Corruption and Seigniorage

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Abstract

There is convincing empirical evidence in cross-section data of a positive correlation between the level of corruption and the rate of inflation. This paper explores whether this correlation can be a consequence of a government exploiting seigniorage to compensate for revenue lost to corruption. We embed corruption within an overlapping generations economy that has money as the only store of value and in which the government optimizes the rate of monetary growth. Three different forms of corruption are modelled, and it is shown that all three can be positively correlated with increased inflation.

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1 Introduction

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 choice of governments as they attempt to compensate for 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.

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 paper is an analysis of this issue in a model in which the growth rate of money supply is chosen by an optimizing government.

A government has two sources of revenue. It can levy tax 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. We 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 analysis 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 our analysis we 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 selection of monetary models in the literature include money in the utility function, cash in advance, or money as a store of value. We 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. We 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 choice of money growth an optimizing decision we are 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. We review these in section 3 and briefly explore their properties in order to explain the logic behind our choice of measure. Ultimately, we 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. We 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. We consider three forms of corruption. 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. There are ranges of parameter values for which an increase in corruption can reduce monetary expansion. In summary, the results make a convincing case that corruption can be positively correlated to inflation.

Section 2 of the paper presents empirical evidence to demonstrate the link between corruption and inflation. Section 3 discusses different definitions of seigniorage that have been presented in the literature. It also shows how these can be expressed in monetary terms. Section 4 characterizes the equilibrium of the model without taxation. Section 5 then looks at optimal seigniorage. Section 6 shows how the presence of corruption affects seigniorage when there is taxation. Section 7 contains the conclusions. The Appendix describes the corruption data used in the empirical work, provides additional details of the algebra, and states the baseline parameter values used in the numerical analysis.

2 Empirical Evidence

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).

Al-Marhubi(2000) was the first to show that there was a positive correlation between the level of corruption and the inflation rate. The results of Abed and Davoodi (2000) also show that a higher corruption level is significantly associated with a higher inflation rate. Although Smith-Hillman (2007) finds 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. Smimi and Abdollahi (2012) also conclude 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) proposes 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) suggest that the existence of inflation could be the motive for corruption.

Before presenting the theoretical analysis of this paper, it is interesting to briefly present an empirical analysis that confirms the previous findings. The analysis is based on the following regression equation

$$INF_{it} = \alpha + \beta GPGDP_{it} + \gamma GM2_{it} + \delta OPENNESS_{it} + \theta FFC_{it} + \varepsilon_{it}, \quad (1)$$

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) (see Appendix 1 for details). The other variables have been obtained from World Development Indicators (2012).

The F test reported in Table 1 shows that the null hypothesis of identical intercepts for countries is rejected, so the OLS method (pooled OLS) is not correct for estimating equation (1). The Hausman Test 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 may be more powerful and parsimonious than a fixed effects model.

Hierarchical tests		P value
F Test	3.3920	0.000
Hausman Test	6.0676	0.1941

Table 1: Fixed effects or random effects

Table 2 presents the results of estimating equation (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			
	Variable	Coefficient (t-statistic)	Probability
Constant	C	29.36 (3.66)	0.0003
Freedom From Corruption	FFC	-0.55 (-3.86)	0.0001
GDP Per Capita Growth (annual%)	$GPGDP$	-1.30 (-2.40)	0.0103
Money and Quasi Money Growth (annual%)	$GM2$	0.02 (6.69)	0.0000
Economic Trade Freedom	$OPENNESS$	0.11 (1.74)	0.0809
R-squared	0.3143		
Included cross-sections	164		
Included observations	1979		

Table 2: Estimation results

These econometric results demonstrate the conclusion of the previous literature that there is a positive and significant correlation between inflation and corruption. The remainder of the paper provides a theoretical analysis of how this correlation can arise.

3 Measures of Seigniorage

The intention of our theoretical analysis is to explore the argument that corruption leads to inflation because it pushes 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 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. A number of alternative measures of the benefit are summarized in Table 3. For this table we define M_t as the nominal money base in year t, and ΔM_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, i_t is the risk-free nominal interest rate, π_t is the inflation rate, and $\hat{\mu}_t$ is the (net) rate of money expansion.

Measure	Source
$S_1 = \Delta M_t / P_t Y_t$	Buiter (2007)
$S_2 = i_t M_{t-1} / P_t Y_t$	Buiter (2007), Flandreu (2006), Bordo (2006)
$S_3 = \pi_t M_{t-1} / P_t Y_t$	Buiter (2007), Edwards and Tabelini (1991)
$S_4 = \hat{\mu}_t M_t / P_t L_t$	Drazan (1985)
$S_5 = \Delta M_t / P_t$	McCandless and Wallace (1991)

Table 3: Definitions of seigniorage

To support our choice of measure we note that several of these different measure are related. First, observe that S_1 is simply proportional to S_5. Second, since the (net) rate of money supply growth is defined by

$$\begin{aligned} \hat{\mu} &= \frac{M_{t+1} - M_t}{M_t} \\ &= \frac{\Delta M}{M_t}, \end{aligned} \tag{2}$$

it follows that S_4 is exactly equal to S_5.

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

$$r_{t+1} = \frac{P_t - P_{t+1}}{P_{t+1}}, \tag{3}$$

and the inflation rate is

$$\pi_{t+1} = \frac{P_{t+1} - P_t}{P_t}. \tag{4}$$

Since the nominal interest rate, i, is defined by

$$1 + i_{t+1} = (1 + r_{t+1})(1 + \pi_{t+1}), \tag{5}$$

it follows from (3) – (5) that $i_{t+1} = 0$. This shows that in the situation described (which is true of the model we use in the following sections) S_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 S_3 and S_5. We choose to use S_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.

4 Monetary Equilibrium

This section describes a basic version of the model we 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. The form of corruption we consider in this section is the direct appropriation of newly issued money by corrupt officials. The model is extended in section 6 by using a more general utility function, adding variable labor supply, and introducing corruption related to effective tax rates and tax revenue.

The model adopts the standard assumptions on population structure. A new generation of individuals is born every period t and each individual lives through that period and period $t+1$. Since there are two generations alive in each period there can be trade between young and old, and consumptions loans between members of the same generation with different endowments. Individuals are born either corrupt or non-corrupt. This can be interpreted as the corrupt being born into a family which is in a position of sufficient authority to beneficially exploit opportunities for corruption. 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 $N(t) = N_1(t) + N_2(t)$.

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 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, $M_{t+1} - M_t = (\mu - 1) M_t$ 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 4.

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 4: Money supply and corruption

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

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

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

$$\begin{aligned} C_t^{h_1}(t) &= \omega_t^{h_1}(t) - \ell^{h_1}(t) - p^m(t)m^{h_1}(t) + p^m(t)\lambda_1(\mu - 1)\frac{M(t-1)}{N_1(t)} \\ &\quad + p^m(t)(1-\lambda)\gamma_2(\mu - 1)\frac{M(t-1)}{N_1(t) + N_1(t)}, \end{aligned} \tag{6}$$

and

$$\begin{aligned} C_t^{h_1}(t+1) &= \omega_t^{h_1}(t+1) + r(t)\ell^{h_1}(t) + p^m(t+1)m^{h_1}(t) \\ &\quad + p^m(t+1)(1-\lambda_1)\gamma_3(\mu - 1)\frac{M(t)}{N_1(t) + N_1(t)}. \end{aligned} \tag{7}$$

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 to $t+1$. $r(t)$ 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

$$\bar{m}^{h_1}(t) = m^{h_1}(t) - (1-\lambda_1)\gamma_2(\mu - 1)\frac{M(t-1)}{N(t)} - \lambda_1(\mu - 1)\frac{M(t-1)}{N_1(t)}, \tag{8}$$

$$\tilde{m}^{h_1}(t) = m^{h_1}(t) + (1-\lambda_1)\gamma_3(\mu - 1)\frac{M(t)}{N(t)}, \tag{9}$$

we can write the lifetime budget constraint as

$$C_t^{h_1}(t) + \frac{C_t^{h_1}(t+1)}{r(t)} = \omega_t^{h_1}(t) + \frac{\omega_t^{h_1}(t+1)}{r(t)} - p^m(t)\bar{m}^{h_1}(t) + \tilde{m}^{h_1}(t)\frac{p^m(t+1)}{r(t)}. \tag{10}$$

There is potential for individuals to arbitrage between money and consumption loans. To prevent this we impose a non-arbitrage condition as a requirement of equilibrium. From (10) the no-arbitrage condition is

$$p^m(t) - \frac{p^m(t+1)}{r(t)} = 0. \tag{11}$$

Using the no-arbitrage condition the level of consumption demand at t is

$$C_t^{h_1}(t) = \frac{1}{1+\beta}\left[\omega_t^{h_1}(t) + \frac{\omega_t^{h_1}(t+1)}{r(t)} + p^m(t)\left(\tilde{m}^{h_1}(t) - \bar{m}^{h_1}(t)\right)\right], \tag{12}$$

and the level of saving is

$$s_t^{h_1}(t) = \frac{\beta}{1+\beta}\omega_t^{h_1}(t) - \frac{1}{r(t)(1+\beta)}\omega_t^{h_1}(t+1) + \frac{p^m(t)}{1+\beta}\left[\bar{m}^{h_1}(t) - \tilde{m}^{h_1}(t)\right] - \ell^{h_1}(t). \tag{13}$$

Repeating the analysis for the non-corrupt consumers, the level of saving is

$$s_t^{h_2}(t) = \frac{\beta}{1+\beta}\omega_t^{h_2}(t) - \frac{1}{r(t)(1+\beta)}\omega_t^{h_2}(t+1) + \frac{p^m(t)}{1+\beta}\left[\bar{m}^{h_2}(t) - \tilde{m}^{h_2}(t)\right] - \ell^{h_2}(t), \tag{14}$$

where

$$\bar{m}^{h_2}(t) = m^{h_2}(t) - (1-\lambda_1)\gamma_2(\mu-1)\frac{M(t-1)}{N(t)}, \tag{15}$$

$$\tilde{m}^{h_2}(t) = m^{h_2}(t) + (1-\lambda_1)\gamma_3(\mu-1)\frac{M(t)}{N(t)}. \tag{16}$$

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

$$S(t) = p^m(t)M(t). \tag{17}$$

We assume that the intertemporal pattern of endowments is such that we can restrict attention to stationary monetary equilibrium with $S(t) = S(t+1)$. 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, we have $M(t+1) = \mu M(t)$ so $p^m(t) = \mu p^m(t+1)$. Using the no-arbitrage condition (11) gives the real interest rate as

$$r(t) = \frac{p^m(t+1)}{p^m(t)} = \frac{1}{\mu}. \tag{18}$$

Using (18) the saving function for type i is

$$s_t^{h_i}(r(t)) = \frac{\beta}{1+\beta}\omega_t^{h_i}(t) - \frac{\mu}{1+\beta}\omega_t^{h_i}(t+1) + \frac{p^m(t)}{1+\beta}[\bar{m}^{h_i}(t) - \tilde{m}^{h_i}(t)] - \ell^{h_i}(t). \tag{19}$$

The aggregate saving function is the sum of individual saving

$$S(t) = \sum_{h=1}^{N_1(t)} s_t^{h_1}(t) + \sum_{h=1}^{N_2(t)} s_t^{h_2}(t). \tag{20}$$

Using the saving functions and fact that $\sum_{i=1}^{2}\sum_{h_i=1}^{N_i(t)} \ell^{h_i}(t) = 0$, (20) can be written as

$$\begin{aligned} S(t) &= \frac{1}{1+\beta}\sum_{i=1}^{2}\sum_{h_i=1}^{N_i(t)}\left[\beta\omega_t^{h_i}(t) - \mu\omega_t^{h_i}(t+1)\right] \\ &\quad - \frac{p^m(t)M(t)(\mu-1)}{1+\beta}\left[(1-\lambda_1)\left(\frac{\gamma_2}{\mu} + \gamma_3\right) + \frac{\lambda_1}{\mu}\right]. \end{aligned} \tag{21}$$

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

$$S(t) = \frac{\beta Y_t(t) - \mu Y_t(t+1)}{1+\beta} - \frac{S(t)(\mu-1)}{(1+\beta)}\left[(1-\lambda_1)\left(\frac{\gamma_2}{\mu}+\gamma_3\right)+\frac{\lambda_1}{\mu}\right]. \quad (22)$$

Solving (22) for $S(t)$ gives the equilibrium level of saving as

$$S(t) = \frac{\beta Y_t(t) - \mu Y_t(t+1)}{1+\beta+\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu}+\frac{\lambda_1(\mu-1)}{\mu}+(1-\lambda_1)\gamma_3(\mu-1)}. \quad (23)$$

Substituting into (17) the equilibrium price of money is given by

$$p^m(t) = \frac{M(t)\left[1+\beta+\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu}+\frac{\lambda_1(\mu-1)}{\mu}+(1-\lambda_1)\gamma_3(\mu-1)\right]}{\beta Y_t(t) - \mu Y_t(t+1)}. \quad (24)$$

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

5 Seigniorage and Inflation

The analysis of equilibrium has taken the growth rate of money supply as given. We now assume that the government chooses the rate of monetary expansion to obtain maximum benefit from seigniorage. In the monetary economy we 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 received by the government. 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. We relax this in the next section. The value of seigniorage is measured by S_5 so the decision problem of the government is

$$\max_{\{\mu\}} S_5. \quad (25)$$

Since S_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

$$S_5 = p^m(t+1)\left[(1-\lambda_1)\gamma_1(\mu-1)M(t)\right]. \quad (26)$$

Money given to the young or old results in no resources for the government so is not included in seigniorage. There could be other political justifications for giving money (e.g. as pension payments to the old) but we do not explore the issue further. Using (23) and (26)

$$\begin{aligned} S_5 &= (1-\lambda_1)\gamma_1\left(\frac{\mu-1}{\mu}\right)p^m(t)M(t) \\ &= \frac{\beta Y_t(t)-\mu Y_t(t+1)}{\frac{(1+\beta)\mu}{(1-\lambda_1)\gamma_1(\mu-1)}+\frac{\gamma_2}{\gamma_1}+\frac{\lambda_1}{(1-\lambda_1)\gamma_1}+\frac{\mu\gamma_3}{\gamma_1}}. \end{aligned} \tag{27}$$

From (27) we obtain a result that links corruption to seigniorage.

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

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

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

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

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

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

■

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, inflation can be positively correlated with inflation through the seigniorage activities of government.

6 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 this analysis that we address in this section. The two major shortcomings were the single form of corruption and the use of a leviathan model of government. We now 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 labor to maximize utility. No labor is supplied on the second period of life. The government levies a tax upon labor 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 to operate. The first is that corrupt consumers can collaborate with tax collectors to reduce the effective tax rate that they face. The second is that the corrupt can also appropriate part of the tax revenue that is raised. The value of public good provision is then equal to tax revenue that is not appropriated plus the value of seigniorage. The government chooses the tax rate and the growth rate of money supply to maximize social welfare taking into account the corrupt activities.

6.1 Characterization of equilibrium

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

$$U^{h_i} = \sum_{i=0}^{1} \beta^i \left(\frac{C_t^{h_i}\left(t+i\right)^{1-\rho} - 1}{1-\rho} + \frac{G\left(t+i\right)^{1-\rho} - 1}{1-\rho} \right) + \frac{\left(1 - L_t^{h_i}(t)\right)^{1-\rho}}{1-\rho}, \tag{28}$$

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

$$\begin{aligned} C_t^{h_1}\left(t\right) + \frac{C_t^{h_1}\left(t+1\right)}{r\left(t\right)} &= \omega_t^{h_1}(t) L_t^{h_1}(t)\left(1 - \lambda_2 \tau\right) + \lambda_3 \frac{R\left(t\right)}{N_1(t)} \\ &\quad + \left[p^m\left(t\right) \bar{m}^{h_1}\left(t\right) - \frac{p^m\left(t+1\right)}{r\left(t\right)} \tilde{m}^{h_1}\left(t\right) \right], \end{aligned} \tag{29}$$

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, and λ_3 is the proportion of tax revenue appropriated by the corrupt. The budget constraint of non-corrupt consumer

h_2 is

$$C_t^{h_2}(t) + \frac{C_t^{h_2}(t+1)}{r(t)} = \omega_t^{h_2}(t) L_t^{h_2}(t)(1-\tau) + \left[p^m(t)\bar{m}^{h_2}(t) - \frac{p^m(t+1)}{r(t)}\tilde{m}^{h_2}(t)\right]. \quad (30)$$

The solution process of section 4 can be used to show that the quantity of saving at the stationary monetary equilibrium is

$$S(t) = \frac{S_{11} + S_{12} + S_{13}\lambda_3 \frac{R(t)}{N_1(t)}}{1 + S_{21} + S_{22}}, \quad (31)$$

where the terms S_{ij} (and other terms used in this section) are detailed in Appendix 2. The next step is to compute the level of revenue from taxation and seigniorage. The level of revenue at time t is

$$R(t) = \sum_{h_1=1}^{N_1(t)} \omega_t^{h_1}(t)\lambda_2 \tau L^{h_1}(t) + \sum_{h_2=1}^{N_2(t)} \omega_t^{h_2}(t)\tau L^{h_2}(t) + (1-\lambda_1)\gamma_1 \left(\frac{\mu-1}{\mu}\right) S(t). \quad (32)$$

The labour supply functions and the solution for saving (31) can be substituted into (32) and the resulting equation solved to give the level of revenue $R(t)$ in terms of underlying parameters. Taking the appropriation of tax revenue by the corrupt into account the level of public good is

$$G(t) = [1-\lambda_3] R(t). \quad (33)$$

The objective function of the government is assumed to be the maximization of social welfare. The tax rate and the rate of monetary growth are chosen to maximize social welfare. Denoting the welfare weights of the corrupt and the non-corrupt by μ^1 and μ^2 respectively, the government optimization is

$$\max_{\{\tau,\mu\}} W = \sum_{h_1=1}^{N_1(t)} \mu^1 U^{h_1} + \sum_{h_2=1}^{N_2(t)} \mu^2 U^{h_2}. \quad (34)$$

6.2 Analysis

The previous sub-section has characterized the stationary monetary equilibrium of the economy. We 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 analysis is undertaken by making one additional simplification. We 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. Under the assumption of an identical wage the provision level of the public good is

$$G(t) = [1-\lambda_3] \frac{N_1(t)\omega\lambda_2\tau R_{11} + N_2(t)\omega\tau R_{13} + \left[\frac{S_{11}+S_{12}}{1+S_{21}+S_{22}}\right](R_{141} - R_{142} - R_{143})}{1 - R_{12} - \frac{S_{13}\lambda_3 R_{14}}{1+S_{21}+S_{22}}}. \tag{35}$$

The first table 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 3. 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 relies 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.

	λ_1				
	0.15	0.20	0.25	0.30	0.35
$\hat{\tau}$	0.5056	0.5010	0.4990	0.4987	0.4995
$\hat{\mu}$	1.5007	1.5700	1.6170	1.6489	1.6702

Table 5: Increased appropriation of newly issued money ($\lambda_2 = 0.50$, $\lambda_3 = 0.45$)

The second table shows that there is a non-montonicity in the relationship of the tax rate to λ_2 (recall that a lower λ_2 implies a greater reduction in the tax rate, so lower λ_2 is interpreted as more corruption). The relationship with λ_3 is monotonic. An increase in λ_3 (more tax revenue is stolen, so greater corruption) means that the tax rate has to rise to offset this effect.

				λ_3		
		0.3	0.35	0.4	0.45	0.5
	0.4	0.4614	0.4722	0.4834	0.4949	0.5068
	0.45	0.4599	0.4717	0.4839	0.4966	0.5098
λ_2	0.5	0.4584	0.4712	0.4847	0.4988	0.5134
	0.55	0.4569	0.4710	0.4859	0.5015	0.5181
	0.6	0.4555	0.4710	0.4875	0.5052	0.5242
	0.65	0.4534	0.4714	0.4899	0.5100	0.5319

Table 6: Effect of parameters on $\hat{\tau}$ ($\lambda_1 = 0.3$)

The third table shows the effect on the 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 increases inflation. Similarly, an increase in λ_3 - more tax revenue appropriated - means that the rate of monetary expansion increases for low λ_2 but rises for high λ_3. So, an increase in either of these forms of corruption may increase inflation. The outcome is dependent on the parameter values. Figure 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	1.6576	1.6601	1.6629	1.6661	1.6697
	0.45	1.6510	1.6527	1.6548	1.6572	1.6600
	0.50	1.6452	1.6460	1.6472	1.6487	1.6508
	0.55	1.6399	1.6399	1.6402	1.6407	1.6416
	0.60	1.6352	1.6343	1.6335	1.6328	1.6325
	0.65	1.6310	1.6290	1.6270	1.6251	1.6232

Table 7: Effect of parameters on $\hat{\mu}$ ($\lambda_1 = 0.3$)

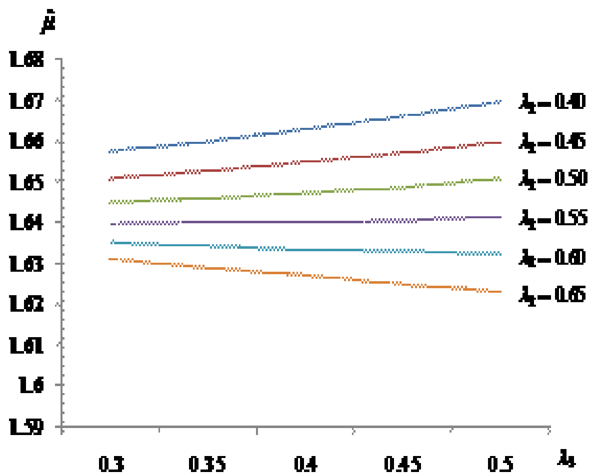

Figure 1: Effect of tax revenue appropriation

The next set of figures show the effect of changing ρ, the coefficient of relative risk aversion upon the tax rate and the rate of growth of money supply. There are many economic models where the outcome can qualititatively change between the cases of $\rho < 1$ and $\rho > 1$. The figures show that this is not the case in our model of corruption. Figure 2 shows that the optimal tax rate increases with the amount of corruption in revenue theft but has a non-monotonic relation to ρ. Figure 3 shows that the optimal growth rate of money supply increases in ρ. This figure is only plotted for $\lambda_3 = 0.4$ because the effect of changing λ_3 on $\hat{\mu}$ is a magnitude smaller than the effect of changing ρ.

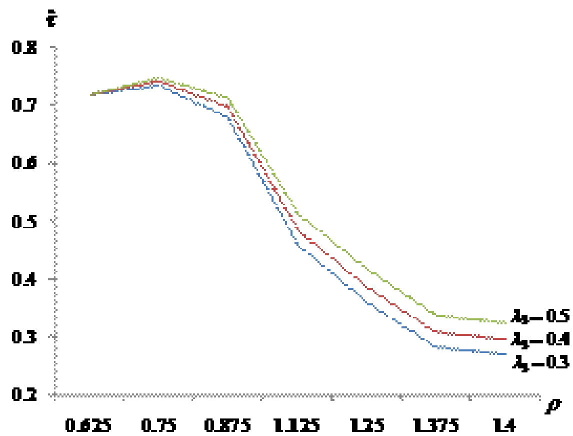

Figure 2: Optimal tax rate

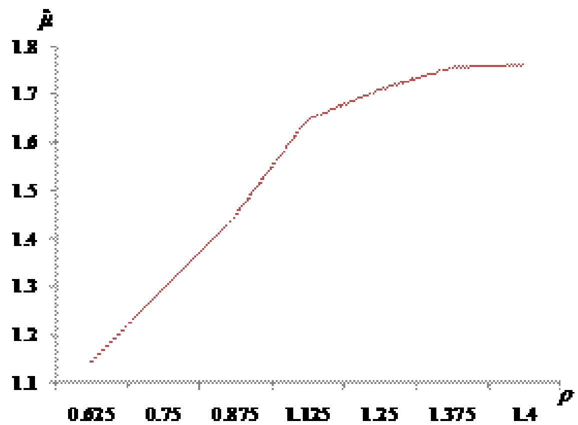

Figure 3: Growth rate of money supply

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 a recommendation for policy. In this economy GDP at time t is given by

$$Y = \sum_{h_1=1}^{N_1(t)} w^{h_1} L^{h_1}(t) + \sum_{h_2=1}^{N_2(t)} w^{h_2} L^{h_2}(t). \tag{36}$$

Figure 4 shows that GDP decreases as 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 labor supply whereas welfare is also dependent on the level of public good. An 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.

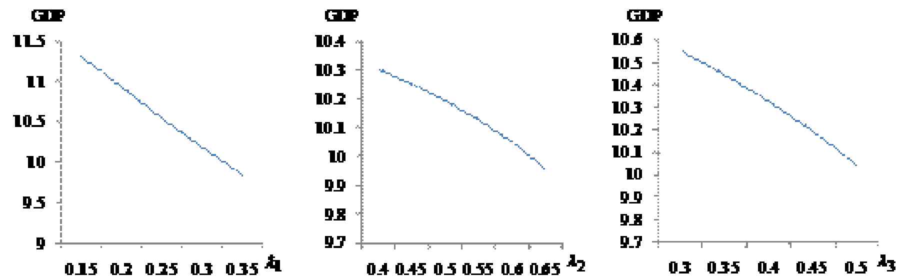

Figure 4: Corruption and GDP

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.

7 Conclusions

There is a significant empirical correlation between corruption and inflation that. In contrast, there is no theoretical explanation of how this correlation can arise. There have been suggestions that it can be a consequence of seigniorage but no demonstration that this can be the case. This paper 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.

We have set our analysis of corruption and inflation in an overlapping generations economy in which money acts as a store of value. Two different versions of the model were used. 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 the money held 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 in this model was equal to the transfer of consumption good 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 labor 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 labor 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 reduces the level of GDP. This finding agrees with the usual perspective on the effects of corruption.

The paper has provided a theoretical analysis that is in agreement with the empirical literature. 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.

Appendix

Appendix 1: Freedom From Corruption Index

The Freedom From Corruption (FFC) index by the Heritage Foundation is derived primarily from data provided by Transparency International (TI) Corruption Perception Index (CPI). The CPI focuses on corruption in the public sector, or corruption which involves public officials, civil servants or politicians. For the purpose of the index corruption is the abuse of entrusted power for private gain

The CPI draws on 17 data sources from 13 institutions. The data sources used to compile the index include questions relating to the abuse of public power and focus on: bribery of public officials, kickbacks in public procurement, embezzlement of public funds, and on questions that probe the strength and effectiveness of anti-corruption efforts in the public sector.

The CPI is based on a 10-point scale. The FFC converts the raw CPI data to a scale of 0 to 100 by multiplying the CPI score by 10. Consequently, a higher level of corruption implies a lower score on the FFC.

Appendix 2: Details of expressions

The expressions used in Section 6 are as follows:

$$S_{11} = \sum_{h_i=1}^{N_1(t)} \left[\frac{\omega_t^{h_1}(t)(1-\lambda_2\tau)\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}}r(t)^{\frac{1-\rho}{\rho}}+[\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \right],$$

$$S_{12} = \sum_{h_i=1}^{N_2(t)} \left[\frac{\omega_t^{h_2}(t)(1-\tau)\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}} r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}} \right]$$

$$S_{13} = \sum_{h_i=1}^{N_1(t)} \left[\frac{\beta^{\frac{1}{\rho}} r(t)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}} r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \right]$$

$$S_{21} = \sum_{h_i=1}^{N_1(t)} \left[\frac{1+[\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}}{1+\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_1}(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}} \right] \left[\frac{(1-\lambda_1)(\mu-1)\left(\frac{\gamma_2}{\mu}+\gamma_3\right)}{N(t)} + \frac{\lambda_1(\mu-1)}{\mu N_1(t)} \right]$$

$$S_{22} = \sum_{h_i=1}^{N_2(t)} \left[\frac{1+[\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}}{1+\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}} \right] \left[\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu N(t)} + \frac{(1-\lambda_1)\gamma_3(\mu-1)}{N(t)} \right]$$

$$R_{11} = \frac{1+\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}}$$

$$R_{12} = \frac{\omega\lambda_2\tau[\omega(1-\lambda_2\tau)]^{-\frac{1}{\rho}}\lambda_3}{1+\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}}$$

$$R_{13} = \frac{1+\beta^{\frac{1}{\rho}} r(t)^{\frac{1-\rho}{\rho}}}{1+\beta^{\frac{1}{\rho}} r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}}$$

$$R_{141} = \frac{(1-\lambda_1)\gamma_1(\mu-1)}{\mu}$$

$$R_{142} = \frac{N_1(t)\omega\lambda_2\tau[\omega(1-\lambda_2\tau)]^{-\frac{1}{\rho}}\left[\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu N(t)} + \frac{\lambda_1(\mu-1)}{\mu N_1(t)} + \frac{(1-\lambda_1)\gamma_3(\mu-1)}{N(t)}\right]}{1+\beta^{\frac{1}{\rho}}\left(\frac{1}{\mu}\right)^{\frac{1-\rho}{\rho}} + [\omega(t)(1-\lambda_2\tau)]^{\frac{\rho-1}{\rho}}}$$

$$R_{143} = \frac{N_2(t)\omega\tau[\omega(1-\tau)]^{-\frac{1}{\rho}}\left[\frac{(1-\lambda_1)\gamma_2(\mu-1)}{\mu N(t)} + \frac{(1-\lambda_1)\gamma_3(\mu-1)}{N(t)}\right]}{1+\beta^{\frac{1}{\rho}} r(t)^{\frac{1-\rho}{\rho}} + [\omega_t^{h_2}(t)(1-\tau)]^{\frac{\rho-1}{\rho}}}$$

Appendix 3: Parameter values

The baseline values of the parameters for the simulation are given in the table.

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	1.125	0.75	0.7	0.1	0.2	1	0.3	0.45	0.5

Table A1: Parameter values

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