Some Effects of Taxes on Schooling and Training

By BILL DUPOR, LANCE LOCHNER, CHRISTOPHER TABER, AND MARY BETH WITTEKIND *

This paper investigates the magnitudes of some distortions in the U.S. tax system on human-capital accumulation for typical individuals using simulations from a structural model of human-capital accumulation. We estimate the parameters of a human-capital production function and simulate the effects of different wage-tax schedules on human-capital investment. We focus on the two distortions in the tax system that influence human capital most directly.

The first distortion we examine arises from the fact that not all inputs into human-capital production are tax-deductible. If all human-capital investment were forgone earnings, a wage tax would be neutral (Michael J. Boskin, 1975). When the investment consists of both forgone earnings and direct goods that are not tax-deductible, an increase in a wage tax discourages human-capital investment since the tax increase reduces the benefits of human-capital investment more than the costs. Philip A. Trostel (1993) assumes a large share of non-tax-deductible direct goods inputs, simulates a general-equilibrium model with human-capital accumulation, and finds that changes in a flat income tax lead to large effects of taxes on human-capital accumulation. Using our partial-equilibrium model we provide estimates of the amount of total investment in human capital that is not tax-deductible and show that it is very small. We also combine this model with estimates from a schooling model to simulate the effect directly and also find it to be small.

The second distortion arises from the progressivity of the tax system, which discourages human-capital investment by reducing its return. We estimate the model using data from the 1970 Census and find that the progressivity in 1970 leads to approximately a 5-percent decline in human-capital investment. We also simulate the model with the 1990 tax code. We find that for many people it is approximately flat and yields no disincentive for investment, but that for others it can yield a decline in investment of as much as 22 percent.

Our work contributes to a relatively small literature on the effects of taxes on human capital. James J. Heckman (1976a) assumes that the only input into human-capital production is tax-deductible forgone earnings and finds that an income tax stimulates human capital because it reduces the after-tax interest rate. Jonathan Eaton and Harvey S. Rosen (1980) include uncertainty in the return to human-capital investment and find that a positive labor tax may improve welfare by decreasing risk. In previous general-equilibrium work with human capital, James Davies and John Whalley (1989) find small effects on human capital of replacing an income tax with a consumption tax because capital adjusts so that the after-tax interest rate returns to approximately its original value. There is almost no literature that integrates the subsidy and tax effects of human-capital accumulation. There is a fundamental trade-off between direct expenditures and indirect tax expenditures. An important policy question is the potential for government to

[†] *Discussants:* James Davies, University of Western Ontario; James Poterba, Massachusetts Institute of Technology; Harvey Rosen, Princeton University.

* Dupor, Lochner, and Wittekind: Department of Economics, University of Chicago, 1155 East 60th Street, Chicago, IL 60637; Taber: Department of Economics and Center for Urban Affairs and Policy Research, Northwestern University, 2003 Sheridan Road, Evanston, IL 60208. We thank James J. Heckman for suggesting the topic and for many useful comments and suggestions. This research was supported by NSF-SBR-93-21048 and a grant from the Russell Sage Foundation, both to James J. Heckman. All errors are our own.

restore levels of wages for American workers, and existing estimates of these subsidy levels (Heckman et al., 1994) are enormous.

I. Current Tax Treatment of Human Capital

Here we briefly describe the major provisions of the current U.S. tax code relating to human capital. For a more complete treatment, see Eugene Steuerle (1995). In describing the code, we distinguish between the following types of human-capital investment: full-time schooling, part-time schooling by employees, on-the-job training (OJT); and employer-provided, employer-financed, and individual-financed; and forgone earnings and direct expenditures.

The provisions in the current tax code for individual-financed full-time formal-schooling investment are straightforward. The forgone earnings portion of this investment is tax-deductible while, in general, direct expenditures for formal schooling are not deductible. Forgone earnings are implicitly tax deductible, because this income would be taxed if the individual were working instead of investing. Most direct expenditures such as tuition and supplies are not tax-deductible for a typical student. The code provides limited exemptions for financial aid and home-mortgage loan interest. Federal student-loan interest payments are not tax-deductible, but student loans are subsidized by interest deferral while a student is in school and by direct interest-rate subsidies.

As opposed to tuition, both informal and formal OJT are essentially tax-deductible. Informal OJT is effectively expensed regardless of whether the training is general or firm-specific. Employer-provided formal training (e.g., seminars conducted by outside personnel) is immediately expensed, so it is also tax-deductible.

The tax deductibility of employer-financed schooling is more complicated. An employee may deduct employer-provided tuition assistance as long as it is relevant to the current job. Tuition benefits from employers that do not meet the requirements are tax-deductible up to a current level of $5,250 when this training is done under the auspices of a nondiscriminatory employer-provided educational assistance program.

Therefore, for human-capital investment, there is a bias toward OJT rather than full-time formal schooling; this bias is driven by the nondeductibility of tuition and other direct goods. In comparison to physical capital, human capital is both encouraged and discouraged. Human capital is discouraged when it is financed with direct goods. On the other hand, human capital is encouraged since firm investment in physical capital and equipment is amortized over the life of the capital while employer-provided formal training is immediately expensed.

II. Life-Cycle Human-Capital Investment Model

Clearly the most natural way to estimate the effects of taxes on human capital would be to measure these effects directly from the data. A major problem with this strategy is the existence of many important factors that vary across regions and across time and which influence these decisions (e.g., school quality, business cycles, changes in the return to human capital, etc.). Therefore, we pursue an alternative approach. Since taxes influence human-capital accumulation through prices in a known manner, we can simulate how an agent would react to tax changes after estimating how the agent reacts to prices. By estimating a structural model of human-capital accumulation we can simulate the effects of changes in the tax code on human-capital investment.

In our model, the agent chooses a lifetime path of investment in human capital that maximizes the present value of his after-tax income net of the costs of schooling. We allow human capital to be produced both on-the-job and through schooling. We assume that people first invest in human capital through formal schooling and then enter the labor force and continue to invest through OJT.[1] This training may occur through formal training programs within the firm, formal external training programs, or informal means. The agent first selects his amount of schooling from among a

[1] Unlike Yoram Ben-Porath (1967), we assume this type of specialization, rather than obtaining it as an implication of the model. However, there are reasonable conditions under which our model would deliver a period of specialization prior to labor-force entry as an implication.

finite number of choices. We restrict the choices to four: (i) drop out of high school; (ii) obtain only a high-school degree; (iii) obtain some college; and (iv) graduate from a four-year college.

Let r be the interest rate, let s denote a level of schooling, and let $C(s)$ be the present value of the cost of schooling level s. We may think of $C(s)$ as embodying nonpecuniary costs and benefits of schooling as well as direct costs. Let $I(t)$ be the fraction of potential earnings that the worker spends investing in period t, and let $H_s(t)$ be the level of human capital at period t of an individual with s years of school. The amount $I(t)$ may represent both time spent investing and income forgone for investment goods financed by the firm (see William J. Haley, 1976). In each period, the worker earns an amount $H_s(t)[1 - I(t)]$ which is taxed according to the possibly nonlinear tax schedule τ. Under this scheme the agent maximizes the objective function

$$\int_{t=s}^{T} e^{-rt}\{ H_s(t)[1 - I(t)] - \tau(H_s(t)[1 - I(t)])\}\,dt - C(s)$$

with respect to feasible human-capital investment strategies (s, I), subject to the constraints imposed by the human-capital production functions at school,

$$H_s(s) = F(s)$$

and on-the-job,

$$\dot{H}_s = A_s I^{\alpha} H_s^{\beta} - \sigma H_s.$$

We can think of the agent solving the problem in two steps. In the first step, for each *potential* level of schooling $s \in S$, he computes the investment path of the amount of OJT he would choose if he entered the labor force with s years of school. Once he has done this, he can compute the present value of lifetime income he would achieve for each schooling choice,

$$V(s) \equiv \max_{I} \int_{t=s}^{T} e^{-rt}\{ H_s(t)[1 - I(t)] - \tau(H_s(t)[1 - I(t)])\}\,dt.$$

He then chooses the level of schooling that maximizes lifetime income,

$$\max_{s \in S}\{ V(s) - C(s)\}.$$

We are relaxing the Ben-Porath neutrality assumption by allowing α, the exponent on time investment, to differ from β, the exponent on human capital. We follow Heckman (1976b) who relaxes the model in this way and finds neutrality to be important and strongly violated. We extend his work by estimating the OJT solution numerically.[2] Furthermore, the assumption that the functional form of the OJT human-capital production function is the same as the schooling human-capital production function implies that the initial level of investment when beginning work is equal to 1. In relaxing this assumption, Heckman (1976b) finds that this implication is strongly rejected. We extend previous work by estimating the schooling human-capital production function separately from the OJT production function, by estimating the model for all of the school groups simultaneously under the assumption of no educational selectivity.

The goal of this empirical work is to characterize the life-cycle earnings paths of the median workers who have achieved each of the alternative schooling levels. We estimate the model using the four median earnings paths from synthetic cohorts of white males derived from the 1970 Census. For a number of reasons, the synthetic-cohort assumption seems more reasonable for 1970 than with more recent data. First of all, we are using the actual tax code in the estimation, so we are implicitly assuming that it remained constant. This assumption is more reasonable in 1970 when the tax code had not changed much in the previous 20 years. Secondly, we are interested in the real tax schedule, and inflation was less important before than after 1970. Finally the changing wage structure of the 1970's and 1980's makes the synthetic cohort assumption

[2] Rather than solve essentially the same model explicitly, Heckman (1976b) assumes a functional form for the investment path. We find the estimates of the model to depend strongly on the solution method.

TABLE 1—RESULTS FROM LIFE-CYCLE HUMAN-CAPITAL INVESTMENT MODEL, WHITE MALES

Variables	High-school dropouts	High-school graduates	Some college	Four-year college graduates
A	0.24	0.27	0.30	0.40
Terminal human capital	3.45	3.86	4.37	5.75
Initial human capital	3.48	4.01	4.63	6.06
Present-value earnings	121,248	124,892	128,261	149,989
Present-value investment	34,212	32,522	31,724	36,335
Human-capital stock	190.20	204.12	221.16	275.78

Notes: Sample size = 213,325; α = 0.89, β = 0.05, σ = 0.01.

hard to interpret for later samples because we are implicitly assuming that the return to human capital is constant over time.

We estimate the model in two steps. We first calculate the sample median synthetic cohorts by taking the median wage for each age/schooling group in the 1970 census. For each potential set of parameters we can solve the model numerically and obtain a predicted wage path. We estimate the parameters of the model by nonlinear least squares by comparing the actual median wage path with the predicted wage path.

The results appear in Table 1. We see that our model deviates from the neutral model in that the exponent on investment time, α, is considerably higher than the exponent on human capital, β. In fact β is close to zero. The depreciation rate is quite small. As expected, both the initial and final levels of human capital monotonically increase with schooling. The coefficient A_s is also monotonically increasing in schooling. Thus school not only directly increases the students' human capital, but also increases their ability to learn by making them more efficient at producing human capital.

We use this model to simulate human-capital investment under various tax regimes. The model is first estimated under the 1970 tax regime. Changing from this scheme to a flat tax increases human-capital investment as expected, but the changes are moderate to small. The present value of forgone wages used to invest in human capital increases by 7.2 percent for dropouts, 5.2 percent for high-school graduates, 2.8 percent for college attenders, and 7.3 percent for college graduates. Thus the progressivity of the 1970 tax schedule discourages human-capital investment, but at first glance the magnitude of this disincentive is not large. However, the tax schedule that these individuals face is not particularly progressive. The change in the level of the marginal tax rate over the life cycle for the typical worker is only approximately 4 percentage points.

We also simulate this model for the 1990 tax schedule. Using median characteristics of the 1970 workers, we find that the majority of the wages we observe place workers in the 15-percent tax bracket. However, this finding is very sensitive to the characteristics and tax schedules that we use. The simplicity of the current tax code makes it quite difficult to characterize the overall effects using data from 1970. For most of the simulations we perform, the workers are not near a kink, and the schedule is approximately flat. However the kinks are fairly large (the federal tax rate changes from 15 percent to 28 percent), so that for the workers who are near kinks, the system is very progressive. Rather than try to characterize a "typical worker," we simulate human-capital investment under alternative assumptions about where the kinks lie in the earnings path. Experimenting in this manner, we found declines in investment of as much as 22 percent. Thus, while for many workers the tax schedule appears to be approximately flat, the disincentives for others are quite large. It also seems likely that for people with high levels of income and people with low levels of income there may be even larger effects. The magnitude of the disincentives at the extremes of the earnings distribution, particularly at the low end, seems to be an important topic for future research. As a summary statistic, we find that a change in the marginal tax rate of about 10 percent that occurs during the increasing portion of an individual's earnings profile will lead to approximately a 15-percent decline in human-capital investment.

We can also use these estimates to approximate the fraction of human-capital investment that is not tax-deductible, which is essentially only tuition. Consider the importance of tuition for college graduates. The present value of OJT investment for them is about \$36,000. Since their opportunity wage is \$4.01 (which is the wage they would receive if they did not invest at all), forgone income while in college also amounts to around \$32,000. Translating to 1990 dollars, the total amount of forgone income for college graduates after high-school graduation is about \$217,000. Thomas J. Kane's (1994) estimate of annual tuition for a public four-year university is in the neighborhood of \$1,500. There are potentially other costs of college such as room and board. Even if we allow these to triple the costs of college, we have an upper bound of 8 percent of total human-capital investment that is not tax-deductible for college graduates after high-school graduation. This number is an upper bound since it does not include income forgone while in high school and does not include out-of-pocket expenses not reimbursed by the firm while in the labor force. Furthermore, for the majority of individuals who attend less than four years of college, the fraction of investment that is not tax-deductible will be much smaller.

We also attempt to simulate the effects of tax policy on schooling choices by linking the OJT model with an assumption about how tuition enters the model. For the tuition effects on schooling, we draw on Kane's (1994) results. Since he focuses only on college attendance, we also ignore high-school dropouts and college graduates. We can link the estimates by using the following implication of our model,

$$\frac{\partial \Pr(\text{College})}{\partial \text{Tuition}} = \frac{-\partial \Pr(\text{College})}{\partial (V(\text{Some College}) - V(\text{High School}))}$$

where "Tuition" means the present value of tuition. This amounts to assuming that increasing the present value of college tuition by \$1,000 will have exactly the same effect on college matriculation as decreasing the present value of after-tax earnings of college attenders by \$1,000. Kane (1994) finds that a \$1,000 increase in tuition decreases the probability of attending college by around 5 percent. This estimate is on the high end of estimates in the literature (see e.g., Larry L. Leslie and Paul T. Brinkman, 1988; Michael S. McPherson, 1993). Now suppose we have a 10-percent across-the-board increase in taxes. Since the gain from attending college is around \$3,000 in 1970 dollars, this will lead to approximately a 2.5-percent decline in college attendance (assuming that this group would stay in college for two years). Since the total present value of human capital possessed by those who attend college is about 8-percent higher than for the other high-school graduates, a 10-percent increase in taxes leads to approximately a 0.2-percent (i.e., two-tenths of 1 percent) decline in human capital. Thus this back-of-the-envelope calculation suggests that changes in flat taxes should not have a large influence on human-capital investment.

There are a number of problems with this calculation. The return to college appears to have risen over this period, which biases the calculation downward. We are ignoring educational selectivity, which will tend to bias the estimate upward. Finally, if credit constraints are important, then tuition should have a larger effect on college enrollment than future gains. This will tend to bias this calculation upward. However, the effect of a flat tax on human-capital accumulation appears to be very small.

We also extend our analysis to a general-equilibrium framework in a simple way by incorporating our OJT human-capital investment estimates into Trostel's (1993) model. In this general-equilibrium model, when there is no leisure and the only inputs into human-capital production are time and human capital, lowering the tax rate on capital has no effect on the steady-state level of human capital. In this representative-agent framework, the level of capital adjusts so that the after-tax rate of return on capital equals the rate of time preference, so there is no effect on human-capital investment. This result is similar, but stronger, than Davies and Whalley's (1989) result in an overlapping-generations model. In the long run, they find that once the rental rate on physical capital returns to its initial net-of-tax level after a reduction in the income tax, steady-state human capital is almost unchanged.

We also look at the long-term effects of a switch from an income tax to a consumption tax in this model, allowing for leisure and for human-capital investment goods. We compute two steady states under the assumption that all goods inputs are financed through forgone earnings. While physical capital rises by 50–60 percent after switching to the consumption-tax system, the effect on human capital is small. It remains relatively constant between the two regimes, rising or falling 1–2 percent depending on the intertemporal elasticity of leisure and the share of goods inputs into human-capital production. The end result on welfare is an increase in consumption of about 15–20 percent, coupled with an increase in leisure of approximately 1 percent.

III. Conclusion

In this paper, we investigate the effects of two major distortions in the U.S. tax system (progressivity and the nondeductibility of direct investment goods) on human capital. Using an extension of the Ben-Porath model of human-capital accumulation, we characterize the life-cycle earnings and OJT investment paths for the median worker in four schooling groups in 1970 using the 1970 tax code. We then simulate the model with a flat tax and find a moderate increase in human capital of approximately 5 percent overall. We also simulate the model using the 1990 tax schedule and find the simplified tax schedule is flat for most workers. However, moving individuals closer to the kinks of the schedule decreases human-capital investment by as much as 22 percent, implying large potential effects of progressivity. We also provide an estimate of how taxes affect schooling choice. Our initial calculations indicate that this effect may be small. We then use data on those individuals who attend some college to estimate that a 10-percent increase in taxes leads to an approximate 0.2-percent decline in human capital, indicating that changes in flat taxes should not have a large effect on schooling human capital. In our general-equilibrium results, we investigate the steady-state effects of switching to a consumption tax from an income tax in a model with leisure; we find large increases in physical capital, but only small effects on human capital. In our general-equilibrium model without leisure, tax rates on physical capital have no effect on human capital.

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