July 2005

Asymmetric Information, Tax Evasion and Alternative Instruments of Government Revenue

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Department of Economics Working Paper Series

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Abstract

Using a pure-exchange overlapping generations model, characterized with tax evasion and information asymmetry between the government (the social planner) and the financial intermediaries, we try and seek for the optimal tax and seigniorage plans, derived from the welfare maximizing objective of the social planner. We show that irrespective of whether the economy is characterized by tax evasion, or asymmetric information, a benevolent social planner, maximizing welfare and simultaneously financing the budget constraint, should optimally rely on explicit rather than implicit taxation.

1 Introduction

The paper explores the relative importance of explicit and implicit taxation, in the presence of tax evasion and asymmetric information. Using a pure-exchange overlapping generations model, characterized with tax evasion and information asymmetry between the government (the social planner) and the financial intermediaries, we try and seek for the optimal tax and seigniorage plans, derived from the welfare maximizing objective of the social planner. In the economic framework, discussed below, the demand for money is a forced-demand, since banks are obligated to hold a "high" fraction of their deposits as cash reserves. Money is assumed to have no other role. In such an environment, the size of the reserve requirement decides the size of the seigniorage tax base, while the implicit tax rate is the money growth rate or the rate of inflation.

The motivation to look into this issue of optimal mix of explicit and implicit taxation, is simply to understand when would, if at all, a government would prefer the former over the latter, based on a welfare maximizing criterion. The social planner, is assumed to have access to income taxation and can choose the size of reserve requirement and money growth rate, and hence, seigniorage, to maximize the welfare of agents subject to its budget constraint.

A popular line of thought, that exists in the literature is that, whenever there are costs of administering taxes or whenever income redistribution is an objective of the government, an implicit tax on domestic financial markets may be part of an optimal taxation structure (Giovanni and De Melo (1993)). Again, Cukierman, Edwards and Tabellini (1992) provides empirical evidence that, countries with a low tax base or high degree of political instability may tend to resort relatively more to seigniorage as an easy source of revenue. In a recent theoretical contribution Roubini and Sala-i-Martin (1995) addresses this issue in a formal fashion, using an endogenous growth framework. They show that governments subjected to large tax-evasion will choose to increase seigniorage by increasing the inflation rates. So, in summary, all these studies tend to suggest the reliance on seigniorage in the presence of explicit costs of tax collection. We use our model, to test the importance of seigniorage revenue from an welfare maximizing perspective, allowing for income tax to be evaded. We analyze whether there exists a correlation between the degrees of tax evasion and the dependance on seigniorage, by numerically solving our model to Greece, Italy, Portugal, and

Spain, and comparing the results with four other developed European economies.

As can be observed from the columns 2 and 3 of Table 1, the Southern European countries have been using both inflation and reserve–deposit ratio as instruments for seigniorage revenue generation. Column 4 of Table 1 reports the degree of tax evasion in eight European economies.[1] Clearly, Greece, Italy, Portugal and Spain, evade a larger percentage of their incomes, in comparison to three of the four developed European Economies and also rely much more on seigniorage. The question is , whether this higher dependance on seigniorage can be motivated out of an optimal decision of the social planner, in the presence of tax evasion.

Besides, trying to relate seigniorage with tax evasion, we analyze whether higher dependance on the same can be a fall out of asymmetric information. In the second half of the paper, we extend our model to incorporate incomplete information, along the lines of Stiglitz and Weiss (1981). The social planner, is assumed to be aware of the facts, that the banks have to access to two alternative investment projects, a risky and a safe one, and would always invest in the former, given that, the latter project promises a higher return than the former. But, the government is in dark regarding the exact probability of success of the project and is only aware of the probability distribution across the banks. In such a situation, we investigate whether the government would resort more to seigniorage for economies which have a lower upper bound to the distribution, than the one with the higher limit. The limits of which are determined by the probability of banking crisis.[2] Note, we start off with the logical premise, that economies with a lower upper bound and hence, higher probability of crisis, might be subjected to higher reserve requirements, which would enhance the seigniorage base. Moreover, given that deposits are insured and the government has to bail out the banks, if and when they fail, the optimally chosen money growth rate, along with the explicit tax rate, might be higher as well. With both the implicit tax rate and tax base higher, presumably, for economies with positive probability of crisis, the seigniorage revenue collected will be comparatively higher than economies where no crisis period could be identified. The model, as before for the certain case, is again numerically evaluated with data from eight European economies. It must, however, be noted that these economies are merely examples and have been chose since they fit the requirements of our modeling. But, the analysis can

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[1]For details regarding the calculation of the degree of tax evasion, see section 5.

[2]See Section 5 for details.

Table 1: **Seigniorage Revenue in some European Economies (1980-2002)**

	Seigniorage (percentages of revenue)	Reserves/ Deposits (percentage)	Annual Inflation rate	Tax Evasion (percentage)
Spain	6.4^a	12.0	6.8	18.0
Greece	19.4^b	22.9	14.9	22.0
Italy	3.7^b	11.7	7.5	21.0
Portugal	6.0^c	17.5	12.2	18.0
Belgium	0.6^c	1.0	3.2	18.0
France	0.5^c	2.0	4.1	13.0
Germany	1.5^c	5.6	2.5	14.0
UK	0.6^c	1.7	5.2	11.0

Source: IFS – IMF International Financial Statistics.

Seigniorage has been calculated from lines 14a and 14c.

Also see notes to Table 1.

[a]: Excludes the year 2002.

[b]:Excludes the years 1998-2002.

[c]: Excludes the years 1999-2002.

See Section 7.

be applied to any other economies that are subjected rely heavily on seigniorage and have "high" obligatory reserve requirements, serving as the seigniorage base.

To the best of our knowledge, such an attempt to figure out the relative importance of explicit and implicit taxation, based on a welfare criterion for a economy characterized by tax evasion and asymmetric information is the first of its kind. The rest of the paper is organized as follows. Sections 2, 3 and 4 lays out and solves the model with tax evasion, defines the equilibrium and the welfare criterion. While, sections 5 and 6 respectively, are devoted in designing the model for an uncertain world and discussing the process of calibration. Section 7 finds out the optimal values of the policy instruments for the certain and the uncertain world and section 8 concludes.

2　The Economic Environment

The economy described here is a modified version of the standard overlapping generations model. Time is discrete and there is an infinite sequence of periods indexed by t=1, 2, 3... Agents live for two periods. 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). At date $t = 1$, there are N people (the initial old) who live for only one period. Note population is constant and hence N is normalized to 1. In addition there is a banking sector and an infinitely-lived government.

Specifically speaking, there are three agents operating in the economy: (i) Each two period lived overlapping household (consumer) has preferences defined over the same private good. The consumer is endowed with 1 unit of consumption good when young. The agent invests the net of tax endowment in bank deposits. When old, the consumer is retired, and consumes out of his young age savings. (ii) The financial sector (banks) simply converts banking deposits into loans, after setting aside a fixed reserve requirement. The banking sector is assumed to be perfectly competitive. The modification of the benchmark model allows for asymmetric information between the government (social planner) and the banks regarding investment opportunities of the latter. Given deposit insurance and assurance of bank bailout results in a moral hazard type of incomplete information problem. (iii) The infinitely–lived government finances its expenditures

and later the cost of bailouts and deposit insurance subsidies by using income taxes, the deposit insurance fees (available only with the presence of information asymmetry) and seigniorage, determined through the optimal choice of inflation rate and the required reserve ratio.

2.1 Complete Information

2.1.1 Consumers, Banks and Government

As outlined above each agent is endowed with one unit of a consumption good when young, and invests the endowment net of taxes in bank deposits, and in the second period consumes out of the income from savings. Each agent born at date $t \geq 1$ have the same preferences defined over their old age consumption and hence, there exists a representative consumer in each generation. The preferences of a consumer born at time t are summarized by the following utility function and can be written as:

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

where c_{t+1} denotes the consumption by an old agent born at time t. We assume that u is twice continuously differentiable, and strictly concave; formally, $u' > 0$, $u'' < 0$ and $\lim_{c \to 0}[u'(c)] = \infty$. 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.[3]

Agents have access to two vehicles for transferring income over time: deposits and money. The former yields a real return of r_{dt} in that each unit of the consumption good placed into deposits at date t yields $1 + r_{dt}$ units of consumption good at date $t + 1$.

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.[4] In equilibrium, with money being return-dominated, banks will hold exactly a fraction γ_t in fiat money. Let m denote nominal money balances per young person. Then, $m_t = \gamma_t d_t p_t$ holds. Note p_t denote the price level at time t. The rest is invested in government bonds. An investment of one unit of consumption good in period t produces $1 + r$ unit of consumption good in period $t + 1$. Consumers do not have direct access

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[3]See Hall (1988).

[4]Note γ_t would be a choice variable for the social planner.

to government bonds. Their only form of savings 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 $\frac{1}{1+\pi_{t+1}} = \frac{1}{1+(p_{t+1}/p_t)}$. Throughout the analysis we restrict our attention to equilibria where money is return dominated, or $1 + r_t > (1/(1+\pi_{t+1}))$. Alternatively, $(1 + R_t) > 1$, where R_t 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 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. Note the weights are being the reserve-deposit ratio. Formally,

$$1 + r_{dt} = (1 - \gamma_t)(1 + r_t) + \gamma_t \frac{1}{1 + \pi_{t+1}} \tag{2}$$

must hold. In the present model, the demand for bank loans is perfectly elastic.

The government has a "purposeless" spending of g_t units (per young person) each period. The revenue needed to fund this expenditure comes from the revenue raised by the two wings of the government: the treasury and the central bank. The former collects income taxes from the young, a fraction $(1 - \alpha)$ of which is evaded.[5] The latter controls the nominal stock of money, M – contributing to the government's revenue needs by creating new money, and reserve requirements and in the process raises seigniorage.

The agent solve a program to maximize lifetime welfare (1). Let τ_t be the income tax rate. Note the agent evades a fraction $(1 - \alpha)$ of the income tax and hence has a tax liability of $\alpha\tau_t$. Agents take τ_t as given when computing their decision rules. The representative agent born at period $t \geq 1$ finds c such that (1) is

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[5]We follow Roubini and Sala-i-Martin (1995) in modeling the tax evasion. Roubini and Sala-i-Martin however, uses a richer specification in modeling tax evasion. The reported income is related to the actual income in the following manner: $RY_t = \frac{\alpha Y_t}{\tau(t)^{1-\zeta}}$, with $\alpha\tau^\zeta \leq \tau$. Large values of ζ and α correspond to efficient legal systems that impose large penalties on tax evaders (efficient police and tax collection departments, etc.) which leads people to report most of their income. Note in this case, income tax revenue collected by the government is given by: $\alpha\tau^\zeta Y_t$. In our case, the choice of a simpler specification, or alternatively a special case ($\zeta = 1$) of the above specification is sufficient and is also data driven. Modeling tax evasion this way helps it to relate it to the size of the underground economy and makes calculations easily interpretable.

maximized subject to the following per-period budget constraints:

$$(1 - \alpha\tau) \geq d_t \tag{3}$$

$$(1 + r_{dt})d_t \geq c_{t+1} \tag{4}$$

Combining the budget constraints for the consumer optimization, and equilibrium interest rates on deposits from the banks optimization problem, yields the solution for the old age consumption $c(t+1)$, defined as

$$c_{t+1} = [(1 - \gamma_t)(1 + r_t) + \gamma_t \frac{1}{1 + \pi_{t+1}}](1 - \alpha\tau_t) \tag{5}$$

The government budget constraint (in nominal terms) represented as:

$$p_t g_t = p_t \alpha\tau_t + M_t - M_{t-1} \tag{6}$$

where B is the aggregate nominal bond holding by the banks.

Note throughout the analysis we assume that money growth is dictated by a rule, $m_t = (1 + \mu_t)m_{t-1}$, where μ is the rate of growth of money. Using, $m_t = \gamma_t p_t d_t$, the government budget constraint in real per-capita terms can be rewritten as

$$g_t = \alpha\tau_t + \gamma_t d_t (1 - \frac{1}{1 + \mu_t}) \tag{7}$$

Note the government (social planner) coordinates the activities of the treasury and the central bank, both of which are "equally subservient to the government".

The planner maximizes the steady state level of welfare for all future generations, obtained by substituting the equilibrium decision rules into the agents utility function,[6] to determine the optimal levels of the policy variables.

3 Equilibrium

A valid perfect-foresight, competitive equilibrium for this economy is a sequence of prices $\{p_t, r_{dt}, r_t\}_{t=0}^{\infty}$, allocations $\{c_t\}_{t=0}^{\infty}$, 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:

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[6]See below for details

- Taking the endowment, τ_t, r_t, γ_t, μ_t, p_t, r_{dt} the agents optimal savings behavior is characterized by (4);

- Banks maximize the gross real return to deposits, taking, r_t, γ_t, and $\frac{p_t}{p_{t-1}}$ as given;

- Goods and money markets clear and (7) is satisfied.

- d_t, r_{dt} and p_t must be positive at all dates and $1 + r_t > \frac{1}{1+\pi_t}$

- The government budget constraint holds on a period-to-period basis.

4   Optimal Policy Choices

Through out the paper we will confine our attention to the stationary equilibrium. In steady-state with no growth, the money market equilibrium implies the equality between the rate of inflation and the rate of growth of fiat money. Formally, $1 + \pi_t = 1 + \mu_t$. Thus, using (2), it follows

$$1 + r_{dt} = (1 - \gamma_t)(1 + r) + \frac{\gamma_t}{1 + \mu_t} \tag{8}$$

The optimal old-age consumption decision, incorporating the money market equilibrium is given as follows:

$$c_{t+1}^* = [(1 - \gamma_t)(1 + r_t) + \gamma_t \frac{1}{1 + \mu_{t+1}}](1 - \alpha\tau_t) \tag{9}$$

The steady-state level of welfare for all future generations is obtained by substituting the equilibrium decision rules into the agents utility function, to yield the following social welfare function:

$$W = U\left([(1 - \gamma)\frac{(1 + R)}{1 + \mu} + \gamma \frac{1}{1 + \mu}](1 - \alpha\tau)\right) \tag{10}$$

Note specifying that the consumer consumes only in the second period, makes the choice of the preference function irrelevant and hence our results are not preference dependent.The social planner maximizes W or alternatively the return on deposits choosing τ, γ and $\mu = \pi$, to determine the optimal choices of the policy variables, subject to the set of inequality constraints: $0 \leq \tau \leq 1$, $0 \leq \gamma \leq 1$, $\mu \geq 0$ and the government budget constraint evaluated at the steady state.

5 Asymmetric Information

The economic environment, characterized by deposit insurance and bailouts, the banks have the incentive to invest in a risky project. The banks are endowed with X units of consumption good and an investment technology which promises a gross nominal return of $(1 + R^h)$, if successful with some positive probability q, but fails with probability $1 - q$, and without any loss of generality, yields zero return. Note we assume that for the investment technology to take effect the banks require an investment greater than the endowment. Moreover, the expected profit from investing in the project is greater than just sitting idle with the endowment and consuming it. These two assumptions rationalizes the demand for deposits on behalf of the banks. The banks are assumed to be risk-neutral. The fact that the banks knows the probability of success but the government does not, is the source of asymmetric information. However, the social planner knows the density function, $f(q)$, which characterizes the distribution of q across the banks.

Given deposit insurance the consumer problem is unchanged. The problem for the bank can be reformulated accordingly to take into account the investment in the risky project. The expected profit of the bank, in real terms, is given by the following expression

$$E(\pi_{Bt}) = q(1 + R_t^h)((1 - \gamma_t)d_t + X) + \gamma_t - q(1 + R_{dt})d_t - \frac{1}{2}q\varepsilon_t d_t^2 \tag{11}$$

where $E(\pi_{Bt})$, d_t, R_{dt}, and ε are expected profit of a bank, the demand for deposits, the gross nominal return on deposits and the deposit insurance premium respectively. Recall that banks have to set aside a cash reserve requirement such that $l_t = (1 - \gamma_t)d_t$. Note when the bank fails there is no payment to the households, but given that deposits are insured the government needs to step in to bail out the banks. So by controlling the size of reserve requirements the government can not only reduce the gambling tendencies of the banks but also the associated budgetary pressures, under possible bank failures, though the revenue raised by the implicit-taxation.

Profit maximization yields the following demand function for deposits

$$d_t^* = \frac{(1 + R_t^h)(1 - \gamma_t) + \frac{\gamma_t}{q} - (1 + R_{dt})}{\varepsilon_t} \tag{12}$$

The equilibrium in the deposit market, given that the supply of deposits $(1 - \alpha\tau_t)$, implies the following

relationship between the interest rate on deposits, the risky return and the deposit insurance premium

$$(1 + R_{dt}) = (1 + R_t^h)(1 - \gamma_t) + \frac{\gamma_t}{q} - \varepsilon_t(1 - \alpha\tau_t) \tag{13}$$

Note just as the size of the population, the number of banks have been normalized to 1. The single-bank, however is assumed to operate in a perfectly competitive free-entry environment. So that, with entry, profits are driven to zero in the long-run. Equation (13) above implies a wedge between the nominal return on the investment and the nominal interest rate on deposits.

To determine the cut-off probability which would ensure that the bank end up investing in the risky project we need to deduce the marginal project. The bank will want to invest in the risky project so long as

$$E(\pi_{Bt}) \geq X \tag{14}$$

holds. Substituting d_t^* into (11) implies

$$\hat{q}_t \geq \frac{X}{(1 + R_t^h)X + \frac{1}{2}\varepsilon_t(1 - \alpha\tau_t)^2} \tag{15}$$

It must be pointed out that, the steady-state analysis ensures that the probability of success, and hence failure, is time-independent. So to summarize the government is perfectly aware of the fact that the banks will invest in the risky project but does not know the exact probability of success of the project. However, the probability distribution is of common knowledge.

Taking into account the bail-out costs and deposit insurance subsidies, the government budget constraint in real per-capita terms can be written out as follows:

$$
\begin{aligned}
g_t &= \int_{\hat{q}_t}^{\theta_2} \alpha\tau_t f(q_t)dq_t + \int_{\hat{q}_t}^{\theta_2} \gamma_t d_t(1 - \frac{1}{1 + \mu_t})f(q_t)dq_t + \int_{\hat{q}_t}^{\theta_2} \frac{1}{2}\varepsilon_t d_t^2 q_t f(q_t)dq_t \\
&\quad - \int_{\hat{q}_t}^{\theta_2} (1 - q_t)(1 + R_{dt})d_t f(q_t)dq_t - \int_{\hat{q}_t}^{\theta_2} \frac{1}{2}(1 - E(q_t))d_t^2 f(q_t)dq_t
\end{aligned} \tag{16}
$$

where θ_2 is the upper-limit of $f(q)$, which will be assumed to be an uniform distribution.[7] The first two terms on the right-hand side of the budget constraint indicate the revenue from income taxation and seigniorage. The third term shows the income of the government from deposit insurance given that the project is successful with the banks having the incentive to invest in the risky-project. The fourth term is indicative of the size

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[7]See below the section on calibration for details.

of the bail out costs of the government when the bank fails given that it invests in the risky project. The last term captures the cost incurred by the government, in case the deposit insurance are subsidized and not set at the actuarially fair level. In our case the actuarially fair level of deposit insurance premium is when $\varepsilon_t = 1 - E(q_t)$, where $E(q_t)$ is the expected value of the probability of success.

Replacing the optimal choices of the consumer, the social welfare function is given by the following expression[8]:

$$W = \left\{ \int_{\hat{q}}^{\theta_2} \left[U \left([(1-\gamma)\frac{(1+R^h)}{1+\mu} + \gamma \frac{1}{q(1+\mu)} - \frac{\varepsilon(1-\alpha\tau)}{1+\mu}](1-\alpha\tau) \right) \right] f(q)dq \right\} \tag{17}$$

The social planner maximizes (17) through the choices of τ, γ and μ subject to the set of inequality constraints: $0 \leq \tau \leq 1$, $0 \leq \gamma \leq 1$, $\mu \geq 0$, and also the government budget constraint evaluated at the steady state.

An equilibrium for the uncertain world can be defined in the same vein as that of the certain world along with a constraint on the deposit insurance suggesting it to be actuarially fair, unless subsidized.

6   Calibration

In this section we attribute values to the parameters, most of them being country–specific. The problem for the social planner is a non-linear constrained maximization problem, which cannot be solve analytically. Hence, assigning values to the parameters of the model is critical. We select the parameter values for our benchmark model using a combination of figures from previous studies and facts about the economic experience for our sample economies between 1980 and 1998. Note, unless otherwise stated, the source for all data is the IMF – International Financial Statistics (IFS).

- Along the lines of Gray and Wu (1995), we assume $f(q)$ to follow an uniform distribution. The rationale for such a choice is simply the fact that the relative frequency with which we may observe the value

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[8]Notice we are implicitly assuming that the participation constrain for the banks always hold,i.e., the probability of success is high enough to ensure that the expected profit from participating is greater than consuming the endowment. Naturally, we are ignoring the range of the probability distribution for which the economy would merely boil down to an autarkic world with consumers and banks consuming there endowments. Such a formulation makes our analysis independent of the choice of any utility function.

of the the probability of success to lie between a region would be approximately the same as the relative frequency with which we observe the value of q between the lower limit and the upper limit of the distribution. The uniform distribution is a two parameter density function defined over a closed interval. A random variable q is said to have an *uniform probability distribution with parameters θ_1 and θ_2* if and only if the density function of q is

$$f(q) = \begin{cases} \frac{1}{\theta_2 - \theta_1}, & \theta_1 > 0, \theta_2 > 0; \theta_1 \leq q \leq \theta_2 \\ \\ 0, & \text{elsewhere} \end{cases} \tag{18}$$

We will set θ_1 equal to 0. The value of θ_2 is obtained by using evidence on banking crises, and corresponds to one less the probability of crisis. The intuition is that, if the economy has a positive probability of banking crises, given its inherent financial and economic structure, the upper limit of the distribution (θ_2) can never be equal to one. Besides, if q is an uniformly distributed random variable with parameters θ_1 and θ_2, then $E(q) = \frac{\theta_1 + \theta_2}{2}$ and $V(q) = \frac{(\theta_2 - \theta_1)^2}{12}$.

- θ_2: The probability of banking crisis is obtained from Gupta (2005). Gupta (2005), follows the Demirgùç-Kunt and Detragiache (2001) study closely and, obtains the probabilities by fitting a logistic model to the panel of eight countries of our concern. The probability of crisis is measured as an an average of the values obtained across the crisis dates, which were obtained based on some ad-hoc measures. Given that, Gupta (2005) could not identify any episodes of banking crisis for Belgium, France, Germany and the U.K., the probability of crisis is zero and hence, θ_2 is set equal to 1 for these economies. Where as given the crisis dates and the associated probabilities of banking crisis, for Spain, Italy, Greece and Portugal, the value of θ_2 evaluated lies between 0.64 (Portugal) and 0.92 (Greece).

  A second set of parameters is determined individually for each country. Here, we use averages over the whole sample period to find values that do not depend on the current business cycle. These parameters are listed in Table 2.

- UGE: The parameter measures the size of the underground economy as a percentage of GDP. The values are obtained from Schneider and Klinglmair (2004) and lies between 12.3 percent (France) to 28.3 percent (Greece).

- $\frac{T}{Y}$: The parameter measures the taxes paid as a percentage of the GDP, and is obtained from www.worldinfigures.org. The country-specific values lies between 22.2 percent (Greece) to 42.1 percent (Belgium).

- α: The parameter measures the fraction of income reported for tax. The values are also derived from Gupta (2005). The country-specific parameters lie between 0.78 (Greece) and 0.89 (U.K.), which implies that for Greece 22 percent of the taxes are evaded and for that of U.K. the value is 11 percent.

- g: Recalling that y is set to 1, g is the government expenditure to GDP ratio, defining the size of the government. We use the ratio of central government outlays to GDP, obtained from www.worldinfigures.org. The country-specific values ranges between 14.55 percent (Greece) to 22.95 percent (Belgium).

- ε: The annual deposit insurance premium is obtained from Demirgüç-Kunt and Sobaci (2001). Note for France and U.K. the deposit insurance is not mandatory and available by demand. We set it at the average of the values of Belgium and Germany. Otherwise the country-specific values lies between 0.03 percent (Belgium) to 0.64 percent (Greece).

- R: The parameter measures the return on bank investment and corresponds to average interest rate on loans over the period. The country-specific values ranges between 10.01 percent (France) and 22.96 percent (Greece).

- ν: The parameter measures the premium on the lending rate, and is derived from the World Bank -World Development Indicators. The value of ν ranges between 0.4346 percent (U.K.) to 7.7143 percent (Greece). Given ν, the nominal rate of return from the investment in the risky project, R^h, is deduced such that $R^h = R + \nu$.

- X: The parameter measuring the bank's endowment is calibrated such that $\hat{q} \leq \min\{\theta_2\}$, for all plausible values of the policy parameters, given R^h. The above condition requires that $X \leq \frac{\frac{1}{2}\min\{\varepsilon\}(1-\alpha)^2}{1-\min\{\theta_2\}\min\{(1+R^h)\}}$. Given, $\min\{\theta_2\}$, $\min\{\varepsilon\}$, and $\min\{(1 + R^h)\}$, as 0.64, 0.0003 and 1.1049, $X \leq 6.197\text{E-}06$.

Table 2: **Calibration of Parameters**

	UGE	$\frac{T}{Y}$	α	g	ε	R	ν
Spain	22.3	25.5	0.82	16.66	0.10	12.89	1.38
Greece	28.3	22.7	0.78	14.55	0.64	22.96	7.71
Italy	26.2	36.3	0.79	18.79	0.20	15.02	2.42
Portugal	22.3	27.7	0.82	16.59	0.10	19.09	7.23
Belgium	21.5	42.1	0.82	22.95	0.03	10.71	3.66
France	14.8	37.3	0.87	23.24	0.04	10.01	1.51
Germany	16.8	31.8	0.86	16.29	0.05	10.85	5.63
UK	12.3	32.9	0.89	20.51	0.04	10.06	0.43
Note: Parameters defined as above.							

7 Optimal Decision Variables

7.1 Certain World

This section calculates the optimal values of the reserve-deposit ratio, the money growth rate and the tax rate in a world with no uncertainty, but subjected to tax evasion. This section is basically devoted to testing whether higher reliance on seigniorage can be associated with higher degrees tax evasion – a common claim in the literature. The results reported in Table 3, however, do not support such a claim. The observation that stands out is that irrespective of the degree of evasion the optimal reserve requirement and money growth rates, and hence seigniorage revenue collected, is always zero. The country-specific optimal tax rate, is determined from the budget constraint and is analytically given by $\frac{g}{\alpha}$. The model, thus, suggests that tax rates are positively correlated to the degree of evasion and larger sizes of government, across countries.

Table 3: **Optimal Decision Variables (Certain World)**

Countries	τ^*	μ^*	γ^*
Spain	20.32	0	0
Greece	18.65	0	0
Italy	23.78	0	0
Portugal	20.23	0	0
Belgium	27.99	0	0
France	26.71	0	0
Germany	18.94	0	0
UK	23.04	0	0
Notes: Values derived from (10).			
All values are in percentages.			

7.2 Asymmetric Information

To seek for the optimal values of the policy parameters we need to solve the non-linear optimization problem, given by equation (17), subject to the inequality and the government budget constraints. Note the objective of introducing asymmetric information is to check whether higher reliance of seigniorage revenue is a fall-out of uncertainty and if, the size of revenue collected through implicit taxation is positively correlated with probability of crisis. More appropriately, in this context this would imply whether economies with a value of θ_2 (the highest probability of country-specific success achievable) less than one, would have the optimal value of reserve requirements and money growth rates, such that the revenue derived from seigniorage in these economies, is higher in comparison to economies with a value of θ_2 equal to unity.

The results from Table 4 indicates that uncertainty causes the values of the reserve-deposit ratio to shoot up to unitary for all economies, irrespective of whether θ_2 is less than or equal to one. But, the optimal money growth rate continues to be zero and hence the seigniorage revenue. With reserve requirements being unity, the model predicts a world of perfectly restrictive banking in the presence of asymmetric information.

Table 4: **Optimal Decision Variables (Asymmetric Information)**

Countries	τ^*	μ^*	γ^*
Spain	88.29	0	100.0
Greece	99.07	0	100.0
Italy	92.02	0	100.0
Portugal	90.54	0	100.0
Belgium	78.71	0	100.0
France	75.78	0	100.0
Germany	74.99	0	100.0
UK	72.79	0	100.0
Notes: Values derived from (17). All values are in percentages.			

So when compared to the world of certainty, we have, in some sense, extreme versions of the world, as far as optimal reserve requirements are concerned. The social planner, in an endowment economy with the existing form of uncertainty always optimally chooses a reserve requirement of 100 percent no matter the extent of the possibility of banking crisis. Note, the tax rates are considerably higher, when compared to the certain world.

However, some interesting observations can be made about the optimal tax rates. To do so, we design a hypothetical average economy, where we take the averages of the parameters of the eight economies of our concern. The results of the following experiments are reported in Table 5. Note we wanted to observe the behavior of the tax rates corresponding to changes in tax evasion, $(1-\alpha)$, and the highest possible probability of success θ_2, and government size. Rows of Table 5 corresponds to the following situations: (a) $\alpha=1$, $\theta_2=1$; (b) $\alpha=0.83$, $\theta_2=1$; (c) $\alpha=1$, $\theta_2=0.90$; (d) $\alpha=0.83$, $\theta_2=0.90$, and ; (e) In all the above cases g is set at the world (eight-economy) average of 18.70 percent. We compare a world in (d) with a different government size of 23.24 percent (France), which corresponds to the highest government size in the sample. The experiments

Table 5: **Counterfactual Experiments (Asymmetric Information)**

Countries	τ^*	μ^*	γ^*
Average-Economy	70.97	0	100.0
Average-Economy	85.50	0	100.0
Average-Economy	72.36	0	100.0
Average-Economy	87.18	0	100.0
Average-Economy	88.60	0	100.0
Notes: Values derived from (17).			
All values are in percentages.			

aim to observe which parameter in uncertain world has the highest influence on the movement of the tax rate. Comparison between the rows suggests that tax evasion has the highest impact in enhancing tax rates. Moreover, tax rates are positively correlated with tax evasion, higher government size and probability of bank failures, which is logical since revenue collected from seigniorage in steady-state is optimally zero. What is perhaps, more interesting is the extent of the effect tax evasion has on tax-rates when compared to probability of crisis and government sizes.

8   Conclusion and Areas of Further Research

The paper explores the relative importance of explicit and implicit taxation, in the presence of tax evasion and asymmetric information. Using a pure-exchange overlapping generations model, characterized with tax evasion and information asymmetry between the government (the social planner) and the financial intermediaries, we try and seek for the optimal tax and seigniorage plans, derived from the welfare maximizing objective of the social planner.

The first half of the paper models a world with no uncertainty and tests for the hypothesis that higher reserve requirements and money growth rates, and hence seigniorage, might be a fallout of high rates of tax evasion. Our analysis does not provide any support to such a claim, when the model is tested with

country-specific parameters. Instead it suggests, that optimal revenue collected through seigniorage should be zero, irrespective of the level of tax evasion. However, it suggests that tax rates are positively correlated with bigger sizes of government and higher rates of tax evasion.

The second half of the analysis is devoted to modeling a world of uncertainty. We introduced a standard moral hazard problem between the social planner and the financial intermediaries, with the latter exactly knowing the probability of success of the projects they invest in and the former informed only about the probability distribution across the banks. The probability distribution is assumed to be uniform. We set the lower limit of the distribution to zero and identified the upper limit based on the probability of banking crisis, derived from a logistic model fitted to a panel of the eight countries of our concern.

The results indicate that irrespective of the size of the probability of crisis, the presence of asymmetric information would cause the social planner to optimally set the reserve requirements at unity, but the optimal money growth rate and, hence, revenue generated through seigniorage continues to be zero. The counterfactual experiments in this case, like that of the certain world, tends to suggest similar positive correlation between tax evasion and government size with tax rates. Tax rates are also found to be positively correlated with the possibility of banking crisis, i.e., an economy with a possibility of banking crisis, the value of $\theta_2 < 1$, will have a higher tax rate, than an economy where $\theta_2 = 1$.

In summary, we show that irrespective of whether the economy is characterized by tax evasion or asymmetric information, a benevolent social planner, maximizing welfare and simultaneously financing the budget constraint, should optimally rely on explicit rather than implicit taxation. An immediate extension of the current model would be to introduce a production side of the model. This will perhaps reduce the possibility of having a situation where the optimal reserve requirement is uncertain. Moreover, it is much easier to model uncertainty in a production economy, and can be done easily through something like a Costly State Verification (CSV) problem. This will enable us to avoid arbitrary assumptions about the probability distribution, while modeling the uncertainty into the economic structure. Besides, as Basu (2001) indicates, cross-country evidences tend to suggest that government expenditure on public good and infrastructure are highly correlated with revenue from seigniorage. Hence unlike in our case, public expenditure needs to be treated as "purposeful". It would be interesting to look into the optimal policy decisions and the

corresponding welfare analysis in such a scenario.

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