European Journal of Political Economy
Vol. 17 (2001) 799–815

European Journal of POLITICAL ECONOMY

www.elsevier.com/locate/econbase

Tax evasion and Ricardian equivalence

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Received 30 March 1999; received in revised form 7 December 1999; accepted 5 June 2000

Abstract

This paper studies whether the Ricardian equivalence holds in a context with tax evasion. In such a context, the degree of uncertainty becomes endogenous since agents control the distribution of their future income through their income report. We find that Ricardian equivalence holds when proportional fines are imposed on evaded taxes, but does not hold when the fines are on the amount of unreported income. We also show that it is possible to explain the empirical negative relation between tax rates and declared income when the path of government spending remains unchanged. © 2001 Elsevier Science B.V. All rights reserved.

JEL classification: E62; H26
Keywords: Tax evasion; Ricardian equivalence

1. Introduction

The aim of this paper is to analyze when the Ricardian equivalence proposition holds in a framework where uncertainty arises as a consequence of tax evasion. The Ricardian equivalence proposition says that, if a change in current taxes is completely offset by a change in future taxes, the consumption path of individuals remains unchanged when the government spending path is not modified (Barro, 1974). There is a large body of literature that analyzes whether this proposition holds under uncertainty. For example, Barsky et al. (1986) introduce individual uncertainty about future income and show how a tax cut coupled with a future

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PII: S0176-2680(01)00056-8

income tax increase can stimulate consumer spending through the precautionary motive for saving. Feldstein (1988) considers a model with altruistic individuals where income uncertainty implies that bequests are also uncertain and that there is a positive probability of leaving zero bequests. The resulting corner solution for equilibrium bequests causes a failure of Ricardian equivalence since individuals cannot offset the change in the calendar of payments to the government by means of intergenerational transfers. Finally, Strawczynski (1995) analyzes the sources of the Ricardian equivalence failure when either current or future income is uncertain and the non-negativity constraint on bequests is binding in some states of nature.

In all the aforementioned models, the nature of income uncertainty is exogenous. In this paper we will present a model where uncertainty about future income arises because taxpayers can evade taxes and they may be audited by the tax authorities. Thus, whereas uncertainty is completely exogenous in the previous models, in our model the degree of uncertainty can be controlled at some extend by the taxpayers, since the amount of declared income determines the distribution of future income.

I consider a model where individuals live for two periods. The young individuals must decide both the amount of income they want to report to the tax authorities and the amount they want to save. There is uncertainty in the second period since, if an agent is inspected by the tax authorities, his saving will be reduced by the fine that he has to pay. In this context, we will investigate the effects both on savings and on declared income (and, as a by-product, on consumption) of a variation in the tax rate that leaves unchanged the level of government spending. This means that, if the tax rate is increased individuals will be compensated by a reduction in their future lump-sum taxes. Note then that our analysis is the typical Ricardian one: we study the effects of changing the financing policy for a given path of government spending. Of course, all the fiscal unbalances incurred by the government generate the corresponding change in the outstanding public debt.

We find that the Ricardian equivalence proposition fails to hold when the penalties on evaders are proportional to the amount of unreported income, while the proposition holds when penalties are proportional to the amount of evaded taxes. When fees are set on evaded income, the result we obtain is similar to the one appearing in the aforementioned papers. However, the mechanism at work is now endogenous. In fact, we show that evasion increases with the tax rate and this generates more uncertainty in the second-period income, since there is an increase in the gap between the disposable income of an audited individual and the disposable income of an individual who has not been inspected. Therefore, in this context the income tax is harmful, since it forces taxpayers to misreport their income, and consequently to increase their precautionary savings. Such precautionary savings are indeed costly, since young agents are forced to consume less that they would have chosen if proportional taxes and fees were absent. On the other hand, the Ricardian equivalence proposition holds under penalties that are proportional to the amount of evaded taxes, since now the increase in taxes results in an increase of declared income, which leaves unchanged the amount of evaded taxes. Therefore, the degree of uncertainty about second-period income remains unchanged as does the amount of fines.

One of the most puzzling results in the tax evasion literature refers to the relationship between tax rates and declared income. Allingham and Sandmo (1972) showed that, under decreasing absolute risk aversion, the relation between declared income and tax rates is ambiguous when the fines are proportional to the unreported income, while declared income is decreasing in the tax rate under the less realistic assumption of non-decreasing absolute risk aversion. On the other hand, Yitzhaki (1974) assumed that the fine paid by an audited evader is proportional to the amount of evaded taxes and found that an increase in the tax rate increases declared income under decreasing absolute risk aversion. This modification of the Allingham and Sandmo model generates an unambiguous result that has not been supported by the empirical evidence since several studies have documented that higher tax rates tend to stimulate tax evasion.[1]

Many authors have searched for alternative models aimed at explaining this contradiction between the empirical findings and the theoretical predictions.[2] In this line of research, Yaniv (1994), in a reexamination of the model of Allingham and Sandmo, shows that it is possible to find a negative relation between declared income and tax rates when the individual's utility exhibits constant relative risk aversion and some other restrictions on the parameters are imposed. On the other hand, Yitzhaki (1987) shows that, when the inspection probability depends on evaded income, an increase in the tax rate might also result in an increase in evaded income.

I will show that it is possible to find the previous empirically plausible relation under much less stringent assumptions in a setup where the government budget constraint is taken into account and the path of government spending remains unchanged, that is, when taxes are modified as a consequence of the government financing policy and the size of the "crowding out" is kept constant. In a similar line of research, Koskela (1983) analyzes in a static context the implications concerning tax evasion of "compensated" changes in the tax rate. He finds that, under decreasing absolute risk aversion and when the taxpayer is compensated with a lump-sum transfer that keeps the expected government revenue unchanged, an increase in the marginal tax rate either stimulates or discourages tax evasion depending on the nature of the penalty scheme.

The paper is organized as follows. Section 2 presents the individual's decision problem. Section 3 introduces the government budget constraint. In Section 4, I

[1] Clotfelter (1983) and Poterba (1987) report a positive relation between tax rate and undeclared income using a real income database.

[2] See Beck and Jung (1989), Landskroner et al. (1990) and Wrede (1995), among others.

analyze the effects both on the consumption path and on the amount of evasion of a rise in the proportional tax rate that is compensated by a reduction in the future lump-sum tax. Section 5 contains some concluding remarks.

2. The taxpayers' problem

Let us consider a large economy populated by a continuum of identical individuals. The mass of individuals is normalized to one. These individuals live for two periods (called periods 1 and 2) and, when they are young, receive an exogenous income y, which is the same for all. This income is subjected to a proportional tax rate ($\tau \in (0,1)$. Each individual declares an amount of income equal to x and, therefore, the amount τx denotes the taxes that are voluntarily paid. Each agent will be audited by the tax authorities with probability p. Inspection allows the tax authorities to find out the true income of an audited individual. Note that, even if the income of an individual were known by the tax authorities, no penalties could be imposed without an inspection that legally established the existence of tax fraud. Individuals have to pay a fine $F(\tau)$ on unreported income if they are caught. The potential dependence of the fine on the tax rate will allow us to cope with the cases of proportional fines both on unreported income and on evaded taxes. Consumption in the first period of life takes place after taxes on declared income have been paid but before the potential inspection occurs. Let S denote the saving of each agent before the potential inspection occurs. Therefore, the effective saving of an agent who has not been audited is also equal to S, while the effective saving of an inspected agent will be $S - F(\tau)(y - x)$. Finally, individuals in the first period of life may have to pay a lump-sum tax T_1.

In their second period of life, individuals only receive the capital income accruing from their effective saving. The gross rate of return on saving is exogenously given and is equal to a constant R. Capital income is devoted to purchase second-period consumption and to pay the lump-sum tax T_2. We allow both T_1 and T_2 to take negative values whenever individuals receive lump-sum transfers from the government. We assume that capital income is tax exempt. Notice that consumption in the second period is a random variable that takes the value $R[S - F(\tau)(y - x)] - T_2$ with probability p and the value $RS - T_2$ with probability $1 - p$.

The temporal sequence of events in each period is summarized in Table 1.

The preferences of an individual are defined by a time-additive Von Neumann–Morgenstern utility function

$$u(C_1) + \delta E\left(u\left(\tilde{C}_2\right)\right) + \delta V(G),$$

where C_1 is the first-period consumption of an individual, $\tilde{C}_2$ is the random consumption in the second period, and G is the level of some public good

Table 1

First period	Second Period
Individuals receive their exogenous income	Return on effective saving is received
Individuals declare their income and pay the corresponding proportional taxes	
Individuals pay the first-period lump-sum tax	Individuals pay the second-period lump-sum tax
First-period consumption takes place	Second-period consumption takes place
Tax inspection occurs with probability p and the corresponding penalty is paid	
Effective saving takes place	

provided by the government in the second period of individuals' life. The random variable $\tilde{C}_2$ takes two values, C_2^{Y} and C_2^{N}, which correspond to second-period consumption if the consumer is inspected and if he is not, respectively. The parameter $\delta > 0$ is the discount factor applying on future utility. The utility function u is twice continuously differentiable with $u' > 0$ and $u'' < 0$, and satisfies the Inada conditions $\lim_{C\to 0} u'(C) = \infty$ and $\lim_{C\to\infty} u'(C) = 0$ in order to guarantee interior solutions for consumption.

Therefore, taking as given the level of public spending G, a consumer chooses the amount of saving S and the declared income x in order to solve the following program:

$$\max\left\{u(C_1) + (1-p)\,\delta u\left(C_2^{\mathrm{N}}\right) + p\delta u\left(C_2^{\mathrm{Y}}\right) + \delta V(G)\right\},$$

subject to

$$C_1 = y - \tau x - S - T_1, \tag{1}$$

$$C_2^{\mathrm{N}} = RS - T_2, \tag{2}$$

$$C_2^{\mathrm{Y}} = R(S - F(\tau)(y - x)) - T_2. \tag{3}$$

An interior solution to the previous maximization problem must satisfy the following first-order conditions:

$$u'(C_1)\tau = p\delta RF(\tau)u'\left(C_2^{\mathrm{Y}}\right), \tag{4}$$

$$u'(C_1) = (1-p)\,\delta Ru'\left(C_2^{\mathrm{N}}\right) + p\delta Ru'\left(C_2^{\mathrm{Y}}\right). \tag{5}$$

According to Eq. (4), the consumer equates the marginal utility obtained from a unit of declared income with the marginal utility when he has been audited. Eq. (5) tells us that he equates the utility of an extra unit of first-period consumption with the expected utility obtained from a marginal increase in second-period consumption. Finally, substituting Eq. (4) into Eq. (5) in order to eliminate C_2^{Y}, we obtain[3]

$$u'(C_1)\left(\frac{F(\tau)-\tau}{F(\tau)}\right)=(1-p)\,\delta R u'\left(C_2^{\mathrm{N}}\right). \tag{6}$$

3. The budget constraint of the government

The government finances an arbitrary level of public spending G in the second period with the proportional taxes on declared income, the lump-sum taxes and the penalty fees collected from the audited taxpayers. Since the law of large numbers applies in this large economy, a proportion p of consumers is inspected. We assume that there is no cost associated with tax inspection. Therefore, the intertemporal budget constraint of the government is[4]

$$G=RT_1+T_2+R\left[(1-p)\tau x+p(\tau x+F(\tau)(y-x))\right]. \tag{7}$$

Note that if $G=0$ and $T_1=0$, the budget constraint (Eq. (7)) is identical to that of a fully funded social security system with proportional contributions and lump-sum benefits, and where individuals could misreport their labor income. Totally differentiating Eq. (7) with respect to, T_1, T_2, τ and x, we obtain

$$R\,\mathrm{d}T_1+\mathrm{d}T_2+R\left[x+pF'(\tau)(y-x)\right]\mathrm{d}\tau+R(\tau-pF(\tau))\,\mathrm{d}x=0. \tag{8}$$

Our next step is to analyze the effect on the individual's consumption of changes in the fiscal policy keeping constant the level G of public spending. In particular, we will consider changes in the proportional tax rate τ accompanied by changes in the second-period lump-sum taxes T_2 such that Eq. (8) is satisfied.

4. The effects of changes in taxes

Barsky et al. (1986) have analyzed whether the Ricardian equivalence proposition applies when the profile of individual endowments is exogenously uncertain.

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[3] Alternatively, combining Eqs. (4) and (5) in order to eliminate C_1, we obtain the typical first-order condition appearing in models of tax evasion with a single period, that is,

$$(1-p)\tau u'\left(C_2^{\mathrm{N}}\right)=p(F(\tau)-\tau)u'\left(C_2^{\mathrm{Y}}\right).$$

In this equation, the marginal utility obtained from an extra unit of consumption when the inspection does not occur is equated with the loss that takes place when the individual is caught and, thus, punished. It is obvious from the previous equation that positive evasion $(x<y)$ occurs if and only if $(1-p)\tau>p(F(\tau)-\tau)$, which is the usual condition found in the tax evasion literature.

[4] The variable G can also be viewed as the final value of government spending, i.e., $G=RG_1+G_2$, where G_i is the government spending in period i. Such a final value would also enter additively in the utility function of individuals.

When tax evasion is present, the uncertainty is not so exogenous since an individual chooses the level of uncertainty he wants to bear when filling his income report. For example, if agents decide to declare all their true income, then the variance of their second-period consumption vanishes and, in consequence, the individual will face no uncertainty.

In order to evaluate the effect of the change in the tax rate on consumption, first observe from Eqs. (1), (2) and (3), that

$$\mathrm{d}C_1 = -x\mathrm{d}\tau - \tau\mathrm{d}x - \mathrm{d}S - \mathrm{d}T_1, \tag{9}$$

$$\mathrm{d}C_2^{\mathrm{N}} = R\mathrm{d}S - \mathrm{d}T_2, \tag{10}$$

$$\mathrm{d}C_2^{\mathrm{Y}} = R\mathrm{d}S + RF(\tau)\mathrm{d}x - RF'(\tau)(y-x)\mathrm{d}\tau - \mathrm{d}T_2. \tag{11}$$

Substituting the government budget constraint (Eq. (8)) into Eqs. (10) and (11), we obtain

$$\mathrm{d}C_2^{\mathrm{N}} = R\mathrm{d}S + R\mathrm{d}T_1 + R\left[x + pF'(\tau)(y-x)\right]\mathrm{d}\tau + R(\tau - pF(\tau))\mathrm{d}x, \tag{12}$$

$$\begin{aligned}\mathrm{d}C_2^{\mathrm{Y}} = {} & R\mathrm{d}S + R\mathrm{d}T_1 + R\left[(1-p)F(\tau) + \tau\right]\mathrm{d}x \\ & + R(x - (1-p)F'(\tau)(y-x))\mathrm{d}\tau.\end{aligned} \tag{13}$$

Define the index of absolute risk aversion $\Phi(C) = -(u''(C))/(u'(C)) > 0$. Taking the first-order conditions Eqs. (4) and (6), and logarithmically differentiating both sides of these equations, we obtain

$$\Phi(C_1)\mathrm{d}C_1 - \frac{1}{\tau}\mathrm{d}\tau = \Phi\left(C_2^{\mathrm{Y}}\right)\mathrm{d}C_2^{\mathrm{Y}} - \frac{F'(\tau)}{F(\tau)}\mathrm{d}\tau, \tag{14}$$

$$\begin{aligned}&\Phi(C_1)\mathrm{d}C_1 - \left[\frac{F(\tau)(F'(\tau)-1) - F'(\tau)(F(\tau)-\tau)}{F(\tau)(F(\tau)-\tau)}\right]\mathrm{d}\tau \\ &\quad = \Phi\left(C_2^{\mathrm{N}}\right)\mathrm{d}C_2^{\mathrm{N}}.\end{aligned} \tag{15}$$

Finally, using Eqs. (9), (12) and (13) to substitute into Eqs. (14) and (15), and assuming $\mathrm{d}T_1 = 0$, we obtain the following equations:

$$\begin{aligned}&\left[-\Phi(C_1) - R\Phi\left(C_2^{\mathrm{Y}}\right)\right]\frac{\mathrm{d}S}{\mathrm{d}\tau} \\ &\quad = \frac{1}{\tau} - \frac{F'(\tau)}{F(\tau)} + \Phi(C_1)x + \Phi\left(C_2^{\mathrm{Y}}\right)Rx \\ &\qquad - \Phi\left(C_2^{\mathrm{Y}}\right)(1-p)RF'(\tau)(y-x) + \left[\Phi(C_1)\tau\right. \\ &\qquad \left. + \Phi\left(C_2^{\mathrm{Y}}\right)(R(1-p)F(\tau) + R\tau)\right]\frac{\mathrm{d}x}{\mathrm{d}\tau},\end{aligned} \tag{16}$$

$$\left[-\Phi(C_1) - R\Phi\left(C_2^{\mathrm{N}}\right)\right]\frac{\mathrm{d}S}{\mathrm{d}\tau}$$

$$= \left[\frac{F(\tau)(F'(\tau)-1) - F'(\tau)(F(\tau)-\tau)}{F(\tau)(F(\tau)-\tau)}\right]$$

$$+ \Phi(C_1)x + \Phi\left(C_2^{\mathrm{N}}\right)Rx + \Phi\left(C_2^{\mathrm{N}}\right)RpF'(\tau)(y-x)$$

$$+ \left[\Phi(C_1)\tau + \Phi\left(C_2^{\mathrm{N}}\right)R(\tau - pF(\tau))\right]\frac{\mathrm{d}x}{\mathrm{d}\tau}. \tag{17}$$

Observe that we have a system of two equations and two unknowns, $(\mathrm{d}S)/(\mathrm{d}\tau)$ and $(\mathrm{d}x)/(\mathrm{d}\tau)$. Solving this system, we will obtain the sign of the previous derivatives.

It is important to remark that our results will crucially depend on the assumptions made about the fine that an individual must pay if he is inspected. We consider two alternative assumptions. The first one consists of imposing a penalty proportional to undeclared income and independent of the tax rate. In this case, we have $F(\tau) = \pi < 1$ as in Allingham and Sandmo (1972). For every unreported unit of income, the taxpayer must pay a constant proportion π. This specification also requires that $\pi > \tau$ since, otherwise, tax evasion would not be punished. The second specification is based on imposing the penalty on evaded taxes as in Yitzhaki (1974). In this case, we have that $F(\tau) = \pi\tau$ with $\pi > 1$, where the inequality restriction is necessary to guarantee that a tax evader pays a penalty greater than the taxes paid by a honest taxpayer.

First, we will examine the case $F(\tau) = \pi$. The following proposition summarizes the results.

Proposition 1. *Let $F(\tau) = \pi < 1$. Assume that the variation in the proportional tax rate τ is compensated with a variation of the second-period lump-sum tax T_2, such that it leaves unchanged the government spending level G. Then,*

(a) the declared income x is decreasing in the tax rate;

(b) the amount of evaded taxes $\tau(y-x)$ is increasing in the tax rate;

(c) if the utility function exhibits decreasing absolute risk aversion, $p < 1/2$, and $\pi < 2\tau$, then first-period consumption is decreasing in the tax rate;

(d) second-period consumption when no inspection takes place is increasing in the tax rate;

(e) second-period consumption when the agent is audited is decreasing in the tax rate.

Proof. Assume that the penalty is imposed on undeclared income, that is, $F(\tau) = \pi$. In this case, it follows that $F'(\tau) = 0$. Thus, Eqs. (16) and (17) can be simplified to

$$\left[-\Phi(C_1) - R\Phi\left(C_2^{\mathrm{Y}}\right)\right]\frac{\mathrm{d}S}{\mathrm{d}\tau} = \frac{1}{\tau} + \Phi(C_1)x + \Phi\left(C_2^{\mathrm{Y}}\right)Rx + \left[\Phi(C_1)\tau + \Phi\left(C_2^{\mathrm{Y}}\right)R(\tau + (1-p)\pi)\right]\frac{\mathrm{d}x}{\mathrm{d}\tau},$$

$$\left[-\Phi(C_1) - R\Phi\left(C_2^{\mathrm{N}}\right)\right]\frac{\mathrm{d}S}{\mathrm{d}\tau} = -\frac{1}{\pi-\tau} + \Phi(C_1)x + \Phi\left(C_2^{\mathrm{N}}\right)Rx + \left[\Phi(C_1)\tau + \Phi\left(C_2^{\mathrm{N}}\right)R(\tau - p\pi)\right]\frac{\mathrm{d}x}{\mathrm{d}\tau}.$$

Solving this system, we obtain the following explicit solutions for $(\mathrm{d}S)/(\mathrm{d}\tau)$ and $(\mathrm{d}x)/(\mathrm{d}\tau)$:

$$\frac{\mathrm{d}S}{\mathrm{d}\tau} = \frac{\alpha D - \beta A}{\alpha C - \beta B}, \tag{18}$$

$$\frac{\mathrm{d}x}{\mathrm{d}\tau} = \frac{BD - AC}{\alpha C - \beta B}, \tag{19}$$

where

$$\alpha = \left[\Phi(C_1)\tau + \Phi\left(C_2^{\mathrm{Y}}\right)R(\tau + (1-p)\pi)\right],$$

$$\beta = \left[\Phi(C_1)\tau + \Phi\left(C_2^{\mathrm{N}}\right)R(\tau - p\pi)\right],$$

$$A = \left[\frac{1}{\tau} + \Phi(C_1)x + \Phi\left(C_2^{\mathrm{Y}}\right)Rx\right],$$

$$B = \left[-\Phi(C_1) - R\Phi\left(C_2^{\mathrm{Y}}\right)\right],$$

$$C = \left[-\Phi(C_1) - R\Phi\left(C_2^{\mathrm{N}}\right)\right],$$

$$D = \left[-\frac{1}{\pi-\tau} + \Phi(C_1)x + \Phi\left(C_2^{\mathrm{N}}\right)Rx\right].$$

Simplifying and collecting terms, it is easy to see that $\alpha C - \beta B < 0$ and $BD - AC > 0$. We obtain thus a negative relation between tax rates and reported income. The positive relation between evaded taxes $\tau(y-x)$ and the tax rate τ follows immediately.

To compute the effect of a change in the tax rate on consumptions, first rewrite Eqs. (9), (10) and (11) as

$$\frac{\mathrm{d}C_1}{\mathrm{d}\tau} = -x - \tau\frac{\mathrm{d}x}{\mathrm{d}\tau} - \frac{\mathrm{d}S}{\mathrm{d}\tau}, \tag{20}$$

$$\frac{\mathrm{d}C_2^{\mathrm{N}}}{\mathrm{d}\tau} = R\frac{\mathrm{d}S}{\mathrm{d}\tau} - \frac{\mathrm{d}T_2}{\mathrm{d}\tau}, \tag{21}$$

$$\frac{\mathrm{d}C_2^{\mathrm{Y}}}{\mathrm{d}\tau} = R\frac{\mathrm{d}S}{\mathrm{d}\tau} + R\pi\frac{\mathrm{d}x}{\mathrm{d}\tau} - \frac{\mathrm{d}T_2}{\mathrm{d}\tau}. \tag{22}$$

Likewise, assume $\mathrm{d}T_1 = 0$ and rewrite Eq. (8) as

$$\frac{\mathrm{d}T_2}{\mathrm{d}\tau} = -Rx - R(\tau - p\pi)\frac{\mathrm{d}x}{\mathrm{d}\tau}. \tag{23}$$

Next, we substitute the solutions of $(\mathrm{d}S)/(\mathrm{d}\tau)$, $(\mathrm{d}T_2)/(\mathrm{d}\tau)$ and $(\mathrm{d}x)/(\mathrm{d}\tau)$ given in Eqs. (18), (19) and (23) into Eqs. (20), (21) and (22). We obtain

$$\frac{\mathrm{d}C_1}{\mathrm{d}\tau} = \frac{\beta(Bx + A) - \alpha(Cx + D) - \tau(BD - AC)}{\alpha C - \beta B}, \tag{24}$$

$$\frac{\mathrm{d}C_2^{\mathrm{N}}}{\mathrm{d}\tau} = \frac{R\left[\alpha(D + xC) - \beta(A + xB) + (\tau - p\pi)(BD - AC)\right]}{\alpha C - \beta B}, \tag{25}$$

$$\frac{\mathrm{d}C_2^{\mathrm{Y}}}{\mathrm{d}\tau} = \frac{R\left[\alpha(D + xC) - \beta(A + xB) + (\tau + (1-p)\pi)(BD - AC)\right]}{\alpha C - \beta B}. \tag{26}$$

Since we know that $\alpha C - \beta B < 0$, the sign of these expressions is determined by the sign of the numerator. Making use of the index of absolute risk aversion. $\Phi(C) = -(u''(C))/(u'(C))$ and rearranging Eqs. (24), (25) and (26), we obtain

$$\frac{\mathrm{d}C_1}{\mathrm{d}\tau} = \frac{\frac{1}{\pi - \tau}\Phi\left(C_2^{\mathrm{Y}}\right)R(1-p)\pi - \frac{1}{\tau}\Phi\left(C_2^{\mathrm{N}}\right)Rp\pi}{\alpha C - \beta B}, \tag{27}$$

$$\frac{\mathrm{d}C_2^{\mathrm{N}}}{\mathrm{d}\tau} = \frac{-\Phi(C_1)p\pi\frac{\pi}{(\pi - \tau)\tau} - \frac{1}{\pi - \tau}\Phi\left(C_2^{\mathrm{Y}}\right)R\pi}{\alpha C - \beta B}, \tag{28}$$

$$\frac{\mathrm{d}C_2^{\mathrm{Y}}}{\mathrm{d}\tau} = \frac{\frac{\pi}{\tau}\left[\Phi(C_1)(1-p) + \Phi\left(C_2^{\mathrm{N}}\right)R\right] + \frac{1}{\pi - \tau}\Phi(C_1)(1-p)\pi}{\alpha C - \beta B}. \tag{29}$$

It is immediately obvious to see that under decreasing absolute risk aversion, $p < 1/2$, and $\pi < 2\tau$, the numerator of expression (27) is positive, which implies that $(dC_1)/(d\tau) < 0$. Moreover, the numerator of Eq. (28) is unambiguously negative since the index of absolute risk aversion is positive and $\pi > \tau$, and this implies that $(dC_2^N)/(d\tau) > 0$. Likewise, it can be checked that the numerator of Eq. (29) is unambiguously positive so that $(dC_2^Y)/(d\tau) < 0$. □

Our specification has allowed us to characterize unambiguously the tax evasion decision in a Ricardian framework. The most important finding in this respect is that declared income is decreasing in the tax rate. In other words, when the tax rate increases, the individuals likewise increase the amount of unreported income, which is a result that is in accord with the empirical evidence. Recall that the theoretical literature in this area obtains either ambiguous results or empirically supported results under very restrictive assumptions on the utility function when the probability of being detected is constant. In particular, when the fines are on unreported income, Allingham and Sandmo (1972) are only able to guarantee the positive relationship between tax rates and unreported income under the not very appealing assumption of non-decreasing absolute risk aversion. Note that, in our framework, no additional assumptions on utility functions besides concavity are needed to obtain the positive relation between tax rates and unreported income.[5]

The intuition behind items (a) and (b) of Proposition 1 lies in the absence of the income effect (that could affect individuals' attitude towards risk) when the tax rate increases, since this effect is completely offset by the lump-sum transfer. On the other hand, an increase in the tax rate makes honest behavior more expensive when compared with cheating, and this generates a substitution effect that stimulates tax evasion.[6]

The effect of a tax rate increase on intended savings S is ambiguous in general. While the aforementioned substitution effect induces more precautionary saving since more tax evasion amounts to more risk associated with second-period income, the lump-sum transfers goes in the opposite direction since the increase in second-period income due to the transfer implies a reduction of savings.

Items (c), (d) and (e) of Proposition 1 tell us that Ricardian equivalence fails since consumption is affected by a change in the timing of taxes.[7] This should not

[5] As we have already mentioned in the Introduction, such an empirical positive relation can also be obtained if the probability of inspection were not constant. This is the case in the model of Yitzhaki (1987) where the inspection probability depends positively on evaded income.

[6] It is important to remark that, when the penalty does not depend on the tax rate, a rise in tax rate does not alter the marginal utility in the case of being audited for a given x.

[7] In this paper, we are usually referring to a Ricardian equivalence exercise consisting of a tax increase today coupled with a cut in lump-sum taxes (or an increase in lump-sum transfers) tomorrow. Of course, our results would be symmetric if we had considered instead the more standard instrumentation of a tax reduction today coupled with an increase in taxes tomorrow.

be surprising since Barsky et al. (1986) and Strawczynski (1995) have already obtained this result in different contexts with uncertainty. However, in our context income uncertainty is endogenous whereas these authors assumed a completely exogenous mechanism generating such uncertainty. When the tax rate increases, individuals evade more income, which implies in turn that they will bear more risk in the second period since the amount of fines to be paid in case of inspection depends on the level of evasion. Therefore, income taxes and evasion fees are the cause of income uncertainty and are thus the driving force of precautionary savings. In fact, higher tax rates (coupled with an equivalent increase of lump-sum taxes) induce more cheating, more income risk and, consequently, more inefficient precautionary savings. Note that the inefficiency of precautionary savings hinges on the fact that individuals end up saving more than they would in absence of both taxes and fees.

The sign of the effects on the consumption path are not ambiguous under the empirically plausible parametric restrictions $p < 1/2$ and $\pi < 2\tau$, and under the assumption of decreasing absolute risk aversion.[8] In particular, first-period consumption decreases when the tax rate is raised. From Eq. (9), we can observe that the variation in first-period consumption depends on three different effects when $\mathrm{d}T_1 = 0$. The first order effect implies that first-period consumption goes down when the tax rate increases since the taxpayer has to pay more taxes and, in consequence, has less disposable income. On the other hand, when the tax rate increases, we know that declared income diminishes, and then the effective tax payment goes down and this has a positive effect on first-period consumption. Finally, the third effect is given by the impact on savings of a change in the tax rate. In general, this effect is ambiguous so that it is not possible to know in which direction the variation in savings modifies first-period consumption. However, in the present context the first-order effect outweighs the indirect effects induced by the changes in both declared income and saving.

We can also observe that an increase in the tax rate implies a reduction in second-period consumption when the individual is audited and an increase in consumption when he is not. In fact, declared income decreases with the tax rate since evasion would become more attractive. This results immediately in an increase in second-period consumption if the individual is not detected. However, the higher level of evasion translates into a higher amount of fees paid in case of inspection, which will imply in turn a lower consumption in such a case.

Finally, we can compute the effect of a rise in the tax rate on aggregate second-period consumption, and we obtain the following corollary.

[8] The restriction $\pi < 2\tau$ implies that the individual must pay the taxes he has evaded plus a fine which amounts to less than 100% of evaded taxes.

Corollary 1. *Let* $\bar{C}_2 = (1-p)C_2^N + pC_2^Y$. *If the utility function exhibits decreasing absolute risk aversion,* $p < 1/2$, *and* $\pi < 2\tau$, *then* $\bar{C}_2$ *is decreasing in the tax rate.*

Proof. The proof follows from a direct computation. □

This result tells us that, despite the probability of being audited being smaller than that of not being audited, the negative effect on C_2^Y outweighs the positive effect on C_2^N.

Let us analyze now the consequence of assuming that $F(\tau) = \pi\tau$, that is, proportional fines are imposed on evaded taxes. The following proposition summarizes the results.

Proposition 2. *Let* $F(\tau) = \pi\tau > 1$. *Assume that the variation in the proportional tax rate* τ *is compensated with a variation of second-period lump-sum tax* T_2, *such that it leaves unchanged the government spending G. Then,*

(a) the declared income x is increasing in the tax rate;

(b) the amount of evaded taxes $\tau(y-x)$ *is not affected by changes in the tax rate;*

(c) the intended saving S is decreasing in the tax rate;

(d) consumption C_1, C_2^N *and* C_2^Y *is not affected by changes in the tax rate.*

Proof. If we assume that the fine takes the form $F(\tau) = \pi\tau$, we have $F'(\tau) = \pi$ and Eqs. (16) and (17) become

$$\left[-\Phi(C_1) - R\Phi\left(C_2^Y\right)\right]\frac{\mathrm{d}S}{\mathrm{d}\tau}$$

$$= \Phi(C_1)x + \Phi\left(C_2^Y\right)R\left[x - (1-p)\pi(y-x)\right]$$

$$+ \left[\Phi(C_1)\tau + \Phi\left(C_2^Y\right)R\tau(1 + (1-p)\pi)\right]\frac{\mathrm{d}x}{\mathrm{d}\tau},$$

$$\left[-\Phi(C_1) - R\Phi\left(C_2^N\right)\right]\frac{\mathrm{d}S}{\mathrm{d}\tau} = \Phi(C_1)x + \Phi\left(C_2^N\right)R\left[x + p\pi(y-x)\right]$$

$$+ \left[\Phi(C_1)\tau + \Phi\left(C_2^N\right)R\tau(1-p\pi)\right]\frac{\mathrm{d}x}{\mathrm{d}\tau}.$$

The solution to this system yields

$$\frac{\mathrm{d}x}{\mathrm{d}\tau} = \frac{y-x}{\tau} > 0, \tag{30}$$

$$\frac{\mathrm{d}S}{\mathrm{d}\tau} = -y < 0. \tag{31}$$

Concerning the amount of evaded taxes $\tau(y-x)$, let us differentiate with respect to τ to obtain

$$\frac{\mathrm{d}[\tau(y-x)]}{\mathrm{d}\tau} = y - x - \tau\frac{\mathrm{d}x}{\mathrm{d}\tau}.$$

From Eq. (30), it immediately follows that $(\mathrm{d}[\tau(y-x)])/(\mathrm{d}\tau) = 0$.
In order to compute the effect of a change in τ on the consumption path, rewrite Eqs. (9), (10) and (11) as

$$\frac{\mathrm{d}C_1}{\mathrm{d}\tau} = -x - \tau\frac{\mathrm{d}x}{\mathrm{d}\tau} - \frac{\mathrm{d}S}{\mathrm{d}\tau}, \tag{32}$$

$$\frac{\mathrm{d}C_2^{\mathrm{N}}}{\mathrm{d}\tau} = R\frac{\mathrm{d}S}{\mathrm{d}\tau} - \frac{\mathrm{d}T_2}{\mathrm{d}\tau}, \tag{33}$$

$$\frac{\mathrm{d}C_2^{\mathrm{Y}}}{\mathrm{d}\tau} = R\frac{\mathrm{d}S}{\mathrm{d}\tau} + R\tau\pi\frac{\mathrm{d}x}{\mathrm{d}\tau} - R\pi(y-x) - \frac{\mathrm{d}T_2}{\mathrm{d}\tau}. \tag{34}$$

Substituting Eq. (30) into Eq. (8), we obtain

$$\frac{\mathrm{d}T_2}{\mathrm{d}\tau} = -Ry. \tag{35}$$

Finally, substituting Eqs. (30), (31) and (35) into Eqs. (32), (33) and (34), we find that

$$\frac{\mathrm{d}C_1}{\mathrm{d}\tau} = 0, \quad \frac{\mathrm{d}C_2^{\mathrm{N}}}{\mathrm{d}\tau} = 0, \quad \text{and} \quad \frac{\mathrm{d}C_2^{\mathrm{Y}}}{\mathrm{d}\tau} = 0.$$

□

We can see in this case that the Ricardian equivalence proposition holds. This result clearly differs from that obtained by Barsky et al. (1986) in a model with exogenous uncertainty and flat rate taxes. This is so because in our model a tax cut modifies not only the saving decision but also the amount of declared income. In particular, these two effects have the opposite sign. When the penalty is imposed on evaded taxes, the penalty rate $F(\tau)$ increases proportionally with τ. Therefore, the substitution effect is eliminated. Observe also that, for given levels of declared income x and saving S, an increase in the tax rate τ reduces both first-period consumption and second-period consumption in case of inspection as a consequence of the proportional increase in the penalty rate. Therefore, the lump-sum compensation would not completely offset the effect on the distribution of second-period consumption and, as a consequence, the individual must raise his declared income.[9] Moreover, the amount of evaded taxes $\tau(y-x)$ is not modified since the decrease in tax rates is exactly offset by the reduction in the amount of evaded income and, therefore, the amount of fees paid if the individual is inspected does not change.

In this case, the effect of raising the tax rate τ on intended saving S is not ambiguous. Note that the intended saving of an individual decreases since declared income increases and, at the same time, there is a lump-sum compensation in the second period of life.

Observe that old consumption in both states of the nature (C_2^{N} and C_2^{Y}) remains unaltered because of two effects. First, an increase in the tax rate generates a decrease in capital income ($R[(\mathrm{d}S)/(\mathrm{d}\tau)]$), which is equal to the corresponding decrease in second-period lump-sum taxes ($(\mathrm{d}T_2)/(\mathrm{d}\tau)$). Second, as we said, the amount of evaded taxes does not change. Consequently, the increase in the tax rate does not modify the risk that individuals bear in their second period of life so that neither precautionary saving nor the consumption profile is affected by the tax rate.

A positive relation between declared income and the tax rate was also found by Yitzhaki (1974) under decreasing absolute risk aversion, while we obtain this relation under just concavity of the utility function. It should be stressed that in Yitzhaki's model, life cycle considerations are absent and the government absorbs the revenues from proportional taxes instead of channeling these revenues to the private sector through either lump-sum transfers or tax rebates. Note that, with fines proportional to the taxes evaded and constant probability of inspection, the result concerning the relationship between declared income and tax rates is now at odds with empirical evidence.

To conclude our discussion, we should mention that the effects of a modification in the tax rate on both the declared income and the consumption path are the same if the tax compensation were made through a modification of the first-period lump-sum tax T_1. Trivially, the change in the calendar of lump-sum taxes should not have any real effect on the consumption path regardless of whether $F(\tau)=\pi\tau$ or $F(\tau)=\pi$.

5. Conclusion

I have considered a very simple Ricardian model that allows us to analyze the implications of tax evasion on the equilibrium consumption path. The results differ

[9] Balassone and Jones (1998) provide a detailed discussion about the sign of the income effect in a similar context.

depending on the assumption made about the fine paid by taxpayers if an inspection occurs. When the penalty is imposed on undeclared income, the Ricardian equivalence proposition fails to hold, whereas it holds when the fine paid by the taxpayers is a constant fraction of evaded taxes. Moreover, the sign of the relationship between tax rates and declared income also depends on the type of penalties. Our Ricardian framework also allows us to isolate the tax evasion implications of an increase in the tax rate by disregarding the crowding out effect accruing from the higher levels of public spending.

The reason behind the previous contradictory results lies in the effects triggered by tax evasion. There are two basic effects: the substitution effect and the income effect. On the one hand, if the penalty is imposed on unreported income, a rise in the tax rate does not modify the amount of income that an agent has to pay if caught for a given amount of reported income. This provides an incentive for tax evasion at the margin. Moreover, the lump-sum transfer received by the individuals offsets the income effect accruing from the increase in the tax rate. In this case, the substitution effect becomes crucial and declared income turns to be decreasing in the tax rate. Therefore, individuals end up facing more uncertainty in the second period of life since the variance of their old income is raised. As the incentives for precautionary saving are modified, the consumption profile changes accordingly. On the other hand, if the fine is proportional to the amount of evaded taxes, an increase in the tax rate implies an increase in the penalty and this leads individuals to increase their declared income since the substitution effect has been eliminated and the lump-sum transfers do not completely offset the effect on the structure of uncertainty. However, the amount of evaded taxes remains unchanged now and, hence, neither precautionary savings nor the consumption distribution in the second period are affected.

Our results concerning Ricardian equivalence immediately extend to an economy with production in which firms hire both the labor supplied by agents and the capital accruing from saving net of outstanding public debt. The rental prices of both labor and capital will be equal to their respective marginal productivities. Whenever Ricardian equivalence holds in our setup, it will hold in such a general equilibrium context. This is so because the change in the financing policy of the government will not affect either the consumption path or the capital lent to the firms, and this is consistent with invariant wages and invariant rates of return from accumulated savings. Obviously, the failure of Ricardian equivalence in our model translates into the same failure in the corresponding economy with productive firms.

Acknowledgements

Financial support from the Spanish Ministry of Education through grant PB96-1160-C02-02 is gratefully acknowledged. This paper has benefited from the comments made by Jordi Caballé, Inés Macho, and two anonymous referees. Consequently, all errors that remain are entirely my own.

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