Increasing the Capital Income Tax Leads to Faster Growth*

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Abstract

This paper shows that under rather mild conditions, higher capital income taxes lead to faster growth in an overlapping generations economy with endogenous growth. Government expenditures are financed with labor income taxes as well as capital income taxes. Since capital income accrues to the old, taxing it reliefs the tax burden on the young and leaves them with more income out of which to save. We argue that savings are sufficiently interest inelastic so that higher savings and therefore higher growth result. The basic argument is not seriously challenged by a grandfather clause for initial capital or by the old receiving some labor income as well.

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1 Introduction

Most economists, when asked about their deep beliefs, would probably agree that a low or zero capital income tax is desirable, at least for efficiency reasons, see e.g. Chamley (1986) or Lucas (1990). An often-heard argument runs that a low capital income tax increases the private return to capital, thus encouraging investment and growth[1].

However, this is not necessarily so. This argument implicitely assumes that the capital income tax can be lowered costlessly. A government, however, is faced with tradeoffs: lower capital income taxation means either lower government expenditures or higher debt financing or higher labor income taxes[2]. Keep the level of government expenditure and debt financing fixed for the sake of the argument. If we think of labor income being paid mostly to the young and capital income accruing mostly to the old, a lower capital income tax and thus a higher labor income tax means that the younger people in an economy are left with less income out of which to save and to buy the capital stock. If savings decisions are not too elastic with respect to long term interest rates, this will lead to lower savings and thereby to slower growth rather than faster growth. The issue becomes clearer when thinking about lump-sum taxes instead: if a given amount of revenue has to be raised, taxing the old rather than the young will lead to faster growth, since agents compensate for the tax shift through higher savings. With proportional taxes, the question simply is whether the substitution effect on savings through lower interest rates is enough to undo the growth effect of the tax-burden shift towards the old. We argue that measured savings elasticities are indeed low enough for the described effect to take place. We therefore claim that higher capital income taxation means faster growth. Note, that the effect on welfare will be ambiguous in general, since the intially old will always prefer less to more capital income taxation and the generations in the far distant future will always prefer faster growth: we therefore focus on the positive analysis only.

Growth is about the long term and thereby necessarily about the tradeoff between generations[3]. Thus, to demonstrate our claim, we will consider a fairly standard, deterministic overlapping generations model with endogenous growth, where the productivity-augmented labor input contains an externality term which relates to aggregate capital. We show the robustness of our claim to three possible objections. Related arguments have been brought

[1]There are also two arguments in favor of capital income taxation. The first stresses its progressivity and the tradeoff between some kind of "fair" income distribution and efficiency. The second argues, that it may be sensible to highly tax capital already in place, since it as a fixed factor, but tax capital little or not at all in the more distant future, see Jones, Manuelli and Rossi (1991). Obviously, the issue of time consistency is not trivial here, see Chari, Kehoe and Prescott (1989)

[2]This argument in turn, of course, ignores Laffer curve type effects, see Sargent (1987). The experience with Reagonomics indicates, however, that this may not be a worrisome issue to ignore.

[3]Unless, of course, one believes in infinitely lived dynasties linked by bequests, see Barro (1974), Kotlikoff and Summers (1979), Abel and Bernheim (1991) and the related literature.

forward by Feldstein (1978) in a two-period model, Auerbach (1979) in an overlapping generations economy with neoclassical growth and in particular Jones and Manuelli (1992), who also consider an overlapping generations economy with endogeneous growth. By using an externality-driven AK model[4] here rather than a concave production function as in the tax analysis in Jones and Manuelli, the growth effects are immediate rather than asymptotic and transfers to the young are not necessary for sustainable growth. In addition to their paper we show that reversing our claim often requires negative savings, see section 4.3. Thus we show that most reasonable specifications will result in the claimed effect. In contrast to Auerbach (1979), the endogeneous growth structure here simplifies as well as amplifies the analysis: heuristically, the economy is always in the first period of the transition phase to a new steady state of a comparable neoclassical growth model. Thus, the effect on the capital stock is greater and no intricate transitional dynamics need to be considered. The engine of growth has been chosen to be particularly simple in order to concentrate on the taxation issue at hand.

The assumption of finite lifetimes is crucial for our model and gives rise to the striking contrast with the infinite-horizon results. Bertola (1994) provides for an elegant comparison by analyzing the intermediate case of exponentially distributed lifetimes. He shows that our analysis can survive in such a model as well, provided for example, that labor supplied by an individual declines sufficiently quickly over its lifetime, i.e. that there is a need to save in order to provide for retirement.

The second section introduces the model. The third section demonstrates our claim for interest inelastic, logarithmic utilities. We then examine three possible objections against that claim in the forth section of the paper and argue that none of these objections is serious enough to undo our claim. The first objection concerns the potential effect of positively interest elastic savings. We argue, that savings decisions are sufficiently interest inelastic in the US economy for our effect to hold. The second objection raises the issue of a grandfather clause for initial capital. We show, that even then our claim holds, as long as the labor income tax is lowered only in those periods in which additional revenue from higher capital income taxes is created. The third objection asks whether possible labor income of the old could undo our result. We show, that the parameter ranges which reverse our claim are either extreme or fragile. We thus conclude in the fifth and final section, that a higher capital income tax leads indeed to faster growth.

2 The Model

A new generation of agents is born every period. Agents live two periods. There is no population growth and that there is one representative agent per generation. When young, the

[4] The term AK model refers to equation (3).

agent is endowed with $0 < \lambda \leq 1$ units of time and when old, his or her time endowment is $1 - \lambda$. There is one consumption good per period and an agent born in period t is assumed to enjoy consumption according to the utility function

$$u(c_{y,t}; c_{o,t+1}),$$

where $c_{y,t} \geq 0$ is the consumption when young and $c_{o,t+1} \geq 0$ is the consumption when old. We assume that u is homothetic and satisfies the usual list of conditions. In particular then, there is a continuously differentiable consumption rule $C(R)$ for $R > 0$, so that the utility function above, subject to the constraint

$$c_{y,t} + \frac{c_{o,t+1}}{R} \leq W,$$

is uniquely maximized at consumption

$$c_{y,t} = C(R)W$$

for any value of the endowment $W > 0$ in terms of consumption at date t and any (after-tax) return $R = 1 + r > 0$ (r is the after-tax interest rate). It is then easy to calculate savings as

$$S_t = S(R; \frac{W_y}{W})W = (1 - C(R))W_y - C(R)W_o/R, \tag{1}$$

where W_y is the value of the time endowment in consumption goods when young, W_o is the value of the time endowment in consumption goods when old and $W = W_y + W_o/R$ is the total endowment in terms of present consumption. The agents supply their time endowment inelastically as labor, so that the total labor supply per period is unity[5]. Below, it will turn out, that wages when young per unit of time are given by $w(K_t/\alpha)$ for some factors w and α, growing at some rate $g-1$ per period. We can then use the formulas above with $W_y = \lambda w K_t/\alpha$ and $W_o = g(1-\lambda)wK_t/\alpha$.

There are many competing firms in this economy. The production function for the individual firm i is given by

$$y_{i,t} = k_{i,t}^{\rho}(n_{i,t}\frac{K_t}{\alpha})^{1-\rho}, \tag{2}$$

where $k_{i,t}$ is the firm-specific capital, $n_{i,t}$ is the labor hired by that firm and $K_t = \sum k_{i,t}$ is the aggregate capital stock. The capital share is given by $0 < \rho < 1$. The labor input is augmented by the factor K_t/α, which generates a simple externality of the kind often used in theories of endogenous growth, see e.g. Romer (1986) or Grossman and Helpman (1991). Since all firms will have the same capital-labor ratio in equilibrium, dividends accruing to the holders

[5] We could assume a preference for leisure as well in the utility function. This would only strengthen our argument, since a lower labor income tax will mean less distortion in the labor market on top of simply leaving more income after taxes.

of all capital in firm i are given by $dk_{i,t} = \rho y_{i,t}$, whereas labor income paid to $n_{i,t}$ will equal $wn_{i,t} = (1-\rho)y_{i,t}$. Aggregating, we find that total production is given by

$$Y_t = aK_t, \tag{3}$$

where $a = \alpha^{\rho-1}$: a high value for a means a large spillover effect and thus higher output[6]. Dividends d per unit of capital are given by

$$d_t = \rho \frac{Y_t}{K_t} = \rho a, \tag{4}$$

independently of t. Wages per unit of time are likewise given by $(1-\rho)Y_t$, so that the wage rate w_t per efficiency unit of labor, $n_t = \alpha/K_t$, is given by

$$w_t = (1-\rho)\alpha^{\rho}, \tag{5}$$

which is again independent of t. We will therefore omit the time index for w_t and d_t below.

We assume that capital depreciates at some rate $0 \leq \delta \leq 1$ and that output each period can be split into private consumption C_t, government consumption H_t and investment X_t to capital:

$$C_t + H_t + X_t = Y_t. \tag{6}$$

The capital stock thus evolves according to

$$K_{t+1} = (1-\delta)K_t + X_t, \tag{7}$$

where we allow X_t to be negative for simplicity. The total value of a unit of old capital at the beginning of period t in terms of the present consumption good is now given by

$$v = d + (1-\delta) = \rho a + 1 - \delta. \tag{8}$$

Note that v is also the total return to a purchase of a unit of capital at t-1.

Finally, we introduce the government which has to finance a given stream of expenditures H_t. Rather than fixing the level of these expenditures beforehand irrespective of the growth rate, we assume that the government wants or needs to spend a certain fraction γ of total output each period[7]:

$$H_t = \gamma Y_t. \tag{9}$$

[6] Note that we normalized the aggregate labor supply N to equal unity. Without this normalization, we would have $a = (N/\alpha)^{1-\rho}$ and all calculations below still go through with the proper accounting for distinguishing individual from aggregate variables. The important point is that the constant a still is the aggregate output to aggregate physical capital ratio.

[7] One may imagine in some richer model, that government expenditures are another factor in producing final services and that for certain specifications of such a production function, it is optimal to keep the ratio of government services and/or government capital to private capital constant. As an example, it certainly makes sense that a richer country would want to build a better road system than a poorer country. In any case, our assumption seems to fit well with actual government behaviour, based on casual empiricism.

We allow there to be three sources of government revenue: capital income taxes, taxes on labor income and government debt.

Let $\tau_{K,0}$ be the capital income tax rate in the first period $t = 0$ and τ_K be the tax rate for all periods after that. The distinction between the first period and all other periods will be important later for discussing grandfather clauses. Let $\tau_{L,t}$ be the tax rate on labor income, which may depend on t. Below, we will restrict ourselves to equilibria, where we need to distinguish only between tax rates $\tau_{L,0}$ for $t = 0$ and $\tau_L \equiv \tau_{L,t}$ for all $t \geq 1$. For formal simplicity, capital income taxes are to be paid on the full amount of capital income, including the resale value of the capital and not just the capital gains[8] and we assume that all savings are financed out of after-tax labor income. Thus, there usually will be double-taxation of savings. This is simply a matter of accounting and notation[9]: it is irrelevant for the individual agent, whether his or her savings are taxed twice or simply once at the appropriate sum of the two rates and similarly, the capital income tax here can equivalently be rewritten as a (larger) tax on the net capital income only. All that matters for the individual is the tradeoff between consuming when young and consuming when old. With linear tax schedules, this tradeoff is constant and can be characterized by a relative price between the two relevant consumption goods, independently of the level of consumption.

Thus, the relevant relative price of the consumption good when young in terms of the consumption good when old is the private total return on capital or the after-tax interest factor on savings. It is given by

$$R = (1 - \tau_K)v = (1 - \tau_K)(\rho a + 1 - \delta) \tag{10}$$

and independent of t. The after-tax interest rate per period is $r = R - 1$.

Finally, let b be the ratio of new one-period government debt to output, which we assume to be constant for all periods. Depending on the parameters, this means that either some part of the debt is serviced and some part of the debt rolled over each period or that some new debt is issued each period. We assume that the government is not initially indebted, so that the total amount bY_0 can be used in period 0 to finance government expenditures. Payments on government debt are tax-free: this just simplifies government budget accounting, since the government would pay as well as receive any such tax. The interest rate paid on the government debt has to equal the after-tax interest rate $r = R - 1$ on capital.

Let

$$g_t = K_t/K_{t-1} = Y_t/Y_{t-1}$$

[8]We assume limited liability throughout. That means, that capital owners cannot be forced to pay more taxes than their capital income and likewise, workers cannot be forced to pay more taxes than their labor income. This puts some mild restrictions on γ

[9]Furthermore, even though actual tax codes seem to avoid double taxation, they are unsuccessful in doing so, since in practice, taxable capital gains are often mostly nominal gains due to inflation. Thus, our notation may not be far from describing tax practice.

be one plus the growth rate from period t-1 to period t. The government budget constraint then requires that

$$\gamma Y_0 = \tau_{K,0} v K_0 + \tau_{L,0} w K_0/\alpha + bY_0, \tag{11}$$

in period $t = 0$ and

$$\gamma Y_t = \tau_K v K_t + \tau_{L,t} w K_t/\alpha + \left(1 - \frac{R}{g_t}\right) bY_t \tag{12}$$

in all other periods $t \geq 1$. Dividing these constraints by the capital stock and solving for the labor income tax rates $\tau_{L,t}$ gives

$$\tau_{L,0} = \frac{\gamma}{1-\rho} - \frac{b}{1-\rho} - \frac{\rho a + 1 - \delta}{(1-\rho)a}\tau_{K,0}, \tag{13}$$

and

$$\tau_{L,t} = \frac{\gamma}{1-\rho} - \left(1 - \frac{R}{g_t}\right)\frac{b}{1-\rho} - \frac{\rho a + 1 - \delta}{(1-\rho)a}\tau_K. \tag{14}$$

These two equations express the labor income tax as a function of the chosen capital income tax rates $\tau_{K,0}$, τ_K, the debt-output ratio b and the growth rate g_t. These equations are the key to our argument: a raise in the capital income tax rate means a fall in the labor tax rate, since we keep the fraction of government expenditure γ unchanged. Note that in order for τ_L to be independent of the time-index t for $t \geq 1$, it needs to be the case that either the government chooses $b = 0$ or that the endogeneous growth rate $g_t - 1$ is independent of t.

Market clearing on the capital market requires

$$bY_t + K_{t+1} = S_t,$$

where S_t is aggregate savings from period t to period t+1. Replacing aggregate savings by the appropriate expression involving wages and the savings function, the capital market clearing condition divided by K_t can be rewritten as

$$ab + g_{t+1} = \frac{1-\tau_{L,t}}{\alpha} w \left((1 - C(R))\lambda - C(R)\frac{g_{t+1}}{R}(1-\lambda) \right). \tag{15}$$

Solving this equation for g_{t+1} and making use of $w/\alpha = a(1-\rho)$ yields

$$g_{t+1} = \frac{(1 - C(R))\lambda - \frac{b}{(1-\tau_{L,t})(1-\rho)}}{C(R)\frac{1-\lambda}{R} + \frac{1}{a(1-\tau_{L,t})(1-\rho)}}. \tag{16}$$

Once, $\tau_{K,0}$, τ_K and b are chosen, the after-tax interest factor on savings is given by equation (10). Thus, $\tau_{L,t}$ is determined by equation (13) for $t = 0$ or by equation (14) and g_{t-1} for $t \geq 1$. Given $\tau_{L,t}$, the next growth rate $g_{t+1} - 1$ is calculated via equation (16). Thus, solving the model means recursively determining labor tax rates and growth rates via equations (14) and (16). In particular, if $b = 0$, it follows that $g_t \equiv g$ for all $t \geq 2$ and $\tau_{L,t} \equiv \tau_L$ for all $t \geq 1$. Alternatively, if $\tau_{K,0}$, τ_K and b are chosen such that $\tau_{L,0} = \tau_{L,1}$, we have $g_t \equiv g$ for all $t \geq 1$ and $\tau_{L,t} \equiv \tau_L$ for all $t \geq 0$, i.e. all periods. These are the cases on which we will concentrate.

3 Higher Capital Income Taxes Mean Faster Growth: The Benchmark Case.

Consider in particular the debtless benchmark case, where $b = 0$, $\tau_K = \tau_{K,0}$ and where only the young earn labor income, i.e. where $\lambda = 1$. In that case, equations (13) and (14) both state

$$\tau_L = \frac{\gamma}{1-\rho} - \frac{\rho a + 1 - \delta}{(1-\rho)a}\tau_K, \tag{17}$$

and equation (16) simplifies to

$$g = a(1-\rho)(1-\tau_L)S(R;1). \tag{18}$$

The argument brought forward in the introduction can now formally be seen in equations (17), (10) and (18): a higher capital income tax rate leads to a lower after-tax return R and a lower labor income tax τ_L. If the decrease in the labor income tax overcompensates the possible decrease in the savings $S(R;1)$, then a higher growth rate results.

As an example, consider the case, where the utility function for consumption is given by

$$u(c_{y,t}; c_{o,t+1}) = \log(c_{y,t}) + \beta \log(c_{o,t+1}). \tag{19}$$

It is easy to see that the savings function $S(R;1)$ is constant:

$$S(R;1) = \frac{\beta}{1+\beta}.$$

In this case, the only effect of a higher capital income tax is to lower the labor tax rate τ_L, thereby unambiguously increasing the growth rate g according to (18). In fact, the growth-rate maximizing capital income tax rate in this environment is to tax away practically all income to capital and use it to subsidize rather than tax labor income.

Likewise, if the intertemporal elasticity of substitution is some constant $\sigma < 1$ (or, equivalently, the relative risk aversion is constant at $1/\sigma > 1$), resulting in the utility function

$$u(c_{y,t}; c_{o,t+1}) = \frac{c_{y,t}^{1-1/\sigma} - 1}{1 - 1/\sigma} + \beta \frac{c_{o,t+1}^{1-1/\sigma} - 1}{1 - 1/\sigma}, \tag{20}$$

it is easy to see that the savings function is given by $S(R;1) = x/(1+x)$, where $x = \beta^\sigma R^{\sigma-1}$. Now, $S(R;1)$ is decreasing in R, so that an increase in capital income taxation leads to an increase in growth even without the labor-income tradeoff, and certainly in our model as well. Let us summarize the results of these examples in the following proposition.

Proposition 1 *If the overall utility is characterized by a constant intertemporal elasticity of substitution of unity or lower, $\sigma \leq 1$, then a higher capital income tax rate will unambiguously result in a higher growth rate.*

It is interesting to note, that Hall (1988) has measured the intertemporal elasticity of substitution and concluded that its "value may even be zero and is probably not above .2", giving empirical credibility to the proposition above[10].

4 Three Possible Objections.

At least three objections may be raised against the result above. The first concerns the effect of positively interest elastic savings: perhaps, the log-utility case is not sufficiently robust and the effect may reverse for some reasonable intertemporal elasticity of substitution $\sigma > 1$, say. Secondly, the result may just come about, because we increase the tax rate on the capital stock owned by the initially old, a nondistortionary, but time-inconsistent tax. Is the result overturned with a grandfather clause for initial capital? Finally, the old too earn labor income in the "real world" but not in the benchmark case considered above - perhaps this will undo the argument.

We examine each of these objections below. We argue that none of them matters enough and that therefore a higher capital income tax means faster growth.

4.1 Objection 1: The Interest Elasticity of Savings is Positive

Consider again the benchmark no-debt case where $\tau_{K,0} = \tau_K$ and $b = 0$. In general, the direction of the marginal change in the growth rate due to a marginal change in the capital income tax at a particular equilibrium will depend on the interest factor elasticity of savings

$$\eta(R) = \frac{\partial S(R;1)}{\partial R} \frac{R}{S(R;1)}$$

at the after-tax interest factor of that equilibrium. E.g., for the constant intertemporal elasticity of substitution utility function used above, we have

$$\eta(R) = \frac{\sigma - 1}{1 + \beta^\sigma R^{\sigma - 1}}. \tag{21}$$

Thus, for $\sigma \leq 1$, the elasticity is zero or negative, leading to the unambiguous result stated in the previous section. If the elasticity is positive, however, the relative strength of each effect - decreased savings due to a lower after-tax return or increased savings due to higher income when young - matters. The following result obtains.

[10] In contrast to our result, Buiter (1991) finds $\sigma \leq 0.04$ as the necessary condition for a higher capital income tax to increase growth and concludes, that this bound is too low to be satisfied. The reason for the difference to our analysis is that he considers a continuous-time overlapping generations model with exponentially distributed lifetime, and very different other assumptions: in his model, agents are essentially always young. An elegant reconciliation of his model with our model and further discussion is in Bertola (1994).

Proposition 2 *A marginally higher capital income tax leads to a marginally higher growth rate across equilibria if and only if the interest elasticity of savings is not too big:*

$$\eta(R) < \frac{R}{a(1-\rho)(1-\tau_L)}. \tag{22}$$

Observe, that the ratio on the right hand side of (22) equals

$$\frac{I_K}{I_L} = \frac{(1-\tau_K)vK_t}{(1-\tau_L)w(K_t/\alpha)},$$

which is simply the ratio of after-tax capital income to after-tax labor income in period t.

Proof:

Substituting (14) and (10) into (18), it follows in a straightforward manner, that $\partial g/\partial\tau_K > 0$ *holds if and only if*

$$\frac{S(R;1)}{(1-\rho)a} - (1-\tau_L)\frac{\partial S(R;1)}{\partial R} > 0.$$

Rewriting this inequality yields the result. •

In order to assess whether or not the claimed effect is relevant for actual economies, the theory has to become quantitative. For the purpose here, it should be enough to simply choose some rough numbers describing, say, the US economy to assess the importance of the proposition. It is important to keep in mind in this calibration exercise, that the model is about periods lasting half the life of a generation, for which we choose 30 years.

For ρ and τ_L, $\rho = .3$ and $\tau_L = .3$ may be reasonable choices, so that, roughly,

$$\eta(R) < 2R/a \tag{23}$$

is necessary and sufficient for the claimed effect. We now have to find values for R and a. We want to be somewhat conservative in these guesses, i.e. we should not overstate the interest factor R and should not understate the spillover parameter a. It is well known, that long term real rates are quite low, but positive, so that $R = 1$ is a good, conservatively low choice[11]. The most difficult parameter to calibrate is the parameter a. Christiano (1988) has found, that $K/Y = 10.59$ or $Y/K = 0.0944$ on a quarterly basis. To translate that into a value for the parameter a on a 30 year or 120 quarter basis as required by equation (3), the latter number needs to be multiplied with 120, resulting in 11.33. To have a round number, we use $a = 12$.

Thus, if the elasticity of savings over long horizons like 30 years with respect to the after-tax interest factor R over the same horizon is less than $1/6$, a higher capital income tax on these savings should lead to faster growth. E.g., for the constant intertemporal elasticity of

[11]Our argument is only strengthened by considering e.g. a yearly real after-tax interest rate of 1% rather than 0%. The compounded 30-year interest factor R then computes to $R = 1.35$ rather than $R = 1$, which makes quite a difference for the right hand side of (23) in favour of our argument.

substitution utility functions used for the benchmark example, this inequality translates into $\sigma < 1.333$ (or $1/\sigma > .75$ for the coefficient of relative risk aversion) at $\beta = 1$, $R = 1$ via equation (21). In order to state the required elasticity $\eta(R) < 1/6$ more intuitively, it is a good idea to annualize it: the elasticity $\eta_1(R_1)$ of "retirement" savings with respect to the yearly after-tax interest factor $R_1 = R^{1/30}$ on these savings must be less than 5 in order to get the claimed effect. In other words, suppose the yearly interest rate on savings for retirement or long-term purposes rises from 0% to 1%. As long as that doesn't raise these savings by 5% or more, taxing these savings more will lead to faster growth as claimed.

Most of the empirical work states savings elasticities $\epsilon(r_1)$ with respect to the yearly interest rate $r_1 = R_1 - 1$ rather than the elasticity $\eta_1(R_1)$ with respect to the yearly interest factor R_1. For some fixed $r_1 = R_1 - 1$, these elasticities translate into each other via

$$\epsilon(r_1) = \eta_1(R_1)\frac{r_1}{R_1}, \tag{24}$$

so that for $r_1 = .04$, say, an interest factor elasticity of 5 corresponds to an interest rate elasticity of about 0.2. Translating estimated elasticities is more problematic due to the stochastic nature of interest rates and since real yearly interest rates are notoriously low.

Empirical estimates for the interest rate elasticity range from negative, insignificant or trivially small (see e.g. Blinder (1975), (1981), Blinder and Deaton (1985), Bosworth and Burtless (1992, Hall (1988) and Skinner and Feenberg (1990)) to quite large: Boskin (1978) found the elasticity to be around 0.4 (which Summers (1981) even considers to be low on theoretical grounds). Thus, while the empirical evidence may not be as clear cut as one may desire it to be, the authors personally side with the majority of the empirical evidence pointing to low savings interest rate elasticities and conclude that this first objection of positively interest elastic savings is not a strong one.

4.2 Objection 2: Grandfather Clauses

The second objection one may raise is that the capital owned by the initial old is taxed in the equilibria considered above. Since that capital is a fixed factor, taxing it is not distortionary and thus desirable from the point of view of efficiency. It thus may not surprise some readers that increasing the tax rate on the initial capital stock can lead to faster growth and one may think that our result hinges on that (compare also to Auerbach and Kotlikoff (1983), the discussion of their paper by Stiglitz (1983 and the time-consistency issues raised in Chari, Kehoe and Prescott (1989)). After all, taxing capital rather than labor means taxing the old rather than the young, which means a shift in the timing of government revenue receipts. If the government had to "grandfather in" rather than taxing the initial capital, it may need to issue debt in order to finance the same expenditure with a tax revenue stream shifted to the future. The higher savings of the young will then be channelled into government debt rather than capital and the overall effect may then be a decrease rather than an increase in the growth rate[12].

This argument can indeed be verified within our framework for the benchmark log-utility case:

Proposition 3 *If the overall utility is given as a discounted sum of logarithmic utility functions of consumption in each period of life (see equation (19)), if only the young earn labor income, if the initial capital income tax $\tau_{K,0}$ remains fixed and if the same labor income tax $\tau_{L,0} = \tau_{L,t} \equiv \tau_L$ is chosen in all periods, then a higher capital income tax rate τ_K will unambiguously result in a lower rather than a higher growth rate.*

Proof: *Equation (16) implies that the constant growth rate g is given by*

$$g = a(1-\rho)(1-\tau_L)\frac{\beta}{1+\beta} - ab, \tag{25}$$

where τ_L is given from equation (14) by

$$\tau_L = \frac{\gamma}{1-\rho} - \left(1 - \frac{R}{g}\right)\frac{b}{1-\rho} - \frac{\rho a + 1 - \delta}{(1-\rho)a}\tau_K, \tag{26}$$

and the debt level b is calculated via (13) as

$$b = \gamma - \tau_L(1-\rho) - \frac{\rho a + 1 - \delta}{a}\tau_{K,0}. \tag{27}$$

Substituting (27) into (25) yields

$$g = \frac{-a}{1+\beta}(1-\rho)(1-\tau_L) + a(1-\rho-\gamma) - (\rho a + 1 - \delta)\tau_{K,0} \tag{28}$$

and thus

$$\frac{dg}{d\tau_L} < 0$$

rather than $dg/d\tau_L > 0$ as before. Similarly , substituting (27) into (26) yields, as usual,

$$d\tau_L/d\tau_K < 0.$$

Taking these two inequalities together delivers the claim. •

Debt lowers growth rates even if it can be rolled over forever[13]. However, it is not necessary to issue debt. Alternatively, consider not lowering the labor income tax on the first young

[12]This effect does not depend on whether savings are before taxes rather than after taxes, if the accounting is done right, since the deferral of the payment of the taxes can be compensated for equivalently with debt equal to the deferred taxes. I.e. before-taxes savings are increased by an amount which simply equals the discounted deferred tax payments.

[13]The argument is similar to the discussion of bubbles in overlapping generations models with endogeneous growth in Yanagawa and Grossman (1993)

generation, but only lowering the labor income tax from the second period onwards, in which the government receives higher capital income taxes as well. The government does not "cheat" here, since the change in the tax plan is known beforehand to any generation which will be affected by it[14]. In contrast to the proposition above and in accordance to our general claim that increasing the capital income tax leads to faster growth, we have

Proposition 4 *If the overall utility is given as a discounted sum of logarithmic utility functions of consumption in each period of life (see equation (19)), if only the young earn labor income, if the initial capital income tax $\tau_{K,0}$ and the initial labor income tax $\tau_{L,0}$ remains fixed and if there is no debt ($b = 0$), then a higher capital income tax rate τ_K will unambiguously result in a higher growth rate g_t from period $t \geq 2$ onwards.*

Proof: *This is a direct consequence of $S(R; 1) = \beta/(1 + \beta)$ and equation (18), which yields the growth rate $g - 1 = g_t - 1$ for $t \geq 2$.* •

We therefore conclude that this objection is not a serious one either. The analysis shows, however, that it is important to raise initial revenue via labor income taxes rather than debt in endogeneous growth frameworks like ours, if one is concerned about time-consistency issues and high growth at the same time.

4.3 Objection 3: The Old Work Too

Finally, let us relax the condition that it is only the young who receive labor income (cmp. Summers (1981)). Consider again the logarithmic example, where the utility function is given by (19). Unfortunately general results look rather messy. Consider the case, where the issue is whether to marginally tax capital income or to marginally subsidize capital income. We have the following result.

Proposition 5 *Suppose, the utility function is given by equation (19) and $b = 0$. Consider the equilibrium, where $\tau_K = 0$. A marginal increase in the capital income tax rate will marginally increase the growth rate if and only if*

$$\frac{1}{1+\beta}\frac{1-\lambda}{R}I_L < \frac{I_K}{I_L}, \tag{29}$$

where $I_L = (1 - \rho)a - a\gamma$ is the after-tax labor income per unit of capital (or the after-tax labor share) and where $I_K = R = \rho a + 1 - \delta$ is the after-tax capital income per unit of capital. Thus, the inequality (29) compares the presently consumed fraction of future, discounted labor income (when capital is normalized to one unit) with the ratio of capital income to labor income after taxes: as long as that fraction is not too high, a higher capital income tax will still lead to faster growth.

[14] Note that there is no change in the resale value of the initial capital stock due to a changed saving behaviour by the first young generation according to equation (8)

Proof: *Note, that $C(R) = 1/(1+\beta)$ is constant. Substituting equations (14) and (10) into equation (16) and some algebra reveals, that $\partial g/\partial \tau_K > 0$ if and only if*

$$\frac{1}{\frac{I_L}{I_K} + \tau_K} + \frac{C(R)(1-\lambda)}{1-\tau_K}$$

has a negative derivative with respect to τ_K. It is easy to see that this is the case at $\tau_K = 0$ if and only if

$$C(R)(1-\lambda)\frac{I_L}{I_K} < \frac{I_K}{I_L}.$$

Rewriting this yields the result. •

To evaluate the issue more directly, consider the following two tables. Each entry in these tables lists firstly the derivative $dg/d\tau_K$ and secondly the savings rate $S(R;\lambda)$ as given in equation (1). We chose log-utilities. For the parameters in our model we chose $a = 12$, $\rho = .3$, $\gamma = .2$, $\delta = .3$. For the first table we chose $\beta = 1$, whereas we chose $\beta = .5$ for the second table to evaluate the effect of a change in the discount factor. We varied both the parameter λ and the parameter τ_K in each table. Note that the parameter λ here corresponds closely to the redistribution parameter η in Jones and Manuelli (1992), section 2, since in their model wage income is negligible asymptotically. The parameter τ_K implies a value for τ_L via equation (14), which is given as well.

When interpreting these tables one needs to keep in mind that the savings rate $S(R,\lambda)$ as given by equation (1) are the savings of the young as a fraction of their wealth, while net savings of the entire economy are found after subtracting the dissaving by the old. Thus, even high values of S in these tables can be consistent with observed low savings rates. Furthermore, negative savings rates S are incompatible with equilibrium, although they can be calculated formally: they should therefore be read as indicating non existence of a steady state.

Table 1

$\beta = 1.0$	$\tau_K =$	-10 %	0 %	10 %	20 %	30 %
λ	$\tau_L =$	41 %	36 %	31 %	25 %	20 %
1.0	$dg/d\tau_K =$	2.15	2.15	2.15	2.15	2.15
	$S =$	0.5	0.5	0.5	0.5	0.5
0.8	$dg/d\tau_K =$	1.25	1.14	1.00	0.82	0.58
	$S =$	0.38	0.38	0.37	0.37	0.37
0.6	$dg/d\tau_K =$	0.69	0.56	0.42	0.23	0.01
	$S =$	0.14	0.13	0.12	0.11	0.10
0.4	$dg/d\tau_K =$	0.33	0.24	0.13	0.00	-0.15
	$S =$	0.14	0.13	0.12	0.11	0.10
0.2	$dg/d\tau_K =$	0.12	0.07	0.02	-0.05	-0.12
	$S =$	0.015	0.01	-0.00	-0.02	-0.03
0.0	$dg/d\tau_K =$	0	0	0	0	0
	$S =$	-0.11	-0.12	-0.13	-0.15	-0.17

Table 2

$\beta = 0.5$	$\tau_K =$	-10 %	0 %	10 %	20 %	30 %
λ	$\tau_L =$	41 %	36 %	31 %	25 %	20 %
1.0	$dg/d\tau_K =$	1.43	1.43	1.43	1.43	1.43
	$S =$	0.33	0.33	0.33	0.33	0.33
0.8	$dg/d\tau_K =$	0.75	0.66	0.55	0.41	0.23
	$S =$	0.24	0.24	0.23	0.23	0.22
0.6	$dg/d\tau_K =$	0.37	0.28	0.17	0.05	-0.11
	$S =$	0.14	0.14	0.13	0.12	0.11
0.4	$dg/d\tau_K =$	0.16	0.09	0.02	-0.06	-0.16
	$S =$	0.05	0.04	0.03	0.02	0.00
0.2	$dg/d\tau_K =$	0.05	0.02	-0.02	-0.06	-0.10
	$S =$	-0.05	-0.06	-0.07	-0.09	-0.11
0.0	$dg/d\tau_K =$	0	0	0	0	0
	$S =$	-0.14	-0.16	-0.17	-0.19	-0.22

It is possible to find parameter combinations in these tables that look reasonable and produce a decrease in the growth rate due to an increase in the capital income tax, while at the same time keeping a positive savings rate for the young. For example, for $\beta = 1.0$, $\lambda = .4$ and $\tau_K = .3$, the derivative has the value -0.15, while the savings rate for the young is equal to 0.10. It is important to note, however, that the parameter ranges for which this occurs are somewhat extreme in that they require either a rather high capital-income tax to begin with[15] or a rather low fraction λ of earned income when young. More importantly, perhaps, these ranges are also rather fragile in the sense that savings rates are extremely low and more often negative rather than positive for those table entries, where the derivative of the growth rate with respect to the capital income tax rate is negative.

We therefore conclude that while this objection may be the most serious of the three, the more robust result here is still the initial claim that a higher capital income tax will lead to faster growth.

5 Conclusion

We have shown that a higher capital income tax rate means faster growth in two-period overlapping generations model with endogenous growth, where government expenditures are a fixed fraction of total GNP. In this model, a higher capital income tax means a lower labor income tax, which leaves the presently young with more net income out of which to save. This in turn leads to faster growth.

We examined three objections against this argument and argue that none of these objections is serious enough. Firstly, while the effect may go the other way with sufficiently interest-elastic savings, we argue that long term savings in the US are not elastic enough for the reversal. Secondly, even if initial capital is grandfathered in, our claimed effect holds, as long as the labor income tax is lowered only in those periods in which additional revenue is generated from higher capital income taxation, i.e. as long as lowered labor income taxes are not deficit-financed. Thirdly, while our effect can be undone, if the old earn labor income too and while it is true, that reasonable parameter values can deliver this, the range of parameters for which a reversal of our effect happens is quite fragile.

We therefore conclude that a higher capital income tax leads to faster growth. We are confident that the results can be generated also in richer models similar to those in Auerbach and Kotlikoff (1987), where the members of each generation live longer than just one period. What is apparently needed for our effect is that an increase in capital income taxation constitutes a shift in the tax burden to the relatively older agents. That this is so in practice can be seen from the calculations performed by Auerbach, Gokhale and Kotlikoff (1991).

[15]Remember that τ_K is the tax on the total capital income and that savings are out of after-tax labor income.

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