Chapter 1

Introduction

1.1 Introduction

This thesis comprises of six independent papers, besides the introduction and conclusions, with the common theme of optimal public policies in dynamic general equilibrium models with different kinds of distortions. Broadly speaking, the issues considered are: tax evasion, bureaucratic corruption, costs of tax collection and endogenous probability of survival.

The objective of this thesis is to provide the theoretical underpinnings behind the design of optimal fiscal and monetary policies under tax evasion, bureaucratic corruption, costs of tax collection and endogenous probability of survival. With each of the models based on proper microfoundations and calibrated to match features of developing economies, the six independent papers attempt to broaden our understanding on public policies in the presence of commonly observed distortions that characterize the developing world.

The first paper analyzes whether financial repression can be explained by endogenous tax evasion. In this regard the chapter develops two dynamic monetary general equilibrium endogenous growth models. When calibrated to four southern European countries, we indicate that higher degrees of tax evasion emanating from higher corruption and lower penalty rates would result in financial repression as an welfare-maximizing outcome.

The second paper develops an overlapping generations monetary endogenous growth model characterized by tax evasion, and analyzes the effect of the nature of tax evasion on the growth maximizing policies. It is concluded that a growth-maximizing government has to take the behavioral nature of tax evasion into account, since failure to do so will lead to misalignment in not only fiscal but also monetary policies. In fact, the government is found to repress the financial sector more than the optimal level if it treats tax evasion as exogenous.

The third paper develops a dynamic general equilibrium overlapping generations monetary endogenous growth model of a financially repressed small open economy characterized by bureaucratic corruption, and uses it to analyze optimal policy decisions of the government following an increase in the degree of corruption. We find that increases in the degree of corruption should ideally result in a fall in seigniorage, as an optimal response of the benevolent government. In addition, higher degrees of corruption should also be accompanied with lower levels of financial repression.

The fourth paper develops a production-economy overlapping generations model characterized by financial repression, purposeful government expenditures and costly tax collection, to analyze whether financial repression can be explained by the cost of raising taxes. It is shown that costs of tax collection cannot produce a monotonic increase in the reserve requirements, what are critical, in this regard, are the weights the consumer assigns to the public good in the utility function and the size of the government.

The fifth paper analyzes the same issues as in the fourth paper, but in a monetary endogenous growth model framework. We show that higher costs of tax collection produce a monotonic increase in reserve requirements. Moreover, the government tends to rely more on indirect taxation, compared to direct taxation as costs of tax collection increase.

The last paper develops a simple monetary pure-exchange two-period overlapping generations model characterized by financial repression and endogenous mortality. The probability of survival of the young agents is assumed to depend upon the share of government expenditure on health, education and infrastructure. In this setting, we analyze the welfare-maximizing policy mix between explicit and implicit taxation for a benevolent government. We show that increases in the survival probability leads to an increase in the reliance on seigniorage as a welfare maximizing outcome. However, for our results to hold, the seigniorage tax base must be large enough for the benevolent planner to use the inflation tax.

The main contribution of this thesis lies in its contribution to the literature on the issues considered. It provides extensions to the literature in ways that have never been done before.

Chapter 2

Tax Evasion and Financial Repression: A Reconsideration Using Endogenous Growth Models

2.1 Introduction

Using two dynamic monetary general equilibrium models characterized by endogenous growth, financial repression and endogenously determined tax evasion, we analyze whether financial repression can be explained by tax evasion, based on an overlapping generations framework. We follow Drazen (1989), Espinosa and Yip (1996), Haslag (1998), Gupta (2008a), and Gupta (2008b) among others, in defining financial repression through an obligatory "high" reserve deposit ratio requirement, that banks in the economy need to maintain. The study attempts to assess whether there exists a plausible explanation as to why the reserve requirements in some economies are higher than others. Specifically, we investigate whether financial repression is an optimal policy outcome in the presence of tax evasion.

Financial repression was originally coined by economists interested in less developed countries. McKinnon (1973) and Shaw (1973), in their seminal, but independent, contributions were the first to spell out the notion of financial repression, defining it as a set of government legal restrictions preventing the financial intermediaries in the economy from functioning at full capacity. Generally, financial repression consists of three elements. First, the banking sector is forced to hold government bonds and money through the imposition of high reserve and liquidity ratio requirements. This allows the government to finance budget deficits at a low cost. Second, given that the government revenue cannot be extracted easily from private securities, the development of private bond and equity markets is discouraged. Finally, the banking system is characterized by interest rate ceilings to prevent competition with public sector fund raising from the private sector and to encourage low-cost investment. Thus, the regulations generally include interest rate ceilings, compulsory credit allocation, and high reserve requirements. However, given the wave of interest rate deregulation in the 1980s, and removal of credit ceiling some years earlier, the major form of financial repression is currently via obligatory reserve requirements.[1] There is still widespread evidence of financial repression, as pointed out by Espinosa and Yip (1996). The authors indicate that the concern is not whether financial repression is prevalent, but the associated degree to which an economy is repressed, since both developed and developing countries resort to such restrictive practices.

The motivation for our analysis emanates from a recent paper by Gupta (2008b). In this paper, using a Solow-type overlapping generations framework, calibrated to four southern European countries, the author analyzed the relationship between tax evasion, determined endogenously, and financial repression. Gupta (2008b) showed that a higher degree of tax evasion within a country, resulting from a higher level

[1] See Demirgúç-Kunt and Detragiache (2001) for further details.

of corruption and a lower penalty rate, yields a higher degree of financial repression as a social optimum. However, a higher degree of tax evasion, due to a lower tax rate, reduces the severity of the financial restriction. In addition, a higher fraction of reported income, resulting from lower level of corruption or higher penalty rates, causes the government to inflate the economy at a higher rate. Money growth rate though, tends to fall, when an increase in the fraction of reported income originates from a fall in the tax rate.

At this juncture, it is important to put into perspective the study by Gupta (2008b) to better understand our motivation to extend the analysis. Besides, a whole host of other factors[2] , studies like Roubini and Sala-i-Martin (1995), Gupta (2005 and 2006) and Holman and Neanidis (2006), by building on the empirical works of Cukierman *et al.* (1992) and Giovannini and De Melo (1993), have outlined tax evasion as a possible rationale for financial repression. However, Gupta (2008b) points out that all the above mentioned theoretical analyses dealing with tax evasion and financial repression suffer from a serious problem, in the sense that they treat tax evasion as exogenous. The author stresses that the optimal degree of tax evasion is a behavioral decision made by the agents of the economy, and is likely to be affected not only by the structural parameters of the economy, but also the policy decisions of the government. Thus, all these models essentially suffer from the "Lucas Critique" as they treat tax evasion to be exogenous when ideally the same should have been determined endogenously in the model. It must be pointed out that all the above studies, looked at the optimal policy decisions of the government emanating from its welfare-maximizing objective following

[2]Other possible explanations as to why governments across the world would want to resort to financial repression has ranged from imperfect information and the possibility of banking crisis (Gupta (2005, 2006) to currency substitution (Gupta, 2008a).

an increase in the exogenous rate of tax evasion without specifying what is causing the change in the degree of evasion in the first place. Under such circumstances, the optimal choices made by the government are likely to be non-optimal, since the actual level of tax evasion changes as policy choices change once we realize that tax evasion is endogenous. Hence, once one determines which policy variables, besides the structural parameters, are affecting the degree of tax evasion, they cannot be available to the government for use to respond optimally to a change in the degree of tax evasion.

Our objectives in this paper are two-fold: First, given that tax evasion is endogenously determined, we want to see if the results of Gupta (2008b) continue to hold under the assumption of endogenous growth, with the endogeneity in the growth process obtained either via production externalities as in Romer (1986), or through productive public expenditures, as outlined in Barro (1990); The second of our objectives essentially follows from the fact that by incorporating a Barro-type model into our analysis, we are allowing for productive government expenditures , which in turn, when compared to the Romer-type model, would allow us to assess the differences between the two alternative scenarios regarding the productivity capabilities of public expenditures.

This paper thus, extends the work of Gupta (2008b), besides, Roubini and Sala-i-Martin (1995), Gupta (2005, 2006) and Holman and Neanidis (2006), by re-evaluating the results in the presence of endogenous tax evasion, as in Atolia (2003), Chen (2003) and Arana (2004), and endogenous growth. To the best of our knowledge, such an attempt to rationalize financial repression based on endogenously determined tax evasion with the economy growing endogenously in steady-state, is the first of its kind.

To validate our analysis, as in Gupta (2008b), the theoretical model is numerically analyzed by calibrating it to four southern European economies, namely, Greece, Italy, Portugal and Spain. It must, however, be noted that our model is a general one and can be applied to any economy subjected to tax evasion. Our choice of countries has been mainly due data availability. Moreover, it has been argued that the chosen countries have experience of underground economies and hence, tax evasion and high reliance on seigniorage through high inflation rates and reserve requirements (Schneider and Klinglmair (2004), Gupta, (2008b)).

This paper incorporates endogenous tax evasion in standard general equilibrium models of endogenous growth with overlapping generations. There are two primary assets in the model, namely, bank deposits and fiat money. Deposits dominate money in rate of return. An intermediary exists to provide a rudimentary pooling function, accepting deposits to finance the investment needs of the firms, but are subjected to mandatory cash-reserve requirements. There is also an infinitely-lived government with two wings: a Treasury which finances expenditure by taxing income and setting penalty for tax evasion when caught; and the central bank, which controls the growth rate of the nominal stock of money and the reserve requirements. In such an environment, we deduce the optimal degree of tax evasion, derived from the consumer optimization problem as a function of the parameters and policy variables of the model. The paper is organized as follows: Section 2 lays out the economic environment; Section 3, 4 and 5 respectively, are devoted to defining the monetary competitive equilibrium, discussing the process of calibration, and analyzing the welfare-maximizing choices of policy following an increase in tax evasion, resulting from either policy changes or alteration to a specific structural parameter of the model. Finally, Section 6 concludes.

2.2 Economic Environment

Time is divided into discrete segments, and is indexed by $t = 1, 2,$. There are four types of economic activities: (i) each two-period lived overlapping generations household (consumer/worker) is endowed with one unit of labor when young, but the agent retires when old. Thus, at time t, there are two coexisting generations of young and old. N people are born at each time point $t = 1$. At t =1, there exist N people in the economy, called the initial old, who live for only one period. The population, N, is normalized to 1. The young inelastically supplies one unit of the labor endowment to earn wage income, part of the tax-liability is evaded, with evasion being determined endogenously to maximize utility, and the rest of the income is deposited into banks for future consumption; (ii) each producer is infinitely lived and is endowed with a production technology to manufacture a single final good using the inelastically supplied labor, physical capital and credit facilitated by the financial intermediaries; (iii) the banks simply convert one period deposit contracts into loans after meeting the cash reserve requirements. No resources are assumed to be spent in running the banks, and (iv) there is an infinitely lived government which meets its expenditure by taxing income, setting penalties for tax evasion and controlling the inflation tax instruments -the money growth rate and the reserve requirements. There is a continuum of each type of economic agent with unit mass.

The sequence of events can be outlined as follows: When young a household works and receives pre-paid wages, evades a part of the tax burden and deposits the rest into banks. A bank, after meeting the reserve requirement, provides a loan to a goods producer, which subsequently manufactures the final good and returns the loan with interest. Finally, the banks pay back the deposits with interest to households at the end of the first period and the latter consumes in the second period.

2.2.1 Consumers

Each consumer possesses a unit of time endowment which is supplied inelastically, and consumes only when old. Formally, the problem of the consumer can be described as follows: The utility of a consumer born at t depends on real consumption, c_{t+1}, which implies that the consumer consumes only when old. This assumption makes computation tractable and is not a bad approximation of the real world (see Hall (1988)). Consumers have the same preferences, so there exists a representative consumer in each generation. The consumer is assumed to be risk averse.

For the potential evader, there are (ex ante) two possible situations: "success" (i.e getting away with evasion) and "failure" (i.e, getting discovered and being convicted). If the consumer is found guilty of concealing an amount of income $(1-\beta)p_t w_t$, then has to pay the amount of the evaded tax liability, $(1-\beta)\tau_t p_t w_t$ and a proportional fine at a rate of $\theta_t > 1$. Thus, the household incurs transaction costs in order to evade taxes. Such costs take the form of expenses of hiring lawyers to avoid/reduce tax burdens, and bribes paid to tax officials and administrators. The transaction costs are assumed to be increasing in both the degree of tax evasion and the wage income of the household.

They take the form $\eta(1-\beta)^2 p_t w_t$. A higher value of η, would imply a less corrupt economy, implying that it is more difficult to evade taxes. The probability of getting caught, $1-q$, is also endogenized by assuming it to be an increasing function of the degree of tax evasion. $1-q$ takes the following quadratic form:

$$1-q=(1-\beta)^2 \tag{1}$$

Formally, the consumer solves the following problem:

$$\frac{d}{d\beta}[\{1-(1-\beta)^2\}U(c^1_{t+1})+(1-\beta)^2U(c^2_{t+1})]=0 \tag{2}$$

where, c^1_{t+1} and c^2_{t+1} are the consumption levels when the consumer can evade taxes with success and failure, respectively, which can be described mathematically as follows:

$$c^1_{t+1} \;=\; (1+r_{Dt+1})[(1-\beta\tau_t)-\eta(1-\beta)^2]w_t \tag{3}$$

$$c^2_{t+1} \;=\; (1+r_{Dt+1})[(1-\beta\tau_t)-\theta_t\tau_t(1-\beta)-\eta(1-\beta)^2]w_t \tag{4}$$

where p_t is the price level at time t; w_t is the real wage at t and i_{Dt+1} is the nominal interest rate received on the deposits, d_t, at $t+1$. The respective sizes of household deposit when he or she successfully or unsuccessfully evades taxes are measured by $[(1-\beta\tau_t)-\eta(1-\beta)^2]w_t$ and $[(1-\beta\tau_t)-\theta_t\tau_t(1-\beta)-\eta(1-\beta)^2]w_t$ respectively. Thus, $d_t=[(1-\beta\tau_t)-\theta_t(1-\beta)^3-\eta(1-\beta)^2]w_t$ gives the size of the expected aggregate deposits in the economy, given that $N=1$. Finally, we assume a utility function of the following form, for i=1, 2:

$$U(c^i_{t+1})=\frac{(c^i_{t+1})^{(1-\sigma)}}{1-\sigma} \tag{5}$$

where U is twice differentiable; $u^{'}>0$; $u^{''}<0$ and $u^{'}(0)=\infty$.

2.2.2 Financial Intermediaries

Financial intermediaries provide a simple pooling function by accepting deposits at the beginning of each period. They then make their portfolio decision (that is, loans and cash reserve choices) with a goal of maximizing profits. At the end of the period they receive their interest income from the loans made and meet the interest obligations on deposits received. For simplicity bank deposits are assumed to be one period contracts. The intermediaries are constrained by legal reserve requirements on the choice of their portfolio (that is, reserve requirements), as well as by feasibility. Given such a structure, the intermediaries obtain the optimal choice for L_t by solving the following problem:

$$\max_{L,D} \Pi_b = i_{Lt}L_t - i_{Dt}D_t \tag{6}$$

$$s.t. : \gamma_t D_t + L_t \leqslant D_t \tag{7}$$

where Π_b is the profit function for the financial intermediary, and $M_t \geqslant \gamma_t D_t$ defines the legal reserve requirement. M_t is the cash reserves held by the bank; L_t is the loans; i_{Lt} is the interest rate on loans, and; γ_t is the reserve requirement ratio. The reserve requirement ratio is the ratio of required reserves (which must be kept in the form of currency) to deposits received. To gain some economic intuition of the effect of reserve requirements on the banking sector, let us consider the solution of the problem for a typical intermediary. It is assumed that financial intermediaries behave competitively and free entry drives profits to zero,

$$i_{Lt}(1-\gamma_t) - i_{Dt} = 0 \tag{8}$$

Simplifying, in equilibrium, the following condition must hold

$$i_{Lt} = \frac{i_{Dt}}{1-\gamma_t} \tag{9}$$

Reserve requirements thus tend to induce a wedge between the interest rate on savings and lending rates for the financial intermediaries.

2.2.3 Firms

All firms are identical and produce a single final good using the following production technologies:

$$y_t = Ak_t^{\alpha}(n_t\overline{k_t})^{(1-\alpha)} \tag{10}$$

$$y_t = Ak_t^{\alpha}(n_t g_t)^{(1-\alpha)} \tag{11}$$

where A > 0; 0$<$ $\alpha((1-\alpha)) < 1$, is the elasticity of output with respect to capital (labor), with k_t , n_t, g_t and $\overline{k_t}$[3] respectively denoting capital, labor, government expenditure and aggregate per capita capital stock inputs at time t. At time t the final good can either be consumed or stored. We assume that producers are able to convert bank loans L_t into fixed capital formation such that $p_t i_{kt} = L_t$, where i_t denotes the investment in physical capital. In each of the respective technologies the production transformation schedule is linear so that the same technology applies to both capital formation and the production of the consumption good and hence both investment and consumption good sell for the same price p_t. We follow Diamond and Yellin (1990) and Chen, Chiang and Wang (2000) in assuming that the goods producer is a residual claimer, that is, the producer uses up the unsold consumption good in a way which is consistent

[3] improves the efficiency of labor and hence serves as a positive production externality.

with lifetime value maximization of the firms. This assumption regarding ownership avoids the "unnecessary" Arrow-Debreu redistribution from firms to consumers and simultaneously retains the general equilibrium structure of the models.

The representative firm maximizes the discounted stream of profit flows subject to the capital evolution and loan constraints. Formally, the problem of the firm can be outlined as follows

$$\max_{k_{t+1},n_t} \sum_{i=0}^{\infty} \rho^i [p_t y_t - p_t w_t n_t - (1 + i_{Lt})L_t] \tag{12}$$

$$k_{t+1} \leqslant (1 - \delta_k)k_t + i_{kt} \tag{13}$$

$$p_t i_{kt} \leqslant L_t \tag{14}$$

$$L_t \leqslant (1 - \gamma_t)D_t \tag{15}$$

where ρ is the firm owners' (constant) discount factor, and δ_k is the (constant) rate of capital depreciation. The firm solves the above problem to determine the demand for labor and investment. The firm's problem can be written in the following respective recursive formulations:

$$V(k_t) = \max_{n,k'}[p_t Y_{t1} - p_t w_t n_t - p_t(1 + i_{Lt})(k_{t+1} - (1 - \delta_k)k_t)] + \rho V(k_{t+1}) \tag{16}$$

$$V(k_t) = \max_{n,k'}[p_t Y_{t2} - p_t w_t n_t - p_t(1 + i_{Lt})(k_{t+1} - (1 - \delta_k)k_t)] + \rho V(k_{t+1}) \tag{17}$$

$$Y_{t1} = Ak_t^{\alpha}(n_t\overline{k_t})^{(1-\alpha)}$$

$$Y_{t2} = Ak_t^{\alpha}(n_t g_t)^{(1-\alpha)}$$

The upshot of the above dynamic programming problems are the following respective first order conditions.

$$k_{t+1} \quad : \quad (1+i_{Lt})p_t = p_{t+1}\rho[A\alpha + (1-\delta_k)(1+i_{Lt+1})] \tag{18}$$

$$(n_t) \quad : \quad A(1-\alpha)k_t = w_t \tag{19}$$

$$k_{t+1} \quad : \quad (1+i_{Lt})p_t = \rho p_{t+1}[A\alpha(\frac{g_{t+1}}{k_{t+1}})^{1-\alpha} + (1+i_{Lt+1})(1-\delta_k)] \tag{20}$$

$$(n_t) \quad : \quad A(1-\alpha)(\frac{g_t}{k_t})^{(1-\alpha)}k_t = w_t \tag{21}$$

Equations (18) and (20) provide the conditions for the optimal investment decisions of the firm. The firm compares the cost of increasing investment in the current period with the future stream of benefits generated from the extra capital invested in the current period. And equations (19) and (21) state that the firm hires labor up to the point where the marginal product of labor equates the real wage.

2.2.4 Government

The government is assumed to be infinitely-lived. It purchases g_t units of the consumption good. In the Romer-type model government expenditure is non-productive, while, in the Barro-type model government expenditures are productive to the agents. Government expenditures are financed through income taxation, penalty rate and seigniorage. In real per-capita terms the government budget constraint can be written as follows:

$$g_t = [\beta + (1-q)\theta_t(1-\beta)]\tau_t w_t + \gamma_t d_t(1 - \frac{1}{\mu_t}) \tag{22}$$

Skinner and Slemrod (1985) point out that the administrative costs of penalties are usually quite minor, and hence, for simplicity we ignore them from the government budget constraint. However, the costs involved in auditing the households have been ignored due to the unavailability of information on such costs for our sample of countries. But adding an extra dimension of cost merely implies an increase in the public expenditures and an inflated level of the policy parameters without qualitatively changing our results.

2.3 Equilibrium

A competitive equilibrium for this economy is a sequence of prices $\{p_t, i_t, i_{Lt}\}_{t=0}^{\infty}$, allocations $\{c_{t+1}^1, c_{t+1}^2, n_t, i_{kt}\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t, d_t\}_{t=0}^{\infty}$, and policy variables $\{\gamma_t, \mu_t, \tau_t, \theta_t, g_t\}_{t=0}^{\infty}$ such that:

- τ_t, g_t, θ_t, γ_t, μ_t, p_t, r_{Dt+1} and w_t, the consumer optimally chooses β such that (2) holds;
- Banks maximize profits, taking i_{Lt}, i_{Dt}, and γ_t as given such that (9) holds;
- The real allocations solve the firm's date–t profit maximization problem, given prices and policy variables, such that (18), (19), (20) and (21) hold;
- The money market equilibrium conditions: $m_t = \gamma_t d_t$ is satisfied for all $t \geqslant 0$;
- The loanable funds market equilibrium condition: $p_t i_{kt} = (1 - \gamma_t) D_t$ where the total supply of loans $L_t = (1 - \gamma_t) D_t$ is satisfied for all $t \geqslant 0$;
- The goods market equilibrium condition require: $c_t + i_{kt} + g_t = y_t - \eta(1 - \beta)^2 w_t$ is satisfied for all $t \geqslant 0$;
- The labor market equilibrium condition: $(n_t)^d = 1$ for all $t \geqslant 0$;

- The government budget is balanced on a period-by-period basis;

- d_t, r_{dt}, r_{Lt}, and p_t must be positive at all dates.

2.4 Calibration

In this section, we attribute parameter values to our model by using a combination of figures from previous studies and facts about the economic experience for our sample economies between 1980 and 1998. We follow standard real business cycle literature in using steady-state conditions to estimate parameter values observed in the data. Some parameters are calibrated using country-specific data, while others correspond to prevailing values from the literature. The calibrated parameters are reported in Table 1. A first set of parameter values is given by numbers usually found in the literature. These are:

- σ: the degree of risk aversion, as stated above, is set to 2;

- α: since the production function is Cobb-Douglas, this corresponds to the share of capital in income. The values of $(1-\alpha)$ for all the countries were obtained from Gupta (2008b). The values of α lie between 37.3 percent (Spain) and 47 percent (Portugal);

- δ_k: the depreciation rate of physical capital was also obtained from Gupta (2008b). The values lie between 3.2 percent (Greece) and 5.2 percent (Italy);

- θ: the penalty imposed by the government when the consumer is caught evading is obtained from Chen (2003) and is set to 1.5 for all countries.

- χ: the gross growth rate for each country. Values for all the countries were obtained from Gupta (2008b). The net growth rate values lie between 1.86 percent (Greece) and 2.95 percent for Portugal;

- γ: the annual reserve-deposit ratio as a percentage. The values lie between 13.7 percent (Italy) and 23.5 percent (Greece);

- τ: tax rate, calculated as the ratio of tax receipts to gross domestic product. The values lie between 22.74 percent (Greece) and 36.25 percent (Italy);

- π: the annual rate of inflation. It lies between 7.52 percent (Spain) and 15.16 percent (Greece);

- i_{Lt}: the nominal interest rate on loans. The values lie between 12.89 percent (Spain) and 22.96 percent (Greece);

- β: the fraction of reported income. The values lie between 0.775 (Greece) and 0.81 (Spain and Portugal);

- λ: the discount factor expressed at an annual rate. It was obtained from Chari et al. (1995) and is set to 0.98 for all countries.

Table 1: **Parameters Values (Gupta, 2008)**

	α	δ_k	π	γ	τ	i_L	β	χ
Spain	0.373	0.05	7.52	14.1	25.53	12.89	0.810	1.0254
Italy	0.383	0.052	8.58	13.7	36.25	15.02	0.786	1.0193
Greece	0.402	0.032	15.16	23.5	22.74	22.96	0.775	1.0186
Portugal	0.470	0.05	13.04	19.8	27.73	19.09	0.810	1.0295

Note: Parameters defined as above.

with σ=2, θ=1.5, and λ=0.98 (Chari et al. (1995,1996))

A second set of parameters are calibrated from the steady-state equations of the models to make them hold exactly: These parameters are:

- μ: the gross money growth rate is calibrated using the growth rate and the inflation rate for each country. The value lies between 1.1030 (Spain) and 1.1730 (Greece);

- η: the cost parameter measuring the resources spent by the households to reduce their tax burden is calibrated to ensure that the degree of tax evasion matches the given values of $1 - \beta$. The value lies between 0.3751 (Greece) and 0.6270 (Italy). These values are obtained based on the second root out of the six.[4] For the other roots, we could not obtain fractional values[5] of η, required to ensure that the degree of tax evasion corresponds to our calculations made above. As a result, based on our choice of η, we eliminate the other five roots.

- ρ: the discount factor of the firms is solved to ensure that equations (18) and (20) hold in both the models for each country. The value ranges between 0.8439

[4] Not presented to save space, details can be made available on request.
[5] Either none or imaginary values were obtained for η from the other roots.

(Portugal) and 0.9209 (Spain) for the Romer-type model. While, the same ranges between 0.8540 (Portugal) to 0.9205 (Spain);

- A: the value of the production function scalar, is calibrated from the equilibrium conditions to match the growth rates and the inflation rates for each country. The value lies between 0.1381 (Spain and Greece) in the Romer-type model and 0.2490 (Portugal). While, for the Barro model the same ranges between 1.4285 (Portugal) and 1.8346 (Spain);

- b: the government expenditure to capital ratio, is calibrated from the government budget constraint. The value lies between 0.0172 (Greece) and 0.0363 (Italy) for the Romer-type model, while, the same value ranges between 0.0174 (Greece) to 0.0364 (Italy) for the Barro-type model.

Table 2: **Calibrated Parameters Values**

	η	μ	A		ρ		b	
			Romer	Barro	Romer	Barro	Romer	Barro
Spain	0.5372	1.1030	0.1381	1.8346	0.9209	0.9205	0.0250	0.0250
Italy	0.6270	1.1070	0.1966	1.5210	0.9087	0.9085	0.0363	0.0364
Greece	0.3751	1.1730	0.1381	1.5785	0.8571	0.8566	0.0172	0.0174
Portugal	0.5934	1.1640	0.2490	1.4285	0.8439	0.8540	0.0328	0.0286
Note: Parameters defined as above.								

2.5 Welfare-Maximizing Monetary Policy in the Presence of endogenous Tax Evasion

In this section, we analyze whether a higher degree of tax evasion would result in an increase in the degree of financial repression within a specific country. For this purpose, we study the behavior of a social planner who maximizes the utility of all consumers, by choosing γ and μ, subject to the set of inequality constraints: $0 \leq \gamma \leq 1$, $\mu \geq 0$ and the government budget constraint, equation (22), evaluated at the steady state, following changes in β^*. The social planner maximizes the discounted stream of life-time consumer utility, specifically with the discount rate $0<\lambda<1$, $\sum_{i=0}^{\infty} \lambda^i[-\{1-(1-\beta)^2\}\frac{1}{(c^1_{t+1+i})} - (1-\beta)^2\frac{1}{(c^2_{t+1+i})}]$, given that $\sigma = 2$.

First, we derive the optimal values of γ and μ for the steady-state values of $\beta = \beta^*$. These are reported in Tables 3 and 4. Next, we analyze the movements of the optimal values of monetary policy parameters, following a one percentage point increase in β^* solely due to a change in either η or τ or θ, as three separate cases. For this purpose, the values of η, τ and θ were re-calibrated, but are not reported in this paper. The optimal values of the monetary policy variables, corresponding to $\beta = \beta^*$ and $\beta^* + 0.01$,

Table 3: **Optimal Monetary Policy Parameters in the Romer-type Model**

	β^*		$(\beta^* + .01)$		$(\beta^* + .01)$		$(\beta^* + .01)$	
				(η)		(θ)		(τ)
	γ	μ	γ	μ	γ	μ	γ	μ
Spain	0.6582	2.1019	0.6575	2.0929	0.6577	2.0930	0.6670	2.1075
Italy	0.6127	2.1229	0.6112	2.1041	0.6120	2.0559	0.6265	2.2280
Greece	0.7012	1.0520	0.6818	1.0500	0.6626	1.0500	0.7497	1.0700
Portugal	0.6974	1.0744	0.6967	1.0600	0.4993	1.0500	0.7044	1.0808
Note: Parameters defined as above.								

Table 4: **Optimal Monetary Policy Parameters in the Barro-type Model**

	β^*		$(\beta^* + .01)$		$(\beta^* + .01)$		$(\beta^* + .01)$	
			(η)		(θ)		(τ)	
	γ	μ	γ	μ	γ	μ	γ	μ
Spain	0.7699	3.6663	0.7697	3.6556	0.7698	3.6516	0.7735	3.7585
Italy	0.9007	2.9619	0.8993	2.8908	0.9001	2.8975	0.9137	3.7991
Greece	0.7644	3.3393	0.7641	3.3314	0.7616	3.2784	0.7669	3.3959
Portugal	0.8960	3.8049	0.8956	3.7133	0.8935	3.4981	0.9049	4.9615
Note: Parameters defined as above.								

arising solely due to a change in either η or τ or θ, are also reported in Tables 3 and 4.[6]

The following inferences can be drawn based on the results reported in Tables 3 and 4:

- In the Romer-type model, a one percentage point increase in the reported income, emerging from an increase in η and θ, causes the optimal value of the reserve requirement (γ^*) and the optimal money growth rate (μ^*) to fall, for all the countries. However, when the increase in the reported income is due to a fall in the tax rate, γ^* and μ^* rise;

[6]Note, the model does not analyze the possibility of transitional dynamics following a change in β^*. Here, we are merely interested in figuring out the movements of μ and γ following a change in the value of β^* across steady-states.

- Similar movements of the optimal reserve requirement (γ^*) and the optimal money growth rate (μ^*) are observed for all the countries in the Barro-type model with productive public expenditures;

- Thus, a higher degree of tax evasion, (a fall in β^*) does imply higher level of financial restrictions for all countries, irrespective of whether government expenditure is productive or not;

In summary, when compared to Gupta (2008b), our results regarding the movement of the reserve requirement is identical. Specifically, we conclude that irrespective of whether we have no-growth or positive-growth in steady-state, a higher degree of tax evasion within a country due to a higher level of corruption or lower penalty rates, leads to a higher degree of financial repression. However, a higher degree of tax evasion due to a higher tax rate leads to a reduction in the severity of financial restriction. The difference with Gupta (2008b), however, lies in the movement of the money growth rate, and, hence inflation. Interestingly, the movements are exactly the opposite, i.e., unlike Gupta (2008b), money growth rate moves in the same direction as that of the reserve requirements following changes in the degree of tax evasion arising out of changes in the penalty rate, the degree of corruption or the tax rate.

At this stage, it is important to compare our results with that of the work done by Roubini and Sala-i-Martin (1995). The authors pointed out that governments subjected to large tax evasion will "choose to increase seigniorage by repressing the financial sector and increasing the inflation rates." In our case though, this result only holds if the increase in the degree of tax evasion results from a lower penalty rate or higher level of corruption, i.e., smaller fraction of resources is needed to be spent to evade tax. Hence, our analysis points out the importance of modeling tax evasion as an endogenous decision. It is also important to stress that our paper is more comparable to that of the Roubini and Sala-i-Martin (1995) analysis, relative to Gupta (2008b), since we, like Roubini and Sala-i-Martin (1995) base our conclusions on an endogenous growth model. Hence, our study should be viewed as an analysis which qualifies the work of Roubini and Sala-i-Martin (1995) by pointing out that higher tax evasion leads to higher financial repression and inflation only under certain conditions.

2.6 Conclusions

Using two overlapping generations dynamic general equilibrium endogenous monetary growth models, we analyze the relationship between tax evasion, determined endogenously, and financial repression. Following the broad literature, we define financial repression through an obligatory "high" reserve deposit ratio requirement. The study attempts to assess whether there exists a plausible explanation as to why the reserve requirements in some economies are higher than others. Specifically, we analyze whether the "high" reserve requirements are a fall out of a welfare maximizing decision of the government, in an economy characterized by endogenous tax evasion.

When numerically analyzed for four southern European countries, the following conclusions could be drawn: (i) Higher degree of tax evasion within a country, resulting from lower penalty rates and higher corruption, produces socially optimum higher degrees of financial repression, i.e., a higher value of the reserve requirement. However, higher degrees of tax evasion, due to higher tax rates, tend to reduce the optimal degree of financial repression; (ii) Higher fraction of reported income, resulting from lower level of corruption or higher penalty rates, causes the government to inflate the economy at a lower rate. Money supply growth, however, tends to rise, when an increase in the fraction of reported income originates from a fall in the tax rate, and; (iii) Finally, the results are robust across growth models with or without productive public expenditures. The only difference being that the policy parameters have higher optimal values in the latter case.

In summary, from a policy perspective, the model suggests that, an increase in the degree of evasion within the country, resulting from lower penalty rates or higher corruption, should be followed by an increase in the reserve requirements and an increase in the money growth rate as part of a welfare maximizing behavior of the consolidated government. However, higher tax evasion due to higher tax rates, causes the growth rate of money supply and the reserve requirement to fall. Our paper, thus, concludes that there exists asymmetries in optimal monetary policy decisions, depending on what is causing a change in the degree of tax evasion. More importantly though, tax evasion and financial repression are positively correlated, if and only if, the change in the former results from an alteration in the penalty rate or the level of corruption. In addition, by extending the analysis of Gupta (2008b), this paper also shows that irrespective of whether we have no-growth or positive- growth in steady-state, higher degree of tax evasion within a country due to a higher level of corruption and a lower penalty rate can lead to higher degrees of financial repression. These results, in turn, also refine the work of Roubini and Sala-i-Martin (1995), who claimed that higher degrees of tax evasion always accompany higher levels of financial repression and inflation. As we show here, this result is contingent upon identifying what is causing the tax evasion to change, and is not always an obvious outcome.

Chapter 3

Misalignment in the Growth-Maximizing Policies under Alternative Assumptions of Tax Evasion

3.1 Introduction

Using an overlapping generations monetary endogenous growth model, we analyze the possible misalignment in the growth-maximizing fiscal and monetary policies, if tax evasion is assumed to be exogenous instead of being treated as a behavioral decision of the agents, and hence, determined endogenously.

The motivation for our analysis emanates from two categories of study dealing with optimal policy decisions under tax evasion. The first group of studies, such as Roubini and Sala-i-Martin (1995), Gupta (2005, 2006), Holman and Neanidis (2006), analyzes the optimal mix of fiscal and monetary policies under tax evasion. However, these studies treat tax evasion as an exogenous fraction of income that is not reported for taxation. The second group of studies, for example Gupta (2008b) and Gupta and Ziramba (2008a) points out that all the above mentioned analyses suffer from the

"Lucas Critique" in the sense, that they treat tax evasion as exogenous.[1] The authors stress that the optimal degree of tax evasion is a behavioral decision made by the agents of the economy, and is likely to be affected by not only the structural parameters of the economy, but also the policy decisions of the government. Given that the first group of studies looked at the optimal policy decisions of the government following an increase in the exogenous rate of tax evasion without specifying what is causing the change in the degree of evasion in the first place. The optimal policy choices made by the government are likely to be non-optimal. This is simply because the degree of tax evasion, following such policy choices, would have changed the actual level of the tax evasion further, once one realizes that tax evasion is endogenous. The second group of studies, thus, looks at the optimal monetary policy responses of the government following a change in the degree of tax evasion resulting from changes in structural parameters, and policy variables such as the tax and penalty rates.

In this paper, using a framework similar to Atolia (2007), Chen (2003) and Gupta and Ziramba (2008a), we study the difference in the size of growth-maximizing policies, both fiscal and monetary, that would arise if the government treats tax evasion as exogenous when ideally it should have been considered to be endogenous. To put it differently, by allowing the growth process to be determined endogenously, resulting from productive public expenditures, we point out to the possible misalignment in the growth-maximizing policies under alternative assumptions regarding the formulation structure of tax evasion. To the best of our knowledge, this is the first attempt to

[1]With regard to endogenous tax evasion, four other studies that deserve mentioning are Lin and Yang (2001), Chen (2003), Arana (2004) and Atolia (2007). All these studies looked into the impact of tax evasion on economic growth, also determined endogenously either due to production externalities, productive public expenditures or due to the role of human capital.

highlight the difference between growth-maximizing (optimal) policies under exogenous and endogenous tax evasion. Thus far, the literature has mainly considered the effects of tax rates, penalty rates and probability of monitoring on the degree of tax evasion, we, however, by allowing for government transfers and hence, a role for monetary policy besides fiscal policy, in the determination of the agents' reported income, extend the previous set of studies.

The remainder of the paper is organized as follows: Section 2 lays out the economic environment and solution of the model. Section 3 defines the competitive equilibrium, while Section 4 discusses the growth-maximizing policy choices. Section 5 concludes.

3.2 Economic Environment

Time is divided into discrete segments, and is indexed by t= 1, 2,..........,∞. There are four types of economic activities: (i) each two-period lived overlapping generations household (consumer/worker) is endowed with one unit of labor when young, but the agent retires when old. Thus, at time t, there are two coexisting generations of young and old. N people are born at each time point t. At t =1, there exist N people in the economy, called the initial old, who live for only one period. The population, N, is normalized to 1. The young inelastically supplies one unit of the labor endowment to earn wage income, part of the tax-liability is evaded, with evasion being determined endogenously to maximize utility and the rest of the income is invested in firms via the banks, for future consumption; (ii) the banks operate in a competitive environment and perform a pooling function by collecting the deposits from the consumers and lending them out to the firms after meeting an obligatory cash reserve requirements;

(iii) each producer is infinitely lived and is endowed with a production technology to manufacture a single final good using the inelastically supplied labor and physical and public capitals; (iv) there is an infinitely lived government which meets its expenditure by taxing income, seigniorage and setting penalty for tax evasion for those who are caught. There is a continuum of each type of economic agent with unit mass.

3.2.1 Consumers

Consumers have the same preferences so that there exists a representative consumer in each generation. Each consumer of generation t possesses a unit of labor when young. This unit of labor is supplied inelastically to the firms and is paid a wage rate w_t. In period $t+1$, when old, he derives income from savings made in period t. The consumer consumes in both periods.

The government levies a tax at rate τ_t on labor income earned in period t which households can evade with an exogenous probability of q. For the potential evader, there are (ex ante) two possible situations: "success" (i.e getting away with evasion) and "failure" (i.e, getting discovered and being convicted). Assuming that β_t is the fraction of income that is reported in period t and τ_t is the income tax rate at t, if the consumer is found guilty of concealing an amount of income $(1-\beta_t)w_t$, then the agent has to pay a penalty on the unreported income in period t itself at higher rate of θ_t.

On receiving the income, the young agent not only makes his consumption-saving decision, but also chooses the fraction of labor income on which to evade taxes. The agent cannot diversify away the risk of being caught even though he is aware of the probability of being caught and the size of the penalty rate. Based on this information, the young agent, decides on the size of the income to report, β_t, and the deposits, d_t. After making his decisions, the agent also realizes whether he has been caught. If he fails to evade taxes, he pays the penalty out of his savings.

Formally, the consumer solves the following problem:

$$\max_{c_{yt},d_t,\beta_t,c^1_{ot+1},c^2_{ot+1}} U = u(c_{yt}) + \rho_1 q u(c^1_{ot+1}) + \rho_1(1-q)u(c^2_{ot+1}) \tag{23}$$

subject to

$$p_t c_{yt} + p_t d_t \leq [(1-\beta_t) + \beta_t(1-\tau_t)]p_t w_t + p_t a_t \tag{24}$$

$$p_{t+1}c^1_{ot+1} \leq (1+i_{dt+1})p_t d_t \tag{25}$$

$$p_{t+1}c^2_{ot+1} \leq (1+i_{dt+1})(p_t d_t - \theta_t(1-\beta_t)p_t w_t) \tag{26}$$

$$0 \leq \beta_t \leq 1 \tag{27}$$

where, $u(.) = log(.)$, a_t is the government transfer to young consumers of period t, w_t is the real wage at t, $1+i_{dt+1}$ is the (gross) nominal interest rate received on the deposits at $t+1$, d_t are the real deposits, c_{yt} is the real consumption when the household is young, c^1_{ot+1} and c^2_{ot+1} are the real consumption levels in the second period when the consumer can evade taxes with success and failure, respectively, and ρ_1 is the discount factor. As the utility function is strictly increasing in consumption in each period, all budget constraints hold with equality in equilibrium.

Defining $1 + r_{dt+1} = \frac{1+i_{dt+1}}{\frac{p_{t+1}}{p_t}}$, the Kuhn-Tucker conditions for maximization by a typical agent are:

$$d_t : u^{'}(c_{yt}) = \rho_1[qu^{'}(c^1_{ot+1}) + (1-q)u^{'}(c^2_{ot+1})][1 + r_{dt+1}], \tag{28}$$

$$\beta_t : \tau_t u^{'}(c_{yt}) \leq \rho_1(1-q)\theta_t u^{'}(c^2_{ot+1})[1 + r_{dt+1}] \quad if \quad \beta_t = 1, \tag{29}$$

$$\tau_t u^{'}(c_{yt}) = \rho_1(1-q)\theta_t u^{'}(c^2_{ot+1})[1 + r_{dt+1}] \quad if \quad 0 \leq \beta_t \leq 1,$$

$$\tau_t u^{'}(c_{yt}) \geq \rho_1(1-q)\theta_t u^{'}(c^2_{ot+1})[1 + r_{dt+1}] \quad if \quad \beta_t = 0.$$

In the first order conditions for β_t the left hand side is the marginal benefit of evading taxes on labor income and the right hand side is the marginal cost. Thus, at corner solution corresponding to no tax evasion, i.e., β_t= 1, the marginal cost is higher than the marginal benefit. An interior solution, i.e., when there is tax evasion in the economy, is obtained when $(1-q)\theta_t < \tau_t$.[2]

3.2.2 Financial Intermediaries

The financial intermediaries in this economy behave competitively but are subject to cash reserve requirements. In period t banks accept deposits and make their portfolio decision, loans and cash reserves choices, with a goal of maximizing profits. The banks provide a simple pooling function by accumulating deposits of small savers and loaning them out to firms after meeting the cash reserve requirements. Bank deposits are assumed to be one period contracts for simplicity, guaranteeing a nominal interest rate of i_{dt} with a corresponding nominal loan rate of i_{lt}. At the end of the period they receive their interest income from the loans made and meet the interest obligations on the deposits. Note the intermediaries are constrained by legal requirements on the

[2]See Atolia (2007) for further details.

choice of their portfolio (that is, reserve requirements), as well as by feasibility. Given such a structure, the real profit of the intermediary can be defined as follows:

$$\max_{l_t, d_t, m_t} \Pi_{Bt} = i_{lt} l_t - i_{dt} d_t \tag{30}$$

subject to

$$l_t + m_t \leqslant d_t \tag{31}$$

$$m_t \geqslant \gamma d_t \tag{32}$$

where Π_{Bt} is the profit of the bank in real terms at period t; l_t is the loans in real terms at period t. Equation (31) ensures the feasibility condition, and m_t is the banks' holding of fiat money in real terms. The banks are also subject to reserve requirements on cash, given by (32).

The solution to the bank's profit maximization problem results from the zero profit condition and is given by

$$i_{lt}(1 - \gamma) = i_{dt} \tag{33}$$

Simplifying, in equilibrium the following condition must hold

$$1 + r_{dt} = (1 - \gamma)(1 + r_{lt}) + \frac{\gamma}{1 + \pi_t} \tag{34}$$

where $1 + \pi_t = \frac{p_{t+1}}{p_t}$ is the gross rate of inflation. As can be observed from (33) the solution to the bank's problem yields a loan rate higher than the interest rate on the deposits, since reserve requirements tend to induce a wedge between borrowing and lending rates for the financial intermediary.

3.2.3 Firms

All firms are identical and produce a single final good using the following production technology:

$$y_t = Ak_t^{\alpha}(n_t \phi g_t)^{(1-\alpha)} \tag{35}$$

where A > 0; 0< $\alpha((1-\alpha)) < 1$, is the elasticity of output with respect to capital (labor), with k_t , n_t and g_t respectively denoting capital, labor, and government expenditure inputs at time t. 0<ϕ<1 denotes the proportion of government expenditure that is productive. At time t the final good can either be consumed or stored. We assume that the loans by the banks into the firms can be converted into fixed capital formation. Note, the production function in (35) is subject to constant returns to scale in k_t and n_t, while there are increasing returns to scale in all the three inputs taken together. We follow Barro (1990) in assuming that g_t is a non-rival and non-excludable input in the production process. Each firm takes the level of g_t as given while solving its own optimization problem. The production function, thus, exhibits private diminishing returns. We follow Diamond and Yellin (1990) and Chen *et al.* (2000) in assuming that the goods producer is a residual claimer, that is, the producer uses up the unsold consumption good in a way which is consistent with lifetime value maximization of the firm. This assumption regarding ownership avoids the "unnecessary" Arrow-Debreu redistribution from firms to consumers and simultaneously retains the general equilibrium structure of the model.

The representative firm maximizes the discounted stream of profit flows subject to the capital evolution and loan constraints. Formally, the problem of the firm can be outlined as follows

$$\max_{k_{t+1},n_t} \sum_{i=0}^{\infty} \rho_2^i [p_t y_t - p_t w_t n_t - (1+i_{lt}) p_t i_{kt}] \tag{36}$$

s. to.

$$\begin{aligned} k_{t+1} &\leqslant (1-\delta_k)k_t + i_{kt} && (37) \\ i_{kt} &\leqslant l_t && (38) \\ l_t &\leqslant (1-\gamma_t)d_t && (39) \end{aligned}$$

where ρ_2 is the firm owners' (constant) discount factor and δ_k is the (constant) rate of capital depreciation. The firm solves the above problem to determine the demand for labor and investment. The firm's problem can be written in the following recursive formulation:

$$V(k_t) = \max_{n,k'} [p_t y_t - p_t w_t n_t - (1+i_{lt}) p_t (k_{t+1} - (1-\delta_k)k_t)] + \rho_2 V(k_{t+1}) \tag{40}$$

The upshot of the above dynamic programming problem are the following first order conditions:

$$\begin{aligned} k_{t+1} &: (1+i_{lt})p_t = \rho_2 p_{t+1}[A\alpha(\phi\frac{g_{t+1}}{k_{t+1}})^{1-\alpha} + (1+i_{lt+1})(1-\delta_k)] && (41) \\ n_t &: w_t = A(1-\alpha)(\phi\frac{g_t}{k_t})^{(1-\alpha)} k_t && (42) \end{aligned}$$

Equation (41) provides the condition for the optimal investment decisions of the firm. The firm compares the cost of increasing investment in the current period with the future stream of benefits generated from the extra capital invested in the current period.

Equation (42) states that the firm hires labor up to the point where the marginal product of labor equates to the real wage.

3.2.4 Government

The government is assumed to be infinitely-lived. It purchases g_t units of the consumption good. The government revenues in excess of public investment are rebated lump-sum to the current young from whom they are collected. This rules out intergenerational transfers. Expenditures on the government good are financed through income taxation and seigniorage. Note the government also earns a per capita revenue to the order of $(1-q)\theta_t(1-\beta_t)w_t$ when tax evaders are caught evading. However, the government faces monitoring costs ($(1-q)\nu w_t$, with $\nu > 0$ measuring the cost parameter) as well. For the sake of simplicity, and as in Del Monte and Papagni (2001), we assume that the revenue raised from fines is exactly matched by the cost involved in monitoring the households. The government budget constraint then can simply be represented as follows:

$$g_t = \beta\tau_t w_t + \frac{M_t - M_{t-1}}{p_t} \tag{43}$$

where $g_t = \phi g_t + (1-\phi)g_t$, with $(1-\phi)g_t = a_t$, given that $N = 1$ and $M_t = \mu_t M_{t-1}$, where μ_t is the gross growth rate of money.

3.3 Equilibrium

A competitive equilibrium for this economy is a sequence of interest rates $\{i_{lt}, i_{dt}\}_{t=0}^{\infty}$, allocations $\{c_{yt}, c^1_{ot+1}, c^2_{ot+1}, \beta_t, n_t, i_{kt}\}_{t=0}^{\infty}$, and policy variables $\{\tau_t, \gamma_t, \theta_t, \mu_t g_t\}_{t=0}^{\infty}$ such that:

- Given τ_t, a_t, θ_t, i_{dt} and w_t, the consumer optimally chooses β_t and deposits, d_t;
- The real allocations solve the firm's date–t profit maximization problem, given prices and policy variables, such that (41) and (42) hold;
- The money market equilibrium conditions: $m_t = \gamma_t d_t$ is satisfied for all $t \geqslant 0$;
- The loanable funds market equilibrium condition: $i_{kt} = (1-\gamma_t)d_t$ where the total supply of loans $l_t = (1-\gamma_t)d_t$ is satisfied for all $t \geqslant 0$;
- The goods market equilibrium condition requires: $c_t + i_{kt} + g_t = y_t$ is satisfied for all $t \geqslant 0$. Note $c_t = c_{yt} + qc^1_{ot} + (1-q)c^2_{ot}$;
- The labor market equilibrium condition: $(n_t)^d$ =1 for all $t \geqslant 0$;
- The government budget constraint, equation (43), is balanced on a period-by-period basis;
- d_t, m_t, i_{dt}, i_{lt} and p_t must be positive at all dates.

3.4 Misalignment in the Growth-Maximizing Policies in the Presence of Tax Evasion

In this section we study the differences between the growth-maximizing reserve requirements, money growth rates and tax rates under the assumptions of exogenous and endogenous tax evasion. For the sake of tractability, we assume that the government follows time-invariant decision rules, i.e., $\tau_t = \tau$, $\gamma_t = \gamma$, $\mu_t = \mu$ and $\theta_t = \theta$. Using $u(.)$ = log(.), and imposing the loanable funds and the money market equilibrium, as well as assuming the government budget to hold on a period-by-period basis, we obtain the steady-state gross growth rate of the economy (λ) as follows:

$$\lambda = A(1-\alpha)(1-\gamma)\left(q-1)(1-\beta)\theta + \frac{q\rho_1(1-\tau+B)\theta}{(\rho_1+1)(\theta-\tau)}\right)\phi(A(1-\alpha)B)^{\frac{1}{\alpha}} - \delta + 1 \tag{44}$$

$$B = \frac{(q-1)(1-\beta)\gamma\theta(\rho_1+1)(\theta-\tau) - q\gamma\theta(\rho\tau+\rho_1)}{\frac{\mu-1}{\mu}(\rho_1+1)(\theta-\tau) - q\gamma\theta\rho_1(1-\beta)}$$

Note, if tax evasion is exogenous, β_t is simply treated as a constant. However, when it is endogenous we replace the optimal reported income into the solution of the growth rate. The proportion of reported income is given by the following equation:

$$\beta^* = 1 - \frac{\rho_1}{1+\rho_1}\left[\frac{1}{\theta} - \frac{1-q}{\tau}\right]\frac{(1-\tau)+\frac{a_t}{w_t}}{1-\frac{\tau}{\theta}} \tag{45}$$

where $\frac{a_t}{w_t} = \frac{(1-\phi)g_t}{w_t}$ is the ratio of the per capita transfer to the real wage rate. Clearly, a rise in the size of the transfer resulting from increases in the reserve requirement and money growth rate would tend to reduce reported income given that $\tau > (1-q)\theta$. With constant relative risk aversion (log is a special case) agents have decreasing absolute risk aversion. With increases in transfers the exogenous component of their income rises. This allows them to take greater risk and reduce the proportion of reported income. Though not quite obvious from the above expression, it is easy to show that a rise in the tax rate reduces reported income as well. Figures 1 through 3, respectively, show the negative relationships of reported income with the reserve requirements, the money growth rate and the tax rate.[3]

[3] We used standard parameterizations, outlined in Gupta and Ziramba (2008a.), for ϕ= 0.75; τ= 0.20; γ= 0.25; μ= 1.1, ρ_1= 0.98, and calibrated q= 0.6523 to match a β of 0.80 for all the figures. The relationships of the reported income with the tax rate, reserve requirement and the money growth rate are, understandably, qualitatively invariant to alternative parameterizations.

Figure 1: The relationship between reserve requirements and the proportion of reported income

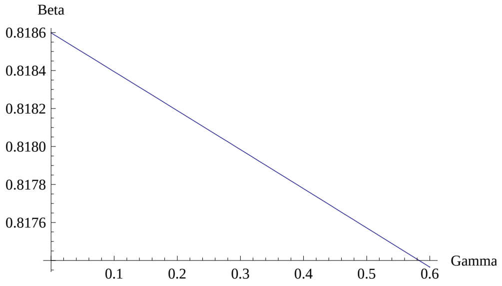


Figure 2: The relationship between money growth rate and the proportion of reported income

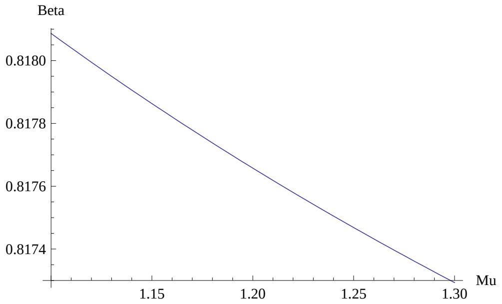
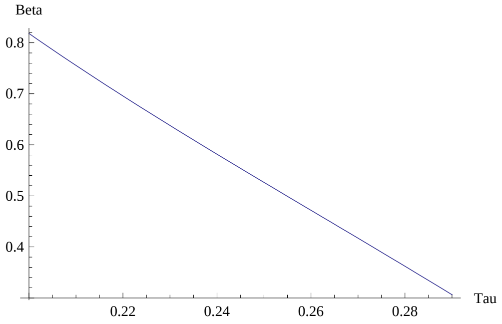


Figure 3: The relationship between tax rate and the proportion of reported income



Replacing out $\frac{(1-\phi)g_t}{w_t}$ from the government budget constraint, and solving for β^* yields the ultimate solution for the reported income and is given as follows:

$$\beta^* = \left(\frac{\mu\rho_1((q-1)\theta+\tau)(\tau\phi-1)}{\gamma\theta(\mu-1)\rho_1(\theta(q-1)^2+(2q-1)\tau)(\phi-1)+\mu\tau(\theta(\rho_1\phi+q(\rho_1-\rho_1\phi)+1)-\tau(\rho_1\phi+1))} + 1 \right) \tag{46}$$

As is standard in Barro (1990)-type endogenous growth models, the relationships between the growth rate and reserve requirements and growth rate and the tax rate produce Laffer-curve type of relationships. Clearly, then there exists growth-maximizing levels of tax rate and reserve requirement. The growth-maximizing (optimal) reserve requirement and tax rate would, however, be higher in the case of exogenous tax evasion when compared to the endogenous case. The intuition of these results is as follows: An increase in the reserve requirement or the tax rate will reduce deposits, which in turn would lower the growth rate. However, increases in the reserve requirement or the tax rate increase government transfers, and hence, deposits, besides public capital investment. Both these effects would tend to increase the growth rate. In the case of endogenous tax evasion, the increase in reserve requirement or the tax rate has an additional effect. These increases reduce the proportion of reported income as shown in Figures 1 and 3 respectively, via the increase in transfers. This, in turn, has an additional negative influence on growth, besides the standard channel described above under exogenous tax evasion. Thus, the growth rate will reach its maximum at lower levels of the reserve requirement and the tax rate under endogenous tax evasion.

In the case where tax evasion is exogenous an increase in the money growth rate will always have a positive influence on growth both through higher transfers and larger public capital investment. However, with endogenous tax evasion, increasing the money supply growth rate would reduce the proportion of reported income as illustrated on

Figure 2. A fall in the proportion of reported income β^* will have a negative impact on the economy's growth path. This, in turn causes the positive effect on growth of the increase in the money growth rate via increases in the public expenditures to be outweighed at some stage, and results in a Laffer-curve type of relationship. So, unlike in the case of exogenous tax evasion, where the optimal money growth rate is infinity, with endogenous tax evasion, the optimal money growth rate would surely be some finite value.[4]

So in summary, we highlight the fact that government policies, both fiscal and monetary, will be misaligned if it fails to realize the behavioral nature of tax evasion. The government not only chooses a higher tax rate, but also represses the financial sector more by choosing higher reserve requirements. Moreover, with optimal money growth rate being higher, unbounded in this case, the economy experiences higher inflation than it should ideally. Finally, with reported income now dependent on monetary instruments, tax evasion can also be controlled through appropriate choices of monetary policies.[5] In fact, if the government wants to reduce tax evasion, it should reduce both reserve requirements and money growth rate – this, however, would come at the cost of lower growth rate.

[4]It must be realized that in our model with deposits and hence, growth rate being independent of the rate of interest, higher money growth rate always results in higher growth rate under exogenous tax evasion. However, it is important to understand that whether the growth rate is interest inelastic or not, given that tax evasion is negatively related to the money growth rate, the optimal value of the same will always be lower under endogenous tax evasion when compared to the exogenous case. The only difference, being that now, under exogenous tax evasion, the growth-maximizing money growth rate will be some finite value as well, since we would also obtain an inverted u-shaped relationship between the growth rate and the money growth rate.

[5]A direct implication of tax evasion being dependent on monetary policy is that, once transfers are allowed in the model, the recent studies by Gupta (2008b) and Gupta and Ziramba (2008a), discussed above are also not immune to the Lucas critique.

3.5 Conclusions

Using an overlapping generations monetary endogenous growth model, we analyze the possible misalignment in the growth-maximizing fiscal and monetary policies if tax evasion is assumed to be exogenous instead of being treated as a behavioral decision of the agents. By allowing for government transfers to affect young-age income and hence, a role for monetary policy, besides fiscal policy, in the determination of the agents' reported income, we extend the previous set of studies.

We show that the failure on part of the government to realize tax evasion as endogenous results in higher tax rates, reserve requirements and money growth rate. Since with tax evasion being positively related to the tax rate, reserve requirement and the money growth rate, the growth-maximizing policies set by the government by assuming tax evasion to be exogenous would be at levels beyond the "actual" growth-maximizing levels (that should prevail under endogenous tax evasion). This, in turn, implies that the economy would end up experiencing lower (higher) steady-state growth (inflation). Clearly then, if tax evasion is assumed to be exogenous when it should ideally be treated as endogenous, results in misaligned fiscal and monetary policies.

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Chapter 4

Openness, Bureaucratic Corruption and Public Policy in an Endogenous Growth Model

4.1 Introduction

This paper develops a microfounded dynamic general equilibrium overlapping generations monetary endogenous growth model of a financially repressed small open economy characterized by bureaucratic corruption and, in turn, analyzes optimal policy decisions of the government following an increase in the degree of corruption. A recent paper by Chang *et al.* (2005), based on a panel of 82 countries, indicates that openness tends to have a bigger impact on growth for less corrupted economies. Given this empirical observation, we, in our theoretical framework, allow bureaucratic corruption to not only adversely affect output directly by reducing the proportion of productive public goods available for production, but also indirectly, via a reduction in the efficiency of openness on output.

The motivation for our analysis emanates from a paper by Al-Marhubi (2000). In a study based on a panel of 41 countries over the period 1980-1995, the author finds a significant positive association between corruption and inflation, thus, suggesting that those countries with more corruption experienced higher inflation. The author points out that the link between corruption and inflation was connected to seigniorage.

In this background, we, in this study, using a panel of 11 African countries[1] over the period 1995-2006, investigated the relationship between the ratio of seigniorage to total revenue and corruption, and found it to be positive and significant[2] after accounting for country fixed effects, based on a feasible GLS estimation with cross-section Seemingly Unrelated Regression (SUR) weights to correct for both cross-section heteroskedasticity and contemporaneous correlation. Given these two empirical findings, the relevant question to ask would be: What is the optimal policy mix between explicit and implicit taxation for the government in the presence of bureaucratic corruption in a small open economy. Or, in other words, we want to investigate whether the increase in the ratio of seigniorage to total revenue with higher levels of corruption, as suggested by the empirical evidence, is an optimal outcome of a benevolent government trying to maximize social welfare.

The need to introduce financial repression[3] , modeled through an obligatory "high" reserve deposit ratio requirement, that the banks in the economy need to maintain,[4]

[1]The countries chosen for our empirical analysis was based on the availability of data, and were namely: Algeria, Congo, Ivory Coast, Egypt, Kenya, Morocco, Senegal, Sierra Leone, South Africa, Tunisia and Zambia. Data on taxes, money growth rates, and total revenue were obtained from the World Bank's World Development Indicators, while, the information on corruption was derived from the World Bank's Governance Indicators database. While, the data on case reserve requirements is obtained from the IMF's International Financial Statistics (IFS) database.

[2]The obtained value for the coefficient on corruption was 0.024 and was statistically significant at the one percent level.

[3]Note, financial repression can be broadly defined as a set of government legal restrictions, like interest rate ceilings, compulsory credit allocation and high reserve requirements, that generally prevent the financial intermediaries from functioning at their full capacity level. However, given the wave of interest rate deregulation in the 1980s, and removal credit ceiling some years earlier, the major form of financial repression is currently via obligatory reserve requirements (Caprio *et al.* (2001)).

in the paper, is mainly to satisfy a second related objective of the paper. Through this study, we also attempt to assay whether there exists a plausible explanation as to why the reserve requirements in some economies are higher than others. Specifically, we analyze whether the "high" reserve requirements in a small open economy characterized by bureaucratic corruption, can be a fall out of a welfare maximizing decision of the government, having access to income taxation and seigniorage as sources of revenue. The hypothesis that bureaucratic corruption might affect the reserve requirements and hence, the degree of financial repression, simply comes from the two above mentioned empirical findings indicating the relationship between corruption and seigniorage. Note, with the banks holding cash-reserves, the size of the reserve requirement determines the magnitude of the seigniorage base. In addition, allowing for financial repression to be represented through cash reserve requirements helps us to monetize the endogenous growth model quite easily.

Given that both developed and developing economies resort to financial repression (Espinosa and Yip (1996)), the pertinent question here is - Why, if at all, would a government want to repress the financial system ? This seems paradoxical, especially when one takes into account the well documented importance of the financial intermediation process on economic activity, mainly via the finance-growth nexus.[5] Besides, the fact that "high" cash reserve requirements simply enhance the size of the implicit tax base and hence, is lucrative for the government to repress the financial system. Alternative explanations for causes of financial repression, with varied success, have

[4]In this regard, we follow Drazen (1989), Bacchetta and Caminal (1992), Haslag and Hein (1995), Espinosa and Yip (1996), Haslag (1998), Haslag and Koo (1999), Bhattacharya and Haslag (2001), Gupta (2005, 2006, 2008a, 2008b) and Gupta and Ziramba (2008a).

[5]See Roubini and Sala-i-Martin (1992), and the references cited there in.

ranged from: inefficient tax systems (Cukierman *et al.*(1992) and Giovannini and De Melo (1993)) and tax evasion (Roubini and Sala-i-Martin (1995), Gupta (2005, 2006, 2008a) and Gupta and Ziramba (2008a)) to the degree of financial development (Di Giorgio (1999)) and imperfect information and banking crisis (Gupta (2005, 2006)) and, ultimately, as of yet, to currency substitution (Gupta (2008a)). This paper, thus, attempts to add bureaucratic corruption to the already existing wide set of possible explanations for the existence of financial repression, besides trying to address the issue of the optimal policy mix of a consolidated government in the presence of bureaucratic corruption.

Given the importance of financial repression, productive public expenditure and bureaucratic corruption in the growth process of economies, the results of the theoretical model clearly have important policy implications. To the best of our knowledge, this study is the first attempt to analyze the relationship between corruption, openness and public policy, by combining the literatures on endogenous growth, openness and bureaucratic corruption in one framework. The remainder of the paper is organized as follows: Section 2 outlines the economic environment, while Section 3 defines the equilibrium. Sections 4 and 5 respectively, present the discussion on calibration and the optimal policy decisions of the consolidated government. Section 6 concludes.

4.2 Economic Environment

The economy is populated by five types of agents, namely, consumers, banks (financial intermediaries), firms, bureaucrats and an infinitely-lived government. The following subsections lay out the economic environment in detail by considering each of the agents separately and accounting for the external sector.

4.2.1 Consumers

The economy is characterized by an infinite sequence of two-period lived overlapping generations of consumers. Time is discrete and indexed by t = 1,2,....∞. N people are born at each time point $t \geq 1$. At t =1, there exist N people in the economy, called the initial old, who live for only one period. Hereafter N is normalized to 1.

Each agent is endowed with one unit of working time (n_t) when young and is retired when old. They supply this unit of labor inelastically and receive a competitively determined wage, w_t. It is assumed that agents consume only when old and hence, the net of tax wage earnings are deposited with the financial intermediaries. The proceeds from the bank deposits are used to obtain second period consumption. The consumption bundle comprises of a domestically produced good and an imported foreign good. The utility function is assumed to be separable and additive in the two goods.

Formally, the agent's problem born in period t is as follows:

$$maxU = \psi \frac{(c_{t+1})^{(1-\sigma)}}{1-\sigma} + (1-\psi)\frac{(c^*_{t+1})^{(1-\sigma)}}{1-\sigma} \tag{47}$$

$$p_t d_t \leqslant (1-\tau) p_t w_t \tag{48}$$

$$p_{t+1} c_{t+1} + p^*_{t+1} e_{t+1} c^*_{t+1} \leqslant (1 + i_{dt+1}) p_t d_t \tag{49}$$

where $U(.)$ is the utility function, with the standard assumption of positive and diminishing marginal utilities in both goods; $\psi(1-\psi)$ is the weight the consumer assigns to the domestic (foreign) good in the utility function; c_{t+1} and c^*_{t+1} are the old age consumption of domestic and foreign good, respectively; d_t are the real deposits held in period t; τ_t is the tax rate at period t; $p_t(p_t^*)$, is the price of the domestic (foreign) consumption good at period t; e_{t+1} is the nominal exchange rate at period $t+1$; i_{dt+1} is the nominal interest rate on bank deposits.

Utility maximization is equivalent to maximizing the old-age consumption bundle with respect to c_{t+1}^* because d_t and c_{t+1} can be substituted out of equations (48) and (49). The maximization problem of the consumer, with $\sigma = 1$, yields the following optimal choices:

$$d_t = (1-\tau)w_t \tag{50}$$

$$c_{t+1} = \psi[(1+r_{dt+1})(1-\tau)]w_t \tag{51}$$

$$c_{t+1}^* = (1-\psi)[(1+r_{dt+1})(1-\tau)]w_t \tag{52}$$

We are assuming that the purchasing power parity (PPP) condition, $p= ep^*$, holds. Since the foreign price, p^*, is given to the small open economy, we set it to unity without any loss of generality. This implies that the domestic price level and the nominal exchange rate are synonymous for the model economy with the PPP condition satisfied, i.e., $p_t = e_t$. Note $\frac{P_{t+1}}{p_t} = 1 + \pi_{t+1}$ is the gross rate of inflation.

4.2.2 Financial Intermediaries

The financial intermediaries in this economy, behave competitively but are subject to cash reserve requirements. In period t banks accept deposits and make their portfolio decision, loans and cash reserves choices, with a goal of maximizing profits. The banks provide a simple pooling function by accumulating deposits of small savers and loaning them out to firms after meeting the cash reserve requirements. Bank deposits are assumed to be one period contracts for simplicity, guaranteeing a nominal interest rate of i_{dt} with a corresponding nominal loan rate of i_{lt}. At the end of the period they receive their interest income from the loans made and meet the interest obligations on the deposits. Note the intermediaries are constrained by legal requirements on the choice of their portfolio (that is, reserve requirements), as well as by feasibility. Given such a structure, the real profit of the intermediary can be defined as follows:

$$\max_{l_t, d_t, m_t} \Pi_{Bt} = i_{lt} l_t - i_{dt} d_t \tag{53}$$

subject to

$$l_t + m_t \leqslant d_t \tag{54}$$

$$m_t \geqslant \gamma d_t \tag{55}$$

where Π_{Bt} is the profit of the bank in real terms at period t; l_t is the loans in real terms at period t. Equation (54) ensures the feasibility condition, and m_t is the banks' holding of fiat money in real terms. The banks are also subject to reserve requirements on cash, given by (55).

The solution to the bank's profit maximization problem results from the zero profit condition and is given by

$$i_{Lt}(1 - \gamma) = i_{dt} \tag{56}$$

Simplifying, in equilibrium the following condition must hold

$$1 + r_{dt} = (1 - \gamma)(1 + r_{Lt}) + \frac{\gamma}{1 + \pi_t} \tag{57}$$

As can be observed from (56) the solution to the bank's problem yields a loan rate higher than the interest rate on the deposits, since reserve requirements tend to induce a wedge between borrowing and lending rates for the financial intermediary.

4.2.3 Firms

All firms are identical and produce a single final good (y_t), which can be allocated to investment demand (i_{kt}) and consumption goods (c_t). We assume that producers are capable of converting bank loans into fixed capital formation such that: $p_t i_{kt} = p_t l_t$ and l_t, $(\frac{L_t}{p_t})$ is the loan in real terms. We also assume that the production transformation schedule is linear so that the same technology applies to capital formation, consumption good and export production, hence, investment, consumption and export goods sell for the same price p_t. Each firm uses a Cobb-Douglas-type production function as follows:

$$y_t = AI^{\lambda} k_t^{\alpha} (\phi n_t g_t)^{1-\alpha} \tag{58}$$

$$\lambda = [\phi(\frac{g_t}{w_t})]^{\eta} \tag{59}$$

where λ is the effectiveness of openness and is defined as follows, to take account of the fact that corruption affects the marginal product of openness (λ), as empirically indicated by Chang *et al.* (2005); y_t is output; n_t is the hours of labor supplied inelastically to production in period t; k_t is the per-firm capital stock in period t; g_t is government expenditure in period t; A is a positive scalar; I is an index of openness;

ϕ is the fraction of government expenditure that is productive, or alternatively, it can also be interpreted as an index of corruption, with smaller values indicating a more corrupt economy; 0< α $(1 - \alpha)$ <1, is the elasticity of output with respect to capital (labor) and; η ($\geq$0) captures the marginal effect of corruption on the marginal product of openness. Note, the production function in (58) is subject to constant returns to scale in k_t and n_t, while there are increasing returns to scale in all the three inputs taken together. We follow Barro (1990) in assuming that g_t is a non-rival and non-excludable input in the production process. Each firm takes the level of g_t as given while solving its own optimization problem. The production function, thus, exhibits private diminishing returns.

Firms operate in a competitive environment and maximize profit taking the wage rate, the price of the consumption good, the level of g_t and the loan rate as given. We follow Diamond and Yellin (1990) and Chen *et al.* (2000) in assuming that the goods producer is a residual claimer, i.e., the producer ingests the unsold consumption good, in a way consistent with lifetime maximization of the value of the firms. The ownership assumption avoids unnecessary Arrow-Debreu redistribution from firms to households and simultaneously maintains the general equilibrium nature of the model.

The representative firm at any point in time t maximizes the discounted stream of profit flows subject to the capital evolution and loan constraints. Formally, the dynamic optimization problem of the firm can be summarized as follows:

$$\max_{k_{t+1},n_t} \sum_{i=0}^{\infty} \rho^i [p_t y_t - p_t w_t n_t - (1 + i_{Lt}) L_t] \tag{60}$$

$$k_{t+1} \leqslant (1-\delta_k)k_t + i_{kt} \tag{61}$$

$$p_t i_{kt} \leqslant L_t \tag{62}$$

$$L_t \leqslant (1-\gamma_t)D_t \tag{63}$$

where ρ is the firm owners' (constant) discount factor, and δ_k is the (constant) rate of capital depreciation. The firm solves the above problem to determine the demand for labor and investment in period t, or the gross amount of capital to be carried over to period $t+1$. The firm's problem can be written in the following recursive formulation:

$$V(k_t) = \max_{n,k'}[p_t y_t - p_t w_t n_t - p_t(1+i_{Lt})(k_{t+1} - (1-\delta_k)k_t)] + \rho V(k_{t+1}) \tag{64}$$

The upshot of the above dynamic programming problem are the following respective first order conditions.

$$k_{t+1} \; : \; (1+i_{Lt})p_t = \rho p_{t+1}[AI^{\lambda}\alpha(\phi\frac{g_{t+1}}{k_{t+1}})^{1-\alpha} + (1+i_{Lt+1})(1-\delta_k)] \tag{65}$$

$$(n_t) \; : \; AI^{\lambda}(1-\alpha)\phi^{1-\alpha}(\frac{g_t}{k_t})k_t = w_t \tag{66}$$

Equation (65) provides the condition for the optimal investment decision of the firm. The firm compares the cost of increasing investment in the current period with the future stream of benefits generated from the extra capital invested in the current period. Equation (66) simply states that the firm hires labor up to the point where the marginal product of labor equates the real wage.

4.2.4 Bureaucrats

The bureaucrats are assumed to be risk neutral and they maximize expected profits from corrupt activities which are given by

$$E(\Pi_B) = (1 - \phi - q\varpi)g_t \tag{67}$$

where q is the probability of getting caught which is defined as $q = \frac{1}{2}(1-\phi)^2$, with $(1-\phi)$ indicating the proportion of public expenditures that the bureaucrats steal. Note, we assume that the chances of getting caught increase as the embezzlements rise, and; $\varpi(> 1)$ is the penalty rate if caught. The optimization problem of the bureaucrat essentially implies that the bureaucrat maximizes the expected profit by choosing $(1-\phi)$. Formally, this is given as follows:

$$\frac{dE(\Pi_B)}{d(1-\phi)} = g_t - (1-\phi)g_t\varpi = 0 \tag{68}$$

The solution to the above optimization problem yields:

$$(1-\phi) = \frac{1}{\varpi} \tag{69}$$

Understandably, the fraction of resources stolen by the bureaucrats is negatively related to the penalty rate. The determination of size of the latter is discussed in the next section.

4.2.5 Government and the External Sector

In this section we describe the activities of an infinite-lived government. The government spends g_t. These expenditures are financed by income tax and printing of fiat money. The government has at its disposal two tools of monetary policy, the reserve requirement and the rate of money supply growth, the tax rate and government expenditures are the tools of fiscal policy. Formally, the government's budget constraint at date t can be defined as follows:

$$p_t g_t = \tau p_t w_t + [M_t - M_{t-1}] \tag{70}$$

where M_t is the banks' holdings of fiat money in nominal terms. We assume that money evolves according to the policy rule $M_t = (1 + \theta_t)M_{t-1}$, where θ (>0) is the money growth rate. Note, the government also gets revenue from penalties on the corrupt bureaucrats who get caught. Following Del Monte and Papagni (2001), we assume that the government incurs monitoring costs which are equal to the revenue generated from the penalties: $q\varpi g_t = qcg_t$ and hence $\varpi = c$.

In the external sector, for simplicity, we assume away capital mobility. Thus, in equilibrium the trade balance is equal to zero. The balance of payments identity of this economy, assuming that (PPP), i.e., $p = ep^*$ holds for all t, is given by

$$x_t - c_t^* = 0 \tag{71}$$

$$x_t = \Omega w_t \tag{72}$$

$$c_t^* = \Omega w_t \tag{73}$$

Realizing that in steady-state all the real variables grow at the same rate, we ensure that exports and imports are a fixed proportion (Ω) of income or the wage rate.

4.3 Equilibrium

A competitive equilibrium for this model economy is a sequence of prices $\{p_t,\ e_t,\ i_{dt},\ i_{Lt}\}_{t=0}^{\infty}$, allocations $\{c_{t+1},\ c_{t+1}^{*},\ n_t,\ i_{kt}\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t,\ d_t\}_{t=0}^{\infty}$, exogenous sequence of $\{p_t^{*}\}_{t=0}^{\infty}$ and policy variables $\{\gamma_t,\ \tau_t,\ \theta_t,\ g_t\}_{t=0}^{\infty}$ such that:

- Taking, τ_t, g_t, p_t, i_{dt+1}, λ and w_t, the consumer optimally chooses c_{t+1}, c_{t+1}^{*}, d_t, such that (48) and (49) hold;
- Banks maximize profits, taking i_{lt}, i_{dt}, and γ_t as given and such that (57) holds;
- The real allocations solve the firm's date–t profit maximization problem, given prices and policy variables, such that (61)-(63) hold;
- The bureaucrats maximize their expected profits such that (69) holds for all $t \geqslant 0$;
- The money market equilibrium conditions: $m_t = \gamma_t d_t$ is satisfied for all $t \geqslant 0$;
- The loanable funds market equilibrium condition: $p_t i_{kt} = (1 - \gamma_t) D_t$ where the total supply of loans $L_t = (1 - \gamma_t) D_t$ is satisfied for all $t \geqslant 0$;
- The goods, money, loanable funds, and labor market equilibrium condition is satisfied at all $t \geqslant 0$;
- The labor market equilibrium condition: $(n_t)^d$ =1 for all $t \geqslant 0$;
- The government budget, equation (70) is balanced on a period-by-period basis;
- The equilibrium condition in the external sector requires, equation (71) to hold, along with the PPP condition being satisfied for all $t \geqslant 0$;
- d_t, m_t, i_{dt}, i_{Lt}, p_t^{*} and $p_t = e_t$ must be positive at all dates.

4.4 Calibration

In this section, we discuss how we assign values to the parameters of our model, based on a combination of figures from previous studies and those that we calibrate. Following the standard real business cycle literature, we use steady-state conditions to establish parameter values observed in the data. Some parameters are calibrated using world economy data, while others, correspond to prevailing values from the literature. This section reveals the general procedures used.

A first set of parameter values is given by numbers usually found in the literature. The following parameter values were chosen initially and the specific source is mentioned in the parentheses given aside, except for the standard ones. These are:

- σ: the degree of risk aversion, as stated above, was set to 1;
- α: since the production function is Cobb-Douglas, this corresponds to the share of capital in income. The value chosen was of 0.70 (Basu (2001));
- δ_k: the depreciation rate of physical capital was set at 0.05 or 5 percent (Zimmermann (1994));
- χ: the gross growth rate set equal to 2.5 percent (Basu (2001));
- γ: the annual reserve-deposit ratio was fixed at 0.15 (Haslag and Young (1998));
- τ: tax rate, calculated as the ratio of tax receipts to gross domestic product, was set to 0.25 or 25 percent (Chari *et al.* (1995));
- π: the annual rate of inflation was fixed at 5 percent, and hence, the gross rate of inflation was $\pi = 1.05$ (Basu (2001));

- i_{Lt}: the nominal interest rate on loans was set to 0.15 or 15 percent (Gupta (2008a));
- β: the discount rate, is set to 0.98 (Chari *et al.* (1995));
- η: defines how the effectiveness of openness on output changes with changes in the level of corruption, and is set to 3 (Chang et al. (2005));
- ϕ: the proportion of government expenditure that is productive. We set this at 1, 0.75, 0.5, 0.25 and 0.01 for the policy experiments discussed in the next section.

A second set of parameters are calibrated from the steady-state equations of the model to make them hold exactly: These parameters are:

- $1+\theta$: the gross money growth rate is calibrated using the money market equilibrium which implied that $1+\theta = \chi \times \pi$. This resulted in the net money growth rate to be equal to 0.076 or 7.6 percent;
- ρ: the discount factor of the firms is solved to ensure that equation (65) holds and is equal to 0.834;
- A: the value of the production function scalar, is calibrated from the equilibrium conditions to match the growth rate of 2.5 percent and an inflation rate of 5 percent and is equal to 0.718;
- b: the ratio of government expenditure to capital which has a value of 0.016 or 1.6 percent, is calibrated from the government budget constraint.

- I: the measure of openness is calculated as ratio of the world exports and imports to world GDP for the year 2005, based on data from the World Bank's World Development Indicators, and has a value of 0.47.

- Ω: as can be seen from the equilibrium in the external sector, defined by equation (71), the parameter defines the fraction of exports and imports to the wage rate and is half of the openness index, with a value of 0.235.

4.5 Optimal Policy Decisions

In this section, we analyze the optimal policies for the government in the face of a rise in bureaucratic corruption. For this purpose, we study the behavior of a social planner who maximizes the utility of all consumers, by choosing γ, τ and θ, subject to a set of inequality constraints: $0 \leq \gamma \leq 1$, $\theta \geq 0$, and $0 \leq \tau \leq 1$, evaluated at the steady state, following changes in ϕ. The social planner maximizes the discounted stream of life-time consumer utility, which specifically, with the discount rate $0<\beta<1$, is captured by: $W = \sum_{i=0}^{\infty} \beta^i U(c_{t+1+i}, c^*_{t+1+i})$, which, in turn, is equal to: $W = \psi \log[\psi] + (1-\psi)\log[1-\psi] + \log[1-\tau_t] + \log[1+r_{dt+1}] + \log[w_t] + \frac{\beta}{(1-\beta)^2}\log[\chi_t]$ where $\chi_t = AI^{\lambda}(1-\gamma_t)(1-\tau_t)(1-\alpha)\phi^{1-\alpha}b^{1-\alpha} + (1-\delta_k)$, $(1+r_{dt+1}) = (1-\gamma)(1+r_{Lt+1}) + \frac{\gamma}{1+\pi_{t+1}}$, $b = [\tau + \frac{\theta}{1+\theta}\gamma(1-\tau)AI^{\lambda}(1-\alpha)\phi^{(1-\alpha)}]^{\frac{1}{\alpha}}$ and $(1+r_{Lt}) = \frac{\rho AI^{\lambda}(\phi b)^{1-\alpha}}{1-\rho(1+\pi_t)(1-\delta_k)}$. We will assume that the government follows time invariant policy rules, which means that the institutionally determined tax rate, τ_t, the cash reserve ratio, γ_t, the money growth rate, θ_t, the level of government expenditures, g_t are constant over time.

We first derive the optimal values of γ, τ, and θ in the cases where $\eta = 3$ for $\phi = 1$, and then repeat the experiment for $\phi = 0.75$, $\phi = 0.5$, $\phi = 0.25$ and $\phi = 0.01$. The

Table 5: **Optimal Policy Decisions η= 3:**

	τ^*	θ^*	γ^*	$\frac{Seigniorage}{Revenue}$
$\phi = 1.0$	0.4485	22.61	44.26	94.77
$\phi = 0.75$	0.4476	22.22	46.97	95.00
$\phi = 0.5$	0.4467	21.58	51.02	95.28
$\phi = 0.25$	0.3243	21.07	60.69	97.01
$\phi = 0.01$	0.1293	20.17	63.04	98.79
(i) Parameters are as defined above.				
(ii) All values in percentages.				

experiments, thus, tend to capture the effect on the optimal policy decisions of the government as the level of corruption increases, under a situation where corruption affects the marginal product of openness, besides directly affecting output. The results have been reported in Table 5.[6]

Based on the results obtained in Table 5, one can draw the following conclusions[7]

:

- Increases (decreases) in the degree of corruption leads the government to resort to reducing (decreasing) taxes and money supply growth rate as an optimal response;

- As a far as the degree of financial repression is concerned, the results indicate that the government should optimally increase the reserve requirements as a response to higher levels of corruption;

- Overall, the ratio of seigniorage to total revenue is found to increase with the degree of corruption.

[6]Note, the model does not analyze the possibility of transitional dynamics. Here, we are merely interested in figuring out the movements of γ, τ and θ following a change in ϕ across steady-states.

[7]While reading the table, one must be aware that what matters in this simulation exercise is the movements in the policy parameters of the government following increases in the level of bureaucratic corruption, and not the exact values of the parameters *per se*.

Intuitively, the obtained results make sense. An increase in the degree of corruption, results in the fall in the growth rate due to a decline in the productive effect of the government expenditure, which in turn, reduces welfare. The government responds by reducing the tax rate, which would boost savings, causing a higher growth rate and higher welfare. However, a reduction in the tax rate results in the fall of government revenue and tends to have a negative indirect impact on growth and welfare. To restore the size of the government revenue, the social planner increases seigniorage by increasing the reserve requirement. But given that increases in the reserve requirements tend to reduce the real interest rate on deposits and thus, welfare, the government compensates by reducing the money growth rate and hence, increasing the real interest rate in such a way that the loss in revenue for a reduction in the money growth rate does not reduce growth and affect welfare indirectly. It must, however, be realized that all these changes occur simultaneously, and the government chooses the policy instruments taking into account the direct and indirect effects on welfare following an increase in the degree of corruption.

4.6 Conclusion

Using a dynamic general equilibrium overlapping generations monetary endogenous growth model of a financially repressed small open economy characterized by bureaucratic corruption, we analyze the relationship between openness, bureaucratic corruption, and public policies. In this paper, we specifically attempt to find what the optimal policies of a benevolent government would be following an increase in the level of bureaucratic corruption, with the latter affecting output not only directly but also through the effectiveness of openness.

When numerically analyzed for a world economy, the following basic conclusions could be drawn: (i) As suggested in the empirical literature, increases in the degree of corruption should ideally result in an increase in the ratio of seigniorage to total revenue as an optimal response of the benevolent government and; (ii) Higher degrees of corruption should be accompanied by higher degrees of financial repression. This paper, thus, indicates that bureaucratically corrupted economies would tend to rely more on indirect taxation than direct taxation, as this is an optimal response for a benevolent social planner. In the process, the paper provides a theoretical background to the empirical observation of higher corruption resulting in higher seigniorage as a percentage of the total revenue. Finally, we also show that bureaucratic corruption produces a positive relationship with financial repression, and hence, can be identified as a possible rationale for the latter. By doing so, we add to the list of explanations trying to reason the existence of financial repression.

Chapter 5

Costly Tax Enforcement and Financial Repression

5.1 Introduction

Using an overlapping generations production-economy model, characterized by costly tax enforcement, we analyze the relationship between the costs of tax collection and financial repression. We follow the dominant trend in the literature[1] in defining financial repression through an obligatory "high" reserve deposit ratio requirement, that the banks in the economy need to maintain.[2] Specifically, we analyze whether the "high" reserve requirements in a closed economy characterized by costly tax collection, are a fall out of a welfare maximizing decision of the government, which has access to income taxation and seigniorage as sources of revenue.

Given that the concern is not whether financial repression is prevalent, but the associated degree to which an economy is repressed, since developed and developing

[1]See for example, Drazen (1989), Bacchetta and Caminal (1992), Haslag and Hein (1995), Espinosa and Yip (1996), Haslag (1998), Haslag and Koo (1999), Bhattacharya and Haslag (2001), Gupta (2005, 2006, 2008a) and Gupta and Ziramba (2008a, b) amongst others.

[2]Financial repression, though, can involve other set of government legal restrictions, like interest rate ceilings and compulsory credit allocation, besides, "high" reserve requirements, that prevent the financial intermediaries from functioning at their full capacity level. However, given the wave of interest rate deregulation in the 1980s, and removal credit ceiling some years earlier, the major form of financial repression is currently via obligatory reserve requirements(Caprio *et al.* (2001)).

economies both resort to such restrictive policies (Espinosa and Yip (1996)), the pertinent question is - Why, if at all, would a government want to repress the financial system ? This seems paradoxical, especially when one takes into account the well documented importance of the financial intermediation process on economic activity, mainly via the finance-growth nexus.[3] Besides, the fact that "high" cash reserve requirements enhance the size of the implicit tax base and hence, is lucrative for the government to repress the financial system. Alternative explanations, with varied levels of success, have ranged from: Inefficient tax systems (Cukierman *et al* (1992)) and Giovannini and De Melo (1993)) and tax evasion (Roubini and Sala-i-Martin (1995), Gupta (2005, 2006, 2008b) and Gupta and Ziramba (2008a)) to the degree of financial development (Di Giorgio (1999)) and asymmetric information (Gupta (2006)) and banking crisis (Gupta (2005)), productive public expenditure (Basu (2001)) and bureaucratic corruption (Gupta and Ziramba (2008b)), and finally, currency substitution (Gupta (2008a)). In this paper, we analyze whether we can add costs of tax collection to this list.

The motivation for believing that costly tax collection can be a possible rationale for financial repression, can be outlined as follows: If tax collection is costly and is increasing at a increasing rate in taxes (Bird and Zolt (2005) and Agénor and Neanidis (2007)), with two sources of revenue, namely, taxation and seigniorage, the government might want to increase either one or both the money supply growth rate (rate of the inflation tax) and the reserve requirements (the seigniorage base) as part of a welfare-maximizing strategy. Given that the size of the reserve requirement is our metric for financial repression, we could thus, check if increases in costs of tax collection can be a

[3]See Roubini and Sala-i-Martin (1992), Rousseau and Wachtel (2002), Agbetsiafa (2004), Acaravci and Ozturk (2007) and Bose *et al.* (2007).

rationale for a more restrictive policy as an welfare maximizing outcome. To the best of our knowledge, this is the first study to analyze costly tax collection as a rationale for financial repression.

Alternatively, the current study can also be viewed as an analysis that looks into the optimal mix of explicit and implicit taxation of a consolidated government in the presence of costs of collecting direct taxes. In this regard, this paper is comparable to Agénor and Neanidis (2007). In this paper, the authors show that in the presence of positive and endogenous cost of tax collection, i.e., with the cost of tax collection depending on the resources spent by the government to improve monitoring of tax payers, growth-maximizing direct and (consumption) indirect taxation are negatively related to their respective (and cross) costs of tax collection. However, the growth-maximizing value of the consumption tax rate is zero when collection costs do not exist, and hence, the government relied completely on direct taxes. Further, with no costs of tax collection, the welfare optimizing outcome indicated the direct and consumption taxes to be substitutable, which was also the case with exogenous cost of tax collection. Finally, under exogenous costs of tax enforcement, the growth-maximizing consumption taxation was found to be negatively related to its "own" degree of inefficiency in collecting indirect taxation, and an increase in collection costs associated with direct (indirect) taxation led to a reduction (increment) in the optimal income tax rate. We, by adding money to the model, analyze the role of seigniorage (the implicit tax) relative to the explicit direct tax in the presence of cost of tax enforcement. Thus, though the main motive of our analysis is to relate financial repression to cost of tax collection, our study, in general, is quite similar to what Agénor and Neanidis (2007) do, especially, in terms of the issues we address, on 'optimal' explicit and implicit taxation when there are costs involved in raising direct taxes. Our framework though, is much simpler than the one adopted by Agénor and Neanidis (2007). The remainder of the paper is organized as follows: Section 2 outlines the economic environment, while section 3 derives the optimal policy decisions for the benevolent government under alternative sizes of the cost of tax collection. Finally, Section 4 concludes.

5.2 Economic Environment

The economy is populated by four types of agents, namely, consumers, entrepreneurs, banks (financial intermediaries), and a consolidated government-monetary authority. All consumers are endowed with a fixed amount of resources, y, which is normalized to 1. Entrepreneurs are also endowed with a fixed amount of resources, W, which is also normalized to 1 and have access to a production technology. Both consumers and entrepreneurs are uniformly distributed in the [0, 1] interval: agents within each class are a continuum with a population normalized to one. Each agent lives for two periods. Each consumer's preferences are defined over a consumption good and a public good when old.[4] Financial intermediation has a crucial role to play since, on one hand, it provides the consumers with a safe way of transferring resources to the future while, on the other hand, banks provide external finance to entrepreneurs who need it to implement their investment projects. Time is discrete and there is an infinite sequence of agents indexed by $t = 1, 2, 3, ...\infty$.

[4] Our economic environment is similar to that of Bacchetta and Caminal (1992) and Di Giorgio (1999).

5.2.1 Agents' behavior

5.2.1.1 Consumers

The consumer is endowed with y units of the consumption good when young. The consumer invests the net of tax endowment in bank deposits. When old, the consumer is retired, and consumes out of one's young age savings. Thus, at time t, there are two coexisting generations of young and old. N people are born at each time point $t = 1$. At date t =1, there exist N people in the economy, called the initial old, who live for only one period. At each date $t \geq$1, N people are born (the young generation) and N people are beginning the second period of their life (the old generation). Note, the population is constant and hence N, is normalized to 1.

Formally, the consumer does not choose anything. What he or she consumes is directly determined from the budget constraint, as follows:

$$U(c_{t+1}, g_{t+1}) = \psi \frac{c_{t+1}^{1-\sigma}}{1-\sigma} + (1-\psi)\frac{g_{t+1}^{1-\sigma}}{1-\sigma} \tag{74}$$

subject to:

$$p_t d_t = (1-\tau_t) p_t y \tag{75}$$

$$c_{t+1} = \frac{p_t}{p_{t+1}}(1 + i_{dt+1}) d_t \tag{76}$$

To check for the robustness of our results we also look at a scenario where the utility of the consumer only depends on consumption good. Specifically,

$$U(c_{t+1}) = \frac{c_{t+1}^{1-\sigma}}{1-\sigma} \tag{77}$$

where $U(.)$ is the utility function, with the standard assumption of positive and diminishing marginal utilities in both goods; $\psi(1-\psi)$ is the weight the consumer assigns to the consumption (public) good in the utility function; c_{t+1} (g_{t+1}) are the old age consumption of consumption good (public good); d_t are the real deposits held in period t; τ_t is the tax rate at period t; p_t, is the price of the consumption good at period t; i_{dt+1} is the nominal interest rate on bank deposits. Each unit of the consumption good placed into deposits at date t yields a real deposit rate $(1+r_{dt+1}) = \frac{(1+i_{dt+1})}{1+\pi_{t+1}}$ with $(1+\pi_{t+1}) = \frac{p_{t+1}}{p_t}$ as the gross inflation rate, units of the consumption good at date $t+1$. As consumption only takes place in the second period of life, the savings function is inelastic with respect to its return. This assumption makes computations much easier and seems to be a good approximation of the real world.[5]

5.2.1.2 Entrepreneurs

All entrepreneurs are endowed with W units of the consumption good. The technology is such that, by investing one unit of the consumption good at time t, $\alpha > 1$ units are produced at time $t+1$. Let α be the marginal product of capital of a single technology and let y_{t+1} be the level of output at time $t+1$. Then:

$$y_{t+1} = \alpha K_t \tag{78}$$

Let L_t be the nominal quantity of loan that entrepreneurs can borrow from banks. Capital investment, K_t, is constrained by the available sources of financing:

$$K_t = W + l_t \tag{79}$$

[5]See Hall (1988).

where $l_t = \frac{L_t}{p_t}$. The entrepreneurs pay a gross interest rate $(1 + i_{lt+1})$ on the amount borrowed in time period t. The entrepreneur's problem can be formalized as follows:

$$p_{t+1}C^e_{t+1} = p_{t+1}y_{t+1} - (1 + i_{lt+1})p_t l_t \tag{80}$$

where C^e_{t+1} represents the entrepreneur's consumption in the second period.

Banks receive the deposits d_t and are subjected to a standard cash reserve requirement which constraints the banks to hold at least γ_t of each unit of the consumption good deposited in the form of money. In equilibrium, with money being return-dominated, banks will hold exactly a fraction γ_t in fiat money. Let M_t denote nominal money balances per young person. Then, $M_t = \gamma_t p_t d_t$ holds. The rest of the deposits is invested into loans that are given to entrepreneurs.

$$L_t \leq (1 - \gamma)(1 - \tau)y \tag{81}$$

An investment of one unit of the consumption good in period t produces $1 + x_{t+1} = \frac{1+i_{lt+1}}{\frac{p_{t+1}}{p_t}}$ units of consumption good in period $t + 1$. The depositors cannot lend directly to the entrepreneurs, and hence, require the banks to perform a pooling function on their behalf. Thus, the only form of savings for the consumers is through the deposits with the financial intermediaries. Because fiat money does not pay any interest rate, the gross real return on money between t and $t + 1$ is $\frac{1}{1+\pi_{t+1}}$. Throughout the analysis we restrict our attention to equilibria where money is return dominated, or $1 + x_{t+1} > (1/(1 + \pi_{t+1}))$. Alternatively, $(1 + i_{lt+1}) > 1$.

The banking sector is assumed to be perfectly competitive and banks have access to a costless intermediation technology. Profit maximization on behalf of the banks causes the gross real return on deposits to be a weighted average of the returns from the investment and money, with the weights being the defined reserve-deposit ratio. Formally,

$$1 + r_{dt+1} = (1 - \gamma_{t+1})(1 + x_{t+1}) + \gamma_{t+1}\frac{1}{1 + \pi_{t+1}} \tag{82}$$

must hold. Further, for the entrepreneurs to have an incentive to invest the following constraint must bind in equilibrium

$$\alpha[W + l_t - (1 + x_{t+1})l_t] \geq \alpha W \tag{83}$$

which, in turn, implies that $(1 + x_{t+1}) = \alpha$.

5.2.2 The consolidated government

The government is assumed to be infinitely-lived. It purchases g_t units of the consumption good. In the first scenario, the public good which is assumed to be useful in the sense that it yields direct-utility to the agents, while in the second scenario government expenditures are useless. These expenditures are financed through income taxation and seigniorage. Moreover, the government faces explicit costs of raising taxes, $\frac{1}{2}\phi\tau_t^2 y$. As in Agénor and Neanidis (2007), we assume these costs to be increasing with the tax rate at an increasing rate and also increasing at a constant rate with the endowment. In real per-capita terms the government budget constraint can be written as follows:

$$g_t = \tau_t y + \gamma(1 - \frac{1}{1 + \theta})(1 - \tau)y - \frac{1}{2}\phi\tau_t^2 y \tag{84}$$

with $M_t = (1 + \theta_t)M_{t-1}$ and $\phi \geq 0$, where θ is the net money growth rate and ϕ is the cost parameter. Note, the consolidated government coordinates the activities of the treasury and the central bank, both of which are "equally subservient to the government". The benevolent government maximizes the steady state level of welfare for all future generations, obtained by substituting the equilibrium decision rules into the agents' utility function(s) to determine the optimal levels of the policy variables.[6]

5.3 Optimal Policy Decisions

In this section, we analyze the optimal policies for the government in the face of a rise in the cost of tax collection. For this purpose, we study the behavior of a benevolent government or social planner who maximizes the utility of all consumers, evaluated at the steady state, by choosing γ, τ and θ, following alternative values of ϕ. Specifically, using $\sigma = 1$, the problem for the social planner, with the discount rate $0<\beta<1$, is captured by: $\sum_{i=0}^{\infty} \beta^i[\psi \log(c_{t+1+i}) + (1-\psi)\log(g_{t+1+i})]$, in the case where public good is useful, and $\sum_{i=0}^{\infty} \beta^i[\log(c_{t+1+i})]$, when public expenditures are pure government consumption. The respective welfare functions reduce to $\frac{\psi}{1-\beta}\log(c_t)+$ $\frac{1-\psi}{1-\beta}\log(g_t)$ and $\frac{1}{1-\beta}\log(c_t)$. Equations (76) and (84) are substituted into the respective welfare functions to give the following: $\frac{\psi}{1-\beta}\log[(1+r_{dt+1})(1-\tau_t)y] + \frac{1-\psi}{1-\beta}\log(\tau y +$ $\gamma(1-\frac{1}{1+\theta})(1-\tau)y - \frac{1}{2}\phi\tau_t^2 y)$ and $\frac{1}{1-\beta}\log[(1+r_{dt+1})(1-\tau_t)y]$. Where $1+r_{dt+1} =$ $(1-\gamma_{t+1})(1+x_{t+1}) + \gamma_{t+1}\frac{1}{1+\pi_{t+1}}$.

The respective welfare functions are maximized subject to the following inequality constraints: $\tau \geq 0$, $\tau \leq 0.99$; $\gamma \geq 0$, $\gamma \leq 0.99$; $\theta \geq 0$. In the case where the public good is not welfare enhancing an additional constraint $\frac{g_t}{y} = \tau_t + \gamma(1-\frac{1}{1+\theta})(1-\tau) - \frac{1}{2}\phi\tau_t^2$

[6] A competitive equilibrium for this model economy is a sequence of prices $\{p_t, i_{dt}, i_{lt}\}_{t=0}^{\infty}$, allocations $\{c_{t+1}\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t, d_t\}_{t=0}^{\infty}$, and policy variables $\{\gamma_t, \tau_t, \theta_t, g_t\}_{t=0}^{\infty}$ such that: The consumer's optimal choices are made via (75) and (76); Banks maximize profits such that (79) holds; the goods and money markets clear, i.e., $y + W - \frac{1}{2}\phi\tau_t^2 y = c_{t+1} + c_{t+1}^e + g_{t+1}$, and $M_t = \gamma_t p_t d_t$, respectively, holds, and; The government budget, equation (84) is balanced on a period-by-period basis.

is added. Further, we assume that the government follows time invariant policy rules, which means that the institutionally determined tax rate, τ_t, the cash reserve ratio, γ_t, the money growth rate, θ_t are constant over time.

The problem of the social planner is non-linear in τ, γ, and θ, and hence, cannot be solved analytically. Numerical solution of the problem requires values for the structural parameters of the model. For our experiments below, we use the following set of values: y is normalized to 1; $\sigma = 1.0$, as seen above; [7] $\beta = 0.98$ (Chari *et al.*(1995)) ; $x =$ 2 percent (Bhattacharya and Haslag (2001)); $\psi = 0.75$, 0.50 and 0.25. Based on $\tau =$ 25.00 percent, $\gamma = 17.30$ percent, $\theta = \pi = 21.40$ percent, obtained from Haslag and Young (1998),[8] yields a value of $\phi = 33.66$ percent, when we take into account, that costs of tax collection amounts to 3 percent of total revenue in developing countries (Bird and Zolt (2005) and Agénor and Neanidis (2007)). Given the values of τ, γ, θ, ϕ and y, the size of the government, derived from the government budget constraint, is equal to 21.77 percent. For deducing financial repression is positively correlated with cost of tax enforcement, we start off with our benchmark case of $\phi = 0$. Finally, to check for the robustness of our results, we also use ϕ=0.01, $\phi = 0.05$ and $\phi = 0.09$.[9]

The results of the experiments have been reported in Table 6. Column 1 of the table reports the alternative sizes of the cost parameter. Columns 2 to 4, 6 to 8 and 10 to 12 report the respective optimal values of γ, θ and τ under $\psi = 0.75$, 0.50 and 0.25, i.e, these columns correspond to the three cases where the government expenditure is valued less, equally and more than the consumption good, by the consumer. Columns 5, 9 and 13 report the respective levels of the welfare value under the different values

[7] Our basic results continued to hold for $\sigma = \frac{1}{2}$ and 2.0

[8] The authors derive these values as averages based on 82 countries.

[9] See below for further details, on the choice of these values of ϕ.

of ψ as the cost of tax collection, ϕ, increases. While, the optimal policy parameters and obtained social welfare, when the government expenditures are pure government consumption, are reported in Columns 14 through 17.

Table 6: **Optimal Policy Decisions**

	Useful Public Good															
	$\psi = 0.75$				$\psi = 0.5$				$\psi = 0.25$				Useless Public Good			
Cost	γ^*	θ^*	τ^*	W	γ^*	θ^*	τ^*	W	γ^*	θ^*	τ^*	W	γ^*	θ^*	τ^*	W
$\phi = 0.00$	0	∞	0.25	-0.5475	0	∞	0.5	-0.6832	0	0	0.75	-0.5574	0	0	0.2177	-0.2257
$\phi = 0.01$	0.25	∞	0	-0.5475	0.5	∞	0	-0.6832	0.75	∞	0	-0.5574	0	0	0.2177	-0.2257
$\phi = 0.05$	0.25	∞	0	-0.5475	0.5	∞	0	-0.6832	0.75	∞	0	-0.5574	0	0	0.2177	-0.2257
$\phi = 0.09$	0.25	∞	0	-0.5475	0.5	∞	0	-0.6832	0.75	∞	0	-0.5574	0.2177	∞	0	-0.2257
$\phi = 0.3366$	0.25	∞	0	-0.5475	0.5	∞	0	-0.6832	0.75	∞	0	-0.5574	0.2177	∞	0	-0.2257

W = Value of the social welfare function.
Policy Parameters defined as above.

The following observations can be made from Table 6:

Useful Public Expenditures (Columns 2 through 13): (a) When $\phi = 0$, i.e., there is no cost of tax collection, the optimal money growth rate is always set at infinity, while reserve requirements are always set to zero, irrespective of the weight the consumer assigns to private consumption and public good in the utility function. Given, that the reserve requirement, which measures the size of the seigniorage base, is equal to zero, the optimal seigniorage is zero in this case. The optimal value of the tax rate, is, however, set equal to the weight of the government good in the utility function; (b) When $\phi = 0.01$, the basic results in (a) are reversed. Now all the revenue is raised via seigniorage, with money growth rate set at infinity and the reserve requirement set to the weight of the government good in the utility function. $\phi = 0.01$, thus, serves as a threshold for the switch from explicit to implicit taxation; (c) Moreover, with ϕ= 0.05; ϕ=0.09; and $\phi = 0.3366$, and beyond, the results in (b) stay the same, and; (d) Across the different weights on the consumption and public good, the size of the optimal value of the welfare, though, remains unaffected following changes in the optimal policy decisions with varying costs of tax collection.

Useless Public Expenditures (Columns 14 through 17): (a) The optimal policy decisions of the government are qualitatively the same as above. However, the threshold required for the switch from direct to indirect taxation takes place at a higher value of ϕ, specifically, 0.09, beyond which the results continue to be the same. Intuitively, this is because in this case the government expenditure is not useful to the consumers, and hence, higher costs of tax collection do not directly affect the utility adversely. So, unless the cost parameter is high enough, to adversely affect the government budget constraint, the switch does not take place. Understandably, thus, the cut-off value for the cost parameter to produce the government to move to seigniorage completely is higher, when compared to the case of productive public expenditures. (b) Further, note that the tax rates and the reserve requirements, when positive, are tied to the size of the government, i.e., $\frac{g}{y}$. (c) Until the threshold level of $\phi = 0.09$, the optimal money growth rate continues to stay at zero, and then rises to infinity. (d) Finally, the size of the optimal value of the welfare, as in the case of purposeful public expenditures, remains unaffected following changes in the optimal policy decisions with varying costs of tax collection.

Thus, in summary, one can draw the following general conclusions:

- Small costs of tax collection can ensure positive levels of financial repression;
- However, cost of tax enforcement cannot produce monotonic increase in financial repression;
- Beyond a certain level of the cost of tax collection, movements in the reserve requirements are governed by weights attached to the government good, or by the size of the government;
- So, as far as the reliance on indirect taxation, in our case seigniorage, is concerned, we show that positive (minor) costs of tax collection can lead to positive levels of indirect taxation, as a welfare maximizing outcome. Interestingly, in Agénor and Neanidis (2007), the welfare optimizing outcome indicated that the direct and consumption taxes to be substitutable irrespective of whether the exogenous cost of tax collection was zero or positive.

- Our results, are, however, relatively comparable to when we consider the case of positive and endogenous cost of tax collection discussed in Agénor and Neanidis (2007). The authors show that growth-maximizing direct and (consumption) indirect taxation are negatively related to their respective (and cross) costs of tax collection. However, the growth-maximizing value of the consumption tax rate is zero when collection costs do not exist, and hence, the government relied completely on direct taxes. But then again, unlike them, our results are based on a welfare optimizing outcome, besides, the fact that our model cannot account for a positive monotonic relationship between seigniorage and the costs of direct tax collection.

5.4 Conclusion

In this paper, using an overlapping generations production-economy model characterized by financial repression, purposeful government expenditures and cost of tax collection, we analyze whether financial repression can be explained by the cost of raising taxes. Following other studies in the literature, we define financial repression through an obligatory "high" reserve deposit ratio requirement, that the banks in the economy need to maintain. In other words, this study attempts to assay whether costly tax enforcement can provide a rationale for financial repression. But more generally, the study also attempts to find the optimal policies of a benevolent government following an increase in the cost of tax collection, when the consolidated government has access to income taxation and seigniorage as sources of revenue.

When numerically analyzed for a world economy, the following basic conclusions could be drawn: (i) Beyond a threshold value, positive cost of tax collection results in financial repression as an welfare maximizing outcome; (ii) However, costs of tax collection and financial repression do not possess a monotonic positive relationship. On and beyond the threshold level, the role and size of the government is critical in the analysis. In fact, as pointed out above, beyond a certain level of the cost of tax collection, movements in the reserve requirements are governed by weights attached to the government good or the size of the government. So, in general, the paper shows that a benevolent social planner would only rely on seigniorage once the cost of tax enforcement crosses a threshold limit, with the latter being relatively higher, when public expenditures are not valued by the consumers. An immediate extension of the current study would be to revisit our results using an endogenous growth framework similar to that of Agénor and Neanidis (2007), but with a monetary side included in it, for we strongly believe that such a framework will help us to produce the monotonicity in the relationship between cost of tax collection and the policy parameters.

Chapter 6

Costly Tax Enforcement and Financial Repression: A Reconsideration Using an Endogenous Growth Model

6.1 Introduction

Using a Barro-type monetary endogenous overlapping generations model, characterized by costly tax enforcement and financial repression, we analyze the relationship between the costs of tax collection and financial repression. We follow the dominant trend in the literature[1] in defining financial repression through an obligatory "high" reserve deposit ratio requirement, that the banks in the economy need to maintain.[2] Specifically, we analyze whether the "high" reserve requirements in a closed economy characterized by costly tax collection are a fall out of a welfare maximizing decision

[1]See for example, Drazen (1989), Bacchetta and Caminal (1992), Haslag and Hein (1995), Espinosa and Yip (1996), Haslag (1998), Haslag and Koo (1999), Haslag and Bhattacharya (2001), Gupta (2005, 2006, 2008a) and Gupta and Ziramba (2008a, b, c) amongst others.

[2]Financial repression, though, can involve other set of government legal restrictions, like interest rate ceilings and compulsory credit allocation, besides, "high" reserve requirements, that prevent the financial intermediaries from functioning at their full capacity level. However, given the wave of interest rate deregulation in the 1980s, and removal credit ceiling some years earlier, the major form of financial repression is currently via obligatory reserve requirements (Caprio *et al.* (2001)).

of the government, which has access to income taxation and seigniorage as sources of revenue.

Given that the concern is not whether financial repression is prevalent, but the associated degree to which an economy is repressed, since developed and developing economies both resort to such restrictive policies (Espinosa and Yip (1996)), the pertinent question is - Why, if at all, would a government want to repress the financial system ? This seems paradoxical, especially when one takes into account the well documented importance of the financial intermediation process on economic activity, mainly via the finance-growth nexus.[3] Besides, the fact that "high" cash reserve requirements enhance the size of the implicit tax base and hence, is lucrative for the government to repress the financial system. Alternative explanations, with varied levels of success, have ranged from: inefficient tax systems (Cukierman *et al* (1992)) and Giovannini and De Melo (1993)) and tax evasion (Roubini and Sala-i-Martin (1995), Gupta (2005, 2006, 2008b) and Gupta and Ziramba (2008a)) to degree of financial development (Di Giorgio (1999)) and asymmetric information (Gupta (2006)) and banking crisis (Gupta (2005)), productive public expenditure (Basu (2001)) and bureaucratic corruption (Gupta and Ziramba (2008b)), currency substitution (Gupta (2008a) and, finally, costly tax enforcement (Gupta and Ziramba (2008c)).

In fact, the motivation for this study emanates from Gupta and Ziramba (2008c). The authors, in this study, using a simple overlapping generations model for a production economy characterized by costly tax enforcement and financial repression, showed

[3] See Roubini and Sala-i-Martin (1992), Rousseau and Wachtel (2002), Agbetsiafa (2004), Acaravci and Ozturk (2007) and Bose *et al.* (2007).

that, with public expenditures affecting utility of the agents, modest costs of tax collection tend to result in financial repression being pursued as an optimal policy by the consolidated government. However, when public expenditures are purposeless, the above result only holds for relatively higher costs of tax collection. But, more importantly, costs of tax collection cannot produce a monotonic increase in the reserve requirements, what are critical, in this regard, are the weights the consumer assigns to the public good in the utility function and the size of the government.

Our objective in this paper is not only checking whether the results of Gupta and Ziramba (2008c) continue to hold under the assumption of endogenous growth, with the endogeneity in the growth process being obtained through productive public expenditures (Barro (1990)), but also, and perhaps more importantly, we would want to analyze if our model, by adding a supply-side to the economy, could produce a monotonic relationship between the reserve requirements and the costs of tax collection. This paper, thus, extends the work of Gupta and Ziramba (2008c). To validate our analysis, and given that the welfare optimization problem in the model is a non-linear one, as in Gupta and Ziramba (2008c), the theoretical model is numerically analyzed by calibrating it to a world economy. It must, however, be noted that our model is a general one and can be applied to any economy subjected to financial repression and costly tax enforcement. To the best of our knowledge, this is the first attempt to analyze costly tax collection as a rationale for financial repression in an economy with productive public expenditures in an endogenous growth framework.

Alternatively, the current study can also be viewed as an analysis that looks into the optimal mix of explicit and implicit taxation of a consolidated government in the presence of costs of collecting direct taxes. In this regard, this paper, is comparable to Agénor and Neanidis (2007). In this paper, the authors show that in the presence of positive and endogenous cost of tax collection, i.e., with the cost of tax collection depending on the resources spent by the government to improve monitoring of tax payers, growth-maximizing direct and (consumption) indirect taxation are negatively related to their respective (and cross) costs of tax collection. However, the growth-maximizing value of the consumption tax rate is zero when collection costs do not exist, and hence, the government relied completely on direct taxes. Further, with no costs of tax collection, the welfare optimizing outcome indicated the direct and consumption taxes to be substitutable, which was also the case with exogenous cost of tax collection. Finally, under exogenous costs of tax enforcement, the growth-maximizing consumption taxation was found to be negatively related to its "own" degree of inefficiency in collecting indirect taxes, and an increase in collection costs associated with direct (indirect) taxation led to a reduction (increment) in the optimal income tax rate. We, by adding money to the model, analyze the role of seigniorage (the implicit tax) relative to the explicit direct tax in the presence of cost of tax enforcement. Thus, though the main motive of our analysis is to relate financial repression to costs of tax collection, our study, in general, is quite similar to what Agénor and Neanidis (2007) do, especially, in terms of the issues we address, on 'optimal' explicit and implicit taxation when there are costs involved in raising direct taxes. Note, our framework as well as our results, unlike those of Gupta and Ziramba (2008c), are more comparable to those of Agénor and Neanidis (2007), since it includes growth. The remainder of the paper is organized as follows: Section 2 outlines the economic environment; Section 3, 4 and 5 respectively, are devoted to defining the competitive equilibrium, discussing the process of calibration, and analyzing the welfare-maximizing choices of policy following an increase in the cost of tax collection. Finally, Section 6 concludes.

6.2 Economic Environment

The economy is populated by four types of agents, namely, consumers, firms, banks (financial intermediaries), and an infinitely-lived government. Time is divided into discrete segments, and is indexed by $t = 1, 2, ...\infty$. There are four types of economic activities: (i) each two-period lived overlapping generations household (consumer/worker) is endowed with one unit of labor when young, but the agent retires when old. Thus, at time t, there are two coexisting generations of young and old. N people are born at each time point t. At t =1, there exist N people in the economy, called the initial old, who live for only one period. The population, N, is normalized to 1. The young inelastically supplies one unit of the labor endowment to earn wage income, which is deposited into banks for future consumption; (ii) the banks simply convert one period deposit contracts into loans, after meeting the cash reserve requirements. No resources are assumed to be spent in running the banks; (ii) each producer is infinitely lived and is endowed with a production technology to manufacture a single final good, using the inelastically supplied labor, physical capital and credit facilitated by the financial intermediaries, and; (iv) there is an infinitely lived government which meets its expenditure by taxing income and controlling the inflation tax instruments -the money growth rate and the reserve requirements. There is a continuum of each type of economic agent with unit mass.

The sequence of events can be outlined as follows: A young household works in a firm and receives wages, the net of tax wage income is then deposited into the banks. A bank, after meeting the reserve requirement, provides loans to a goods producer, which subsequently manufactures the final good and returns the loan with interest. Finally, the banks pay back the deposits with interest to households at the end of the first period, and the latter consumes in the second period.

6.2.1 Consumers

Each consumer possesses a unit of time endowment which is supplied inelastically, and consumes only when old. Formally the problem of the consumer can be described as follows: The utility of a consumer born at t depends on real consumption, c_{t+1}, which implies that the consumer consumes only when old. This assumption makes computation tractable and is not a bad approximation of the real world (see Hall (1988)). Consumers have the same preferences so there exists a representative consumer in each generation.

Formally, the agent's problem, born in period t, is as follows:

$$U_t = U(c_{t+1}) \tag{85}$$

where U(.) is the utility function and is twice differentiable; $u' > 0$; $u'' < 0$ and $u'(0) = \infty$. The utility function is maximized subject to:

$$\begin{aligned} p_t d_t &= (1-\tau_t) p_t w_t && (86) \\ c_{t+1} &= \frac{p_t}{p_{t+1}}(1+i_{dt+1}) d_t && (87) \end{aligned}$$

Specifically, we use the following utility function:

$$U(c_{t+1}) = \frac{c_{t+1}^{1-\sigma}}{1-\sigma} \tag{88}$$

where d_t are the real deposits held in period t; σ is the degree of risk aversion; τ_t is the tax rate at period t; p_t, is the price of the consumption good at period t; i_{dt+1} is the nominal interest rate on bank deposits. Each unit of the consumption good placed into deposits at date t yields $(1+r_{dt+1}) = \frac{(1+i_{dt+1})}{1+\pi_{t+1}}$ units, with $(1+\pi_{t+1}) = \frac{p_{t+1}}{p_t}$ as the gross inflation rate.

6.2.2 Financial Intermediaries

Financial intermediaries provide a simple pooling function by accepting deposits at the beginning of each period. They then make their portfolio decisions (that is, loans and cash reserve choices) with a goal of maximizing profits. At the end of the period, they receive their interest income from the loans made and meet the interest obligations on the deposits received. For simplicity, bank deposits are assumed to be one period contracts. The intermediaries are constrained by legal requirements on the choice of their portfolio (that is, reserve requirements), as well as by feasibility. Given such a structure, the intermediaries obtain the optimal choice for loans, L_t, by solving the following problem:

$$\max_{L,D} \Pi_b = i_{lt}L_t - i_{dt}D_t \tag{89}$$

$$s.t. \; : \; \gamma_t D_t + L_t \leqslant D_t \tag{90}$$

where Π_b is the profit function for the financial intermediary, and $M_t \geqslant \gamma_t D_t$ defines the legal reserve requirement. M_t is the cash reserves held by the bank; L_t is the loans;

i_{lt} is the interest rate on loans, and; γ_t is the reserve requirement ratio. The reserve requirement ratio is the ratio of required reserves (which must be kept in the form of currency) to deposits received. To gain some economic intuition of the effect of reserve requirements on the banking sector, let us consider the solution of the problem for a typical intermediary. It is assumed that financial intermediaries behave competitively and free entry drives profits to zero,

$$i_{lt}(1-\gamma_t) - i_{dt} = 0 \tag{91}$$

Simplifying, in equilibrium, the following condition must hold

$$i_{lt} = \frac{i_{dt}}{1-\gamma_t} \tag{92}$$

Reserve requirements, thus, tend to induce a wedge between the interest rate on savings and lending rates for the financial intermediaries.

6.2.3 Firms

All firms are identical and produce a single final good using the following Cobb-Douglas-type production technology:

$$y_t = Ak_t^{\alpha}(n_t g_t)^{(1-\alpha)} \tag{93}$$

where A > 0; 0$< \alpha((1-\alpha)) < 1$, is the elasticity of output with respect to capital (labor), with k_t , n_t and g_t respectively denoting capital, labor, and government expenditure inputs at time t. At time t the final good can either be consumed or stored. We assume that producers are able to convert bank loans L_t into fixed capital formation such that $p_t i_{kt} = L_t$, where i_{kt} denotes the investment in physical capital. The production transformation schedule is linear so that the same technology applies to both capital formation and the production of the consumption good and hence, both investment and consumption goods sell for the same price p_t in each period. We follow Diamond and Yellin (1990) and Chen *et al.* (2000) in assuming that the goods producer is a residual claimer, that is, the producer uses up the unsold consumption good in a way which is consistent with lifetime value maximization of the firms. This assumption regarding ownership avoids the "unnecessary" Arrow-Debreu redistribution from firms to consumers and simultaneously retains the general equilibrium structure of the model.

The representative firm maximizes the discounted stream of profit flows subject to the capital evolution and loan constraints. Formally, the problem of the firm can be outlined as follows

$$\max_{k_{t+1},n_t} \sum_{i=0}^{\infty} \rho^i [p_t y_t - p_t w_t n_t - (1 + i_{lt}) L_t] \tag{94}$$

$$k_{t+1} \leqslant (1 - \delta_k) k_t + i_{kt} \tag{95}$$

$$p_t i_{kt} \leqslant L_t \tag{96}$$

$$L_t \leqslant (1 - \gamma_t) D_t \tag{97}$$

where ρ is the firm owners' (constant) discount factor, and δ_k is the (constant) rate of capital depreciation. The firm solves the above problem to determine the demand for labor and investment. The firm's problem can be written in the following recursive formulation:

$$V(k_t) = \max_{n,k'} [p_t y_t - p_t w_t n_t - p_t(1 + i_{lt})(k_{t+1} - (1 - \delta_k) k_t)] + \rho V(k_{t+1}) \tag{98}$$

The upshot of the above dynamic programming problem are the following respective first order conditions.

$$k_{t+1} \quad : \quad (1+i_{lt})p_t = \rho p_{t+1}[A\alpha(\frac{g_{t+1}}{k_{t+1}})^{1-\alpha} + (1+i_{lt+1})(1-\delta_k)] \tag{99}$$

$$(n_t) \quad : \quad A(1-\alpha)(\frac{g_t}{k_t})^{(1-\alpha)}k_t = w_t \tag{100}$$

Equation (99) provides the condition for the optimal investment decisions of the firm. The firm compares the cost of increasing investment in the current period with the future stream of benefits generated from the extra capital invested in the current period. And equation (100) states that the firm hires labor up to the point where the marginal product of labor equates the real wage.

6.2.4 Government

The government is assumed to be infinitely-lived. It purchases g_t units of the consumption good. Government expenditures are productive to the agents. Government expenditures are financed through income taxation and seigniorage. The government faces explicit costs of raising taxes, $\frac{1}{2}\phi\tau_t^2 w_t$. As in Agénor and Neanidis (2007), we assume these costs to be increasing with the tax rate (at an increasing rate) and the wage rate. In real per-capita terms the government budget constraint can be written as follows:

$$g_t = \tau_t w_t + \frac{M_t - M_{t-1}}{p_t} - \frac{1}{2}\phi\tau_t^2 w_t \tag{101}$$

with $M_t = (1+\mu_t)M_{t-1}$ and $\phi \geq 0$, where μ is the net money growth rate and ϕ is the cost parameter. Note, the consolidated government coordinates the activities of the treasury and the central bank, both of which are "equally subservient to the government". The benevolent government maximizes the steady-state level of welfare for all future generations, obtained by substituting the equilibrium decision rules into the agents' utility function to determine the optimal levels of the policy variables.

6.3 Equilibrium

A competitive equilibrium for this economy is a sequence of prices $\{p_t, i_{dt}, i_{lt}\}_{t=0}^{\infty}$, allocations $\{c_{t+1}, n_t, i_{kt}\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t, d_t\}_{t=0}^{\infty}$, and policy variables $\{\gamma_t, \mu_t, \tau_t, g_t\}_{t=0}^{\infty}$ such that:

- The consumer maximizes utility given by (85) subject to (86) and (87);
- Banks maximize profits, taking i_{lt}, i_{dt}, and γ_t as given and such that (92) holds;
- The real allocations solve the firm's date–t profit maximization problem, given prices and policy variables, such that (99) and (100) hold;
- The money market equilibrium condition: $m_t = \gamma_t d_t$ is satisfied for all $t \geqslant 0$;
- The loanable funds market equilibrium condition: $p_t i_{kt} = (1 - \gamma_t) D_t$ where the total supply of loans $L_t = (1 - \gamma_t) D_t$ is satisfied for all $t \geqslant 0$;
- The goods market equilibrium condition requires: $c_t + i_{kt} + g_t = y_t - \frac{1}{2}\phi\tau_t^2 w_t$ is satisfied for all $t \geqslant 0$;
- The labor market equilibrium condition: $(n_t)^d$ =1 for all $t \geqslant 0$;
- The government budget is balanced on a period-by-period basis;
- d_t, i_{dt}, i_{Lt}, and p_t must be positive at all dates.

6.4 Calibration

In this section we discuss how we assign values to the parameters of our model, based on a combination of figures from previous studies and those that we calibrate. The problem of the social planner is non-linear in τ, γ, and μ, and hence, cannot be solved analytically. The numerical solution of the problem, in turn, requires values for the structural parameters of the model, and hence, the calibration. Following the standard real business cycle literature, we use steady-state conditions to establish parameter values observed in the data. Some parameters are calibrated using world economy data, while others, correspond to prevailing values from the literature. This section reveals the general procedures used.

A first set of parameter values is given by numbers usually found in the literature. The following parameter values were chosen initially and the specific source is mentioned in the parentheses given aside, except for the standard ones. These are:

- σ: the degree of risk aversion, as stated above, was set to 2;
- α: since the production function is Cobb-Douglas, this corresponds to the share of capital in income. The value chosen was of 0.70 (Basu (2001));
- δ_k: the depreciation rate of physical capital was set at 0.05 or 5 percent (Zimmermann (1994));
- γ: the annual reserve-deposit ratio was fixed at 0.15 (Haslag and Young (1998));
- τ: tax rate was set to 0.25 or 25 percent (Chari *et al.* (1995));

- π: the annual rate of inflation was fixed at 5 percent, and hence, the gross rate of inflation was $1 + \pi = 1.05$ (Basu (2001));

- i_{lt}: the nominal interest rate on loans was set to 0.15 or 15 percent (Gupta (2008a));

- β: the discount rate, is set to 0.98 (Chari *et al.* (1995)).

A second set of parameters are calibrated from the steady-state equations of the model to make them hold exactly: These parameters are:

- ϕ: the cost of tax enforcement. Based on τ = 25.00 percent, γ = 15.00 percent, yields a value of ϕ = 33.66 percent from the steady state measure of the government budget constraint, when we take into account that costs of tax collection amounts to 3 percent of total revenue in developing countries (Bird and Zolt (2005) and Agénor and Neanidis (2007)). We also set this value at 0 (benchmark case), 0.05, 0.1 for the policy experiments discussed in the next section;

- $\frac{g}{k}$: the ratio of government expenditure to capital. Given the values of τ, γ, μ, and ϕ, this was calibrated from the government budget constraint and has a value of 0.0714.

- χ=$\left\{A(1-\alpha)(1-\gamma)(1-\tau)\left(\frac{g}{k}\right)^{1-\alpha}-\delta\right\}$: the net growth rate which is set equal to 2.5 percent (Basu (2001));

- $1 + \mu$: the gross money growth rate is calibrated using the money market equilibrium which implied that $1 + \mu = (1 + \chi) \times (1 + \pi)$. This resulted in the net money growth rate to be equal to 0.076 or 7.6 percent;

- ρ: the discount factor of the firms is solved to ensure that equation (99) holds and is equal to 0.8011;

- A: the value of the production function scalar, is calibrated from the equilibrium conditions to match the growth rate of 2.5 percent and an inflation rate of 5 percent and is equal to 0.8659.

6.5 Optimal Policy Decisions

In this section, we analyze the optimal policies for the government in the face of a rise in the cost of tax collection. For this purpose, we study the behavior of a benevolent government or social planner who maximizes the utility of all consumers, evaluated at the steady state, by choosing γ, τ and μ, following alternative values of ϕ. Specifically, the problem for the social planner is captured by: $\sum_{i=0}^{\infty} \beta^i U(c_{t+1+i})$ subject to inequality constraints $\tau \geq 0$, $\tau \leq 1$; $\gamma \geq 0$, $\gamma \leq 1$; $\mu \geq 0$. Furthermore, as in Basu (2001), we will assume that the government follows time invariant policy rules, which means that the institutionally determined tax rate, τ_t, the cash reserve ratio, γ_t, the money growth rate, μ_t are constant over time.

For deducing whether financial repression is positively correlated with the cost of tax enforcement, we start off with our benchmark case of $\phi = 0$. Finally, to check for the robustness of our results, we also use $\phi = 0.05$ and $\phi = 0.1$, besides, $\phi = 0.3366$.

The results of the policy experiments have been reported in Table 7. Column 1 of the table reports the alternative sizes of the cost parameter. Columns 2 to 4 report

Table 7: **Optimal Policy Decisions**

Cost Parameter	γ^*	μ^*	τ^*	$\frac{Seigniorage}{Tax}$
$\phi = 0.00$	33.68	257.01	50.93	11.90
$\phi = 5.00$	70.34	161.90	36.09	27.86
$\phi = 10.00$	74.81	139.06	28.06	31.31
$\phi = 33.66$	77.36	129.32	22.25	33.92
(i) Parameters defined as above.				
(ii) All values are in percentages.				

the optimal values of τ, γ and μ respectively, under ϕ = 0.00, 0.05, 0.10 and 0.3366, respectively.[4]

One can draw the following general conclusions from Table 7:

- The government optimally reduces the tax rate in response to rising costs of tax collection. Note that in Gupta and Ziramba (2008c), for $\phi = 0$, the tax rate was equal to either the share of the public good in the utility function or equal to size of the government, depending on whether government expenditures were useful or purposeless. Higher values of the cost parameter caused the optimal tax rate to fall to zero;[5]

- Just as the tax rate, the money supply growth rate (rate of inflation tax) tends to fall. However, also note that the value of the money growth rate is always very high. This, though, is a widely observed feature in models analyzing welfare-maximizing policies.[6] In the Gupta and Ziramba (2008c) framework, money

[4]The movement of the optimal policy variables continue to hold for values of ϕ higher than 0.3366. However, given that the obtained value is derived from empirical evidence, we do not report our results beyond it. Further, our results were also found robust to alternative values of α and when we allowed only a fraction of government expenditure to be productive.

[5]In Gupta and Ziramba (2008c), relatively, higher value of the cost parameter was required to produce a zero tax rate, under the case of purposeful public expenditures.

[6]See Bhattacharya and Haslag (2001) for further details.

growth rate was always optimally set at infinity in the case where public expenditure was productive, but was equal to zero in the case of purposeless public expenditure until the reserve requirement became positive;

- As the cost of tax enforcement rises, reserve requirements, or alternatively, the metric for financial repression, increases as part of a welfare maximizing outcome;

- Importantly note, unlike Gupta and Ziramba (2008c), higher costs of tax collection produce a monotonic increase in financial repression. In the production economy model of Gupta and Ziramba (2008c), as long as the tax rate was positive, the reserve requirements continued to be equal to zero. Once higher costs of tax collection ensured an optimal tax rate of zero, the reserve requirement moved with either the share of the public good in the utility function or the size of the government, depending on whether government expenditures were useful or purposeless;

- So, as far as the reliance on indirect taxation, in our case seigniorage, is concerned, we show that as the cost of tax collection increases, the ratio of seigniorage to total revenue increases as part of a welfare-maximizing outcome. Interestingly, in Agénor and Neanidis (2007), the welfare optimizing outcome indicated direct and consumption taxes to be substitutable irrespective of whether the exogenous cost of tax collection was zero or positive.

- Our results are, however, partially comparable when we consider the case of positive and endogenous cost of tax collection discussed in Agénor and Neanidis (2007). The authors show that growth-maximizing direct and (consumption) indirect taxation are negatively related to their respective (and cross) costs of tax collection. However, the growth-maximizing value of the consumption tax rate is zero when collection costs do not exist, and hence, the government relied completely on direct taxes. As can be seen from Table 7, our results, indicate a positive relationship between the cost of collecting direct tax and the size of seigniorage to tax revenue, but, unlike Agénor and Neanidis (2007), we continue to have a non-zero reliance on indirect taxation even when cost of tax collection for direct taxes is equal to zero. But then again, unlike them, our results are based on a welfare optimizing outcome. Note in Gupta and Ziramba (2008c) this was not the case. In that study, movements of the policy variables were not monotonic, neither was the ratio of indirect to direct taxation. The movement in this ratio depended crucially on the size of the government or the weight on the public good in the utility function.

So, in summary, by incorporating a production sector, and hence, extending the simple production economy model of Gupta and Ziramba (2008c), allows us to produce a monotonic positive relationship between financial repression and cost of tax enforcement. Though, even when there does not exist any cost of tax collection ($\phi = 0$), the government relies on a positive level of seigniorage, and thus, positive levels of money growth rate and the reserve requirement, unlike in Gupta and Ziramba (2008c). Further, the share of seigniorage to tax revenue continues to increase as the value of ϕ increases.

Intuitively, the obtained results make sense. An increase in the cost of direct tax collection, results in the fall in the growth rate due to a decline in the productive effect of the government expenditure, which in turn, reduces welfare. The government responds by reducing the tax rate, which, in turn, boosts savings and causes higher growth rate and higher welfare. However, a reduction in the tax rate results in a fall in government revenue and tends to have a negative indirect impact on growth and welfare. To restore the size of the government revenue, the social planner increases seigniorage by increasing the reserve requirement. But given that increases in the reserve requirement tends to reduce the real interest rate on deposits and thus, welfare, the government compensates this move by reducing the money growth rate, and hence, increasing the real interest rate, in such a way that the loss in revenue for a reduction in the money growth rate does not reduce growth and affect welfare indirectly. It must, however, be realized that all these changes occur simultaneously, and the government chooses the policy instruments taking into account the direct and indirect effects on welfare following an increase in the cost of tax collection.

6.6 Conclusion

Using a dynamic general equilibrium overlapping generations monetary endogenous growth model of a financially repressed economy characterized by costly tax enforcement and productive public expenditures, we analyze whether the cost of tax collection can result in a monotonic increase in financial repression, with the latter being modeled through an obligatory “high” reserve deposit ratio requirement, that the banks in the economy need to maintain. In other words, this study attempts to assay whether costly tax enforcement can provide a rationale for financial repression. But more generally, the study also attempts to find the optimal-mix of monetary and fiscal policies of a benevolent government, following an increase in the cost of tax collection.

When numerically analyzed for a world economy, the following basic conclusions could be drawn: (i) Unlike Gupta and Ziramba (2008c), where beyond a threshold value, positive cost of tax collection resulted in financial repression, but costs of tax collection and financial repression did not possess a monotonic positive relationship, we find a positive monotonic relationship between the two, with the government relying on a positive level of seigniorage, even when there are no positive costs of tax collection, and; (ii) The paper shows that a benevolent social planner would rely more on seigniorage relative to the income tax as the cost of tax enforcement increases. Clearly then, cost of direct tax collection can serve as a rationale for the existence of financial repression.

Chapter 7

Optimal Public Policy with Endogenous Mortality

7.1 Introduction

Using a pure-exchange overlapping generations model, where the probability of survival of the agents depends upon the share of government expenditure on health, education and infrastructure, we analyze optimal (welfare-maximizing) policy mix between explicit and implicit taxation. In other words, we investigate how the optimal revenue mix evolves as a benevolent social planner tends to spend greater fractions of its resources into affecting the probability of survival.

Though recent studies, such as Chakraborty (2004), Hashimoto and Tabata (2005), Bhattacharya and Qiao (2006), Bunzel and Qiao (2005), Agénor (2006) and Aisa and

Pueyo (2006) have endogenized mortality rate[1] in general equilibrium models by making it a function of the government expenditure on either health only or health, education and infrastructure,[2] none of these studies,[3] barring Agénor (2006), to some extent, has discussed the role of policies in financing such purposeful public expenditures. But, in his paper, Agénor (2006), proposes a theory of long-run development based on public infrastructure. Besides investing in infrastructure, the government, in this model, is assumed to spend on health services, which, in turn, raises the productivity of labor and lowers the rate of time preference. Moreover, infrastructure is designed to affect the production of both commodities and health services. As a result of network effects, the degree of efficiency of infrastructure is nonlinearly related to the stock of public capital itself, and this, in turn, is shown to possibly lead to multiplicity of equilibrium growth paths. The author indicates that an increase in the share of spending on infrastructure, financed by a cut in unproductive expenditure or foreign grants, may facilitate the shift from a low growth equilibrium to a high growth steady state, provided that governance is adequate enough to ensure a sufficient degree of efficiency in productive public investment.

We, unlike Agénor (2006), are more interested in studying the change in the distributional structure of the revenue as the government spends a greater fraction of its resources on health, education, and infrastructure, and in the process affecting the probability of survival. We assume that the government finances its expenditure

[1] A different set of studies, namely, Blackburn and Cipriani (2002), Kalemli-Ozcan (2002), and Ehrlich and Kim (2005), endogenize the mortality rate by assuming instead that the survival probability of individuals depends on either per capita income or consumption.

[2] See also Agénor (2005) and Agénor and Neanidis (2006) for recent studies that have allowed for the role of health expenditures in the production process in a general equilibrium set up.

[3] Most of these studies have mainly concentrated on steady-state and transitional dynamics of capital accumulation and growth in the endogenous mortality, affected by public expenditure on health.

through direct income taxation and seigniorage, as is generally the case in developing economies, given the poorly developed public debt markets.[4] Though, we must confess that our framework, being a pure-exchange monetary[5] overlapping generations model, is much simpler than the elaborate endogenous growth model used by Agénor (2006). Nevertheless, our framework is suitable enough to study the change in the welfare-maximizing policy mix as the probability of survival increases with the government spending greater fractions of its resources on health, education and infrastructure. An immediate extension of this study would obviously be to check for the robustness of the obtained results based on an endogenous growth framework comparable to that of Agénor (2006). But, to the best of our knowledge, this is the first attempt to study policy mix in the presence of endogenously determined survival probability. The remainder of the paper is organized as follows: Section 2 outlines the economic environment; Section 3 and 4 respectively, are devoted to defining the competitive equilibrium and analyzing the welfare-maximizing policy mix following an increase in the share of government expenditure on health, education and infrastructure in total public outlays. Finally, Section 5 concludes.

7.2 Economic Environment

The economy is populated by three types of agents, namely, consumers, banks (financial intermediaries), and an infinitely-lived government. Time is discrete and indexed by $t = 1, 2{,}3{,}.....\infty$. There is an infinite sequence of agents. Agents live

[4]See Holman and Neanidis (2006) for further details.

[5]We follow Drazen (1989), Bacchetta and Caminal (1992), Haslag and Hein (1995), Espinosa and Yip (1996), Haslag (1998), Haslag and Koo (1999), Bhattacharya and Haslag (2001), Gupta (2005, 2006, 2008a, b) and Gupta and Ziramba (2008a,b,c,d,e) amongst others in introducing money through cash-reserve deposit ratio that the banks in the economy needs to maintain.

for no more than two periods. Each two-period lived overlapping generations consumer/household has preferences defined over a consumption good. The consumer is endowed with y units of the consumption good when young. The agent divides the net of tax endowment, $(1-\tau_t)y$ between consumption, c_t and savings, d_t. The savings are deposited into a bank, operating in a perfectly competitive market.[6] When old, the consumer consumes out of the return on one's young age savings. Thus, at time t, there are two coexisting generations of young and old. Young agents of unit measure are born at each period of time. However, they only survive into the next period with probability ϕ_t, which depends upon their health capital. We assume that the health capital is determined by the fraction of the government spending that is devoted to health, education and infrastructure investment per young person. The young agent born at time point t gives birth to a child at the end of period t, before realizing the mortality shock. The new individual becomes economically active at the beginning of the next period $(t+1)$, but is not assumed to inherit the parent's health stock.

Formally, the agent's problem born in period t is as follows:

$$U(c_t, c_{t+1}) = \log c_t + \phi_t \log c_{t+1} \tag{102}$$

subject to:

$$c_t + d_t = (1-\tau_t)y \tag{103}$$

$$c_{t+1} = \frac{(1+i_{dt+1})}{\phi_t} d_t \tag{104}$$

where $U(.)$ is the utility function, with the standard assumption of positive and diminishing marginal utility; ϕ_t is the probability of survival into the next period; c_t (c_{t+1})

[6] If the banking sector was not perfect then, a higher survival rate would increase the rate of return on savings and encourage more deposits. Note we could have also assumed the households to self-insure against mortality risks via inter-family transfers, in the absence of a banking sector.

are the respective young and old age consumption levels; d_t are the real deposits held in period t; τ_t is the tax rate at period t; p_t, is the price of the consumption good at period t; i_{dt+1} is the nominal interest rate on bank deposits. Each unit of the consumption good placed into deposits at date t yields $(1+r_{dt+1}) = \frac{(1+i_{dt+1})}{1+\pi_{t+1}}$ units, with $(1+\pi_{t+1})$ $= \frac{p_{t+1}}{p_t}$ as the gross inflation rate. Note ϕ, the probability of survival, is defined as a non-decreasing concave function

$$\phi_t = \frac{\beta\psi\left(\frac{g_t}{y}\right)}{1+\beta\psi\left(\frac{g_t}{y}\right)} \tag{105}$$

satisfying $\phi(0) = 0$ and $lim_{\frac{g_t}{y}\to\infty}\ \phi\left(\frac{g_t}{y}\right) = \frac{\beta}{1+\beta} < 1$; $\beta >0$ is a positive scalar; and, $0 < \psi \leq 1$ denotes the fraction of the government expenditure devoted to building up the per capita health capital.

Banks receive the deposits, d_t and are subjected to a standard cash reserve requirement which constraints the banks to hold at least γ_t of each unit of the good deposited, in the form of money. In equilibrium, with money being return-dominated, banks will hold exactly a fraction γ_t in fiat money. Let M_t denote the nominal money balances per young person. Then, $M_t = \gamma_t p_t d_t$ holds. The rest is invested into riskless assets. An investment of one unit of the consumption good in period t produces $1+x$ units of the consumption good in period $t+1$. Consumers do not have direct access to this riskless investment, and hence, require the banks to perform a pooling function on their behalf.[7] Thus, the only form of savings for the consumers is through the deposits with the financial intermediaries. Because fiat money does not pay any interest rate, the gross real return on money between t and $t+1$ is $\frac{1}{1+\pi_{t+1}}$. Throughout the analysis we restrict our attention to equilibria where money is return dominated, or $1+x$

[7]Implicitly, we are assuming that the investment into the riskless assets needs to be in bulk, and hence, cannot be accessed by the young agents on their own.

$>(1/(1+\pi_{t+1}))$. Alternatively, $(1+i_{lt+1})>1$, where i_{lt} is the nominal return on bank investment.

The banking sector is assumed to be perfectly competitive and banks have access to a costless intermediation technology. Profit maximization by the banks causes the gross real return on deposits to be a weighted average of the returns from the investment and money, with the weights being the defined reserve-deposit ratio. Formally,

$$1 + r_{dt+1} = (1 - \gamma_{t+1})(1 + x) + \gamma_{t+1}\frac{1}{1 + \pi_{t+1}} \tag{106}$$

must hold.

The government is assumed to be infinitely-lived. It purchases g_t units of the consumption good. ψ fraction of the public good, which is assumed to be useful in the sense that they indicate the fraction of total government expenditure devoted to building up the health capital of the young individual through investments in health, education and infrastructure. The total government expenditure is financed through income taxation, and seigniorage. In real per-capita terms the government budget constraint can be written as follows:

$$g_t = \tau_t y + \frac{M_t - M_{t-1}}{p_t} \tag{107}$$

with $M_t = (1 + \theta_t)M_{t-1}$ and where θ is the net money growth rate. Note, the consolidated government coordinates the activities of the treasury and the central bank, both of which are "equally subservient to the government". The benevolent government maximizes the steady state level of welfare for all future generations, obtained by substituting the equilibrium decision rules into the agents' utility function to determine the optimal reliance on direct taxation and seigniorage as the value of ψ increases.

7.3 Equilibrium

A competitive equilibrium for this economy is a sequence of prices $\{p_t, i_{dt}, i_{lt}\}_{t=0}^{\infty}$, allocations $\{c_t, c_{t+1}\}_{t=0}^{\infty}$, stocks of financial assets $\{m_t = \frac{M_t}{p_t}, d_t\}_{t=0}^{\infty}$, and policy variables $\{\gamma_t, \theta_t, \tau_t, g_t\}_{t=0}^{\infty}$ such that:

- The consumer maximizes utility given by (102) subject to (103) and (104);
- Banks maximize profits, taking i_{lt}, i_{dt}, and γ_t as given and such that (106) holds;
- The money market equilibrium condition: $m_t = \gamma_t d_t$ is satisfied for all $t \geqslant 0$;
- The goods market equilibrium condition requires: $c_t + c_{t+1} + g_t = y$ is satisfied for all $t \geqslant 0$;
- The government budget is balanced on a period-by-period basis;
- d_t, i_{dt}, i_{Lt}, and p_t must be positive at all dates and $1 + x_{t+1} > (1/(1 + \pi_{t+1}))$.

7.4 Optimal Public Policy

In this section, we analyze how the optimal policy mix between direct taxation and seigniorage would vary as the government spends a greater fraction of its resources in building the health capital of the young agents. In other words, we want to study how government raises its revenue as the value of ψ increases given the size of the government, $\frac{g_t}{y} = z_t$. For the sake of tractability we will assume that the government follows time-invariant decision rules, i.e., $\tau_t = \tau$, $\gamma_t = \gamma$, $\theta_t = \theta$ and finally, $z_t = z$. We will also assume that $\tau y = \delta \times g_t$ and hence, $\frac{M_t - M_{t-1}}{p_t} = (1-\delta) \times g_t$, with $0 \leq \delta (1-\delta) \leq 1$ indicating the share of taxes (seigniorage) in total government expenditures.

Given this, we investigate the behavior of a benevolent government or social planner who maximizes the utility of all consumers, evaluated at the steady state, by choosing δ following increases in the value of of ψ. Specifically, the problem for the social planner, with the discount rate of ϕ, is captured by: $W = \sum_{i=0}^{\infty} \phi^i U(c_{t+i}, c_{t+1+i})$, subject to $0 \leq \delta \leq 1$. Formally, we have the following problem:

$$\max_{0<\delta<1} W = \frac{1}{1-\phi} \log c_t^* + \frac{\phi}{1-\phi} \log c_{t+1}^* \tag{108}$$

where $c_t^* = \frac{1}{1+\phi}(1-\tau)y$; $c_{t+1}^* = \frac{1}{1+\phi}[(1+x)(1-\gamma) + \frac{\gamma}{1+\theta}](1-\tau)y$; $d_t^* = \frac{\phi}{1+\phi}(1-\tau)y$; $\phi = \frac{\beta\psi z}{1+\beta\psi z}$; $\tau = \delta z$; and $\theta = \left(\frac{\beta\,\gamma\,(-1+z\,\delta)\,\psi}{1+2\,z\,\beta\,\psi - \beta\,\gamma\,\psi + \delta\,(-1+z\,\beta\,(-2+\gamma)\,\psi)} - 1\right)$ using the government's budget constraint and the fact that the money market equilibrium holds.

The problem of the social planner is a cubic function in δ, and hence, yields analytical solutions that are difficult to analyze, given the complexity of the two roots. Numerical analysis of the problem, in turn, requires values for the structural parameters of the model. For our experiments below, we use the following set of values based on a combination of figures from previous studies and those that we calibrate.[8]

A first set of parameter values is given by numbers usually found in the literature. The following parameter values were chosen and the specific source is mentioned in the parentheses given aside, except for the standard ones. These are:

- γ: the annual reserve-deposit ratio was fixed at 0.25 (Haslag and Young (1998));
- τ: tax rate was set to 0.20 or 20 percent (Chari *et al.* (1995));
- π: the annual rate of inflation was fixed at 10 percent, and hence, the gross rate of inflation was $1 + \pi$=1.10 (Basu (2001));

[8]The qualitative results of the model are, however, unchanged to alternative choices of parameter values.

- x: net real return on banks' investment in the riskless asset. It was set at a value of 2 percent (Bhattacharya and Haslag (2001));

- ϕ: The survival probability was fixed at 0.80 (Chakraborty (2004)).

A second set of parameters are calibrated from the steady-state equations of the model to make them hold exactly: These parameters are:

- θ: the annual rate of money supply was fixed at 10 percent, and hence, the gross money supply rate was $1+\theta$=1.10=$1+\pi$, given the money market equilibrium;

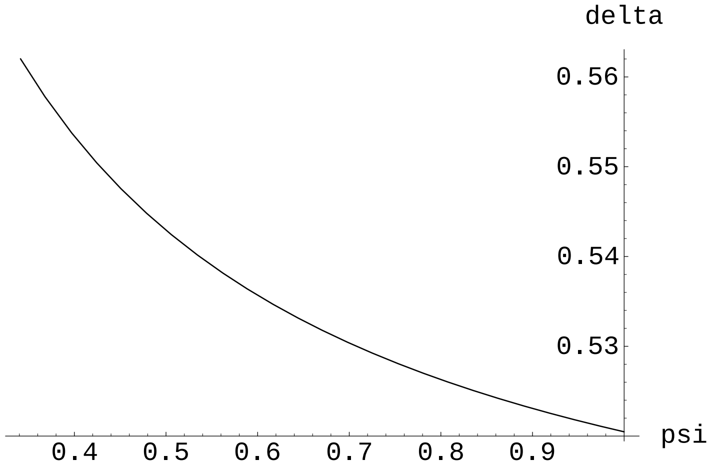
- $\frac{g}{y}$: the ratio of government expenditure to income. Given the values for τ, γ, θ and ϕ, this was calibrated to a value of 20.81 percent from the government budget constraint;

- ψ: the share of health, education and infrastructure in total government expenditure, was obtained using the fact that the average public expenditure share on health, education and infrastructure for over eighty lower income, lower middle income and upper middle income developing countries amounted to 7.10 percent of the GDP (Estache *et al.* (2007)). Using the calibrated value of the total government outlays to GDP, this yielded a value of 0.3412 for ψ.

- β: the scalar in the survival probability function was calibrated to 56.34 so that it matched a value of $\phi = 0.80$, given $\psi = 0.3412$.

Note, maximization of the welfare function, W, with respect to δ yielded two roots for δ as a function of the other parameters of the model. Once the calibrated values of the structural parameters were replaced, the minimum values of γ required to ensure

Figure 4: Relationship between the Share of Taxes in Government Revenue (δ) with the Share of Public Expenditure on Health, Education and Infrastructure



that the value of the roots of δ was between 0 and 1 were, respectively, 0.62 and 0.17.[9] Because the value of 0.62 for γ was higher than 0.25, the value used in the calibrations, we decided to discard the root that yielded this value of γ.[10] Now, assuming a value of $\gamma = 0.25$, Figure 4 plots the relationship between δ and ψ, with the value of ψ being increased from 0.3412 to 1.0.[11]

As can be seen from Figure 4, increases in survival probability as the share of health, education and infrastructure in the total government expenditure increases, causes δ to fall. In other words, the reliance of the benevolent government on seigniorage tends to increase. Intuitively speaking the result makes perfect sense. As the probability of survival increases, *ceteris paribus*, both young- and old-age consumption levels tend to fall, while saving, understandably increases, given the fixed endowment. In such a

[9]The welfare-maximizing solutions for the optimal δ yielded a cubic equation in γ. For our calibration the two other roots for each of the solutions of δ were greater than one, and hence, were ignored.

[10]See Bhattacharya and Haslag (2001) for further details regarding the procedure adopted.

[11]The relationship between ψ and the cut off γ required to ensure a positive δ, was found to be negative, hence, our choice of $\gamma = 0.25$ was maintained for higher values of ψ used in the experiment. Interestingly, if the binding reserve requirements are a metric for financial repression (Gupta, 2005, 2006, 2008a,b and Gupta and Ziramba, 2008a,b,c,d,e), our result indicates that financial repression should be negatively related with the probability of survival.

scenario, it is then optimal for the government to reduce the tax rate to boost young age consumption directly and old age consumption through savings. However, with the reliance on tax rate going down and a fixed amount of government expenditure to be financed, the government has to resort to seigniorage. This, in turn, results in higher money growth rate, given the binding reserve requirements, and hence, taxes the old indirectly.

Recall that taxes on the old are not available, hence, seigniorage serves as the viable alternative for a tax on the old. The fact that the increased use of the inflation tax is an optimal move as the survival probability increases, is easily understood when one realizes that the weight ($\frac{1}{1-\phi}$) on young age consumption in the welfare function is greater than the weight ($\frac{\phi}{1-\phi}$) on the old-age consumption, even though both weights tend to increase at the same rate of $\frac{1}{(1-\phi)^2}$ as ϕ increases. However, it must be noted, that the mere fact that use of seigniorage indirectly taxes the old is not a sufficient justification for its higher utilization as part of welfare maximizing outcome following an increase in the survival rate. The reserve requirement has to be large enough to warrant the use of seigniorage. If the reserve requirement is below the threshold level, the gap between returns to the riskless asset (x) and deposits (r_d), is too small, which, in turn, implies that the old cannot be taxed as required to satisfy the governments budget constraint.[12] Alternatively speaking, our results only hold, when the seigniorage tax base is large enough for the benevolent planner to use the inflation tax.[13]

[12]Note, for every unit of young age savings, the agent loses (x- r_d) units of income when old because of the binding reserve requirement. It is in this sense that it is ultimately the old agents who are effectively getting taxed, if seigniorage is employed.

[13]See Bhattacharya and Haslag (2001) for further details.

7.5 Conclusion

In this paper, using a monetary pure-exchange overlapping generations model, where the probability of survival into the next period depends on the share of health, education and infrastructure expenditures in total public outlays, we analyze the welfare-maximizing policy mix between explicit and implicit taxation. In other words, we investigate how the optimal revenue mix evolves as a benevolent social planner spends a greater fraction of its resources into affecting the probability of survival.

When numerically analyzed for a world economy, the following basic conclusions could be drawn: (i) Increases in the survival probability lead to an increase in the reliance on seigniorage as a welfare maximizing outcome; (ii) Hence, given a binding reserve requirement, increases in the survival rate is found to optimally cause higher inflation via the increase in the money growth rate causing the rise in the seigniorage[14] ; (iii) However, for our results to hold, the seigniorage tax base, determined by the size of the cash reserve requirements, must be larger than a threshold value for the benevolent planner to use the inflation tax. As suggested at the onset, given the simplified nature of our endowment economy model, it would be worthwhile to check for the robustness of our results by moving to an endogenous growth framework similar to that of Hashimoto and Tabata (2005) and Agènor (2006).

[14] Note the rise in seigniorage is not only due to a rise in the money growth rate, but also due to a fall in the tax rate which causes the size of the deposits, and hence, the seigniorage base to increase, given the threshold level of reserve requirements.

Chapter 8

Conclusion

This thesis comprises of six independent papers, besides the introduction and conclusions, with the common theme of optimal public policies in dynamic general equilibrium models with different kinds of distortions. Broadly speaking, the issues considered are: tax evasion, bureaucratic corruption, costs of tax collection and endogenous probability of survival.

The objective of this thesis is to provide the theoretical underpinnings behind the design of optimal fiscal and monetary policies under tax evasion, bureaucratic corruption, costs of tax collection and endogenous probability of survival. With each of the models based on proper microfoundations and calibrated to match features of developing economies. The six independent papers attempt to broaden our understanding on public policies in the presence of commonly observed distortions that characterize the developing world.

The second chapter analyzes whether financial repression can be explained by endogenous tax evasion. In this regard, the chapter develops two dynamic monetary general equilibrium endogenous growth models. When calibrated to four southern European countries, we indicate that higher degrees of tax evasion emanating from higher corruption and lower penalty rates would result in financial repression as a welfare-maximizing outcome.

The third chapter uses a simple monetary economy overlapping generations model characterized by tax evasion, to analyze what the optimal policies are in cases where tax evasion is exogenously determined and where it is a behavioral decision. We highlight the fact that government policies, both fiscal and monetary, will be misaligned if it fails to realize the behavioral nature tax evasion. The government not only chooses a higher tax rate, but also represses the financial sector more by choosing higher reserve requirements. Moreover, with optimal money growth rate being higher, unbounded in this case, the economy experiences higher inflation than it should ideally. Finally, with reported income now dependent on monetary instruments, tax evasion can also be controlled through appropriate choice of monetary policies.

The fourth chapter uses a simple overlapping generations framework to analyze the relationship between openness, bureaucratic corruption, and public policies within a financially repressed economy. When numerically analyzed for a world economy that is developing, the following conclusions could be drawn: (i) increases (decreases) in the degree of corruption lead the government to resort to increasing taxes and money supply growth rate as a social optimum; (ii) as a result of higher corruption the government also reduces the severity of financial repression; (iii) overall, seigniorage to total revenue as well as seigniorage itself fall as the degree of corruption increases. We conclude that corruption is not inflationary due to seigniorage but due to the negative growth-inflation relationship as well as the higher money supply growth.

The fifth chapter uses a production-economy overlapping generations model characterized by financial repression, purposeful government expenditures and cost of tax collection, to analyze whether financial repression can be explained by the cost of raising taxes. When numerically analyzed for a world economy, the following basic conclusions could be drawn: (i) cost of tax collection is *necessary but not sufficient* in producing a positive correlation between financial repression and the size of the cost, and (ii) the role and size of the government is critical in the analysis. In fact, as pointed out earlier, beyond a certain level of the cost of tax collection, movements in the reserve requirements are governed by weights attached to the government good or the size of the government. So, in general, the paper shows that a benevolent social planner would only rely on seigniorage once the cost of tax enforcement crosses a threshold limit, with the latter being relatively higher, when public expenditures are not valued by consumers.

The sixth chapter uses a dynamic general equilibrium overlapping generations monetary endogenous growth model of a financially repressed economy characterized by costly tax enforcement and productive public expenditures, to analyze whether the cost tax collection can result in a monotonic increase in financial repression. When numerically analyzed for a world economy, the following basic conclusions could be drawn: (i) unlike Gupta and Ziramba (2008c), where the cost of tax collection was found to be *necessary but not sufficient* in producing a positive correlation between financial repression and the size of the cost, we find a positive monotonic relationship between the two, with the government relying on a positive level of seigniorage, even when there was no positive costs of tax collection, and; (ii) the paper shows that a benevolent social planner would rely more on seigniorage relative to the income tax as the cost of tax enforcement increases.

The seventh chapter uses a monetary pure-exchange overlapping generations model where the probability of survival of the young agents depends upon the share of government expenditure on health, education and infrastructure, to analyze the welfare-maximizing policy mix between explicit and implicit taxation. We show that increases in the survival probability lead to an increase in the reliance on seigniorage as a welfare maximizing outcome. However, for our results to hold, the seigniorage tax base must be large enough for the benevolent planner to use the inflation tax.

This thesis has contributed to our knowledge on how economies work in a number of ways. First, it provides new explanations for financial repression in the form of tax evasion, costly tax enforcement and bureaucratic corruption. Second, it broadens our understanding on public policies in the presence of commonly observed distortions that characterize the developing world. An immediate extension to the seventh chapter will involve looking at the same issues using an endogenous growth framework and assessing what the optimal policies will be under political instability.