NBER WORKING PAPER SERIES

TAXATION AND EXCESS BURDEN: A LIFE-CYCLE PERSPECTIVE

E. John Driffill

Harvey S. Rosen

Working Paper No. 698

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge MA 02138

June 1981

This research was supported in part by NSF grant No. SOC-7907847. We are grateful to Alan Auerbach, Alan Blinder, Mervyn King, and Kenneth Small for useful suggestions. The research reported here is part of the NBER's research program in Taxation. Any opinions expressed are those of the authors and not those of the National Bureau of Economic Research.

NBER Working Paper #698
June 1981

TAXATION AND EXCESS BURDEN:

A LIFE CYCLE PERSPECTIVE

ABSTRACT

A lifetime perspective is appropriate in assessing the welfare implications of government tax policies. Although a number of attempts have been made to examine the excess burden of taxation in life-cycle models, these have tended to ignore the role of human capital accumulation and/or the leisure-income choice. In this paper, we do numerical simulations with a model that takes both of these phenomena into account.

We find that under reasonable assumptions, the failure to take into account distortions of human capital decisions produces substantial underestimates of the excess burden of income taxation. In addition, allowing for the endogeneity of human capital increases the efficiency of a personal consumption tax relative to that of an equal yield income tax.

E. John Driffill
Department of Economics
University of Southampton
Southampton, England

(0703) 559122

Harvey S. Rosen
Department of Economics
Princeton University
Princeton, New Jersey 08544

609-452-4022

I. INTRODUCTION

Proper understanding of many important economic decisions requires that they be viewed in a life cycle context. Similarly, such a perspective is appropriate in assessing the welfare implications of government tax policies. Quite possibly, a tax that appears efficient from the point of view of one year may be inefficient in a life cycle perspective because of intertemporal allocation effects.

This important point was made several years ago by Levhari and Sheshinski [1972] when they analyzed the excess burden of an income tax in a model of lifetime utility maximization. However, as Levhari and Sheshinski recognized, their model was characterized by several restrictive features: (a) Utility depended only upon the lifetime consumption vector -- the value of leisure was ignored; (b) The elasticity of the marginal utility of consumption was constrained to be unity; and (c) There was no consideration of pre-tax wage determination; i.e., earnings capacity was exogenous rather than generated by rational human capital investment decisions. Even more recent models of tax policy in life cycle models have tended to ignore the role of human capital accumulation.[1]

The payoff for such restrictive assumptions is that they allow the derivation of an elegant analytic expression for excess burden. The problem is that the substantial lack of "realism" precludes the possibility of producing numerical estimates of what the welfare costs of taxation might actually be. An important purpose of this paper is to study via

---

[1] See, for examples, King [1980] or Summers [1980].

simulations the impact of taxation in a model that allows for endogenous leisure and human capital decisions. Our main focus is on how the lifetime excess burden of an income tax varies with key behavioral parameters. However, the study also sheds light on such issues as the relative efficiency of income and consumption taxes, and the consequences of failing to account for human investment decisions when considering the welfare costs of taxation.

In Section II we describe the model of lifetime earnings and labor supply, and explain how its parameters are set. The simulation results are presented and discussed in Section III. A final section contains a summary and suggestions for future research.

II. THE MODEL

A. Framework

Theoretical analysis of the individual's allocation of time over the life cycle has been done by a number of investigators (see Blinder and Weiss [1976], Heckman [1976] or Ryder, Stafford and Stephan [1975]). In basic structure the models are quite similar. Each period the individual divides his time between work, leisure and training (either at school or on-the-job). Earnings capacity in a given period depends on past training, i.e., the stock of human capital. Saving and borrowing can be done freely, subject to the constraint that there be no outstanding debts at the end of the life. All parameters of the model are known with certainty,[2] and

---

[2]Problems which arise as a consequence of stochastic returns to human capital are treated by Levhari and Weiss [1974] and Eaton and Rosen [1980].

conditional on their values, the individual maximizes a utility function which depends upon vectors of leisure, consumption, and possibly bequests.

Such models have been quite successful in reproducing the stylized facts of observed life cycles: early specialization in formal schooling followed by entry into the labor force, at first in a job with a relatively high proportion of on-the-job training and then, as time goes on, in jobs involving little human capital investment. On the other hand, the models cannot purport to be general equilibrium, because the gross rate of return on capital is set exogenously.

Conceptually, the incorporation of taxes into the analysis is straightforward. Because individuals react to net rather than gross magnitudes, the imposition of a proportional income tax leads to new effective wage and interest rates and hence to new optimal paths of leisure, consumption, savings and human capital.[3] In practice, the models are sufficiently complex that the only way to generate useful comparative dynamics results is by means of simulations. (See Driffill [1977].)

Similarly, the computation of excess burden poses no serious conceptual problems. Suppose that in the absence of taxation the individual's consumption and leisure vectors are $\underline{c}^o$ and $\underline{\ell}^o$, respectively. Then prior to taxation, lifetime utility is

$$u^o = u(\underline{c}^o , \underline{\ell}^o)$$

where $u(\cdot)$ is the utility function. Suppose that the post tax bundles are $\underline{c}^1$ and $\underline{\ell}^1$, so that post tax utility is

$$u^1 = u(c^1 , \ell^1) \quad .$$

[3] The effects of taxation on human capital accumulation and labor supply have been studied in a one-period framework by Kesselman [1976].

Excess burden is the diminution in utility in excess of that which would have occurred had the tax been collected as a lump sum, and can be calculated by the following procedure: (i) Compute utility with the tax imposed (u^1). (ii) Find utility u^2 when the same tax revenue as in (i) is obtained by a lump sum payment. (iii) Compute the compensating variation associated with $u^2 - u^1$; i.e., calculate the lump sum payment which will raise utility to u^2 in the presence of the tax.[4]

B. Functional Forms

We could flesh out the general framework just discussed with any number of models. One that is particularly well suited to our present purpose is that of Blinder and Weiss (B-W) [1976]. They postulate that the individual's maximand is additively separable over time with a constant discount rate. The time endowment each period is one, and time not spent on leisure is devoted to work and human capital accumulation h, $(h = 1-\ell)$. A fraction x of h is devoted to human capital accumulation. x can be thought of as an index that rates jobs on the basis of the proportional growth rate in human capital that they allow. When $x = 0$, potential earnings are fully realized; while $x = 1$ is associated with the maximum rate of growth: "pure schooling." B-W assume that as x decreases, earnings increase less than in proportion, because combining training and work on-the-job is not equivalent to dividing one's time between working and attending school. The

---

[4]This differs slightly from the definition of excess burden used by Diamond and McFadden [1974], who define it as the compensating variation associated with the change from u^0 to u^1 minus the tax revenues collected along a compensated demand curve. As Diamond and McFadden as well as a number of others have pointed out, the notion of excess burden is consistent with a number of possible conceptual experiments. Our is quite suitable for the purpose at hand. See Auerbach and Rosen [1980].

effective fraction of time spent on earning is therefore a function $g(x)$, which B-W argue is likely to be characterized by $g''(x) < 0$. (p.453.)

The next important component of the model is the human capital production function. The individual's stock of human capital, $K(t)$, is equivalent to his potential earnings. B-W assume that the percentage growth rate in K is proportional to the amount of time devoted to human capital accumulation, hx , less a constant depreciation rate, δ :

$$\dot{K}(t) = K(t)(ahx - \delta) , \tag{1}$$

where the constant a is the rate of return to "education." This equation is based upon the assumption that the human capital production function is homogeneous of degree one in K (Blinder and Weiss [1976, p. 455].)

The remaining equation[5] in the B-W model is simply an accounting identity which relates saving $(\dot{A})$ to the stock of physical assets (A) , the rate of return to physical assets (r) , earnings $(g(x)hK)$, and consumption:

$$\dot{A} = rA + g(x)hK - c . \tag{2}$$

In order to make the Blinder-Weiss model operational for our simulations, first we must postulate specific functional forms for the lifetime utility function, and for $g(x)$, the effective fraction of time spent on earning.

[5] There are also a number of non-negativity constraints which are not detailed here.

We assume that the utility function takes the form

$$u = \int_0^T \left(\frac{\alpha c(t)^{1-E}}{1-E} + We^{-B\ell(t)}\right)e^{-\rho t}dt \quad , \tag{3}$$

where $\alpha(>0)$, $E(>0)$, $W(<0)$, $B(>0)$ and $\rho(>0)$ are parameters, and T is the length of life. This specification, of course, is far from general: leisure and consumption are separable, the elasticity of the marginal utility of consumption is constant, and a constant percentage rate of change of the marginal utility of leisure is imposed. Unfortunately, allowing for non-separability would render the problem virtually intractable. Utility function (3) is chosen because it is tractable and yields interesting results. It is, incidentally, considerably more general than others that have appeared earlier in this literature.[6] (See, for example, Levhari and Sheshinski [1979], who implicitly set $E = 1$ and $W = 0$.)

utility of leisure is imposed. However, this functional form is tractable, yields interesting results, and is considerably more general than the one used by Levhari and Sheshinski, who implicitly set $E = 1$ and $W = 0$.

For the effective fraction of time spent on earning, we choose a quadratic functional form:

$$g(x) = \xi x^2 - (1+\xi)x + 1 \qquad (0 \geq \xi > -1) \tag{4}$$

[6]Econometric testing of whether or not the separability assumption is correct is very difficult. For example, the careful study of Blundell and Walker [1981] rejects separability, but their specification ignores both saving and the role of human capital in determining of the wage.

Finally, B-W's budget constraint (2) must be modified to allow for the existence of personal taxes. For a proportional income tax[7] at rate t_Y

$$\dot{A} = (1-t_Y)(rA+g(x)hK) - c \,, \tag{2'}$$

and for an expenditure tax at rate t_e

$$\dot{A} = rA + g(x)hK - \frac{c}{1-t_e} \,. \tag{2''}$$

The solution to the problem of maximizing (3) subject to (1), (2), (or (2') or (2")) and (4) is obtained by applying Pontryagin's maximum principle. The optimal paths for the variables in the general case are described in detail by B-W.

A possible limitation of our model is its partial equilibrium nature. Following Levhari and Sheshinski [1972], Feldstein [1978], Heckman [1976], and many others, we assume that the pre-tax rate of return is invariant with respect to changes in the tax system. As King [1980] and Fullerton, Shoven and Whalley [1978] have pointed out, it might be more appropriate to analyze broad based taxes in a general equilibrium framework. Given our desire to concentrate upon the human capital and life cycle aspects of the problem, such a course would appear to be computationally infeasible.[8]

---

[7] Since all variables in the model are in real terms, we are not able to analyze the distortive effects of an unindexed tax system in the presence of inflation.

[8] Moreover, King [1980] has pointed out that if the government has available to it certain policy instruments in addition to tax rates (e.g., debt policy), then the gross rate of return can be set optimally, independent of tax rates.

C. Parameter Values

As noted above, for models of this complexity, the only way to obtain interesting results on the efficiency effects of taxation is by means of simulations based on specific parameter values. A number of attempts have been made to estimate jointly the parameters of human capital models. (See, e.g., Heckman [1976] or Rosen [1976].) However, serious econometric problems arise in the course of estimation, and the results cannot be viewed with great confidence. Our strategy, therefore, is to piece together a set of parameter values by appealing to empirical studies in various parts of the literature. One of the advantages of a simulation methodology is that the sensitivity of our substantive results to changes in the parameters can be examined.

1. The Rate of Interest.

The model assumes that the individual can borrow and lend at the same interest rate. Historically, in the U.S. the average of long term real before tax interest rates has been quite low. Brown [1976] and Feldstein [1973] have suggested a figure of 3 or 4 percent, about the growth rate of real output. Interest rates inferred from optimal human capital accumulation models vary widely. Ben-Porath [1970] found an implied interest rate of about 20%, while Haley's [1974] estimate was between 5 and 8 percent. We settle upon a value for r of 5%.

2. Rate of Return to Education.

Estimating the return to education is a well-established activity, and the evidence indicates that the return depends on the level of education, assumptions concerning mortality, etc. (See the survey by Psacharopoulos [1973].) We choose a conservative estimate of 5%. Note, however, that in the simulations h is scaled so that its "normal" value is one-half. Therefore, in order for a normal year's work at school to increase potential earnings by 5%, the value for a must be set at twice that, i.e., 0.10.

3. Depreciation of Human Capital.

Several estimates of the human capital depreciation rate are available. Heckman [1976] computed a figure of 3.7% for people with 13-16 years of education and 7% for people with 16 years of school. Haley [1976] found rates in the region of 3-4%, and Mincer's [1974] estimate was 1.2%.[9] At the same time an individual ages, his human capital may be growing in value due to economy-wide increases in productivity. In our models, δ reflects the net effects of depreciation and exogenous increases in productivity. We settle upon a value of δ of -0.01, which is consistent with (say) a 4% annual growth in productivity and a 3% reduction in potential earnings due to aging.

---

[9] These estimates are all generated by models in which gross human capital accumulation is constrained to be positive throughout the lifetime, and may be biased if there is a phase of "pure work" during some part of the lifetime.

4. Length of Life.

It is assumed that the beginning of economic life occurs at the end of compulsory education, and that differences in human capital accumulated to that point are exogenous to the model. We set $T = 55$, which might be interpreted as the horizon of a plan made at age 15 by a person with a life of 70 years.

5. Utility Functions.

The parameter E of equation (1) is the elasticity of the marginal utility of income. As Maital [1976] has noted, a value of 1.5 crops up often in the literature, and it is used in many of our simulations. We choose B, the parameter that multiplies leisure in the utility function, so that it is consistent with econometric results on the supply of labor. More specifically, we take Kiefer's [1975] estimate of 0.181 for the fraction of a change in nonlabor income spent on leisure, and work backwards from the first order conditions to find the implied value of B (conditional on a value of $E = 1.5$). This results in a value of B equal to about 20.0.

The parameters α and W affect the relative preferences for consumption and leisure, and only their ratio matters. For each simulation, we set them so that a period of "pure schooling" of approximately three years occurs at the beginning of the individual's life.

6. Endowments.

In order to solve the model, two initial conditions are required, endowments of human and physical capital. The human capital endowment, K_0 , is set at \$13,000, implying that if the individual devoted the entire year to work, he would earn \$13,000. (As noted above, the "normal" individual would be working only half time.) The endowment of non-human capital A_o , is set at zero.

7. Productivity of On-The-Job Training

No direct evidence on the productivity of on-the-job training as reflected in the parameter ξ of equation (2) is available. Therefore, ξ was chosen by experimenting with alternative values, and setting it with reference to its effects on the simulated life-cycles. These experiments showed that the principal effect of changing ξ was to alter the length of the period of on-the-job training (OJT) in the model. Following a suggestion by Mincer [1974], we assume that OJT is completed at about age 47, which is consistent with $\xi = -0.25$.

8. The Rate of Time Preference.

Blinder and Weiss show that if $\rho > r + \delta$ an individual will "retire" at the beginning of his life, if at all, whereas if $\rho < r + \delta$, an individual may retire at the end of his life. The size of ρ also affects the profiles of consumption and leisure over the individual's life. The rate of growth of consumption is $(r-\rho)/E$. During the schooling phase, hours of non-leisure rise at a rate $\dot{h} = \rho/B$ and during the working phase of life, they fall if $r + \delta - \rho > 0$ since $\dot{h} = -(r+\delta-\rho)/B$.

A "stylized fact" of lifetime labor supply is that hours of non-leisure activity $(h(t))$ at first rise with age, reaching a peak in middle life, and then fall somewhat. This suggests a value of ρ in the range $0 < \rho < r + \delta$.

It seems reasonable too that consumption should rise gently over the life-cycle, suggesting $\rho < r$. Within this range variations in the value of ρ had small effects on the simulations, and a value of $\rho = .01$ was used.

III. SIMULATIONS

With specific functional forms and parameter values in hand, we can compute the excess burden of any given tax system. The procedure is as follows: Solve the model[10] assuming no taxation, generating the optimal pre-tax paths of human capital accumulation, savings, consumption, leisure and hence (by substituting into equation (3)) a value for lifetime utility. Then solve the model with budget constraint (2') in order to find post-tax utility u^1 . Next, find the utility level (u^2) which results when the present value of the income tax receipts is extracted from the individual as a lump sum. Finally, compute the amount by which the non-human wealth endowment, A_o , must be increased to raise utility from u^1 to u^2 . This amount is the excess burden of the tax.

In the process of doing these calculations, a good deal of interesting comparative dynamics information is generated. For the sake of brevity,

---

[10] The solution of the model is obtained by a numerical method. The solution is defined by differential equations describing the motion of the state variables (assets A and human capital K) and two co-state variables, and the initial conditions and transversality conditions on the values of those variables. For any given set of initial values, the differential equations define a path and a set of terminal values. The numerical algorithm found the correct initial values of the state and co-state variables and solved the differential equations numerically using discrete, piecewise-linear approximations to the true, continuous, nonlinear functions. The algorithm is D02ADF of the Fortran NAG (Numerical Algorithms Group) Library, and the calculations were done on an ICL 2970 computer at Southampton University.

these results are not reported here in any depth. The reader is referred to Driffill [1977] for a thorough discussion. One should note, however, the interesting result that in this model a proportional income tax increases human capital accumulation.[11] This is due to two mutually reinforcing effects. The tax lowers net earnings, and for some values of the parameters, individuals reduce leisure, increasing both training and working. At the same time, the income tax reduces the effective interest rate, which also tends to encourage human investment.[12] (The decrease in the interest rate increases the attractiveness of human capital vis à vis physical capital as a vehicle for carrying consumption into the future, *ceteris paribus*.)

We begin our simulations by examining how excess burden varies with the income tax rate and with the behavioral parameters. In the next set, lifetime excess burdens are computed on the assumption that human capital accumulation is exogenous. Because this assumption is implicitly made in most studies of the efficiency of taxation, it is of some interest to see whether or not it leads to large differences in the estimates. Next, we

---

[11] The magnitude of the response depends upon particular parameter values and stage of the life cycle, but tends to be substantial. Around the neighborhood of $t_Y=0$, when $B=20$, and $E=2.0$, the elasticity of lifetime human capital with respect to t_Y is about -0.09. In the absence of very much econometric evidence on the long-run elasticity of human capital with respect to its rate of return, it is hard to say whether or not this value is realistic (although Willis and Rosen [1979] have found very large values for the elasticity of the probability of college attendance with respect to its return). It is likely that a model with capital market constraints would lead to less responsiveness, but this is beyond the scope of the present paper.

[12] A similar effect is found by Heckman [1976]. Again, the precise response depends upon the specific parameters. For most values of B and E used in this study, the elasticity of lifetime human capital accumulation with respect to the interest rate is about -3.5.

calculate excess burden on the assumption that leisure is not a choice variable, which is close to the spirit of the Levhari-Sheshinski model, and leads us to the kind of results that might have been obtained if they had attempted numerical solutions. Finally, we use the model to compare the efficiency of income and consumption taxes, an exercise of considerable interest given the current policy debate over the relative merits of these two tax bases.

1. Excess Burden of an Income Tax.

Table I shows how the excess burden of a proportional income tax depends upon the tax rate (t_y), and the utility function parameters. Thus, for example, when the tax rate is 0.05, $E = 1.5$ and $B = 15$, lifetime tax revenues are $4,021, and the liftetime excess burden is $646. The following observations are based upon the table:

(a) For a given tax rate, reasonable changes in the utility function parameters change the excess burden somewhat, but not wildly. The figures are quite similar, except for the case of $E = 0.5$, and this value of E is rather far from the "consensus" value for the elasticity of the marginal utility of income.

(b) For given values of B and E, the excess burden increases approximately with the square of the tax rate. This result accords with intuitions developed in the simple static case for small changes in the tax rate. When the algebraic expression for the famous "Harberger triangle" is written in elasticity form, it indicates that excess burden varies in direct proportion to the square of the *ad valorem* tax rate. (Harberger [1964, p. 45].)

TABLE I

Excess Burden of a Proportional Income Tax

($T = 55$, $a = 0.1$, $r = 0.05$, $\xi = -.25$, $K_o = 13{,}000$)

Utility Function	$t_y = .05$ Tax Revenues	$t_y = .05$ Excess Burden	$t_y = .10$ Tax Revenues	$t_y = .10$ Excess Burden	$t_y = .20$ Tax Revenues	$t_y = .20$ Excess Burden
E=1.5, B=15	4021	646	6480	2337	9334	8109
E=1.5, B=20	3987	632	6486	2257	9474	7858
E=1.5, B=30	3977	603	6526	2190	9663	7637
E=0.5, B=20	8998	756	15680	2918	24630	11340
E=1.0, B=20	5279	666	8785	2448	13310	8773
E=2.0, B=20	3470	605	5440	2179	7683	7473

(c) As a proportion of tax collections, the excess burdens are considerably higher than those which have been generated in static models. Analysis of static models has yielded ratios of excess burden to tax revenue under 5%. (See Harberger [1964, p. 51] or Rosen [1978, p. 512].) In contrast, Table I indicates a ratio of about 15% for low tax rates, and about 80% for higher tax rates. This large discrepancy between the static and life-cycle results suggests that ignoring the endogeneity of human capital may lead to serious underestimates of excess burden.

2. Excess Burden with Human Capital Fixed.

In light of point (c) above, it is important to know what the excess burdens would have been if we had (mistakenly) assumed that human capital investments are fixed exogenously. We consider the following experiment: for a given set of behavioral parameters, and assuming no taxes, generate the optimal life cycle plan as before. Now impose a proportional income tax, but constrain the growth of human capital investment to be exactly the same as it was in the pre-tax situation. Taxes, then, can distort the leisure-income tradeoff during a given period as well as intertemporal consumption decisions, but they have no effect on human capital.

The outcome of this experiment is shown in Table II. Compared to Table I, the most striking aspect is the dramatic fall in the ratio of excess burden to tax revenues. The figures are now on the order of 2 to 3% for low tax rates, and 10 or 15% for higher tax rates. Thus, as conjectured above, the failure to consider human capital accumulation generates substantial downward errors in excess burden calculations. It is also noteworthy that this failure leads to overestimates of tax revenues.

TABLE II

Excess Burden of a Proportional Income Tax Assuming Fixed Human Capital
($T = 55$, $a = 0.1$, $r = 0.05$, $\xi = -.25$, $K_o = 13,000$)

Utility Function	$t_y = .05$ Tax Revenues	$t_y = .05$ Excess Burden	$t_y = .10$ Tax Revenues	$t_y = .10$ Excess Burden	$t_y = .20$ Tax Revenues	$t_y = .20$ Excess Burden
E=1.5, B=15	5172	139	10310	574	21060	2419
E=1.5, B=20	5077	127	10180	525	20780	2221
E=1.5, B=30	5016	113	10030	469	20620	1983
E=0.5, B=20	9876	342	18720	1421	34440	6071
E=1.0, B=20	6270	189	12300	775	24130	3238
E=2.0, B=20	4554	99	9256	409	19360	1742

The reason for this overestimate is related to the fact, noted above, that the income tax leads to expansion of human capital. The increase in human capital delays the individual's earnings and increases the value of his debts. Both of these effects reduce the present value of tax revenue relative to what it would have been had human capital been fixed, and they more than offset the revenue effects of the tax-induced increases in earnings capacity.

3. Excess Burden with Fixed Labor Supply

It is often assumed in human capital models that the individual's goal is income maximization rather than utility maximation. In the next set of simulations, we investigate the errors that might be induced when the leisure-income tradeoff is not taken into account. To do so, we first compute the optimal lifetime plan in the absence of taxation. We then recompute the plan including taxes, but constraining the values of leisure to their pre-tax values, although human capital decisions are still endogenous.

The results are shown in Table III. Compared to Table I, there are smaller excess burdens, but the differences are not as dramatic as those in Table II. Failing to consider the distortionary effects of taxes on the leisure-income choice does not lead to as much of an error as ignoring the endogeneity of human capital. This perhaps suggests that more effort should be devoted to estimating the effects of taxes on human capital accumulation, and less to refining estimates of the elasticity of hours of work with respect to the tax rate.

TABLE III

Excess Burden of a Proportional Income Tax Assuming Fixed Labor Supply
($T = 55$, $a = 0.1$, $r = 0.05$, $\xi = -.25$, $K_o = 13{,}000$)

Utility Function	$t_y = .05$ Tax Revenues	$t_y = .05$ Excess Burden	$t_y = .10$ Tax Revenues	$t_y = .10$ Excess Burden	$t_y = .20$ Tax Revenues	$t_y = .20$ Excess Burden
E=1.5, B=15	4404	514	7744	2111	13320	6965
E=1.5, B=20	4277	525	7475	1949	12790	7017
E=1.5, B=30	4179	538	7259	1987	12330	7086
E=0.5, B=20	9197	696	16520	2720	28540	10730
E=1.0, B=20	5498	578	9721	2177	6680	8040
E=2.0, B=20	3734	503	6463	1852	11010	6562

4. Income Versus Consumption Taxation

A major debate in public finance concerns the merits of consumption versus income taxation. An important issue is the relative efficiencies of the two tax bases. In order to investigate this matter, we did the following: (i) For a given income tax rate, compute lifetime tax revenues and excess burden as before. (ii) Find the consumption tax rate (t_e of equation (2")) that generates the same present value of tax revenues. (iii) Compute the excess burden associated with the consumption tax, and examine its ratio to that of the income tax.

Before presenting these results, it should be emphasized that although our utility function (3) is separable in consumption and leisure, it is not homothetic in leisure. If homotheticity obtained, then a consumption tax would be more efficient than an income tax, independent of the parameter values chosen. Given (3), however, it cannot be known *a priori* which tax is more efficient. (See Atkinson and Stiglitz]1976] or Auerbach [1979].)

The results are shown in the first three columns of Table IV. Each entry gives the ratio of the excess burden of a consumption tax to that of an equal yield income tax, for each income tax rate and set of utility function parameters. (Thus, for example, if $E = 1.5$, $B = 15$, and the income tax is 0.05, then the excess burden of a consumption tax is 2.1% of the excess burden of an equal yield income tax.) The figures suggest that for all parameter values, the consumption tax is considerably more efficient than the income tax, and that the relative efficiency is an increasing function of the income tax rate.

Because consumption taxation is often analyzed using models which ignore human capital, it is of some interest to see how these results would have changed if we had assumed exogenous human capital accumulation. The outcomes are shown in the last three columns of Table IV. A glance at these

TABLE IV

Relative Excess Burdens of Consumption and Income Taxes

($T = 55$, $a = 0.1$, $r = 0.05$, $\xi = -0.25$, $K_o = 13,000$)

Utility Function	Endogenous Human Capital (1) $t_y = 0.05$	(2) $t_y = 0.10$	(3) $t_y = 0.20$	Fixed Human Capital (4) $t_y = 0.05$	(5) $t_y = 0.10$	(6) $t_y = 0.20$
E=1.5, B=15	0.021	0.015	0.0088	0.098	0.096	0.092
E=1.5, B=20	0.015	0.011	0.0069	0.083	0.082	0.080
E=1.5, B=30	0.010	0.0076	0.0048	0.067	0.064	0.064
E=0.5, B=20	0.083	0.089	0.044	0.133	0.119	0.094
E=1.0, B=20	0.027	0.021	0.014	0.090	0.086	0.080
E=2.0, B=20	0.011	0.0073	0.0043	0.081	0.081	0.081

ratios indicates that although they are still small (generally under 0.10), they are larger than their counterparts in the first half of the table. Thus, failure to take human capital into account would bias downwards one's estimate of the efficiency gains achievable by moving from an income tax to a consumption tax.

Of course, we cannot claim that these simulations have "proven" that a consumption tax is more efficient than an income tax. The results, after all, are consequences of the specific functional forms we have chosen. It is nevertheless interesting to see this conclusion fall out of a model of a sort that has achieved widespread acceptance in other contexts.

IV. CONCLUDING REMARKS

Most attempts to analyze the excess burden of taxation have relied on static models. A few studies have viewed excess burden in a dynamic context but these have ignored the potentially important role of human capital accumulation. In this paper, we have used simulations to analyze a more general model which explicitly allows for endogenous human capital decisions.

Our results suggest that conventional measures of excess burden seriously understate the true efficiency losses of taxation. This outcome occurs despite the fact that we impose on the model a rather conservative value for the rate of return to education. As stressed above, no claims to perfect generality can be made because our results are conditional upon specific functional forms and parameter values. However, we did attempt to make these as "realistic" as possible. Moreover, previous attempts have used assumptions considerably more restrictive than our own.

While searching for parameter values for the model, we discovered a surprising scarcity of estimates of the impact of taxes on human capital accumulation. Our simulation results suggest that there might be a high payoff to econometric work that improves upon these estimates.

BIBLIOGRAPHY

Atkinson, Anthony B. and Joseph Stiglitz, "The Design of Tax Structure: Direct versus Indirect Taxation," Journal of Public Economics 6:1 (July-August 1976), 55-75.

Auerbach, Alan, "A Brief Note on a Non-existent Theorem About the Optimality of Uniform Taxation," Economics Letters 3:1 (1979), 49-52.

Auerbach, Alan and Harvey S. Rosen, "Will the Real Excess Burden Please Stand Up?" National Bureau of Economic Research, Working Paper No. 495 (June 1980).

Ben-Porath, Yoram, "The Production of Human Capital Over Time," in Education, Income and Human Capital, W. Lee Hansen, ed., Studies in Income and Wealth, Columbia University Press for NBER, New York, 1970.

Blinder, Alan and Yoram Weiss,"Human Capital and Labor Supply: A Synthesis," Journal of Political Economy, 84:3 (June 1976), 449-472.

Blundell, Richard W. and Ian Walker, "The Demand for Goods and Leisure With Female Labour Supply and Rationing: Testing for Separability," University of British Columbia, mimeo, 1981.

Brown, Charles, "A Model of Optimal Human Capital Accumulation and the Wages of Young High School Graduates," Journal of Political Economy 84:2 (April 1976), 299-316.

Diamond, Peter and Daniel McFadden, "Some Uses of the Expenditure Function in Public Finance," Journal of Public Economics 3:1, (February 1974), 3-22.

Driffill, E. John, "Essays on Human Capital Accumulation and Labour Supply," Unpublished Ph.D. thesis, Princeton University, 1977.

Eaton, Jonathan and Harvey S. Rosen, "Taxation, Human Capital and Uncertainty," American Economic Review, forthcoming.

Feldstein, Martin S., "Social Security, Induced Retirement, and Aggregate Capital Accumulation," Journal of Political Economy 82:5 (September-October 1974), 905-26.

Feldstein, Martin S., "The Welfare Cost of Capital Income Taxation," Journal of Political Economy, 85 (April 1978), S29-S52

Fullerton, Donald, John Shoven and John Whalley, "General Equilibrium Analysis of U.S. Taxation Policy," 1978 Compendium of Tax Research, Office of Tax Analysis, U.S. Treasury Department, Washington, D.C., 1978, 23-58.

Haley, William J., "Estimation of the Earnings Profile from Optimal Human Capital Accumulation," Econometrica 44:6 (November 1976), 1223-38.

Harberger, Arnold, C., "Taxation, Resource Allocation, and Welfare," in J. Due (ed.), The Role of Direct and Indirect Taxes in the Federal Revenue System, Princeton University Press, 1964, 25-80.

Heckman, James, "A Life Cycle Model of Earning, Learning and Consumption," Journal of Political Economy, 84:4 (August 1976), Part II, S11-S44.

Kesselman, J. R., "Tax Effects on Job Search, Training, and Work Effort," Journal of Public Economics 6:3 (October 1976), 255-272.

Kiefer, Nicholas, "A Bayesian Analysis of Labor Supply and Commodity Demand," International Economic Review 18:1 (February 1977), 209-218.

King, Mervyn, "Savings and Taxation," National Bureau of Economic Research, Working Paper No. 428, January 1980.

Levhari, David and Eytan Sheshinski, "Lifetime Excess Burden of a Tax," Journal of Political Economy 80;1 (Febrary 1972), 139-147.

Levhari, David and Yoram Weiss, "The Effect of Risk on Investment in Human Capital," American Economic Review 64:6 (December 1974), 950-963.

Maital, Shlomo, "Public Goods and Income Distribution: Some Results," Econometrica 41:3 (May 1976), 561-568.

Mincer, Jacob, Schooling, Experience and Earnings, New York: Columbia University Press, 1974.

Psacharopoulos, George, Returns to Education: An International Comparison, Amsterdam, Elsevier, 1973.

Rosen, Harvey S., "The Measurement of Excess Burden with Explicit Utility Functions," Journal of Political Economy 86:2 (April 1978), Part II, S121-S136.

Rosen, Sherwin, "A Theory of Life Earnings," Journal of Political Economy, 84:4, Part II (August 1976), S45-S68.

Ryder, Harl E., Frank P. Stafford and Paula E. Stephan, "Labor, Leisure and Training over the Life Cycle," International Economic Review, 17:3, (October 1976), 651-674.

Summers, Lawrence H., "Tax Policy in a Life Cycle Model," National Bureau of Economic Research, undated mimeo.

Willis, Robert and Sherwin Rosen, "Education and Self-Selection," Journal of Political Economy 85:5 (October 1979), S7-S36.