Consumption and Income Taxation

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CONSUMPTION AND INCOME TAXATION[1]

By MARTIN BROWNING *and* JOHN BURBIDGE

1. Introduction

THE CONTEMPORARY preoccupation with the optimality of consumption over income taxation dwells uneasily alongside the ambiguities in the older optimal tax literature.[2] In effect, the recent tax literature has turned the optimal tax problem into one of optimal debt policy with very special assumptions about life-cycle consumption and saving patterns; this has progressed to the point where one can no longer take a position on tax reform without simultaneously adopting a position on whether the U.S. economy saves too little or too much.[3] Burbidge (1989) demonstrates the sensitivity of the macroeconomic, efficiency case for consumption over wage taxation to its particular life-cycle assumptions. In the present paper, we argue that, even in a *microeconomic* setting, it is far from clear that consumption taxation dominates income taxation.

Driffill and Rosen (1983) adapted Heckman's (1976) human capital model to argue that the much greater deadweight loss of income as opposed to consumption taxation stems not so much from the distortion of the static labour-leisure choice but rather from the dynamic distortions of the human capital decision caused by the taxation of interest income. Hamilton (1987) showed that the introduction of wage uncertainty into a model with human capital may make wage (not income) taxation superior to consumption taxation because wage taxation provides better social insurance against the possibility of obtaining a bad draw from the wage distribution. And Hubbard and Judd (1986) demonstrated the fragility of the case for consumption taxation to the presence of liquidity constraints, but their general-equilibrium model, of course, intertwines debt policy questions with microeconomic-efficiency ones.[4]

In the next section, we lay out a microeconomic model of a single individual from whom the government must raise given revenue—this to emphasize that our results are nothing to do with macroeconomic issues,

[1] This paper was written while the first author was on sabbatical at Stanford University and the second author was on sabbatical at University College London and the Institute for Fiscal Studies; we are grateful to both these institutions, and to the University of Essex, for their generous hospitality. We also thank Jim Davies, Mike Veall, Guglielmo Weber, Peter Sinclair, two anonymous referees and participants in seminars at the IFS and the University of Salford, Trent University and the University of Western Ontario for helpful comments, and the Social Sciences and Humanities Research Council of Canada for financial support.

[2] Contrast the guarded assessment of the relative merits of consumption and income taxation in Atkinson and Stiglitz (1980, pp. 564–565), who were summarizing the results of the older optimal taxation literature, with the much stronger statements in favour of consumption taxation in Summers (1981), Auerbach, Kotlikoff and Skinner (1983) and Auerbach and Kotlikoff (1987a,b).

[3] See the comments of Hall and Summers on Hubbard and Judd (1986).

[4] Hubbard and Judd (1987) argue against the payroll-tax financing of social security in the context of a model with uncertain lifetimes and liquidity constraints.

such as debt policy. On the assumption that the government must choose between a proportional interest income tax and a proportional consumption tax, we examine optimal tax policy with and without a liquidity constraint. Section 3 repeats the exercise with human capital in the model and demonstrates, under quite general assumptions, how delicate the case for consumption taxation is, even on what is arguably its strongest ground. Next, we conduct simulations to illustrate situations in which it is optimal to tax both consumption and interest income; we also show how dependent optimal tax patterns may be on the intertemporal elasticity of substitution. Section 5 comprises a summary and some conclusions.

2. A basic model

Assume that the individual's lifetime is T years and let c and e be T-dimensional column vectors of consumption and earnings. We abstract from initial assets and a bequest motive so that proportional wage and consumption taxes are equivalent.[5] We also assume fixed labour supply and nominal prices. The choice between consumption and income taxation in this model is equivalent to choosing between an interest income tax, θ, and a consumption tax, λ. Let

$$m(\theta) = \left[1, \frac{1}{1 + r(1-\theta)}, \ldots, \frac{1}{[1 + r(1-\theta)]^{T-1}}\right], \tag{2.1}$$

where r is the (real or nominal) interest rate and $m(\theta)$ is the row vector of discounted prices. The individual's lifetime budget constraint is:

$$m(\theta) \cdot \{e - (1+\lambda)c\} = 0, \tag{2.2}$$

where "$\cdot$" stands for matrix multiplication. Indirect utility may be written as a function of the two tax rates:

$$V(\lambda, \theta) = \underset{c,\mu}{\text{Max}}\, u(c) + \mu[m(\theta) \cdot \{e - (1+\lambda)c\}], \tag{2.3}$$

where $u(c)$ is the individual's lifetime utility function and μ is the marginal utility of money.[6] Let c^0 be purchased in the presence of λ and θ. Since the government eventually obtains any resources not consumed by the individual and the government discounts future revenues at r, the present

[5] Some earlier readers of this paper, who were familiar with the work of Hubbard and Judd, argued that wage and consumption taxes are not equivalent with liquidity constraints. It is straightforward to show that this is false. In partial-equilibrium models, proportional, equal-yield wage and consumption taxes have identical effects on consumption plans and welfare, with or without variable labour supply, and with or without liquidity constraints. In fact, for the particular liquidity constrained model set out below, one can replace the word "proportional" with "linear-progressive".

[6] It is customary to write the indirect utility function as follows.

$$V^*(\lambda, \theta) = \underset{c}{\text{Max}}\, u(c), \text{ such that } m(\theta) \cdot e = (1+\lambda)m(\theta) \cdot c$$

We note that V, as defined in (2.3), is the same as V^*.

value of tax revenue, R, can be written as:

$$R(\lambda, \theta) = m(0) \cdot \{e - c^0\}. \tag{2.4}$$

The government's objective is to choose λ and θ to maximize V, given some revenue requirement, R^0.

Although it is well known that, if there is no labour-leisure choice, a proportional consumption tax is equivalent to a lump-sum tax and that the optimal level of the interest income tax could never be different from zero, a review of the argument will set the stage for understanding the implications of more complicated models. Consider a diagram in the two tax rates.[7] Assume that the utility and government revenue functions are sufficiently well-behaved that points of tangency between indifferences and iso-revenue curves represent optima. Define Z^λ to be $-(\partial R/\partial\lambda)/(\partial V/\partial\lambda)$, which is the extra revenue obtained per unit loss in utility for the consumption tax, λ; define Z^θ analogously. Using equations (2.3) and (2.4) one can show that:

$$Z^\lambda = \frac{-m(0) \cdot \partial c/\partial\lambda}{\mu m(\theta) \cdot c} \tag{2.5}$$

and that:

$$Z^\theta = \frac{-m(0) \cdot \partial c/\partial\theta}{\mu m'(\theta) \cdot \{(1+\lambda)c - e\}}. \tag{2.6}$$

Differentiating the budget constraint (2.2) with respect to λ and θ and setting θ equal to zero, one obtains:

$$-m(0) \cdot \frac{\partial c}{\partial\lambda} = \frac{m(0) \cdot c}{1+\lambda} \tag{2.7}$$

and

$$-m(0) \cdot \frac{\partial c}{\partial\theta} = \frac{m'(0) \cdot \{(1+\lambda)c - e\}}{(1+\lambda)}, \tag{2.8}$$

for any level of λ. Substituting (2.7) into (2.5) and (2.8) into (2.6), we see that at θ equals zero:

$$Z^\lambda = Z^\theta = \frac{1}{\mu(1+\lambda)} \equiv Z. \tag{2.9}$$

These equations imply that here the consumption tax alone is optimal, and, as noted above, it is also nondistortionary; Z equals the inverse of the individual's marginal utility of money. Graphically, the locus of tangencies between indifference curves and iso-revenue curves (the "efficiency" locus), is the λ-axis ($\theta = 0$) in Fig. 1. At point E, for example, AEC is the indifference curve and curves representing higher levels of utility would lie

[7] One advantage of using diagrams is that second-order conditions can be readily verified for the particular numerical examples studied.

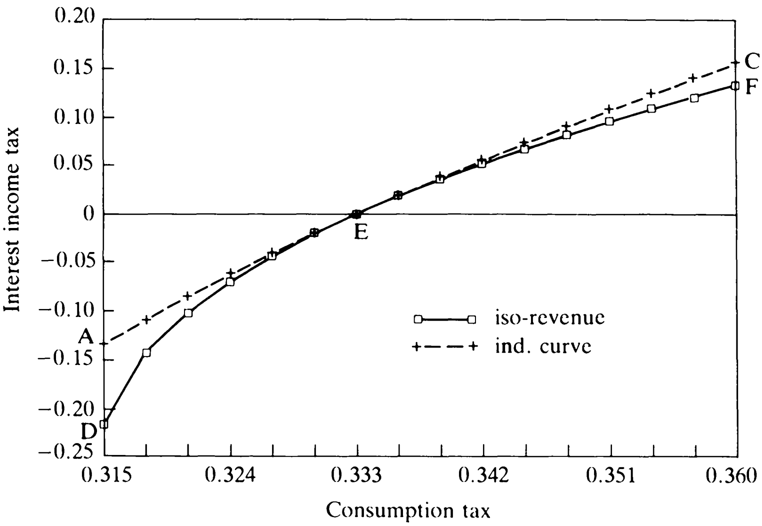

FIG. 1

north–west of E; DEF is the iso-revenue curve with higher revenue obtained as one moves south-east of E.[8,9]

Hubbard and Judd (1986) demonstrated that substituting interest income taxes for consumption taxes in the presence of liquidity constraints can raise welfare. Although their analysis is couched in macroeconomic-debt-policy terms, the argument is essentially a microeconomic one, as the comments of Hall and Summers make clear. For the sake of completeness and to clarify what occurs in more complex models, we present a formal analysis of liquidity constraints in this setting.

Suppose the individual's desired consumption exceeds income in period 1. The budget constraint, equation (2.2), is replaced by (2.10) and (2.11).

$$e_1 - (1+\lambda)c_1 = 0 \tag{2.10}$$

$$n(\theta) \cdot \{\hat{e} - (1+\lambda)\hat{c}\} = 0 \tag{2.11}$$

The subscripts denote particular elements of vectors, $\hat{e}$ and $\hat{c}$ are $(T-1)$-dimensional for periods 2 to T, and $n(\theta)$ is $m(\theta)$ without the first element. The indirect utility function can be written as:

$$V(\lambda, \theta) = \underset{c, \mu_1, \mu_2}{\text{Max}}\ u(c_1, \hat{c}) + \mu_1[e_1 - (1+\lambda)c_1] + \mu_2[n(\theta) \cdot \{\hat{e} - (1+\lambda)\hat{c}\}] \tag{2.12}$$

[8] It is clear from the positions of the curves that the second-order conditions are met at their tangencies.

[9] One might expect that "normally" both these curves would be downward-sloping. The reason they are not is that, in the particular example upon which they rest (which will be discussed at length in Section 4), the young are net borrowers and thus the interest income tax is actually a subsidy.

and the present value of government revenue is:

$$R(\lambda, \theta) = m(0) \cdot \{e - c\} = \lambda c_1 + n(0) \cdot \{\hat{e} - \hat{c}\}. \tag{2.13}$$

It is straightforward to show that:

$$Z^{\lambda} = \frac{c_1/(1+\lambda) - n(0) \cdot \partial\hat{c}/\partial\lambda}{\mu_1 c_1 + \mu_2 n(\theta) \cdot \hat{c}} \tag{2.14}$$

and that:

$$Z^{\theta} = \frac{-n(0) \cdot \partial\hat{c}/\partial\theta}{\mu_2 n'(\theta) \cdot \{(1+\lambda)\hat{c} - \hat{e}\}}. \tag{2.15}$$

Differentiating (2.10) and (2.11) and setting θ equal to zero, we obtain:

$$Z^{\lambda} = \frac{c_1 + n(0) \cdot \hat{c}}{(1+\lambda)\{\mu_1 c_1 + \mu_2 n(0) \cdot \hat{c}\}} \tag{2.16}$$

and

$$Z^{\theta} = \frac{1}{\mu_2(1+\lambda)}. \tag{2.17}$$

Equations (2.16) and (2.17) hold for any level of λ. Our assumption that the person is liquidity constrained only in the first period means that the marginal utility of money in period 1, μ_1, exceeds that for all subsequent periods, μ_2, and thus, at θ equals zero, $Z^{\theta} > Z^{\lambda}$. In other words, at any level of the consumption tax, a first-order welfare improvement can be gained by making the interest income tax positive; so long as the person is liquidity constrained, the efficiency locus never crosses the horizontal axis.[10]

What accounts for this turnabout in conclusions? The answer is that supplementing a consumption tax with an interest income tax here shifts lifetime wealth into period 1 thereby generating a first-order welfare improvement; the welfare losses arising from the distortions induced by θ to $\hat{c}$ are of secondary importance when θ is small. As R increases, the distortionary effects of the interest income tax become relatively more important and increases in revenue needs are met primarily by increaeses in the consumption tax.[11] In the next section, we introduce a human capital choice into the model.

3. The model with human capital

We assume that human capital can be acquired only in the first period; let s be the fraction of this period spent accumulating human capital and $(1-s)$ be the time spent at work. e_1 would be the person's earnings if s were equal to zero. The budget constraint can now be written as:

$$(1-s)e_1 + n(\theta) \cdot \hat{e}(s) - (1+\lambda)m(\theta) \cdot c = 0, \tag{3.1}$$

where $\hat{e}(s)$ is the earnings vector for given s; assume each element is

[10] See the discussion of Fig. 2 and Table 3 in Section 4.

[11] Again, this point is discussed at greater length in Section 4.

positively sloped and concave in s. The first-order condition for s is:

$$n(\theta) \cdot \hat{e}'(s) = e_1, \tag{3.2}$$

from which it follows that:

$$\frac{ds}{d\lambda} = 0 \tag{3.3}$$

and that

$$\frac{ds}{d\theta} = -\frac{n'(\theta) \cdot \hat{e}'(s)}{n(\theta) \cdot \hat{e}''(s)}. \tag{3.4}$$

Since n and $\hat{e}$ are strictly increasing and $\hat{e}(s)$ is also concave, $ds/d\theta$ must be positive. This is the Heckman (1976) and Driffill and Rosen (1983) result that, with certain lifetimes and perfect capital markets, (interest) income taxation encourages people to acquire too much human capital—a higher level of θ raises discounted prices, thereby increasing the benefits of education without affecting the costs (foregone earnings). As noted earlier, it is Driffill and Rosen's view that the distortion of the human-capital decision by the income tax dwarfs whatever other distortions this tax may cause to consumption or work effort.

In the model described above the individual could borrow (at $r(1-\theta)$, in fact), and for many sets of "realistic" parameters would want to borrow, to finance consumption while attending school in period 1. What happens if agents cannot borrow to acquire human capital? To take the simplest case, suppose the persion is "liquidity constrained" only in period 1 so that $(1-s)e_1$ equals $(1+\lambda)c_1$ and equation (2.11) holds. The indirect utility and revenue functions are equations (3.5) and (3.6):

$$V(\lambda, \theta) = \underset{\substack{c,s,\\ \mu_1,\mu_2}}{\text{Max}}\ u(c_1, \hat{c}) + \mu_1[(1-s)e_1 - (1+\lambda)c_1] + \mu_2[n(\theta) \cdot \{\hat{e} - (1+\lambda)\hat{c}\}] \tag{3.5}$$

$$R(\lambda, \theta) = m(0) \cdot \left\{\begin{bmatrix} (1-s)e_1 \\ \hat{e} \end{bmatrix} - c\right\} = \lambda c_1 + n(0) \cdot \{\hat{e} - \hat{c}\}. \tag{3.6}$$

The corresponding equations for Z^λ and Z^θ, evaluated at θ equals zero, are (3.7) and (3.8).

$$Z^\lambda = \frac{c_1 + n(0) \cdot \hat{c} + \lambda(ds/d\lambda)[n(0) \cdot \hat{e}'(s) - e_1]}{(1+\lambda)\{\mu_1 c_1 + \mu_2 n(0) \cdot \hat{c}\}} \tag{3.7}$$

$$Z^\theta = \frac{n'(0) \cdot \{\hat{e} - (1+\lambda)\hat{c}\} + \lambda(ds/d\theta)[n(0) \cdot \hat{e}'(s) - e_1]}{\mu_2(1+\lambda)n'(0) \cdot \{\hat{e} - (1+\lambda)\hat{c}\}} \tag{3.8}$$

It is now transparent that at λ equals zero, Z^θ exceeds Z^λ and thus the optimal θ will be positive in a neighbourhood of λ equals zero. This means that for low values of desired government revenue, it will be optimal to combine an interest income tax with consumption *subsidy*.[12] Further interpretation of these equations requires a better understanding of the behaviour of s. The first-order condition for s is:

$$n(\theta)\cdot\hat{e}'(s)=\frac{e_1\mu_1}{\mu_2}. \tag{3.9}$$

Comparing equations (3.2) and (3.9) and remembering that $\mu_1>\mu_2$, one can deduce the intuitively plausible result that being liquidity constrained in period 1 causes the person to acquire too little human capital, once again providing a striking contrast with the unconstrained result. This observation also implies that the term in square brackets in each numerator must be positive; if s were at its optimal level the Z's would be independent of $\mathrm{d}s/\mathrm{d}\lambda$ and $\mathrm{d}s/\mathrm{d}\theta$, whatever the level of λ.

4. A specific model with human capital

To say more one has to place some restrictions on the utility function u. For example, many assume that u is additively separable and, in particular , write u as:

$$u(c)=\sum_{i=1}^{T}\frac{p_i[c_i^{1-\gamma}-1]}{1-\gamma},\qquad \gamma>0, \tag{4.1}$$

where $\{p_i\}_{i=1}^{T+1}$ is a set of time-dependent discount factors (p_1 equals unity and p_{T+1} equals zero) and γ is the negative of the inverse of the intertemporal elasticity of substitution, σ. The right-hand side of (3.9) equals $e_1n_1(\theta)MRS_{c_1,c_2}$. With this utility function, MRS_{c_1,c_2} can be written as:

$$MRS_{c_1,c_2}=\frac{\left\{\dfrac{(1-s)e_1}{(1+\lambda)}\right\}^{-\gamma}}{\left\{\dfrac{f(\theta)}{(1+\lambda)}\right\}^{-\gamma}}=\left\{\frac{f(\theta)}{[(1-s)e_1]}\right\}^{\gamma} \tag{4.2}$$

and thus s is independent of λ and $\mathrm{d}s/\mathrm{d}\lambda$ equals zero. The sign of $\mathrm{d}s/\mathrm{d}\theta$ depends on γ and other parameters; we provide an example in which it is positive and another in which it is negative, below. For any given level of λ, so long as the absolute value of $\mathrm{d}s/\mathrm{d}\theta$ is small Z^{θ} must exceed Z^{λ} at θ equals zero and thus in the optimum tax configuration the interest income tax must be positive. Only if the absolute value $\mathrm{d}s/\mathrm{d}\theta$ is "large" and has the opposite sign to $n'(0)\cdot\{\hat{e}-(1+\lambda)\hat{c}\}$ could this result be overturned. We now present some simulations to illustrate possible optimal tax patterns when individuals are liquidity constrained.

Suppose that the individual's lifetime is 85 years and think of the period between ages 16 and 85 as comprising seven ten-year periods. Furthermore,

[12] See Table 3 below.

TABLE 1
Optimal taxes in a second-best setting

Period	*Consumption*	*Earnings / Pensions*	*Assets*
1	6,503	8,827	0
2	13,737	21,308	0
3	16,893	24,763	2,663
4	20,461	28,469	5,945
5	23,793	30,355	9,875
6	22,515	18,425	13,305
7	19,453	13,425	8,407
8	—	—	0

Ratio of MU of money in period 1 to period 2: 2.9384
$\frac{Z^{\lambda}}{\mu_2}$ and $\frac{Z^{\theta}}{\mu_2}$ are: 0.66284
s, θ and λ are: 0.11733 0.16168 0.35731
Revenue is: \$11,850 or $\frac{1}{4}$ of maximum lifetime resources
The percentage increase in wage rates required to raise the utility level here up to that attainable with no liquidity constraints is 12.64%.
Parameter values: $r = 5\%$ per annum and $\sigma = -\frac{1}{2}$.

assume that the individual works in periods two to five and is retired in periods six and seven. We used the data described and analyzed in Robb and Burbidge (1989) to estimate $\hat{e}(s)$.[13] The discount factors (p) are taken from the survival probabilities in the 1970–1972 Canadian male life tables (Statistics Canada (1974)), except that the numbers for periods 6 and 7 are reduced by 20% to induce the person to choose lower consumption in retirement.[14] We choose various values for the intertemporal elasticity of substitution, σ; initially, we report results for $\sigma = -\frac{1}{2}$, which is about the median estimate in the taxation literature.

The numerical simulations solve for the optimal levels of θ and λ, given a pre-determined level of desired tax revenue, R.[15] We measure R in terms of the present values of lifetime resources when there are no taxes; this number, which is \$47,400, depends only on the earnings function and the interest rate (5%). The optimal levels of all variables, when the present value of tax revenue is \$11,850 ($\frac{1}{4}$ of \$47,400), are shown in Table 1.[16] Note first of all that the optimal interest income tax rate is positive, $\theta = 0.16$. As we explained earlier, this occurs because, at $\theta = 0$, if the person is liquidity

[13] The Appendix gives a brief description of the procedures employed and the numbers actually used.
[14] This is a dominant characteristic of consumption-age profiles; see Hamermesh (1984) and Robb and Burbidge (1989). The latter show that the addition of a retirement decision to a standard life-cycle model can lead to discrete declines in consumption at retirement, if consumption and leisure are substitutes.
[15] Data manipulations were performed with GAUSS, version 1.49B, written by L. E. Edlefsen and S. D. Jones. Copies of the programs are available upon request.
[16] Assets are reported for the beginning of the period.

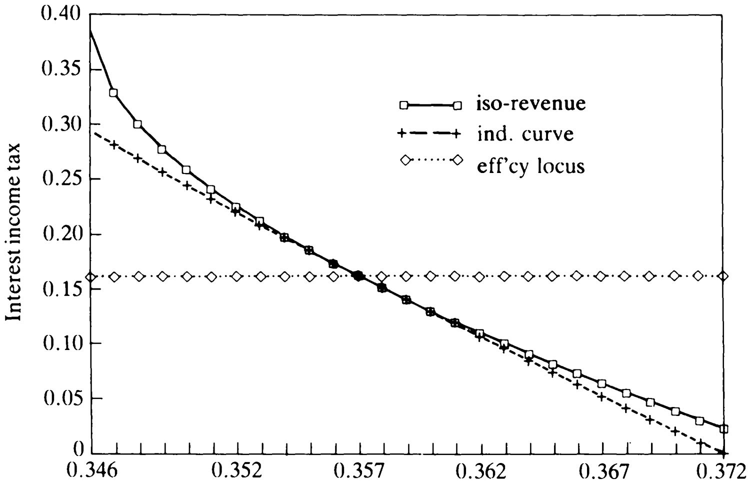

FIG. 2

constrained in the first period, the first-period marginal utility of money exceeds the discounted marginal utility of money for subsequent periods and therefore it is optimal to implement tax switches that shift purchasing power into periods when the marginal utility of money is high, that is, substitute θ for λ.

The optimum described in Table 1 is illustrated in Fig. 2. Both the indifference curve (shown with crosses) and the iso-revenue curve (boxes) are convex, with the latter being more convex than the former, so that their tangency does indeed pinpoint an optimum. The "efficiency" locus (shown with triangles), that is, points of tangency between indifference and iso-revenue curves, is very close to being a straight line, with a slight positive slope.

The setting depicted in Table 1 is a second-best one in the sense that the government is constrained to employ distortionary taxes to raise revenue; $1-(Z^i/\mu_2)$, $i=\lambda$, θ, which is about $\frac{1}{3}$ in Table 1, measures the marginal welfare cost of taxation. It is instructive to contrast the numbers in Table 1 with those for a setting in which capital markets are assumed to be perfect; now λ is nondistortionary and thus a first-best optimum can be attained. In Table 2, the government is raising the same revenue as in Table 1, but the individual is permitted to be in debt. Only λ is employed ($\theta=0$) and the person chooses to acquire much more human capital, to have a flatter consumption profile and to be in debt until period 5. This optimum is illustrated in Fig. 1. The extended interval of indebtedness implies that the present value of interest income tax revenue is actually negative—in effect, θ acts as a subsidy for borrowing, and, as a consequence, both the indifference and iso-revenue curves are upward sloping.

TABLE 2
Optimal taxes in a first-best setting

Period	*Consumption*	*Earnings/Pensions*	*Assets*
1	10,303	3,500	0
2	13,121	26,405	−10,238
3	16,674	32,723	−7,969
4	20,871	34,224	−2,649
5	25,081	40,040	2,028
6	24,526	23,062	9,943
7	21,899	18,062	6,755
8	—	—	0

Ratio of MU of money in period 1 to period 2: 1.00000
s, θ and λ are: 0.65003 0.0 0.33333
Revenue is: $11,850 or $\frac{1}{4}$ of maximum lifetime resources
Parameter values: $r = 5\%$ per annum and $\sigma = -\frac{1}{2}$.

The patterns of optimal second-best taxes, for various intertemporal elasticities of substitution, σ, are shown in Table 3. The smaller the absolute value of σ, the flatter the desired consumption profile and therefore the more critical is the borrowing constraint and the higher is the ratio of the first-period marginal utility of money to that for subsequent periods. The level of schooling chosen is positively related to σ, that is, the higher the opportunity cost of education the lower s. A corollary is that if the individual is less willing to substitute consumption across periods (the absolute value of σ is lower), and thus s is lower, both tax rates must be higher to raise any given level of tax revenue. It is also apparent from Table 3 that, relative to the optimal values for λ, the optimal levels of θ change slowly with increases in desired revenue (when $\sigma = -\frac{3}{2}$, θ actually declines with increases in R). At low levels of tax revenue, it is optimal to use θ to

TABLE 3
Patterns of optimal second-best taxes, for different intertemporal elasticities of substitution

	$\sigma = -\frac{1}{4}$			$\sigma = -\frac{1}{2}$			$\sigma = -\frac{3}{2}$		
Revenue[a]	θ	λ	s	θ	λ	s	θ	λ	s
0	0.36939	−0.01300	0.0005162	0.14003	−0.01110	0.1167	0.01091	−0.00360	0.5854
0.05	0.37038	0.04697	0.0005178	0.14343	0.04569	0.1168	0.01082	0.04898	0.5854
0.10	0.37151	0.11470	0.0005196	0.14726	0.10936	0.1169	0.01072	0.10737	0.5854
0.15	0.37281	0.19179	0.0005217	0.15151	0.18129	0.1170	0.01061	0.17264	0.5854
0.20	0.37429	0.28034	0.0005241	0.15625	0.26320	0.1172	0.01046	0.24610	0.5854
0.25	0.37603	0.38310	0.0005270	0.16168	0.35731	0.1173	0.01030	0.32937	0.5854
0.30	0.37810	0.50380	0.0005304	0.16787	0.46658	0.1175	0.01014	0.42456	0.5854
0.35	0.38038	0.64758	0.0005342	0.17510	0.59497	0.1177	0.00994	0.53444	0.5854
0.40	0.38345	0.82175	0.0005393	0.18351	0.74801	0.1180	0.00970	0.66269	0.5854
0.45	0.38720	1.03710	0.0005457	0.19362	0.93352	0.1183	0.00942	0.81433	0.5854
0.50	0.39201	1.31020	0.0005539	0.20570	1.16310	0.1186	0.00908	0.99641	0.5855

Revenue is expressed as a fraction of the present value of lifetime resources when there are no taxes ($47,400).

finance a consumption subsidy. In addition, we note that for the parameters considered here, the elasticity of s with respect to the interest income tax declines as the absolute value of σ increases and is negative when σ is -2.[17]

5. Summary and conclusions

We have shown that in the presence of liquidity constraints, it may be optimal to tax interest income, even when the individual can choose how much human capital to acquire. An implication of our model is not that consumption taxes alone may lead to agents saving too much but rather that, without some interest income taxation, agents may choose too little education. The paper complements the work of those who maintain (e.g. Hubbard and Judd (1986) and Hamilton (1987)) that the case for preferring consumption to income taxation is more fragile than one might infer from reading the modern tax literature. More generally, we conjecture that any theoretically based justifications for particular mixes of taxes are unlikely to be robust to modifications of assumptions in plausible directions.

Following a dominant strand of recent tax literature, we have framed the government's problem as a choice between interest income and consumption taxation. If further research were to reveal that many of those acquiring human capital are also liquidity constrained, the government could, of course, devise better instruments than an interest income tax to correct the problem (e.g., education subsidies). Nevertheless, recognition of the point that the marginal utility of money may vary systematically over the life cycle obviously has important implications for understanding the entire system of age-, income- and spending-conditioned tax rates.

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APPENDIX—HUMAN CAPITAL EARNINGS AND PENSIONS

In this appendix we provide a brief description of the procedures employed to obtain estimates for the earnings/pensions vector used in the model. Robb and Burbidge (1985, 1989) have developed procedures for manipulating cross-sectional data to obtain predicted values of family wealth, consumption and after-tax incomes of married-couple families, as a function of various household characteristics, including the education level of the husband. Their techniques can be applied to the Family Expenditure data used in Robb and Burbidge (1989) to generate predicted values of annual pre-tax earnings and pensions for particular cohorts. The numbers in the Table B are based on a married-couple cohort, aged 45 in 1982, resident in Montreal, Canadian born, with no children or other adults present in the household. The retirement age is fixed at 65 and those with less than ten years of education are assumed to be unemployed for ten weeks each year, while those with high school education are assumed to work full-time. We then used these data as fixed points, with s equal to zero and 0.2 respectively, to calibrate quadratic functions for the earnings/pension vector. To obtain

[17] At $R=0$, for example, the elasticity of schooling with respect to the interest income tax rate, $(ds/d\theta)(\theta/s)$, is 1.16, 0.035 and -0.00042 for $\sigma=-\frac{1}{4}$, $-\frac{1}{2}$ and $-\frac{1}{32}$, respectively.

TABLE B
Schooling, earnings and pensions

Head's Age	*Less than* 10 *years*	*High School*
30	20,000	22,000
40	22,000	26,000
50	27,000	30,000
60	27,000	32,000
70	15,000	19,000
80	10,000	14,000

"reasonable" levels of s, for example, some numbers greater than 0.2, we chose maximum earnings at age 20 to be $10,000 per annum, which seems low. On the other hand, this model abstracts from contributions made by parents and others towards educational expenses. We should emphasize that while these numbers may be useful for illustrating the properties of the model discussed in this paper, they may be quite unreliable for other purposes.

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