

Corruption and Inflation

by

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To my Parents,
Their great love always lights up my way

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Abstract

Public sector corruption is endemic in many economies and is frequently cited as a cause of poor economic performance. Corruption hinders the completion of beneficial transactions and distorts the outcomes of economic policies. It can also affect the policy choices of governments as they attempt to counteract the consequences of corruption. Excessive inflation may be a negative side effect of corruption if the government compensates for lost revenue by increasing the rate of monetary expansion to exploit seigniorage.

There is convincing empirical evidence from cross-section studies that inflation and corruption are positively correlated. It has been suggested that this is a consequence of governments in corrupt economies turning to the use of seigniorage as a method of raising revenue (Al-Marhubi, 2000). This seems a likely route through which the correlation can arise, but the mechanism at work has not received any theoretical attention. In particular, there has been no demonstration that an optimizing government will rationally exploit seigniorage as a response to corruption. The contribution of this study is an analysis of this issue in theoretical models in which the growth rate of money supply is chosen by an optimizing government. Although an empirical analysis is undertaken to explore the relationship between corruption and inflation in chapter one, the main focus of the study is on chapters three, four, and five where theoretical analysis plays the principal role in the research.

Key words: *Corruption, seigniorage, tax rate, bribe, bargaining*

Chapter 1

Introduction

1.1 Motivation

There is a general agreement among macroeconomists that inflation is a monetary phenomenon in the long-run. There are some effects such as growth in public expenditure, tax cuts, and an increase in individual consumption that pull up market demand and the price level as well. On the other side, some other factors shifting the market supply curve upwards could also lead to a growth in the consumer price level such as an increase in wages or a growth in raw materials and oil prices. However, these demand-pull effects as well as cost-push causes of inflation are negligible, and they will not persist in the long-run. Since the rise of monetarism in the 1970s, there has been a general agreement in macroeconomics that inflation is a monetary phenomenon in the long-run and is caused by the growth in the money supply in excess of the growth rate of trend output.

Friedman and Schwartz (1963) and Friedman (1968, 1970) were the first generation of monetarists who highlighted the demand-pull inflation where fluctuations are due to an

increase in aggregate demand resulting from a growth in the money supply. They believed that adaptive expectations caused the level of price to be adjusted gradually, so the effect of money supply growth remains in prices even in the long-run, but the output level will be affected only in the short-run. The next generation of monetarists, including Lucas (1972), Sargent and Wallace (1975) and Barro (1978), agreed on the same consequence for the effect of money growth on inflation in the long-run, and they added the concepts of rational expectations and misperception of suppliers to the literature. However, although post-Keynesian macroeconomists such as Davidson and Weintraub (1973) believe that a growth in money supply and in the inflation rate result from an increase in the level of wages, New-Keynesian macroeconomists do agree on the inflationary effect of the excessive money supply in the market.

1.2 Theories of Inflation

If there is such an agreement that inflation is a monetary phenomenon, what could be the explanation behind the story of inflation and persistent growth in the money supply? Although inflation has been under control in developed economies in recent years, it has been the main concern for developing nations with high inflation rates. Some theories including time inconsistency of optimal planning by Kydland and Prescott (1977) and political business cycle theories by Nordhaus (1975) and Hibbs (1977) explore the causes of the high inflation rates and monetary expansions, but they are applicable to developed economies with well-established democracies, and they cannot appropriately explain the high growth rate in money supply and high inflation rate in many developing countries.

The main objective of this research is to explore whether corruption can be an explanation for continuous monetary expansion and the persistently high inflation rate. There must be a political economy explanation for the effect of corruption on the inflation rate in developing nations as well as developed economies. It is interesting to see the evidence on developed economies where the inflation rate is even higher than the social optimal rate targeted by monetary officials. There have been studies exploring this phenomenon. Nordhaus (1975) states that voters are sensitive to the inflation rate and the unemployment rate, and the economic aspects of life are influenced by the government's position in the trade-off between these two variables. He shows that opportunistic political parties in power aim to influence the short-sighted voters to win the re-election and stay in power. The Nordhaus Opportunistic Model shows that democratic systems tend to choose a policy that achieves an inflation rate which is higher than the optimal rate in the long-run. Kydland and Prescott (1977) introduced the time inconsistency of optimal planning to explain the high rate of monetary expansion and, therefore, the high inflation rate. They model a dynamic game between informed monetary officials and provident private sector agents who know the incentives of policy makers and do not trust them unless there are some restricted commitments. Kydland and Prescott (1977) discuss how monetary authorities choose discretionary policies to reduce the unemployment rate by creating surprise positive inflation which is higher than the optimal rate.

Seigniorage is the third reason that is offered to explain the high inflation rate. Tanzi (1978) argued that because the financial markets are inefficient in developing countries with fiscal deficits, the public sector turns to an inflation tax to finance for budget deficits.

Phelps (1973), using the theory of optimal taxation, describes how the government chooses to exploit seigniorage to equate the marginal cost of the inflation tax with the marginal cost of the output tax. Cukierman *et al.* (1992) show that countries with unstable and polarized political systems suffer from inefficient tax structures, and that they rely more on seigniorage.

The contribution of this study is to explore an additional explanation for money supply growth and inflation. The hypothesis is examined that corruption in the public sector can explain the growth rate of money supply. In fact, the effect of corruption on macroeconomic indicators has been analyzed recently, and corruption is cited as a significant cause of poor economic performance. The analysis of the destructive effect of corruption on economic growth commenced in the 1990s using both empirical and theoretical techniques. The effect of corruption on growth and investment has been well-analyzed by Baumol (1990), Shleifer and Vishny (1993), Mauro (1995), and Guetat (2006). The basis argument is that technological development is the main engine of the economic growth and is generated by talented forces active in the economy. These productive agents could decide to be a rent-seeker instead of a producer if the reward structure is poorly organized and biased towards corruption. Therefore, when there is corruption the economic sources will be allocated to unproductive activities, and there could be less innovation and lower growth in the economy. Although all the explanations provided for the negative effect of corruption on growth could also explain its effect on inflation, there are some studies investigating this link in a political economic framework.

1.3 Public Sector Corruption

The literature that analyzes the effect of corruption on the public sector can be divided into two categories including monetary and fiscal outcomes of corruption. The literature review below briefly summarizes both parts of this literature. However, there has been very little work that focuses explicitly on corruption and inflation.

Aisen and Veiga (2006) consider political instability and economic freedom as explanations for the high inflation rate. They claim to use robust variables of political instability including the number of government crises in a year where the current regime was threatened with downfall. The number of cabinet changes and the level of economic freedom are other proxies for political instability used in this study. Using a dataset on 178 countries from 1960 to 1999 and a dynamic panel data approach, it is shown that higher political instability is significantly associated with a higher inflation rate, and this link is stronger in countries with higher inflation. Aisen and Veiga mentioned that, although inflation is an output from monetized budget deficit, they decided to ignore this in their model.

Cukierman *et al* (1992) suggest another political economic explanation for the persistent cross-country differences in seigniorage. They blame inefficient tax systems in those countries that failed to administer a skillful and sophisticated tax system. A high tax-collection cost is one of the main problems for the public sector in such countries to collect and monitor taxes. This makes it easier for tax evasion to occur. Hence, a government with an inefficient tax system relies heavily on seigniorage and inflation to provide finance for public expenditure. They provide various estimates in their empirical work to prove this

hypothesis. Their cross-sectional analysis over 79 countries shows that political instability and polarization are positively correlated with seigniorage in the dataset of all countries. However, their results show that countries with unstable and polarized economies rely relatively more on seigniorage. They also show that central bank independence decreases inflation volatility.

In addition, Aisen and Veiga (2008) indicate that less central bank independence is associated with a lower rate of inflation volatility. The focus of their study is to investigate the explanatory variables for seigniorage in a panel data analysis on a dataset covering 169 countries from 1960 to 1999. They show that total government revenue from seigniorage for developing countries is five times the level of revenue in industrialized countries during 1960-1999. This motivated them to explore for the explanation of higher seigniorage in developing countries. They believe that the variables explaining inflation could not necessarily explain seigniorage. Their analysis shows that there is a negative correlation between seigniorage and inflation for countries with hyperinflation above 400 percent although it is positive for all other countries with less than 400 percent in inflation. They emphasized that the study of explanatory variables for seigniorage must be different from their study of inflation in 2006. Their findings show that political instability and social polarization is associated with higher seigniorage which confirms the results of Cukierman *et al.* (1992), Click (1998), and Woo (2002, 2003). Aisen and Veiga (2008) added a new result indicating that the positive correlation between seigniorage and political instability and social polarization is stronger in some circumstances, such as in countries with higher inflation, less democracy, and lower economic freedom.

Huang and Wei (2006) introduced a theoretical model of a monetary policy game to see how the quality of public institutions affects the desirability of several popular monetary regimes such as inflation targeting or a conservative central banker. They found that the quality of public institutions determines the optimal level of conservatism in central bankers. Hence, central banks are less conservative in developing countries with poorly qualified public sectors. Their model shows that in an extreme case, when poor institutes make it impossible for the government to collect tax revenues, the degree of conservatism of central banks is zero. Their assumption is to consider weak quality of institutions as an ablation in the government capability to raise taxes through official channels. They assume that this might be a result of “outright theft” by tax officials as well as collusion between tax inspectors and taxpayers in the form of bribe to reduce the tax obligation. This is the point that Huang and Wei (2006) mentioned as the reason behind their assumption discussed above. However, they did not explicitly model this type of corruption and tax evasion in their study. Furthermore, their results include another interesting point in which the optimal targeted inflation rate is higher for the economies with weaker public institutions than economies with highly qualified public institutions (1% - 4%).

1.4 Empirical Research

The empirical work undertaken by Woo (2003) was an investigation of the main determinants of budget deficits. He examined a set of 40 explanatory variables classified as economic variables, sociopolitical determinants, and institutional variables. The proxy used to illustrate the quality of government institutions was International Country Risk Guide

(ICRG) data in this study. ICRG is measured by the Political Risk Services (PRS) group based on the components of the rule of law, bureaucratic quality, corruption, expropriation risk, and government repudiation of contracts. Their panel analysis on a sample covering 57 developed and developing countries from 1970 to 1990 showed that low-quality institutions are significantly associated with a lower budget surplus. Although Woo (2003) did not embed corruption directly in his model, he provided an explanation that the level of corruption can be a good measure of the quality of budgetary institutions.

The empirical studies seeking to explicitly determine the effect of corruption on inflation started with an analysis undertaken by Al-Marhubi (2000). His investigation on a cross-country dataset considers 41 countries over the period 1980–1995. Alternative indicators for corruption have been tested in econometrics analysis with two of them obtained from Transparency International. Others are the measure of corruption by Business International (BI) and the bureaucratic efficiency index by Mauro's (1995). All four of the indices are positively associated with the inflation rate and statistically significant. Al-Marhubi provided four clear explanations about how this positive link between corruption and inflation might arise. First, it could be optimum for the government to generate seigniorage (according to the theory of optimal taxation). Second, he considered tax collection costs likely to be higher in countries with higher level of corruption, and this make it optimal for the public sector to turn to seigniorage as an alternative source of revenue. He also added that corruption could lead to a reduction in taxable assets by making capital flight easier, and a reduction in public revenues and increasing costs could simultaneously lead to a deficit with inflationary outcomes for economies with less-developed financial markets.

All the suggested ways in which corruption could affect inflation have this capacity to be examined individually. Although he did not continue to test explicitly each of these assumptions, he believed that all the effects of corruption on inflation are through the channel of seigniorage.

The significant positive correlation between corruption and inflation appears to be robust in a range of data sets. Empirical studies by Abed and Davoodi (2000), Smith-Hilman (2007) and Samimi *et al.* (2012) also confirmed that the link between corruption and inflation is significant and positive. While these empirical investigations show that corruption could be an explanation for inflation, conversely there is some evidence showing that inflation motivates corruption as well. Studies by Braun and Di Tella (2000), Gerring and Thacker (2005), and Akca *et al.* (2012) explain that inflation increases auditing and monitoring costs, and this makes some level of corruption to be condoned and more demanded. Of course, the demand for corruption could be influenced by other economic characteristics and social norms. However, if inflation is a motive for corruption this leads to an implication that corruption could lead to further corruption due to inflation.

1.5 Organization

In this study the main objective is to explore the effect of the existence of corruption in the public sector on inflation in a theoretical framework. The thesis is divided into six chapters. Chapter two is an empirical analysis to confirm the results discussed above that show a positive link between corruption and inflation. This chapter is considered as a motivation to undertake the research, and the main body of the thesis includes chapter

three, four and five.

In chapter three, corruption is considered to be exogenous and embedded in an overlapping generations model where a social welfare maximizing government chooses the optimal rate of money supply to compensate for the revenue lost to corruption in the economy. The novelty of chapter four is to make the level of corruption endogenous in which individuals in the model have an option to choose between being honest and corrupt if they choose to work in the public sector. Corruption leads to a loss of self-esteem, so the set of corrupt public employees is determined by the individual-specific value placed on self-esteem. The analysis determines the equilibrium in employment allocation across the private and public sectors, and the division between honest and corrupt. This endogenizes the level of corruption in a static time scale. Bribes are paid by a representative firm as a reward for being charged a reduced rate of tax, with the division of gains determined by Nash bargaining. This endogenized corruption will be embedded in a dynamic monetary model in Chapter five to explore the impacts of endogenized corruption on inflation. The findings of the research show that both exogenous and endogenous corruption increase the optimal rate of monetary expansion. The final chapter provides concluding remarks.

Chapter 2

Empirical Evidence

2.1 Introduction

The empirical link between corruption and inflation has been clear for some time. A significant positive correlation between the two is apparent in a range of data sets and seems robust to the choice of conditioning variables (see Akça *et al.*, 2012, for numerous references). There have been several studies that looked at the detrimental effects of corruption on economic growth and investment (Barro (1999), Mauro (1995) and Cole and Chawdhry (2002)). However, Al-Marhubi (2000) was the first to show empirically that there was a positive correlation between the level of corruption and the inflation rate. His cross-sectional analysis of 41 countries over 1980-95 showed that four alternative indices of corruption were positively and significantly correlated with inflation.

Further research has followed Al-Marhubi. The results of Abed and Davoodi (2000) also showed that a higher corruption level is significantly associated with a higher inflation rate in both a cross-section data set for 24 countries and in a panel data analysis including

82 countries. Although Smith-Hillman (2007) found that the coefficient of corruption as a regressor for the inflation rate is not statistically significant for African and industrialized countries separately, the estimated coefficient for the full sample of all countries is significant and positive. Samimi *et al.* (2012) also concluded that the link is significant and positive, and that higher corruption is correlated with a higher inflation tax.

The causality in the relationship between inflation and corruption could run in either direction. Al-Marhubi (2000) proposed the explanation that corruption in the public sector encourages the government to exploit seigniorage to raise revenue. Conversely, Akça *et al.* (2012) and Broun and Di Tella (2004) suggested that the existence of inflation could be the motive for corruption. Later chapters of the dissertation provide theoretical models of the transmission mechanism.

The contribution of this chapter is to illustrate the empirical correlation between inflation and corruption by conducting a panel data analysis of a dataset including 164 countries. The following section briefly introduces the two main sources of data available for corruption indices and the description of the corruption data provided by these sources.

2.2 Corruption Data

2.2.1 Corruption Perception Index (CPI)

The CPI compiled by Transparency International is one of the most popular data sources on corruption. It ranks countries based on how corrupt their public sector is perceived to be. Corruption is defined by Transparency International as the abuse of entrusted power for private gain. The CPI measures the perception of corruption in the public sector

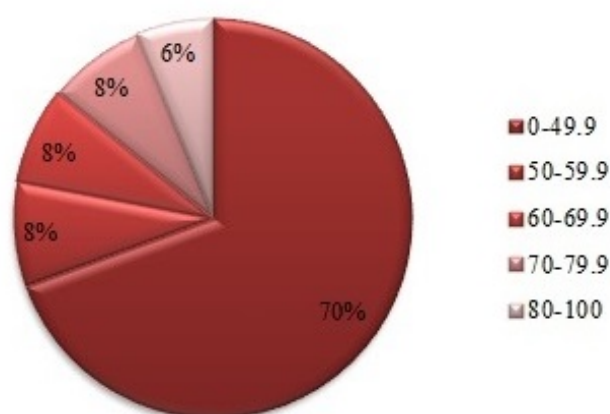


Figure 2.1: Classification of 177 countries based on CPI in 2013

that involves either public officials, civil servants, or politicians.

To construct the CPI, Transparency International uses information from 13 data sources that are recognized as expert in governance and business climate analysis (Appendix A). Each country is given a score between 0-100. Zero indicates a country perceived to be highly corrupt and 100 means the country is observed to be very clear from corruption. Figure 1.1 represents a cross-section data sample of the very recently published CPI for 177 Countries. It shows that 70% of the countries scored under 50 while only 6% of the sample is placed in the range of 80-100. Such a significant proportion of countries perceived to be corrupt emphasizes the importance of exploring this phenomenon especially since the set of corrupt countries includes both developing and developed countries. However, the 6% of countries with the least corruption were all developed countries and OECD members (Appendix C).

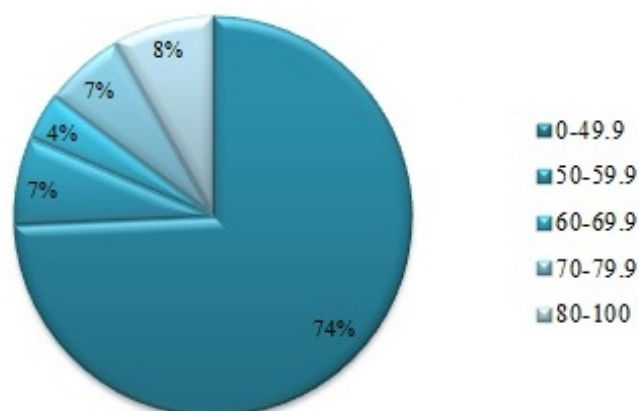


Figure 2.2: Classification of 177 countries based on FFC in 2013

2.2.2 Freedom From Corruption (FFC)

The FFC is one of the 10 components used to construct the index of Economic Freedom produced by the Heritage Foundation. The Economic Freedom index provides a picture of the level of freedom in the economic environment of a country. The Foundation focuses on four important aspects of the rule of law, government size, regulatory efficiency, and market openness to measure the 10 components where FFC is placed the aspect of the rule of law. Corruption is considered as reducing economic freedom by generating insecurity, creating uncertainty in economic relations, increasing the cost of activities, and shifting economic resources into unproductive activities.

The FFC is basically derived from Transparency International's CPI. However, more countries are covered by FFC. The Heritage Foundation uses other reliable data sources to compile a corruption index for the countries that are not covered in the CPI country sample. Therefore, in this chapter the FFC has been used in the analysis because the data

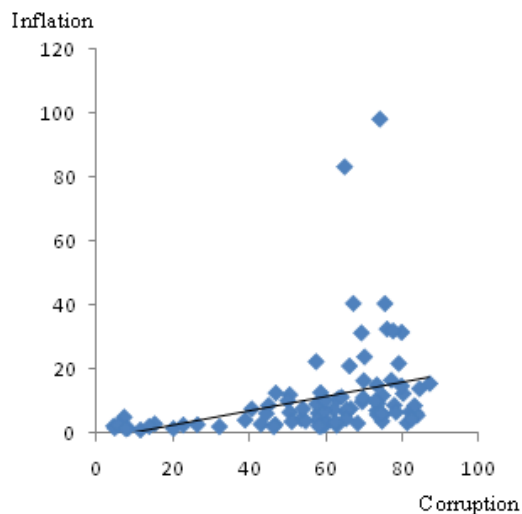


Figure 2.3: Inflation and corruption

validation is more comprehensive than the CPI. Each country is graded on a scale of 0 to 100 where 0 represents highly corrupt and 100 is very free from corruption. Figure 1.2 also shows that a large proportion of the countries (74%) are placed in a range of 0-49.9 in the year 2013.

2.3 Scatter Plots

Figures 2.3 and 2.4 depict scatter graphs of inflation against the two measures of corruption. The data points represent country averages over the period 1995 to 2010 for a sample of 87 countries that have complete data over the sample period. Appendix B provides a list of the countries included.

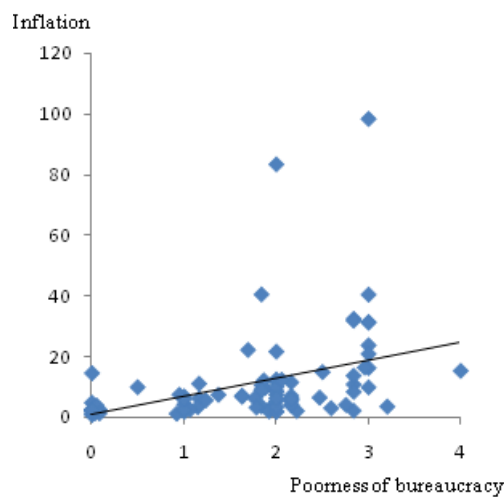


Figure 2.4: Inflation and bureaucracy

Averaged inflation is the annual percentage increase in consumer prices obtained from World Development Indicators (2012). The measure of corruption is based on the Heritage Foundation "Freedom From Corruption" (FFC) index which is between 0-100. A higher value of this index shows higher freedom from corruption in a country, so the value of $(100 - \text{FFC})$ is plotted in the figure. The positive correlation between corruption and inflation can be clearly seen.

An alternative to the FFC index is the index of Bureaucracy Quality (BQ) from Political Risk Services (PRS) group. Each country receives a score from 0 to 4 where high-risk countries with weak bureaucratic infrastructure receive low scores. We call the value of $(4 - \text{BQ})$ the "Poorness of bureaucracy" and plot this against inflation in figure 2.4. The figure shows that poor bureaucratic quality is positively correlated with high inflation.

These figures illustrate why previous empirical investigations have discovered a positive and significant correlation between inflation and corruption even if the direction of causality cannot be determined.

2.4 Panel Data Approach

This section analyzes the relationship between corruption and inflation in a regression model. As noted, the data on corruption has been generated since 1995. Therefore, a panel dataset has been used in this study to enhance the degrees of freedom.

The analysis is based on the following regression equation:

$$INF_{it} = \alpha + \beta GPGDP_{it} + \gamma GM2_{it} + \delta OPENNESS_{it} + \theta FFC_{it} + \varepsilon_{it}, \quad (2.1)$$

where INF is inflation in consumer prices (annual %), $GPGDP$ is per capita GDP growth (annual %), $GM2$ is growth in money and quasi money (annual %), and $OPENNESS$ is economic trade freedom. The subscripts i and t indicate country and time respectively. Finally, FFC stands for freedom from corruption as measured by the Heritage Foundation. This variable is derived primarily from the Corruption Perception Index (CPI) of Transparency International (TI). The other variables have been obtained from World Development Indicators (2012). Data from 164 countries is used ($i = 1, 2, \dots, 164$) over 16 years ($t = 1995, 1996, \dots, 2010$). The data has been embedded in a panel dataset, and the analysis is undertaken by using Eviews software.

The process of checking for panel data unit roots is a recent topic introduced and proposed by Levin and Lin (1992) for the first time, and since developed by other econometricians. It offers slightly different types of null hypothesis in defining unit roots.

Panel unit root tests simply consider the asymptotic behavior of the time series (t) and cross-sections (i), and this leads to obtaining a higher power test compared to the unit root test in time series analysis. Table 2.1 shows the results of group unit root tests offered by the Eviews programme. The null hypothesis in each case is the existence of a unit root. The whole test outputs are listed and show that the variables are all stationary.

Test	<i>INF</i>	<i>GPGDP</i>	<i>GM2</i>	<i>OPENNESS</i>	<i>FFC</i>
Levin, Lin and Chu	0.000	0.000	0.000	0.000	0.000
Im, Pesaran and Shin	0.000	0.000	0.000	0.000	0.000
ADF - Fisher Chi-square	0.000	0.000	0.000	0.000	0.000
PP - Fisher Chi-square	0.000	0.000	0.000	0.000	0.000

Table 2.1. Probabilities of unit root tests (null is unit root)

When the variables are stationary in the panel data sample the next step is to choose the analysis method. Fixed effect analysis assumes that intercepts are different across countries. To estimate the fixed effect model the Fisher test is used to examine whether the null hypothesis of identical intercepts can be rejected or not. The test statistic is given by

$$F = \frac{(R_{UNRESTRICTED}^2 - R_{RESTRICTED}^2) / (n - 1)}{(1 - R_{UNRESTRICTED}^2) / (nt - n - 1)} \sim F(n - 1, nt - n - 1),$$

where the restricted model is the model with identical intercepts for all countries (estimated by the fixed effect method), and in the unrestricted model (estimated by the Ordinary Least Squares method) each country has its own intercept. The variable n is the number of regressors, which is 4 in this study.

The result for the F test in Table 2.2 shows that the null hypothesis of identical intercepts for the countries is rejected, so the OLS method (pooled OLS) is not the right method for estimating equation (2.1). In addition, the random effects model that explores

differences in error variances can be used to estimate (2.1) when there is no correlation between the error term and the regressors. The Hausman (1978) test has been used to test the null hypothesis assuming the error term to be uncorellated with the regressors. The results in Table 2.2 shows that the null hypothesis could not be rejected so there is no significant correlation between the regressors and the error term. This implies that a random effects model is more powerful and parsimonious than a fixed effects model.

Hierarchical tests		P value
<i>F</i> Test	3.3920	0.000
Hausman Test	6.0676	0.1941

Table 2.2. Fixed effects or random effects

Table 2.3 presents the results of estimating equation (2.1) using random effects. The coefficient on Freedom From Corruption is negative and significant, so corruption has a significant positive correlation with inflation. Other things equal, countries with more corruption experience a higher inflation rate. The results also support the prediction that countries with a greater growth rate will have lower inflation. The coefficient of openness is significant at a 10% significance level, and its positive sign in the inflation equation can be explained by currency devaluation in more open countries.

Dependent variable: Consumer price inflation, 1995-2010					
Method: Random Effects					
	all countries	OECD	non OECD	Oil-exporting	non Oil-exporting
C	29.36 (**)	19.74 (**)	4.16 ()	11.98 (*)	28.59 (**)
FFC	-0.55 (**)	-0.166 (**)	-0.19 (**)	-0.03	-0.37 (**)
$GPGDP$	-1.30 (**)	0.01	-2.01 (**)	-0.77 (**)	-2.24 (**)
$GM2$	0.02 (**)	0.0001	1.008 (**)	1.00 (**)	0.001
$OPENNESS$	0.11 (*)	-0.03 (*)	0.01	-0.16 (**)	0.04
R-squared	0.31	0.44	0.85	0.97	0.37
Included cross-sections	164	32	132	51	113
Included observations	1979	387	1592	664	1315

Table 2.3. Estimation results ((**) is 5% significance level, (*) is 10% significance level)

To explore the impact of corruption on inflation in countries with different level of development, a simple separation has been made among the countries in the sample. 32 OECD countries are considered as developed nations (see appendix C1) while the remaining countries are treated as developing economies (132 countries). Estimation results of the equation (2.1) for both data samples are presented in Table 2.3 in the columns *OECD* and *non OECD*. The estimated coefficients of *FFC* still show a positive correlation between corruption and inflation in both developed and developing countries that is significant at 5% level. Moreover, in developing countries the estimated impact of the level of corruption on the inflation rate is higher (in absolute value) than in developed countries (0.166 and 0.19). This implies that inflation is more sensitive to a change in corruption in developing countries.

The final partition in the data sample is between oil-exporting and non-oil exporting countries (See appendix C2 for the list of countries). The classification is derived from the U.S. Energy Information Administration that ranks world oil exporters (bbl/day). The

idea is that there are more temptations towards corruption in the oil-exporting countries with high oil revenues increasing the potential gains from corruption. OPEC countries would be a proper sample to analyze this idea, but because of limitations in the availability of the data for OPEC countries, this was not possible.

The results suggest that the coefficient of FFC is sensibly lower in oil-exporting countries (0.03 versus 0.37) and it is not statistically significant although its sign is negative in both samples. The reason for this unexpected result is because there are countries with higher bureaucratic quality (i.e. Germany and Norway and Italy) among the oil-exporting countries, so the effect of corruption on inflation cannot go higher.

2.5 Conclusion

The data shows a large number of economies placed in the category of highly corrupt countries. This highlights the importance of exploring the impact of corruption on economic outcomes. This empirical analysis has explored the link between corruption and the inflation rate. To begin with, the scatter graphs illustrated that there is a positive relationship between corruption and inflation when the average data of inflation and corruption is used for 87 countries over 15 years (1995-2010). This has provided the main motivation of the empirical part of the study.

The results of a panel data analysis confirm the conclusion of the previous literature about a positive and significant correlation between inflation and corruption. A sample of 164 countries from 1995 to 2010 has been used to estimate the correlation between corruption and inflation. With all other things given, an increase of one unit in corruption leads to a

0.55 increase in inflation in consumer prices (annual %) which is statistically significant. As already noted, the main purpose of this chapter was to confirm previous empirical findings using new data sets and new econometric techniques. Al-Marhubi found that the magnitude of the estimated coefficients of corruption were 0.17, 0.21, 0.22 and 0.26 .

The first two indicators were obtained from Transparency International and are based on a perception of corruption that is mostly captured from people in multinational firms and institutions. The third index used by Al-Marhubi was from the Business International (BI) that is based on perceptions drawn from BI overseas correspondents. The last indicator was bureaucratic efficiency index from Mauro (1995).

To compare the impact of corruption in developed and developing countries, a separation has been made in data sample between OECD countries and non OECD where the estimated coefficient of corruption in non OECD countries is slightly higher than OECD nations. However, the model did not show a significant heterogeneity between oil-exporting and non-oil exporting countries, but still the results indicate the positive link between corruption and inflation in both economies.

These results show the link between corruption and inflation and provide the justification for pursuing a theoretical analysis of the economic activity that can lie behind this correlation.

Chapter 3

Exogenous Corruption

3.1 Introduction

Corruption has been shown to be positively correlated with inflation by numerous empirical analyses. To demonstrate how a theoretical causality running from corruption to inflation can arise is the main purpose of this research. Corruption is needed to be modelled in a theoretical framework. It has been claimed that a government facing a corrupt economy will exploit monetary expansion to compensate for the revenue lost, so the contribution of this chapter is to embed corruption within a monetary model and to explore the effect of increased corruption.

It is assumed that a government has two sources of revenue. It can levy taxes on observable transactions or it can exploit the monopoly it holds over the creation of fiat money to obtain revenue from seigniorage. If corruption reduces the revenue that the government can derive from taxation then a motive is created for the government to turn to seigniorage as an alternative source of revenue. When seigniorage is exploited, the implied

monetary expansion will increase the rate of inflation. The missing link in this chain of reasoning to connect corruption with inflation is a demonstration that the government has a motive to exploit seigniorage in this way. I model a government that chooses seigniorage to maximize a legitimate objective function and demonstrate that corruption can increase the chosen level of seigniorage. This confirms that the positive correlation can emerge in a world in which all economic agents pursue the standard objective of individual optimization.

The only previous theoretical analysis of the correlation between corruption and inflation is Bohn (2010). That paper analyses a monetary policy game in the spirit of Rogoff (1985) but with corruption affecting the payoff function of the government. It is therefore a static analysis that does not model the role of money in the economy nor the dynamic mechanism lying behind an intertemporal inflationary process. There has been rather more analysis of the link between corruption and growth. Blackburn *et al.* (2010) and Blackburn and Forues-Puccio (2010) show the damaging effect of corruption on the process of economic development. However, in common with much of the growth literature, the models analyzed are non-monetary so cannot be used to explore the effect of corruption on inflation.

To undertake my analysis I need to construct a model of the economy that is explicitly monetary. This requires there to be a role for money in order to explain its use and value, and some motive behind the government's choice of money supply. The range of monetary models in the literature includes money in the utility function, cash in advance, or money as a store of value. I choose to focus on the latter, and analyze a model in which money is the only store of value that allows purchasing power to be carried between periods. I consider an overlapping generations economy with money and consumption loans.

Individuals can use money to transfer purchasing power between different periods of life. When, on average, individuals wish to hold money then money will have value. Seigniorage will increase money supply and reduce the value of money or, conversely, raise the money-price of the consumption good. By making the government choice of money growth rate the outcome of an optimizing decision I am then able to explore how the resulting level of inflation is linked to corruption.

A key element of the model is the selection of an appropriate measure of the return to the government from seigniorage. A number of definitions have been proposed in the literature. review these in section "Measures of Seigniorage" and briefly explore their properties in order to explain the logic behind my choice of measure. Ultimately, I model government revenue as the sum of tax receipts and seigniorage. The government chooses the growth rate of money supply and the tax rate to maximize revenue. I can then analyze how the optimal choices depend on the level and composition of corruption. The second key element in the model is the representation of corruption. The work of Hindriks *et al.* (1999) studies the details of the interaction between a taxpayer and a tax inspector. In contrast, we adopt a more reduced form version of this interaction to allow us to embed corruption within a dynamic equilibrium model. Three forms of corruption are considered. The first two, the reduction of effective tax burden and the appropriation of tax revenue, are related to Hindriks *et al.* (1999). The third, the appropriation of newly produced fiat money, is a channel not previously analyzed in the corruption literature.

The analysis of the model demonstrates that the use of seigniorage to raise revenue can be a rational strategy for a government when confronted with corruption that reduces

revenue. An increase in any of the three forms of corruption can raise the rate of monetary expansion as the government exploits seigniorage as a source of revenue. It is also shown that this is not always the case and that there are some combinations of the corruption variables for which an increase in the appropriation of revenue can reduce monetary expansion. In summary, the results make a convincing case that corruption can be positively correlated to inflation.

3.2 Measures of Seigniorage

The intention of the theoretical analysis is to explore the argument that corruption leads to inflation because it creates an incentive for the government to exploit seigniorage as a source of revenue. To proceed with the analysis it is necessary to have a suitable definition of the benefits to the government of seigniorage. This section explores the alternative definitions of seigniorage that have been provided in the literature.

Seigniorage is generally interpreted as the increase in resources that the government obtains by issuing new fiat money. The alternative measures of this benefit are summarized in table 3.1. For this table we define $M(t)$ as the nominal money base in year t , and $\Delta M(t)$ as the increase in base over the previous year: $\Delta M(t) = M(t) - M(t-1)$. $P(t)$ is the (aggregate) price level, $Y(t)$ is real GDP, $L(t)$ is the population, $\pi(t)$ is the inflation rate, and $\tilde{\mu}(t)$ is the (net) rate of money expansion.

Measure	Source
$V^1 = \Delta M(t) / P(t) Y(t)$	Buiter (2007)
$V^2 = i(t) M(t-1) / P(t) Y(t)$	Buiter (2007), Flandreu (2006), Bordo (2006)
$V^3 = \pi(t) M(t-1) / P(t) Y(t)$	Buiter (2007), Edwards and Tabelini (1991), Bailey (1995), Freidman (1953)
$V^4 = \tilde{\mu}(t) M(t) / P(t) L(t)$	Drazan (1985), Fridman (1971)
$V^5 = \Delta M(t) / P(t)$	Walsh (2010), McCandless and Wallace (1991)

Table 3.1. Definitions of seigniorage

V^1 is the real per capita change in the stock of nominal base money at the end of period t . V^2 is considered as central bank revenue when $i(t)$ is the risk-free nominal interest rate on financial instrument. A distinct but relevant implication of seigniorage is represented in V^3 which is Inflation Tax Revenue. It is a reduction in the real value of the stock of base money caused by inflation (Buiter 2007). V^4 is the rate of money growth multiplied by real value of the cash balance. It is assumed that the revenue rises in this way is because of individual's desire to keep real balance of money when there is an inflation. In V^5 the government sells new printed money to the individuals so that the consumption sources would be transferred from individuals to the public sector.

To support the choice of measure I note that several of these different measures are closely related. First, observe that, given $Y(t)$, V^1 is simply proportional to V^5 . Second, since the (net) rate of money supply growth is defined by

$$\begin{aligned} \tilde{\mu} &= \frac{M(t+1) - M(t)}{M(t)} \\ &= \frac{\Delta M(t)}{M(t)}, \end{aligned} \tag{3.1}$$

it follows that V^4 is also proportional to V^5 given $L(t)$.

In an economy where the real interest rate is determined by the change in prices

(as it is in the models in the following sections) we have

$$r(t+1) = \frac{P(t) - P(t+1)}{P(t+1)}, \quad (3.2)$$

and, similarly, the inflation rate is

$$\pi(t+1) = \frac{P(t+1) - P(t)}{P(t)}. \quad (3.3)$$

Since the nominal interest rate, i , is defined by

$$1 + i(t+1) = [1 + r(t+1)][1 + \pi(t+1)], \quad (3.4)$$

it follows from (3.2) – (3.4) that $i(t+1) = 0$. This shows that in the models we use V^2 will be identically zero. Hence, it is not a successful measure of seigniorage in this context.

These observation shows that the selection of a measure of seigniorage leaves an effective choice between V^3 and V^5 . I choose to use V^5 because in the model we consider this is equal to the quantity of commodity transferred from the private sector to the government in exchange for the new addition to the money stock. It is therefore consistent with the idea of seigniorage as the resources obtained by the government from the issue of money.

3.3 Monetary Equilibrium

This section describes a basic version of the model I employ and details the derivation of the monetary equilibrium. The model is a variant of the Samuelson (1958) consumption-loan model with fiat money issued by a government. A single form of corruption is considered which is manifested in the direct appropriation of newly issued money by corrupt officials. The model is extended in section 3.5 by using a more general utility

function, adding variable labour supply, and introducing corruption related to the effective tax rate and government revenue.

The model adopts the standard assumption on population structure of the overlapping generations economy. A new generation of individuals is born every period t and each individual lives through that period and through period $t + 1$. Since there are two generations alive in each period there can be trade between young and old, and consumption loans between members of the same generation with different endowments. Individuals are born either corrupt or non-corrupt, so the decision to become corrupt is not a choice. One interpretation that can be placed on this assumption is that the corrupt are born into a family which is in a position of sufficient authority to beneficially exploit opportunities for corruption. In addition, there is some evidence that genetics variation may affect criminal and impulsive behavior (Sherman *et al.* 1997). However, there is no discussion yet for the case that corruption would be a cause of the genetics behavior. Perhaps corrupt behavior could be inheritable, so the individuals could be corrupt by their birth. The number of corrupt young individuals born at time t is denoted $N_1(t)$ and the number of non-corrupt individuals is denoted $N_2(t)$. The total population of young at time t is therefore $N(t) = N_1(t) + N_2(t)$.

There is only one good available and there is no storage technology to permit transfers of this good from one period to the next. In each period the total endowment of consumption good must either be consumed or wasted. Every individual receives an endowment (which can be zero) in each period and, potentially, receives money from the government. Young individuals may also buy additional money from the old or from the government to allow the transfer of purchasing power across periods. Consumption loans

between members of the same generation are granted in the first period of life and repaid with interest in the second period of life.

The government issues additional fiat money every period. The accrued stock of money is the only store of value in the economy and its price in terms of the commodity adjusts to ensure the equality of demand to the accrued stock. We assume that the (gross) growth rate of money supply, μ , is constant. Hence, $M(t) - M(t - 1) = (\mu - 1)M(t - 1)$ for all t . The growth rate, μ , is a choice variable of the government. A fraction $\lambda_1 \geq 0$ of newly issued money is stolen by corrupt officials. Out of the remaining fraction $(1 - \lambda_1)$ of newly issued money a share $\gamma_1 \geq 0$ is sold to the young, and shares $\gamma_2 \geq 0$ and $\gamma_3 \geq 0$ are given to the young and the old respectively. By definition, $\gamma_1 + \gamma_2 + \gamma_3 = 1$. The evolution of the money supply and the distribution of newly issued money is summarized in table 3.2.

Period t
$M(t) = M(t - 1) + (\mu - 1)M(t - 1)$
$M(t - 1)$ carried into t from $t - 1$
$(1 - \lambda_1)\gamma_1(\mu - 1)M(t - 1)$ sold to young by government
$(1 - \lambda_1)\gamma_2(\mu - 1)M(t - 1)$ given to young by government
$(1 - \lambda_1)\gamma_3(\mu - 1)M(t - 1)$ given to old by government
$\lambda_1(\mu - 1)M(t - 1)$ stolen by corrupt consumers

Table 3.2. Money supply and corruption

We assume that the utility function for individual h_i of generation t is given by

$$U = \ln \left(C_t^{h_i}(t) \right) + \beta \ln \left(C_t^{h_i}(t + 1) \right), \quad i = 1, 2,$$

where $C_t^{h_i}(j)$ is the consumption at time j of an individual of type i born at time t . Type $i = 1$ denotes the corrupt and type $i = 2$ the non-corrupt. The form of utility is the same for both corrupt and non-corrupt individuals. We also assume that the appropriated money is divided equally among the corrupt young, and that any gifts of money from the government to consumers are given equally to all young and to all old.

Under these assumptions the budget constraints of corrupt individual h_1 of generation t in the two periods of life are

$$\begin{aligned} C_t^{h_1}(t) &= \omega_t^{h_1}(t) - \ell^{h_1}(t) - p^m(t)m^{h_1}(t) + p^m(t)\lambda_1(\mu - 1)\frac{M(t-1)}{N_1(t)} \\ &\quad + p^m(t)(1 - \lambda_1)\gamma_2(\mu - 1)\frac{M(t-1)}{N_1(t) + N_2(t)}, \end{aligned} \quad (3.5)$$

and

$$\begin{aligned} C_t^{h_1}(t+1) &= \omega_t^{h_1}(t+1) + r(t)\ell^{h_1}(t) + p^m(t+1)m^{h_1}(t) \\ &\quad + p^m(t+1)(1 - \lambda_1)\gamma_3(\mu - 1)\frac{M(t)}{N_1(t) + N_2(t)}. \end{aligned} \quad (3.6)$$

where $\omega_t^{h_1}(j)$ is the endowment received at time j , $\ell^{h_1}(t)$ is the quantity of consumption loans granted at t , $p^m(t)$ is the price of money in units of commodity, and $m^{h_1}(t)$ is the quantity of money carried from $t-1$ to t that is bought from old individuals and from government. $r(t)$ is the gross interest earned on consumption loans. By defining the net money demand, $\bar{m}^{h_1}(t)$, and net money supply, $\tilde{m}^{h_1}(t)$, where

$$\bar{m}^{h_1}(t) = m^{h_1}(t) - (1 - \lambda_1)\gamma_2(\mu - 1)\frac{M(t-1)}{N(t)} - \lambda_1(\mu - 1)\frac{M(t-1)}{N_1(t)}, \quad (3.7)$$

$$\tilde{m}^{h_1}(t) = m^{h_1}(t) + (1 - \lambda_1)\gamma_3(\mu - 1)\frac{M(t)}{N(t)}, \quad (3.8)$$

I can write the lifetime budget constraint as

$$C_t^{h_1}(t) + \frac{C_t^{h_1}(t+1)}{r(t)} = \omega_t^{h_1}(t) + \frac{\omega_t^{h_1}(t+1)}{r(t)} - p^m(t)\bar{m}^{h_1}(t) + \frac{p^m(t+1)}{r(t)}\tilde{m}^{h_1}(t). \quad (3.9)$$

It is assumed that all consumption loans are repaid for sure. Hence, there is potential for individuals to arbitrage between money and consumption loans. To prevent this I impose a no-arbitrage condition as a requirement of equilibrium. From (3.9) the

no-arbitrage condition is

$$p^m(t) - \frac{p^m(t+1)}{r(t)} = 0. \quad (3.10)$$

The utility maximization condition is,

$$\frac{C_t^h(t+1)}{\beta C_t^h(t)} = r(t) \quad (3.11)$$

Using the no-arbitrage condition the level of consumption demand at t for a corrupt consumer is

$$C_t^{h_1}(t) = \frac{1}{1+\beta} \left[\omega_t^{h_1}(t) + \frac{\omega_t^{h_1}(t+1)}{r(t)} - p^m(t) \left(\bar{m}^{h_1}(t) - \tilde{m}^{h_1}(t) \right) \right], \quad (3.12)$$

The level of saving for individual i of generation t when young is the amount that is left after consumption and loans are granted from the endowment at time t

$$s_t^{h_i}(r(t)) = \omega_t^{h_i}(t) - C_t^{h_i}(t) - \ell^{h_i}(t), i = 1, 2. \quad (3.13)$$

Therefore, the level of saving for the corrupt individual is

$$s_t^{h_i}(r(t)) = \omega_t^{h_i}(t) - \frac{1}{1+\beta} \left[\omega_t^{h_1}(t) + \frac{\omega_t^{h_1}(t+1)}{r(t)} - p^m(t) \left(\bar{m}^{h_1}(t) - \tilde{m}^{h_1}(t) \right) \right] - \ell^{h_i}(t), \quad (3.14)$$

$$s_t^{h_1}(t) = \frac{\beta}{1+\beta} \omega_t^{h_1}(t) - \frac{1}{r(t)(1+\beta)} \omega_t^{h_1}(t+1) + \frac{p^m(t)}{1+\beta} \left[\bar{m}^{h_1}(t) - \tilde{m}^{h_1}(t) \right] - \ell^{h_1}(t). \quad (3.15)$$

The budget constraint for the non-corrupt individual ($i = 2$) of generation t :

$$C_t^{h_2}(t) = \omega_t^{h_2}(t) - \ell^{h_2}(t) - p^m(t)m^{h_2}(t) + p^m(t)(1-\lambda)\gamma_2(\mu-1)\frac{M(t-1)}{N_1(t)+N_1(t)}, \quad (3.16)$$

$$C_t^{h_2}(t+1) = \omega_t^{h_2}(t+1) + r(t)\ell^{h_2}(t) + p^m(t+1)m^{h_2}(t) + p^m(t+1)(1-\lambda)\gamma_3(\mu-1)\frac{M(t)}{N_1(t)+N_1(t)}. \quad (3.17)$$

Each young non-corrupt individual receives endowment $\omega_t^{h_2}(t)$ and the fraction of $(1 - \lambda)\gamma_2$ of new issued money from government at time t . $\ell^{h_2}(t)$ is the loan granted and $m^{h_2}(t)$ is the amount of money bought from government and from old generation at time t . Let

$$\begin{aligned}\bar{m}^{h_2}(t) &= m^{h_2}(t) - (1 - \lambda)\gamma_2(\mu - 1)\frac{M(t-1)}{N(t)}, \\ \tilde{m}^{h_2}(t) &= m^{h_2}(t) + (1 - \lambda)\gamma_3(\mu - 1)\frac{M(t)}{N(t)}.\end{aligned}$$

By simplifying

$$C_t^{h_2}(t) + \frac{C_t^{h_2}(t+1)}{r(t)} = \omega_t^{h_2}(t) + \frac{\omega_t^{h_2}(t+1)}{r(t)} - p^m(t)\bar{m}^{h_2}(t) + \tilde{m}^{h_2}(t)\frac{p^m(t+1)}{r(t)}. \quad (3.18)$$

With (3.11) the demand function for non-corrupt individual is:

$$C_t^{h_2}(t) = \frac{1}{1 + \beta} \left[\omega_t^{h_2}(t) + \frac{\omega_t^{h_2}(t+1)}{r(t)} - p^m(t)\bar{m}^{h_2}(t) + \tilde{m}^{h_2}(t)\frac{p^m(t+1)}{r(t)} \right],$$

so the saving function (3.13):

$$\begin{aligned}s_t^{h_2}(r(t)) &= \frac{\beta}{1 + \beta} \omega_t^{h_2}(t) - \frac{1}{r(t)(1 + \beta)} \omega_t^{h_2}(t+1) + \frac{p^m(t)}{1 + \beta} \bar{m}^{h_2}(t) - \frac{p^m(t+1)}{r(t)(1 + \beta)} \tilde{m}^{h_2}(t) - \ell^{h_2}(t), \\ s_t^{h_2}(t) &= \frac{\beta}{1 + \beta} \omega_t^{h_2}(t) - \frac{1}{r(t)(1 + \beta)} \omega_t^{h_2}(t+1) + \frac{p^m(t)}{1 + \beta} \left[\bar{m}^{h_2}(t) - \tilde{m}^{h_2}(t) \right] - \ell^{h_2}(t).\end{aligned} \quad (3.19)$$

An equilibrium for the economy requires aggregate saving, $S(t)$, to be equal to the value of money supply at time t

$$S(t) = p^m(t)M(t). \quad (3.20)$$

I assume that the intertemporal pattern of endowments is such that there exists a stationary monetary equilibrium with $S(t) = S(t+1)$. I choose to restrict attention to such equilibria but note that there may be other non-stationary rational expectations equilibria of the

form described by Hahn (1982) and Wallace (1980). The restriction to stationary monetary equilibrium determines the relationship between the price of money and the quantity of money $p^m(t)M(t) = p^m(t+1)M(t+1)$. Since the (gross) growth rate of money supply is constant at μ , I have $M(t+1) = \mu M(t)$ so $p^m(t) = \mu p^m(t+1)$. Using the no-arbitrage condition (3.10) gives the real interest rate as

$$r(t) = \frac{p^m(t+1)}{p^m(t)} = \frac{1}{\mu}. \quad (3.21)$$

Using (3.21) the saving function for type i is

$$s_t^{h_i}(t) = \frac{\beta}{1+\beta} \omega_t^{h_i}(t) - \frac{\mu}{1+\beta} \omega_t^{h_i}(t+1) + \frac{p^m(t)}{1+\beta} [\bar{m}^{h_i}(t) - \tilde{m}^{h_i}(t)] - \ell^{h_i}(t). \quad (3.22)$$

The aggregate saving function is the sum of individual saving

$$S(t) = \sum_{h_1=1}^{N_1(t)} s_t^{h_1}(t) + \sum_{h_2=1}^{N_2(t)} s_t^{h_2}(t). \quad (3.23)$$

Using the saving functions and fact that $\sum_{i=1}^2 \sum_{h_i=1}^{N_i(t)} \ell^{h_i}(t) = 0$, (3.23) can be written as

$$\begin{aligned} S(t) &= \frac{1}{1+\beta} \sum_{i=1}^2 \sum_{h_i=1}^{N_i(t)} [\beta \omega_t^{h_i}(t) - \mu \omega_t^{h_i}(t+1)] \\ &\quad - \frac{p^m(t)M(t)(\mu-1)}{1+\beta} \left[(1-\lambda_1) \left(\frac{\gamma_2}{\mu} + \gamma_3 \right) + \frac{\lambda_1}{\mu} \right]. \end{aligned} \quad (3.24)$$

Now define the aggregate endowments of generation t when young by $Y_t(t) = \sum_{i=1}^2 \sum_{h_i=1}^{N_i(t)} \omega_t^{h_i}(t)$ and when old by $Y_t(t+1) = \sum_{i=1}^2 \sum_{h_i=1}^{N_i(t)} \omega_t^{h_i}(t+1)$, and use the fact that $S(t) = p^m(t)M(t)$ to give

$$S(t) = \frac{\beta Y_t(t) - \mu Y_t(t+1)}{1+\beta} - \frac{S(t)(\mu-1)}{(1+\beta)} \left[(1-\lambda_1) \left(\frac{\gamma_2}{\mu} + \gamma_3 \right) + \frac{\lambda_1}{\mu} \right]. \quad (3.25)$$

Solving (3.25) for $S(t)$ gives the equilibrium level of saving as

$$S(t) = \frac{\beta Y_t(t) - \mu Y_t(t+1)}{1+\beta + \frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu} + \frac{\lambda_1(\mu-1)}{\mu} + (1-\lambda_1)\gamma_3(\mu-1)}. \quad (3.26)$$

Substituting into (3.20) the equilibrium price of money is given by

$$p^m(t) = \frac{\beta Y_t(t) - \mu Y_t(t+1)}{M(t) \left[1 + \beta + \frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu} + \frac{\lambda_1(\mu-1)}{\mu} + (1-\lambda_1)\gamma_3(\mu-1) \right]}. \quad (3.27)$$

This completes the construction of the stationary monetary equilibrium for the economy.

3.4 Seigniorage and Inflation

The analysis of equilibrium has taken the growth rate of money supply as given. I now assume that the government chooses the rate of monetary expansion to obtain maximum benefit from seigniorage. In the monetary economy I have described the young consumers purchase newly issued money by transferring units of the commodity to the government. Seigniorage, therefore, has a very real interpretation as units of consumption good received by the government in exchange for money. In this sense, the government has an incentive to maximize seigniorage.

The analysis is simplified in this section by assuming that the issue of new money is the only source of revenue for the government. I relax this in the next section. The value of seigniorage is measured by V^5 so the decision problem of the government is

$$\max_{\{\mu\}} V^5. \quad (3.28)$$

Since V^5 measures the resources received by the government this optimization describes a leviathan model of government. That is, the government chooses the policy that maximizes its size in terms of the flow of resources that it receives each period.

The value of seigniorage is determined by the share of the newly issued money sold

to the young

$$V^5 = p^m(t) [(1 - \lambda_1)\gamma_1(\mu - 1)M(t - 1)]. \quad (3.29)$$

Money given to the young or old results in no resources for the government so is not included in the measure of seigniorage. There could be other political justifications for giving money to these groups (e.g. as pension payments to the old) but we do not explore the issue further. Using (3.20), (3.26) and (3.29)

$$\begin{aligned} V^5 &= (1 - \lambda_1)\gamma_1 \left(\frac{\mu - 1}{\mu} \right) p^m(t)M(t) \\ &= \frac{\beta Y_t(t) - \mu Y_t(t + 1)}{\frac{(1 + \beta)\mu}{(1 - \lambda_1)\gamma_1(\mu - 1)} + \frac{\gamma_2}{\gamma_1} + \frac{\lambda_1}{(1 - \lambda_1)\gamma_1} + \frac{\mu\gamma_3}{\gamma_1}}. \end{aligned} \quad (3.30)$$

From (3.30) I obtain a result that links corruption to seigniorage.

Lemma 1 (i) If $Y_t(t)\beta\gamma_3 - Y_t(t + 1)[1 - \gamma_2] > 0$ an increase in corruption (λ_1 increases) raises the rate of inflation. (ii) If $Y_t(t)\beta\gamma_3 - Y_t(t + 1)[1 - \gamma_2] < 0$ an increase in corruption (λ_1 increases) decreases the rate of inflation.

Proof. The first-order condition for maximizing the value of seigniorage gives the condition

$$\begin{aligned} &\beta Y_t(t) \left[\frac{1 + \beta}{(1 - \lambda_1)\gamma_1(\mu - 1)^2} - \frac{\gamma_3}{\gamma_1} \right] \\ &= Y_t(t + 1) \left[\frac{(1 + \beta)\mu^2}{(1 - \lambda_1)\gamma_1(\mu - 1)^2} + \frac{\gamma_2}{\gamma_1} + \frac{\lambda_1}{(1 - \lambda_1)\gamma_1} \right]. \end{aligned}$$

From the first-order condition it follows that

$$\frac{d\hat{\mu}}{d\lambda_1} = \frac{(\mu - 1)^2 [Y_t(t)\beta\gamma_3 - Y_t(t + 1)[1 - \gamma_2]]}{2 [Y_t(t)\beta\gamma_3(1 - \lambda_1)(\mu - 1) + Y_t(t + 1)[(1 + \beta + \lambda_1)\mu + \gamma_2(1 - \lambda_1)(\mu - 1)]}.$$

It can be seen that $\frac{d\hat{\mu}}{d\lambda_1}$ has the same sign as $Y_t(t)\beta\gamma_3 - Y_t(t + 1)[1 - \gamma_2]$. Since $p^m(t) = \mu p^m(t + 1)$ this implies

$$\frac{d\mu}{d\lambda_1} \leq 0 \Leftrightarrow \frac{d}{d\lambda_1} \left(\frac{p^m(t)}{p^m(t + 1)} \right) \leq 0.$$

The commodity price is $p = p^m(t)^{-1}$ so that

$$\frac{d}{d\lambda_1} \left(\frac{p^m(t)}{p^m(t+1)} \right) \leq 0 \iff \frac{d}{d\lambda_1} \left(\frac{p(t+1)}{p(t)} \right) \leq 0.$$

■

There is a clear intuition behind this result. The total amount of consumption available in each period is fixed by the size of endowments. Since money has value, holding money increases the share of this endowment a consumer can obtain relative to the share if no money is held. The government gives some money away and some is stolen by the corrupt. This disadvantages those who do not receive a gift of money and the non-corrupt. Combining these observations, it can be seen that there is an incentive for those who can buy money to do so. The government exploits this incentive to buy through seigniorage to raise revenue.

This intuitive argument can be used to explain the role of the component terms in the condition in Lemma 1. Money is held to transfer consumption into the second period. The motive for doing this is strongest when $Y_t(t+1)$ is small relative to $Y_t(t)$. A high value of β gives greater weight on second period consumption which enhances the incentive to carry money into the second period. The role of γ_3 in the sufficient condition reflects the fact that money given to the old increases the total stock of money so a young consumer must respond by buying more money to maintain their share of future consumption. The identity $\gamma_1 + \gamma_2 + \gamma_3 = 1$ can be used to write

$$Y_t(t)\beta\gamma_3 - Y_t(t+1)[1 - \gamma_2] = [Y_t(t)\beta - Y_t(t+1)]\gamma_3 - Y_t(t+1)\gamma_1. \quad (3.31)$$

Hence, it becomes more difficult to exploit seigniorage when the *proportion* of money sold to the young is large relative to that given to the old. If all money were sold to the young

then monetary expansion would not change the level of real resources that the young would be prepared to sacrifice to buy money; only the value of money would change. In contrast, giving money to the old exploits the different lifecycle positions of the young and old, and can raise the real resources obtained from monetary expansion.

This section has demonstrated that there are circumstances in which increased corruption in the form of the direct appropriation of newly issued money will cause a government that is maximizing seigniorage to increase the rate of growth of money supply. This causes the price of money in terms of commodity to fall over time which is equivalent to an increase in the rate of inflation of the commodity price. Hence, corruption can be positively correlated with inflation through the seigniorage activities of government.

3.5 Taxation

The basic version of the model has demonstrated that it is possible for corruption to lead a rational government to generate inflation as it pursues supplementary revenue from seigniorage. There are, of course, limitations with the previous analysis that we address in this section. The two major shortcomings are the single form of corruption and the use of a leviathan model of government. I extend the model to add additional forms of corruption and replace the leviathan with a benevolent government that enacts policy to maximize social welfare.

The consumers are now assumed to be endowed with a unit of time in the first period of life. Each consumer is also endowed with a skill level that determines their wage rate per unit of time. The time allocation is divided between leisure and labour to maximize

utility. No labour is supplied in the second period of life. This assumption ensures that there is a need to purchase money (or provide a consumption loan) if consumption in the second period of life is to be positive. The government levies a tax upon labour income at rate τ . The tax revenue that is collected, plus the revenue from seigniorage, is used to finance a public good. The public good is enjoyed by all consumers in both periods of life.

These additions to the model open up two new channels through which corruption can operate. The first is that corrupt consumers can collaborate with tax collectors to reduce the effective tax rate that they pay. The second is that the corrupt can also appropriate part of the revenue that is raised. Public good provision is then equal to the level of revenue that remains after some has been appropriated. The government chooses the tax rate and the growth rate of money supply to maximize social welfare taking into account the existence of the corrupt activities.

3.5.1 Characterization of equilibrium

The utility function of a type i consumer, $i = 1, 2$, born at time t is now assumed to take the CRRA form

$$U^{h_i} = \sum_{i=0}^1 \beta^i \left(\frac{C_t^{h_i}(t+i)^{1-\rho} - 1}{1-\rho} + \frac{G(t+i)^{1-\rho} - 1}{1-\rho} \right) + \frac{\left(1 - L_t^{h_i}(t)\right)^{1-\rho} - 1}{1-\rho}, \quad (3.32)$$

where $L_t^{h_i}(t)$ is labour supply and $G(t)$ the provision of public good at time t . The intertemporal budget constraint for a typical corrupt individual is

$$\begin{aligned} C_t^{h_1}(t) + \frac{C_t^{h_1}(t+1)}{r(t)} &= \omega_t^{h_1}(t) L_t^{h_1}(t) (1 - \lambda_2 \tau) + \lambda_3 \frac{R(t)}{N_1(t)} \\ &+ \left[p^m(t) \bar{m}^{h_1}(t) - \frac{p^m(t+1)}{r(t)} \tilde{m}^{h_1}(t) \right], \end{aligned} \quad (3.33)$$

where $\omega_t^{h_1}(t)$ is the wage rate obtained by individual h_1 at time t , λ_2 is the reduction achieved in the tax rate, $R(t)$ is the government revenue of tax and seigniorage, and λ_3 is the proportion of revenue appropriated by the corrupt. The wage rate is expressed in units of output and reflects the (constant) marginal productivity of the individual. The budget constraint of non-corrupt consumer h_2 is

$$C_t^{h_2}(t) + \frac{C_t^{h_2}(t+1)}{r(t)} = \omega_t^{h_2}(t)L_t^{h_2}(t)(1-\tau) + \left[p^m(t)\bar{m}^{h_2}(t) - \frac{p^m(t+1)}{r(t)}\tilde{m}^{h_2}(t) \right]. \quad (3.34)$$

The solution process of section 3.3 can be used to show that the quantity of saving at the stationary monetary equilibrium is

$$S(t) = \frac{S_{11} + S_{12} + S_{13}\lambda_3\frac{R(t)}{N_1(t)}}{1 + S_{21} + S_{22}}, \quad (3.35)$$

where the terms S_{ij} (and other terms used in this section) are detailed in Appendix D. The next step is to compute the level of revenue from taxation and seigniorage. The level of revenue at time t is

$$R(t) = \sum_{h_1=1}^{N_1(t)} \omega_t^{h_1}(t)\lambda_2\tau L^{h_1}(t) + \sum_{h_2=1}^{N_2(t)} \omega_t^{h_2}(t)\tau L^{h_2}(t) + (1-\lambda_1)\gamma_1\left(\frac{\mu-1}{\mu}\right)S(t). \quad (3.36)$$

The labour supply functions and the solution for saving (3.35) can be substituted into (3.36) and the resulting equation solved to give the level of revenue $R(t)$ in terms of underlying parameters. Taking the appropriation of revenue by the corrupt into account the level of public good is

$$G(t) = [1 - \lambda_3]R(t). \quad (3.37)$$

The government is assumed to act benevolently in its choice of policy and pursues the maximization of welfare despite the presence of corruption elsewhere in the economy.

Corruption, therefore, does not extend to the choice of policy. Denoting the welfare weights of the corrupt and the non-corrupt by μ^1 and μ^2 respectively, the government chooses the tax rate and the rate of monetary growth to maximize social welfare.

$$\max_{\{\tau, \mu\}} W = \sum_{h_1=1}^{N_1(t)} \mu^1 U^{h_1} + \sum_{h_2=1}^{N_2(t)} \mu^2 U^{h_2}. \quad (3.38)$$

3.5.2 Analysis

The previous sub-section has characterized the stationary monetary equilibrium of the economy. I now employ a numerical analysis to investigate the optimal choices of tax rate and rate of growth of money supply arising from the government maximization of welfare. The intention of the analysis is to explore the relationship between the different forms of corruption and the rate of monetary expansion. Since the tax rate is a choice variable, I also determine the relationship between the rate of tax and corruption.

The analysis is undertaken by making one additional simplification. I now assume that all consumers have the same wage rate, so $\omega_t^{h_i}(t) = \omega$, all h_i , $i = 1, 2$. It seems unlikely that this assumption will significantly affect any of the conclusions. However, it does reinforce the need to purchase money since the consumption loan channel for saving will become less effective with identical labour incomes. Under the assumption of an identical wage the provision level of the public good is

$$G(t) = [1 - \lambda_3] \frac{N_1(t)\omega\lambda_2\tau R_{11} + N_2(t)\omega\tau R_{13} + \left[\frac{S_{11}+S_{12}}{1+S_{21}+S_{22}} \right] (R_{141} - R_{142} - R_{143})}{1 - R_{12} - \frac{S_{13}\lambda_3 R_{14}}{1+S_{21}+S_{22}}}. \quad (3.39)$$

Table 3.3 shows how corruption in the form of the appropriation of newly issued money supply affects the optimal choice of the tax rate and the rate of monetary expansion. The parameter values for this analysis are reported in Appendix E. The table shows that

an increase in this form of corruption reduces the tax rate but raises the rate of monetary expansion. As λ_1 increases it becomes optimal to rely less on taxation to raise revenue but instead to rely more on seigniorage even though an increased proportion of the new monetary base is being appropriated. This can be explained by the same argument as given earlier. More appropriation of newly-issued money leaves the young non-corrupt in a relatively disadvantaged position so they have greater need to purchase money. This can be exploited by the government to raise additional seigniorage revenues.

	λ_1				
	0.15	0.20	0.25	0.30	0.35
$\hat{\tau}$	0.6735	0.6672	0.6627	0.6594	0.6568
$\hat{\mu}$	1.0057	1.0759	1.1319	1.1776	1.2153

Table 3.3. Increased appropriation of newly issued money ($\lambda_2 = 0.50$, $\lambda_3 = 0.45$)

Table 3.4 shows that there is a monotonic relationship between λ_2 and the effective tax rate. As λ_2 decreases (recall that a lower λ_2 implies a greater reduction in the tax rate, so lower λ_2 is interpreted as more corruption) the tax rate chosen by the government falls. Hence, this form of corruption discourages the government from using taxation as a source of revenue. The relationship between $\hat{\tau}$ and λ_3 is also monotonic. An increase in λ_3 (more revenue is appropriated, so there is greater corruption) implies that the tax rate rises to offset this effect.

		λ_3				
		0.3	0.35	0.4	0.45	0.5
λ_2	0.4	0.62786	0.63368	0.63960	0.64517	0.65038
	0.45	0.62921	0.63665	0.64420	0.65120	0.65827
	0.5	0.63122	0.64075	0.65006	0.65941	0.66908
	0.55	0.63428	0.64636	0.65834	0.67111	0.68375
	0.6	0.63895	0.65424	0.67066	0.68748	0.70571
	0.65	0.64606	0.66654	0.68900	0.71376	0.74072

Table 3.4. Effect of corruption on tax rate ($\lambda_1 = 0.3$)

Table 3.5 shows the effect on the optimal rate of monetary expansion of changes in corruption. The optimal rate of monetary expansion increases as λ_2 decreases. This shows that more corruption in the reduction of effective rate of tax encourages seigniorage and increases inflation. When the effective tax rate is reduced through corruption then seigniorage naturally becomes more significant as a source of revenues. Similarly, an increase in λ_3 - more revenue being appropriated - means that the rate of monetary expansion increases for low λ_2 but decreases for high λ_2 . So, an increase in either of these forms of corruption may increase inflation but the effect of λ_3 is dependent upon the interaction between the two forms of corruption. Figure 3.1 provides a graphical representation of the non-monotonicity with respect to λ_3 .

		λ_3				
		0.3	0.35	0.4	0.45	0.5
λ_2	0.40	1.179156	1.181890	1.184693	1.187649	1.190951
	0.45	1.175311	1.177543	1.179854	1.182675	1.185573
	0.50	1.171853	1.173418	1.175395	1.177608	1.179877
	0.55	1.168637	1.169430	1.170735	1.172006	1.173762
	0.60	1.165453	1.165370	1.165335	1.165756	1.166236
	0.65	1.162064	1.160439	1.158822	1.157268	1.156021

Table 3.5. Effect of corruption on monetary expansion ($\lambda_1 = 0.3$)

The final analysis investigates the effect of corruption on GDP. A similar analysis of the effect of corruption on welfare could be undertaken but the interpretation of this would raise questions. An increase in corruption would tend to raise the welfare of the corrupt at the cost of the non-corrupt. It is not clear the extent to which this could be taken as a real increase in welfare, or provide any recommendations for policy. This could be addressed by suitable selection of the welfare weights but again there is a tension between what the government may choose (which could be controlled more or less by the corrupt) and what a moralistic judgement would suggest.

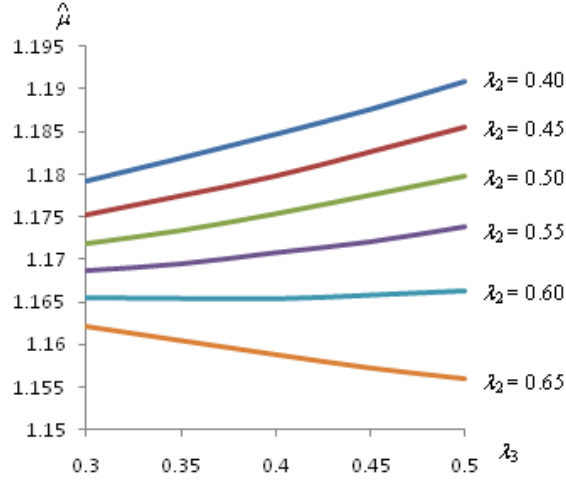


Figure 3.1: Effect of tax revenue appropriation

For these reasons that focus is placed on GDP. In the economy under consideration

GDP at time t is given by

$$Y = \sum_{h_1=1}^{N_1(t)} w^{h_1} L^{h_1}(t) + \sum_{h_2=1}^{N_2(t)} w^{h_2} L^{h_2}(t). \quad (3.40)$$

Figure 3.2 shows that GDP decreases when there is increased corruption through the appropriation of money and tax revenue. Conversely, when the corrupt are able to secure a lower effective tax rate an increase in corruption raises GDP. The reason for this latter result is that GDP is determined by labour supply whereas welfare is also dependent on the level of public good. A decrease in the effective tax rate faced by the corrupt encourages more labour supply so GDP rises. But revenue collected will fall, as will aggregate welfare. There is also a distributional effect as more of the revenue burden is placed on the non-corrupt. The results are given for two values of ρ , the coefficient of relative risk aversion, because there are many economic models where the outcome can qualitatively change between the cases of $\rho < 1$ and $\rho > 1$. The figures show that this is not the case in our model of

corruption and the relationship between corruption and GDP is the same in both cases.

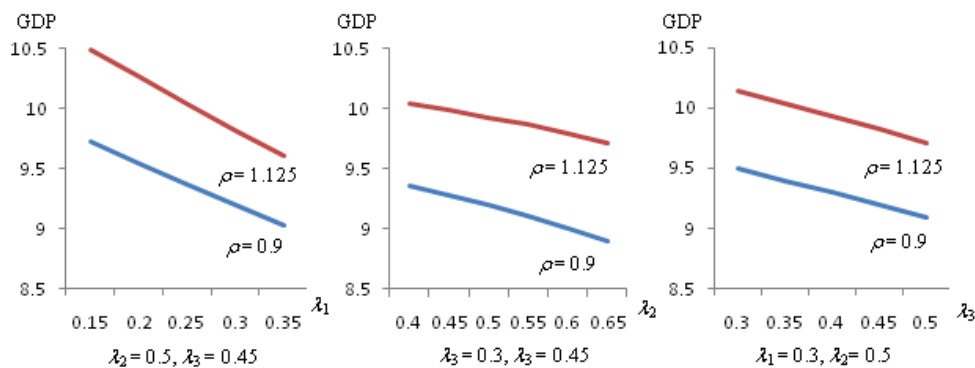


Figure 3.2: Corruption and GDP

The numerical results show that it is possible for an increase in corruption to increase inflation through monetary expansion. For the parameter values considered an increase in the appropriate of money always raises inflation. The effect is not so clear for the appropriation of tax revenue since this interacts with corruption through reduction of the effective tax rate.

3.6 Conclusions

There is a significant empirical correlation between corruption and inflation. In contrast, there is no theoretical explanation of why this correlation might arise. There have been suggestions that it can be a consequence of the government exploiting seigniorage as an alternative means of raising revenue but there has been no demonstration that this can be a rational policy. This chapter has provided an analysis of why a welfare-maximizing

government faced by corruption in the economy may choose to exploit seigniorage as a source of revenue even though this increases the rate of inflation.

I have set the analysis of corruption and inflation within an overlapping generations economy in which money acts as a store of value. Two different versions of the model were analyzed. In the basic model each consumer received an endowment of the single consumption good in the first period of life which was either consumed, used to provide consumption loans, or used to purchase money. An endowment was also received in the second period of life and money carried over from the first period was used to purchase additional consumption to supplement the endowment. The government chose the rate of increase of money supply to maximize the value of seigniorage. Seigniorage was measured as the quantity of consumption good transferred from consumers to the government. The model had a single form of corruption which involved corrupt individuals appropriating part of the newly produced money supply. A sufficient condition was derived for an increase in corruption to increase inflation.

The second model enriched the analysis by adding labour supply as a choice variable, using tax revenue and the proceeds from seigniorage to finance a public good, and introducing additional forms of corruption. The two additional forms of corruption were the reduction of the effective labour tax rate levied on the corrupt and the appropriation of tax revenue. This model had to be analyzed by numerical simulation which naturally limits the extent to which we can claim generality for the results. Even so, the model was able to demonstrate that it was possible for there to be situations in which all three types of corruption could be positively correlated with an increase in the optimal rate of monetary

expansion and, hence, with inflation. There were also parameter combinations for which one, or more, forms of corruption could be negatively correlated with inflation. The analysis also showed that an increase in the appropriation of new money or of tax revenue reduced the level of GDP. This finding agrees with the usual perspective on the effects of corruption.

In the overlapping generations economy money acts as a store of value. It allows consumers to carry purchasing power from early in life to later in life in order to ensure that consumption can be smoother across the lifecycle. It is this wish to benefit from consumption smoothing that the government exploits when it engages in seigniorage. An increase in the money holding of one consumer, either by purchase, gift, or appropriation, reduces the relative consumption of other consumers. The other consumers therefore have an incentive to purchase additional money to restore their relative consumption levels. This effect is most marked when all endowment is obtained in the first period of life so that money has to be held to avoid zero second-period consumption. The level of seigniorage chosen by the government is determined by the trade-off between an increased quantity of money and a reduced consumption-price for each unit of money. The analysis shows that corruption can shift this trade-off in the direction of increased monetary expansion and resulting inflation.

The paper has provided a theoretical analysis that is in agreement with the empirical finding of a positive correlation between inflation and corruption. We have modelled three different forms of corruption, each of which can give the government an incentive to exploit seigniorage to compensate for effects of corruption. This establishes very clearly that excessive inflation can be the consequence of a rational policy response to the existence of

corruption.

Chapter 4

Static Endogenous Corruption

4.1 Introduction

Public sector corruption is endemic in many economies, including both developed and developing nations, and is frequently cited as a cause of poor macroeconomic performance. Corruption hinders the completion of beneficial transactions and distorts the outcomes of economic policies. It can also affect the policy choice of governments as they attempt to compensate for the consequences of corruption.

The previous chapter has shown that excessive inflation may be a negative side effect of corruption if the government compensates for lost revenue by exploiting seigniorage and increasing the rate of monetary expansion. In that analysis the major limitation was that corruption was assumed to be exogenous. Some individuals were corrupt by nature and did not have an option to choose to be honest. This was a good starting point for an explanation of how corruption could be linked to inflation, but it is far from the situation observed in reality. In practice, the choice to be corrupt is endogenously determined by

various factors including individual characteristics and the social setting. Therefore, to move closer toward reality, corruption needs to be explained as an endogenous outcome that reacts to changes in the economic environment. Hindriks *et al.* (1999) study the details of the interaction between a taxpayer and a tax inspector. In a neo-classical growth model, Blackburn *et al.* (2010) and Blackburn and Forues-Puccio (2010) show that there is an opportunity for public sector bureaucrats who are responsible for collecting taxes to collude with households in bribery and tax evasion. Collusion occurs when a high-income tax payer and a corruptible bureaucrat find it mutually advantageous to hide information from the government. A high-income taxpayer will agree to pay a bribe when the expected utility of paying the bribe is no less than expected utility from being compliant. Our model differs by focusing on occupational choice and the bureaucrats decision to act corruptly. In this chapter I build upon this research to provide a model of endogenous corruption.

The contribution of the chapter is to construct a model in which there is an option to choose to be corrupt, and the benefits of corruption are endogenously shared between participants in corrupt acts. The people in the model make a choice between private or public employment on the basis of rewards that are offered and the level of work effort expected. One of the benefits of choosing public employment is that it makes it possible to act in a corrupt way. Corruption gives access to additional income in the form of bribes but leads to a loss of self-esteem. Individuals are heterogenous with respect to their willingness to undertake effort in employment and in the loss of self-esteem when acting corruptly. These characteristics determine the set of people who choose to be corrupt. The effective tax rate paid by firms is assumed to be determined endogenously through a generalized Nash

bargain that determines the allocation of the benefits of corruption between tax payers and tax officials. The analysis constructs the equilibrium employment allocation across the private and public sectors, and the division between those who choose honesty and those who are corrupt.

Section 4.2 describes the components of the model. A characterization of equilibrium is given in section 4.3. The equilibrium is analyzed in section 4.4 and a comparative statics exercise is conducted. Section 4.5 concludes the chapter.

4.2 Model

The main idea of the analysis is that people working in the public sector have the opportunity to be corrupt. They may choose to make use of this opportunity or they may choose to be honest. Introducing this choice into the individual decision problem can endogenize the level of corruption. To make this work there must be a heterogeneity in the population so they do not all make the same choice.

The choice facing each person is between employment in the private sector and employment in the government. The public sector and the private sector offer contracts that specify the wage and the required effort level. It is assumed the government offers a lower wage and a lower effort level. Public sector employment involves the collection of taxes levied on firms and the provision of public goods. Within government employment the option then arises of being corrupt. It is assumed that corruption involves levying a lower rate of tax than required and sharing the benefit of this with the firms. The value of government employment is then the wage plus the benefits of corruption less a loss of social

esteem through being corrupt.

4.2.1 Employment choice

The basic idea is that people working in the public sector have the opportunity to be corrupt. They may choose to make use of this opportunity or they may choose to be honest. The government and the private sector offer contracts that state the wage rate and the required level of effort. The representation of effort is based on standard models of shirking (Bulkley and Myles 1996, Strobl and Walsh 2007). All private sector contracts are identical. Employees in the public sector are involved with the collection of taxes and the provision of public goods. Within government employment the option then arises of being corrupt and it is assumed that the opportunity to be corrupt involves taking benefits from taxation activities. Corruption gives a financial benefit from bribes received but also leads to a loss of self esteem.

Let consumers be differentiated with respect to the valuation of the social sanction (χ) and with respect to their disutility of effort (v). Hence, utility in the public sector when corrupt is

$$U^c = u_1(w^g + b, G) - ve^g - \chi k, \quad (4.1)$$

when honest

$$U^h = u_2(w^g, G) - ve^g, \quad (4.2)$$

and in the private sector

$$U^p = u_3(w^p, G) - ve^p, \quad (4.3)$$

where w^g and w^p are the wages provided by public and private sector respectively. b is

the bribe received by each corrupt person. v and χ are parameters that differ across the population. k is the same for all people and is the social sanction on corruption. A low value of k means a lower economy-wide sanction on corruption. The product χk is the loss of self esteem from acting in a corrupt way.

From these payoffs it is possible to partition the space of characteristics according to the choice of occupation and the corruption decision. Let $\{v, \chi\} \in \Theta \equiv [0, 1] \times [0, 1]$. To simplify the notation define $u_1 = u_1(w^g + b, G)$, $u_2 = u_2(w^g, G)$, and $u_3 = u_3(w^p, G)$. Then the separating value of v between the private sector and honest public sector is given by

$$u_3 - v^* e^p = u_2 - v^* e^g,$$

so

$$v^* = \frac{u_3 - u_2}{e^p - e^g}. \quad (4.4)$$

Anyone with $v > v^*$ will work in the public sector, and anyone with $v < v^*$ will work in the private sector. The critical value of χ that separates the honest from dishonest in the public sector is obtained from

$$u_2 - v e^g = u_1 - v e^g - \chi k,$$

so

$$\chi^* = \frac{u_1 - u_2}{k}. \quad (4.5)$$

People with $\chi > \chi^*$ will be honest, and anyone with $\chi < \chi^*$ will be corrupt. The final division is between the corrupt in public and the private sector. The line of equality is

$$u_3 - v e^p = u_1 - v e^g - \chi k,$$

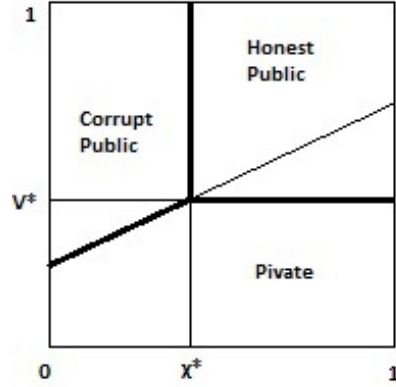


Figure 4.1: Distribution of occupation

so

$$v(\chi) = \frac{\chi k}{e^p - e^g} + \frac{u_3 - u_1}{e^p - e^g}. \quad (4.6)$$

The number in each occupation can then be found by integrating the areas in the set Θ .

From the figure it can be read that

$$n^h = \int_{\chi^*}^1 \int_{v^*}^1 N g(\chi, v) dv d\chi,$$

and

$$n^c = \int_0^{\chi^*} \int_{\max\{0, v(\chi)\}}^1 N g(\chi, v) dv d\chi,$$

where $g(\chi, v)$ is the distribution of characteristics in the population, and by definition

$$n^p = N - n^c - n^h. \quad (4.7)$$

These can be reduced to the statements

$$n^c = n^c(w^p, w^g, b),$$

$$n^h = n^h(w^p, w^g, b),$$

which show the functional dependence on the three endogenous variables w^p, w^g , and b . The properties of these functions could be established by a comparative statics analysis of the integrals.

The integrals can be written explicitly by assuming a uniform distribution for χ and v , so over the unit square $g(\chi, v) = 1$. First, take n^h . Writing the integral in full gives,

$$\begin{aligned}
n^h &= N \int_{\frac{u_1(w^g+b, G) - u_2(w^g, G)}{k}}^1 \int_{\frac{u_3(w^p, G) - u_2(w^g, G)}{e^p - e^g}}^1 g(\chi, v) \, dv d\chi \\
&= N \int_{\frac{u_1(w^g+b, G) - u_2(w^g, G)}{k}}^1 \int_{\frac{u_3(w^p, G) - u_2(w^g, G)}{e^p - e^g}}^1 1 \, dv d\chi \\
&= N \left(1 - \frac{u_3(w^p, G) - u_2(w^g, G)}{e^p - e^g}\right) \left(1 - \frac{u_1(w^g + b, G) - u_2(w^g, G)}{k}\right). \quad (4.8)
\end{aligned}$$

The solution for n^c depends on whether $v(\chi) \lesseqgtr 0$. The simpler case occurs when $v(\chi) > 0$, so

$$\begin{aligned}
n^c &= N \int_0^{\frac{u_1(w^g+b, G) - u_2(w^g, G)}{k}} \int_{v(\chi)}^1 1 \, dv d\chi \\
&= N \left(\frac{u_1(w^g + b, G) - u_2(w^g, G)}{k} \right) \times \\
&\quad \left[1 - \frac{u_3(w^p, G) - u_1(w^g + b, G)}{e^p - e^g} - \frac{u_1(w^g + b, G) - u_2(w^g, G)}{2(e^p - e^g)} \right]. \quad (4.9)
\end{aligned}$$

Given values of w^p, w^g , and b (4.8) and (4.9) determine the number of and honest and corrupt public sector employees and the comparative statics are straightforward to derive.

4.2.2 Firm's profit

There is a representative firm with total production function $f(n^p)$ where n^p is employment in the private sector. The firm in a literal interpretation of the model deals

with all of the officials. Some of these officials are corrupt, but some are not. The firm should pay an amount $\tau f(n^p)$ in tax, where τ is the tax rate, but it actually pays $\lambda\tau f(n^p)$, $\lambda \leq 1$, where λ is the proportion by which the tax is reduced due to collusion with corrupt tax officials.

The profit of the firm is given by

$$\pi = [1 - \lambda\tau] f(n^p) - w^p n^p.$$

Note that this statement of profit adopts a normalization of the output price at 1. Then the choice of n^p satisfies the necessary condition

$$[1 - \lambda\tau] f'(n^p) - w^p = 0.$$

This can be written with functional dependence as

$$[1 - \lambda\tau] f' \left(N - n^h(w^p, w^g, b) - n^c(w^p, w^g, b) \right) - w^p = 0.$$

With Constant Returns to Scale (CRS) the equivalent statements would be

$$\pi = [1 - \lambda\tau] f' \left(N - n^h(w^p, w^g, b) - n^c(w^p, w^g, b) \right) - w^p n^p,$$

and

$$[1 - \lambda\tau] f' = w^p.$$

4.2.3 Nash bargaining

There is a reduced tax rate as a result of public sector corruption endogenized in the analysis, and that reduction in the tax rate is determined as one of the equilibrium conditions of the model. The premise is that the share of the proceeds from corruption are

shared between the firm and the corrupt tax officials using a generalization of the Nash (1950) bargaining model (see also Harsanyi, 1977).

It might be possible to try and match firms and officials, so that some firms meet honest tax officials and some firms meet corrupt tax officials. This approach would run into significant number problems when the number of each is variable and the modelling of matching would become a significant problem. The approach taken here is to assume that the representative firm bargains with the collective of tax officials, some of whom are honest and some corrupt. The payoffs that enter the bargain are those for the representative firm and for the collective of tax officials. The two-player bargaining problem is to understand how two sides cooperate when it leads to a Pareto-inefficient result if they do not bargain. Therefore, at this point the requirement is to clarify the details of what does exactly happen if they cooperate and if one decides not to bargain.

The component parts of the bargain are described in Table 4.1 where the value of λ is the proportion of tax officials that are honest. The firm should pay $\tau f(n^p)$ in tax but actually pays $\lambda \tau f(n^p)$, so the surplus to be shared between the firm and the collective officials is $[1 - \lambda] \tau f(n^p)$. The share of the surplus the officials receive is denoted s , so the firm receives share $1 - s$. The powers in the bargain over the share, s , depend on the proportion of corrupt tax officials so that the more corrupt officials there are, then the larger is the power of the officials in the bargain.

$f(n^p) = [1 - \tau] f(n^p) + \lambda \tau f(n^p) + s [1 - \lambda] \tau f(n^p) + [1 - s] [1 - \lambda] \tau f(n^p)$	
$[1 - \tau] f(n^p)$	Amount directly accruing to the firm
$\lambda \tau f(n^p)$	Reduced tax take going to the government
$s [1 - \lambda] \tau f(n^p)$	Share to corrupt tax collectors after bargaining
$[1 - s] [1 - \lambda] \tau f(n^p)$	Share to the firm after bargaining

Table 4.1. Distribution of the firm's total product ($0 < \tau < 1$, $0 < \lambda < 1$ and $0 < s < 1$)

Therefore, the profit of the firm taking the outcome of the bargain into account is

$$\pi = [1 - \tau] f(n^p) + [1 - s][1 - \lambda] \tau f(n^p) - w^p n^p.$$

The payoff and the threat point for the firm, in the bargain are

$$U^f = [1 - \tau] f(n^p) + [1 - s][1 - \lambda] \tau f(n^p) - w^p n^p,$$

$$U_0^f = [1 - \tau] f(n^p) - w^p n^p,$$

where U_0^f is the utility obtained if the bargain is unsuccessful. Combining these expressions

$$U^f - U_0^f = [1 - s][1 - \lambda] \tau f(n^p).$$

There is a potential difficulty at this point that can be easily circumvented. If the values of v and χ enter into the bargain the fact that these differ among the corrupt officials means that there is no simple way to write the bargain. The resolution is to assume that the social sanction is incurred even in the case that no agreement is reached in bargaining. The interpretation of this is that the social sanction is incurred through the act of offering to be corrupt, even if corruption does not take place.

Under this assumption the payoff of a corrupt official in the event of a successful bargain is

$$U^c = u\left(w^g + \frac{s[1 - \lambda] \tau f(n^p)}{n^c}, G\right) - ve^g - \chi k,$$

and the threat point is

$$U_0^c = u(w^g, G) - ve^g - \chi k.$$

The difference between these is given by

$$U^c - U_0^c = u\left(w^g + \frac{s[1 - \lambda] \tau f(n^p)}{n^c}, G\right) - u(w^g, G).$$

In the generalized Nash bargain the value of s is chosen to solve

$$\begin{aligned} \max_{\{s\}} X &= (U^f - U_0^f)^{1-\omega} (U^c - U_0^c)^\omega \\ &= ([1-s][1-\lambda] \tau f(n^p))^{1-\omega} \left(u(w^g + \frac{s[1-\lambda] \tau f(n^p)}{n^c}, G) - u(w^g) \right)^\omega, \end{aligned} \quad (4.10)$$

where ω is the power of the corrupt officials in the bargain. It is assumed that ω is the share of corrupt officials in the public sector, so

$$\omega = \frac{n^c(w^p, w^g, b)}{n^h(w^p, w^g, b) + n^c(w^p, w^g, b)}, \quad (4.11)$$

and λ is assumed to be the share of honest tax collectors who do not offer a reduced rate of tax

$$\lambda = \frac{n^h(w^p, w^g, b)}{n^h(w^p, w^g, b) + n^c(w^p, w^g, b)}. \quad (4.12)$$

The solution of the bargain gives the share of s as a function of λ and ω

$$s = s(\lambda, \omega).$$

The values of λ and ω are, in turn, determined by the variables w^p , w^g and b .

4.3 Equilibrium

Employment levels (n^c , n^h and n^p) are determined by the level of wages (w^p , w^g) offered by employees as well as the endogenous level of bribe per person (b). The equilibrium conditions that are now constructed will determine the endogenous variables of the model (w^p , w^g and b).

The total payment in bribes to the corrupt officials is determined by the outcome of the bargain. That is, given the share s of the surplus that the corrupt officials receive

that total value of bribes is

$$B = s [1 - \lambda] \tau f \left(N - n^h (w^p, w^g, b) - n^c (w^p, w^g, b) \right).$$

Dividing B by the number of corrupt employees in the public sector gives the bribe per corrupt official as

$$b = \frac{s [1 - \lambda] \tau f \left(N - n^h (w^p, w^g, b) - n^c (w^p, w^g, b) \right)}{n^c (w^p, w^g, b)}.$$

The wage in the private sector is determined from the condition for choice of labour input by the firm. With constant returns to scale the first-order condition for the choice of labour input is

$$[1 - \tau] f + [1 - s] [1 - \lambda] \tau f = w^p.$$

The government collects taxes to provide a public good and to pay a wage to the public sector employees, including both the corrupt and the honest individuals. The government budget constraint is

$$\lambda \tau f (n^p (w^p, w^g, b)) = w^g \left[n^h (w^p, w^g, b) + n^c (w^p, w^g, b) \right] + G.$$

Collecting these equations, the three equilibrium conditions are given in (4.13) - (4.15)

$$b = \frac{s (\lambda(n^h, n^c), \omega(n^h, n^c)) [1 - \lambda(n^h, n^c)] \tau f n^p}{n^c}, \quad (4.13)$$

$$w^p = \left[1 - \tau (s(n^h, n^c) + \lambda(n^h, n^c) - s(n^h, n^c) \lambda(n^h, n^c)) \right] f, \quad (4.14)$$

$$w^g = \frac{n^h \tau f n^p - G \cdot [n^h + n^c]}{[n^h + n^c]^2}, \quad (4.15)$$

where the number of workers in each category are given by

$$n^c = n^c(w^p, w^g, b), \quad (4.16)$$

$$n^h = n^h(w^p, w^g, b), \quad (4.17)$$

$$n^p = N - n^c - n^h. \quad (4.18)$$

Solving the system (4.13) - (4.15) taking account of the relations in (4.16) - (4.18) determines the equilibrium values of w^p , w^g , and b .

4.3.1 Specification

To make further progress I now assume a specific distribution for the individual characteristics and a functional form for utility. The equilibrium conditions are derived using these assumptions and subjected to a numerical analysis in the next section.

Assume that $g(\chi, v)$ is uniform on Θ . Since Θ is the unit square it follows that $g(\chi, v) = 1$ for all $\{\chi, v\} \in \Theta$. The utility function is assumed to be quasi linear so that

$$U^c = (C^c)^\alpha + G^\alpha - ve^g - k\chi, \quad (4.19)$$

$$U^h = (C^h)^\alpha + G^\alpha - ve^g, \quad (4.20)$$

and

$$U^p = (C^p)^\alpha + G^\alpha - ve^p. \quad (4.21)$$

Individuals receive wages from their employer, and the corrupt officials also benefit from bribes. The budget constraints for the three types of individuals are

$$C^c = w^g + b,$$

$$C^h = w^g,$$

and

$$C^p = w^p.$$

Since all income is spent on private consumption, the indirect utility functions are, respectively,

$$U^c = (w^g + b)^\alpha + G^\alpha - ve^g - k\chi, \quad (4.22)$$

$$U^h = (w^g)^\alpha + G^\alpha - ve^g, \quad (4.23)$$

and

$$U^p = (w^p)^\alpha + G^\alpha - ve^p. \quad (4.24)$$

Using the uniform distribution it can be calculated that

$$v^* = \frac{(w^p)^\alpha - (w^g)^\alpha}{e^p - e^g}, \quad (4.25)$$

$$\chi^* = \frac{(w^g + b)^\alpha - (w^g)^\alpha}{k}, \quad (4.26)$$

and

$$v(\chi) = \frac{\chi k}{e^p - e^g} + \frac{(w^p)^\alpha - (w^g + b)^\alpha}{e^p - e^g}.$$

Evaluating the integrals (4.8) and (4.9) gives

$$n^h = N \left(1 - \frac{(w^p)^\alpha - (w^g)^\alpha}{e^p - e^g}\right) \left(1 - \frac{(w^g + b)^\alpha - u(w^g)^\alpha}{k}\right), \quad (4.27)$$

$$n^c = N \left(\frac{(w^g + b)^\alpha - (w^g)^\alpha}{k}\right) \left[1 - \frac{(w^p)^\alpha - (w^g + b)^\alpha}{e^p - e^g} - \frac{(w^g + b)^\alpha - (w^g)^\alpha}{2(e^p - e^g)}\right], \quad (4.28)$$

and

$$n^p = N - n^c - n^h. \quad (4.29)$$

4.4 Analysis

So far the numbers of corrupt and honest officials as well as people working in the private sector have been endogenized in the model in which government deals with a firm to collect the tax to finance public goods. In addition, there is an endogenized share of the payable tax in the form of bribe that is determined by a bargain between the firm and corrupt officials. Before taking any further steps, it is necessary to check the basic functioning of the model to show that an equilibrium can exist and to determine the comparative statics. To see how the model behaves it is first analyzed under the assumption that there is no corruption. Once this is completed, corruption is re-introduced.

In the economy without corruption individuals choose between the public and private sectors based on their disutility of effort in working and the wages offered. They do not have an opportunity or a tendency to be corrupt. Therefore, there are just two type of individuals with the indirect utility functions (4.23) and (4.24). The critical value v^* that separates the two sets of individuals is determined by (4.25) where people with $v > v^*$ are those who choose to work in the public sector and the remainder of population work in the private sector. It follows from (4.27) and (4.29) that

$$n^h = N \left(1 - \frac{(w^p)^\alpha - (w^g)^\alpha}{e^p - e^g} \right),$$

and

$$n^p = N \left(\frac{(w^p)^\alpha - (w^g)^\alpha}{e^p - e^g} \right).$$

In the absence of corruption there are only two equilibrium conditions: firm maximization (4.30) and the government budget constraint (4.31). Without corruption, the

government benefits from the total effective tax rate (τ) paid by the firm. Solving these provides the equilibrium values of the exogenous variables of w^g and w^p and consequently n^h and n^p . From the profit maximization condition

$$w^p = [1 - \tau] f. \quad (4.30)$$

Solving the budget constraint gives

$$\begin{aligned} w^g &= \frac{\tau f n^p - G}{n^h} \\ &= \frac{\tau f N \left(\frac{([1-\tau]f)^\alpha - (w^g)^\alpha}{e^p - e^g} \right) - G}{N \left(\frac{([1-\tau]f)^\alpha - (w^g)^\alpha}{e^p - e^g} \right)}. \end{aligned} \quad (4.31)$$

(4.31) can be re-written as

$$N \left(\frac{([1-\tau]f)^\alpha - (w^g)^\alpha}{e^p - e^g} \right) (\tau f - w^g) = G.$$

The left-hand side is monotonically decreasing in w^g for all $w^g < \min \{[1 - \tau] f, \tau f\}$, and is equal to zero when $w^g = \min \{[1 - \tau] f, \tau f\}$. Hence, for any $G \geq 0$ there will be a solution for w^g if

$$N \left(\frac{([1-\tau]f)^\alpha}{e^p - e^g} \right) \tau f > G.$$

Moreover, the solution occurs when $([1 - \tau] f)^\alpha - (w^g)^\alpha > 0$, so in equilibrium $w^g < w^p$. We assume that the effort that is needed for working in the private sector is exogenous and higher than the required effort in the public sector ($e^p > e^g$). Therefore, when there is no corruption (no bribe), w^p has to be greater than w^g otherwise no one will take the job in the private sector. Moreover, when there is a corruption option available, the bribe raises value of working in the public sector, and $w^g + b$ will be the payoff if corruption is chosen. Hence, there is a need to have even stronger w^p compared to w^g .

Table 4.2 shows the results of a numerical simulation of the model when there is no corruption in the public sector. The equilibrium is calculated for different tax rates with the parameter values for the simulation given in Appendix F. There are no corrupt public sector officials so n^h is the total number of public sector employees. In this baseline with no corruption the model has the proportion of public sector workers ranging from 27 percent (at $\tau = 0.2$) to 56 percent (at $\tau = 0.5$). The results show that a higher tax rate leads to a lower wage level in the private sector due to a fall in the (net) marginal product of labour. Therefore, the wage in public sector also decreases because of the flow of labour into the public sector.

τ	w^g	w^p	n^h	n^p	rev
0.2	0.5051	0.8000	269.44	730.55	146.11
0.3	0.4690	0.7000	377.06	622.93	186.88
0.4	0.4239	0.6000	473.30	526.69	210.67
0.5	0.3712	0.5000	562.40	437.59	218.79

Table 4.2. Model without corruption

The choice to be corrupt is now re-introduced into the model. Table 4.3 summarizes the comparative statics of the model with respect to the tax rate (τ) when there is an option to either to be corrupt or to be honest. The values chosen are (coincidentally) around the maximum of revenue (see Appendix G). The interesting observations from the table are that a higher tax rate lowers the private sector wage, decreases the public sector wage, but increases the share of the benefit of corruption that goes to corrupt tax collectors. It also increases the proportion of the corrupt ($\frac{n^c}{n^c+n^h}$) and the size of the bribe that each corrupt official receives.

τ	b	s	w^g	w^p	rev	n^c	n^h	$\frac{n^c}{n^c+n^h}$
0.1	0.1290	0.1721	0.5260	0.9152	71.92	21.750	95.970	0.1847
0.2	0.2328	0.2885	0.4985	0.8454	109.02	63.513	135.13	0.3197
0.3	0.3030	0.3590	0.4647	0.7776	131.89	105.97	156.29	0.4040
0.4	0.3530	0.41063	0.4273	0.7099	145.68	148.06	169.45	0.4663
0.5	0.3884	0.45261	0.3872	0.6415	152.55	190.36	177.75	0.5171
0.6	0.4118	0.48942	0.3449	0.5720	153.53	233.73	182.50	0.5615
0.7	0.4242	0.52360	0.3004	0.5009	149.27	279.26	184.24	0.6024
0.8	0.4255	0.55704	0.2538	0.4275	139.85	328.46	183.07	0.6421
0.9	0.4142	0.59156	0.2046	0.3508	125.10	383.74	178.63	0.6823

Table 4.3. Model with corruption

The explanation for these results is that the higher tax rate motivates the firm to offer a higher bribe in the bargain to reduce the effective tax rate, consequently the share going to corrupt tax official (s) predictably increases. Therefore, a higher tax rate provides more incentives to move to corrupt side which is confirmed by the increasing line of $\frac{n^c}{n^c+n^h}$ in the Figure 4.2. The non-monotonicity of b shows that an increase in the tax rate initially permits the bribe per person to increase as the potential revenue from taxation rises. However, this causes further public sectors officials to become corrupt so the total value of the bribe must be divided between a larger group of corrupt officials. This latter effect eventually dominates, so the bribe per person then begins to fall. The wage effects are driven by the cost of labour in the private sector operating through the equalization of wage and marginal revenue product. The public sector wage, adjusted for the bribe, must then keep pace with the private sector wage through labour market equilibrium.

Figure 4.3 shows how does the endogenized number of corrupt individuals working in the public sector changes as the value of the social sanction on corruption is changed. The figure shows that a higher level of the social sanction is associated with a lower number of corrupt individuals in the population. This outcome is obtained through the occupational

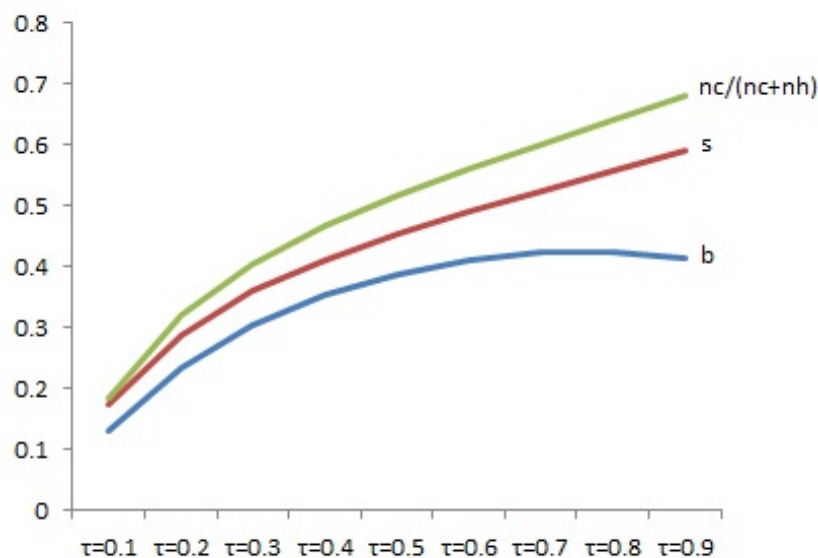


Figure 4.2: Tax rate, bribe and proportion of corrupt officials

choice decision of each individual. If the social sanction is high then corruption is less appealing given levels of the wages and bribe. It will therefore be chosen by a smaller group of individuals (those who place less weight on the social sanction). The results show that this reasoning applies even after all equilibrium adjustments have been taken into account. Consequently, if society can establish a social convention that corruption is bad, then the level of corruption will fall.

4.5 Conclusions

There is currently a lack of theoretical examinations of public sector corruption and its effects on economic indicators. The main objective of this chapter was to investigate a model in which corruption emerges endogenously. Corruption is modelled as an option that can be chosen when it is considered beneficial, and heterogeneity between people en-

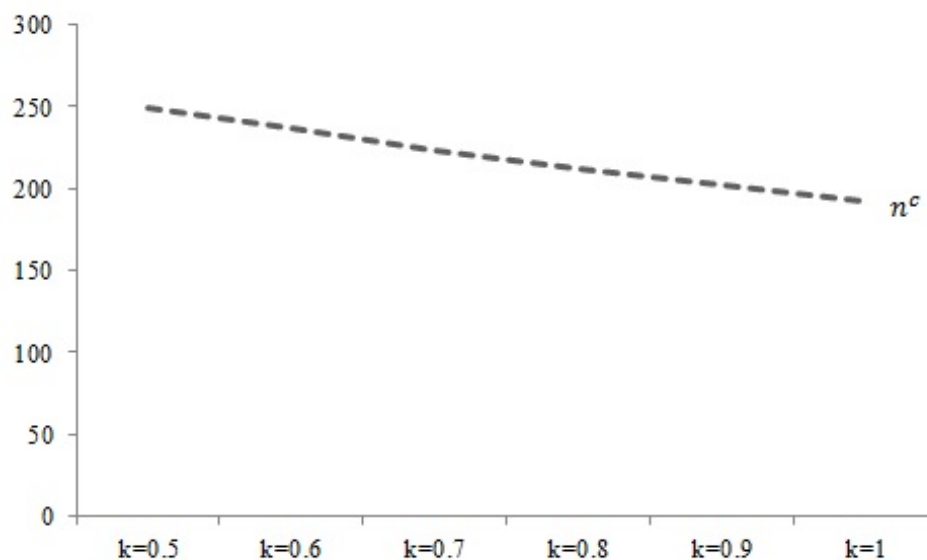


Figure 4.3: Endogenized number of corrupt individual and social sanction

sures that some may be corrupt and some honest. This is a result of individuals being differentiated with respect to their evaluation of the loss of self-esteem that results from acting corruptly, as well as being heterogenous in their disutility of effort.

These factors determine the choice between employment in the public (being honest or corrupt) and employment in the private sector. Corruption leads to a loss of self-esteem but opens up an opportunity to benefit from a bribe after bargaining with the firm. The firm enters the bargain with corrupt tax officials to reduce the tax rate at the cost of the payment of a bribe. The weight in the generalized Nash bargain determines the share of the benefits of corruption between the corrupt and the firm.

The comparative statics of the model are determined for the cases of both corruption and the absence of corruption. The central result is that an increase in the tax rate causes a flow in employment from the private sector to the public sector and an increase

in the number of corrupt working in public sector. In addition, a lower level of the social sanction on corruption leads to an increase in the number of the corrupt working in the public sector. The results show that the level of corruption and the benefits of corruption can be endogenized in an equilibrium model.

Chapter 5

Endogenous Corruption in A Dynamic Model

5.1 Introduction

Evidence has shown that there are some officials who choose to act corruptly in public sector employment. It is therefore unrealistic to assume in models of economic policy design that there is no opportunity to be corrupt, and it is far from reality to consider all doors to corruption are quite under control and closed. Corruption seems to always be able to find a way to penetrate, and throughout history people have always been tempted by the potential for personal gain arising from corruption.

In the model of this chapter people choose employment in the public sector or in the private sector taking all components of the reward offered by the work contract into account. This includes the formal parts of the contract, such as wage levels and required

work effort, and the non-contractual benefits that can arise from corruption. If employment in the public sector is chosen, officials have to weight up the gains from abusing their power and acting corruptly against the welfare loss that corruption incurs. It is assumed that public sector employees are tempted by additional income in the form of bribes which provide the incentive for them to engage in corruption. The cost is a loss in self-esteem due to the general social sanction and objection to corruption in society. This is the process through which corruption has been endogenized in chapter four.

The contribution of this chapter is to embed endogenized corruption within a dynamic monetary model to analyze its interaction with inflation. The dynamic model adopted is an overlapping generations economy (OLG) where people live for two periods, and there is a growth in money supply with money as the only store of value. The modelling builds on the work in chapter 3.

5.2 Dynamic Model

Assume that each consumer has one unit of labour to supply when young and none when old. Consumers can grant (or accept) consumption loans and can purchase money. They choose whether to work in the private or public sector, and if employment in the public sector is chosen they have a decision on whether to be honest or corrupt.

The government issues new money in each period at (gross) rate μ . If $\mu > 1$ then there is monetary expansion. Assume that a share of new issued money (φ) is directly stolen by corrupt officials before it is introduced into the economy by the government. Shares $\gamma_1 \geq 0$, $\gamma_2 \geq 0$ and $\gamma_3 \geq 0$, $\gamma_1 + \gamma_2 + \gamma_3 = 1$, of the remainder of the newly printed

money are respectively sold to the young, given to the young, and given to the old by the government. The following table summarizes the growth and distribution of money in the economy.

Period t
$M(t) = M(t-1) + (\mu-1)M(t-1)$
$M(t-1)$ purchased by young from old
$\varphi(\mu-1)M(t-1)$ stolen by corrupt official
$(1-\varphi)\gamma_1(\mu-1)M(t-1)$ sold to young by government
$(1-\varphi)\gamma_2(\mu-1)M(t-1)$ given to young by government
$(1-\varphi)\gamma_3(\mu-1)M(t-1)$ given to old by government

Table 5.1. Money distribution

The number of consumers in each generation is N , so total population size is $2N$.

Consider the payoff for the corrupt officials. The wage at time t is given by $w^g(t)$ and the required effort level by $e^g(t)$. The budget constraints facing a consumer who has chosen to be corrupt are

$$C_t^c(t) = \omega^g(t) + b(t) - \ell^c(t) - p^m(t)m^c(t) + p^m(t)\varphi(\mu-1)\frac{M(t-1)}{n^c} + p^m(t)(1-\varphi)\gamma_2(\mu-1)\frac{M(t-1)}{N},$$

and

$$C_t^c(t+1) = r(t)\ell^c(t) + p^m(t+1)m^c(t) + p^m(t+1)(1-\varphi)\gamma_3(\mu-1)\frac{M(t-1)}{N}.$$

Define the net monetary quantities by

$$\bar{m}^c(t) = m^c(t) - \varphi(\mu-1)\frac{M(t-1)}{n^c} - (1-\varphi)\gamma_2(\mu-1)\frac{M(t-1)}{N}, \quad (5.1)$$

$$\tilde{m}^c(t) = m^c(t) + (1-\varphi)\gamma_3(\mu-1)\frac{M(t-1)}{N}. \quad (5.2)$$

The two budget constraints can then be combined into a lifetime budget constraint

$$C_t^c(t) + \frac{C_t^c(t+1)}{r(t)} = \omega^g(t) + b(t) - p^m(t)\bar{m}^c(t) + \frac{p^m(t+1)}{r(t)}\tilde{m}^c(t).$$

The no-arbitrage condition that prevents gains from arbitraging money across periods is

$$p^m(t) - \frac{p^m(t+1)}{r(t)} = 0. \quad (5.3)$$

Using (5.3) the lifetime budget constraint can be simplified to

$$C_t^c(t) + \frac{C_t^c(t+1)}{r(t)} = \omega_t^g(t) + b(t) - p^m(t)[\bar{m}^c(t) - \tilde{m}^c(t)]. \quad (5.4)$$

The same process for the honest officials and for individuals working in the private sector can be followed. If an individual chooses to act honestly in the public sector, there is no bribe as an additional source of revenue, so $\omega_t^g(t)$ is the only income. Hence, the budget constraints for an honest individual are

$$C_t^h(t) = \omega^g(t) - \ell^h(t) - p^m(t)m^h(t) + p^m(t)(1 - \varphi)\gamma_2(\mu - 1)\frac{M(t-1)}{N},$$

and

$$C_t^h(t+1) = r(t)\ell^h(t) + p^m(t+1)m^h(t) + p^m(t+1)(1 - \varphi)\gamma_3(\mu - 1)\frac{M(t-1)}{N}.$$

Define the net monetary quantities by:

$$\bar{m}^h(t) = m^h(t) - (1 - \varphi)\gamma_2(\mu - 1)\frac{M(t-1)}{N}, \quad (5.5)$$

$$\tilde{m}^h(t) = m^h(t) + (1 - \varphi)\gamma_3(\mu - 1)\frac{M(t-1)}{N}. \quad (5.6)$$

Combining the two budget constraints into a lifetime constraint using (5.3) gives

$$C_t^h(t) + \frac{C_t^h(t+1)}{r(t)} = \omega^g(t) - p^m(t)[\bar{m}^h(t) - \tilde{m}^h(t)]. \quad (5.7)$$

Finally, for a private sector worker the budget constraints in the two periods of life are

$$C_t^p(t) = \omega^p(t) - \ell^p(t) - p^m(t)m^p(t) + p^m(t)(1 - \varphi)\gamma_2(\mu - 1)\frac{M(t-1)}{N},$$

and

$$C_t^p(t+1) = r(t)\ell^p(t) + p^m(t+1)m^p(t) + p^m(t+1)(1-\varphi)\gamma_3(\mu-1)\frac{M(t-1)}{N}.$$

With the net monetary quantities

$$\bar{m}^p(t) = m^p(t) - (1-\varphi)\gamma_2(\mu-1)\frac{M(t-1)}{N}, \quad (5.8)$$

$$\tilde{m}^p(t) = m^p(t) + (1-\varphi)\gamma_3(\mu-1)\frac{M(t-1)}{N}, \quad (5.9)$$

the lifetime budget constraint becomes

$$C_t^p(t) + \frac{C_t^p(t+1)}{r(t)} = \omega^p(t) - p^m(t)[\bar{m}^p(t) - \tilde{m}^p(t)]. \quad (5.10)$$

The lifetime budget constraint of the three types of individual in the model are determined by (5.4), (5.7) and (5.10). Now assume that the lifetime utility functions for the three types of individual are respectively

$$U^c = [C_t^c(t)]^\alpha + \delta [C_t^c(t+1)]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^g - k\chi,$$

$$U^h = [C_t^h(t)]^\alpha + \delta [C_t^h(t+1)]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^g, \quad (5.11)$$

$$U^p = [C_t^p(t)]^\alpha + \delta [C_t^p(t+1)]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^p, \quad (5.12)$$

where the superscript denotes a corrupt public sector worker (c), an honest public sector worker (h), and a private sector worker (p).

In every case, the maximization of utility leads to the necessary condition

$$C_t^i(t+1) = (r\delta)^{\frac{1}{1-\alpha}} C_t^i(t), \quad i = c, h, p. \quad (5.13)$$

By writing $\beta = r^{\frac{\alpha}{1-\alpha}}\delta^{\frac{1}{1-\alpha}}$, the demand functions will take the forms below

$$C_t^i(t) = \left(\frac{1}{1+\beta} \right) [\omega^j(t) + q[b(t)] - p^m(t)[\bar{m}^i(t) - \tilde{m}^i(t)]], \quad (5.14)$$

and

$$C_t^i(t+1) = \left(\frac{r}{1+\beta} \right) [\omega^j(t) + q[b(t)] - p^m(t)[\bar{m}^i(t) - \tilde{m}^i(t)]]. \quad (5.15)$$

Define the indicator variable, q , where $q = 1$ when $i = c$, otherwise $q = 0$. Let $j = g$ when $i = c, h$ and $j = p$ when $i = p$. The indirect utility function can then be written as

$$U^i = A. \left[\omega_t^j(t) + q[b(t)] - p^m(t)[\bar{m}^i(t) + \tilde{m}^i(t)] \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^j - q[\chi k], \quad (5.16)$$

where,

$$A = (1+\beta)^{-\alpha} + \delta \left(\frac{1+\beta}{r} \right)^{-\alpha}. \quad (5.17)$$

The income received by individuals in their first period of life can be consumed, granted as a loan, or held in the form of money. The saving function is the income left after consumption expenditure and granting of loans

$$S_t^i(t) = \omega^j(t) + q[b(t)] - C_t^i(t) - \ell^i(t).$$

By substituting the demand functions for the first period of life (5.14) with the net monetary quantities respectively [(5.1), (5.2)], [(5.5), (5.6)] and [(5.8), (5.9)] into the saving function, the saving of a corrupt individual is given by

$$\begin{aligned} S_t^c(t) &= \left(\frac{\beta}{1+\beta} \right) [\omega^g(t) + b(t)] - \left(\frac{1}{1+\beta} \right) p^m(t) \left(\varphi(\mu-1) \frac{M(t-1)}{n^c} + (1-\varphi)\gamma_2(\mu-1) \frac{M(t-1)}{N} \right. \\ &\quad \left. + (1-\varphi)\gamma_3(\mu-1) \frac{M(t-1)}{N} \right) - \ell^c(t). \end{aligned}$$

As $M(t-1) = (1/\mu) M(t)$

$$\begin{aligned} S_t^c(t) &= \left(\frac{\beta}{1+\beta} \right) [\omega^g(t) + b(t)] \\ &\quad - \left(\frac{1}{1+\beta} \right) p^m(t) M(t) \left(1 - \frac{1}{\mu} \right) \left(\frac{\varphi}{n^c} + \frac{(1-\varphi)(\gamma_2 + \gamma_3)}{N} \right) - \ell^c(t). \end{aligned}$$

The same process for the individuals of type h and p gives

$$S_t^h(t) = \left(\frac{\beta}{1 + \beta} \right) \omega^g(t) - \left(\frac{1}{1 + \beta} \right) p^m(t) M(t) \left(1 - \frac{1}{\mu} \right) (1 - \varphi) (\gamma_2 + \gamma_3) \left(\frac{1}{N} \right) - \ell^h(t),$$

and

$$S_t^p(t) = \left(\frac{\beta}{1 + \beta} \right) \omega^p(t) - \left(\frac{1}{1 + \beta} \right) p^m(t) M(t) \left(1 - \frac{1}{\mu} \right) (1 - \varphi) (\gamma_2 + \gamma_3) \left(\frac{1}{N} \right) - \ell^p(t).$$

The aggregate saving function is the sum of individual savings. As already noted, money is the only outside asset. The money market is therefore in equilibrium when aggregate saving is equal to the value of the money supply

$$S(t) = p^m(t) M(t). \tag{5.18}$$

In a stationary monetary equilibrium, the saving of generation t is the same as the saving of generation $t + 1$, so the amount of goods spent on purchasing money (as the only tool of saving) at time t equals the quantity of time $t + 1$ goods that are given up to buy money.

$$S(t) = S(t + 1).$$

Hence,

$$p^m(t) M(t) = p^m(t + 1) M(t + 1).$$

Money supply creation occurs at the gross growth rate of μ

$$M(t + 1) = \mu M(t).$$

This gives

$$p^m(t) = \mu p^m(t + 1),$$

with the no-arbitrage condition (5.3) implying

$$r(t) = \frac{p^m(t+1)}{p^m(t)} = \frac{1}{\mu}. \quad (5.19)$$

Therefore, the aggregate saving function is

$$S(t) = \frac{\beta [(n^c + n^h) \omega^g(t) + n^p \omega^p(t) + n^c \cdot b]}{1 + \beta + (1 - \frac{1}{\mu})[\varphi + (1 - \varphi)(\gamma_2 + \gamma_3)]}, \quad (5.20)$$

and the equilibrium price level with (5.18) is

$$p^m(t) = \frac{1}{M(t)} \left[\frac{\beta [(n^c + n^h) \omega^g(t) + n^p \omega^p(t) + n^c \cdot b]}{1 + \beta + (1 - \frac{1}{\mu})[\varphi + (1 - \varphi)(\gamma_2 + \gamma_3)]} \right].$$

5.3 Seigniorage and Inflation

The next step is to clarify the measure of seigniorage in the model. By definition, the level of government revenue obtained from seigniorage is the share of the value of newly issued money sold to the young. Selling money transfers consumption goods from the individuals who purchase the money to the government. Following this reasoning seigniorage is given by

$$V_5(t) = p^m(t) [(1 - \varphi)\gamma_1(\mu - 1)M(t - 1)]. \quad (5.21)$$

Since $M(t - 1) = (1/\mu)M(t)$ it follows that

$$V_5(t) = (1 - \varphi)\gamma_1(1 - \frac{1}{\mu})p^m(t)M(t).$$

The aggregate saving function (5.20) can be substituted in to replace $p^m(t)M(t)$ giving the level of seigniorage as

$$V_5(t) = (1 - \varphi)\gamma_1(1 - \frac{1}{\mu}) \left[\frac{\beta [(n^c + n^h) \omega^g(t) + n^p \omega^p(t) + n^c \cdot b]}{1 + \beta + (1 - \frac{1}{\mu})[\varphi + (1 - \varphi)(\gamma_2 + \gamma_3)]} \right]. \quad (5.22)$$

To this point the analysis has been phrased in terms of $p^m(t)$, the price of money. However, this is defined as the quantity of consumption good that has to be given up to buy one unit of money. Consequently, the amount of money that has to be given up to purchase one unit of consumption good is $1/p^m(t)$. This is the price of goods at time t in the model. Inflation occurs when there is an increase in the price of goods or a decline in the price of money. Therefore, the inflation rate in period t is defined by

$$Inf(t) = \frac{\frac{1}{p^m(t)} - \frac{1}{p^m(t-1)}}{\frac{1}{p^m(t-1)}}.$$

Using (5.19), the rate of inflation is determined by the net rate of money supply growth

$$Inf(t) = \mu - 1. \tag{5.23}$$

5.4 Welfare Function

In the model the government is assumed to maximize a welfare function that is a weighted sum of the individual utilities. The weights may differ according to employment status and engagement in corruption. ξ^c , ξ^h and ξ^p are respectively the welfare weights of corrupt, honest and private employees. The government chooses the tax rate and the growth rate of money supply to maximize the welfare function.

The welfare function can be constructed by referring back to the areas in the set Θ described in figure 4.1 of chapter 4. The individual utility functions of the three types can be written in the form

$$U^c = u_1(w^g(t) + b(t), G(t)) - ve^g - \chi k,$$

$$U^h = u_2(w^g(t), G(t)) - ve^g,$$

and

$$U^p = u_3(w^p(t), G(t)) - ve^p.$$

The critical values that separate the types are

$$v^* = \frac{u_3 - u_2}{e^p - e^g},$$

$$\chi^* = \frac{u_1 - u_2}{k},$$

and

$$v(\chi) = \frac{\chi k}{e^p - e^g} + \frac{u_3 - u_1}{e^p - e^g}.$$

The welfare function is then given by

$$\begin{aligned} W = & \int_0^{\chi^*} \int_{\max\{0, v(\chi)\}}^1 \xi^c U^c N g(\chi, v) dv d\chi + \int_{\chi^*}^1 \int_{v^*}^1 \xi^h U^h N g(\chi, v) dv d\chi \\ & + \left[\int_0^{\chi^*} \int_0^{\max\{0, v(\chi)\}} \xi^p U^p N g(\chi, v) dv d\chi + \int_{\chi^*}^1 \int_0^{v^*} \xi^p U^p N g(\chi, v) dv d\chi \right] \end{aligned}$$

Assume that the individual characteristics are uniformly distributed on the unit square so

$g(\chi, v) = 1$. Then the welfare function can be written in detail as

$$\begin{aligned}
W = & \xi^c N \left[u_1 - \frac{e^g}{2} - u_1 \left[\frac{u_3 - u_1}{e^p - e^g} \right] + \left[\frac{e^g}{2} \right] \left[\frac{u_3 - u_1}{e^p - e^g} \right]^2 \right] \left[\frac{u_1 - u_2}{k} \right] \\
& + \xi^c N \left[-\frac{1}{2} - u_1 \left[\frac{1}{2(e^p - e^g)} \right] + \frac{1}{2} \left[\frac{u_3 - u_1}{e^p - e^g} \right] + e^g \left[\frac{1}{2(e^p - e^g)} \right] \left[\frac{u_3 - u_1}{e^p - e^g} \right] \right] \left[\frac{(u_1 - u_2)^2}{k} \right] \\
& + \xi^c N \left[\frac{1}{3(e^p - e^g)} + \left[\frac{e^g}{2} \right] \left[\frac{1}{3(e^p - e^g)^2} \right] \right] \left[\frac{(u_1 - u_2)^3}{k} \right] \\
& + \xi^h N \left[u_2 - \frac{e^g}{2} - u_2 \left[\frac{u_3 - u_2}{e^p - e^g} \right] + \left[\frac{e^g}{2} \right] \left[\frac{u_3 - u_2}{e^p - e^g} \right]^2 \right] \left[1 - \frac{u_1 - u_2}{k} \right] \\
& + \xi^p N \left[u_3 \left[\frac{(u_1 - u_2)^2}{2k(e^p - e^g)} \right] + u_3 \left[\frac{u_3 - u_1}{e^p - e^g} \right] \left[\frac{u_1 - u_2}{k} \right] - \frac{e^p}{2} \left[\frac{(u_1 - u_2)^3}{3k(e^p - e^g)^2} \right] \right] \\
& + \xi^p N \left[-\frac{e^p}{2} \left[\frac{u_3 - u_1}{e^p - e^g} \right]^2 \left[\frac{u_1 - u_2}{k} \right] - e^p \left[\frac{(u_1 - u_2)^2}{2k(e^p - e^g)} \right] \left[\frac{u_3 - u_1}{e^p - e^g} \right] \right] \\
& + \xi^p N \left[u_3 \left[\frac{u_3 - u_2}{e^p - e^g} \right] - \frac{e^p}{2} \left[\frac{u_3 - u_2}{e^p - e^g} \right]^2 \right] \left[1 - \frac{u_1 - u_2}{k} \right]
\end{aligned}$$

The welfare function depends on the endogenous variables w^p, w^g, b and s which are determined in the equilibrium through the terms u_1, u_2 , and u_3 .

5.5 Equilibrium

It now becomes possible to define and analyze the equilibrium of the model. The representative firm in the dynamic model offers a work contract to the young individuals in each period. This contract states the wage level w^p and the required work effort e^p . The firm deals with the government tax officials (honest and corrupt). The condition derived from firm's profit maximization (5.25) specifies the wage level paid by the private sector w^p . Using this information individuals decide whether to join the firm to work or join the government which offers a contract with wage w^g and effort e^g . Public sector employment also offers the opportunity to earn a bribe, b , from acting corruptly.

$$b = \frac{s(\lambda(n^h, n^c), \omega(n^h, n^c)) [1 - \lambda(n^h, n^c)] \tau f n^p}{n^c}, \quad (5.24)$$

$$w^p = \left[1 - \tau(s(n^h, n^c) + \lambda(n^h, n^c) - s(n^h, n^c)\lambda(n^h, n^c)) \right] f, \quad (5.25)$$

$$w^g = \frac{n^h \tau f n^p + V_5 \cdot [n^h + n^c] - G \cdot [n^h + n^c]}{[n^h + n^c]^2}, \quad (5.26)$$

As already discussed, there is a bargain between the firm and the corrupt officials to reduce the effective tax rate from τ to $\lambda\tau$. λ represents the share of honest officials in the public sector (4.12). Table 4.1 shows the distribution of the firm's total product. The benefit from the reduced tax rate is $(1 - \lambda)\tau$ which is distributed between the firm and the corrupt officials. The Nash bargaining solution determines the shares according to (4.10). The share that goes to corrupt officials is distributed equally as a bribe and is determined by (5.24). The government's budget constraint is (5.26). The government is responsible for providing public goods (G) and paying a total wages $w^g (n^c + n^h)$ to public officials financed by tax collected and seigniorage. The government neither borrows nor lends, so is assumed to balance the budget in every period.

The division of the population determined by (4.7), (4.8) and (4.9) as well as assumptions (4.11) and (4.12) are the final components of the system. This equilibrium system can be solved for the endogenous variables.

5.6 Analysis

To start the analysis of equilibrium the full set of conditions that have been specified so far are stated. There are eight conditions in the system that jointly determine

the endogenous variables (w^p , w^g , b and s) and the division of the population between occupations.

The first three conditions are the indirect utility functions derived from consumer optimization (5.16). The indirect utilities can be written as

$$U^c = A \left[w^g(t) + b(t) - p^m(t)M(t)\left(1 - \frac{1}{\mu}\right) \left[\frac{\varphi}{n^c} + (1 - \varphi)(\gamma_2 + \gamma_3) \frac{1}{N} \right] \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^g - \chi k,$$

$$U^h = A \left[w^g(t) - p^m(t)M(t)\left(1 - \frac{1}{\mu}\right) (1 - \varphi)(\gamma_2 + \gamma_3) \frac{1}{N} \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^g,$$

and

$$U^p = A \left[w^p(t) - p^m(t)M(t)\left(1 - \frac{1}{\mu}\right) (1 - \varphi)(\gamma_2 + \gamma_3) \frac{1}{N} \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha - ve^p.$$

These expressions have used the fact that aggregate saving is given by $p^m(t)M(t)$ from (5.20).

The indirect utility functions enter into the determination of the endogenized employment levels n^h and n^c using (4.8) and (4.9) which are the fourth and fifth equilibrium conditions

$$n^h = N \left(1 - \frac{u_3 - u_2}{e^p - e^g}\right) \left(1 - \frac{u_1 - u}{k}\right),$$

$$n^c = N \left(\frac{u_1 - u_2}{k}\right) \left[1 - \frac{u_3 - u_1}{e^p - e^g} - \frac{u_1 - u_2}{2(e^p - e^g)}\right],$$

where, in the dynamic case, u_1 , u_2 and u_3 are given by

$$u_1(w^g(t) + b(t), G(t)) = A \left[w^g(t) + b(t) - p^m(t)M(t)\left(1 - \frac{1}{\mu}\right) \left[\frac{\varphi}{n^c} + (1 - \varphi)(\gamma_2 + \gamma_3) \frac{1}{N} \right] \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha,$$

$$u_2(w^g(t), G(t)) = A \left[w^g(t) - p^m(t)M(t)\left(1 - \frac{1}{\mu}\right) (1 - \varphi)(\gamma_2 + \gamma_3) \frac{1}{N} \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha,$$

and

$$u_3(w^p(t), G(t)) = A \left[\omega^p(t) - p^m(t)M(t)\left(1 - \frac{1}{\mu}\right)(1 - \varphi)(\gamma_2 + \gamma_3)\frac{1}{N} \right]^\alpha + [G(t)]^\alpha + \delta [G(t+1)]^\alpha.$$

The next three equilibrium conditions are the bribe per person (5.24), the firm maximization condition (assuming CRS) (5.25), and the government budget constraint (5.26). Finally, s is determined by the Nash bargain solution (4.10).

5.6.1 Equilibrium analysis

The purpose of constructing the model is to explore the link between government actions and the level of corruption. The government controls the tax rate, the level of public good provision, and the rate of monetary expansion. The interesting question is how the endogenous variables - particularly the level of corruption - change as these choices are varied. This section considers how the equilibrium depends on the key underlying parameters by conducting numerical simulations of a range of scenarios. The next section considers optimization of the choice variables.

Table 5.2 presents the effect of a change in the rate of tax holding public good provision and the rate of monetary expansion constant. The basic parameter values chosen for the simulation are given in Appendix H. Government revenue at time t , $rev(t)$, defined as the sum of taxes and seigniorage is increasing when the tax rate $\tau(t)$ is increased. The use of seigniorage $V_5(t)$ as an alternative source of revenue correspondingly falls as the tax rate increases even though the rate of monetary expansion is constant because the level of seigniorage (5.22) depends on the endogenous variables in the model (w^p , w^g and b). Moreover, in agreement with the static model of the previous chapter, when the tax rate

increases the wage rates $w^g(t)$ and $w^p(t)$ both decrease.

$\tau(t)$	$s(t)$	$b(t)$	$w^g(t)$	$w^p(t)$	$rev(t)$	$V_5(t)$
0.1	0.5430545793	0.3090712065	0.3149361971	0.9248146303	50.56441569	10.75542257
0.15	0.5404171732	0.3193548536	0.3185091123	0.8872549678	66.54811853	9.849847076
0.2	0.5369851564	0.3225431746	0.3194690180	0.8497264196	81.26112086	9.314275179
0.25	0.5337728788	0.3228941549	0.3182361764	0.81221484822	94.40665641	8.764551544
0.3	0.5299953111	0.3210323599	0.3152998259	0.7747300844	106.2217964	8.250570855
0.35	0.5253269841	0.3173321017	0.3109704911	0.7372754904	116.8597961	7.813939139
0.4	0.5200500248	0.3122874544	0.3053871738	0.6998391986	126.2641516	7.372989672
0.45	0.5140297826	0.3060087533	0.2986897694	0.6624114243	134.4902386	6.949537076
0.5	0.5072431098	0.2986106977	0.2909581736	0.6249737687	141.5362395	6.540450402

Table 5.2. Effects of a tax increase

The relationship between the tax rate and the level of the bribe is more interesting. Table 5.2 illustrates that there is a non-monotonic relationship with the bribe per person reaching a maximum at a tax rate of $\tau = 0.25$ and then decreasing as the tax rate increases further. This relationship is shown in more detail in figure 5.1. An increase in the tax rate increases the potential gain to the firm and the officials from engaging in corruption. The non-monotonic relationship is explained by the fact the b is the bribe received by each corrupt official. As the tax rate increase the number of corrupt as the tax rates increases, and wages decrease. This makes a given size of bribe relatively more attractive.

Figure 5.2 shows the distribution of the three types of individuals for different tax rates. It can be seen that employment in the public sector increases when the tax rate increases, and consequently the number of individuals working in the private sector is reduced. This can be explained by the decreasing wage offered by the firm (table 5.2) that makes public sector employment relatively more attractive. Moreover, the number of corrupt officials also increases as the tax rate increases, and increases even faster as a proportion of workers in the private sector. The first effect is due to some of the workers

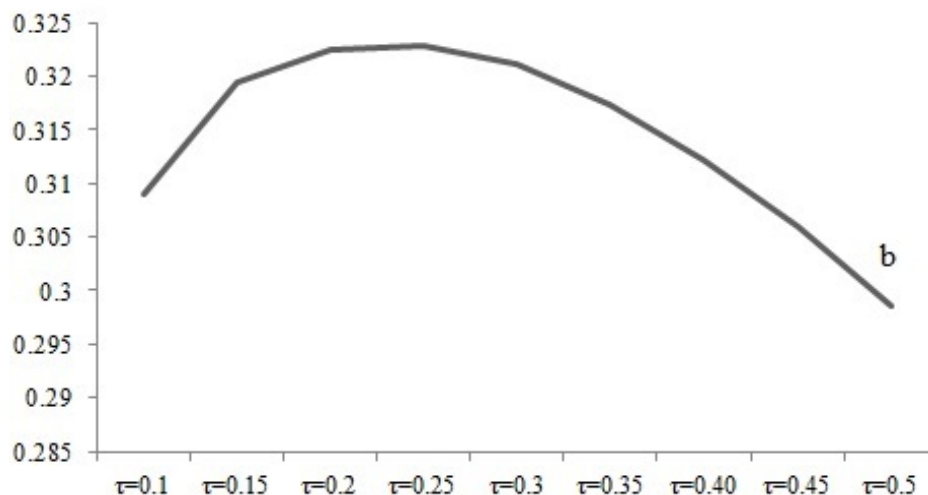


Figure 5.1: Bribe and the tax rate

transferring from the private sector to the public sector being willing to engage in corruption, while the second effect is a consequence of the falling denominator in the expression for the proportion.

Further insight into how the division of the population between types is affected by the tax rate is given in figure 5.3. The proportion of corrupt in the population is increasing as the tax rate increases. This is not surprising since the private wage is falling and there is a greater surplus to be shared as bribes. What seems surprising is that the proportion of public sector workers that are corrupt falls as the tax rate increases. This is explained by the influx of former private sector workers into the public sector as the tax rate increases, who were formerly in the private sector partially because of their reluctance to engage in corruption.

It has been assumed that the social sanction on corruption is a determinant of each

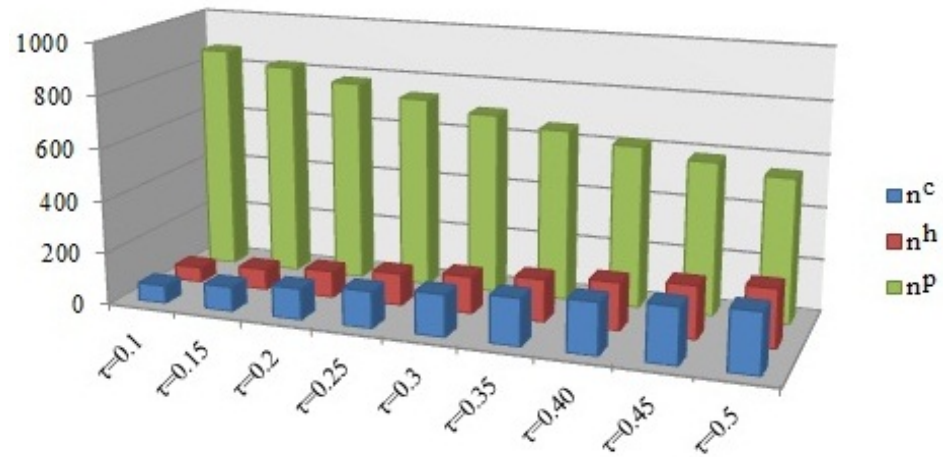


Figure 5.2: Distribution of population

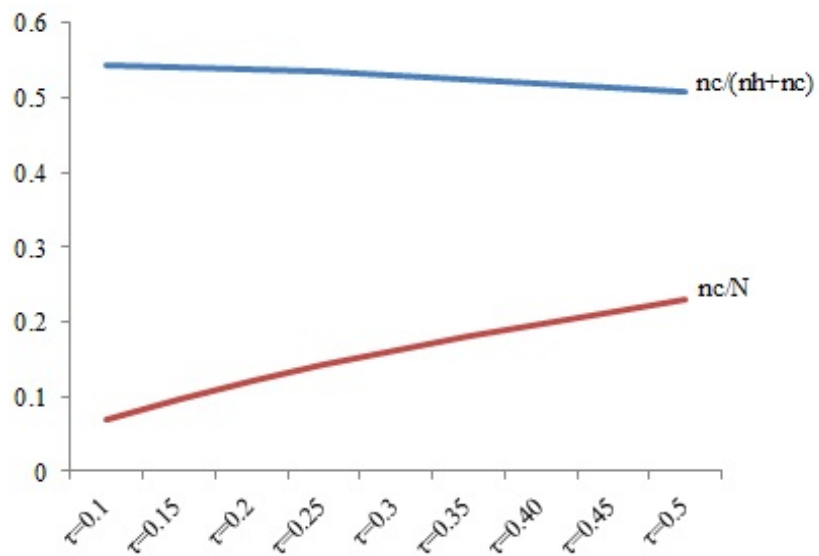


Figure 5.3: Proportion of corrupt officials

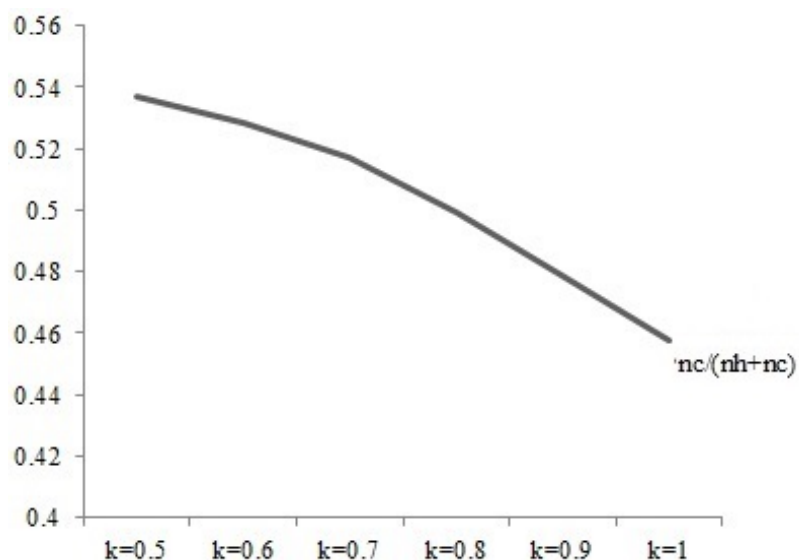


Figure 5.4: Social sanction and corruption

consumer's behaviour. The consumers who work in the public sector choose to be corrupt based on their attitude towards the social sanction level and how the sanction affects their self-esteem (equation 4.1). The simulated effect of increasing the social sanction upon the proportion of public employees that are corrupt is displayed in Figure 5.4. The figure demonstrates that an economy with a higher social sanction on corruption will experience a lower level of corruption. This is the case when the level of social sanction is exogenously determined.

As the government controls the tax rate, the level of public good provision, and the rate of monetary expansion, the next step is to analyze how the endogenous variables change if the rate of money expansion is changed by the government (given the tax rate and the level of public good remain constant). Table 5.3 shows that a higher rate of monetary expansion is associated with a higher number of corrupt officials working in the public sector

but a lower bribe per person and a lower share goes to corrupt officials in the bargain. The level of seigniorage and government revenue are higher when μ increases.

$\mu(t)$	$s(t)$	$b(t)$	$w^g(t)$	$w^p(t)$	$rev(t)$	$V_5(t)$	n^c	n^h
1.1	0.5562	0.3371	0.3162	0.849366	75.90	5.658	115.92	92.46
1.2	0.5358	0.3216	0.3196	0.849743	81.58	9.537	120.00	103.9
1.3	0.5251	0.3140	0.3208	0.849873	84.50	11.58	121.9	110.2
1.4	0.5168	0.3083	0.3213	0.849943	86.67	13.09	123.3	115.2
1.5	0.5108	0.3046	0.3213	0.849976	88.11	14.06	124.1	118.9
1.6	0.5063	0.3021	0.3210	0.849991	89.07	14.65	124.7	121.5
1.7	0.5028	0.3004	0.3205	0.849998	89.69	14.99	125.0	123.5
1.8	0.5002	0.2993	0.3199	0.849999	90.09	15.15	125.2	125.1
1.9	0.4980	0.2986	0.3193	0.849999	90.32	15.18	125.29	126.2
2	0.4963	0.2982	0.3186	0.849997	90.42	15.13	125.3	127.1

Table 5.3. Effects of a monetary expansion

As already noted the assumption is that the value of omega (the power of bargaining) is assumed to be endogenized in the share of corrupt officials so far ($\omega = \frac{n^c}{n^c+n^h}$). Moreover, the simulation has been regenerated to see how the results change if there is a constant power of bargaining ($\omega = 0.5$). This captures a Nash bargain in which the relative power of the two parties is not affected by the level of corruption. It acts as a baseline case from which to judge the later results. The tables and figures in Appendix I show that there are no significant changes in the results compared to the case of variable omega. The interesting point is that when the relative power of the two parties is affected by corruption, the level of corruption is higher than for the case with constant bargaining power (in terms of the the level of the bribe, the number of corrupt officials).

Figure 5.5 shows the effect of monetary expansion on the wage rates in the private and public sectors. When there is a higher rate of monetary expansion (the government sells more money to the population as a source of revenue), the wage rate in both public and private sector initially increase. The explanation could be a flow to the public sector

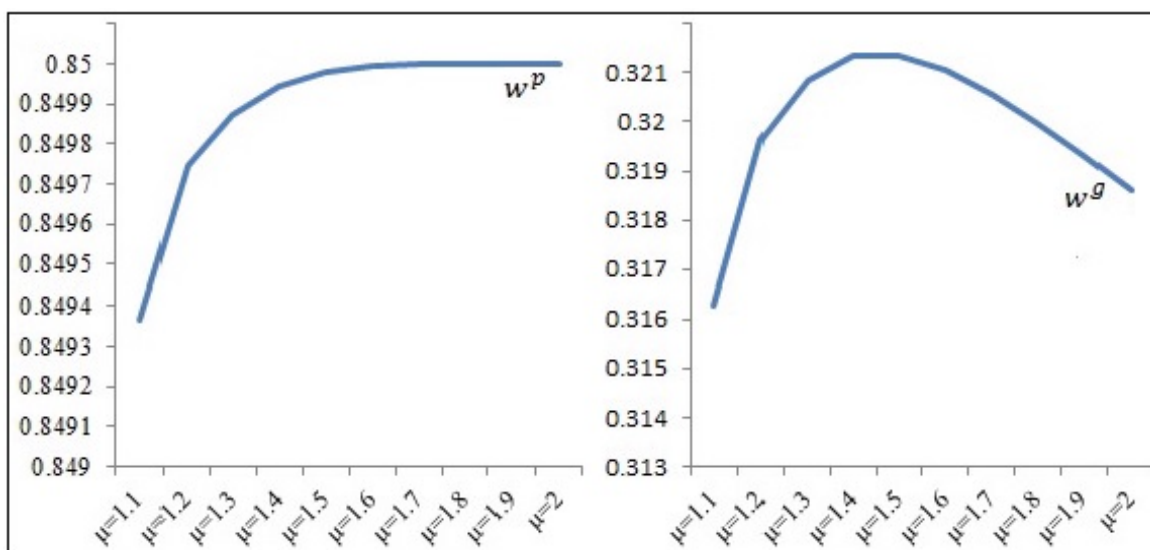


Figure 5.5: Effect of monetary expansion on wages

when the public revenue increases. However, there is a point for both at which the wage rates $w^g(t)$ and $w^p(t)$ begin to decrease with further monetary expansion.

5.6.2 Welfare effects

I now consider how social welfare depends on the tax rate and the rate of monetary expansion. These welfare results lead into the analysis of optimal policy.

Table 5.4 displays how social welfare changes as the rate of monetary growth increases. The idea is that a welfare-maximizing government will have an incentive to rely on seigniorage to compensate for the reduction in tax revenue that results from corruption. However, seigniorage causes inflation which affects the intertemporal distribution of resources. The table assumes a tax rate of 20% ($\tau = 0.2$) and the value of the social sanction on corruption is assumed to be 1/2 ($k = 0.5$). The values of other parameters used in this simulation are the same as given in Appendix G.

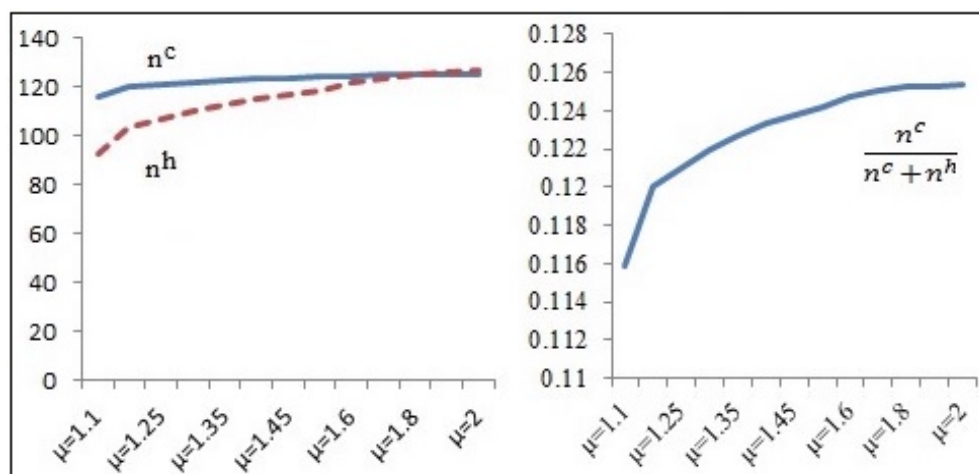


Figure 5.6: Monetary expansion and the number of corrupt officials

$\mu(t)$	1.3	1.31	1.32	1.33	1.34	1.35	1.36	1.37	1.38	1.39
$W(t)$	375.33	375.40	375.45	375.49	375.52	375.53	375.54	375.53	375.51	375.49
n^c	121.94	122.11	122.27	122.42	122.56	122.70	122.83	122.96	123.08	123.20
$\frac{n^c}{n^c+n^h}$	0.5251	0.5241	0.5232	0.5223	0.5214	0.5206	0.5198	0.5190	0.5182	0.5175

Table 5.4. Welfare function and the growth rate of money supply

Figure 5.6 show that higher monetary expansion raises the number of corrupt individuals and their share in the public sector. (while the rate of tax, public goods and the level of social sanction on corruption are constant)

The maximum level of the welfare (375.54) is achieved when money supply growth is at the net rate of 36%. The key observation is that there is an optimum rate of monetary expansion and hence a limit of the beneficial amount of seigniorage. Equation (5.23) indicated that in fact the inflation rate equals the net rate of money supply growth. Therefore, at this rate of monetary expansion the inflation rate is also 36%. The number of corrupt official is 122 individuals out of 1000 of population and their share in the public sector is 51%. This is optimum numbers for the case when government chooses 36% of monetary

expansion, 20% for the tax rate, and when there is a given social sanction at 0.5. To see whether the welfare function shows the same behavior (with a maximum level) the simulation was repeated for different values of k and τ , and table 5.5 reports the values of the optimal growth rate of money supply (μ) as τ and k are varied. The graphs of the welfare functions are nicely concave with a clear optimum point in each case (see an example plot in Appendix J).

It has already been noted that an economy with a lower social sanction experiences higher corruption in the public sector. Moreover, the table shows that when the social sanction increases, the optimal value of monetary expansion, $\hat{\mu}$, that is chosen by the government declines. Therefore, a higher level of corruption is associated with the government choosing a higher growth rate of money supply. The mechanism underlying this result is that corruption causes some potential tax revenues to be translated into bribes. The government reacts to this loss of revenue by turning to the alternative revenue source of seigniorage. In turn, greater seigniorage causes the value of money to fall and inflation to rise. This is one of the central conclusions from the analysis: for any given tax rate, increased corruption and higher monetary expansion will occur together in equilibrium.

	k=0.5		k=0.6		k=0.7		k=0.8		k=0.9		k=1.0		k=2.0	
\mathcal{T}	$\hat{\mu}$	\bar{W}	$\hat{\mu}$	\bar{W}	$\hat{\mu}$	\bar{W}	$\hat{\mu}$	\bar{W}	$\hat{\mu}$	\bar{W}	$\hat{\mu}$	\bar{W}	$\hat{\mu}$	\bar{W}
0.1	1.47	394.9	1.37	426.1	1.30	447.5	1.221	462.8	1.229	473.9	1.2199	482.4	1.12	522.7
0.15	1.41	383.5	1.32	409.5	1.27	428.6	1.230	442.9	1.200	454.1	1.18	463.2	1.018	508.7
0.2	1.36	375.5	1.29	397.7	1.24	415.3	1.200	429.1	1.160	440.2	1.13	449.4	1.000000010	495.3
0.25	1.32	369.8	1.26	388.9	1.21	405.0	1.160	418.2	1.121	428.9	1.1	437.9	1.000000005	481.8
0.3	1.28	365.6	1.22	382.0	1.17	396.7	1.130	409.0	1.100	419.2	1.100000006	427.7	1.000000008	468.3

Table 5.5. Optimum rate of money supply and social sanction on corruption

The optimal growth rate of the money supply, $\hat{\mu}$, declines as the social sanctions

on corruption increases (and the proportion of corrupt public sector officials also declines) no matter what the tax rate is. This is shown in figure 5.7. Hence, seigniorage (5.21) and inflation (5.23) are lower in a society with less corruption, what is important is that there is no causality of one variable on the other. Both are endogenous and are determined simultaneously in equilibrium.

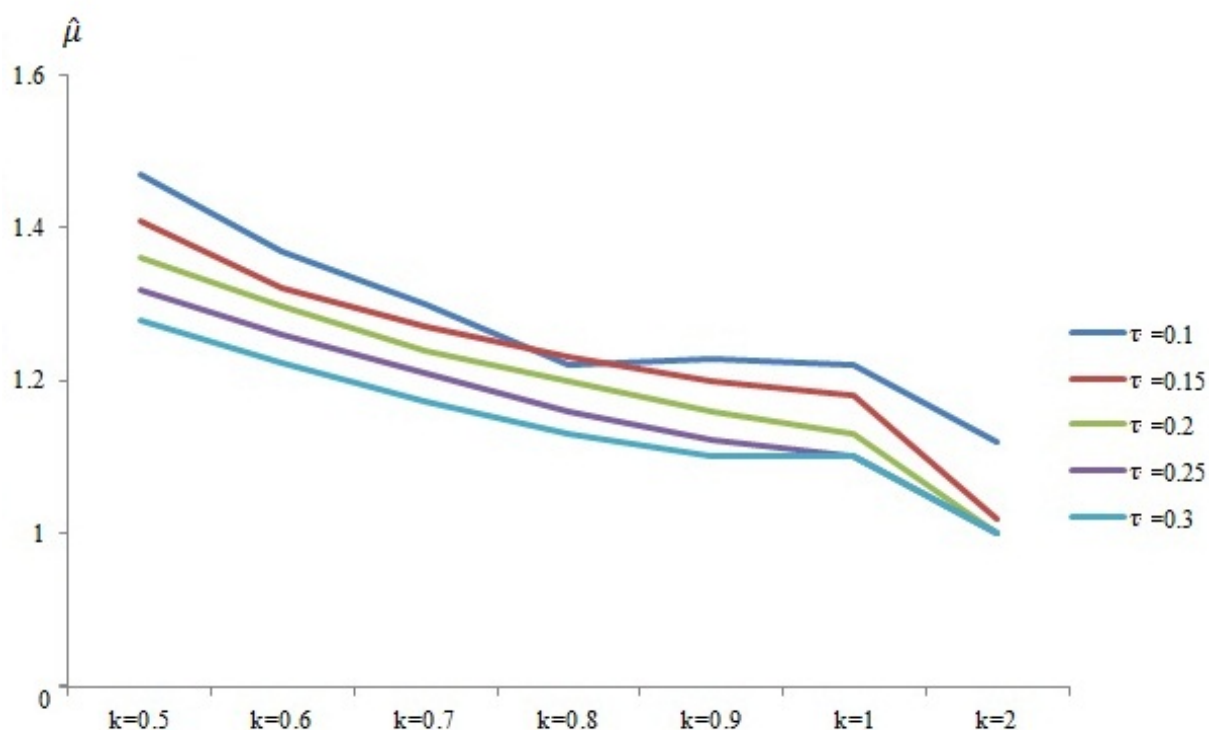


Figure 5.7: Optimal growth rate of money supply and social sanction on corruption

The parameter φ captures the direct appropriation of the newly issued money by corrupt officials. The parameter describing the degree of appropriation is assumed to be exogenous in this model where corrupt officials have been endogenized. Table 5.6 shows that when a greater proportion of the new money supply is stolen the optimal growth

rate of money approaches zero, and the level of welfare is decreasing with higher φ . This is a consequence of seigniorage becoming less effective as a source of revenue when more money is stolen, so the incentive for the government to inflate the money supply to exploit seigniorage is reduced.

$\varphi = 0.1$		$\varphi = 0.15$		$\varphi = 0.2$		$\varphi = 0.25$		$\varphi = 0.3$	
$\hat{\mu}$	\hat{W}	$\hat{\mu}$	\hat{W}	$\hat{\mu}$	\hat{W}	$\hat{\mu}$	\hat{W}	$\hat{\mu}$	\hat{W}
1.36	375.54	1.3	368.91	1.24	362.64	1.12	357.20	1.00001	355.67

Table 5.6. Exogenous appropriation of newly issued money and the monetary expansion

In addition, the optimal tax rate ($\hat{\tau}$) that maximizes social welfare is also affected by the value of the social sanction. Table 5.6 shows that $\hat{\tau}$ increases with a higher social sanctions until the point $k = 0.8$, and then declines after this point (μ is assumed to be 1.1 in this table). However, the maximum welfare level is still higher in an economy with a higher social sanction (even with lower $\hat{\tau}$). When the social sanction is higher we saw that government chooses lower seigniorage (figure 5.7) but uses a higher tax rate as a source of revenue (table 5.7) where at some point of social sanction upwards ($k = 0.8$ in this simulation) the optimal tax rate levied is lower. This means that lower seigniorage and lower tax rate are associated with higher level of social sanction on corruption.

$k = 0.5$		$k = 0.6$		$k = 0.7$		$k = 0.8$		$k = 0.9$		$k = 1.0$		$k = 2.0$	
$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}
0.12	372.9	0.12073	404.9	0.1362	425.4	0.1409	440.8	0.1406	453.5	0.1379	464.3	0.0985	522.7

Table 5.7. Optimal tax rate in different social sanctions

The table 5.8 as well as figure 5.8 show that the optimal tax rate tends to zero when the government relies on more monetary expansion. This result shows that for the parameter values used, it is better to use seigniorage to finance the public good. This is because tax revenue is subject to corruption which limits its effectiveness. The graphs of

the welfare functions are nicely concave with a clear optimum point in each case (see an example plot in Appendix K).

$\mu = 1.1$		$\mu = 1.15$		$\mu = 1.2$		$\mu = 1.25$		$\mu = 1.3$		$\mu = 1.35$		$\mu = 1.4$	
$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}	$\hat{\tau}$	\hat{W}
1.12	372.98	0.08	382.35	0.06	391.79	0.03	401.34	0.02	411.044	0.004	420.71	0.000000001	429.58

Table 5.8. Optimal tax rate and growth rate of money supply

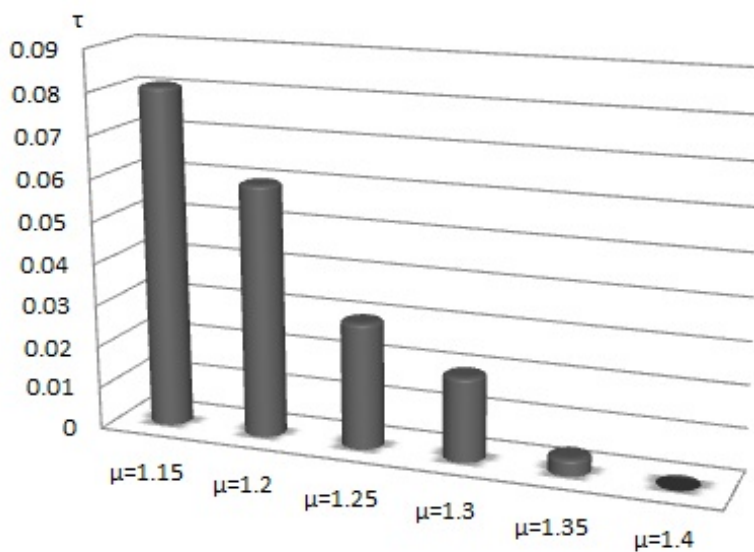


Figure 5.8: Optimal tax rate and monetary expansion

5.7 Conclusion

This chapter completes the model of endogenous corruption presented for the static case in the previous chapter. The main objective was to develop the model in a dynamic monetary framework in which there is a growth in money supply and to investigate the equilibrium relationship between corruption and inflation. This was intended to answer

the main question of the thesis which was to find how seigniorage reacts to endogenized corruption. Hence, the equilibrium conditions embedded in an overlapping generations model were used to obtain numerical results. These conditions include optimal consumption of the three types of individuals, firm maximization, government budget constraint, F.O.C of the Nash bargaining solution, the number of corrupt and honest individual and people who work in the private sector. The simulation results of the model are briefly listed below.

First, the numerical results demonstrate the positive economics of the equilibrium. The higher corporation tax rate leads to a lower wage level in the private sector $w^p(t)$ and in the public sector $w^g(t)$. The decline in $w^g(t)$ could be explained by an increase in labour supply in public sector due to a decline in $w^p(t)$. A higher tax rate also causes an increase in the number of corrupt individuals. However, their share in the public sector population is lower when the tax rate is higher. When the economy faces a higher level of social sanction on corruption (k), the number of corrupt officials in the public sector is lower. This confirms the first assumption that considers the social sanction as a disincentive of the self-esteem in the utility function of corrupt officials.

The second part of the results is summarized as follows. There is an optimal growth rate of money supply and an optimal tax rate ($\hat{\tau}$) that are chosen by welfare-maximizing government. The government chooses a higher optimal tax rate ($\hat{\tau}$) when there is a higher social sanction on corruption, but this increase reaches a maximum point and declines afterwards. This implies that there is an optimum social sanction in which government could impose higher tax rate (when μ is chosen around the optimum). Moreover, lower monetary expansion leads to a sharp increase in optimal tax rate ($\hat{\tau}$) when the social sanction (k) is

assumed to be given. This is predictable as monetary expansion is an alternative source of revenue rather than taxes in a same level of social sanction (k).

The final part of the results indicates that the growth rate of money supply ($\hat{\mu}$) that is chosen by government is higher when there is a lower social sanction on corruption (k), and as the lower social sanction causes a higher proportion of corrupt individual in the public sector there is a conclusion that the higher optimal inflation rate ($\hat{\mu}$) is associated with lower k and so greater corruption in the public sector. This is the outcome that the theoretical part of the endogenous study was aiming to reach.

Chapter 6

Conclusion

Corruption as an economic issue has been cited as a cause of poor economic performance. The negative impact of corruption on economic growth has been explored empirically and theoretically by many scholars. Susan Rose-Ackerman (1999) states that corruption is a condition in which people (politicians, public officials, and businesses) use their privileged positions in order to pursue economic gain. She considers corruption as a reason for low rates of economic growth in countries with well-educated labour and rich natural resources. In contrast, there are some studies suggesting that corruption might be beneficial in economies with poor-functioning institutions. The idea is that inefficient bureaucracies hinder investment, and corruption acts as "grease" to help circumvent these inefficiencies. The idea of corruption greasing the wheels is explored by Huntington (1968), Leys (1965), Beck and Maher (1986) and Lien (1986) although this idea is not consistent with literature of the empirical and theoretical evidence on the negative effect of corruption on growth and investment which is called the "sand the wheels" hypothesis (Méon and Sekkat (2005),

Kurer (1993), and Shleifer and Vishny (1993)).

The analysis of the impact of corruption on inflation has become a topic of interest since 2000. The empirical study by Al-Marhubi (2000) showed that corruption could be an explanation for inflation while Braun and Di Tella (2000) explained that inflation is an incentive for corruption. There have been suggestions that corruption can increase inflation because of the government exploiting seigniorage to compensate for the lost revenue. However, there has been no demonstration that this can be a rational policy. The main objective of this study was to provide an analysis in which higher corruption is associated higher inflation rate as a result of rational behavior of the public officials and individuals.

The general definition of inflation is a sustained increase in the general price level. Monetarists are agreed that the main reason behind increasing prices is growth in money supply. Consequently, inflation is a monetary phenomenon in the long-run. In this study the idea has been explored that corruption could cause the rate of monetary expansion to be higher and, hence, increase the inflation rate.

The study started with an empirical exploration of the link between corruption and inflation. A panel data analysis has been undertaken by using a dataset covering 164 countries with stationary variables from 1995 to 2010. By considering the whole sample, the coefficient on corruption is significant and indicates a positive link between corruption and inflation. The model has also been tested with two divisions in the data sample. In the first division the coefficient for corruption is slightly lower for OECD countries in comparison to non-OECD countries, and in both cases the coefficient is statistically significant. This result shows that in developed countries the impact of corruption on inflation is lower than

its impact in developing countries. In the second division the coefficient of corruption is statistically significant for non oil-exporting countries, but it is insignificant for oil-exporting economies.

These results show that corruption is positively associated with inflation in each data sample, and they confirm previous findings in the literature. This finding was taken as a motivation to undertake the theoretical study at the very early stage of the research.

The main body of the work started with chapter three in which the analysis of corruption and inflation has been set within two versions of an overlapping generations model in which money was the only store of value, and seigniorage was introduced as the quantity of consumption good transferred from consumers to the government. In the basic version of the model where the government chose the rate of money supply growth to maximize the level of seigniorage, a single type of corruption was examined in the form of direct appropriation of newly issued money. A sufficient condition was derived for an increase in corruption to increase inflation.

In the second version of analysis model has been developed by adding labor supply as a choice variable. A tax rate upon labor income levied by government as well as the revenue raised from seigniorage financed the provision of public goods in the public sector. These additional elements provided the model to explore for two other types of corruption. In the first type taxpayers were able to collaborate with tax collectors to decrease the effective tax rate, and the second type was in a form of an appropriation of a share of public revenue. Each of three forms of corruption was an incentive for the public sector to exploit seigniorage. A welfare-maximizing government chose the tax rate and the growth rate of

money supply by taking into account the existence of the corrupt activities.

The numerical analysis of the simulation restricted the demonstration to claim generality for the results. Nevertheless, the model was able to illustrate that all three exogenous types of corruption could be positively associated with an increase in the optimal rate of money supply growth and, therefore, with the inflation rate. The results also showed that higher appropriation of newly-issued money or of the tax revenue was correlated with lower levels of GDP. This was in agreement with the literature of corruption sanding the wheels of economic growth. This establishes very clearly that excessive inflation can be the consequence of a rational policy response to the existence of corruption.

This was a motivational starting point of the research. To step further into the theoretical analysis of corruption and inflation, the assumption of endogenous corruption was introduced in chapter four which was closer to the situation observed in reality. In practice, choosing to act corruptly is an option that is determined by various individual characteristics and the social setting. In the endogenous model corruption was an option chosen when it is considered beneficial, and there was heterogeneity between individuals to ensure that some may be honest and some corrupt. Individuals were heterogeneous in their evaluation of the disutility of effort and the loss of self-esteem resulted from acting corruptly. These factors endogenized corruption and determined the choice between employment in the public sector (being honest or corrupt) and employment in the private sector. If corruption is chosen, it leads to a loss in self-esteem but opens up an opportunity to benefit from a bargain with a firm. It is assumed that there is a bargaining game between tax officials and the firm to reduce the effective tax rate at the cost of the payment of a bribe. The

endogenous share that is exchanged between the players was determined by a generalized Nash bargain.

The comparative statics of the model were determined for the cases of both corruption and the absence of corruption. In both analyses the results showed that there was a flow of employment from the private sector to the public sector when there was an increase in the tax rate. Moreover, a lower level of social sanction on corruption caused an increase in the population of corrupt officials working in the public sector. These central results demonstrated that it is possible to endogenize corruption and benefits from corruption in an equilibrium.

To explore the impact of endogenized corruption and inflation, the static model developed in chapter four has been embedded in a monetary dynamic model in chapter five. In an overlapping generations model (OLG) individuals lived for two periods of life, and there was a growth in money supply as the only store of value. It was assumed that each individual worked in the first period of life and chose to work either in public sector or in private sector by taking into account the components introduced in the static model. A welfare-maximizing government chose the rate of corporation tax as well as the rate of money supply growth, and it provided public goods financed by revenue raised from tax and seigniorage. Because of the complicated nine equilibrium conditions, the model had to be analyzed by numerical simulations. Results showed that higher social sanction causes smaller corrupt public sector. The main finding of the analysis was where the higher social sanction (lower corruption) was associated with the lower optimal rate of money supply, and then with inflation.

Although the theoretical analysis of exogenous and endogenous corruption and inflation ends here in a form of a PhD thesis, it opens up some further research paths that are summarized below:

- Corruption could be endogenized in not only social settings but also individual characteristics. How could the heterogeneity in individual characteristics such as age and occupations influence decision makers to choose between corruption and honesty? How does this affect inflation?

- A comparison between social and individual effects on corruption and inflation could be another interesting point to analyze.

- In this study, corruption was analyzed as a reason for the lost public revenue and therefore for the budget deficit. However, the next point that could enrich the analysis of corruption and inflation is to explore corruption as a cause of excess public expenditure that could also result in budget deficit and exploiting seigniorage!

- How auditing and monitoring of corruption could play a role in this analysis.

Chapter 7

Appendix

Appendix A - List of resources measuring CPI used by International Transparency

1	African Development Bank Governance Ratings 2012
2	Bertelsmann Foundation Sustainable Governance Indicators 2014
3	Bertelsmann Foundation Transformation Index 2014
4	Economist Intelligence Unit Country Risk Ratings
5	Freedom House Nations in Transit 2013
6	Global Insight Country Risk Ratings
7	IMD World Competitiveness Yearbook 2013
8	Political and Economic Risk Consultancy Asian Intelligence 2013
9	Political Risk Services International Country Risk Guide
10	Transparency International Bribe Payers Survey 2011
11	World Bank - Country Policy and Institutional Assessment 2012
12	World Economic Forum Executive Opinion Survey (EOS) 2013
13	World Justice Project Rule of Law Index 2013

Appendix B - List of countries classified by codes

Albania	Alb	Dominican Republic	Dor
Algeria	Alg	Egypt	Egy
Argentina	Arg	El Salvador	Els
Armenia	Arm	Estonia	Est
Australia	Aus	Finland	Fin
Azerbaijan	Aze	Gabon	Gab
Bahamas	Bhm	Gambia	Gam
Bangladesh	Ban	Ghana	Gha
Belarus	Bls	Guatemala	Gut
Bolivia	Bol	Haiti	Hai
Botswana	Bts	Honduras	Hnd
Brazil	Bra	Hong Kong	Hng
Bulgaria	Blg	Hungary	Hun
Cameroon	Cam	Iceland	Ice
China	Chn	India	Ind
Colombia	Col	Indonesia	Ins
Costa Rica	Cos	Ireland	Ire
Cote d'Ivoire	Cot	Israel	Isr
Croatia	Cro	Japan	Jap
Cyprus	Cyp	Jordan	Jor
Czech Republic	Czr	Kazakhstan	Kaz
Denmark	Den	Kenya	Ken
Latvia	Lat	Senegal	Sen
Lithuania	Lit	Singapore	Sin
Malaysia	Mal	Slovenia	Slo
Malta	Mlt	South Africa	Soa
Mexico	Mex	Sri Lanka	Sri
Moldova	Mol	Sudan	Sud
Mongolia	Mon	Sweden	Swe
Morocco	Mor	Switzerland	Swi
Mozambique	Moz	Syria	Syr
New Zealand	New	Tanzania	Tan
Nigeria	Nig	Thailand	Tha
Pakistan	Pak	Tunisia	Tun
Panama	Pan	Turkey	Tur
Papua New Guinea	Pap	Uganda	Uga
Paraguay	Par	United Kingdom	Gbr
Peru	Per	United States	Usa
Philippines	Phi	Uruguay	Uru
Poland	Pol	Venezuela	Ven
Romania	Rom	Vietnam	Vie
Russia	Rus	Yemen	Yem
Saudi Arabia	Sau	Zambia	Zam

Appendix 1.3 - List of oil-exporting county codes

Alg	Ang	Ecu	Irn	Irq	Kwt	Lib	Nig	Qat	Sau	Uae	Ven	Aze	Col	Con	Equ	Gab
Ins	Kaz	Mex	Nor	Omn	Rus	Sud	Syr	Tri	Cub	Chn	Tha	Cot	Tur	Yem	Bra	
Bru	Vie	Bah	Chd	Tim	Egy	Tun	Cam	New	Pap	Alb	Cnd	Phi	Gre	Per	Ger	
Gut	Est	Sur	Mrt	Ita	Mon	Blz	Pol									

Appendix C - List of OECD country codes

Aus	Aut	Bel	Can	Chl	Czr	Den	Est	Fin	Fra	Ger	Gre	Hun	Ice	Ire	Isr	Ita	Jap
Kor	Lux	Mex	Net	New	Nor	Pol	Por	Slr	Slo	Spa	Swe	Swi	Tur	Gbr	Usa		

Appendix D - Details of the expressions used in Section 3.5 are as follows:

$$\begin{aligned}
S_{11} &= \sum_{h_i=1}^{N_1(t)} \left[\frac{\omega_t^{h_1}(t)(1-\lambda_2\tau)\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \right], \\
S_{12} &= \sum_{h_i=1}^{N_2(t)} \left[\frac{\omega_t^{h_2}(t)(1-\tau)\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}} \right], \\
S_{13} &= \sum_{h_i=1}^{N_1(t)} \left[\frac{\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \right], \\
S_{21} &= \sum_{h_i=1}^{N_1(t)} \left[\frac{1+[\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}}{1+\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \right] \left[\frac{(1-\lambda_1)(\mu-1)\left(\frac{\gamma_2}{\mu} + \gamma_3\right)}{N(t)} + \frac{\lambda_1(\mu-1)}{\mu N_1(t)} \right] \\
S_{22} &= \sum_{h_i=1}^{N_2(t)} \left[\frac{1+[\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}}{1+\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}} \right] \left[\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu N(t)} + \frac{(1-\lambda_1)\gamma_3(\mu-1)}{N(t)} \right] \\
R_{11} &= \frac{1+\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \\
R_{12} &= \frac{\omega\lambda_2\tau[\omega(1-\lambda_2\tau)]^{-\frac{1}{\rho}}\lambda_3}{1+\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \\
R_{13} &= \frac{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}} \\
R_{141} &= \frac{(1-\lambda_1)\gamma_1(\mu-1)}{\mu} \\
R_{142} &= \frac{N_1(t)\omega\lambda_2\tau[\omega(1-\lambda_2\tau)]^{-\frac{1}{\rho}} \left[\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu N(t)} + \frac{\lambda_1(\mu-1)}{\mu N_1(t)} + \frac{(1-\lambda_1)\gamma_3(\mu-1)}{N(t)} \right]}{1+\beta^{\frac{1}{\rho}} \left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \\
R_{143} &= \frac{N_2(t)\omega\tau[\omega(1-\tau)]^{-\frac{1}{\rho}} \left[\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu N(t)} + \frac{(1-\lambda_1)\gamma_3(\mu-1)}{N(t)} \right]}{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}}
\end{aligned}$$

Appendix E - The baseline values of the parameters for the simulation in the

exogenous model

N_1	N_2	μ^1	μ^2	ρ	β	γ_1	γ_2	γ_3	w	λ_1	λ_2	λ_3
10	10	1	1	0.9	0.4	0.7	0.1	0.2	1	0.3	0.45	0.5

Appendix F - The baseline values of the parameters for the simulation in the endogenous static model

α	f	N	e^p	e^g	δ	μ	k	G
0.2	1	1000	1	0.5	0.5	1.2	0.5	10

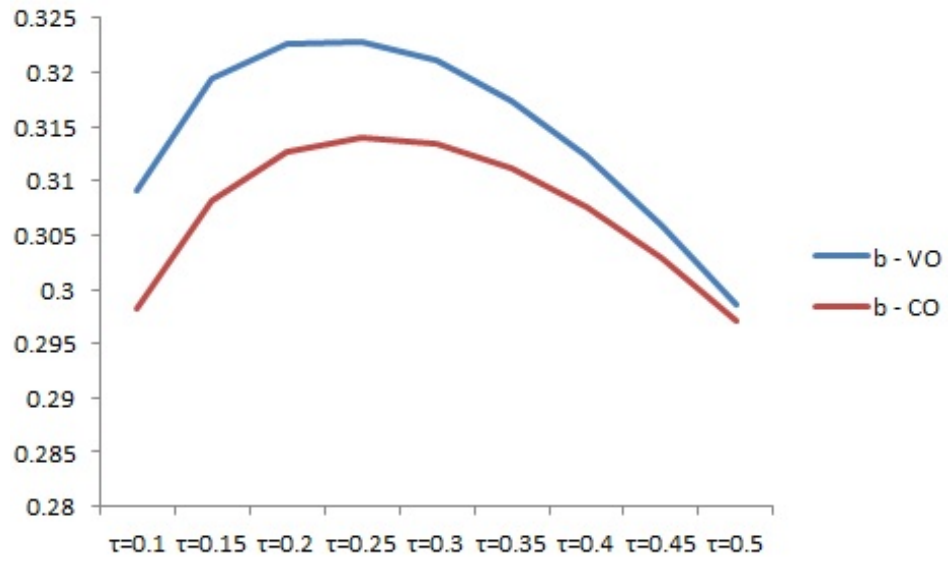
Appendix G -The baseline values of the parameters for the simulation in the endogenous static model

α	f	N	e^p	e^g	δ	τ	k	G
0.2	1	1000	1	0.5	0.5	0.2	0.5	10

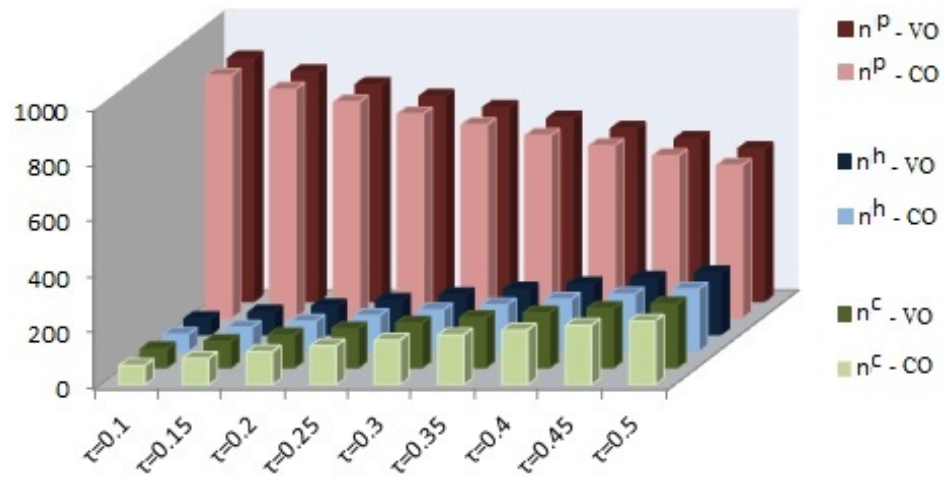
Appendix H -The baseline values of the parameters for the simulation in the endogenous dynamic model

α	f	N	e^p	e^g	δ	μ	k	G
0.2	1	1000	1	0.5	0.5	1.2	0.5	10

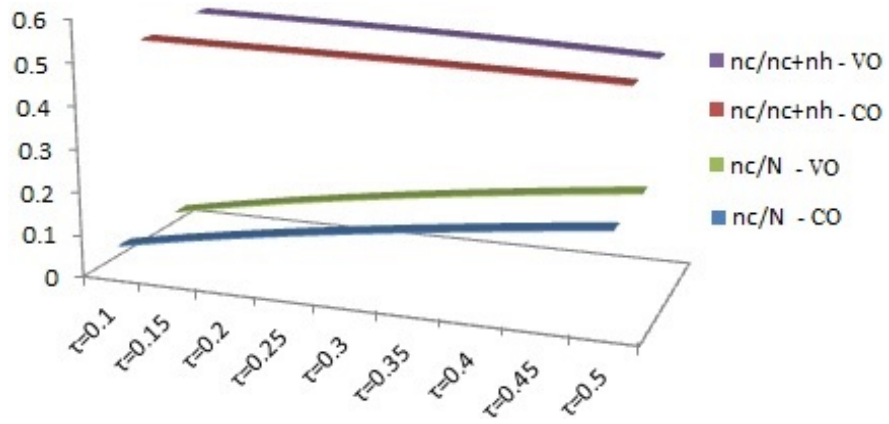
Appendix I - Results for when there is constant ω (CO) in the model ($\omega = 0.5$) versus when the power of bargaining is variable (Variable Omega (VO) $\omega = \frac{n^c}{n^c+n^h}$)



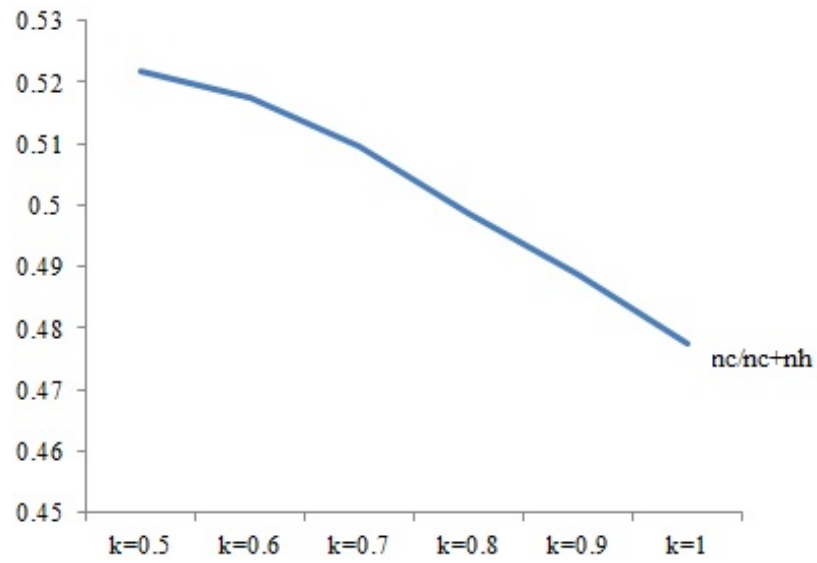
Bribe per person and the tax rate



Distribution of population



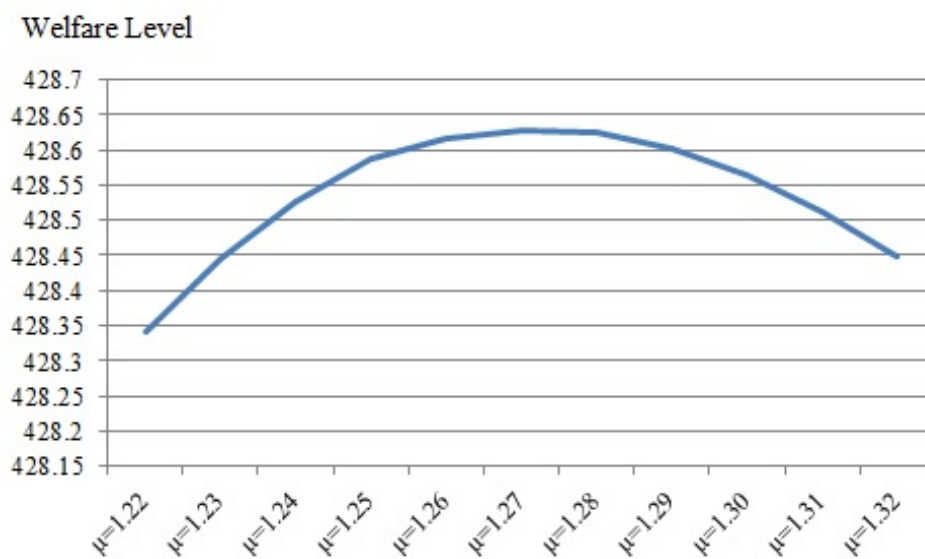
Proportion of corrupt officials



Social sanction and corruption (with constant ω (CO))

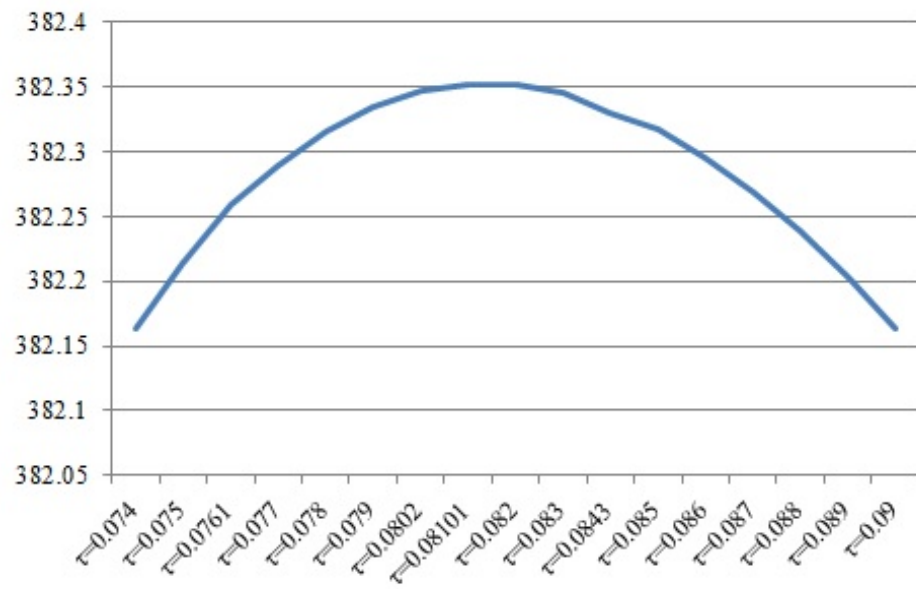
μ	s	b	w^g	w^P	rev	$V5$	n^c	n^h
1.1	0.5	0.321566	0.321922	0.853207	79.13579	5.647582	114.2661	100.4933
1.2	0.5	0.312612	0.322955	0.852187	83.19777	9.245348	118.2817	108.3681
1.3	0.5	0.307202	0.323141	0.851501	85.81507	11.57534	120.8322	113.7867
1.4	0.5	0.303831	0.322855	0.851015	87.53095	13.08754	122.508	117.6333
1.5	0.5	0.301719	0.322301	0.850657	88.6578	14.05578	123.6281	120.4226
1.6	0.5	0.300425	0.321595	0.850386	89.38716	14.65373	124.3796	122.4749
1.7	0.5	0.299678	0.320808	0.850177	89.84191	14.99517	124.8787	123.9991
1.8	0.5	0.299307	0.319982	0.850013	90.1036	15.15662	125.2009	125.1365
1.9	0.5	0.299199	0.319146	0.849883	90.22782	15.1907	125.3968	125.9856
2.0	0.5	0.299276	0.318317	0.849779	90.2533	15.13421	125.5012	126.6167

Effects of a monetary expansion (when ω is constant 0.5) while Table 5.3 is for ω variable



Appendix J. The plot of the simulated welfare function ($k = 0.7$ and

$$\tau = 0.15)$$



Appendix K. The plot of the simulated welfare function ($k = 0.5$ and $\mu = 0.15$)

Chapter 8

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