Tax Avoidance, Human Capital Accumulation and Economic Growth

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December 2011

Barcelona GSE Working Paper Series

Working Paper nº 599

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December 2011

Abstract

Human capital accumulation may negatively affect economic growth by increasing tax avoidance and reducing effective tax rates and productive public investment. This paper analyzes how the endogenous feedback between human capital accumulation and tax avoidance affects economic growth and macroeconomic dynamics. Our findings show that this interaction produces remarkable growth and welfare effects.

JEL code: E62, H26, O30, O40, O41.

Keywords: Tax avoidance, Tax non compliance, Economic growth.

*Financial support from the Spanish Ministry Science and Innovation through grant ECO2008-02752; Spanish Ministry of Education through grants PR2010-0352 and ECO2009-09847; the Xunta de Galicia through grant 10PXIB30001777PR, and support of the Generalitat of Catalonia through grant SGR2009-00350 are acknowledge. M.J. Freire-Serén also thanks the Research School of Economics at the Australian National University and Geary Institute at University College of Dublin for their hospitality during the visits where this paper was written. Finally, the authors thank Jaime Alonso-Carrera for his very useful comments.

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1. Introduction

Tax evasion and tax avoidance phenomena are present in all economies.[1] Although both imply reducing the taxpayers' tax bill, tax evasion is an illegal activity, while the behaviour of tax avoidance is legal. Tax avoidance includes not only the use of strategies that allow for the legal minimization of taxes (for instance to increase the pension savings to use the tax relief), but also for the search of strategies to exploit deficiencies or ambiguities in the law (known as aggressive tax planning strategies). For this reason, sometimes the line that separates both phenomena is a very fine one, and the economic literature usually denotes both terms jointly as tax "non-compliance".

However,it is important to analyze both avoidance and evasion separately, not only for the legal and moral issues, but more so for economic reasons. Since the returns of tax evasion and tax avoidance are of a different nature, they must be introduced in an economic model in a different way. The return from tax evasion is contingent, because it is subject to possible auditing. However, the return from tax avoidance is riskless since there is no chance of its being penalised. The fact that one is contingent and the other is not in itself constitutes a great difference between them. Furthermore, the effects that some variables (for instance, education) have on both behaviours could even be opposite.

The effect of human capital on tax avoidance is clear. Avoiding taxes requires some skills that are achieved at a certain level of educational. Thus, the reported results for the relationship between the taxpayer's educational level and the avoidance and aggressive tax planning behaviour are doubtless. Auerbach et al (2002) tested that tax avoidance increases over time because taxpayers have learned successful techniques to shelter gains from taxes. Fox and Luna (2005) find that the number of limited liability companies relates positively to the percentage of the population with bachelor degrees. Murphy (2006) finds that the taxpayers involved in aggressive tax planning are considerably more educated than taxpayers from the general population.[2] However, when tax evasion behaviour is analyzed the obtained results are not always conclusive. Some papers find that more education reduces the preference to cheat [see Kinsey and Grasmick (1993) and Hite (1997)]. However, others have found mixed results. That is, education could either increase or reduce tax evasion [see Jackson and Milliron (1986)].

Therefore, with this empirical evidence, to introduce the role of human capital in analyzing how non-compliance affects economic growth we should explicitly separate tax avoidance from tax evasion. As far as we know, no previous paper analyzes the effect of tax avoidance on economic growth. In fact, only a few papers have analyzed the role that non compliance tax plays on economic growth. The main conclusion obtained by the literature is that the relation between tax evasion and economic growth

[1] In US, for the period 1976-1992, the nominal tax gap, generated by non-compliance, increases from $ 22.7 billion to $95.3 billion [see Adreoni et al. (1998)]. In New Zealand, Giles (1999) estimated that over the period 1968-94, the total tax gap was in the order of 6.4% to 10.2% of total tax liability. More recent estimations for the shadow economy are in Scheneider (2005), although a significant proportion of income is unreported for reasons other than taxation.

[2] One can also consider that higher your income is, the higher are your possibilities to pay someone to tell you how to avoid taxes. This issue does not invalidate our statement when education is positively related to income.

is ambiguous, and depends mainly on the degree of productivity of public goods.[3]

Computing the actual dimension of tax avoidance is difficult, but some papers have highlighted its relevance. Thus, Oxfam (2000) has computed that the cost of corporate tax avoidance in developing countries is around $50 billion annually. Murphy (2002) also shows that during the 1990s, an estimated $4 billion in tax revenue was lost as a result of 42,000 Australians becoming involved in aggressive mass market tax schemes. Moreover, Braithwaite (2003) relates that a multitude of strategies that seek to exploit deficiencies in the law are continuously being devised each year. Therefore, tax avoidance is an important issue that deserves to be considered.

This paper analyzes how tax avoidance affects to economic growth, by introducing the role of human capital accumulation. It is well known that human capital accumulation is an important source of economic growth because it increases the efficiency units of labour. However, there is also other mechanism through which human capital may reduce economic growth. Our hypothesis is that the causality between tax avoidance and human capital accumulation goes in both directions. Tax avoidance significantly reduces government revenues and therefore affects the level of public expenditure. In an economy where human capital accumulation depends on public expenditure, it is clear that tax avoidance can also affect this process.

The aim of this paper is to analyze how the endogenous feedback between human capital accumulation and tax avoidance affects economic growth and macroeconomic dynamics. To do this, we introduce endogenous tax avoidance in an endogenous economic growth model with human and public capital accumulation. The analysis will show that the interaction between human capital accumulation and tax avoidance may produce remarkable growth and welfare effects. Moreover, it will show how these two effects have in general opposite sign. Avoidance can either increase or reduce economic growth depending on both the value of the legal tax rate and the intensity of the tax avoidance technology.

The paper is organized as follows. Section 2 presents the economic model. Section 3 defines the balanced growth equilibrium of the economy. Section 4 numerically characterizes how human capital accumulation, fiscal policy and avoidance affect growth and welfare. Finally, Section 5 summarizes and discusses the main findings of the analysis, and prospects future research.

2. The economy

We consider an infinite horizon, continuous time, endogenous growth model with accumulation of private and public capital. In particular, we extend the one-sector growth model with productive public investment introduced by Barro (1990). We introduce two main modifications. First, instead of considering public expenditure we consider public capital. as do Futagami et al. (1993). Second, we assume the effective tax rate as being endogenous due to tax avoidance.

Our economy consists of competitive firms, a representative household and the government. We assume that the unique good of this economy is produce by means of

[3] See Roubini and Sala i Martin (1995), Caballe and Panades (1997), Ho and Yang (2002), Chen (2003), and Eichhorn (2004a, b). Note that all of these papers analyze tax non-compliance or tax evasion, but not explicitly tax avoidance.

a production function that uses private and public capital as inputs. We consider a broad definition of private capital to include physical and human capital. For simplicity in the exposition, from now on we will refer to human capital to denote this broad stock of capital. We consider a Cobb-Douglas production function, so that output is given by

$$y_t = Ah_t^{\beta} g_t^{1-\beta}, \tag{2.1}$$

with $\beta \in (0,1)$ and where A is the constant total factor productivity; h_t is the per capita stock of human capital; and g_t is the per capita stock of public capital. Observe that the production function exhibits private diminishing returns to human capital, and social constant returns to scale. This implies that the competitive firms operate with strictly positive profits.[4] Profit maximization implies that the rental price of human capital equals its marginal productivity:

$$w_t = \beta A h_t^{\beta-1} g_t^{1-\beta}, \tag{2.2}$$

and profits are given by

$$\pi_t = (1-\beta) A h_t^{\beta} g_t^{1-\beta}. \tag{2.3}$$

Output y_t can either be used for consumption c_t, producing new human capital or public investment I_t. Hence, the stock of human capital evolves as

$$\dot{h}_t = y_t - c_t - I_t - \delta h_t, \tag{2.4}$$

where $\delta \in (0,1)$ is the depreciation rate of human capital stock.

The household preferences are represented by the discounted lifetime utility:

$$U_t = \int_0^{\infty} \left(\frac{c_t^{1-\sigma} - 1}{1-\sigma} \right) e^{-\rho t} dt, \tag{2.5}$$

where $\rho > 0$ is the constant subjective rate of time preference, and $\sigma > 0$ denotes the inverse of the constant elasticity of intertemporal substitution. Household is endowed with private capital that inelastically supplies to firms. She allocates her after-tax income to consumption and investment in human capital. Accordingly, the consumer's budget constraint is given by

$$(w_t h_t + \pi_t) \left[1 - \tau \left(1 - \phi_t \right) \right] = c_t + \dot{h}_t + \delta h_t, \tag{2.6}$$

where $\tau \in (0,1)$ is the nominal tax rate on total income, and $\phi_t \equiv \Phi(h_t, y_t) \in (0,1)$ is the rate of tax avoidance. Given a tax rate τ set by the government, the household faces to an effective tax rate given by $\tau(1-\phi_t)$. We assume that the ability to avoid taxes is an increasing and concave function $\Phi' > 0$ and $\Phi'' < 0$. For a given level of human capital, economic development makes avoidance more complicated. This modelling assumption eliminates the effects of sustained growth on tax avoidance. If tax avoidance were not be only a function of human capital-output ratio, then the level

[4] We can also interpret profits as the return of a fixed input. For instance, we can consider that the production function uses raw labour as an input that is exogenously supplied by the household. In this case we could follow Mankiw et al. (1992) to assume that labor and human capital cannot be disentangled, but they exhibit different marginal productivities.

of avoidance would explode as the stock of human capital tends to infinity. In other words, this assumption is needed to ensure the existence of a balanced growth path along which output grows at a constant rate. We will consider the following functional form for the rate of tax avoidance:

$$\phi_t \equiv \Phi(h_t, y_t) = ae^{-\frac{y_t}{h_t}}, \tag{2.7}$$

with $a \in (0,1)$ measures the intensity of tax avoidance or, equivalently, the productivity of human capital in avoiding taxes. Finally, observe that tax avoidance is a non rival activity, i.e., household immediately reduces the effective tax rate when she acquires new human capital.[5]

The objective of the household is to maximize the utility function (2.5) subject to (2.6) and (2.7). From the first-order conditions of this maximization problem, we obtain that the household's optimal plan is given by:

$$\frac{\dot{c}_t}{c_t} = \left(\frac{1}{\sigma}\right)\left\{w_t\left[1-\tau\left(1-\phi_t\right)\right] + \tau\left(\frac{\partial \phi_t}{\partial h_t}\right)\left(w_t h_t + \pi_t\right) - \rho - \delta\right\}, \tag{2.8}$$

together with the budget constraint (2.6), the avoidance rate (2.7) and the usual transversality condition

$$\lim_{t \longrightarrow \infty} e^{-\rho t} c_t^{-\sigma} h_t. \tag{2.9}$$

Equation (2.8) is the Euler equation that determines the intertemporal allocation of consumption and investment, i.e., the growth rate of consumption. As usual, this condition equates the return from investing one unit of output y_t and the growth of the marginal utility arising from consuming one additional unit of this good. Due to endogenous avoidance, in our economy the marginal return from investing in human capital has two components. The first component, $R_{1,t}$, is the market return given by the effective after-tax wage rate:

$$R_{1,t} = w_t\left[1-\tau\left(1-\phi_t\right)\right]. \tag{2.10}$$

The second component, $R_{2,t}$:

$$R_{2,t} = \tau\left(\frac{\partial \phi_t}{\partial h_t}\right)\left(w_t h_t + \pi_t\right), \tag{2.11}$$

comes from the fact that the investment in human capital also increases tax avoidance. In consequence, the effective tax rate diminishes and the disposable income increases.

The government in this economy only provides productive public capital to firms. This government finances public investment I_t by means of a flat-tax income. We assume that this public intervention is subject to a balanced budget. Tax revenues depends on the nominal tax rate τ and on the rate of avoidance ϕ_t. Hence, public investment is given by

$$I_t = \tau\left(1-\phi_t\right)\left(w_t h_t + \pi_t\right). \tag{2.12}$$

Finally, the law of motion for public capital is

$$\dot{g}_t = I_t - \eta g_t, \tag{2.13}$$

where $\eta \in (0,1)$ is the depreciation rate of public capital.

[5] Alternatively, we may consider that individuals should allocate their stock of human capital either to producing or avoiding taxes. Since we consider a broad concept of capital, this would include the case in which the taxpayers use capital to pay someone to assess them on how to avoid taxes.

3. Competitive equilibrium

Given the initial stocks of human capital h_0 and public capital g_0, a *competitive equilibrium* under a fiscal policy τ is defined as the time path of prices $\{w_t\}$ and quantities $\{c_t, k_t, g_t, \pi_t\}$ that satisfies: (i) the utility maximization conditions (2.8), (2.6), (2.7) and (2.9); (ii) the profit maximization conditions (2.2) and (2.3); and (iii) the government constraints (2.12) and (2.13). After manipulating these equilibrium conditions we obtain the growth rate of human capital

$$\frac{\dot{h}_t}{h_t} = \left[1 - \tau\left(1 - ae^{-A\left(\frac{h_t}{g_t}\right)^{\beta-1}}\right)\right] A\left(\frac{h_t}{g_t}\right)^{\beta-1} - \frac{c_t}{h_t} - \delta, \tag{3.1}$$

of public capital

$$\frac{\dot{g}_t}{g_t} = \tau\left(1 - ae^{-A\left(\frac{h_t}{g_t}\right)^{\beta-1}}\right) A\left(\frac{h_t}{g_t}\right)^{\beta} - \eta, \tag{3.2}$$

and of consumption

$$\frac{\dot{c}_t}{c_t} = \left(\frac{1}{\sigma}\right)\left\{\begin{array}{c} \beta\left[1 - \tau\left(1 - ae^{-A\left(\frac{h_t}{g_t}\right)^{\beta-1}}\right)\right] A\left(\frac{h_t}{g_t}\right)^{\beta-1} \\ +\tau ae^{-A\left(\frac{h_t}{g_t}\right)^{\beta-1}} A^2\left(\frac{h_t}{g_t}\right)^{2(\beta-1)} - \rho - \delta \end{array}\right\}. \tag{3.3}$$

Our economy exhibits a *balanced growth path (BGP, henceforth) equilibrium*, along which the stock of human capital, consumption and the stock of public capital grow at a constant and equal rate denoted by γ, whereas the rental rate of human capital and the output-human capital ratio remain constant.

As is standard procedure, to proceed with the analysis, we consider the aggregate ratios $z_t = \frac{h_t}{g_t}$ and $x_t = \frac{c_t}{h_t}$, which will be constant along a BGP. Combining (3.1) and (3.2), we get

$$\frac{\dot{z}_t}{z_t} = \left[1 - \tau\left(1 - ae^{-Az_t^{\beta-1}}\right)(1 + z_t)\right] Az_t^{\beta-1} - x_t + \eta - \delta, \tag{3.4}$$

and combining (3.1) and (3.3) we obtain

$$\frac{\dot{x}_t}{x_t} = \left(\frac{Az_t^{\beta-1}}{\sigma}\right)\left\{\begin{array}{c} (\beta - \sigma)\left[1 - \tau\left(1 - ae^{-Az_t^{\beta-1}}\right)\right] \\ +\tau ae^{-Az_t^{\beta-1}} Az_t^{(\beta-1)} \end{array}\right\} + x_t - \frac{\delta(1-\sigma) + \rho}{\sigma}. \tag{3.5}$$

The dynamic equilibrium is thus fully characterized by a set of paths $\{z_t, x_t\}$ such that, given the initial value z_0 of human to public capital ratio, solves the system of equations (3.4) and (3.5), and satisfies the transversality condition (2.9). Observe that in this characterization of the equilibrium paths z_t is the unique state variable and x_t is the control variable.

4. Numerical analysis

It is not possible to analytically prove the existence, uniqueness and stability properties of the BGP equilibrium. The existence of an avoidance function that depends on z_t

impedes the analytical characterization of these properties. Furthermore, note that, unlike Barro (1990), this is not an AK model. Both the existence of public capital and an endogenous rate of avoidance generate transitional dynamics. Hence, our economy exhibits transitional adjustment when there are initial imbalances in human and public capital. In the rest of the paper we will perform numerical simulations to characterize the growth and dynamics effects of human capital accumulation, fiscal policy and avoidance.

4.1. Calibration

We set the parameter values of our economy by mapping its BGP equilibrium onto some facts observed in the data of US economy. This defines the benchmark economy from which we numerically characterize the effects of avoidance and fiscal policy on long-run growth rate and welfare. In performing this calibration exercise we should note that we are considering that h_t is a broad measure of capital that includes physical and human capital. Hence, in this exercise we have to take this fact into account when fitting the model with the data.

The calibration targets that we use are the following: (i) the private capital share is taken from Mankiw et al. (1992); (ii) a private investment-capital ratio equal to 0.076; (iii) a stationary growth rate of 2%; (iv) an after-tax net marginal return on human capital equal to 5.6%; (v) a public capital to GDP ratio of 2; (vi) a public investment to GDP ratio equal to 0.05; (vii) a intertemporal elasticity of substitution of 2; and (viii) an avoidance rate of 6%. There are not disposable estimations on the length of avoidance. However, as a benchmark value we take this rate of avoidance, which seems to correspond with a conservative approximation of the actual value according to the literature. We summarize the parameters of our benchmark economy in Table 1.

Note that the benchmark tax rate in this model is equal to 5.26%, which corresponds to an effective rate of 5%. However, in our economy the only public expenditure is public investment, and the public budget is balanced.

[Insert Table 1]

4.2. Growth effects

Taking the benchmark economy as a starting point, we have computed the stationary growth rate for different values of the nominal tax rate τ and the avoidance intensity a. Table 2 shows the results of these simulations. If we look at the table by rows, we first observe that the stationary growth rate γ decreases with the avoidance intensity a when the tax rate τ is sufficiently small. On the contrary, when the tax rate τ is sufficiently high, the relationship between the long-run growth rate γ and the avoidance intensity a displays inverted-U shape. In particular, our simulations show that the threshold value of τ that modifies the pattern in the growth effects of avoidance intensity is equal to 0.26.

[Insert Table 2]

We summarize the growth effects of avoidance in the following result:

Result 1. There exists a threshold value $\overline{\tau}$ of tax rate, such that

(a) If $\tau < \overline{\tau}$, then $\frac{\partial \gamma}{\partial a} < 0$;

(b) If $\tau > \overline{\tau}$, then there is a growth-maximizing level of a and, moreover, this level increases in τ.

From this result, we conclude that tax avoidance can either stimulate or reduce long-run economic growth depending on the value of nominal tax rate τ and the intensity of tax avoidance a. The first panel of Figure 1 illustrates this conclusion by plotting the relationship between the stationary growth rate γ and the avoidance intensity a for two alternatives values of the nominal tax rates: (i) $\tau = 0.1$ (continuous line); and (ii) $\tau = 0.4$ (dashed line). The growth rate has a negative slope for all values of avoidance intensity a when $\tau = 0.1$, whereas that rate reaches a maximum at some value of a in $(0, 1)$ when $\tau = 0.4$. Hence, avoidance may be positive for growth when the tax rate takes sufficiently high values. This conclusion leads us to compute the growth-maximizing value of avoidance rate for each value of the tax rate. The results of this exercise are given by the second panel of Figure 1 and by Table 3. Observe that stationary growth is maximized in absence of avoidance ($a = 0$) if τ is smaller than $\overline{\tau} = 0.26$, whereas when $\tau > \overline{\tau} = 0.26$ the growth-maximizing value of a is strictly-positive and increasing with τ. Table 3 computes the growth-maximizing value of a for alternative values of τ (second column), as well as the corresponding effective tax-rate (third column), the stationary growth rate (forth column), and the deviation of these maximum growth rates from the benchmark value of 2% (fifth column). We observe that the growth rate is much larger (the double in average) under the growth-maximizing value of avoidance intensity a than it is under its benchmark value. Therefore, we can conclude that the growth effects of avoidance are important and not trivial.

[Insert Figure 1 and Table 3]

The intuition behind Result 1 is quite simple. The growth effects of avoidance come from the distortion the effective tax rate has on the accumulation of human capital. Remember that the marginal return from accumulating human capital has two components: (i) the effective after-tax wage rate (R_1); and (ii) the increase in the avoidance and thus in the disposable income (R_2). We must characterize the effects of an increase of the avoidance intensity on these two returns from investing in human capital.

(i) The increase in a reduces the effective tax rate. This has two opposite sign effects on the effective after-tax wage rate (R_1). The first one is positive, since the disposable income goes up. The second one is negative, since this change stimulates capital accumulation, which will reduce the marginal productivity of human capital. This second effect dominates when the effective tax rate is low (small values of τ).

(ii) The increase in a also affects long-run growth by raising the avoidance gain from investment (R_2). The smaller the effective tax rate is, the smaller is this effect on the avoidance consequences from investing in human capital.

Another relevant result is derived from Table 2. Looking at the columns we observe that when the avoidance intensity a is larger than 0.6, the growth rate always increases with τ. However, for avoidance intensity values between 0 and 0.6,the steady-state growth rate γ is a function with an inverted-U shape of the tax rate τ. That is, the stationary growth rate γ increases with τ until it reaches a maximum, and then that growth rate decreases for larger τ values. The next result summarizes the growth effects of the tax rate τ:

Result 2. There is a threshold avoidance intensity value $\overline{a}$, such that

(a) When $a > \overline{a}$, there exists a threshold value τ^* of tax rate, such that

(a.1) If $\tau < \tau^*$, then $\frac{\partial \gamma}{\partial \tau} > 0$;

(a.2) If $\tau > \tau^*$, then $\frac{\partial \gamma}{\partial \tau} < 0$.

(b) When $a > \overline{a}$, then $\frac{\partial \gamma}{\partial \tau} > 0$.

Moreover, in anycase $\tau^* > 1 - \beta$, and $\frac{\partial \tau^*}{\partial a} > 0$.

From this result we conclude that the threshold τ^* is the value of tax rate that maximizes long-run economic growth. More interestingly, this growth-maximizing tax rate increases in the intensity of avoidance a. Moreover, this tax rate τ^* is larger than the elasticity $1-\beta$ of output y_t with respect to public capital g_t provided that avoidance is strictly positive ($a > 0$). Obviously, in absence of avoidance ($a = 0$) we obtain that $\tau^* = 1 - \beta$ as was established by Barro (1990) and Futagami et al. (1993). Figure 2 and Table 4 clearly illustrate these conclusions. The first panel of Figure 2 shows the dependence of growth rate γ on the tax rate τ for the benchmark value of avoidance intensity a. This dependence has a inverted-U shape, so that there is an interior value of τ that maximizes the stationary growth rate. The second panel of Figure 2 and Table 4 show the growth-maximizing tax rate τ^* as an increasing function of the avoidance intensity a. Furthermore, the growth rate is much larger (more than the double on average) under the growth-maximizing tax rate than it is under the benchmark tax rate. These results corroborate the importance of avoidance for the long-run growth rate.

[Insert Figure 2 and Table 4]

The intuition behind Result 2 is easily obtained by checking the distortion on the decision of accumulating human capital. Consider an increase in the nominal tax rate τ. The two channels through which this policy change affects long-run growth can be summarized as follows:

(i) As in Barro (1990), the increase in the nominal tax rate has two opposite sign effects on the effective after-tax wage rate (R_1). First, the disposable income goes down because of the increase in the effective tax rate. Second, this change discourages the accumulation of human capital, which will drive the marginal productivity of human capital up. This productivity effect dominates when the nominal tax rate is low.

(ii) In addition, the increase in τ also affects growth by raising the avoidance gain from accumulating human capital (R_2). This avoidance effect of tax rate reinforces the positive productivity effect of increasing τ. Therefore, this avoidance effect increases the growth-maximizing tax rate above the elasticity $1-\beta$ of output with respect to public capital.

Note that the existence of avoidance not only reduces the effective tax rate until recovering the nominal tax rate without avoidance, but also introduces new mechanisms that affect the economic growth rate. Table 4 clearly shows this result. Imagine a nominal tax rate increase from 0.33 to 0.38. In a economy without avoidance ($a = 0$) this policy has a negative impact on economic growth rate. However, in a economy where $a = 0.1$ this fiscal policy will have a positive impact, although the corresponding effective tax rate is 0.35, larger than 0.33.

Before closing this subsection, we study how the elasticity $1 - \beta$ of output with respect to public capital affects the derived conclusions. It is clear that the contribution of public capital to production is a crucial piece of the mechanism that we have proposed to explain the relationship between avoidance, human capital accumulation and growth. We now perform some sensitivity analysis regarding this elasticity. Table 5 illustrates the dependence of the growth-maximizing value of avoidance intensity a with respect to $1 - \beta$. Observe that the growth effects of avoidance are qualitatively robust to the value of $1 - \beta$. Given a value of τ, the growth-maximizing value of a increases when $1 - \beta$ goes to the extreme values in its domain $(0, 1)$. On the contrary, Table 6 shows how the growth-maximizing tax rate depends on the elasticity of output with respect to public capital. The growth effects of nominal tax rate τ are also qualitatively robust to the value of $1 - \beta$. Given a value of avoidance intensity a, the growth-maximizing value of τ generally decreases in $1 - \beta$.

[Insert Tables 5 and 6]

4.3. Welfare effects

In this subsection we characterize the dynamic adjustment of our economy to imbalances between human and public capital, and how this adjustment depends on the intensity of avoidance a. In particular, we study the dynamic response of the economy to a negative shock on the stock of human capital h_t and to a variation on the nominal tax rate τ. The procedure for our analysis is the following. We assume that the economy is initially in the benchmark BGP and, unexpectedly, one of the proposed perturbations is introduced on a permanent basis. We characterize the dynamic adjustment to the new BGP by computing the associated equilibrium paths of the aggregate variables.

To illustrate the effects of avoidance intensity on the dynamic response we compute the welfare cost of the aforementioned exogenous shocks. As in Lucas (1987), we measure the welfare cost by the percentage increase in consumption that the household should receive as a compensation for the shock. To illustrate this procedure, we denote the policy function relating the equilibrium value of consumption c_t with the capital ratio z_t by $c_t = c(z_t; \theta_t)$, where $\theta_t = \{A, \beta, \delta, \eta, \rho, \sigma, \tau, a, z_t\}$ is the vector of fundamentals. Consider that the vector of fundamentals changes from θ_0, corresponding to the benchmark economy, to θ_1. The welfare cost of this change is the constant fraction

λ of consumption that one should give to the household every period after the shock to obtain the same utility as in the situation where the economy permanently stays at the benchmark BGP. Thus, the fraction λ is the that solves the following equation:

$$\int_0^\infty \left[\frac{c(z^*;\theta_0)-1}{1-\sigma}\right] e^{\rho t} dt = \int_0^\infty \left[\frac{c(z_t;\theta_1)(1+\lambda)-1}{1-\sigma}\right] e^{\rho t} dt,$$

where z^* denotes the stationary value of capital ratio z_t along the benchmark BGP. If λ is positive (negative), then the shock generates a welfare cost (gain) because this means that the household should receive (give) consumption as a compensation for the shock. We are interested in numerically studying how our measure of welfare cost λ depends on the avoidance intensity a. In order to make the welfare costs comparable across the alternatives values of a, we will adjust the TFP parameter A when we change a. This ensures that all of the simulated economies converge to the same stationary growth rate regarding their different avoidance intensity.

Figures 3 and 4 illustrate the welfare costs of reducing the stock of human capital h_0 by 15% in two different scenarios. Figure 3 computes this welfare cost when the tax rate takes its benchmark value, $\tau = 0.0526$, whereas Figure 4 computes this cost for a larger nominal tax value, $\tau = 0.4$. The main conclusion is that the effects of avoidance on this welfare cost depends on the nominal tax rate τ. When τ is at the benchmark level, the welfare cost decreases in the intensity of avoidance a. Note that this effect has an opposite sign on the growth effects of avoidance. However, the magnitude of the effects of a on the welfare cost in this case is very small. To better illustrate this point, the second panel of Figure 3 shows the logarithmic deviation of the welfare cost under each value of a with respect to the welfare cost in absence of avoidance ($a = 0$). This figure shows that the maximum reduction is of 12% for very high values of a.

Figure 4 shows that when $\tau = 0.4$, the relationship between the welfare cost of the negative shock in h_0 and the intensity of avoidance a is not monotonic. The welfare cost increases (decreases) in a for sufficiently small (large) values of this parameter. In this case, there exists an interior value of a such that, the welfare cost of the negative shock in human capital reaches its maximum value. In any case, the welfare cost is again of a quite small magnitude. The second panel of Figure 4 shows these magnitudes.

[Insert Figures 3 and 4]

Let us now study the dynamic response of the economy to a variation on the nominal tax rate τ. Figure 5 presents the welfare costs of reducing the nominal tax rate τ from its benchmark value to 0.04. The main conclusion is that this tax reduction generates a welfare cost. The intuition behind this result is simple. The policy change increases disposable income and stimulates the accumulation of human capital, which drives the marginal productivity of human capital down. Furthermore, the reduction in τ decreases the effect of investing on the ability to avoid taxes (R_2). This reinforces the aforementioned effect from the reduction in the marginal productivity of capital. The first panel of Figure 5 shows that this welfare cost increases in the intensity of avoidance a. Moreover, the second panel illustrates that the effects of avoidance on the welfare cost of this policy reform is quite large. The logarithmic deviation of welfare cost from the welfare cost in absence of avoidance ($a = 0$) is between 0 and 50% depending on the value of the avoidance intensity a.

[Insert Figure 5]

As was explained above, the welfare cost of reducing the tax rate from its benchmark value derives from the fact that this value is quite below the social optimal value. We have checked that if the initial value of the tax rate is sufficiently large, the results are just the opposite of those provided by Figure 5. In this case, reducing the tax rate generates a welfare gain, whereas increasing the tax rate results in a welfare cost. In any case, the welfare effects are always increasing in the intensity of avoidance a, and the effects of this intensity in the welfare effects are quantitatively important.

5. Concluding remarks

This paper has shown that the interaction between human capital accumulation and tax avoidance may have remarkable growth and welfare effects. In our model, individuals can change their ability to avoid taxes by investing in human capital. Moreover, changes on avoidance intensity alter the human capital accumulation process. Taking this feedback into account, we have found that tax avoidance can either increase or reduce economic growth depending on the value of the nominal tax rate and on the avoidance intensity, i.e., the productivity of human capital in avoiding taxes. For instance, in economies with low nominal tax rates, human capital accumulation could affect economic growth negatively if the taxpayers avoid taxes. We have also found that growth-maximizing tax rates crucially depend on the intensity of avoidance. Concerning welfare analysis, we have found that the impact of avoidance on the welfare produced by changes in the nominal tax rate is quite large. However the impact of the avoidance on the welfare produced by imbalances in human and public capital is small.

The analysis of the paper can extend in several directions. First, we can perform an optimal taxation analysis. In this type of endogenous growth model, private investment is socially suboptimal because it is a source of productive externalities. The private decision on consumption and investment determines the tax base and thus the stock of public capital and the marginal productivity of human capital. In the present model, the productive externalities also operate through avoidance technology. A second extension could be to study the effects of avoidance on income inequality. Avoidance may be an important mechanism for inequality dynamics because it affects tax progressivity. Furthermore, the rate of avoidance differs across the different types of incomes. These two issues will define our future research agenda.

References

[1] Andreoni , J., B. Erard and J. Feinstein, (1998). ”Tax Compliance.” *Journal of Economic Literature*, 362, 818-860.

[2] Auerbach, A., L. Burman and J. Siegel (2002) “Capital Gains Taxation and Tax Avoidance: New Evidence from Panel Data.” in *Does Atlas Shrug? The Economic Consequences of Taxing the Rich* edited by J. Slemrod, Harvard University Press (also in *NBER* wp 6399)

[3] Barro,R.J., (1990). "Government spending in a simple model of endogenous growth," *Journal of Political Economy* 98 (5), S103-S126.

[4] Braithwaite, J. (2003). ”Aggressive Tax Planning: Marketing local and global shelters in New York, Sydeny and Melbourne.” *Center for Tax System Integrity*, The Australian National University. manuscript

[5] Caballe, J. and J. Panades, (1997). “Tax Evasion and Economic Growth.” *Public Finance* 52, 318-340.

[6] Chen, B., (2003).“Tax Evasion in a model of endogenous growth.”*Review of Economic Dynamics* 6, 381-403.

[7] Eichhorn, C., (2004a). ”Tax evasion and Economic Growth. A neutrality Result.” Mimeo

[8] Eichhorn, C., (2004b). ”The implications of tax evasion for Economic Growth.” Mimeo

[9] Fox, W. and L. Luna (2005). “Do LLCs Explain Declining State Corporate Tax Revenues.” *Public Finance Review* 33, 690-720.

[10] Futagami, K., Y. Morita and A. Shibata, (1993). “Dynamic Analysis of an Endogenous Growth Model with Public Capital.” *Scandinavian Journal of Economic* 95, 607-625.

[11] Giles, D., (1999) ”Modelling the hidden economy and the tax-gap in New Zealand.” *Empirical Economics*, 24, 621-640.

[12] Hite, P. (1997) ”An Investigation of Moral Suasion and Vertical Equity Arguments on Intended Taxpayer Non-compliance.” *Law and Policy* 19, 1-22.

[13] Ho, W. and C. Yang., (2002). ”Is Tax Evasion beneficial or harmful to growth.” Mimeo.

[14] Jackson, B. and V. Milliron, (1986). ”Tax compliance research: Findings, problems and prospects.” *Journal of Accounting Literature* 5, 125-165.

[15] Kinsey, K. and H. Grasmich, (1993). ”Did the Tax reform act of 1986 improve compliance? Three studies of pre- and port-TRA compliance attitudes.” *Law and Policy* 15, 239-325.

[16] Lucas, R.E. (1987). *Models of Business Cycles*, Basil Blackwell.

[17] Mankiw, N.G., D. Romer and D.N. Weil, (1992). "A contribution to the empirics of economic growth," *Quarterly Journal of Economics* 107, 407-437.

[18] Murphy, K. (2002). "Procedural Justice and the Australian Taxation Office: a study of scheme investors." *Center for Tax System Integrity,* W.P. No 35 A.N.U.

[19] Murphy, K. (2006). "An examination of taxpayers' attitudes towards the Australian tax system: Findings from a survey of tax scheme investor" *Center for Tax System Integrity*, The Australian National University. manuscript

[20] Oxfam (2000): "Tax havens: releasing the hidden billions for poverty eradication" *Oxfam GB Policy paper*

[21] Roubini, N. and X. Sala i Martin, (1995). "A growht model of inflation, tax Evasion and financial Repression." *Journal of Monetary Economics* 35, 275-301.

[22] Schneider, F.(2005). "Shadow Economies of 145 Countries all over the World: What Do We Really Know?," *CREMA W.P. Series 2005-13, Center for Research in Economics, Management and the Arts .*

Table 1. Benchmark economy

A	β	δ	η	ρ	σ	τ	a
0.2499	2/3	0.056	0.005	0.016	2	0.0526	0.0597

Table 2

Steady-state growth rate

	Intensity of avoidance										
τ \ a	0	0.05	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.8	0.9
0.01	0.0051	0.0048	0.0045	0.0038	0.0032	0.0025	0.0017	0.0009	0.0000	-0.0010	-0.0022
0.05	0.0200	0.0195	0.0190	0.0179	0.0167	0.0154	0.0139	0.0123	0.0104	0.0081	0.0054
0.1	0.0286	0.0282	0.0276	0.0265	0.0253	0.0238	0.0222	0.0203	0.0180	0.0152	0.0117
0.2	0.0368	0.0366	0.0363	0.0356	0.0347	0.0335	0.0320	0.0302	0.0278	0.0248	0.0207
0.3	0.0396	0.0398	0.0399	0.0399	0.0397	0.0391	0.0381	0.0366	0.0346	0.0317	0.0275
0.4	0.0392	0.0399	0.0405	0.0416	0.0422	0.0424	0.0421	0.0413	0.0397	0.0372	0.0331
0.5	0.0364	0.0378	0.0391	0.0413	0.0430	0.0442	0.0448	0.0447	0.0438	0.0417	0.0380
0.6	0.0315	0.0337	0.0358	0.0394	0.0425	0.0448	0.0465	0.0473	0.0471	0.0457	0.0424
0.7	0.0247	0.0278	0.0308	0.0362	0.0408	0.0445	0.0473	0.0492	0.0499	0.0491	0.0463
0.8	0.0157	0.0200	0.0241	0.0315	0.0379	0.0432	0.0474	0.0504	0.0521	0.0521	0.0500
0.9	0.0045	0.0097	0.0152	0.0253	0.0340	0.0411	0.0469	0.0512	0.0539	0.0548	0.0533

Table 3. Growth-maximizing avoidance

τ	a^*	τ^{ef}	γ	$\gamma/0.02$
< 0.26	0	–	–	–
0.26	0.02	0.2562	0.0390	1.9481
0.30	0.16	0.2646	0.0399	1.9973
0.40	0.40	0.2820	0.0424	2.1207
0.50	0.54	0.3014	0.0474	2.2444
0.60	0.63	0.3228	0.0449	2.3684

Table 4. Growth-maximizing tax rate

a	τ^*	τ^{ef}	γ	$\gamma/0.02$
0	0.33	0.3300	0.0398	1.9884
0.1	0.38	0.3500	0.0406	2.0300
0.2	0.43	0.3600	0.0417	2.0825
0.3	0.51	0.4035	0.0430	2.1500
0.4	0.61	0.4418	0.0449	2.2426
0.5	0.76	0.5018	0.0475	2.3730
0.6	0.99	0.5940	0.0514	2.5710

Table 5. Effects of public capital elasticity of output on the growth-maximizing intensity of avoidance

	Values of $1-\beta$				
τ	0.1	0.25	**1/3**	0.5	0.7
0.1	0.14	0	**0**	0	0
0.2	0.63	0	**0**	0	0
0.30	0.79	0.36	**0.16**	0	0
0.40	0.87	0.55	**0.40**	0.22	0.24
0.50	0.92	0.66	**0.54**	0.39	0.42

Table 6. Effects of public capital elasticity of output on the growth-maximizing tax rate

	Values of $1-\beta$				
a	0.1	0.25	**1/3**	0.5	0.7
0	0.10	0.25	**0.33**	0.50	0.70
0.1	0.11	0.28	**0.38**	0.57	0.69
0.2	0.13	0.32	**0.43**	0.65	0.68
0.30	0.14	0.37	**0.51**	0.75	0.69
0.40	0.17	0.44	**0.61**	0.88	0.71
0.50	0.20	0.54	**0.76**	0.99	0.75

Figure 1. Growth effects of avoidance

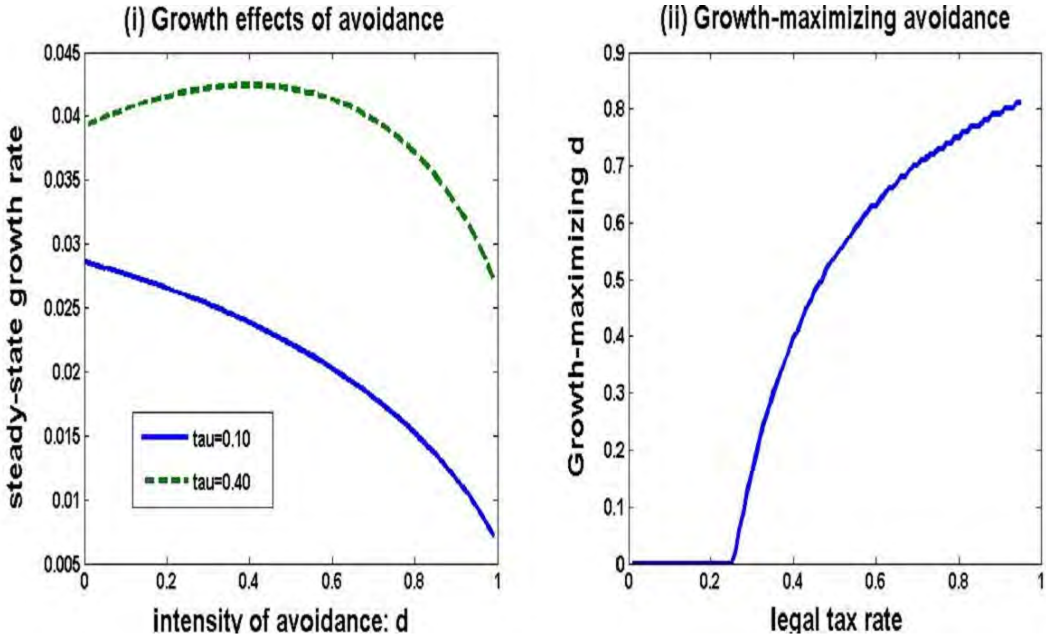

Figure 2. Growth effects of tax rate

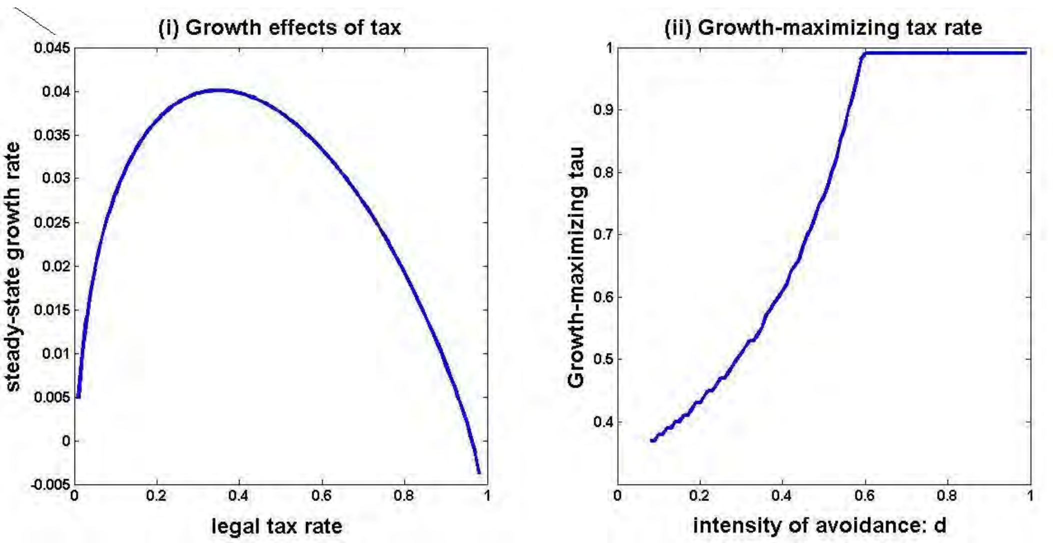

Figure 3. Welfare cost of reducing h_0 by a 15% when $\tau = 0.0526$ (benchmark)

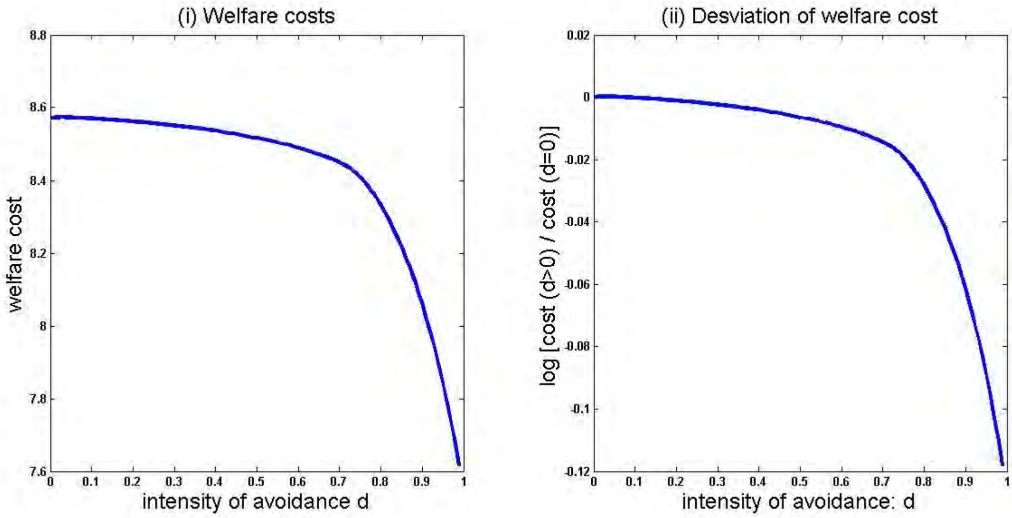

Figure 4. Welfare cost of reducing h_0 by a 15% when $\tau = 0.4$

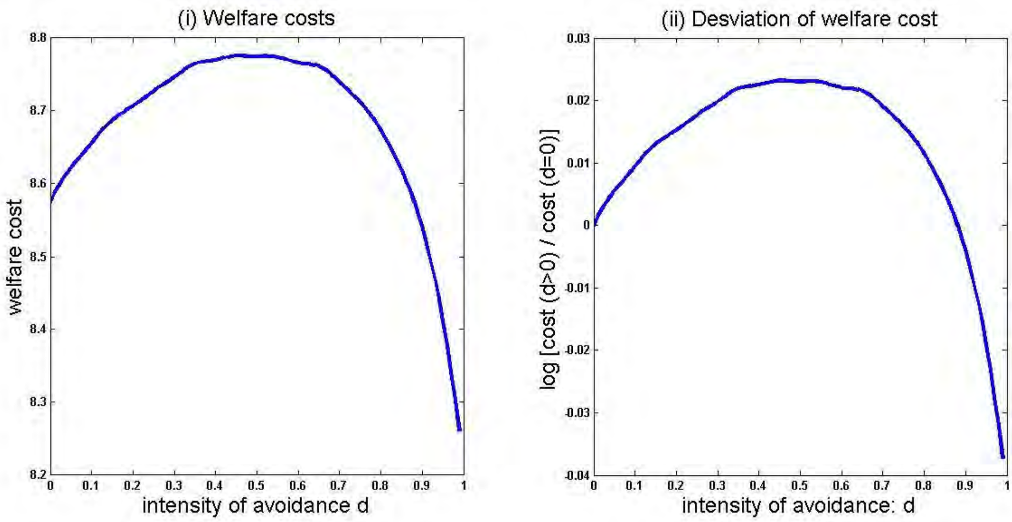

Figure 5. Welfare cost of reducing τ from the benchmark value to 0.4