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Policy Response of Endogenous Tax Evasion

Rangan Gupta
University of Connecticut and University of Pretoria

Abstract

The paper analyzes the relationship between the "optimal" degree of tax evasion and policy decisions in a simple overlapping generations framework. The model suggests that the best way to effectively reduce tax evasion is through increases in penalty rates.

1 Introduction

Using a simple overlapping generations framework, we analyze the relationship between tax evasion, determined endogenously, and different policy instruments. More precisely, the analysis tries to provide microeconomic foundation to the process of tax evasion, and in turn, reflect on the behavior of the same in response to alternative policy decisions of the consolidated government. The motivation for this study is simply, to understand better the process of tax evasion decision taken by agents in the economy, and which policies can be utilized best to tackle the problem.

Surprisingly, even though the importance of tax evasion has been widely realized, not much attempt has been made to endogenize the process and analyze the effects of alternative policies on the same. Studies have tended to concentrate on alternative instruments of government finance in an environment where tax evasion is prevalent, with the consolidated government aiming to maximize growth or utility (See Roubini and Sala-i-Martin (1995), Holman and Neanidis (2003) and Gupta (2005).). But in all these analyses, tax evasion has been treated as an exogenous fraction of taxable income which does not get reported. Our study, in this regard, to the best of our knowledge, is the first of its kind.

Due to the non-linearity of the system, there are no closed-form solutions and, hence, the model needs to be numerically evaluated. The model is calibrated to four southern European economies, namely, Greece, Italy, Portugal and Spain. It must, however, be noted that our model economy is a general one and can be applied to any economy subjected to tax evasion. Our restriction of the applicability to other economies, was plainly due to the unavailability of data regarding the sizes of the underground economy, hence tax evasion, and production parameters. Moreover, the chosen economies, have had the tradition of high sizes of underground economy and, hence, tax

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evasion (See Schneider and Klinglmair (2004).). Besides, their reliance on seigniorage, through high inflation rates and reserve requirements, is also well documented in the literature (See Gupta 2005.).

As suggested at the onset, the paper incorporates endogenous tax evasion in a standard general equilibrium model of overlapping generations. There are two primary assets in the model storage (capital) and fiat money. Storage dominates 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 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 in defining the monetary competitive equilibrium, discussing the process of calibration, and analyzing the behavior of the optimal degree of tax evasion corresponding to movements in the policy parameters. Section 6 concludes and lays out the areas of further research.

2   Economic Environment

Time is divided into discrete segments, and is indexed by $t = 1, 2,......$ There are four theaters 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. The labor en-

dowment is supplied inelastically to earn wage income, a part of the tax-liability is evaded, with evasion being determined endogenously to maximize utility, and the rest is deposited into banks for future consumption; (ii) each infinitely lived producer is endowed with a production technology to manufacture the single final good, using the inelastically supplied labor, physical capital and credit facilitated by the financial intermediaries; (iii) the banks simply converts 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 penalty for tax evasion when caught, and controlling the inflation tax instruments – the money growth rate and the reserve requirements. There is a continuum of each type of economic agents with unit mass.

The sequence of events can be outlined as follows: When young a household works 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 interests. Finally, the banks pay back the deposits with interests to households at the end of the first period and the latter consumes in the second period.

2.1 Consumers

Given that the consumers possess an 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}, implying that the consumer consumes only when old. The assumptions make computations tractable and is not a bad approxi-

mation of the real world (See Hall (1988).). All consumers have the same preferences so that there exists a representative consumer in each generation. The utility function of a consumer born at time t can be written as follows:

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

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

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\begin{aligned}
D_t \;\leq\;& q[(1 - \beta\tau_t)p_t w_t - \eta(1-\beta)^2 p_t w_t] \tag{2}\\
+\;& (1-q)[(1-\beta\tau_t)p_t w_t - \theta_t\tau_t(1-\beta)p_t w_t - \eta(1-\beta)^2 p_t w_t]\\
p_{t+1}c_{t+1} \;\leq\;& (1 + i_{Dt+1})D_t \tag{3}
\end{aligned}
$$

where equation (2) is the feasibility (first-period) budget constraint and equation (3) denotes the second period budget constraint for the consumer. Note equation (2) implicitly assumes the existence of some sort of an insurance mechanism that always ensures the consumer a certain amount of deposits d_t, in our case. Alternatively, we could have assumed the consumer to be risk-neutral. In that case, equation (2) would be the expected value of the deposits obtained. So in some sense we have an observationally equivalent formulation. Our results are, however, independent of whether the consumer is risk-averse or risk neutral, once we assume the existence of an implicit insurance scheme. p_t (p_{t+1}) denotes the money price of the final good at t $(t+1)$; D_t is the per-capita nominal deposits; $1 - q$ is the probability of getting caught when evading tax; β is the fraction of tax paid; τ_t is the income tax rate at t; θ_t is the penalty imposed, when audited and caught, at t; w_t is the real wage at t, $\eta > 0$, is a cost parameter, and; i_{Dt+1} is the nominal interest rate received on the

deposits at $t + 1$.

The constraints can be explained as follows: 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 he 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 $\theta_t > 1$. Notice we have assumed that the household has to incur transaction costs to evade taxes. These basically involve costs of hiring lawyers to avoid/reduce tax burdens, and bribes paid to tax officials and administrators. The transaction costs are incurred in evading taxes are assumed to be increasing in both degree of tax evasion and the wage income of the household. The form $\eta (1 - \beta)^2 p_t w_t$ is consistent with our assumptions about the behavior of transaction costs. Note a higher value of η, would imply a less corrupted economy, implying that it is more difficult to evade taxes. We also endogenize the probability of getting caught, q, by assuming it to be an increasing function of the degree of tax evasion. q takes the following quadratic form:

$$1 - q = (1 - \beta)^2 \tag{4}$$

The second-period budget constraint is self-explanatory suggesting that the consumer when old consumes out of the interest income from deposits – the only source of income, given that he is retired. The household chooses β to maximize his utility from second-period consumption subject to the intertemporal budget constraint given as follows:

$$c_{t+1} \leq (1 + r_{dt+1})[(1 - \beta\tau_t) - \theta_t\tau_t(1 - \beta)^3 - \eta(1 - \beta)^2]w_t \tag{5}$$

where r_{dt+1} is the real interest rate on deposits at period $t + 1$. Note $(1 + r_{dt+1}) = \frac{1+i_{Dt+1}}{1+\pi_{t+1}}$, where $1 + \pi_{t+1} = \frac{p_{t+1}}{p_t}$.

Realizing that both the real interest rate on deposits and the wages would depend on the degree of tax evasion, the first order condition for the consumer is given as follows:

$$\frac{dU}{d\beta} = 0 = u'(c_{t+1}) \left[\{ \frac{d}{d\beta} (1 + r_{dt+1}) \} d_t + (1 + r_{dt+1}) \frac{dd_t}{d\beta} \right] \tag{6}$$

The optimal value of β at steady-state is determined below after the equilibrium conditions are imposed and the steady state value of the capital stock is determined.

2.2 Financial Intermediaries

At the start of each period the financial intermediaries accept deposits and make their portfolio decision (that is, loans and cash reserves choices) with a goal of maximizing profits. At the end of the period they receive their interest income from the loans made and meets 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 intermediaries obtains the optimal choice for L_t by solving the following problem:

$$\max_{L,D} \pi_b = i_{Lt} L_t - i_{Dt} D_t \tag{7}$$

$$s.t. \quad : \quad \gamma_t D_t + L_t \leqslant D_t \tag{8}$$

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 held in form of currency) to deposits.

To gain some economic intuition of the role of reserve requirements, let us consider the solution

of the problem for a typical intermediary. Free entry, drives profits to zero and we have

$$i_{Lt}(1 - \gamma_t) - i_{Dt} = 0 \tag{9}$$

Simplifying, in equilibrium, the following condition must hold

$$i_{Lt} = \frac{i_{Dt}}{1 - \gamma_t} \tag{10}$$

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

2.3 Firms

Each firm produces a single final good using a standard neoclassical production function $F(k_t, n_t)$, with k_t and n_t, respectively denoting the capital and labor input at time t. The production technology is assumed to take the Cobb-Douglas form:

$$Y = F(k, n) = k^\alpha n^{(1-\alpha)} \tag{11}$$

where $0 < \alpha \ ((1 - \alpha)) < 1$, is the elasticity of output with respect to capital (labor). At date t the final good can either be consumed or stored. Next we assume that producers are capable of converting 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. Notice that the production transformation schedule is linear so that the same technology applies to both capital formation and the production of consumption good and hence both investment and consumption good sell for the same price p. Moreover, we follow Diamond and Yellin (1990) and Chen, Chiang and Wang (2000) in assuming that the goods producer is a residual claimer, i.e., the producer uses up the unsold consumption good in a way

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which is consistent with lifetime value maximization of the firms. such an assumption regarding ownership avoids the "unnecessary" Arrow-Debreu redistribution from firms to consumers and simultaneously retains the general equilibrium structure.

The representative firm at any point of time t maximizes the discounted stream of profit flows subject to the capital evolution and loan constraint. Formally, the problem of the firm can be outlined as follows

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

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

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

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:

$$V(k_t) = \max_{n, k'} [p_t k_t^\alpha n_t^{(1-\alpha)} - p_t w_t n_t - p_t (1 + i_{Lt})(k_{t+1} - (1 - \delta_k) k_t)] + \rho V(k_{t+1}) \tag{15}$$

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

$$k_{t+1} : (1 + i_{Lt}) p_t = \rho V'(k_{t+1}) \tag{16}$$

$$(n_t) : (1 - \alpha) \left(\frac{k_t}{n_t} \right)^\alpha = w_t \tag{17}$$

And the following envelope condition.

$$V'(k_t) = p_t [\alpha \left(\frac{n_t}{k_t} \right)^{(1-\alpha)} + (1 + i_{Lt})(1 - \delta_k)] \tag{18}$$

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Optimization, leads to the following efficiency condition, besides (17), for the production firm.

$$(1 + i_{Lt}) = \rho(1 + \pi_{t+1})[\alpha \left(\frac{n_{t+1}}{k_{t+1}} \right)^{(1-\alpha)} + (1 + i_{Lt+1})(1 - \delta_k)] \tag{19}$$

Equation (19) 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 benefit generated from the extra capital invested in the current period. And equation (17) simply states that the firm hires labor up to the point where the marginal product of labor equates the real wage.

2.4 Government

As discussed above we have an infinitely lived government with two wings: the treasury and the central bank. The government finances its expenditure $p_t g_t$ through taxation, penalty on consumers when caught evading and the inflation tax (seigniorage). Formally the government budget constraint can be written as follows:

$$p_t g_t = \beta \tau_t p_t w_t + (1 - q)\theta_t(1 - \beta)\tau_t p_t w_t + (M_t - M_{t-1}) \tag{20}$$

Note throughout the analysis we will 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, $M_t = \gamma_t D_t$, the government budget constraint in real terms can be rewritten as

$$g_t = [\beta + (1 - q)\theta_t(1 - \beta)]\tau_t w_t + \gamma_t d_t(1 - \frac{1}{1 + \mu_t}) \tag{21}$$

where $d_t = (\frac{D_t}{p_t})$ is the size of deposits in real terms. Skinner and Slemrod (1985) points out that the administrative costs of penalties is usually quite minor, and, hence, for simplicity we ignore them from the government budget constraint.

3 Equilibrium

A valid perfect-foresight, competitive equilibrium for this economy is a sequence of prices $\{p_t, i_{Dt}, i_{Lt}\}_{t=0}^{\infty}$, allocations $\{c_t, n_t, i_{kt}\}_{t=0}^{\infty}$, 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:

- Taking, τ_t, g_t, θ_t, γ_t, μ_t, p_t, the consumer optimally chooses β such that (6) holds;

- Banks maximize profits, taking, i_{Lt}, i_{Dt}, and γ_t as given and such that (9) holds;

- The real allocations solve the firm's date–t profit maximization problem, (12), given prices and policy variables.

- 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: $c_t + i_{kt} + g_t = k_t^{\alpha} n_t^{(1-\alpha)}$ 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, $(1 + r_{dt})$ and p_t must be positive at all dates and $1 + i_{Lt} > 1$.

4 Optimal Degree of Tax Evasion

Using the equilibrium conditions, realizing that there is no growth in the model and allowing the government to follow time invariant policy rules, which means the reserve–ratio, γ_t, the money supply growth–rate, μ_t, the tax–rate, τ_t, and the penalty, θ_t, are constant over time, we have the following set of equations:

$$1 + r_d = (1 + r_l)(1 - \gamma) + \frac{\gamma}{1 + \pi} \qquad (22)$$

$$w = (1 - \alpha)k^\alpha \qquad (23)$$

$$(1 + r_l) = \frac{\rho\alpha k^{(\alpha-1)}}{1 - \rho(1 + \pi)(1 - \delta_k)} \qquad (24)$$

$$(1 - \gamma)[(1 - \beta\tau) - \theta\tau(1 - \beta)^3 - \eta(1 - \beta)^2]w = \delta_k k \qquad (25)$$

where r_l is the real interest rate on loans. Using (22) to (25) we can solve k in terms of the policy variables, production parameters of the model and β and is given by the following equation:

$$k = \left(\frac{(1 - \gamma)(1 - \alpha)[(1 - \beta\tau) - \theta\tau(1 - \beta)^3 - \eta(1 - \beta)^2]}{\delta} \right)^{\frac{1}{1-\alpha}} \qquad (26)$$

Realizing that $\mu = \pi$, from the money market equilibrium condition, the gross real interest rate on deposits $(1 + r_d)$, and real wage w are given by the following expressions:

$$(1 + r_d) = \left[\frac{\rho\alpha\delta_k}{(1 - \alpha)(1 - \rho(1 + \mu)(1 - \delta_k))} \right] \left[\frac{1}{[(1 - \beta\tau) - \theta\tau(1 - \beta)^3 - \eta(1 - \beta)^2]} \right] (27)$$
$$+ \frac{\gamma}{1 + \mu}$$

$$w = (1 - \alpha) \left\{ (1 - \alpha)(1 - \gamma) \frac{[(1 - \beta\tau) - \theta\tau(1 - \beta)^3 - \eta(1 - \beta)^2]}{\delta_k} \right\}^{\frac{\alpha}{(1-\alpha)}} \qquad (28)$$

where $1 + r_l = \left(\frac{\rho\alpha\delta_k}{(1-\gamma)(1-\alpha)(1-\rho(1+\mu)(1-\delta_k))} \right) \left(\frac{1}{[(1-\beta\tau)-\theta\tau(1-\beta)^3-\eta(1-\beta)^2]} \right)$

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Using (2) evaluated at steady-state, (27) and (28) we can rewrite equation (6) as follows:

$$\frac{d}{d\beta}\left(\frac{\left\{\frac{\rho\alpha\delta_k}{(1-\alpha)(1-\rho(1+\mu)(1-\delta_k))}+\frac{\gamma}{1+\mu}[(1-\beta\tau)-\theta\tau(1-\beta)^3-\eta(1-\beta)^2]\right\}}{(1-\alpha)\left\{(1-\alpha)(1-\gamma)\frac{[(1-\beta\tau)-\theta\tau(1-\beta)^3-\eta(1-\beta)^2]}{\delta_k}\right\}^{\frac{\alpha}{(1-\alpha)}}}\right)=0 \qquad (29)$$

given that $u'(c_{t+1}) > 0$. Once we derive the optimal value of β by solving (29) in terms of the parameters and policy variables we can obtain the reduced form solution to the other endogenous variables in the model.

The derivative of (29) yields a non-linear equation for β and needs to be analyzed in essentially an non-algebraic fashion, and hence, the choice of parameter values become essential. The following section discuses the process of calibration.

5   Calibration

In this section we attribute values to the parameters of 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.

We follow the standard real business cycle literature in using steady–state conditions to establish parameter values observed in the data. Some parameters are calibrated using country–specific data, while others, without sufficient country–specific evidence over a long period, correspond to prevailing values from the literature. This section reveals the general procedures used. The calibrated parameters are reported in Table 1. Note unless otherwise stated, the source for all data is the IMF – International Financial Statistics (IFS).

A first set of parameter values is given by numbers usually found in the literature. These are:

- $(1 - \alpha)$: since the production function is Cobb-Douglas, this corresponds to the share of labor in income. $(1 - \alpha)$ for Spain, Italy and Greece is derived from Zimmermann (1997) and the value for Portugal is obtained from Correia, Neves and Rebelo (1995). The values lie between 53.0 percent (Portugal) and 62.7 percent (Spain);

- δ_k: the depreciation rate of physical capital for Spain, Italy and Greece is derived from Zimmermann (1997) and the value for Portugal is obtained from Correia, Neves and Rebelo (1995). The values lie between 3.2 percent (Greece) and 5.2 percent (Italy);

- 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 23.1 percent (Spain and Portugal) to 29.0 percent (Greece).

- 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.

- η: the transaction cost parameter is obtained from Chen (2003) and is set to 0.15.

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:

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

- γ: the annual reserve–deposit ratio lies between 13.7 percent (Italy) and 23.5 percent (Greece);

- τ: the tax rate, calculated as the ratio of tax–receipts to GDP, lies between 22.74 percent (Greece) and 36.25 percent (Italy);

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

The following set of parameters are calibrated from the steady state equations of the model:

- μ: the money growth rate is set equal to the rate of inflation, given the money market equilibrium condition. The annual rate of money growth rate hence, lies between 7.52 percent (Spain) and 15.16 percent (Greece);

- ρ: the discount factor of the firms is solved to ensure that equation (24) holds. The value ranges between 0.87 (Greece) to 0.94 (Spain).

- β: the fraction of reported income is determined by the following method:

$$\frac{TE}{Y} = UGE \times \tau \tag{30}$$

where $\frac{TE}{Y}$ is tax evasion as a percentage of GDP.

We have assumed that the effective average tax rate is the same in the official and the underground economy. Given that

$$(1 - \beta) = \frac{\frac{TE}{Y}}{\left[\frac{TE}{Y} + \tau\right]} \tag{31}$$

We consider this exogenously evaluated value of the reported income parameter as the steady-state value. Note the value hinges critically on the size of the underground economy as a percentage of the GDP. The value of β lies between 0.775 (Greece) and 0.810 (Spain and Portugal), implying that 22.5 percent of the taxes are evaded in Greece and the figure in Spain and Portugal corresponds to a tx evasion of 19.0 percent.

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6 Effects of policy decision on Tax Evasion

As suggested earlier, given that the non-linearity of the model does not allow us to solve it in an algebraic fashion, we map the function for β, obtained from equation (29), given the parameters of the model. Note the point where the function crosses the X-axis, is where we obtain our country-specific steady state value of the reported income. The movements in this function is studied corresponding to changes in values of the policy parameters. The response of the reported income to changes in τ, θ, γ and μ are discussed below. Figures 1 through 20 reports the effects of policies in the (β, F) plane. F on the Y-axis corresponds to the value of the function, given by equation (29).

First, we analyze the effect of a change in the reserve requirements. An increase (decrease) in reserve requirements by 10 percent increases (decreases), the steady-state value of the reported income. As can be observed from Figures 1 through 4, a hike in the reserve requirements, moves the economy from the initial equilibrium at E to E^1, while a reduction in the reserve ratio, results in E^2, as the new equilibrium. So reserve ratio and reported income are positively related, however, as can be observed from the scales, the strength of the effect is negligible.

Figures 5 through 8 study the effect of a 1 percent change in the money growth rate. Just like in the case of the reserve requirements, increase (decrease) of money growth rate reduces (increases) the degree of evasion, but only marginally. Starting from E, an increases in the inflation rate, takes the economy to E^1 (E^2). However, as figures 9 to 12 shows, marked increases in money growth rates can drastically, reduce the level of reported income. Note multiple equilibria arise.

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An increases in the money growth rate by the amount of 10 percent for Greece, 20 percent for Spain and 30 percent for Italy and Portugal, causes the L curve to move to L^1, such that we have two equilibria at E^1 and E^2. While at E^1, the reported income increases marginally in comparison to E, the tax evasion jumps enormously at E^2. So the model predicts that high reliance on seigniorage, mainly based on higher money growth rates, can result in very high degrees of tax evasion.

Figures 13 through 16 analyze a 1 percent change in tax rates. An increase (decrease) in tax rate moves the economy from E to E^1 (E^2), resulting in an increase (decrease) in the degree of tax evasion. So higher tax rates result in higher evasion. Finally, we analyze the changes in the penalty rate. The penalty rate is increases to 1.55 from 1.50 and then reduced to 1.45. As figures 17 through 20 shows, the increase in the penalty rate moves the economy to E^1, reducing the degree of tax evasion, while a reduction in the penalty rate, causes the agents in the economy to report less of their income, and move the economy to E^2. Note, a look at the scale on the X-axis, reveals that the effects of changes in tax and penalty rates are relatively stronger when compared to changes in the reserve requirement and mild inflation or deflation, starting from the initial equilibrium at E.

7   Conclusion and Areas of Further Research

This paper analyzes the relationship between the "optimal" degree of tax evasion and policy decisions, for four European economies, using a simple overlapping generations framework. More precisely, the analysis tries to provide a microeconomic foundation to the process of tax evasion given the policy decisions of the social planner. The motivation for such an analysis simply emerges from the lack of any study, that endogenizes the process of tax evasion to understand better the effects of alternative policies on the same.

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When numerically analyzed for four southern European countries, the following conclusions could be made: (i) Reserve ratio and reported income have a very weak positive relationship; (ii) Mild changes in money growth rate moves the reported income in the same direction, and as in the case of reserve ratio, the strength of the effect is very weak. However, high increases in money growth rate can result in multiple equilibria, with the possibility of reported income increasing marginally and simultaneously falling by a very large extent; (iii) Increases (decreases) in the penalty rates of evading taxes would induce consumers to report greater (smaller) fraction of their income, while increases (decreases) in the income-tax rates would cause them to evade greater (lesser) fraction of their income.

So in summary, from a policy perspective, the model suggests that, the best way to reduce tax evasion is by increasing the penalty rates, in cases taxes cannot be reduced due to budgetary pressures. Changes in inflation and reserve requirements can only have mild effect on the degree of evasion, unless the money growth rates are increased significantly, in which case reported income can fall drastically. An immediate extension of the current model would be to study the effects of tax evasion on growth in an endogenous growth model, and in turn, also analyze the role of policies in fostering growth and reducing tax evasion.

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Table 1: **Calibration of Parameters**

	$(1-\alpha)$	δ_k	UGE	$\pi = \mu$	γ	τ	i_L	ρ	β
Spain	0.627	0.05	23.1	7.52	14.1	25.53	12.89	0.94	0.810
Italy	0.617	0.052	27.3	8.58	13.7	36.25	15.02	0.93	0.786
Greece	0.598	0.032	29.0	15.16	23.5	22.74	22.96	0.87	0.775
Portugal	0.530	0.05	23.1	13.04	19.8	27.73	19.09	0.88	0.810

Note: Parameters defined as above.

Figure 1: Effect of Reserve Ratio (Spain)
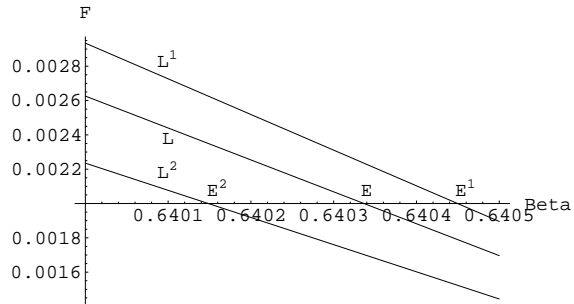
Figure 4: Effect of Reserve Ratio (Portugal)
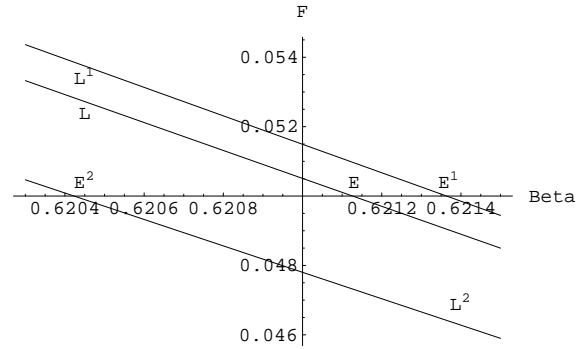
Figure 2: Effect of Reserve Ratio (Italy)
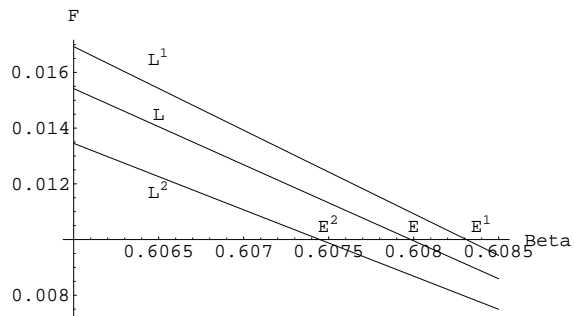
Figure 5: Effect of Money Growth Rate (Spain)
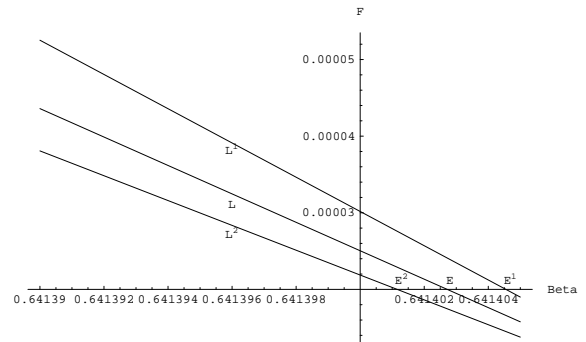
Figure 3: Effect of Reserve Ratio (Greece)
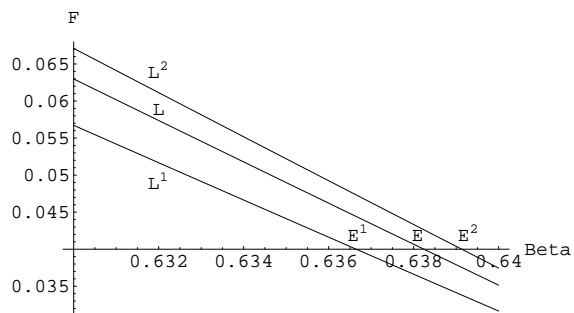
Figure 6: Effect of Money Growth Rate (Italy)

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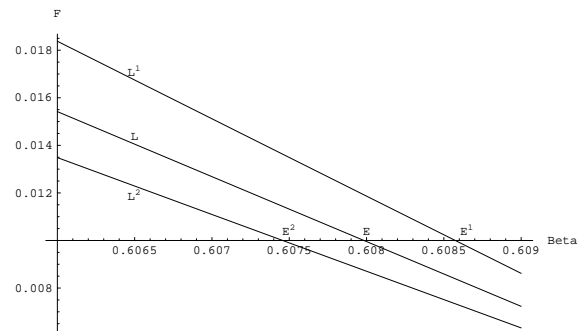
Figure 7: Effect of Money Growth Rate (Greece)
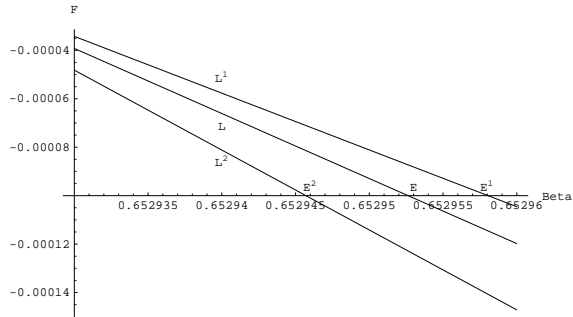
Figure 10: Effect of Money Growth Rate (Italy)
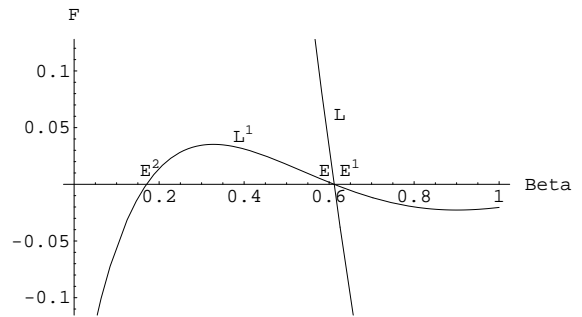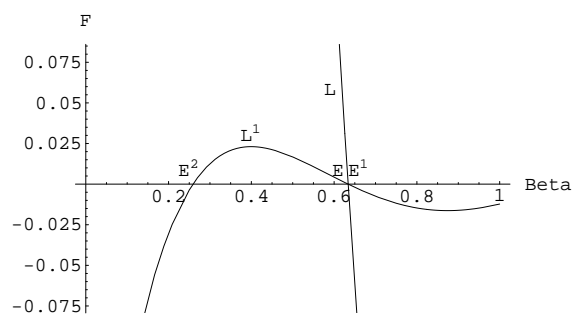
Figure 8: Effect of Money Growth Rate (Portugal)
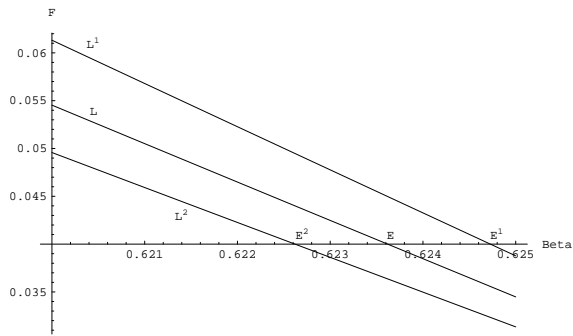
Figure 11: Effect of Money Growth Rate (Greece)
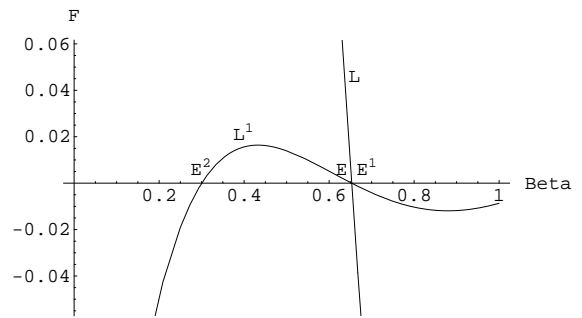
Figure 9: Effect of Money Growth Rate (Spain)
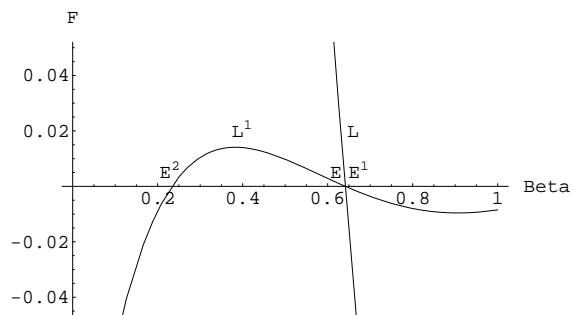
Figure 12: Effect of Money Growth Rate (Portugal)

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Figure 13: Effect of Tax Rate (Spain)
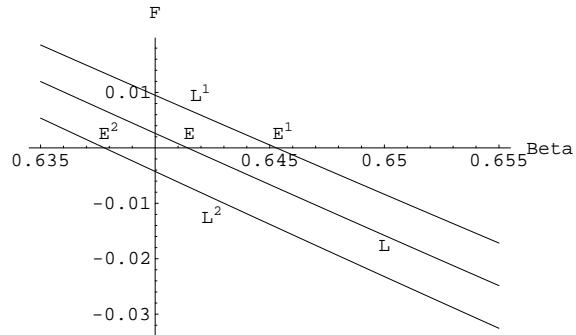
Figure 16: Effect of Tax Rate (Portugal)
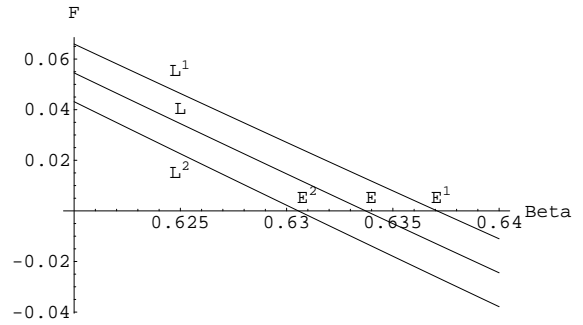
Figure 14: Effect of Tax Rate (Italy)
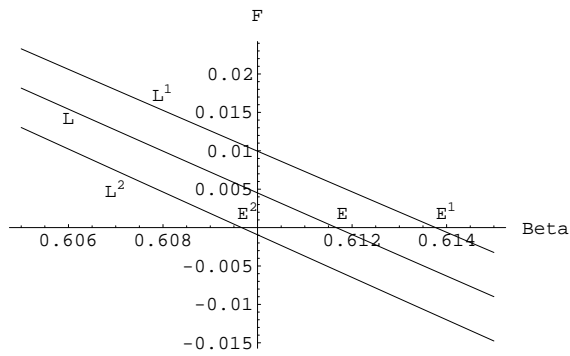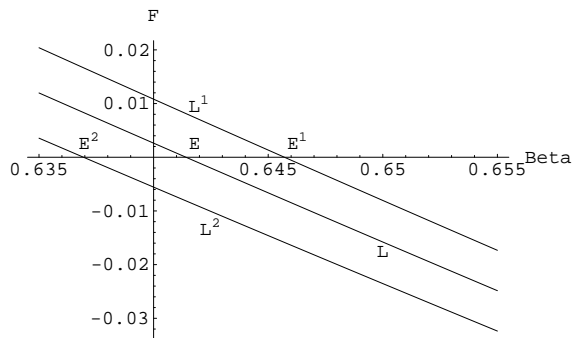

Figure 17: Effect of Penalty Rate (Spain)

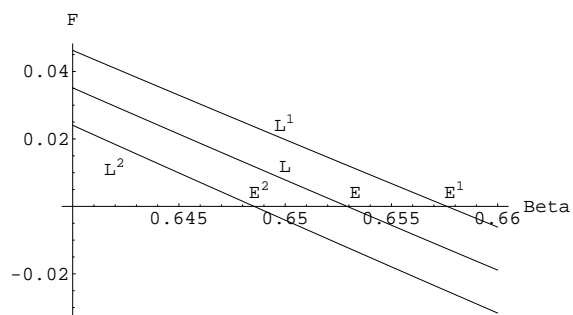## Figure 15: Effect of Tax Rate (Greece)

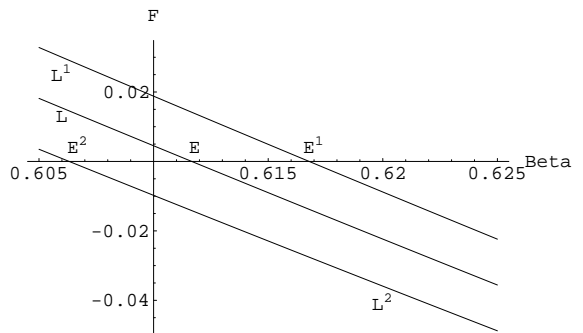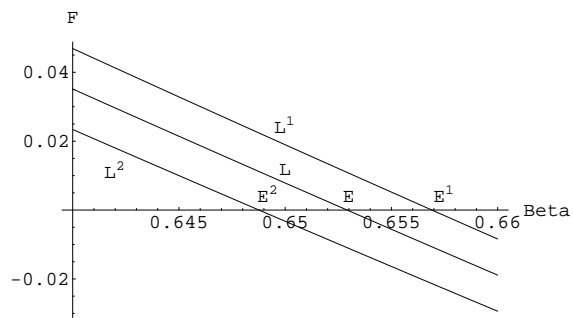## Figure 18: Effect of Penalty Rate (Italy)

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Figure 19: Effect of Penalty Rate (Greece)

Figure 20: Effect of Penalty Rate (Portugal)