

Tax evasion, social norms and economic growth

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Abstract

This paper proposes a theoretical model to account for the most relevant micro- and macroeconomic empirical facts in the tax evasion literature. To do so, we integrate tax morale into a dynamic overlapping generations model of capital income tax evasion. Tax morale is modeled as a social norm for tax compliance. It is shown that accounting for such nonpecuniary costs of evasion may not only explain (i) why some taxpayers never evade even if the gamble is profitable, and (ii) how a higher tax rate can increase evasion, but also that (iii) the share of evaded taxes over GDP decreases with the stage of economic development and (iv) that tax morale is positively correlated with the level of GDP per capita, as suggested by recent empirical evidence. Finally, a higher tax rate increases aggregate evasion as well as the number of evaders in the economy when taxpayers decisions are interdependent. Simulations highlight the quantitative importance of our findings.

Keywords tax evasion, social norms, economic growth, overlapping generations

JEL-Classification H24, H26, D91

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1 Introduction

Tax evasion is one of the main problems faced by fiscal authorities. For example, [Slemrod \(2007\)](#) estimates that the U.S. income tax gap in 2001 amounts to a total of \$345 billion—more than 15% of the estimated actual (paid plus unpaid) tax liability. However, tax evasion is not a particular phenomenon in developed countries.¹ As estimated by [Cobham \(2005\)](#), for instance, the overall level of tax revenue lost due to tax evasion in developing countries is equal to \$285 billion per year. Thus, explaining the patterns of tax evasion and identifying tools to reduce it is an important concern in all economies.

The theoretical analysis of tax evasion starts with the seminal papers by [Allingham and Sandmo \(1972\)](#) and [Yitzhaki \(1974\)](#) which model tax evasion as a static portfolio selection issue.² Subsequent empirical and experimental findings, however, have revealed important inconsistencies between theory and evidence³. Specifically, the literature has identified four main puzzles: first, the finding that tax evasion increases with the tax rate ([Clotfelter, 1983](#), [Poterba, 1987](#), [Joulfaian and Rider, 1996](#)) while theory predicts the opposite. Second, the finding of low levels of tax evasion in many countries compared to the high level predicted by theory given the low levels of deterrence (see [Alm \(1999\)](#) and [Torgler \(2002\)](#) for a review). Third, the finding that some taxpayers never evade, even if evasion is the profitable

¹See [Fuest and Riedel \(2009\)](#) for a survey of tax evasion in developing countries. [Alm et al. \(1991\)](#), e.g., put the figure for tax evasion (and avoidance) at 46% of the Jamaican income tax in 1983.

²[Andreoni et al. \(1998\)](#), [Slemrod and Yitzhaki \(2002\)](#) and [Slemrod \(2007\)](#) are recent surveys reviewing the main literature on the nature and determinants of tax evasion.

³See [Alm et al. \(1992\)](#) and [Frey and Feld \(2002\)](#) among others.

option (Baldry, 1986, Alm, 1999). Fourth, the finding that the level of tax evasion and taxpayers' attitudes towards evasion are related to the behavior of other taxpayers (Gaechter, 2006). This paper sets up a dynamic model of tax evasion in order to reconcile theory with empirical evidence.

While many studies have extended the basic portfolio selection model to explain these puzzles in a similar *static* framework⁴, only a few recent papers analyze tax evasion in a *dynamic* context (Lin and Yang, 2001, Chen, 2003, Dzhumashev and Gahramanov, 2011, Levaggi and Menoncin, 2012, 2013). However, as the main focus of these papers is on how tax evasion affects the relationship between income taxation and economic growth in the long-run, none of these papers studies the effects of tax evasion behavior in the short-run and in particular throughout the transition towards the steady state. To close this gap in the literature is the aim of the present paper.

We set up a general equilibrium model of capital income tax evasion. More precisely, we integrate the Allingham-Sandmo framework into a dynamic two period overlapping-generations setting with production.⁵ Our model departs from a simple version with amoral agents and subsequently,

⁴Most of the existing literature has focused on explaining the positive relationship between the tax rate and evasion. Among these papers, Cowell and Gordon (1988) poses a framework where taxpayers consider the provision of public goods, Lee (2001) considers the possibility of self-insurance against possible penalties and Bayer (2006) endogenizes the probability of audit. A more recent literature also incorporates techniques of behavioral economics to address the puzzling tax effect (see Hashimzade et al. (2013)). Moreover, Kleven et al. (2011) emphasize the role of information available to the tax authority as a limiting factor of actual evasion opportunities to explain the low levels of observed tax evasion and the fact that some taxpayers never evade.

⁵See e.g. Boadway and Keen (1998) for a related approach. They study the role of capital income tax evasion in alleviating welfare losses due to time inconsistent taxation within an open economy model.

in order to address the inconsistencies between theory and evidence, considers a more sophisticated version with tax morale (namely, taxpayers' attitudes, perceptions and moral values) and heterogeneous agents.

The importance of tax morale for individual evasion decisions has recently been emphasized by many empirical studies, see [Luttmer and Singhal \(2014\)](#) for a recent overview. According to these findings, the decision to evade taxes is not only determined by rational cost-benefit considerations but also by social and morale influences which are, in turn, shaped by the (perceived) compliance of other taxpayers: Individuals consider tax evasion to be a less serious wrongdoing the more widespread they presume it to be ([Frey and Torgler, 2007](#)). In line with this evidence, we define tax morale as an internalized social norm for tax compliance ([Elster, 1989](#)) which expands the cost incurred by evaders to include not only the fines payable upon detection, but also certain non-pecuniary considerations. Specifically, as in [Gordon \(1989\)](#) and [Traxler \(2010\)](#), the strength of the norm depends on an individual specific degree of norm internalization and the endogenously determined share of evaders in the economy (with a higher share inducing a weaker norm). Hence, individual evasion decisions depend on the behavior of others implying that individuals act conditionally cooperative ([Gaechter, 2006](#)).

As in [Yitzhaki \(1974\)](#), taxpayers are audited with a positive probability and, if caught, have to pay a penalty on the amount of evaded taxes.⁶ Aggregate savings of utility maximizing agents determine the dynamics of the eco-

⁶For reasons of simplicity we assume that tax revenue is wasted (as e.g. in [Levaggi and Menoncin \(2013\)](#)). Alternatively, this can be interpreted as financing a public consumption good which increases individual utility.

nomy. Given a neoclassical technology, per capita capital increases throughout the transition towards the steady state, which in turn decreases the rate of return and therefore the incentives to evade taxes. In such a framework, the amount of undeclared taxes may increase both in the transition and in the steady state when the tax rate rises and individuals care about morality. More specifically, an increase in the tax rate generates two competing effects: a negative income effect that provides incentives to evade less and a net increase in the benefit of being dishonest which encourages taxpayers to evade. Thus, for a reasonable set of parameters the second effect prevails. Moreover, it is shown that increases in the strength of the norm to honestly pay what is owed as well as in the audit probability produce low levels of tax evasion in the long-run and throughout the transition towards the new steady state. Consequently, policies aimed at deterring tax evasion may not only alter economic incentives but also have long-lasting and amplifying effects through changes in the formation of social norms.

The main contribution of this paper is to present a simple dynamic model of tax evasion which accounts simultaneously for well known micro empirical findings as well as for the latest macro-dynamic observations. Specifically, our model allows us to derive several new results in the literature on tax evasion which are consistent with existing empirical evidence.

First, our model predicts that the share of tax evasion is declining during the transition towards the steady state level. In this respect, [Crane and Nourzad \(1986\)](#) who focus on aggregate tax evasion in the United States over the period 1947-81, show that despite tax evasion increases in absolute terms, it has fallen in relative terms when income has risen. This result is

further supported by evidence in [Schneider et al. \(2011\)](#). According to their findings, the relative size of the shadow economy⁷ for 162 countries over the period 1999 to 2007 has decreased whereas the unweighted average of GDP per capita for the same set of countries and over the same time horizon has increased.⁸

Second, neoclassical growth theory which describes the dynamics of the economies in the model, predicts that countries with low levels of per capita GDP (per capita capital) display high levels of tax evasion. By contrast, high-income countries (high levels of per capita capital) show low levels of tax evasion, for the same size of tax rates and similar technologies and preferences. [Gordon and Li \(2009\)](#), for example, document sharp differences in the ability to generate tax revenue among developed and developing countries: though statutory tax rates are fairly similar across countries, effective tax rates differ widely given the lower fraction of GDP collected by these taxes among poorer countries. For instance, the maximum personal income tax rate in developed countries is on average 1.23 times higher than in developed countries, whereas income tax revenue over GDP is 2.47 times larger in developed countries. A similar pattern is also demonstrated by [Easterly and](#)

⁷Tax evasion can be considered to be an integral part of the shadow economy. Though it is difficult to have reliable information about the exact size of tax evasion, since it is an illegal activity and individuals have strong incentives to conceal their cheating, and though the shadow economy is clearly not synonymous with tax evasion, many researchers ([Schneider \(2005\)](#) and [Alm and Embaye \(2013\)](#) among others) frequently use shadow economy estimates as an indicator for the size of tax evasion. See [Alm \(2012\)](#) for a detailed discussion about the measuring of tax evasion.

⁸Specifically, this unweighted average of GDP per capita rose from 5200 US\$ to 8400 US\$ over the whole period, while the unweighted average size of the shadow economies of all of these 162 countries decreased from 34.0% of official GDP in 1999 to 31.2% of official GDP in 2007. Data on GDP per capita are taken from the World Bank, see <http://data.worldbank.org/>.

[Rebelo \(1993a\)](#) and [Easterly and Rebelo \(1993b\)](#). According to their findings, income tax evasion is an important phenomenon, in particular for developing countries⁹. Consistent with these observations, our model predicts that the size of tax evasion decreases insofar countries accumulate capital and reach higher levels of income.

Finally, we find a positive relationship between per capita GDP and tax morale. More precisely, our model predicts that countries with high levels of per capita income display low levels of evasion and a low share of evaders in the economy. A low share of evaders, in turn, implies larger moral costs of evading since the majority of population pays what they owe and this is perceived as the right behavior. Thus, the more other taxpayers are perceived to be honest, the more willing individuals are to pay their own taxes and reduce evasion. In this respect, [Weck \(1983\)](#) and [Torgler \(2003\)](#) document the existence of a positive relationship between tax evasion and tax morale for a wide sample of countries. Their findings support the hypothesis that the behavior of a taxpayer is influenced strongly by his perception of the behavior of other taxpayers. Moreover, [Frey and Torgler \(2007\)](#) and [Torgler and Schneider \(2007\)](#) find that countries which display higher rates of tax evasion are characterized by low quality institutions or weak direct democratic rights¹⁰, and [Acemoglu et al. \(2005\)](#) and [Bethencourt \(2013\)](#) among others, show that these countries are typically developing countries with low levels of per capita income. Thus, the empirical facts support the finding that high

⁹Also, the cross sectional findings about the relative size of the informal economy by [Friedman et al. \(2000\)](#) indicate that informality is (on average) a more severe problem in countries with low GDP per capita, especially in Latin American countries.

¹⁰These results are further supported by evidence in [Friedman et al. \(2000\)](#) suggesting that weak economic institutions imply a large unofficial economy.

income countries exhibit high quality institutions, high levels of tax morale and so, low levels of evasion.

Our work relates to the literature analyzing the effects of morality, customs and stigma on tax evasion behavior, see [Gordon \(1989\)](#), [Myles and Naylor \(1996\)](#), [Kim \(2003\)](#), [Fortin et al. \(2007\)](#) and [Traxler \(2010\)](#). While these papers demonstrate how such non-pecuniary considerations may account for some of the tax evasion puzzles within a static framework¹¹, our contribution relative to these studies lies in modeling the dynamics of per capita capital and linking the size of tax evasion to the state of economic development.

Our work also relates to papers studying dynamic models of tax evasion, see e.g. [Lin and Yang \(2001\)](#), [Chen \(2003\)](#), [Dzhumashev and Gahramanov \(2011\)](#) and [Levaggi and Menoncin \(2012, 2013\)](#). Relative to these papers, however, we do not focus on the tax evasion-growth nexus, but rather on the dynamics of tax evasion throughout the transition towards the steady state. This in turn allows us to document not only cross country variations in levels of tax evasion but also to account for the development of these levels over time.

The remainder is organized as follows. Section 2 describes the basic model without morality. Section 3 extends the basic framework to account for nonpecuniary costs of evasion and presents numerical results from Monte Carlo simulations to illustrate our main findings and explore their robustness against several alternative modeling assumptions. Section 4 concludes.

¹¹Note that we refer to these models as static insofar as they do not allow for income dynamics. However, as in the present paper, the share of evaders may well change over time.

All proofs and technical considerations are included in the appendix.

2 The Basic Model

The basic framework is a two period overlapping-generations model in the tradition of Diamond (1965). The size of each generation is assumed to be constant and normalized to one. Non-altruistic individuals are endowed with one unit of labor time when young, and are retired during old age. Markets are competitive.

The government collects a proportional tax on capital income which may, however, be evaded by individuals. The reason we focus on capital income tax evasion is twofold. First, the probability of detection is much lower than for other income sources and therefore the opportunities for hiding true income from the tax collector are substantially higher than for example in the case of labor (Poterba, 1987, Sandmo, 2012). Second, capital income tax evasion is indeed a serious problem in many countries (see e.g., Slemrod (2007) for the US). Also, as pointed out by Sandmo (2012), ‘in the theoretical literature, the evasion of taxes on labor income has received considerably more attention than the evasion of taxes on capital. It is not obvious why this should be so; as already noted, it is difficult to argue that capital income evasion is of less empirical importance.’

2.1 Firms

On the production side of the model, perfect competition between a large number of identical firms is assumed. A representative firm in period t pro-

duces a homogenous output good according to a Cobb–Douglas production function with capital K_t and homogeneous labour L_t as inputs:

$$Y_t = AK_t^\alpha L_t^{1-\alpha}, \quad (1)$$

where $1 > \alpha > 0$ is the share parameter of capital.

Each firm maximizes profits under perfect competition, implying that, in equilibrium, production factors are paid their marginal products:

$$w_t = (1 - \alpha)AK_t^\alpha L_t^{-\alpha} = (1 - \alpha)Ak_t^\alpha \quad (2)$$

and

$$r_t = \alpha AK_t^{\alpha-1} L_t^{1-\alpha} = \alpha Ak_t^{\alpha-1} \quad (3)$$

where $k_t = K_t/L_t$ is the capital intensity.

2.2 Consumers

Each generation consists of agents whose life has two periods of equal lengths: the young adult age during which each agent inelastically supplies one unit of labor time to work and raises one offspring, and the old age spent in retirement. Since each young adult produces one offspring, the population remains constant in every generation and is normalized to one. When adult, working individuals receive the wage w_t . Income is spent on consumption c_t and savings s_t :

$$w_t = c_t + s_t. \quad (4)$$

When old, each individual consumes the return to his savings and may evade a fraction $e_{t+1} \in [0, 1]$ of this return. The declared income gets taxed with a proportional income tax at rate τ . With a fixed probability p the evasion gets detected. In this case, the tax evader has to pay the full taxes and a penalty γ which is proportional to the taxes evaded [Yitzhaki \(1974\)](#). With probability $1 - p$ the evasion remains undetected and the evader only pays taxes on the declared income. The corresponding levels of second period consumption for state u - escaping undetected - or state d - getting detected - are given by

$$d_{t+1}^u = R_{t+1}^u s_t \quad (5)$$

$$d_{t+1}^d = R_{t+1}^d s_t \quad (6)$$

where $R_{t+1}^u = 1 - \delta + r_{t+1}(1 - \tau + \tau e_{t+1})$, $R_{t+1}^d = 1 - \delta + r_{t+1}(1 - \tau - \gamma \tau e_{t+1})$ and $\delta \in [0, 1]$ denotes the depreciation rate of capital. The life-cycle utility function of an individual born in t is

$$E[U(c_t, d_{t+1}^u, d_{t+1}^d)] = u(c_t) + (1 - p)\beta u(d_{t+1}^u) + p\beta u(d_{t+1}^d) \quad (7)$$

where $\beta > 0$ is a discount factor. For reasons of tractability we will assume that the expected utility representation u is logarithmic, i.e., $u(x) = \ln(x)$. Each individual maximizes the utility (7), subject to the constraints (4), (5) and (6), by choosing c_t , s_t , e_{t+1} , d_{t+1}^u and d_{t+1}^d . With logarithmic preferences, it is straight forward to show that

$$s_t = \frac{\beta}{1 + \beta} w_t \quad (8)$$

and that the decision on e_{t+1} does not depend on s_t . The first and second order conditions with respect to the choice of e_{t+1} are then given by

$$E[U(e_{t+1})]' \equiv \beta\tau r_{t+1} \left[(1-p)u'(R_{t+1}^u) - \gamma p u'(R_{t+1}^d) \right] = 0 \quad (9)$$

$$E[U(e_{t+1})]'' \equiv \beta(\tau r_{t+1})^2 \left[(1-p)u''(R_{t+1}^u) + p\gamma^2 u''(R_{t+1}^d) \right] < 0 \quad (10)$$

Equation (9) characterizes e_{t+1}^* , the optimal fraction of income concealed. We will assume in the following that such an interior solution $e_{t+1}^* \in [0, 1]$ always exists.

The fraction of evasion decreases as tax enforcement becomes stricter, i.e. $de_{t+1}^*/dp < 0$ and $de_{t+1}^*/d\gamma < 0$. This can be seen by implicitly differentiating the first order condition (9). Furthermore, a marginal increase in the tax rate reduces the optimal share of evasion:

$$\frac{de_{t+1}^*}{d\tau} = \frac{(1-p)\tau\beta r_{t+1}^2 u'(R_{t+1}^u) [\rho(R_{t+1}^u)(1-e_{t+1}) - \rho(R_{t+1}^d)(1+\gamma e_{t+1})]}{-E[U(e_{t+1})]''} < 0 \quad (11)$$

where $\rho(x) = -u''(x)/u'(x)$ is the Arrow-Pratt measure of absolute risk aversion, which satisfies $\rho'(x) \leq 0$ and thereby $\rho(R_{t+1}^d) \geq \rho(R_{t+1}^u)$ for non-increasing absolute risk aversion¹². Intuitively, a higher tax rate reduces taxpayers' income and makes them less willing to take risks. There is no substitution effect as the penalty is assumed to be levied on the share of income evaded, implying that marginal gains and marginal costs from evasion exactly offset each other. In addition to the standard model which considers evasion in levels, however, the above result predicts a decreasing share of evasion

¹²Note that this assumption is always satisfied for our logarithmic preference representation.

instead of a decreasing level.

Similarly, for $\rho(R_{t+1}^d) \geq \rho(R_{t+1}^u)$, an increase in the interest rate (capital income) lowers the optimal share of evasion:

$$\frac{de_{t+1}^*}{dr_{t+1}} = \frac{(1-p)\tau\beta r_{t+1}u'(R_{t+1}^u)[\rho(R_{t+1}^d)(1-\tau-\tau\gamma e_{t+1})-\rho(R_{t+1}^u)(1-\tau+\tau e_{t+1})]}{-E[U(e_{t+1})]''} \leq 0 \quad (12)$$

Thus, our model predicts that the percentage of evasion over total income decreases. The intuition is similar to the one coming from an increase in the tax rate. First, there is no substitution effect as the penalty is assumed to be levied on the share of income evaded, implying that marginal gains and marginal costs from evasion exactly offset each other. Second, a higher interest rate increases taxpayers' income and makes them more willing to evade income¹³. However, given that concealed income has an income elasticity of demand less than one, the percentage of evaded taxes decreases.

2.3 Dynamics and Steady State

We are now able to define the intertemporal equilibrium of the economy. Given a fiscal policy (parameters τ , p and γ) and an initial value of the capital stock $k_0 = K_0/N_{-1} = s_{-1}$, a perfect-foresight intertemporal equilibrium is characterized by a sequence of quantities and prices:

$$\{c_t, d_t, k_t, s_t, e_t; w_t, r_t\}_{t \geq 0}.$$

¹³It is straight forward to show that the amount of concealed income, $e_{t+1}r_{t+1}$, increases in r_{t+1} .

Individuals maximize utility, firms maximize profits, factor markets are competitive, and all markets clear. The market-clearing conditions for the labour and capital markets are

$$L_t = 1, \tag{13}$$

$$K_t = s_{t-1}. \tag{14}$$

The dynamics of the basic model are characterized by the following first order difference equation (using (2), (3) and (13)):

$$k_{t+1} = \frac{\beta}{1 + \beta} (1 - \alpha) A k_t^\alpha \tag{15}$$

which monotonically converges towards a unique steady state k^* . Clearly, the tax rate does not affect the dynamics so that the share of evasion increases throughout the transition towards the steady state, i.e. $de_{t+1}/dk_t > 0$.

Therefore, the basic model turns out to be inconsistent with a wide range of empirical findings: First, it predicts a decrease of the share of evasion as a response to a tax increase whereas empirical studies point to an increase of evasion at the individual level (see e.g. [Clotfelter \(1983\)](#) and [Joulfaian and Rider \(1996\)](#)) as well as at the aggregate level ([Poterba, 1987](#)). Second, in this model agents will always evade taxes as long as this is the profitable option while empirical evidence shows that there are individuals that never evade (see for example, [Baldry \(1986\)](#) and [Alm \(1999\)](#)). Third, recent empirical literature shows that taxpayers' attitudes towards evasion are related

to the behavior of other taxpayers in the society (see e.g. [Gaechter \(2006\)](#)). Still, in the basic framework taxpayers behavior is absolutely independent of others. Moreover, cross sectional data and longitudinal data suggest that the share of evasion over GDP decreases with the stage of economic development (see for instance, [Besley and Persson \(2014\)](#) and [Gordon and Li \(2009\)](#) for the cross-sectional case and, [Crane and Nourzad \(1986\)](#) and [Schneider et al. \(2011\)](#) for the longitudinal one). By contrast, the results of the basic model imply an increase of the share of evasion along the transitional path of an economy.

In order to reconcile theory with empirical evidence, the next section introduces moral concerns into the basic model.

3 Morality

In this section we introduce morality and reputation concerns along the lines of [Gordon \(1989\)](#).¹⁴ Accordingly, tax morale is modeled as an internalized social norm for tax compliance. The strength of this norm is assumed to be endogenous and depends on the number of individuals in society adhering to it ([Akerlof, 1980](#), [Lindbeck et al., 1999](#)). Hence, the more individuals evade taxes, the weaker the social norm, as it becomes easier for the individual taxpayer to justify his own wrongdoing to himself, the more other people violate the societies' code of conduct. Preferences therefore do not only depend on consumption levels but also on the 'moral costs' of tax evasion. Conse-

¹⁴Similar approaches have extended the classical portfolio choice model to allow for a social custom for tax compliance ([Myles and Naylor, 1996](#)) or a stigmatization effect ([Kim, 2003](#)). See [Traxler \(2010\)](#) for a discussion of these different approaches and a generalization of the model by [Gordon \(1989\)](#).

quently, the life-cycle utility function of an individual i born in period t can be represented by the following additive preference structure:

$$U_i(c_t, d_{t+1}^u, d_{t+1}^d, e_{t+1}) = E[U(c_t, d_{t+1}^u, d_{t+1}^d)] - e_{t+1}(\theta_i + \mu(1 - n_t)) \quad (16)$$

where the expression $(\theta_i + \mu(1 - n_t))e_{t+1}$ captures the moral costs of tax evasion. These costs are linearly increasing in the individual degree of norm internalization $\theta_i \geq 0$, which has distribution function $F(\theta_i)$ and support $[0, \bar{\theta}]$. Furthermore, moral costs depend on individually fixed (marginal) reputation costs $\mu > 0$ and on the share of evaders in society n_t .¹⁵ Equivalent assumptions are made in static models by [Gordon \(1989\)](#), [Fortin et al. \(2007\)](#) and [Traxler \(2010\)](#). Moreover, for reasons of analytical tractability, we assume that moral costs are linearly increasing in the share rather than the absolute amount of evaded income. This latter assumption captures the idea that the extent of guilt or shame incurred by evaders is evaluated relative to the amount of taxes that could have been evaded. For example, moral concerns should be more pronounced for a taxpayer evading almost all of his income as compared to one evading only a small fraction, given that both have the same amount of income (see [Bosco and Mittone \(1997\)](#) and [Levaggi and Menoncin \(2013\)](#) for a similar approach).¹⁶

Individuals maximize (16) subject to (8), (5) and (6) taking prices and the number of evaders n_t as given. The first order condition for an interior

¹⁵Our main results would equally hold for $\mu = 0$. In this case, however, the dynamics of the model would be completely determined by the evolution of the capital stock and not depend on the share of evaders in society.

¹⁶In the appendix, however, we show, by means of Monte Carlo simulations, that our main results readily carry over to the alternative framework where moral costs depend on the level of evaded income (as in [Gordon \(1989\)](#)).

solution with respect to e_{t+1} is

$$E[U(.)]' \equiv \beta\tau r_{t+1} \left[(1-p)u'(R_{t+1}^u) - \gamma p u'(R_{t+1}^d) \right] = \theta_i + \mu(1-n_t) \quad (17)$$

while the second order condition is the same as (10). Norm guided taxpayers will choose a share of evasion such that the marginal expected utility $E[U(.)]'$ equals $\theta_i + \mu(1-n_t)$, the marginal moral costs from concealing income. An interior solution requires the evasion gamble to be better than fair¹⁷, i.e.

$$z(r_{t+1}) \equiv E[U(0)]' = \frac{(1-p(1+\gamma))\beta\tau r_{t+1}}{1-\delta+(1-\tau)r_{t+1}} > 0 \quad (18)$$

>From equations (17) and (10) it follows that taxpayers with $\theta_i + \mu(1-n_t) > z(r_{t+1})$ do not conceal any income. This implies the threshold¹⁸

$$\hat{\theta}(n_t, r_{t+1}) \equiv z(r_{t+1}) - \mu(1-n_t) \quad (19)$$

which allows us to characterize the optimal individual evasion behavior $e_{t+1}^{*,i}$ for a given level of n_t and r_{t+1} :

$$e_{t+1}^{*,i} = \begin{cases} 0 & \text{for } \theta_i \geq \hat{\theta}(n_t, r_{t+1}) \\ e_{t+1}^{*,i} & \text{for } \theta_i < \hat{\theta}(n_t, r_{t+1}) \end{cases} \quad (20)$$

Those individuals with $\theta_i < \hat{\theta}(n_t, r_{t+1})$ will choose an intermediate share of

¹⁷This requires $1-p(1+\gamma) > 0$ or equivalently $\gamma < (1-p)/p$. The opposite case, in which $1-p(1+\gamma) < 0$ is negative, is of little interest, since tax evasion would never take place.

¹⁸Note that the threshold value of the individual tax morale parameter $\hat{\theta}$ results from the combination of the standard concave utility function with the linear functional form of the tax morale term.

evasion, $e_{t+1}^{*,i} \in [0, e_{t+1}^*]$, whereas those with $\theta_i \geq \hat{\theta}(n_t, r_{t+1})$ do not evade as compliance to the norm is the best policy.

Similar to the basic model without morality, evasion decreases when p or γ increase for those individuals with $\theta_i < \hat{\theta}$. Moreover, $\hat{\theta}$ falls in both cases, so that the number of individuals choosing $e_{t+1}^* = 0$ increases. Hence, aggregate evasion must fall. The effects of a change in τ and r_{t+1} are described by the following proposition:

Proposition 1 *There exists some $\tilde{\theta}(n_t, r_{t+1}) < \hat{\theta}(n_t, r_{t+1})$ such that $\partial e_{t+1}^{*,i} / \partial \tau \leq 0$, $\partial e_{t+1}^{*,i} / \partial r_{t+1} \leq 0$ if $\theta_i < \tilde{\theta}(n_t, r_{t+1})$ and $\partial e_{t+1}^{*,i} / \partial \tau > 0$, $\partial e_{t+1}^{*,i} / \partial r_{t+1} > 0$ if $\theta_i > \tilde{\theta}(n_t, r_{t+1})$ for all k_t and n_t .*

Proof: *See Appendix.*

The effect of a change in the tax rate on tax evasion has been demonstrated before by [Gordon \(1989\)](#) and [Traxler \(2010\)](#) in a static framework. It is shown here how such a result carries over to a dynamic framework and that it holds along the complete transitional path of the economy. The basic intuition is the following: a higher tax rate increases the marginal benefits, as well as the marginal costs (associated with higher expected fines and with morality concerns). In the model of the previous section (without morality) we show that this marginal gains and marginal costs from evasion exactly offset each other, implying no substitution effect and only a negative income effect which encourages taxpayers to take less risks and so, to reduce tax evasion. However, in this version of the model, given that moral costs of evasion are assumed to depend on the share of income concealed rather than on taxes evaded, costs are not affected by a tax change. As a result, marginal

benefits from concealing exceed marginal expected costs implying a substitution effect that provides an incentive to increase evasion. We prove that, for those with $\theta_i < \tilde{\theta}$, the negative income effect dominates and tax evasion reduces as taxes rises, whereas for those with $\theta_i > \tilde{\theta}$ the substitution effect prevails and tax evasion increases.

An increase in the interest rate produces similar effects to those of the tax rate. It increases the marginal benefits as well as the marginal costs of evasion. However, as moral costs of evasion are assumed to depend on the share of income concealed, the increase in marginal benefits from concealing is above the increase in marginal expected costs, producing a substitution effect which provides incentives to increase tax evasion. Moreover, similar to the model without morality, there is a positive income effect which increases the total amount of evaded taxes. However, given that tax evasion has an income elasticity of demand less than one, the percentage of evaded taxes decreases. Thus, the resulting effect depends on a positive income effect as in the basic model and a substitution effect working into the opposite direction. It will be negative for those individuals with $\theta_i < \tilde{\theta}$ and positive otherwise.

Finally, differentiation of (19) yields

$$\frac{\partial \hat{\theta}(n_t, r_{t+1})}{\partial \tau} > 0 \quad \text{and} \quad \frac{\partial \hat{\theta}(n_t, r_{t+1})}{\partial r_{t+1}} > 0. \quad (21)$$

Therefore, the emergence of new evaders tends to increase the share of aggregate evasion. Only those evaders with a sufficiently small degree of norm internalization act according to the standard portfolio approach and reduce

their holdings of the risky asset whereas the more honest individuals evade more the higher the tax rate.

3.1 Dynamics and Steady State

The definition of an intertemporal equilibrium is analogous to the basic model without morality. Nevertheless, apart from a fiscal policy (parameters τ , p and γ) and an initial value of the capital stock $k_0 > 0$, an additional initial value of the share of evaders in society is required, $n_0 \geq 0$. Thus, a perfect-foresight intertemporal equilibrium is characterized by a sequence of quantities and prices:

$$\{c_t, d_t, k_t, s_t, e_t, n_t; w_t, r_t\}_{t \geq 0}$$

such that individuals maximize utility, firms maximize profits, factor markets are competitive, and all markets clear.

The capital stock in period $t + 1$ results from individuals' savings in the preceding period, i.e. $k_{t+1} = s_t$ which implies (using (8)):

$$k_{t+1} = \frac{\beta}{1 + \beta} (1 - \alpha) A k_t^\alpha \quad (22)$$

The equilibrium share of evaders evolves according to the following dynamic equation:

$$n_{t+1} = F(\hat{\theta}(n_t, r_{t+1})) \quad (23)$$

Clearly, the share of evaders in period $t + 1$ is a positive function of the tax rate, the share of evaders in the preceding period and the interest rate. Just

note that $F' = f(\theta_i) > 0$ and recall equations (19) and (21).

The aggregate (average) share of evasion in period $t + 1$ is given by

$$\bar{e}_{t+1} = \int_0^{\hat{\theta}} e_{t+1}^{*,i} f(\theta_i) d\theta_i = \int_0^{\hat{\theta}(n_t, r_{t+1})} e_{t+1}^{*,i} f(\theta_i) d\theta_i. \quad (24)$$

The derivatives of \bar{e}_{t+1} with respect to k_t and τ can be written as follows¹⁹:

$$\frac{\partial \bar{e}_{t+1}}{\partial k_t} = \left[\int_0^{\hat{\theta}(n_t, r_{t+1})} \frac{\partial e_{t+1}^{*,i}}{\partial r_{t+1}} f(\theta_i) d\theta_i + e_{t+1}^{*,i} \Big|_{\theta_i = \hat{\theta}(n_t, r_{t+1})} \frac{\partial \hat{\theta}(n_t, r_{t+1})}{\partial r_{t+1}} \right] \frac{\partial r_{t+1}}{\partial k_t} \quad (25)$$

and

$$\frac{\partial \bar{e}_{t+1}}{\partial \tau} = \int_0^{\hat{\theta}(n_t, r_{t+1})} \frac{\partial e_{t+1}^{*,i}}{\partial \tau} f(\theta_i) d\theta_i + e_{t+1}^{*,i} \Big|_{\theta_i = \hat{\theta}(n_t, r_{t+1})} \frac{\partial \hat{\theta}(n_t, r_{t+1})}{\partial \tau} \quad (26)$$

The second summand in both equations describes the change of aggregate evasion due to the emergence of new evaders in the society. Since $\partial \hat{\theta} / \partial \tau > 0$ and $\partial \hat{\theta} / \partial r_{t+1} > 0$, an increase of the share of evaders should increase the share of tax evasion. However, at the margin, this effect is equal to zero and the second summand vanishes as $e_{t+1}^{*,i}$ evaluated at $\theta_i = \hat{\theta}$ is equal to zero according to its definition. The first summand describes the response of existing evaders and can be decomposed into a negative effect for those individuals with $\theta_i < \tilde{\theta}(n_t, r_{t+1})$ and a positive effect for those with $\theta_i > \tilde{\theta}(n_t, r_{t+1})$, as has been demonstrated in proposition 1. The overall effect thus critically depends on the distribution function $F(\theta_i)$.

As has been demonstrated in Gordon (1989), a sufficient condition for an

¹⁹For the derivation of these formulae, see Leibniz's rule for differentiation of parametric integrals.

interior steady state $n_* \in (0, 1)$ is given by

$$\max\{\bar{\theta}, \mu\} > \hat{\theta}(k_*, 1) > \min\{\bar{\theta}, \mu\} \quad (27)$$

where $k_* = (\beta/(1 + \beta)(1 - \alpha)A)^{1/(1-\alpha)}$ is the steady state solution of equation (22). Moreover, in the appendix it is shown that a sufficient condition for a stable steady state (n_*, k_*) of the dynamic system defined by equations (22) and (23) is

$$\frac{1}{F'(\hat{\theta}(n_*, r_*))} > \beta\alpha(1 - \alpha)Ak_*^\alpha \left(\frac{\mu}{1 + \beta} + \frac{\tau(1 - \delta)(1 - p(1 + \gamma))}{k_*(1 - \delta + (1 - \tau)r_*)^2} \right) \quad (28)$$

The existence of multiple steady states clearly depends on the functional form of F .²⁰ For an uniform distribution, however, there is a unique steady state (n_*, k_*) and the stability condition boils down to assuming that $\bar{\theta}$ is sufficiently large.²¹ As a consequence, in this case it is also possible to explicitly determine the signs of equations (25) and (26). More precisely, we get

$$\text{sign} \left(\frac{\partial \bar{e}_{t+1}}{\partial k_t} \right) = - \text{sign} \left(\frac{\partial \bar{e}_{t+1}}{\partial \tau} \right) = \quad (29)$$

$$= \mu(1 - n_t)(\gamma - 1)R_{t+1} - \beta\tau\gamma r_{t+1} + \bar{m} \quad (30)$$

where $R_{t+1} = 1 - \delta + (1 - \tau)r_{t+1}$ and

$$\bar{m} = \sqrt{(\beta\tau\gamma r_{t+1} - \mu(1 - n_t)(\gamma + 1)R_{t+1})^2 + 4p\beta\tau\gamma r_{t+1}\mu(1 - n_t)(\gamma + 1)R_{t+1}}. \quad (31)$$

²⁰See [Kim \(2003\)](#) or [Traxler \(2010\)](#) for an analysis of multiple steady states.

²¹It is important to note that our main results are robust to alternative functional forms which however preclude analytical solutions. Section 3.2 presents Monte Carlo simulations with alternative functional forms to illustrate this point.

Straight forward calculations show that

$$- \text{sign} \left(\frac{\partial \bar{e}_{t+1}}{\partial k_t} \right) = \text{sign} \left(\frac{\partial \bar{e}_{t+1}}{\partial \tau} \right) > 0 \quad \Leftrightarrow \quad \hat{\theta}(n_t, r_{t+1}) > 0. \quad (32)$$

These findings are summarized in the following propositions:

Proposition 2 *Assume that θ_i is uniformly distributed with support $[0, \bar{\theta}]$. Then, a higher level of per capita capital decreases the aggregate share of evasion throughout the transition towards the steady state, i.e. $\partial \bar{e}_{t+1} / \partial k_t < 0$.*

Proof: *See Appendix.*

When the initial amount of per capita capital is below its steady state level, the rate of return to investing into the capital stock is high. Capital accumulation however decreases the interest rate and thus the threshold determining the number of evaders in the economy (see equation (21)). A lower interest rate reduces the tax base which in turn renders tax evasion less profitable so that the number of tax evaders declines throughout the transition towards the steady state. However, as has been established in proposition 1, the behavioral responses of the remaining evaders are generally ambiguous and depend on the individual specific degree of honesty. If θ_i is uniformly distributed, proposition 2 demonstrates that the overall effect is negative, implying that both the share of evaded taxes and the number of evaders decline throughout the transition. The decrease in the number of evaders increases the moral costs of tax evasion for the remaining evaders in each of the following periods, thereby reinforcing the decline in the share of tax evasion. As a result, economies with low levels of per capita capital and an initial stage of economic development are characterized by high levels of tax

evasion and a large number of evaders, whereas economies with high levels of per capita capital are characterized by the opposite.

These results are consistent with the empirical findings of [Crane and Nourzad \(1986\)](#) who analyze aggregate tax evasion in the US over the period 1947-81. Furthermore, interpreting each point along the dynamic path of the economy as a specific set of countries, our model accounts for the observation that tax evasion is a more severe problem in developing countries as compared to developed ones (see e.g. [Gordon and Li \(2009\)](#) and [Besley and Persson \(2014\)](#)). In particular, our simple model predicts that the share of evasion decreases as economies converge towards the (unique) steady state. Moreover, as a consequence, the average moral cost of tax evasion increases with per capita income, which is consistent with empirical results (see [Torgler and Schneider \(2007\)](#) and [Bethencourt \(2013\)](#)).

The next proposition summarizes the effect of income taxation on the aggregate share of evasion:

Proposition 3 *Assume that θ_i is uniformly distributed with support $[0, \bar{\theta}]$. Then, a higher tax rate increases the aggregate share of evasion, i.e. $\partial \bar{e}_{t+1} / \partial \tau > 0$.*

Proof: *See Appendix.*

To understand the effect of the tax rate suppose that the economy is initially in steady state. An increase in the tax rate then implies a larger threshold which determines the number of evaders in the economy (according to equation (21)): Tax evasion becomes more profitable and therefore the subset of tax evading individuals increases. At the same time, proposition 1 es-

establishes that only those individuals with sufficiently high moral concerns expand their evasion activities. The overall change in the share of tax evasion will thus depend on the relative size of the decrease in tax evasion for individuals with low moral concerns. Similarly to the preceding proposition, if θ_i is uniformly distributed, the first effect dominates, and so the share of evaded taxes increases. In each of the following periods, the larger number of evaders will reduce the moral cost of evading taxes which will in turn increase tax evasion and the number of evaders even more. The economy will then converge to a new steady state with a larger number of evaders and a higher share of tax evasion.

The extended version of our model therefore allows us to account for existent puzzles in the literature of tax evasion which the basic model without morality could not explain. In fact, predictions of the model are consistent with the following empirical findings: a positive relationship between tax evasion and tax rates at the individual and aggregate level; the fact that there exists taxpayers that never evade as long as this is the profitable option and the observation that taxpayers' evasion decisions are interdependent.

Summarizing, the model is able to account simultaneously for well known micro empirical findings as well as for the latest macro-dynamic observations which have been recently documented in the empirical literature on tax evasion.

3.2 Monte Carlo simulations

The aim of this section is twofold. First, it serves to illustrate how the aggregate share of evasion and the share of evaders in the economy react to an increase in the tax rate and how these variables evolve along the transition towards the steady state. Second, and importantly, it shows that our main results are robust against alternative functional forms of the underlying distribution function $F(\cdot)$.

In order to simulate the model, we use the following parameter configuration: $\alpha = 0.3$, a standard value in the literature, $p = 0.05$, $\gamma = 2$ which implies $1 - p(1 + \gamma) = 0.85$ and therefore corresponds to the average value implied by the fiscal systems of most countries (see [Kim \(2003\)](#)), and $A = 8$ and $\delta = 0.9$ as in [Rivas \(2003\)](#). Finally, in order to generate plausible values for the share of evaded income and the number of evaders in the economy, we set $\beta = 0.7$ and $\mu = 0.1$. We consider three alternative distribution functions with support on the positive real axis: the uniform distribution (on $[0, 1]$), the log-normal distribution (with parameters $\text{LN}(0, 1)$) and the Weibull distribution (with parameters $\text{WBL}(1, 1.5)$).

For a given distribution function $F(\cdot)$, the model is solved using Monte Carlo simulations. Specifically, we take $N = 100000$ draws from the corresponding density function and solve the first order conditions for each draw numerically. The individual choices are then averaged to obtain the aggregate stock of capital and the aggregate amount of evaded income in each period t . The threshold level $\hat{\theta}$ which, together with the underlying distribution function, determines the evolution of the number of evaders in society

(see equation (23)) is obtained by taking the maximum value of θ_i for which $e_{t+1}^{*,i}$ is larger or equal to zero.

Table 1 summarizes the share of evaders and the share of evaded income in steady state for varying levels of τ and the different functional forms of $F(\cdot)$. In particular, we solve the economy for $\tau = \{0.2, 0.3, 0.4\}$. Notice that for the characterization of the economy we propose, in almost all cases the share of evaded income ranges from 1.7-7.9%. These numbers seem to be consistent with recent evidence. More precisely, estimations for the US show that the share of evaded taxes is about 2-3% of GDP (Andreoni et al., 1998, Slemrod, 2007), whereas Lang et al. (1997) find a tax gap for Germany in 1983 which corresponds to about 7% of GDP.

Clearly, an increase in the capital income tax rate by ten percentage points raises the share of evaders in society as well as the share of taxes evaded. For example, increasing τ from 0.2 to 0.3 raises the share of evaders by 4.6 percentage points from 2.2% to 6.7% while the aggregate share of evaded income increases by 2.2 percentage points from 1.6% to 3.8% (for the log-normal distribution).

[Insert table 1 around here.]

Figures 1-3 present the dynamics of \bar{e}_{t+1} and n_{t+1} for alternative levels of τ and the different functional forms of $F(\cdot)$. More precisely, in each figure, $\tau = 0.2$ corresponds to the lowest transitional paths whereas the highest ones correspond to $\tau = 0.4$. Two findings are noteworthy. First, the underlying distribution function does indeed affect the quantitative implications

of our model (as expected). For example, the drop in the share of evaded income throughout the transitional path seems to be more pronounced for the uniform as compared to the log-normal or the Weibull distribution. Second, the qualitative results, however, are not sensitive to alternative functional forms of $F(\cdot)$. Specifically, both the share of evaded income as well as the share of evaders in society monotonically decrease as capital accumulates in line with our theoretical predictions.

[Insert Figures 1-3 around here.]

4 Conclusions

This paper integrates non-pecuniary costs of evasion into a dynamic overlapping generations model of capital income tax evasion to explain the empirical observation that evasion is a more severe phenomenon among developing countries as compared to developed countries. It is shown that morale concerns may not only explain why some taxpayers never evade even if the gamble is better than fair, and how a higher tax rate can increase evasion but also that the share of evaded taxes over GDP decreases with the stage of economic development as per capita income increases. By contrast, tax morale increases with per capita income as the number of evaders in society declines. Moreover, an increase in the tax rate increases aggregate evasion as well as the number of evaders in the economy when taxpayers decisions are interdependent. Hence, an important insight emerging from our analysis is that policies aimed at deterring tax evasion may have long-lasting and

amplifying effects by altering both economic incentives *and* the formation of social norms throughout an economy's transitional path and in steady state.

Our findings complement the existing literature on evasion in important ways by demonstrating how the size of tax evasion evolves along the transitional path of an economy, whereas previous studies either consider a static environment without production (see e.g. [Gordon \(1989\)](#) or [Kim \(2003\)](#)) or focus on the relationship between tax evasion and economic growth on a balanced growth path (see e.g. [Dzhumashev and Gahramanov \(2011\)](#) or [Levaggi and Menoncin \(2012\)](#)). Furthermore, the present paper documents a positive relationship between per capita income and tax morale consistent with recent empirical evidence (see [Torgler and Schneider \(2007\)](#) and [Bethencourt \(2013\)](#)).

Our theoretical model thus emphasizes the role of social norms in determining the dynamics of tax evasion. A complementary explanation of these dynamics, however, is related to the quality of institutions. Indeed, as has been shown, e.g., by [Torgler and Schneider \(2009\)](#), both a higher tax morale *and* a higher quality of institutions imply a smaller size of the shadow economy. Given that the institutions of advanced economies have on average a higher quality and these countries are thus better at collecting taxes (e.g. due to better information available to tax authorities as has been emphasized by [Kleven et al. \(2011\)](#)), tax moral and the quality of institutions tend to reinforce each other if a share of tax collections is devoted to quality improvements. To disentangle the relative importance of both mechanisms in shaping the relationship between tax evasion and economic development, however, is ultimately a quantitative question.

Our analysis could be extended in various ways. First, incorporating productive public spending (and endogenous growth) or redistributive transfers would be valuable. This complicates the analysis but should not change our results qualitatively. For example, if tax revenue is redistributed lump sum to the young households, an increase in the share of evaders in the economy exerts a direct negative effect on per capita income as individuals save less due to a smaller transfer. Furthermore, if public spending increases productivity and thus wages, the level of savings would increase, which in turn accelerates the process of capital accumulation and therefore the decline in the rate of return, implying a lower share of evaded taxes and a lower share of evaders in the economy. In such a framework, however, poverty traps may arise if the level of tax evasion is sufficiently large and tax collections are thus too low to generate productive spending and the accompanying increases in productivity.

Second, even though the main focus of our analysis is on capital income tax evasion, one could introduce evasion activities from alternative income sources, as e.g. wage income. The possibility to evade wage income taxes would increase the potential to save and therefore foster capital accumulation. This, in turn, would imply a sharper decline of the interest rate throughout the economy's transitional path and thus lower the incentive to evade taxes on capital income. Quantitatively, however, the aggregate amount of tax evasion might then decrease more moderately since tax evasion on wages should increase with capital accumulation.²²

²²We have experimented with simulations for such an extended model. The results of these simulations are available upon request. They suggest that our conjecture is warranted.

Finally, more elaborated numerical simulations may be used to address the welfare implications of capital income tax evasion in a dynamic context (see [Boadway and Keen \(1998\)](#) for a related static analysis).

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Appendix

Proof of proposition 1:

In order to prove proposition 1 we need to obtain the derivatives of $e_{t+1}^{i,*}$ with respect to r_{t+1} and τ . The derivation of these expressions relies on the explicit solution of equation (17). More precisely, solving for $e_{t+1}^{i,*}$ gives²³

$$e_{t+1}^{i,*} = \frac{\beta r_{t+1} \gamma \tau - R_{t+1}(\gamma - 1)(\theta_i + \mu(1 - n_t)) - \tilde{m}}{2r_{t+1} \gamma \tau (\theta_i + \mu(1 - n_t))} \quad (\text{A.1})$$

where $R_{t+1} = 1 - \delta + (1 - \tau)r_{t+1}$ and

$$\tilde{m} = \sqrt{(\beta \tau \gamma r_{t+1} - (\theta_i + \mu(1 - n_t))(\gamma + 1)R_{t+1})^2 + 4p\beta \tau \gamma r_{t+1}(\theta_i + \mu(1 - n_t))(\gamma + 1)R_{t+1}}. \quad (\text{A.2})$$

Derivation of the above expression gives:

$$\frac{\partial e_{t+1}^{i,*}}{\partial r_{t+1}} = \frac{(1 - \delta)(\gamma - 1)\tilde{m} + (\gamma + 1)(R_{t+1}(\gamma + 1)(\theta_i + \mu(1 - n_t)) - \beta r_{t+1} \gamma \tau(1 - 2p))}{2r_{t+1}^2 \gamma \tau \tilde{m}} \quad (\text{A.3})$$

and

$$\frac{\partial e_{t+1}^{i,*}}{\partial \tau} = \frac{(1 - \delta + r_{t+1})(\gamma - 1)\tilde{m} - (\gamma + 1)(R_{t+1}(\gamma + 1)(\theta_i + \mu(1 - n_t)) + \beta r_{t+1} \gamma \tau(1 - 2p))}{2r_{t+1} \gamma \tau^2 \tilde{m}} \quad (\text{A.4})$$

²³Note that there are two solutions. However, one of them can be excluded from the analysis due to economic reasoning as such a solution is positive for all values of θ_i .

Solving the inequalities $\frac{\partial e_{t+1}^{i,*}}{\partial r_{t+1}} \geq 0$ and $\frac{\partial e_{t+1}^{i,*}}{\partial \tau} \geq 0$ for θ_i yields:

$$\frac{\partial e_{t+1}^{*,i}}{\partial \tau} \begin{cases} > 0 & \text{if } \theta_i > \tilde{\theta} \\ \leq 0 & \text{if } \theta_i \leq \tilde{\theta} \end{cases} \quad (\text{A.5})$$

and, similarly,

$$\frac{\partial e_{t+1}^{*,i}}{\partial r_{t+1}} \begin{cases} > 0 & \text{if } \theta_i > \tilde{\theta} \\ \leq 0 & \text{if } \theta_i \leq \tilde{\theta} \end{cases} \quad (\text{A.6})$$

with

$$\tilde{\theta} = \frac{\beta \tau r_{t+1} \sqrt{\gamma} (\sqrt{p(1-p)}(\gamma-1) - \sqrt{\gamma}(1-2p))}{(1+\gamma)R_{t+1}} - \mu(1-n_t) \quad (\text{A.7})$$

Finally, a comparison of $\tilde{\theta}$ and $\hat{\theta}$ (see equation (19)) yields

$$\tilde{\theta} < \hat{\theta} \Leftrightarrow \gamma < \frac{1-p}{p}. \quad (\text{A.8})$$

This condition is assumed to hold throughout the paper as it ensures the existence of an interior solution (see also equation (18)).

Proof of equation (28):

A steady state (k_*, n_*) of the dynamic system

$$k_{t+1} = \Phi(k_t) \quad (\text{A.9})$$

$$n_{t+1} = \Psi(n_t, k_t) \quad (\text{A.10})$$

is locally stable if the following conditions are met (see [de la Croix and Michel \(2002\)](#))

$$|1+D| > |T| \quad \text{and} \quad |D| < 1 \quad (\text{A.11})$$

where $T = \Psi_{k_t}(n_*, k_*) = F'(n_*, k_*) \frac{\partial \hat{\theta}}{\partial r_{t+1}} \frac{\partial r_{t+1}}{\partial k_t}$ is the trace of the Jacobian matrix G derived from a first order Taylor expansion of the dynamic system around a steady state, i.e.

$$G = \begin{pmatrix} 0 & \Phi_{k_t}(k_*) \\ \Psi_{n_t}(n_*, k_*) & \Psi_{k_t}(n_*, k_*) \end{pmatrix} \quad (\text{A.12})$$

and $D = -\alpha \frac{\beta}{1+\beta} (1-\alpha) A k_*^{\alpha-1} F'(n_*, k_*) \mu$. The condition $|D| < 1$ is equivalent to

$$\frac{1}{F'(n_*, k_*)} > \frac{\beta}{1+\beta} \alpha (1-\alpha) A k_*^{\alpha-1} \mu. \quad (\text{A.13})$$

Similarly, the condition $|1+D| > |T|$ is equivalent to (note that $1+D > 0$ since $|D| < 1$)

$$\frac{1}{F'(n_*, k_*)} > \beta \alpha (1-\alpha) A k_*^{\alpha-1} \left(\frac{\mu}{1+\beta} + \frac{\tau(1-\delta)(1-p(1+\gamma))}{k_*(1-\delta+(1-\tau)r_*^2)} \right). \quad (\text{A.14})$$

This proves equation (28).

Proof of propositions 2 and 3:

In order to prove propositions 2 and 3 we need to derive the derivatives of \bar{e}_{t+1} with respect to r_{t+1} and τ . As in the proof of proposition 1, the derivation of these expressions relies on the explicit solution of $e_{t+1}^{i,*}$, see equation

(A.1). the derivative of $e_{t+1}^{i,*}$ with respect to r_{t+1} and τ are given by equations (A.3) and (A.4). Integrating these equations over the relevant range ($[0, \hat{\theta}]$) and assuming an uniform distribution yields:

$$\frac{\partial \bar{e}_{t+1}}{\partial r_{t+1}} = \frac{(1 - \delta)\{\beta r_{t+1} \gamma \tau - R_{t+1}(\gamma - 1)\mu(1 - n_t) - \tilde{m}\}}{2R_{t+1}r_{t+1}^2 \gamma \tau} \quad (\text{A.15})$$

and

$$\frac{\partial \bar{e}_{t+1}}{\partial \tau} = \frac{(1 - \delta + r_{t+1})\{\beta r_{t+1} \gamma \tau - R_{t+1}(\gamma - 1)\mu(1 - n_t) - \tilde{m}\}}{2R_{t+1}r_{t+1} \gamma \tau^2} \quad (\text{A.16})$$

The sign of these derivatives is determined by the sign of the expression in curly brackets. The proof of propositions 2 and 3 follow immediately by noting that $dr_{t+1}/dk_t < 0$ and by recalling equation (32).

An alternative framework: Tax evasion in levels

The aim of this section is to illustrate that our main results do not depend on the assumption that moral costs are linear in the share of evaded income. To do so, we consider the following alternative specification of the individual's maximization problem where moral costs are linear in the amount of evaded

income (as in [Gordon \(1989\)](#)):

$$U_i = \ln(c_t) + \beta[p \ln(d_{t+1}^d) + (1-p) \ln(d_{t+1}^u)] - \tilde{e}_{t+1}(\theta_i + \mu(1-n_t)) \quad (\text{A.17})$$

$$\text{s.t.} \quad w_t = c_t + s_t \quad (\text{A.18})$$

$$d_{t+1}^u = (1 - \delta + r_{t+1}(1 - \tau))s_t + \tau \tilde{e}_{t+1} \quad (\text{A.19})$$

$$d_{t+1}^d = (1 - \delta + r_{t+1}(1 - \tau))s_t - \gamma \tau \tilde{e}_{t+1} \quad (\text{A.20})$$

where \tilde{e}_{t+1} is the individual amount of evaded income. Using equations (2) and (3), the first order conditions with respect to s_t and \tilde{e}_{t+1} can be written as

$$\frac{\partial U_i}{\partial s_t} : \quad 0 = -\frac{1}{(1-\alpha)Ak_t^\alpha - s_t} + \frac{\beta p(1-\delta + (1-\tau)\alpha Ak_{t+1}^{\alpha-1})}{(1-\delta + (1-\tau)\alpha Ak_{t+1}^{\alpha-1})s_t - \tau \gamma \tilde{e}_{t+1}} + \frac{\beta(1-p)(1-\delta + (1-\tau)\alpha Ak_{t+1}^{\alpha-1})}{(1-\delta + (1-\tau)\alpha Ak_{t+1}^{\alpha-1})s_t + \tau \tilde{e}_{t+1}} \quad (\text{A.21})$$

and

$$\frac{\partial U_i}{\partial \tilde{e}_{t+1}} : \quad 0 = -\theta_i - \mu(1-n_t) - \frac{\beta p \tau \gamma}{(1-\delta + (1-\tau)\alpha Ak_{t+1}^{\alpha-1})s_t - \tau \gamma \tilde{e}_{t+1}} + \frac{\beta(1-p)\tau}{(1-\delta + (1-\tau)\alpha Ak_{t+1}^{\alpha-1})s_t + \tau \tilde{e}_{t+1}} \quad (\text{A.22})$$

As in section 3.2, the model is solved using Monte Carlo simulations with $N = 100000$ draws from a given distribution function $F(\cdot)$ (either the uniform, the log-normal or the Weibull distribution). The numerical solutions of equations (A.21) and (A.22) for individual choices s_t and \tilde{e}_{t+1} and each of the

corresponding draws are then averaged which in turn yields the aggregate stock of capital and the aggregate amount of evaded income in each period t , given the capital market clearing condition. The parameters are basically the same as in section 3.2. The only difference is that we set $\mu = 0.01$ in order to obtain plausible solutions for the size of evaded income and the number of evaders in society.²⁴ The threshold level $\hat{\theta}$ which, together with the underlying distribution function, determines the evolution of the number of evaders in society (see equation (23)) is obtained by taking the maximum value of θ_i for which $\tilde{e}_{t+1}^{*,i}$ is larger or equal to zero.

[Insert table 2 around here.]

Similar to the presentation of the results in the basic model, table 2 summarizes the share of evaders and the share of evaded income in steady state for varying levels of τ and different functional forms of $F(\cdot)$. Clearly, an increase in the capital income tax rate by ten percentage points raises the share of evaders in society as well as the share of taxes evaded. This holds independent of the underlying distribution function. For example, with a Weibull distribution (WBL(1,1.5)), increasing τ from 0.2 to 0.3 raises the share of evaders by 4.8 percentage points from 3.6% to 8.4% while the aggregate share of evaded income increases by 3.3 percentage points from 1.7% to 4.97%. Figure 4 illustrates the dynamics of the share of evaded income, i.e. $\bar{e}_{t+1}/(r_{t+1}k_{t+1})$, and the numbers of evaders in society n_{t+1} for a uniform

²⁴Note that in the baseline model the moral costs of evasion are naturally smaller as they are assumed to depend on the share of evaded income rather than on the absolute amount. In order to reproduce a similar economy with similar levels of morality, however, the size of μ is reduced accordingly.

distribution while figures 5 and 6 present the results with a log-normal and a Weibull distribution, respectively. The lowest transitional path in each figure corresponds to the case $\tau = 0.2$ whereas the highest one corresponds to $\tau = 0.4$. Clearly, the qualitative results are the same as in section 3. Hence, our simulations suggest that the main findings are robust against assuming moral costs to be linear in the share rather than the level of evaded income.

[Insert figures 4-6 around here.]

Tables and Figures

$F(.)$	τ	0.2	0.3	0.4
uniform	n_*	0.0364	0.1380	0.2688
	\bar{e}_*	0.0170	0.0776	0.1165
log-normal	n_*	0.0217	0.0674	0.1416
	\bar{e}_*	0.0155	0.0377	0.0559
Weibull	n_*	0.0472	0.1007	0.1812
	\bar{e}_*	0.0372	0.0653	0.0797

Table 1: Predicted steady state shares of evaded income and of evaders in society for alternative distributions of F and varying levels of the capital income tax (moral costs linear in the share of evaded income). Uniform distribution on $[0, 1]$; log-normal distribution (with parameters LN(0,1)); Weibull distribution (with parameters WBL(1,1.5)).

$F(\cdot)$	τ	0.2	0.3	0.4
uniform	n_*	0.0387	0.0653	0.0997
	\bar{e}_*	0.0340	0.0481	0.0495
log-normal	n_*	0.0005	0.0032	0.0105
	\bar{e}_*	0.0005	0.0017	0.0036
Weibull	n_*	0.0076	0.0166	0.0309
	\bar{e}_*	0.0058	0.0106	0.0135

Table 2: Predicted steady state shares of evaded income and of evaders in society for alternative distributions of F and varying levels of the capital income tax (moral costs linear in the level of evaded income). Uniform distribution on $[0, 1]$; log-normal distribution (with parameters LN(0,1)); Weibull distribution (with parameters WBL(1,1.5)).

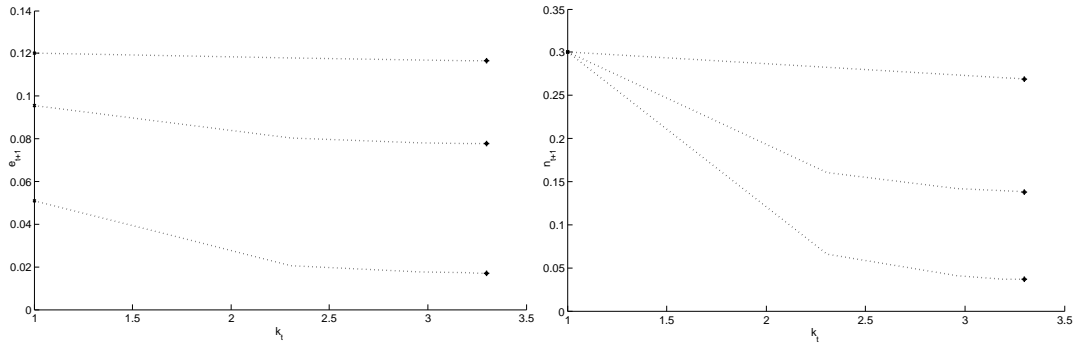


Figure 1: Underlying distribution: Uniform (on $[0,1]$). Dynamics of the share of evaded income (left) and the share of evaders in society (right) for different levels of τ and initial values $k_0 = 1$ and $n_0 = 0.3$. Stars indicate steady state levels.

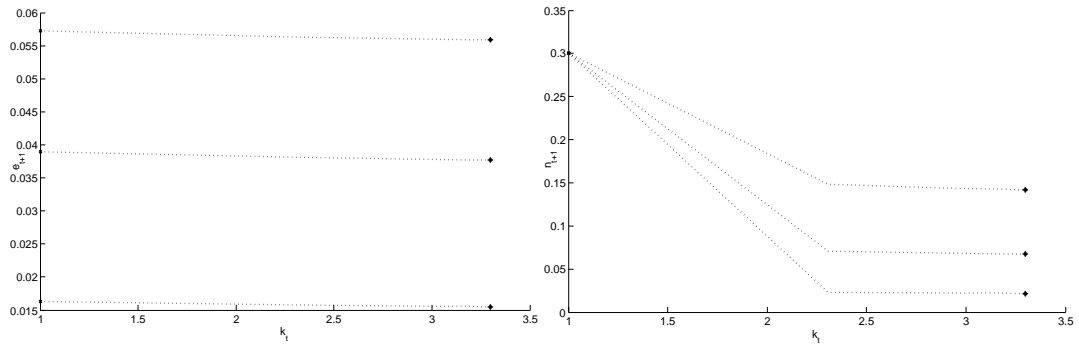


Figure 2: Underlying distribution: Log-normal (LN(0,1)). Dynamics of the share of evaded income (left) and the share of evaders in society (right) for different levels of τ and initial values $k_0 = 1$ and $n_0 = 0.3$. Stars indicate steady state levels.

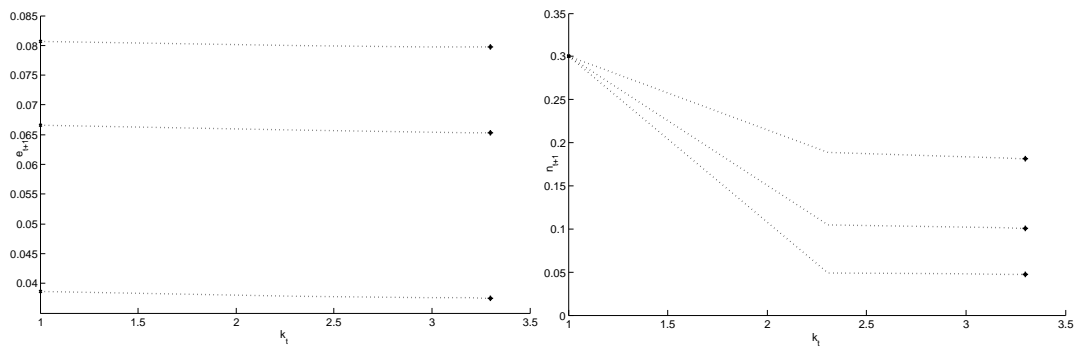


Figure 3: Underlying distribution: Weibull (WBL(0,1.5)). Dynamics of the share of evaded income (left) and the share of evaders in society (right) for different levels of τ and initial values $k_0 = 1$ and $n_0 = 0.3$. Stars indicate steady state levels.

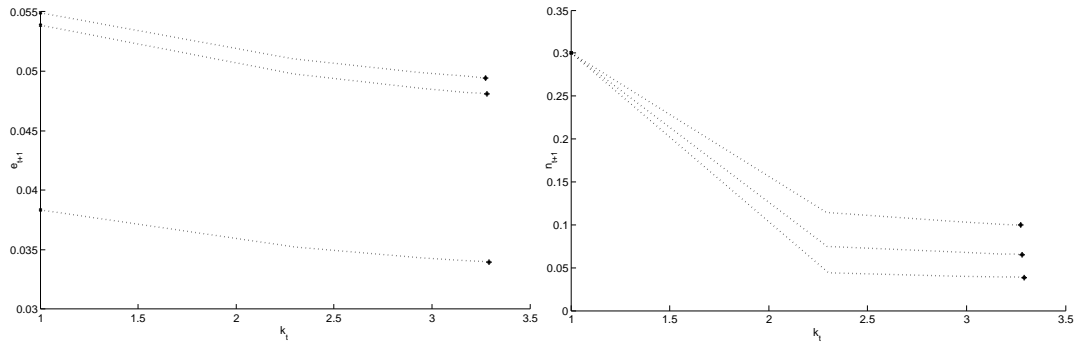


Figure 4: Underlying distribution: Uniform (on $[0,1]$). Dynamics of the share of evaded income (left) and the share of evaders in society (right) for different levels of τ and initial values $k_0 = 1$ and $n_0 = 0.3$ (moral costs linear in the level of evaded income). Stars indicate steady state levels.

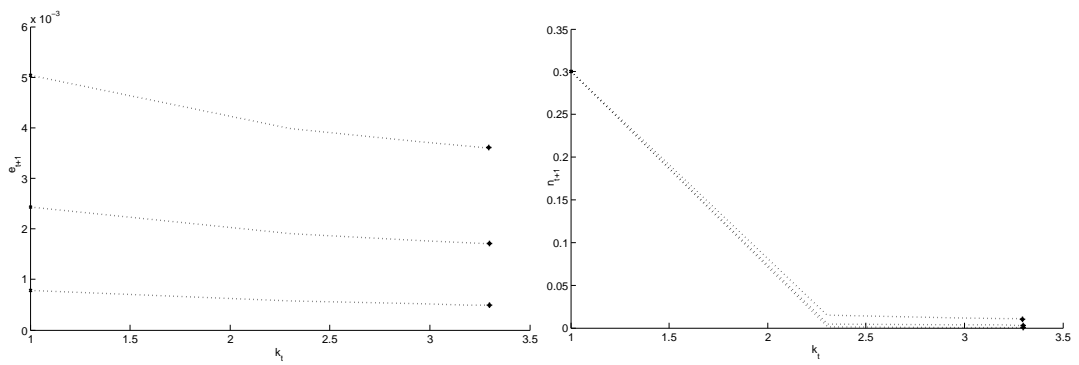


Figure 5: Underlying distribution: Log-normal ($LN(0,1)$). Dynamics of the share of evaded income (left) and the share of evaders in society (right) for different levels of τ and initial values $k_0 = 1$ and $n_0 = 0.3$ (moral costs linear in the level of evaded income). Stars indicate steady state levels.

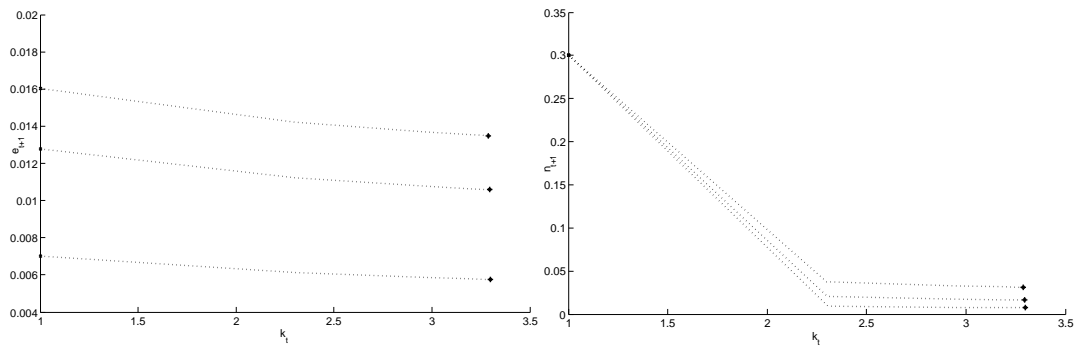


Figure 6: Underlying distribution: Weibull (WBL(0,1.5)). Dynamics of the share of evaded income (left) and the share of evaders in society (right) for different levels of τ and initial values $k_0 = 1$ and $n_0 = 0.3$ (moral costs linear in the level of evaded income). Stars indicate steady state levels.