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Abstract

A strictly risk-averse individual with an exogenous gross income in period one can acquire human capital in the same period and evade taxes. Period-two income rises with educational investments in period one and can also be hidden from tax authorities. It is shown that a greater tax deductibility of educational investments and higher individual ability induce a positive correlation between tax evasion and educational investments in period two, whereas the relationship in period one is ambiguous. These theoretical predictions can explain diverse empirical findings on the correlation between education and tax evasion.

JEL-Code: H240, H260, I200.

Keywords: human capital, income tax, tax evasion.

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1. Introduction

Once compulsory schooling has been completed, individuals can either continue their education or start working. Therefore, a trade-off between current educational expenditure and future income arises. Since labour income is generally taxed, the costs of and gains from human capital formation can be affected by taxation. Taking into account the fact that tax evasion is a widespread phenomenon in many societies would imply, then, that educational decisions are influenced by tax evasion activities. However, the causal chain may also operate in the opposite direction. If human capital formation alters the gains and costs resulting from income tax evasion, educational decisions will influence tax evasion choices.

Although, then, a relationship between tax evasion and education seems plausible, the body of knowledge pertaining to this link is limited. While the burgeoning literature on educational incentives and taxes has not (yet) allowed for tax evasion, the impact of education on tax evasion outcomes has been investigated empirically. The findings are mixed: some studies do not observe a significant correlation (Dubin et al. 1987, 1990; Wilson and Sheffrin 2005), while others report education variables to have a negative impact on compliance measures (Witte and Woodbury 1985; Beron et al. 1992, Chan et al. 2000, Ritsema et al. 2003), or a positive effect on tax fraud (Groot and van den Brink 2010). Finally, there is also evidence that educational attainments mitigate tax evasion activities (Dubin and Wilde 1988; Richardson 2006; Gërxhani 2007). Furthermore, the relationship between education and tax morale, i. e., the intrinsic motivation to comply with tax laws, has been studied (Torgler 2005; Frey and Torgler 2007; Torgler 2007, pp. 31 ff). In sum, empirical contributions strongly suggest a relationship between tax evasion behaviour and educational attainment but yield no clear picture of its nature. There are, moreover, virtually no theoretical contributions that shed light on the matter.[1]

To address this deficiency, in the present paper we set up a model that includes a channel of influence between educational investments and tax evasion choices which has, to the best of our knowledge, hitherto gone unnoticed. More educated people earn higher gross incomes, once the educational phase has been completed. Therefore, human capital formation raises the tax burden, subsequent to the education period. However, educational investments are costly and lower taxable income during the investment phase. Both effects alter the incentives to evade taxes. To investigate their interplay, we employ a two-period model in which a

[1] Kolm and Larsen's (2010) contribution represents possibly the only exception. However, in their model, tax evasion and education are dichotomous variables and individual tax evasion behaviour is not linked to educational decisions. Instead, the relationship relies on general equilibrium effects.

representative individual, characterised by non-increasing relative risk aversion, undertakes educational investments in period one. In period two, the gross income depends on the amount of educational investments and savings (or debts) accumulated in the previous period.

We show, first, that greater tax deductibility of expenditure for educational investments enhances human capital formation not only in the absence of tax evasion activities, but also where they are present. In consequence, non-compliance with tax laws does not affect the relationship between this tax instrument and educational investments. Furthermore, we find that greater tax deductibility raises evasion in period two and has ambiguous effects in period one. Therefore, such a parameter change establishes a relationship between education and tax evasion, the direction of which depends on the phase of working life the individual is in. Second, we focus on individual abilities. If the costs of a given educational investment are lower for one individual than for another, this reflects greater efficiency in the usage of educational resources. Similarly, greater gross returns for a given amount of human capital formation indicate a more pronounced ability on the part of the individual to utilise such investments. Hence, changes in the costs of and returns from a given educational investment indicate differences in abilities. Higher ability individuals undertake greater educational investments, also in the presence of tax evasion opportunities. Furthermore, individual ability unambiguously enhances tax evasion in period two, and tends to have the same impact on the overall amount of taxes evaded, whereas the effect on tax evasion in period one is ambiguous.

Our findings indicate that the relationship between tax evasion and educational attainments may depend on whether the educational process is already completed, for which the model predicts a positive relationship, or educational expenses still reduce current taxable income. In the latter instance, the relationship may also be negative. The intuition for the potentially differential effects is as follows. Greater educational investments reduce disposable income in period one, and raise gross income in period two. Higher income in period two induces the individual to evade a greater amount of taxes in that period due to the assumption of non-increasing relative risk aversion. In period one, disposable income shrinks. This makes the individual more risk-averse and induces a higher voluntary tax payment, ceteris paribus. However, greater educational investments will reduce the official tax burden if they are tax deductible. As a consequence, the penalty payment declines which, on its own, induces a lower voluntary tax payment. If risk aversion is not decreasing too strongly, the penalty impact will dominate the income effect. Since the official tax burden shrinks as well, the direction of the change in the amount of taxes evaded in period one cannot be determined.

The theoretical analysis generates a number of testable predictions. For example, better educated individuals with higher incomes will evade taxes more than individuals with lower educational investments, once their education has been completed. Furthermore, controlling for income (and wealth), educational attainments should not be correlated with tax evasion because the predicted relationship relies on the income effects of educational choices. On an aggregate level, the relationship between human capital and tax evasion will depend on the share of individuals who have completed their education and, hence, may vary with the age structure of the society. In consequence, our investigation implicitly calls for more clearly differentiated measures of educational characteristics in empirical investigations.

The remainder of the paper is structured as follows. In the next section the model is set up; the third section then analyses the impact of greater tax deductibility of educational expenses. Subsequently, we investigate the consequences of differences in abilities and finally provide a summary. Some derivations are relegated to an appendix.

2. Model

Let the working life of an individual consist of two periods. In both periods, the individual has a fixed time endowment which is either divided between labour supply and time spent on human capital formation (in period one) or utilised to supply labour (in period two). We denote all variables and parameters determining payoffs in period one (two) by small (capital) letters, unless no distinction is required. Effective educational investments are given by e and reduce the exogenous gross income in period one from w to $w - \alpha e$. The parameter α, $\alpha > 0$, is known to the individual and measures the private costs of investments e in terms of foregone wages or actual expenditure. To illustrate, one may think of e as the amount of knowledge acquired in school or university. Higher ability people will need less time to obtain this knowledge, that is, they may miss out a school year or complete a university degree ahead of schedule, whereas less able people will require costly private lessons to finish school or university. In consequence, acquiring a given level of human capital is less costly for more able individuals. Accordingly, we may interpret α as an (inverse) measure of individual input efficiency with regard to educational investments, i.e. of individual ability.[2]

Income is subject to a given linear tax at rate t, $0 \leq t < 1$. Educational investments e are tax deductible at the rate γ, $0 \leq \gamma \leq 1$. There is no withholding system for taxes. This assumption allows, first, our findings to be related to those of earlier contributions and will, second, be

[2] We borrow this terminology from Levhari and Weiss (1974) who distinguish between input and output risk in educational investments and assume, for example, that (an analogue) to the parameter α is uncertain.

without impact if the tax system enables individuals to reclaim previously made tax payments by, for example, declaring tax deductible expenditures. Besides deciding on e, in period one the individual determines how much to save or borrow (S) and the amount of voluntary (but insufficient) tax payments z. If tax evasion is detected with the exogenous probability (1 - q), $0 < q < 1$, a fine will be levied on the amount of unpaid taxes. The fine equals $[(w - \gamma\alpha e)t - z]f$, where f constitutes the fine parameter and is subject to the standard restriction $1/(1 - q) > f > 1$. Disposable income will equal $y^n = w - \alpha e - z - S$ if evasion is successful, and $y^c = y^n - [(w – \gamma\alpha e)t - z]f = w - \alpha e - z - S - [(w - \gamma\alpha e)t - z]f$ if evasion fails. The minimum value for f ($f > 1$) ensures that disposable income y^c if caught evading taxes rises with voluntary tax payments and, therefore, guarantees the existence of a penalty for tax evasion. The maximum value ($f < 1/(1 – q)$) implies that the deterrent effect of the penalty, relative to (the inverse) of the detection probability 1 – q, is not too high. Otherwise, no tax evasion would take place and an analysis of the relationship between tax evasion and education could not be undertaken.

Capital markets are perfect. Moreover, we set the interest rate to zero. Therefore, saving an amount S (> 0) or borrowing S (< 0) in period one causes an income change of the opposite direction and same magnitude in period two. Furthermore, the savings decision is undertaken *before* the uncertainty about the success of tax evasion activities in period one is revealed. We make these simplifying assumptions for the following reasons. First, if the interest rate on savings were non-zero, the evasion of interest income would become feasible. To rule out the interaction of tax evasion choices from different income sources, savings are assumed to yield no (monetary) returns. Conversely, if the individual were able to incur debts, the tax deductibility of interest payments and the possibility of exaggerating these costs for tax purposes would have to be considered. Second, if the decision about S were made subsequent to having learned about the outcome of the tax evasion gamble, savings (or debts) could be used to insure against income variations. Accordingly, savings opportunities would directly affect tax evasion choices. Since our interest lies in the relationship between educational investments and tax evasion, we rule out that S has an insurance role of this kind. Moreover, we will subsequently refer to S as 'savings' to simplify the exposition.[3]

In period two, the individual can also evade taxes. In a setting with heterogeneous individuals, tax evasion behaviour in period one could convey information about evasion activities in period two. In consequence, the detection probability in period two may depend on whether tax evasion is detected in period one. However, in the present setting we consider a

[3] Most results derived below will also hold if savings are impossible. The derivations are available upon request.

representative individual so that period-one behaviour cannot reveal individual-specific features. Since a possible relationship between tax evasion activities in period one and the detection probability in period two is unlikely to vary with education, we assume the detection probability in period two to be unaffected by period-one behaviour and to be the same as in period one, that is 1 - q. Furthermore, the income Y^n if tax evasion is not detected will be given by $Y^n = \beta W(e) - Z + S$, where $\beta W(e)$ depicts the wage resulting from an effective educational investment e and Z denotes the amount of taxes paid voluntarily. The disposable income if caught evading taxes in period two equals $Y^c = \beta W(e) - Z + S - [\beta W(e)t - Z]f$. The wage $\beta W(e)$ is increasing in educational investments e at a decreasing rate, $W'(e) > 0 > W''(e)$. The parameter β, $\beta > 0$, is known to the individual and an indicator of the productivity of an effective educational investment e. This indicator can vary between individuals and will be higher for those who can transform a given educational investment e into future monetary income more successfully. A greater value of β, therefore, captures a higher ability on the part of individuals to exploit educational investments.

The timing of decisions is as follows. In period one, the individual makes decisions regarding educational investments e, the amount of tax payments z made voluntarily, and savings S. Subsequently, the tax declaration may be audited. If tax evasion is detected, a fine will be imposed. At the beginning of period two, the individual decides on the level of the voluntary tax payment Z. Afterwards, another audit may take place. If such an audit occurs, only period-two tax evasion activities will be observed and penalised. Since savings are determined prior to the outcome of the tax evasion gamble, voluntary tax payments Z are independent of whether tax evasion in period one has been successful or not.

The individual's (indirect) utility is separable in the sub-utility u from the consumption of the sole private good available in the economy, and in the sub-utility from a public good provided by the government. The (indirect) sub-utility function u is an increasing and strictly concave function of disposable income (y^j in period one; and Y^j in period two), given that the price of the private good is normalised to unity, where the superscript j, j = c, n, indicates whether the individual was caught evading taxes (c) or not (n). The individual exhibits non-increasing relative risk aversion r_r, $r_r := -u''(\tilde{y})\tilde{y}/u'(\tilde{y}) > 0$ at income $\tilde{y}$. This implies that absolute risk aversion, r_a, $r_a := r_r/\tilde{y}$, is declining with $\tilde{y}$. In the presence of tax evasion activities, $y^c < y^n$ and $Y^c < Y^n$ hold, so that $r_a(y^n) < r_a(y^c)$ and $r_a(Y^n) < r_a(Y^c)$ result. To close the model, we assume that the government spends tax revenues, less any enforcement costs, on the purchase of the public good. If the economy is populated by a large number of individuals, tax revenues will therefore be certain and the supply of the public good will be constant.

Let the expected utility from private good consumption EU be additive in the expected utility of periods 1 and 2. Furthermore, we allow for a positive rate of time preference, by discounting payoffs in period two by the factor μ, $0 < \mu \leq 1$. Accordingly, ignoring the constant and separable sub-utility from public good consumption, expected utility EU can be written as:

$$EU(e,z,S,Z) = qu\underbrace{(w - \alpha e - z - S)}_{:=y^n} + (1-q)u\underbrace{(w - \alpha e - z - [(w - \gamma\alpha e)t - z]f - S)}_{:=y^c}$$

$$+ \mu qu\underbrace{(\beta W(e) - Z + S)}_{:=Y^n} + \mu(1-q)u\underbrace{(\beta W(e) - Z - [\beta W(e)t - Z]f + S)}_{:=Y^c} \quad (1)$$

The first-order conditions for a maximum are:

$$\frac{\partial EU}{\partial z} := U_z = -qu'(y^n) - (1-q)u'(y^c)(1-f) = 0 \quad (2)$$

$$\frac{\partial EU}{\partial Z} := U_Z = -\mu\left[qu'(Y^n) + (1-q)u'(Y^c)(1-f)\right] = 0 \quad (3)$$

$$\frac{\partial EU}{\partial e} = -\alpha[qu'(y^n) + (1-q)u'(y^c)(1-\gamma tf)] + \mu\beta W'(e)\{qu'(Y^n) + (1-q)u'(Y^c)(1-tf)\} = 0 \quad (4)$$

$$\frac{\partial EU}{\partial S} := U_S = -qu'(y^n) - (1-q)u'(y^c) + \mu\left[qu'(Y^n) + (1-q)u'(Y^c)\right] = 0 \quad (5)$$

The values of z and Z defined by equations (2) and (3) are strictly positive because, for example, non-positive tax payments would immediately be observed and penalised. Substituting (2) and (3) into the first-order condition (5) for savings shows that $u'(y^n) = \mu u'(Y^n)$ and $u'(y^c) = \mu u'(Y^c)$ hold. Using this information and $qu'(y^n) = -(1 - q)u'(y^c)(1 - f)$ from (2) in equation (4) yields a modified first-order condition denoted by U_e:

$$U_e := qu'(y^n)(\beta W'(e) - \alpha) + (1-q)u'(y^c)(\beta W'(e)(1-tf) - \alpha(1-\gamma tf))$$

$$= (1-q)u'(y^c)f[\beta W'(e)(1-t) - \alpha(1-\gamma t)] = 0 \quad (6)$$

Inspection of equations (2), (3), and (6) indicates that the rate of time preference is without impact because the savings decision effectively neutralises the impact of the parameter μ on the education decision. Furthermore, equation (6) clarifies that the choice of e is not affected directly by tax evasion and, hence, tax enforcement instruments, such as the detection probability, 1 – q, and the fine, f. Formally, this is the case because investment and evasion choices maximise expected utility, while savings ensure an optimal allocation of expected income over time. Therefore, voluntary tax payments will not be used for this purpose. This, in turn, implies that the only role of tax evasion is to maximise expected disposable income. These features of the optimal educational investment have a number of implications. First, equation (6) clarifies that educational investments cannot be used to insure against the income risk due to evasion activities. This feature contrasts with findings for a setting in which uncertainty is linked to the outcome of educational investments. The difference arises since tax evasion creates uncertainty within a period but not across periods, as educational investments can (cf. Levhari and Weiss 1974). This is the case because tax evasion activities in a given period can either be successful or fail, so that income in each period becomes a priori uncertain. Given the assumption that savings cannot be conditioned on the success or failure of evasion activities, the outcome of the attempt to reduce tax payments illegally does not affect period-two consumption levels. Second, variations in the probability (1 - q) of being detected evading taxes, and in the penalty rate f, leave educational investments unaffected. Third, if educational expenses are fully tax deductible ($\gamma = 1$), the constant marginal tax rate will not affect educational investments, irrespective of whether individuals evade taxes or not.[4] More generally, distortions in educational decisions will neither be directly aggravated nor mitigated by tax evasion opportunities at the individual level.

In order to derive comparative static predictions, we use a further subscript to denote the derivatives of equations (2), (3), and (6) and observe that $U_{zZ} = U_{Zz} = U_{eZ} = U_{ez} = 0$. Totally differentiating equations (6), (2) and (3) with respect to the endogenous variables e, z, and Z and an exogenous parameter x yields:

[4] Boskin (1975) has shown that an income tax will not alter the extent of human capital formation in the absence of tax evasion opportunities if the marginal income is constant and all expenditure for educational investments is tax deductible. His finding is based on a number of further (implicit) assumptions, namely that taxation does not affect labour supply, there are no non-taxable, i.e. non-observable elements of educational investments and of returns to these investments, and capital income is not affected by tax rate variations (cf. Eaton and Rosen 1980 and Jacobs 2007). Since these prerequisites are fulfilled in the present setting, Boskin's (1975) neutrality prediction extends to a world with tax evasion.

$$\begin{bmatrix} U_{ee} & 0 & 0 \\ U_{ze} & U_{zz} & 0 \\ U_{Ze} & 0 & U_{ZZ} \end{bmatrix} \begin{bmatrix} de \\ dz \\ dZ \end{bmatrix} = \begin{bmatrix} -U_{ex} \\ -U_{zx} \\ -U_{Zx} \end{bmatrix} [dx] \tag{7}$$

The second derivatives U_{ee}, U_{zz}, and U_{ZZ} are negative (see Appendix 6.1). Hence, the determinant D of the system given by (7) has the same sign and the values of z, Z and e guaranteeing the first-order conditions (2), (3) and (6) maximise expected utility EU. Given optimal choices z*, Z*, and e*, the resulting (desired) amounts of taxes evaded in periods one and two can be defined as $\delta := (w - \gamma\alpha e^*)t - z^*$ and $\Delta := \beta W(e^*)t - Z^*$.

Extracting $qu'(\cdot)$ from the term in square brackets in the first lines of (8) and (9), and making use of the definition of absolute risk aversion r_a, the cross-derivatives U_{ze} and U_{Ze}, which differ from U_{ez} and U_{eZ} due to the substitution in equation (4), are given by:

$$U_{ze} = \alpha\left[qu''(y^n) + (1-q)u''(y^c)(1-f)(1-\gamma tf)\right]$$

$$= \alpha qu'(y^n)\left[r_a(y^c)(1-\gamma tf) - r_a(y^n)\right] \tag{8}$$

$$U_{Ze} = -\beta W'(e)\left[qu''(Y^n) + (1-q)u''(Y^c)(1-f)(1-tf)\right]$$

$$= -\beta W'(e)qu'(Y^n)\left[r_a(Y^c)(1-tf) - r_a(Y^n)\right] \tag{9}$$

$U_{ze} < 0$ and $U_{Ze} > 0$ will hold if absolute risk aversion is not decreasing too strongly with income, and tax and penalty rates are sufficiently large. Assumption A formalises this restriction and, hence, guarantees $U_{ze} < 0 < U_{Ze}$.

Assumption A: $r_a(y^c)(1 - \gamma tf) < r_a(y^n)$ and $r_a(Y^c)(1 - tf) < r_a(Y^n)$

A rise in educational investments e reduces income in both states of the world in period one. However, the decline in disposable income will be less pronounced if tax evasion is detected because the fine payment also declines with educational expenses, given their tax deductibility. Assumption A, on the one hand, ensures that this uneven fall in incomes in both feasible states of the world in period one leads to a decline in voluntary tax declarations z.

Because educational investments raise period-two income, Assumption A, on the other hand, guarantees that this rise in disposable income induces the individual to expand voluntary tax declarations Z in the second period. Assumption A is likely to hold because marginal income tax rates, inclusive of social security contributions, may easily amount to 45% - 50% of labour costs (OECD 2011, p. 151). In addition, penalty rates are considerably lower than 100% in most countries, even for severe cases of tax evasion (OECD 2009, pp. 136 ff). This implies a value of f of greater than unity (for it to be a penalty) but of less than 2. Therefore, tf and γtf are likely to be less than but not too far away from unity.

The model developed above exhibits the standard feature of most static and dynamic set-ups, namely that a higher detection probability (1 – q) and a higher fine f reduce evasion and raise voluntary declarations z* and Z*.[5] In addition, the present model predicts that a higher tax rate t reduces the desired amount of taxes evaded in period two Δ raises voluntary declarations in period one z* given Assumption A, and has ambiguous effects on voluntary declarations in period two Z* and the desired amount of taxes evaded in period one δ and in total δ + Δ (see Appendix 6.2). The finding for the desired amount of evasion in period two Δ is the same as can be obtained from other static models of tax evasion, based on similar assumptions (see, for example, Yitzhaki 1974 and Christiansen 1980). Dynamic models, however, often predict a positive correlation between tax evasion and the tax rate (see footnote 5 for references). The effect of a rise in the tax rate, t, on the desired amount of taxes evaded in period one is ambiguous in the present setting, because the decline in the optimal amount e* of educational investments (for 0 < γ < 1) raises the official tax burden in period 1, ceteris paribus. This outcome is qualitatively comparable to that resulting in a static setting in which the tax rate change induces an adjustment in labour supply (cf. Pencavel 1979)

3. Tax Deductibility of Human Capital Expenditure (γ)

In this section we show how variations in the measure γ of tax deductibility affect the optimal amount e* of educational investments, voluntary tax payments z* and Z*, as well as the resulting amounts of tax evasion δ and Δ. Initially, we will investigate the consequences of a rise in the measure of tax deductibility γ on the first-order conditions (2), (3), and (6). Subsequently, we can combine these considerations, using equation (7).

[5] See Appendix 6.2 for the analysis of the effects of variations in q and f on z*, Z*, δ and Δ and the contributions, for example, by Lin and Yang (2001), Chen (2003) and Dalamagas (2011) for investigations of dynamic general equilibrium settings with qualitatively comparable predictions.

A rise in the tax deductibility γ of expenditure for educational investments has no direct effect on the incentives to pay taxes in period two, $U_{Z\gamma} = 0$, because Z* is independent of period-one income. The direct impact on investment incentives is positive because, firstly, after-tax costs of education decline ($U_{e\gamma} = \alpha tf(1-q)u'(y^c) > 0$) and, secondly, the decision with regard to educational investments is not affected by tax evasion choices (see equation (6)). Furthermore, greater tax deductibility will, ceteris paribus, reduce voluntary tax payments z* in period one ($U_{z\gamma} = -\alpha etf(1-f)(1-q)u''(y^c) < 0$). The fall in z*, for a given investment e, occurs because the optimal amount of voluntary tax payments results from a trade-off between the increase in income if caught evading taxes and the decline in income if evasion is successful. A rise in γ only raises income in the former state of the world and, thus, lowers the marginal utility from making voluntary tax payments.

The overall impact of greater tax deductibility on the amount z* of taxes paid voluntarily in period one can be obtained from equation (7) for $x = \gamma$. Given Assumption A, both the direct effect of greater tax deductibility on voluntary tax payments in period one and the indirect effect via higher educational investments e* reinforce each other.[6] This is the case because the income reduction due to greater expenditure makes the individual more reluctant to pay taxes. The change in period-two voluntary tax payments Z* is determined solely by the indirect effect via the adjustment in educational investments e*. Given Assumption A, the direct effect of educational investments on voluntary tax payments in period two is positive, $U_{Ze} > 0$, and greater tax deductibility raises voluntary tax payments ($dZ^*/d\gamma = -(de^*/d\gamma)(U_{Ze}/U_{ZZ}) > 0$).

The desired amount of taxes evaded Δ in period two, $\Delta := \beta W(e^*)t - Z^*$, rises with the tax deductibility γ of human capital expenditure, because the legal tax burden $\beta W(e^*)t$ increases by more with γ than voluntary tax payments Z*.[7] The desired amount of taxes evaded in period one is given by δ, $\delta := (w - \gamma\alpha e^*)t - z^*$. The change in δ is ambiguous because the tax base $w - \gamma\alpha e^*$ declines with γ. A fall in the tax base reduces the incentives to evade taxes, ceteris paribus. If this tax base effect is not too strong, the increase in the tax deductibility of educational expenses will raise taxable income sufficiently for total desired tax evasion to rise (see Appendix 6.4). This implies that a lower initial level γ of tax deductibility makes d(Δ +

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[6] $dz^*/d\gamma = (U_{e\gamma}U_{ze} - U_{ee}U_{z\gamma})/(U_{zz}U_{ee})$

[7] See Appendix 6.3. The result with regard to Δ can also be obtained from the first-order condition (3). Suppose that $\beta W(e^*)t - Z^*$ remained constant, despite the changes in e* and Z*. Accordingly, $\beta W(e^*) - Z^*$ would rise. Higher incomes in both states of the world would induce more tax evasion, given decreasing absolute risk aversion. Accordingly, the assumption of $\beta W(e^*)t - Z^*$ being constant is not compatible with an optimal evasion choice. A positive impact of income on the amount of taxes evaded has already been derived by Yitzhaki (1974).

$\delta)/d\gamma > 0$ and $d\delta/d\gamma > 0$ more likely because the fall in the tax base owing to a higher level of educational investments rises with γ.

The above considerations yield

Proposition 1:
Greater tax deductibility of expenses for educational investments
a) raises educational investments e^* and the desired tax evasion Δ in period two,
and given Assumption A,
b) lowers taxes z^* paid voluntarily in period one,
c) raises taxes Z^* paid voluntarily in period two, and
d) will raise desired tax evasion δ in period one and total desired tax evasion $\Delta + \delta$ if $\gamma\alpha t$ is not too large.

Period one may be interpreted as the initial phase of an individual's working life that commences with the end of compulsory schooling. Period two would then represent the remaining working life until retirement. Alternatively, if human capital formation also takes place during working life, period one would be a phase in which working time is reduced substantially in order to acquire human capital, while period two represents periods of full-time activity. Focussing on the first interpretation, part a) of Proposition 1 suggests that there is a positive relationship between education and tax evasion activities for full-time employees who have completed the process of human capital formation. Part d), in addition, indicates that the relationship may be different during phases of human capital formation. For empirical studies, these findings suggest that the relationship between tax evasion and education may diverge for societies in which a large fraction of the population is still in the process of acquiring human capital and societies characterised by (already) well-educated individuals. On an individual level, the relationship between education and tax evasion behaviour may differ accordingly with age, if age is taken as an indicator of the extent to which the formation of human capital has been completed.[8] If income and wealth in all states of the world (that is

[8] Empirical studies linking tax evasion behaviour to age generally use dummies such as for being 65 years of age or older (Dubin and Wilde 1987, 1988; Dubin et al. 1990; and Richardson 2006), or employ three to four age categories (Torgler 2005; Wilson and Sheffrin 2005). With the exception of Wilson and Sheffrin (2005) who observe a positive effect of age on honesty with respect to tax declarations, age is generally an insignificant covariate. Gërxhani (2007) uses a continuous measure and finds tax evasion to decrease with age at a declining rate. Torgler and Valev (2010) show that age has a positive impact on the assessment of whether tax evasion is regarded as justified or not.

y^n, y^c, Y^n, Y^c) are adequately controlled for, however, education characteristics should not affect evasion choices.[9]

4. Individual Abilities (α, β)

In the model outlined in the second section, two indicators have been incorporated which measure an individual's ability to transform expenditure pertaining to the formation of human capital into monetary returns. The measure α captures efficiency on the input side, in that a lower value of α indicates an individual who can acquire a given amount of effective educational investments with a smaller reduction in period-one income than an individual with a higher value of α. The measure β captures the efficiency effect on the output side, as it describes the amount by which income in period two rises, for a given amount of educational investments. The two measures diverge in so far as the monetary effects of different abilities do not arise in the same period.

Input Efficiency(α)

If the measure α of input efficiency varies between individuals, its effect on voluntary tax payments z^* and Z^* as well as on the desired amount of tax evasion $\delta = (w - \gamma\alpha e^*)t - z^*$ and $\Delta = \beta W(e^*)t - Z^*$ will indicate the consequences of differential abilities to transform expenditure into productive educational investments. Partly rewriting equation (1) in terms of desired tax evasion δ in period one yields:

$$EU(e,\delta,Z,S) = qu\big(\underbrace{w(1-t) - e\alpha(1-\gamma t) + \delta - S}_{=y^n}\big) + (1-q)u\big(\underbrace{w(1-t) - e\alpha(1-\gamma t) - \delta(f-1) - S}_{=y^c}\big)$$

$$+ \mu qu\big(\beta W(e) - Z + S\big) + \mu(1-q)u\big(\beta W(e) - Z - [\beta W(e)t - Z]f + S\big) \qquad (1')$$

Inspection of equation (1') clarifies that changes in the tax deductibility of educational expenses γ and the measure α of individual ability affect period-one income in both states of the world in a qualitatively (almost) identical manner, because $\partial y^n/\partial\alpha = -(\partial y^n/\partial\gamma)(1 - \gamma t)/(\alpha t)$ and $\partial y^c/\partial\alpha = -(\partial y^c/\partial\gamma)(1 - \gamma t)/(\alpha t)$ hold, where $(1 - \gamma t)/(\alpha t) > 0$. In consequence, the variations in the optimal amount of human capital formation e^* and in voluntary tax payments Z^* in period two which have been derived for a higher tax deductibility γ of educational

[9] In general, empirical studies on the individual determinants of tax evasion do not include indicators both of education and income. Of the studies surveyed in the introduction, only Ritsema et al. (2003) and Gërxhani (2007) consistently incorporate a continuous income measure.

investments will occur as well, if the measure α of individual ability decreases. Since, moreover, the desired amount of taxes evaded in period two, $\Delta = \beta W(e^*)t - Z^*$, is a function of e* and Z* only, we find that sign($d\Delta/d\alpha$) = -sign($d\Delta/d\gamma$) as well. Accordingly, with the exception of part b), all results summarised in Proposition 1 are valid for a decrease in the measure α of individual ability as well. The effect of a decline in α on the optimal amount z* of voluntary tax payments in period one is ambiguous, as the change in α alters income y^n if tax evasion is successful for given amounts of educational investments e* and voluntary tax payments z* in period one, in contrast to a variation in the tax deductibility of expenses (cf. equation (1)). We can summarise our findings as

Proposition 2:[10]
A greater ability to transform expenses into educational investments, that is, a lower value of the measure α and, thus, a higher input efficiency
a) raises educational investments e* and desired tax evasion Δ in period two,
b) has ambiguous effects on taxes z* paid voluntarily in period one,
and given Assumption A,
c) raises taxes Z* paid voluntarily in period two, and
d) will raise desired tax evasion δ in period one and total desired tax evasion $\Delta + \delta$ if $\gamma\alpha t$ is not too large.

Changes in the ability to transform expenditure into effective educational investments affect the payoff in both states of the world in period one, that is, irrespective of whether tax evasion is detected or not. Variations in the tax deductibility of such costs will have an impact only if tax evasion is penalised (cf. equation (1)). Nevertheless, the intuition for the effects of higher ability is similar to that applicable to the analysis of greater tax deductibility. This is because both alterations lower the penalty payment in period one which, on its own, induces more evasion in that period. In period two, the induced increase in educational investments raises income and makes tax evasion more attractive, given decreasing absolute risk aversion.

Output Efficiency (β)

Educational investments can differ between otherwise identical individuals because not only the costs associated with them, but also the returns they generate vary. The indicator β measures the amount by which a given educational investment e raises gross income in period

[10] The findings can obviously also be derived explicitly. The respective calculations resemble those underlying Proposition 1 and are available upon request.

two. Ceteris paribus, an increase in the measure of output efficiency β raises investments e* ($U_{e\beta} = (1 - q)u'(y^c)fW'(e)(1 - t) > 0$), does not affect the voluntary tax payment z* in period one ($U_{z\beta} = 0$), and raises the voluntary tax payment Z* in period two, given Assumption A ($U_{Z\beta} = U_{Ze}W(e)/(\beta W'(e)) > 0$). To obtain the impact of an increase in individual ability, as measured by the parameter β, on voluntary tax payments in period one, note that educational investments reduce disposable income in period one. Given, first, the positive impact of β on investments e* and, second, Assumption A, the individual's willingness to pay taxes falls and, therefore, voluntary tax payments z* decline ($dz^*/d\beta = -de^*/d\beta(U_{ze}/U_{zz}) < 0$). The effect on voluntary payments Z* in period two consists of the direct impact via the rise in income and the indirect effect owing to higher investments. Since, therefore, income unambiguously rises in period two, Assumption A ensures that the voluntary declaration Z* increases.[11]

Desired tax evasion in period two Δ, $\Delta := \beta W(e^*)t - Z^*$, rises with the returns from educational investments, because the direct impact together with the effect via the rise in educational investments e* dominates the consequences arising from higher voluntary tax payments (see Appendix 6.5). Next, we turn to desired tax evasion δ, $\delta := (w - \gamma\alpha e^*)t - z^*$, in period one. On the one hand, a rise in the indicator β reduces δ because the tax base decreases with higher educational investments, given their tax deductibility. On the other hand, the fall in income in period one lowers the voluntary tax payment ($dz^*/d\beta < 0$), contributing to a rise in the desired amount of tax evasion.[12] If the fall in the legal tax liability is not too large, the second impact will dominate, and desired tax evasion in period one will rise.

We can summarise the findings as

Proposition 3:

An increase in the returns from educational investments, that is a higher value of the measure β and, thus, greater output efficiency of educational investments,

a) raises educational investments e* and desired tax evasion Δ in period two,

and given Assumption A,

b) lowers taxes z* paid voluntarily in period one,

c) raises taxes Z* paid voluntarily in period two,

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11 $$\frac{dZ^*}{d\beta} = \frac{-U_{ee}U_{Z\beta} + U_{e\beta}U_{Ze}}{U_{ZZ}U_{ee}} = U_{Ze}\frac{W'(e)^2 - W''(e)W(e)}{U_{ZZ}\beta W''(e)W'(e)} > 0$$

12 $$\frac{d\delta}{d\beta} = -\gamma\alpha t\frac{de^*}{d\beta} - \frac{dz^*}{d\beta} = \frac{de^*}{d\beta}\left[\frac{U_{ze}}{U_{zz}} - \gamma\alpha t\right]$$

d) will raise desired tax evasion δ in period one and total desired evasion $\Delta + \delta$ if $\gamma\alpha t$ is not too large.

Propositions 2 and 3 clarify that irrespective of the exact way in which an individual's ability affects the efficiency with which expenditure for educational investments translates into higher income, the consequences for the relationship between education and tax evasion are similar. More able and, hence, better educated individuals will evade more taxes than less able individuals once the educational phase is completed. The relationship between tax evasion and educational investments in the phase during which human capital is acquired is not linked to ability in a clearly predictable manner.

5. Summary

In this paper, we have analysed a model in which educational investments reduce income early in life and generate certain returns later on. Income is taxed and expenditure for human capital formation is tax deductible. If individuals evade taxes, variations in taxable income due to educational investments affect the penalty payments that will have to be made if tax evasion is detected. Therefore, policies which affect human capital formation and individual abilities regarding the efficiency with which expenditure for educational investments can be transformed into additional income also alter tax evasion behaviour.

In the third and pen-ultimate sections we have investigated the impact of greater tax deductibility of human capital expenditure and individual ability. The analysis clarifies that the relationship between tax evasion and educational investments depends on whether human capital formation enhances or reduces income, that is, the phase of working life the individual currently occupies. If income declines because of greater expenditure for education purposes, risk aversion will rise and tax evasion will fall, ceteris paribus. This effect occurs during the time when human capital is created. Later on in life, when the returns from human capital formation accrue, the income effect will work in the other direction. The income effect in period one is mitigated or perhaps reversed because, for example, a policy which raises educational investments tends to lower the tax base and will, thus, reduce the penalty payment if tax evasion is detected. In consequence, it is possible to derive conditions under which voluntary tax payments will rise or fall, respectively. However, unconditional statements about the relationship between tax evasion and education cannot always be established for the period of human capital formation.

The present setting could be extended to allow for a normative analysis of the linkage between education and tax evasion. If human capital formation generates positive externalities, society will face a trade-off between, for example, subsidising education and fostering tax evasion activities. If, alternatively, it is assumed that the government can alter educational efficiency at a lower cost than individuals, because of the existence of increasing returns to scale, the resulting expenditure for schooling etc. will require tax payments. If individuals attempt not to pay these taxes, once again, optimal government policy will become an issue. Furthermore, individuals with different abilities have different preferences for the extent of government intervention. Accordingly, the trade-off between education policy and the enforcement of fiscal obligations could also been looked at from a positive perspective. Such issues remain for future work.

6. Appendix

6.1 Second Derivatives

Making use of the first-order conditions (2), (3), (6) and the definition of absolute risk aversion, the second derivatives U_{ee}, U_{zz}, and U_{ZZ} are given by:

$$U_{ee} = (1-q)u'(y^c)f\beta W''(e)(1-t) < 0 \quad (A.1)$$

$$U_{zz} = qu''(y^n) + (1-q)u''(y^c)(1-f)^2 = qu'(y^n)[r_a(y^c)(1-f) - r_a(y^n)] < 0 \quad (A.2)$$

$$U_{ZZ} = qu''(Y^n) + (1-q)u''(Y^c)(1-f)^2 = qu'(Y^n)[r_a(Y^c)(1-f) - r_a(Y^n)] < 0 \quad (A.3)$$

6.2 Effects of Tax Rate (t) and Tax Enforcement Parameters (q, f)

The derivatives of equations (2), (3), and (6) with respect to the fine, f, the probability, q, of non-detection, and the tax rate, t, are given by $U_{ef} = U_{eq} = 0$ and:

$$U_{zf} = (1-q)\{u'(y^c) + u''(y^c)(1-f)[(w-\gamma\alpha e)]t - z\} > 0 \quad (A.4)$$

$$U_{Zf} = (1-q)\{u'(Y^c) + u''(Y^c)(1-f)[\beta W(e)t - Z\} > 0 \quad (A.5)$$

$$U_{zq} = u'(y^c)(1-f) < 0 \quad (A.6)$$

$$U_{Zq} = u'(Y^c)(1-f) < 0 \quad (A.7)$$

$$U_{zt} = (1-q)u''(y^c)(1-f)(w-\gamma\alpha e)f > 0 \quad (A.8)$$

$$U_{Zt} = (1-q)u''(Y^c)(1-f)\beta W(e)f > 0 \quad (A.9)$$

$$U_{et} = -(1-q)u'(y^c)f[\beta W'(e) - \alpha\gamma] \leq 0 \quad (A.10)$$

The sign of (A.10) can be derived from equation (6) which implies that $(\beta W'(e) - \alpha)(1 - t) - \alpha t(1 - \gamma) = 0$. Accordingly, for $\gamma < 1$, the term in square brackets in (A.10) is positive.

From equation (7) and $U_{ef} = U_{eq} = 0$ we obtain $de^*/dq = de^*/df = 0$. Furthermore, $dz^*/dq = -U_{zq}/U_{zz} < 0$, $dZ^*/dq = -U_{Zq}/U_{ZZ} < 0$, $dz^*/df = -U_{zf}/U_{zz} > 0$, $dZ^*/df = -U_{Zf}/U_{ZZ} > 0$ can be derived from equations (7) and (A.4) to (A.7). Since the amounts of tax evasion, $\delta := (w -$

$\gamma\alpha e^*)t$ - z^* and $\Delta := \beta W(e^*)t - Z^*$, are only influenced by changes in q and f via variations in z^* and Z^*, the above derivatives imply that $d\delta/dq > 0$, $d\delta/df < 0$, $d\Delta/dq > 0$, and $d\Delta/df < 0$.

In addition, optimal educational investments e* weakly decline with the tax rate, t, $d^*/dt = -U_{et}/U_{ee} < 0$ (cf. equation (6)). The variation in voluntary tax payments in period one, z*, is:

$$\frac{dz^*}{dt} = \frac{U_{et}U_{ze} - U_{ee}U_{zt}}{U_{ee}U_{zz}} > 0 \tag{A.11}$$

where the sign restriction in (A.11) relies on the validity of Assumption A. The change in voluntary tax payments Z* in period two is ambiguous. Since there is a positive direct impact of the tax rate, t, on the desired amount of evasion in period one δ while voluntary payments z* also rise and, hence, exert a negative indirect impact, the change in δ cannot be signed. However, when calculating the variation in the desired amount of tax evasion in period two Δ, it can be shown that the ambiguous change in period two voluntary payments Z* is dominated by the direct tax impact.

$$\frac{d\Lambda}{dt} = \beta\left(W'(e^*)t\frac{de^*}{dt} + W\right) - \frac{dZ^*}{dt}$$

$$= -\frac{U_{et}}{U_{ZZ}U_{ee}}\left[U_{Ze} + \beta W'(e^*)tU_{ZZ}\right] + \frac{U_{zt} + \beta W(e^*)U_{ZZ}}{U_{ZZ}}$$

$$= \frac{\beta\left[r_a(Y^c) - r_a(Y^n)\right]qu'(Y^n)}{U_{ZZ}}\left(W(e^*) + \frac{U_{et}W'(e^*)(1-t)}{U_{ee}}\right) > 0 \tag{A.12}$$

While the last term in (A.12) is positive, the first term subsequent to the third equality sign will be negative for decreasing absolute risk aversion, $r_a(Y^c) > r_a(Y^n)$, as assumed above. Therefore, the desired amount of tax evasion in period two Δ shrinks with the tax rate t.

6.3 Desired Tax Evasion (Δ) in Period Two and Tax Deductibility (γ)

Using equations (A.3) and (9), desired evasion Δ in period two, $\Delta := \beta W(e^*)t - Z^*$, can be shown to rise with the tax deductibility γ:

$$\frac{d\Delta}{d\gamma} = \frac{de^*}{d\gamma}\left[\beta W'(e)t + \frac{U_{eZ}}{U_{ZZ}}\right] = \frac{de^*}{d\gamma}\beta W'(e)(1-t)\frac{r_a(Y^n) - r_a(Y^c)}{r_a(Y^c)(1-f) - r_a(Y^n)} > 0 \tag{A.13}$$

6.4 Total Desired Tax Evasion (Δ + δ) and Tax Deductibility (γ)

The variation in total desired evasion Δ + δ equals:

$$\frac{d(\Delta+\delta)}{d\gamma}=\frac{de^*}{d\gamma}\left[\beta W'(e)t+\frac{U_{eZ}}{U_{ZZ}}-\gamma\alpha t\right]-\left(\alpha e^*t+\frac{dz^*}{d\gamma}\right) \tag{A.14}$$

Substituting for dz*/dγ and, subsequently, U_{ee} and U_{ZZ} (cf. (A.1) and (A.2)) as well as $U_{Z\gamma}$, the last term in (A.14) can be rewritten as:

$$\alpha e^*t+\frac{dz^*}{d\gamma}=\frac{U_{ee}(\alpha e^*tU_{zz}-U_{z\gamma})+U_{e\gamma}U_{ze}}{U_{zz}U_{ee}}$$

$$=\frac{\alpha e^*tqu'(y^n)(r_a(y^c)-r_a(y^n))}{U_{zz}}+\frac{U_{e\gamma}U_{ze}}{U_{zz}U_{ee}}<0 \tag{A.15}$$

The term in square brackets in (A.14) will be positive in accordance with equation (A.13) if γαt is not too large. This establishes part d) of Proposition 1.

6.5 Desired Tax Evasion (Δ) in Period Two and Output Efficiency (β)

Using the derivations for U_{ee} (cf. A.1), $U_{e\beta}$, dZ*/dβ, U_{ZZ} (cf. A.3), and equation (9), the change in desired tax evasion in period two is found to be positive.

$$\frac{d\Delta}{d\beta}=W(e^*)t+\beta W'(e^*)t\frac{de^*}{d\beta}-\frac{dZ^*}{d\beta}$$

$$=W(e^*)\left[t+\frac{U_{Ze}}{U_{ZZ}\beta W'(e)}\right]-\frac{(W'(e^*))^2}{W''(e)}\left[t+\frac{U_{Ze}}{U_{ZZ}\beta W'(e^*)}\right]$$

$$=\frac{r_a(Y^n)-r_a(Y^c)}{U_{ZZ}}qu'(Y^n)(1-t)\left(W(e^*)-\frac{(W'(e^*))^2}{W''(e)}\right)>0 \tag{A.16}$$

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