

The effects of taxation on human capital accumulation

by

Guy Coderre

175178

Major paper presented to the department of economics

University of Ottawa

to obtain the masters diploma

Major paper Director: Professor Jean-François Tremblay

ECO 7997

Ottawa, Ontario

May 2006

The effects of taxation on human capital

1. Introduction

Most economists agree that human capital is one of the most important factors to foster growth in modern economies. Many believe that there are important positive externalities to human capital accumulation, both in the area of overall production and in the specific area of production of human capital. It is important that we enhance our understanding of the effects of policy choices on human capital accumulation. Clearly, taxation is one of the most important tools available to policymakers to influence choice and correct externalities. Recently, there have been a number of studies related to the impact of taxation on human capital accumulation, particularly accumulation in the form of education. This issue will be taking on even more importance in the context of earlier retirement, which will reduce the value of human capital accumulation. In this paper, we will discuss many of the ideas put forward surrounding the relationship between taxation and human capital accumulation during the past several years. We will be comparing approaches and assumptions behind often strikingly contrasting views on this topic.

Because human capital is of such paramount importance to the health of our economy, enhancing our understanding of the intricate relationship between taxation and its accumulation helps us to improve our policy design in a number of areas. For example, we need to consider the impact on human capital accumulation when pondering many policy questions. We will show that the allocation of tax burden between labour and capital has important impacts on human capital accumulation. We will also show that the tax schedule, and in particular the degree of

progressivity, affects the decision to accumulate human capital. We will discuss the interrelationships between taxation, education funding and human capital accumulation, and how different forms of education funding affect accumulation differently.

The paper is organized as follows: Section 2 will describe a number of mechanisms through which taxation can affect human capital accumulation. In Section 3 we review the results of simulation studies that examine the impact of tax policy on human capital accumulation. In section 4, we discuss empirical results. Section 5 analyses the literature reviewed and attempts to highlight the important policy implications suggested by this area of study. Finally, in Section 6 we conclude by identifying where further research may prove useful in enhancing our understanding of the relationship between taxation and human capital accumulation.

2. Taxation and human capital accumulation: The theory

Economic theory has proposed a number of mechanisms that can help explain how accumulation of human capital might react to income taxation. Let us review some of these.

2.1 Human capital as a tax-sheltered savings mechanism

Because most of the cost of accumulating human capital is foregone earnings, it provides a mechanism for saving without paying taxes on the related earnings. This is a salient feature of many of the models used to analyse the relationship between taxation and human capital accumulation. The first authors to broach this subject were Eaton and Rosen (1980). They clearly demonstrate that, if all income (labour and interest) is taxed in the same manner, higher taxation rates tend to foster higher levels of human capital accumulation.

In their model, education is costless, save foregone earnings. Utility is derived from consumption in the two periods. Labour and investment income are taxed at the same rate. Also, human capital investment in the first period increases labour income in the second period, but at a diminishing rate. In this setting human capital is accumulated until its marginal return is equal to the net return on savings. Clearly, because income taxation reduces this net return, an increase in the tax rate will result in a corresponding increase in human capital.

Sgontz (1982) considers the case of progressive taxation. He modifies the Eaton-Rosen model by introducing a second (higher) tax rate for income over a set value x . He shows that in this context, the relationship between taxation and human capital accumulation is ambiguous. This is because the return on human capital will be reduced for all income above x . The result will depend on the difference in tax rates. In some cases, the reduced return on human capital will dominate the tax-sheltering effect.

Boadway, Marceau, Marchand (1996) propose a model that clearly demonstrates the existence of a tax-sheltering effect of human capital accumulation. However, it is important to point out that in his highly stylized model, there is no physical capital. Therefore, human capital accumulation is the only way to transfer consumption between two periods in reacting to policy decisions.

Lin (1998) extends Eaton-Rosen's two period model of human capital accumulation by setting it in an overlapping generation general equilibrium context. Each generation lives for two periods, and chooses first period human capital accumulation effort and consumption to maximize a logarithmic utility function of consumption over both periods. Savings and borrowing are possible across periods.

The cost of human capital is restricted to foregone earnings, and its productivity is a function of time invested, average human capital of the parent's generation, and government expenditure on human capital. Production is a function of physical and human capital and the government runs a balanced budget collecting income and flat taxes and spending on education and general goods, as well as providing lump-sum transfers to both generations.

Lin concludes that how the government uses funds matters: he is able to show that taxation does not affect human capital accumulation if government revenue is redistributed to those who paid it (compensated tax policy). This result may simply be due to the fact that in this context, compensated policy is equivalent to no taxes. Nerlove (1993) in particular finds that the impact of taxation on human capital accumulation can be considerable when taxation is redistributive. We will see later that net savers are more likely to accumulate human capital than net borrowers. This would imply that if redistribution reduces the requirement for agents to borrow during the human capital accumulation period, it would tend to increase their level of human capital accumulation.

When government instead spends its tax revenue, Lin shows that labour income taxation affects human capital accumulation in the same way it affects savings, even though income from physical capital is not taxed in this framework. This is because reduced savings will increase the real interest rate required to clear the market, which will in turn reduce the future value of human capital, hence its attractiveness.

Of course, foregone earnings are not the only costs of education. Such out-of-pocket costs are often taxed or not deductible at the same tax rate as the return will be taxed. Therefore, the tax-sheltering effects described above will not apply to such costs. This was first brought up by Sgontz (1982). He concluded that this was an important oversight in the analysis of the taxation-human capital relationship conducted by Eaton-Rosen.

Caucutt, Imrohoroglu and Kumar (2006) analyse the impact of progressive tax schemes on human capital accumulation in the context of an endogenous growth model. In their model, parents are either skilled or unskilled. Individuals are either skilled or unskilled. Becoming skilled is a function of a (deductible) education investment made by parents: The probability of being skilled increases with education investment. All individuals are assumed to have identical ability. Parents choose the level of education expenditure on their children to maximize their own lifetime utility, which is a function of their own consumption and of the expected utility of their children.

The authors distinguish between productivity as a function of total skilled labour and productivity as a function of the proportion of skilled labour explicitly devoted to enhancing productivity (in essence, productivity as a function of research and development). They conclude that if productivity is a function of total skilled labour, progressivity of taxation impedes human capital accumulation of all individuals and reduces growth. However, if productivity is a function of the proportion of skilled labour devoted to R&D, then progressivity of taxation always decreases human capital accumulation of the unskilled, may **increase** human capital accumulation of the skilled (if growth is sufficiently high) and increases the skill premium (ratio of wages of skilled and unskilled). In effect, they argue that progressive taxation increases inequality and decreases upward mobility!

Bovenberg and van Ewijk (1997) examine the same question in an overlapping generation context. They assume that households consume their lifetime income by investing savings in a lifelong annuity (some sort of reverse life insurance). They further assume that new generations

inherit a fraction of the previous generation's human capital. This inherited human capital is arbitrarily distributed amongst the individuals. There is no utility derived by parents from their children's expected utility. They conclude that individuals require higher return on human than physical capital, because they will consume their physical capital (through the annuity described above), but their human capital will depreciate to 0 when they die. They also observe that progressive taxation reduces human capital accumulation, and consequently reduces growth. Finally, in general they find that increased progressivity of taxes improves the welfare of the young generations, at the expense of the old (whose return on their high levels of human capital is reduced) and the unborn (who suffer from the reduced growth).

In summary, in this section we have seen that taxation of interest income creates an impetus for human capital accumulation because it becomes a tax-sheltered form of saving. However, when general income taxes (taxing both labour and interest income) are progressive, the reduced return on human capital may dominate the tax-shelter effect and reduce human capital accumulation.

2.2 - Uncertainty, risk-taking and human capital investment.

The return on human capital is often considered uncertain. The fact that it is taxed reduces its variability, and hence its associated risk.

The possibility of using redistributive taxation as social insurance against the idiosyncratic risk of income was first suggested by Varian (1980) who first analysed the topic. Empirical evidence suggests that an important factor affecting income is the “luck of the draw”. Varian shows that, in this context, it might be preferable to have quite a high tax rate at the upper echelons, as the distortion of labour supply might be quite small when compared to the corresponding gains due to risky income insurance. His analysis suggests that the optimal tax rate will depend on the level of risk aversion. If risk-aversion does not diminish too rapidly with an increase of income, it can be shown that the tax schedule that maximizes expected utility will have a non-zero tax rate at the highest levels.

Note that this is in contrast with the zero marginal tax rate of highest income levels suggested by the Mirrlees theory of optimal taxation, where only the equity-efficiency trade-off is considered. Because a zero marginal tax rate on the very highest earnings increases the welfare of that individual without reducing the amount of redistribution, it Pareto-dominates any other tax rate at that level.

The impact of uncertainty is discussed in detail in the seminal Eaton-Rosen paper. They carefully analyse the relationship between taxation and human capital accumulation under the assumption

of risky return. They consider two different forms of risk aversion: Constant Absolute Risk aversion (CARA) and Constant Relative Risk Aversion (CRRA). They also assume that tax rates of labour and interest income can differ. Under CARA, they show that increased labour income taxation induces increased human capital accumulation, because the tax reduces the risk associated with the level of second period consumption. However, under CRRA, labour income taxation has an ambiguous effect on human capital accumulation. While the risk reduction mechanism described above is still present, its level is reduced, because the tax reduces the level of second period consumption, on which risk level depends. This effect will tend to decrease human capital accumulation.

Similarly, increasing the rate of interest income taxation can be shown to have an ambiguous effect. While the tax sheltering effect is still present, it also serves to decrease the relative return on the risky asset (H), which tends to reduce its accumulation. Eaton-Rosen compare the magnitude of the two effects, by replacing a labour income tax with an interest income tax. This still leads to ambiguous results, because both forms of taxation can in some cases serve to encourage investment in H , and neither effect dominates.

Introducing savings into the model by making period 1 consumption endogenous also has an ambiguous effect on the relationship between the level of accumulation of human capital and income taxation. The increase in the return on capital accumulation tends to discourage human capital accumulation. However, the increased savings also tend to reduce the risk associated with the accumulation of H , which has the opposite effect.

Finally, they examine the effect of allowing for an endogenous labour supply. They show that if labour income taxation reduces work effort, it reduces investment in human capital. However, they point out that empirical evidence suggests that wage elasticity is close to zero. If that is the case, labour supply will actually increase when labour income taxation increases, leading to an increase in H . This positive relation is further enhanced when uncertainty is introduced, especially in the case of net savers. However, if initial wealth is less than period 1 consumption, labour income taxation may discourage the accumulation of human capital.

In this section, we have seen that taxation can induce human capital accumulation by providing social insurance against the risk associated with its risky return. It is important to note that this relationship depends on the form and degree of risk aversion. If risk aversion is high, or if it is absolute, in the sense that it does not depend on income level, the social insurance effect will be important. However, in general, the social insurance effect only dominates the income effect in the case of net savers. Thus only net savers will increase their human capital accumulation as a result of the combination of these two competing effects. This means that initial wealth is an important encouraging factor in human capital accumulation.

2.3 - The issue of time-inconsistency

The models we have discussed so far assume that the form of taxation is constant. However, agents will consider not only current tax policy, but how they expect tax policy to evolve over time. In this context, one of the main problems with implementing taxation measures which affect people differently in different periods of their lives is the inability of governments to commit to a form of taxation in the second period. This is known as time-inconsistency.

Boadway, Marceau, Marchand (1996) study this problem. They argue that, in a redistributive taxation framework, once the decision of agents pertaining to the level of education has been made governments have an incentive to maximize utility in the productive period, disregarding the effects of the human capital investment decisions in the initial period on the utility of agents. They show that under these conditions mandatory education will serve to alleviate the time-inconsistency problem and be Pareto improving.

In this model, high and low ability households (ability in the sense of higher productivity of education) select education levels to maximize their lifelong utility. Education is costless save foregone earnings, and utility is a function of consumption, additive over time. There is no credit market. Households know their ability levels, and there is no uncertainty regarding the productivity of human capital. Four different equilibriums are examined. The first is laissez-faire, where high-ability households will clearly have higher utility, and likely higher education levels, than low-ability households.

Next they examine first best, which is defined as the redistributive lump-sum tax that equates the second-period marginal utilities of the two types of households. In this case, high-ability households have higher tax rates and education levels than under laissez-faire, while the opposite holds for low-ability households. This is because in this context, education is the only way to transfer consumption from one period to the next. Since the lump-sum redistribution operates in the second period, it will decrease the second-period consumption of high-ability households. Under normal assumptions about utility functions, they will want to transfer some of their first period consumption to the second. The only way to do this is to study more. The reverse is true for low-ability households, who will receive a lump-sum transfer in the second period. However, because the utility of high ability households is less than that of low-ability ones (consumption is identical in period 2, but less for high-ability in period 1 because of higher education and consequent foregone earnings), it is clearly not incentive-compatible, hence unachievable.

Another equilibrium examined is second-best through self-selection, where the planner must pick a combination of tax rates which maximize redistribution without making high-ability households better off by pretending to be low-ability ones. High-ability mimickers will choose education levels to equate their second period wages to those of low-ability households. Since their productivity of education is higher, this level will be lower than that of low-ability households. This level of education depends on the tax-rate imposed on low-ability households. We can therefore define a mimicker's education function in terms of the tax-rate of low-ability households. This in turn can be used to define the mimicker's indirect utility function, which must not be higher than the indirect utility of a high-ability person. The equilibrium here is similar to that of the first best, except that less redistribution is achieved, and there is a lower

level of education in high-ability households (and a correspondingly higher one in low-ability households). However, even these levels are unachievable, because they are time-inconsistent: Once the decisions regarding education levels have been made, the social planner has no incentive to respect his announced plan, and will implement a tax policy that equates second-period consumption ex-post, resulting in higher total utility. Agents will anticipate this and adjust their human capital accumulation period behaviour accordingly.

Finally, the authors analyse the Time-Consistent Optimal Tax Equilibrium. In this case only a pooling equilibrium exists, which will result in both groups of households choosing the same level of pre-tax income. This can be shown to be Pareto-worsening with respect to laissez-faire. High-ability households will require less education than low-ability ones to obtain this income, therefore will be better off. However, since this education level will be constrained to that imposed by the planner (though the use of a tax schedule that penalizes all but the desired income level), they will necessarily be worse off than in the laissez-faire context.

The authors show that, under these conditions, compulsory education policies will unambiguously improve welfare, hence alleviating the time-inconsistency problems. They show that in certain settings, the optimal mandatory education level is higher than that preferred by either type of agent. Finally, they show that in certain cases, mandatory education can be used to achieve first-best.

Another paper dealing with this issue is Konrad (2001). He studies the effects of time-inconsistency in a different setting. He proposes a model where all individuals are identical but the productivity of education is stochastic. He shows that this incomplete information pertaining to the productivity of the education investment alleviates the time-inconsistency problem, cause the government to choose a lower taxation level, and increase welfare.

His model is one where a continuum of identical individuals (no differences of ability) choose an education investment in period 1, and earnings in period 2 to maximize an additive utility function of consumption (i.e. income) and leisure. Leisure is expressed in terms of disutility of education investment and labour. The productivity of the education investment has two states (high or low) determined stochastically by a probability that is a function of the education investment $p(e)$. Finally, taxation is a function of income. Konrad compares time-consistent equilibriums with and without perfect information pertaining to productivity with the laissez-faire outcome.

He concludes that the important characteristic of the laissez-faire outcome in this context is that, because the effectiveness of the first units of education are high, the equilibrium education level must be greater than zero. Similarly to Boadway et al., Konrad demonstrates that the equilibrium level of education will be lower in time-consistent taxation with complete information than in laissez-faire. In fact, in this model, the equilibrium level of education would be zero. Again as in Boadway et al., redistribution and taxation levels will be zero, and this result will be Pareto-inferior to the laissez-faire outcome, where a zero level of education is achievable yet not chosen.

In the time-consistent equilibrium with incomplete information, it can be shown that the introduction of a self-selection constraint for highly productive individuals to the government's maximization problem results in these individuals having a strictly higher utility level than low-productivity types. Therefore, individuals have an incentive to increase their probability of being highly productive, which can only be achieved through acquiring education in period 1.

Therefore, the education level chosen will again be strictly positive, but inferior to that obtained in a laissez-faire setting.

Unfortunately, this time-consistent outcome will not be Pareto-superior to laissez-faire: redistribution will increase the utility levels of low-productivity individuals, and decrease that of high-productivity individuals. Nor can we determine whether expected utilities will be higher or lower, because of competing effects of redistribution (which increase expected utility) and disincentive for education (which decreases expected utility). We can, however, show that expected utility is higher than in the complete information case, and that it is weakly Pareto-superior.

Konrad also demonstrates that the complete information case renders education subsidies useless, while in the incomplete information case they may or may not be beneficial. This is because even though in this context the subsidies increase the probability of being highly productive and the consequent information rent (increased utility of being highly productive described above), it also permits the government to modify its tax policy to reduce the size of this rent. This produces ambiguous results.

We have seen that time-inconsistency may severely limit the options of the policymaker. The argument surrounding time-inconsistency is that once the education decision is made, governments have no incentive to respect the first-best taxation policy which would lead to the optimal education level, and instead opt for a higher tax rate in order to obtain the second period optimum, given the education investments which cannot be “unmade”. However, in reality, there are always agents making education investment decisions simultaneously to others beginning their productive period. We think that perhaps an overlapping generation model would better capture these aspects than the simple two-period models we have seen here. At the very least, this argues for taking a closer look at the results of these models in their time-inconsistent states, on the grounds that the taxation policy implemented will affect not only the decisions of those in the productive period, but also of those in the education investment period.

2.4 - Taxation and subsidization of education

Clearly, some form of taxation is necessary to permit subsidization of education and other forms of human capital accumulation. A number of authors focus on the trade-off between the reduced utility due to taxation and the improvements caused by human capital subsidization. This literature often assumes that higher human capital accumulation fosters higher general production. Three recent examples are Poutvaara-Kanniainen (2000), Poutvaara (2000) and Andersson-Konrad (2003).

Poutvaara and Kanniainen develop a model where only education and unskilled labour enter into the production function. The environment is competitive; hence both factors have a return equal to their marginal productivity. In their model, there are skilled agents who invest in education, and unskilled agents who do not. They assume that human capital production is a function of education investment that increases with average level of education of the skilled agents.

Markets are perfectly competitive; therefore human capital and the input of unskilled labour are rewarded at their marginal products. Individuals choose an education investment to maximize their total lifetime income net of investment costs

They conclude that low-ability agents benefit from higher education levels of high-ability agents. They construct a Nash-bargaining framework showing that subsidization of education by low-ability agents is welfare improving in a closed economy, and will be agreed to by all resulting in a social contract. However, in an open economy where the mobility of skilled workers is high, tax competition negates this effect, because skilled workers will migrate to where taxes are low

and unskilled workers, anticipating this, may even refuse to finance any education whatsoever.

Poutvaara analyses the effects of taxation on education in an open economy where human capital can migrate. He uses a variation of the model described in Poutvaara / Kanniainen, but he incorporates uncertainty of educated wages. He also replaces the unskilled labour factor with a fixed factor.

Individuals choose first period human capital investment, savings and leisure to maximize total utility subject to first and second period budget constraints. The government runs a balanced budget, collecting taxes on labour and the fixed factor to finance lump-sum transfers to students, and borrowing or lending at an exogenous interest rate r . He demonstrates that higher tax rates tend to increase human capital investment and leisure in the first period, at the expense of labour supply.

Konrad and Andersson analyse a similar problem in a different context. Their model is one where a continuum of identical individuals make an education investment in the first period and work in the second. No one works in the first period, and the cost of education is borne by the agent (presumably through a costless loan). Return on education in the second period can be positive with probability p , or null with probability $(1 - p)$.

The individual chooses education effort to maximize a utility function of expected total net income and the intrinsic value of the education investment.

Konrad and Andersson demonstrate that in this context, although private insurance against risky return of education is welfare improving, it actually lowers the equilibrium level of education. This is because insurers cannot impose a specific level of education on the agents. Accordingly, they will choose a lower level of education than in a laissez-faire environment. They also demonstrate that, if labour taxation is introduced, educational investment will increase with respect to a private insurance context, but decrease with respect to laissez-faire. Furthermore they find that if this tax is used to subsidize the private cost of education, utility will be higher than otherwise and that this will crowd out the private insurance market. Finally, they demonstrate that with tax competition, redistribution is reduced, but welfare is at its highest if governments can subsidize education and private insurance exists. That is because the reduced redistribution levels do not result in a crowded-out private insurance sector.

A novel feature in their model is that utility depends on total income as well as education level (perhaps because it leads to an occupational choice which the individual prefers). In other words, education is treated as both an intermediate and final good. This factor does not, however, affect the results of their analysis in any substantial way. The only impact is to raise the general level of education investment.

Although Sgontz (1982) does not discuss this explicitly, he argues that one of the limitations to the positive relationship between taxation and human capital accumulation is the costs other than foregone income. Clearly in this context, if taxation can finance education subsidies sufficient to make these costs disappear, this will strengthen the positive relationship. Finally, Gomez (2000) finds that the form of assistance matters: his simulations suggest that subsidization is vastly superior to in-kind transfers in enhancing the level of human capital accumulation.

2.5 The effect of tax competition and migration

In section 2.3 we discussed time-inconsistency, and described how this phenomenon might hinder the implementation of first or second-best policies surrounding taxation and education. Similarly, the fact that competing jurisdictions can structure their tax schedules in such a way as to attract any human capital produced as a result of their policy choices in the area of education subsidies can prevent authorities from implementing first-best policies. Let us examine how some of the suggested policy instruments might be affected by tax competition:

In his paper, Poutvaara (2001) shows that tax competition leads to sub-optimal tax rates and lower levels of education than that which is optimal in a closed economy, or in a federation with nationally-based taxation, especially if the income from the fixed factor principally accrues to others than the skilled workers.

Another factor which will limit the ability of governments to implement first-best is labour mobility. Poutvaara-Kanniainen, Poutvaara and Andersson-Konrad all discuss these issues. They conclude that jurisdictions might benefit from tax coordination. They also note that if taxes were paid in the jurisdictions where human capital was acquired, higher levels of education subsidization would result. Although they cannot determine if globalization reduces the level of education subsidy, they demonstrate that it shifts its burden to the uneducated labour force.

2.6 - Taxation and allocation of resource within a family

Taxation can enhance the capacity of parents to equalize the total lifetime utility of their children, who may have varying ability levels. In a very interesting paper, Nerlove argues that parents may wish for their children to be equally well off despite varying degrees of ability. In this context (parental utility is of maximin form on the utility of their children), he demonstrates that parents will tend to restrict the education provided to their able children (those whose return on education investment is higher), preferring instead to increase the bequest to their less able ones. This is largely a consequence of parent's inability to provide negative bequests, or to force a transfer from able children to less-able ones. Redistributive income taxation can alleviate this problem and, as a result, be Pareto improving and increase education levels for able children.

The setting is a two period model. In the first period, the parents invest in education of their children, consume, and leave the remainder as bequests to their children in such a manner as to have all children consume the same amount in the second period. The utility function is a well-behaved function of family consumption in the first period and children's consumption in the second.

Parents choose different education expenditures and bequests for children of differing ability levels to maximize their utility such that all children consume the same amount in second period subject to a budget constraint, and a restriction that there be no negative bequest (i.e. no enforceable transfer amongst siblings).

In this context, Nerlove shows that parent's utility may be maximized by a negative bequest to their high-ability children (i.e. last constraint is binding). Since this cannot be enforced, first best cannot be achieved, and parents will underinvest in the education of their high-ability children. Nerlove shows that both education loans reimbursable by the children and linear taxation used to finance lump-sum transfers to all children will be welfare improving and will increase the amount of education investment with respect to the laissez-faire equilibrium.

2.7 - Taxation, retirement age and human capital investment

The advent of early retirement is contributing to decreasing the useful life, and hence the return, of investments in human capital. Labour income taxation only increases this problem.

This was pointed out by Echeverria (2000). Consequently, he developed a simulation model that encompasses a retirement phase in an attempt to measure the impact of this factor. His simulations suggest that the impact of retirement age on the relationship between taxation and human capital accumulation is important. This is in line with the results predicted by Bovenberg, which we discussed in section 2.1. In this case, however, Echeverria argues that human capital depreciates even more quickly (at retirement instead of at death), and that more physical capital is required to fund consumption during the retirement phase.

2.8 Taxation and the education decisions of heterogeneous individuals

Do policy choices affect agents of heterogeneous ability in a symmetric way? If not, who is affected how, and which is the preferable policy choice? A number of models we discussed earlier (Poutvaara, Andersson-Konrad, Boadway, Nerlove) study the impact of taxation on human capital accumulation where ability (defined here as the productivity of human capital investment) varies. However, most of the models impose a human capital investment choice on each of the groups, basically assuming that the able group will make all (or most) of the investments in human capital.

Boadway examines the impact of policy choices on the investment decision of the members of each group. He concludes that certain policy choices can lead to high-ability individuals mimicking the behaviour of low-ability ones and obtain less education than optimal. Although we did not see this discussed in the literature that we reviewed, we could easily construct cases where the opposite might be true (i.e. high levels of subsidization result in low-ability individuals accumulating too much human capital, especially if it is a good).

Another characteristic that may have significant impact on human capital accumulation is wealth. Eaton-Rosen (1980) suggests that increased taxation might increase the accumulation for net savers and decrease it for net borrowers. Lin (1998) finds that taxation affects human capital accumulation in the same way that it affects savings.

Eaton and Rosen show that introducing savings into the model by making period 1 consumption

endogenous also has an ambiguous effect on the relationship between the level of accumulation of human capital and income taxation. The increase in the return on capital accumulation tends to discourage human capital accumulation. However, increased savings also tend to reduce the risk associated with the accumulation of H, which has the opposite effect.

2.9 The impact of human capital accumulation on optimal taxation theory

Eaton and Rosen (1980), which we discussed extensively in section 2.2, also examined the optimal form of a linear labour income tax in a setting of risky return on human capital. They concluded that sole reliance on a lump-sum tax in this context is inefficient, and that some positive rate of labour income tax is desirable. This is because labour income taxation acts as a form of insurance against the risk related to human capital accumulation.

Judd (1997) incorporates human capital in his optimal taxation model. He demonstrates that, similarly to other intermediate goods, the taxation of human capital is sub-optimal. He demonstrates that taxing labour income and immediately expensing all costs related to human capital accumulation can effectively achieve this. He suggests that this should include the portion of taxes used to finance public education (for example, school board property taxes)!

However, there remains the possibility that human capital is not merely an intermediate good, but has utility on its own. It has been suggested that individuals may gain utility from learning, or from the resulting occupational choices that are offered to them. Judd also discussed this aspect. He suggests that if education is truly a good, then taxing a portion of its cost will be

optimal. Once again, this is in line with the theory regarding taxation of intermediate goods: the final good portion of human capital should be taxed.

Judd's model also shows that human capital should be taxed positively if it is a "bad" (i.e. if its utility is negative, for example if given the choice between education or work, where lifelong income will not be affected, the agent will choose to work). This result derives from the requirement to equalize demand elasticities of different commodities (here consumption and human capital) in an optimal taxation framework.

Andersson-Konrad explicitly incorporate this concept into their model. They do not discuss its implication, however clearly this will serve to increase the equilibrium level of education.

3. Simulation results

In addition to the theoretical literature surrounding the issue of human capital accumulation, there has been considerable simulation work aimed at enhancing our understanding of this relationship. Trostel (1993) conducts a simulation in a computable general equilibrium setting in which a representative agent maximizes well-behaved utility function of consumption and leisure over an infinite lifespan. His model incorporates most of the concepts we have discussed in this paper: depreciation of physical and human capital, leisure, tax rates on labour and interest income, real human capital costs in addition to foregone income, and proportional subsidy of education expenses. However, he does not incorporate uncertainty of productivity of human capital. Also, he does not postulate a positive externality on production (either of human capital or of general production) of aggregate human capital.

Trostel calibrates his model using a variety of estimates available in the literature. Furthermore, he conducts extensive sensitivity analysis of his parameters. His simulation shows a strong negative effect of both forms of taxation on human capital accumulation.

Dupor, Lochner, Taber and Witterkind (1996) simulate the relationship between human capital accumulation and taxation in a representative agent framework. Individuals choose a level of schooling (s), and then select a path for investing in human capital accumulation through on-the-job training. Taxation varies in time, and tax schedules can be non-linear.

Individuals are presumed to solve their maximization problem by first calculating their optimal investment path given each potential level of schooling. Next, they calculate total lifetime income (less cost of schooling) for each of the investment paths. Finally, they select the schooling level that maximizes their lifetime income.

The model was calibrated by creating synthetic cohorts using 1970 census data and applying the 1970 tax schedule to their lifetime earnings. The results of the simulation demonstrate that in general, increased taxation has little effect on human capital accumulation. However, when tax rates are progressive, a change in tax schedules can have a considerable effect on individuals whose path puts them on or near the “kinks” in the schedule. In other words, individuals who project their lifetime income to be at or near income levels where tax rates change may react significantly to modification in these tax rates or income levels.

Nerlove (1993) studies the same relationship using an overlapping generation framework. The setting is as follows:

There is one individual in each generation. The utility function is a properly behaved function of consumption in the two periods. Individuals are initially endowed with N units of a composite consumption good, part of which they spend on the acquisition of human capital in the first period. The remainder is either consumed or saved, in which case it becomes capital in the second period and earns a return of r . The effective labour supply (A) is presumed to depend on an agent's human capital and general state of knowledge. Each effective labour unit receives a wage of w . Production is Cobb-Douglas on capital and effective labour. Labour and capital are taxed at different rates. The government returns the proceeds in the form of a lump sum payment in the second period. The government runs a balanced budget.

Nerlove solves the model numerically, and concludes that while wage taxes lower human capital accumulation, capital taxes increase it. Because productivity also depends on general state of knowledge, he shows that tax effects also have similar effects on overall productivity. Finally, he comments that if the tax revenue is used to fund or subsidize human capital accumulation, these effects can be mitigated.

Etcheverria (2000) expands upon this model to incorporate a retirement phase. He runs the model against 59 periods (one for each year between the ages of 16 and 75), with the possibility of varying the duration of the human capital accumulation, production and retirement phases. While his analysis partially confirms the findings of Nerlove that positive physical capital

taxation may be optimal, this effect is mitigated substantially by the utility of physical capital related to its necessity to fund consumption during the retirement phase. However, he finds that the reduction in retirement age tends to increase the optimal rate of taxation of physical capital.

Gomez (2000) also examines the relationship between various tax structures and human capital accumulation in a general equilibrium simulation setting. The model consists of an infinitely lived representative household who choose leisure and consumption to maximize a standard intertemporal utility function with time preference. Human and physical capital have different rates of returns and tax rates. Physical output and human capital are produced by Cobb-Douglas technologies. Physical capital stock is utilized in either physical or human capital production. Foregone earnings used to produce human capital are not counted in production. Only explicit human capital (i.e. teachers) is counted. Like physical capital, human capital here is defined as the sum of investments in human capital less depreciation. The only difference between the two kinds of capital is that human capital can include foregone earnings.

Government runs a balanced budget, taxes physical and human capital differently by production sector, taxes consumption and spends on transfers, human capital investment and other goods.

The model is calibrated to US mid-90s data.

Optimal taxation is defined as that which produces the highest percentage consumption growth that does not reduce household lifetime utility. The author examines public education expenditures treated as subsidy versus treated as infra marginal in-kind transfer.

The author concludes that consumption taxes are welfare improving. He also shows that while capital taxes are too high, income taxes are generally too low. In fact, he concludes that if education is funded through in-kind transfers, optimal taxation would be principally a consumption tax, with very little human capital taxation. Finally, he demonstrates that under the assumptions of their model, optimal tax policy reduces growth. However, he does not comment on their effects on human capital stock.

In summary, most of the models suggest that shifting the tax burden from labour to physical income will help increase the level of human capital accumulation, as well as overall welfare. The main exception to this contention is Trostel's analysis. However, he does not incorporate any "state of knowledge" parameters into his production function. It seems that this is a key factor in simulations surrounding human capital accumulation, especially when no risky return is modelled: If we accept that human capital is more important than physical capital in producing growth, then interest income should be taxed more than human capital income. This is just a restatement of the Pigouvian argument for subsidizing activities that have positive externalities. Here, we are arguing for a tax-subsidy of human capital income.

4. Empirical evidence

There is very little empirical work surrounding the relationship between taxation and human capital accumulation. One such study was recently conducted by Taber (1997). He uses a general equilibrium context to analyse the data from the National Longitudinal Study of Youth. In his model, individuals of varying ability initially decide whether or not to attend college. Cost of a college education is 4 year of foregone wages plus tuition. They also have individual utility or disutility related to schooling. They make the college education decision to maximize a lifelong utility function of consumption, with risk aversion and time preferences. In other words, they go to college if the additional utility related to lifelong earnings, plus (minus) the additional (dis)utility of schooling less the present value of tuition exceeds the utility of lifelong earnings with high-school education. In each period, they will select consumption, savings and human capital investment to maximize their lifetime utility. Youth also receive a bequest from their parents, which they can either invest along with their savings, or use to pay for their tuition.

Wages are a function of human capital, with a different rate for college and high-school graduates. Human capital accumulation varies with level of schooling and ability. Production depends on capital and human capital of high school and college graduates, and exhibits constant returns to scale.

The author first estimates some model parameters exogenously, and then uses regression techniques to estimate the remaining parameters. He then uses the parameter values to simulate various changes to the tax code. His findings are difficult to summarize, as different policy

changes produce varying effects in both directions on both the college decision and lifelong human capital accumulation of different ability types. However, it seems that flat taxation of wages at a different rate than capital income would tend to increase human capital accumulation with respect to progressive wage taxes, flat tax on all income, or consumption taxes.

Another interesting empirical result on this topic was found by Konrad (2004), who concludes that individuals of high ability may prefer progressive wage taxes as a barrier for access to skilled wages. However, his model assumes that the skilled wage rate will vary inversely to the number of skilled resources. This seems contrary to prevalent assumptions regarding the positive externality of human capital in production.

5. Policy implications

We have reviewed a number of papers that predict different effects of taxation on human capital accumulation. Despite the fact that many of these effects tend to offset each other, we believe there are a certain number of principles that could help guide policy makers in this area:

We have seen that progressive taxation tends to reduce human capital accumulation. One of the reasons this happens is because human capital depreciates to zero upon retirement. With the increased duration of retirement due to reduced age of retirement and increased expected lifespan, we can expect an increase in the desire of agents to accumulate physical capital. As we have seen, this could have considerable impact on growth. We believe policymakers should consider this issue in determining the progressivity of the tax system.

On this same topic, the literature suggests that the requirement for providing for retirement may lead to inefficiently high levels of physical capital. Perhaps this argues for increasing the level of retirement income provided publicly. Freed from the requirement to provide for their futures, agents might then increase their investment in human capital that, if we accept the assumption that productivity depends on the overall level of human capital in society, would stimulate growth. In the Canadian context, we might partially achieve this for example by providing full-time students with Canada Pension Plan credits.

We have seen that the distortion of taxation on the human capital accumulation decision is less important for wealthy, or net-saver, individuals. We have also seen that out-of-pocket expenses

of education can have an important impact on education levels. In this context, it may be preferable to favour either universal or need-based subsidy of education over subsidizing only those with highest ability. This is especially true if, as we believe, there is a correlation between ability and initial wealth (both are inherited, and wealthy people tend to have more ability than poor people).

Open economy considerations considerably impede the ability of governments to implement first-best policy choices. The solutions to the jurisdictional issues related to migration and tax-competition may be in the form of policy coordination. It may be appropriate for different jurisdictions within a federation to agree to limit their authority in the area of income taxation to prevent rent-induced migration of educated workers.

In a similar manner, time-consistency issues prevent governments from implementing optimal policies. Here, the solution might be to impose constitutional restrictions on the form of taxation, so that agents can make optimal decisions that affect their lifelong earnings without worrying that the benefits they gain will be eventually taken away by what we might call abusive ex-post taxation.

6. Conclusion

In this paper, we have reviewed a number of papers that discuss the relationship between taxation and human capital accumulation. We have described a number of mechanisms that can help understand this relationship. However, the mechanisms often compete against each other, making it very difficult to ascertain whether certain effects dominate. Furthermore, it is very difficult to obtain empirical evidence surrounding this question. We think that is because human capital accumulation is a lifelong decision that requires long-term planning. Therefore agents cannot react quickly to policy changes in this area, as they are often constrained by the choices they made prior to the policy change.

Nevertheless, we believe that further research in this area, especially on the relationship between taxation used for education subsidy and human capital accumulation, and its effect on individuals of varying ability and wealth, could provide a valuable contribution to future education funding policy.

Finally, we have seen that the theory exposed herein suggest that the prevailing views surrounding the allocation of tax burden between physical and human capital may hinder human capital accumulation. We believe that more work in this area might help policymakers in determining the optimal allocation of the tax burden.

References

Andersson F, Konrad KA. **Globalization and risky human-capital investment.** Int Tax Public Finance. 2003; 10(3):211-228.

Boadway R, Marceau N, Marchand M. **Investment in education and the time inconsistency of redistributive tax policy.** 1996; *Economica* 63: 171-189.

Bovenberg AL, van Ewijk C. **Progressive taxes, equity, and human capital accumulation in an endogenous growth model with overlapping generations.** *Journal of Public Economics.* 1997; 64:153-179.

Caucutt EM, Imrohoroglu S, Kumar KB. **Does the Progressivity of Income Tax Matter for Human Capital and Growth?** *Journal of Public Economic Theory.* 2006; 8(1): 95-118

Dupor B, Lochner L, Taber C, Wittekind MB. **Some effects of taxes on schooling and training.** *Am Econ Rev.* 1996; 86(2):340-346.

Eaton, J. and Rosen, H. **Taxation, Human Capital, and Uncertainty.** *The American economic review.* 1980; 70(4):705.

Etcheverria CA, Iza A. **Income Taxation and Finite Horizons in a Human Capital Model.** *Int Tax Public Finance.* 2000; 7: 665-689

Gomez MA. **Welfare-maximizing tax structure in a model with human capital.** *Economics Letters.* 2000; 68: 95-99.

Judd KL. **Taxes, uncertainty, and human capital.** *Am Econ Rev.* 1998; 88(2):289-292.

Judd KL. **Optimal taxation and spending in general competitive growth models.** *Journal of Public Economics.* 1999; 71: 1.26.

Konrad KA. **Privacy and time-consistent optimal labour income taxation.** *Journal of Public*

Economics. 2001; 79: 503-520.

Konrad KA, Spadaro A. **Education, Redistributive Taxation and Confidence.** Institute for the Study of Labour (IZA). 2005; Discussion Paper 1478.

Lin SG. **Labor income taxation and human capital accumulation.** Journal of Public Economics. 1998; 68(2):291-302.

Nerlove M, Razin A, Sadka E. **Investment in Human and Nonhuman Capital, Transfers Among Siblings, and the Role of Government.** Econometrica. 1984; 52(5): 1191-1198.

Nerlove M, Razin A, Sadka E, Weizsacker, RK. **Comprehensive income taxation, investments in human and physical capital, and productivity.** Journal of Public Economics. 1993; 50:397-406.

Poutvaara P. **Education, mobility of labour and tax competition.** Int Tax Public Finance. 2000; 7(6):699-719.

Poutvaara P. **Alternative tax constitutions and risky education in a federation.** Regional Science and Urban Economics. 2001; 31(2-3):355-377.

Poutvaara P, Kannianen V. **Why invest in your neighbour? social contract on educational investment.** Int Tax Public Finance. 2000; 7(4-5):547-562.

Sgontz LG. **Does the income-tax favour human-capital.** National Tax Journal. 1982; 35(1):99-104.

Taber C. **Tax Reform and Human Capital Accumulation: Evidence from an Empirical General Equilibrium Model of Skill Formation.** Advances in Economic Analysis & Policy. 2002; 2(1): Article 3, 1-33.

Trostel PA. **The effect of taxation on human-capital.** Journal of Political Economy. 1993; 101(2):327-350.

Varian HR. **Redistributive taxation as social insurance.** Journal of Public Economics. 1980;
14:49-68.