(\bar{x}_2+\bar{g}_2\right). \tag{4.11}$$

Moreover, using the Expressions (4.9) and (4.10), it follows that, in equilibrium, the values of output and public spending rates are given by

$$x_1^* = \frac{\frac{\delta_1}{\gamma_1}\bar{x}_1-\phi\bar{g}_1}{\phi^2+\frac{\delta_1}{\gamma_1}}, \tag{4.12}$$

$$x_2^* = \frac{\frac{\delta_2}{\gamma_2}\bar{x}_2-\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}}, \tag{4.13}$$

$$g_1^* = \phi\frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1+\phi\bar{g}_1}{\phi^2+\frac{\delta_1}{\gamma_1}}, \text{ and} \tag{4.14}$$

$$g_2^* = \frac{-\frac{\delta_2}{\gamma_2}\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}}. \tag{4.15}$$

Table 4.1 captures the effects of parameters on inflation, output and public spending for both countries.

	$\bar{x}_1$	$\bar{x}_2$	$\bar{g}_1$	$\bar{g}_2$	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 4.1: 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 4.11). Besides, the fiscal authority of country i decreases its tax rate in order to be closer to its output target (see the Expressions 4.9 and 4.10). As a result, the reduction in tax rates gives rise to an increase in the output level of country i and a decrease in its public spending. Notice that in this basic model an increase in $\bar{x}_i$ has no effect on the behaviour of the other fiscal authority (see the

Expressions 4.9 and 4.10). Hence, the changes in $\bar{x}_i$ do not affect the output and the 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. Note that the increase in the inflation rate is predicted by price-setters and then output of country i is only affected by the change in its tax rate.

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 main macroeconomic variables. 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 growth and public spending rates of both countries are not affected by the changes in δ_{CCB}. As we have mentioned previously, the increase in the inflation rate is predicted by price-setters and then output and public spending of country i are only affected by the change in its tax rate (see the Expressions 4.6 and 4.7).

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 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 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.

4.3 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. The following corollary summarises the impact of a change in ϕ on output, public spending and inflation rates:

Corollary 2. *In equilibrium:*
a) as the degree of corruption of country 1 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 of country 1 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 of country 1.

Corollary 2 indicates that the effects of corruption on both the output growth rate of country 1 and the inflation rate depend on how much the fiscal authority of country 1 cares about stabilising its public spending with respect to inflation stabilisation (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 with the degree of corruption. On the other hand, the opposite result holds whenever $\gamma_1 < \bar{\gamma}_1$. In addition, Corollary 2b suggests that an increase in the degree of corruption always leads to a decrease in the public spending of country 1. Finally, Corollary 2c shows that the output and public spending of country 2 are not affected by changes in corruption.

The rationale behind Corollary 2 is as follows. When the fiscal authority of country 1 gives a high relative weight to public spending stabilisation ($\gamma_1 > \bar{\gamma}_1$), an increase with the degree of corruption causes an increase in the tax rate of country 1. This raise in the tax rate increases the incentive to inflate by the central bank, as shown in the Expression (4.8). As the increase in the inflation rate is predicted by price-setters, the output of country 1 is only affected by the change in the tax rate and, therefore, the output of country 1 decreases with 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 with 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 not really 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 the Expression (4.10). Therefore, the output and public spending rates of country 2 are independent of the degree of corruption.

The effects of corruption on the main macroeconomic objectives are summarised in Figure 4.1.

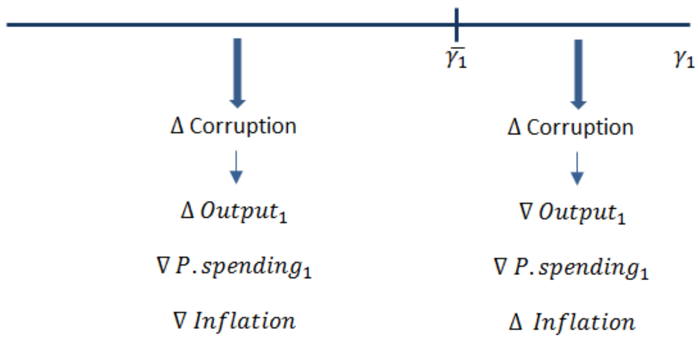

Figure 4.1: The effects of the degree of corruption according to the relative weight on public spending of country 1.

4.3.1 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 the government's losses coincide with society's losses. This is because if the government has been elected by society, its preferences will be close to the society's in order to be re-elected (Beetsma and Bovenberg, 1998; 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 this country 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 not really concerned about public spending stabilisation ($\gamma_1 < \tilde{\gamma}_1$), an increase in the degree of corruption favours both countries, whereas the reverse result holds if $\gamma_1 > \bar{\gamma}_1$.

Corollary 3. *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* $\tilde{\gamma}_1 < \bar{\gamma}_1$,[5] *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 an increase in the degree 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 a high relative weight to public spending stabilisation ($\gamma_1 > \bar{\gamma}_1$), Corollary 2 shows that the inflation rate goes up and, hence, we can conclude that the losses in country 2 increase. Moreover, Corollary 2 also points out that the output and public spending rates of country 1 decrease in the degree of corruption, and therefore, the deviations from their respective targets increase. Thus, we can also conclude that, in

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

this case, the losses in country 1 also increase and, hence, this leads to conclude that both countries are worse off with an increase in the level of corruption. However, if the fiscal authority of country 1 is not really 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, an increase in the degree of 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, Figure (4.2) represents the effects of corruption on losses in both countries in equilibrium.

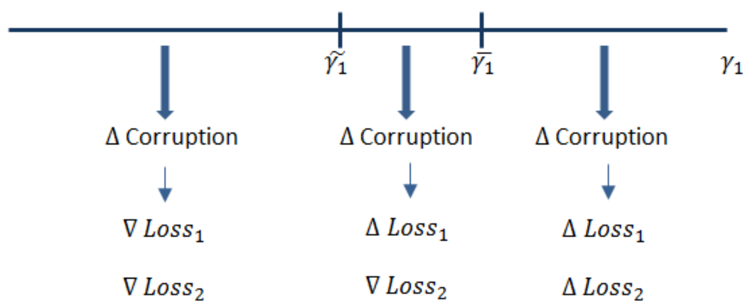

Figure 4.2: Relationship between corruption and losses in equilibrium.

As indicated in Fig. 4.2, 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 an increase in the level of 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 stabilisation. 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.

4.3.1.1 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., $L_2^*(\phi) - L_2^*(1) > 0$.[6] Combining the expression of the losses in country 2 and Corollary 2, 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 the Expression (4.11), 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.[7] 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

[6] $L_2^*(\phi)$ 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.

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

that reduce inflation would be effective. By virtue of (4.11), we can conclude that the implementation of some austerity measures in country 1 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.[8] In this new framework, the fiscal authority of country 1 selects the tax rate that minimises the loss function 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 4. *Country 2 is fully compensated for the negative externality caused by country 1 (corruption) if* $\bar{g}_1^R = \bar{g}_1 - \Psi$, *where* $\Psi = (1-\phi)\frac{\gamma_1 - \delta_1 \frac{(1+\phi)\bar{x}_1 + \bar{g}_1}{\phi \bar{g}_1}}{\delta_1 + \gamma_1}\bar{g}_1$.

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

$$\begin{aligned} L_1^*(\Psi) &= \frac{1}{2}\Bigg(\Bigg(z\frac{\phi\delta_{CCB}}{\phi^2 + \frac{\delta_1}{\gamma_1}}(\phi\bar{x}_1 + \bar{g}_1 - \Psi) \\ &\quad + (1-z)\frac{\delta_{CCB}}{1+\frac{\delta_2}{\gamma_2}}(\bar{x}_2 + \bar{g}_2)\Bigg)^2 \\ &\quad + \delta_1\left(\frac{\frac{\delta_1}{\gamma_1}\bar{x}_1 - \phi(\bar{g}_1 - \Psi)}{\phi^2 + \frac{\delta_1}{\gamma_1}} - \bar{x}_1\right)^2 \\ &\quad + \gamma_1\left(\phi\frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1 + \phi(\bar{g}_1 - \Psi)}{\phi^2 + \frac{\delta_1}{\gamma_1}} - \bar{g}_1\right)^2\Bigg), \end{aligned} \tag{4.16}$$

[8] A similar analysis could be performed assuming a reduction in the relative weight associated to public spending of country 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 5. *If the fiscal authority of country 1 is not really 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 a high relative weight to public spending stabilisation ($\gamma_1 > \widehat{\gamma_1}$), this country is worse off with such a measure.*[9]

Suppose that $\gamma_1 > \widehat{\gamma_1}$. In this case, it would be interesting to study (i) under which conditions country 1 would be willing to accept the austerity measure and remain in the monetary union and, (ii) under which conditions country 1 would reject the measure and, as a result, country 1 would 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, the losses are given by

$$
\begin{aligned}
L_1^{NM*} &= \frac{1}{2}\left(\left(\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1+\bar{g}_1\right)\right)^2\right. \\
&\left. +\delta_1\left(\frac{\frac{\delta_1}{\gamma_1}\bar{x}_1-\phi\bar{g}_1}{\phi^2+\frac{\delta_1}{\gamma_1}}-\bar{x}_1\right)^2+\gamma_1\left(\phi\frac{-\frac{\delta_1}{\gamma_1}\bar{x}_1+\phi\bar{g}_1}{\phi^2+\frac{\delta_1}{\gamma_1}}-\bar{g}_1\right)^2\right),
\end{aligned} \tag{4.17}
$$

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

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

Notice that country 1 has incentives to leave the monetary union if and only if $L_1^*(\Psi) > L_1^{NM*}$. From the Expressions (4.16) and (4.17), it follows that inflation rate is lower if country 1 decides to remain in the monetary 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 decides to remain in the monetary union, while the public spending deviation is lower if country 1 chooses to leave the monetary union. This leads us to the following conclusion:

Corollary 6. *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 decides to remain in the monetary union and country 1 is highly concerned about this fact (i.e., γ_1 and $\frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}}$ are low enough).*

4.3.1.2 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. 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 4.1). Thus, Corollary 5 suggests that if Greece is not really concerned about public spending stabilisation, this country would be better off with a reduction in its public spending target. By contrast, if Greece gives a high 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 EMU and, from our study, Corollary 6 provides the following intuitions: if (i) Greece not really concerned about its public spending stabilisation, (ii) the output and public spending targets of other countries of the EMU are low, and (iii) these last countries are very concerned about output stabilisation (or not very concerned about public spending stabilisation), Greece's optimal decision would be to remain in the EMU. Otherwise, if Greece is very concerned about stabilising its spending, '*Grexit*' from the Eurozone would be the optimal decision for Greece and, consequently, the reduction in its public spending would not be implemented.

4.4 Conclusions

In this chapter, we have examined the effects of corruption in a monetary union with two countries. To do so, we have extended the model of Hefeker (2010) to consider more asymmetry between countries, i.e., different preferences on the authorities' objectives and different output target levels among countries. However, we have focused 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 a high 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 not really 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 a high relative weight to public spending stabilisation.

Third, we argue that country 2 could require a reduction in the public spending target of 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 target, 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 a high 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.

Acknowledgments

We are grateful to all comments received during the seminars at Universitat Rovira i Virgili in Reus (2015). Financial support from project ECO2013-42884-P, project 2014 SGR 631, and from the fellowship granted by Universitat Rovira i Virgili are also gratefully acknowledged.

Appendix

Appendix A: Figure

Figure 4.3 illustrates the EMU and World Rankings. The first position means the cleanest country. By contrast, the last position is the most corrupt country.

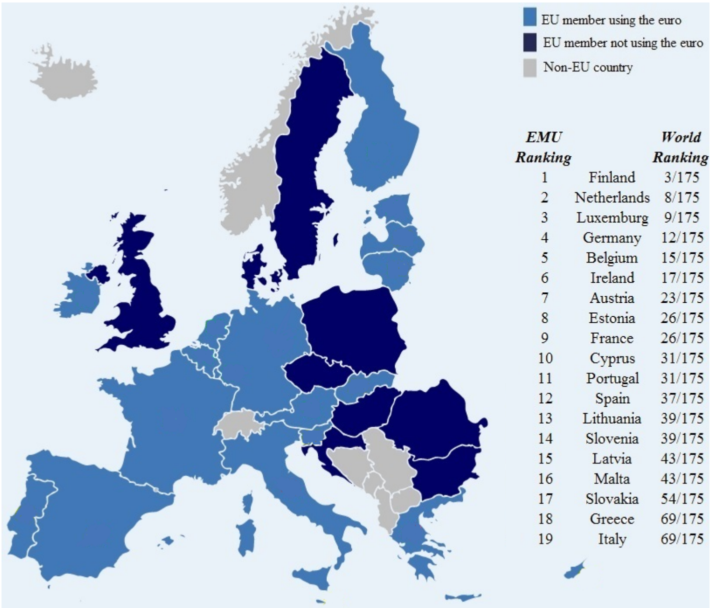

Figure 4.3: The Corruption Perception Index in the European Monetary Union.

Appendix B: Proofs

Proof of Proposition 1. Substituting the Expressions (4.1), (4.2) and (4.3) into (4.4) and (4.5), it follows that

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

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

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,

$$\tau_1 = \frac{\bar{g}_1}{\phi} - \frac{\frac{\delta_1}{\gamma_1}}{\phi\left(\phi^2 + \frac{\delta_1}{\gamma_1}\right)} (\phi\bar{x}_1 + \bar{g}_1) + \frac{\frac{\delta_1}{\gamma_1}}{\phi^2 + \frac{\delta_1}{\gamma_1}} (\pi - \pi^e) \text{ and} \tag{4.18}$$

$$\tau_2 = \bar{g}_2 - \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}} (\bar{x}_2 + \bar{g}_2) + \frac{\frac{\delta_2}{\gamma_2}}{1 + \frac{\delta_2}{\gamma_2}} (\pi - \pi^e). \tag{4.19}$$

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

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

Thus,

$$\pi = \frac{\delta_{CCB}}{1+\delta_{CCB}} \left(\pi^e + z\left(\tau_1 + \bar{x}_1\right) + \left(1-z\right)\left(\tau_2 + \bar{x}_2\right)\right). \tag{4.20}$$

Plugging the Expressions (4.18) and (4.19) into (4.20), it follows that

$$\begin{aligned} \pi &= \frac{z\frac{\phi^2}{\phi^2+\frac{\delta_1}{\gamma_1}} + \left(1-z\right)\frac{1}{1+\frac{\delta_2}{\gamma_2}}}{\Delta}\pi^e + z\frac{\phi}{\left(\phi^2+\frac{\delta_1}{\gamma_1}\right)\Delta}\left(\phi\bar{x}_1 + \bar{g}_1\right) \quad (4.21) \\ &\quad + \left(1-z\right)\frac{1}{\left(1+\frac{\delta_2}{\gamma_2}\right)\Delta}\left(\bar{x}_2 + \bar{g}_2\right), \end{aligned}$$

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

Using rational expectation hypothesis, we know that $\pi = \pi^e$. Therefore, from the Expression (4.21), it follows that

$$\pi = z\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1 + \bar{g}_1\right) + \left(1-z\right)\frac{\delta_{CCB}}{1+\frac{\delta_2}{\gamma_2}}\left(\bar{x}_2 + \bar{g}_2\right). \tag{4.22}$$

Substituting the Expression (4.22) in (4.18) and (4.19), and after some algebra, we obtain the Expressions (4.9) and (4.10). ■

Proof of Corollary 2. We differentiate the expressions for the output (4.12 and 4.13), public spending (4.14 and 4.15) and inflation (4.11) 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 3. a) Substituting the Expressions (4.11), (4.12) and (4.14) into (4.4) 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

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

$p_1 = 2z\left(1-z\right)\phi^3\delta_1\delta_{CCB}^2\bar{x}_1\left(\bar{x}_2 + \bar{g}_2\right)$
$\quad +\phi\delta_1\left(\delta_1\left(\phi\bar{x}_1 - \bar{g}_1\right) + z^2\delta_{CCB}^2\left(2\phi\bar{x}_1 + \bar{g}_1\right)\right)\left(1 + \frac{\delta_2}{\gamma_2}\right)\left(\phi\bar{x}_1 + \bar{g}_1\right)$ and

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

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

$$\bar{\gamma}_1 > \tilde{\gamma}_1 \tag{4.23}$$

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

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

hence, (4.23) 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 2, it follows that $\frac{\partial L_2^*}{\partial \phi} < 0$ if and only if $\gamma_1 > \bar{\gamma}_1$. ■

Proof of Corollary 4. To study how can country 1 compensate country 2 for its negative externality (corruption), we will take into account the Expression (4.4) for country 2. Therefore, in equilibrium

$$L_2^* = \frac{1}{2}\left(\left(z\frac{\phi\delta_{CCB}}{\phi^2+\frac{\delta_1}{\gamma_1}}\left(\phi\bar{x}_1+\bar{g}_1\right)+(1-z)\frac{\delta_{CCB}}{1+\frac{\delta_2}{\gamma_2}}\left(\bar{x}_2+\bar{g}_2\right)\right)^2 + \frac{\delta_2}{1+\frac{\delta_2}{\gamma_2}}\left(\bar{x}_2+\bar{g}_2\right)^2\right). \quad (4.24)$$

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

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

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 5. Using the expression of Ψ, we get that

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

where

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

Note that

$$l\left(\delta_1\frac{(1+\phi)\bar{x}_1+\bar{g}_1}{\phi\bar{g}_1}\right) < 0 \text{ and}$$

$$\lim_{\gamma_1\to\infty} l(\gamma_1) > 0.$$

Moreover, applying the Descartes' rule, we can conclude that there exists a unique value of γ_1, denoted by $\widehat{\gamma_1}$, that satisfies $L_1^*(\Psi) - L_1^*(0) = 0$. 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 6. Using the expression of Ψ, it follows that the inequality $L_1^*(\Psi) > L_1^{NM*}$ is equivalent to

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

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 $\frac{\bar{x}_2+\bar{g}_2}{1+\frac{\delta_2}{\gamma_2}} < \frac{\phi}{\phi^2+\frac{\delta_1}{\gamma_1}}(\phi\bar{x}_1+\bar{g}_1)$. ■

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Chapter 5

Concluding Remarks

5.1 Summary of the Main Results

In the last two decades, cases of corruption have been unveiled in different countries, raising public awareness and reinforcing a trend in which society expects more from their leaders. This feature is prevalent in developing economies. However, developed countries also suffer this problem but it is less common than in many developing countries. Thus, developing countries rely more on getting finance through seigniorage revenues and less through tax revenues. The concept of seigniorage refers to the difference between the face value of a note or coin and its costs of production and mintage (Buiter, 2007). In order to develop a model that is also applicable to developed economies, I have allowed for seigniorage revenue to take different proportions.

I have incorporated corruption in the analytic models of this thesis for the growing number of corruption scandals around the world. In this thesis, corruption refers to the fact that the private sector pays taxes but only a proportion is collected by the government (as in Huang and Wei, 2006) and seigniorage is modeled as the revenue from inflation that it is transferred from the central bank to public spending of each government (as in Beetsma and Bovenberg, 1998; Hefeker, 2010).

This thesis has been mainly focused on two concepts: corruption and seigniorage. Concretely, the central aim of this thesis has been to analyse the effects of corruption and seigniorage on some of the main macroeconomic objectives and on the conservativeness of the central bank with a broader model than the ones proposed in the related literature. In what follows, I present the key findings and some suggestions for future research.

There are four main results found in my thesis. The first one is how corruption and seigniorage affect central bank conservativeness. On the one hand, I have shown that if the degree of corruption increases, the central bank should be less conservative when supply shocks are not important. The reason of this result is that if corruption increases, the resources available for the government through taxes decrease. Hence, the fiscal authority needs to collect financing resources through seigniorage and then the central bank should be less conservative. By contrast, the opposite result may hold when shocks are relevant. On the other hand, the higher the degree of seigniorage, the less conservative the central bank should be. Intuitively, if seigniorage increases, then the funding available through seigniorage (taxes) becomes more (less) important. For this reason, in contexts where the government's and society's preferences coincide, the government (society) prefers to appoint a less conservative central bank for the conduct of the monetary policy.

The second result is related to the impact of seigniorage on output growth and the inflation rates. I have found that when the degree of seigniorage increases, the output growth rate always increases but the inflation rate can increase or decrease (depending on some parameter values). Concretely, when the degree of seigniorage increases, seigniorage revenue also increases. This allows the government to set a lower tax rate, which has a positive effect on output growth rate. The decrease in the tax rate brings two effects on the behaviour of the central bank. If the central bank prioritises considerably more the stabilisation of output over public spending, the central bank has less incentives to inflate. By contrast, if the central bank prioritises more the stabilisation of public spending over output, the opposite result could be true.

The third result is linked to the effect of corruption on output growth and inflation rates. I have studied this relationship in two frameworks. First, I have focused on the case of one country where the government could benefit from seigniorage revenue and the output target level is zero. Second, I have analysed the effects of corruption on two countries in a monetary union where one country has a corrupt government, both governments can only obtain finance through taxes, and output targets for both governments may be not null. In both cases, I have found that when an increase in corruption leads to a decrease in output growth rate, then the inflation rate increases. Moreover, if an increase in corruption leads to a decrease in the inflation rate, then output growth rate increases. For the monetary union case, this result is only satisfied for the corrupt country since, in our model, corruption has no effect on output growth rate for the other country. In addition, it is important to point out that there is another possible result in the first study case: an increase in corruption could lead to an increase in both the output growth and inflation rates. This is due to the fact that an increase in corruption leads to a decrease in the tax rate and, hence, output growth rate increases. Moreover, if the central bank places a high relative weight on public spending objective, the inflation rate increases.

The fourth result is connected with the effects of corruption on the loss functions of both countries in a monetary union. Assuming that the government's and society's preferences coincide, I have found that if the fiscal authority of country 1 (with a corrupt government) is not really concerned about public spending stabilisation, both countries are better off with an increase in corruption. However, if the fiscal authority gives a high relative weight to public spending stabilisation, an increase in corruption causes both countries to be worse off. As country 2 may be negatively affected by corruption in country 1, I have studied how country 1 might compensate country 2 for the negative externality. I have shown that the implementation of austerity measures minimises the losses of country 2. One easy way to model such measures has been to require a reduction in the public spending target of country 1. In this case, I have analysed if the reduction in the required spending target harms or benefits country 1. Concretely, I have found that if the fiscal authority of country 1 is very concerned about public spending stabilisation, this country is worse off with such a measure. In this case, country 1 prefers to reject the measure and to exit the union.

5.2 Future Research

Of course, some potentially relevant considerations are not covered by the analysis provided in this thesis and could significantly alter the results presented. In the models developed in this thesis, authorities select their instruments simultaneously and debt is not modeled. Therefore, one possible extension could be that the government finances its debt repayments. Thus, I could focus on debt dynamics as in Beetsma and Bovenberg (1997). The government would control taxes, public spending and public debt.

An interesting extension would be to study what happens with the "eaten up" part of taxes on the economy. Moreover, an interesting possibility in chapter 4 would be that this fraction is sent to the output of the other country.

Another avenue for future research would be to endogenise the degree of corruption. The cost in fighting corruption could be modelled in two different ways, as proposed by Hefeker (2010) and Dimakou (2013). Hefeker (2010) assumes that the personal or political costs of fighting corruption is considered in the loss function of the government. By contrast, Dimakou (2013) considers that these costs are in the government's budget constraint. In this setup, the timing would be: (i) the government sets corruption, (ii) rational expectations are formed, and (iii) the government and central bank choose fiscal and monetary instruments.

The analytic models developed in this thesis have been carried out as simultaneous games where all agents act like Nash players. Therefore, it would be interesting to examine the framework where the decisions are taken sequentially and, therefore, to study the properties of the Stackelberg equilibrium. There are two alternative ways to do this: the case of monetary leadership and the case of fiscal leadership. This last case seems more likely since monetary policy is adjusted more quickly than fiscal policy.

Another interesting extension in this literature would be to empirically estimate the parameters of the model and test the implications presented here.

After analysing the possible extensions of this thesis, let me now focus on some extensions for each chapter.

One possible extension in the second and third chapters would be to include an output target as I incorporated in Chapter 4 and as in Debelle and Fischer (1994). This feature would be another extension of Huang and Wei (2006). In addition, for Chapter 2 and Chapter 3, it could be interesting to incorporate the Laffer curve effect in seigniorage, as in Huang and Wei (2006). In this case, I would replace how I model seigniorage revenues by the Laffer curve effect. I could compare the new effects of seigniorage with the results obtained in Chapter 2 and Chapter 3. Moreover, including an exogenous supply shock in the second and fourth chapters would be relevant to consider since, from my knowledge, no one in this literature has studied the effects of corruption and seigniorage in an economy with shocks.

Finally, the study of the corruption effects in a monetary union, Chapter 4, allows to extend the model in many ways. First, I could include seigniorage as another source of revenue for the governments. I will assume that governments get seigniorage revenues according to their relative share in the monetary union. Second, following Beetsma et al. (2001) and Dixit and Lambertini (2003), I could study fiscal coordination in the monetary union. With fiscal coordination, governments would minimise the collective losses. Third, I could explore how conservative should the common central bank be as I analysed in Chapter 3. Fourth, I could consider the case where both countries in the monetary union are corrupt.

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