Tax Policy and Human-Capital Formation

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Missing from recent discussions of tax reform is any systematic analysis of the effects of various tax proposals on skill formation (see the papers in the collection edited by Henry Aaron and William Gale [1996]). This gap in the literature in empirical public finance is due to the absence of any empirically based general-equilibrium models with both human-capital formation and physical-capital formation that are consistent with observations on modern labor markets. This paper is a progress report on our ongoing research on formulating and estimating dynamic general-equilibrium models with endogenous heterogeneous human-capital accumulation. Our model explains many features of rising wage inequality in the U.S. economy (Heckman et al., 1998). In this paper, we use our model to study the impacts on skill formation of proposals to switch from progressive taxes to flat income and consumption taxes. For the sake of brevity, we focus on steady states in this paper, although we study both transitions and steady states in our research.

I. Our Model

Our analysis builds on the model of Alan Auerbach and Laurence Kotlikoff (1987) in two ways: (i) we introduce skill formation and consider both schooling choices and investment in on-the-job training; and (ii) we allow for heterogeneity in ability, endowments and skills. Different schooling levels are associated with different skills and different post-school investment functions. We relax their efficiency-units assumption for labor services. Models with efficiency units for labor services do not explain rising wage inequality among skill groups. Our model has three sources of heterogeneity among persons: (i) in age; (ii) in ability to learn and in initial endowments; and (iii) in the economic histories experienced by cohorts. In a transition period, different cohorts face different skill prices, make different investment decisions, and hence, accumulate different amounts of human capital and have different wage levels and trajectories. Our model extends the analysis of James Davies and John Whalley (1991) who introduce human capital into the Auerbach-Kotlikoff model but assume only one skill. We allow for multiple skills, incorporate both schooling and on-the-job training, and allow for rational expectations in calculating transition paths.

In our model, individuals live for $\bar{a}$ years and retire after $a_R \leq \bar{a}$ years. In the first stage of the life cycle, a prospective student chooses the schooling option that gives him the highest level of lifetime utility. Define K_{at} as the stock of physical capital held at time t by a person age a; H^S_{at} is the stock of human capital at time t of type S at age a. The optimal-life-cycle problem can be solved in two stages. First, condition on schooling and solve for the optimal path of consumption (C_{at}) and post-school investment time (I^S_{at}) for each schooling level. Second, let individuals select among schooling levels to maximize lifetime welfare.

Given S, an individual age a at time t has the following value function:

$$(1)\quad V_{at}(H^S_{at}, K_{at}, S) = \max_{C_{at}, I^S_{at}} \frac{C^{\gamma}_{at} - 1}{\gamma} + \delta V_{a+1,t+1}(H^S_{a+1,t+1}, K_{a+1,t+1}, S)$$

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where δ is a time preference discount factor. We follow Kotlikoff et al. (1997) by assuming that the tax schedule can be approximated by a progressive tax on labor income and a flat tax on capital income. This gives the following dynamic budget constraint:

$$(2)\quad K_{a+1,t+1} \leq K_{a,t}[1+(1-\tau_{\mathrm{k}})r_t] + R_t^S H_{at}^S(1-I_{at}^S) - \tau_\ell[R_t^S H_{at}^S(1-I_{at}^S)] - C_{at}$$

where τ_{k} is the proportional tax rate on capital, τ_ℓ is the progressive tax schedule on labor earnings, R_t^S is the price of human capital services of type S at time t, and r_t is the net return on physical capital at time t. We experiment with other progressive tax schedules and obtain results similar to the ones we report here. In this paper, we abstract from labor supply. Estimates of intertemporal substitution in labor supply estimated on annual data are small, so ignoring labor supply does not affect our analysis. This simplification makes our model comparable to that of Davies and Whalley (1991), who also ignore leisure.

On-the-job human capital for a person of schooling level S accumulates through the human-capital production function:

$$(3)\quad H_{a+1,t+1}^S = A^S(\theta)(I_{at}^S)^{\alpha_S}(H_{at}^S)^{\beta_S} + (1-\sigma^S)H_{at}^S$$

where the conditions $0 < \alpha_S < 1$ and $0 \leq \beta_S \leq 1$ guarantee that the problem is concave, and σ^S is the rate of depreciation of skill (S)-specific human capital. This functional form is widely used in both the empirical literature and the literature on human-capital accumulation. The parameters α and β are also permitted to be S-specific, which emphasizes that schooling affects the process of learning on the job in a variety of different ways.

Notably absent from our model are short-run credit constraints which are often featured in the literature on schooling and human capital accumulation. Our model is consistent with the evidence presented in Stephen Cameron and Heckman (1998) that long-run family factors correlated with income [the θ operating through $A^S(\theta)$ and the initial condition for (3)] affect schooling but that short-term credit constraints are not empirically important. Such long-run factors account for the empirically well-known correlation between schooling attainment and family income.

At the beginning of life, agents choose the value of S that maximizes lifetime utility:

$$(4)\quad \hat{S} = \underset{S}{\operatorname{argmax}}[V^S(\theta) - D^S + \varepsilon^S]$$

where $V^S(\theta)$ is the tax-adjusted present value of earnings at schooling level S computed from the optimal program, D^S is the discounted tuition cost of schooling, and ε^S represents nonpecuniary benefits expressed in present-value terms.

Tuition costs are permitted to change over time so that different cohorts face different schooling costs. The economy is assumed to be competitive so that the prices of skills and capital services are determined as derivatives of an aggregate production function. In order to compute service-flow prices for capital and the different types of human capital, it is necessary to construct aggregates for each of the factors over each of the ability types and over all cohorts to insert into an aggregate production function.

Human capital of type S is a perfect substitute for any other human capital of the same schooling type, whatever the age or experience level of the agent, but it is not perfectly substitutable with human capital from other schooling levels. In our model, cohorts differ from each other because they face different price paths and policy environments within their lifetimes.

Our aggregate production function exhibits constant returns to scale. The equilibrium conditions require that marginal products equal pretax prices. In the two-skill economy we analyze, the production function at time t is defined over the inputs $\bar{H}_t^1$, $\bar{H}_t^2$, and $\bar{K}_t$, where $\bar{H}_t^1$ and $\bar{H}_t^2$ are aggregates of *utilized* skills (high school and college, respectively) supplied to production, and $\bar{K}_t$ is the aggregate stock of capital. The technology we use is

$$F(\bar{H}_t^1, \bar{H}_t^2, \bar{K}_t)$$
$$= a_3 \{ a_2[a_1(\bar{H}_t^1)^{\rho_1} + (1 - a_1)(\bar{H}_t^2)^{\rho_1}]^{\rho_2/\rho_1} + (1 - a_2)\bar{K}_t^{\rho_2} \}^{1/\rho_2}.$$

We estimate that $\rho_2 = 0$ but $\rho_1 = 0.693$, which yields an elasticity of substitution between high school and college human capital of 1.441.

Human-capital accumulation functions (3) are estimated using micro data assuming that taxes are proportional. However, an extensive sensitivity analysis reveals that, within the range of the data for the U.S. economy, misspecification of the tax system does not affect parameter estimates if the model is recalibrated on aggregate data. We now use the model to investigate tax policies.

II. Tax Effects on Human-Capital Accumulation

In the absence of labor-supply and direct pecuniary or nonpecuniary costs of human-capital investment, there is no effect of a proportional wage tax on human-capital accumulation. Both marginal returns and costs are scaled down in the same proportion. When untaxed costs or returns to college are added to the model (i.e., nonpecuniary costs/benefits), proportional taxation is no longer neutral. An increase in the tax rate decreases college attendance if the net financial benefit before taxes is positive ($V^2 - D^2 - V^1 > 0$). Progressivity reinforces this effect. A progressive wage tax reduces the incentive to accumulate skills, since human capital promotes earnings growth and moves persons to higher tax brackets. As a result, marginal returns on future earnings are reduced more than marginal costs of schooling.

Heckman (1976) notes that in a partial-equilibrium model, proportional taxation of interest income with full deductibility of all borrowing costs reduces the after-tax interest rate and, hence, promotes human-capital accumulation. In a time-separable, representative-agent general-equilibrium model, the after-tax interest rate is unaffected by the tax policy in steady state as agents shift to human capital from physical capital (see Philip Trostel, 1993). In that framework, flat taxes with full deductibility have no effect on human-capital investment. In a dynamic overlapping-generations model with heterogeneous agents and endogenous skill formation and with progressive rates, taxes have ambiguous effects on human capital, and both their quantitative and qualitative effects can only be resolved by empirical research. We use our empirically grounded model to study alternative proposals for tax reform.

III. Analyzing Two Tax Reforms

Following Kotlikoff et al. (1997), we assume that the U.S. income tax can be captured by a progressive tax on labor income and a flat tax on capital income. Each earner has 1.22 children and is single. For each additional dollar beyond $9,660, there is an increase in itemized deductions of 7.55 cents. An individual with labor income Y has taxable income $(Y - 9{,}660)(1 - 0.0755)$. Using the 1995 tax schedule, we compute the taxes paid by income and approximate this schedule by a second-order polynomial. We assume a 0.15 flat tax rate on physical capital.

We consider two revenue-neutral tax reforms from this benchmark progressive schedule. The first reform (which we call "flat tax") is a revenue-neutral flattening of the tax on labor earnings, holding the initial flat tax on capital income constant. The second reform ("flat consumption tax") is a uniform flat tax on consumption. In both flat-tax schemes, tuition is not treated as deductible. (We discuss the consequences of making it deductible below.) For each tax, we consider two models: (i) a partial-equilibrium model in which skill prices and interest rates are fixed and (ii) a closed-economy general-equilibrium model where skill prices and interest rates adjust.

Table 1 presents both partial-equilibrium and general-equilibrium results measured relative to a benchmark economy with the Kotlikoff et al. (1997) tax schedule. We first discuss the partial-equilibrium effects of a move to a flat tax, which eliminates progressivity in wages and stimulates skill formation.

TABLE 1—COMPARISON OF STEADY STATES UNDER ALTERNATIVE TAX REGIMES

	Percentage difference from benchmark progressive case			
	Flat tax		Flat consumption tax	
Variable	PE	GE	PE	GE
After-tax interest rate	0.00	1.96	17.65	3.31
Interest rate	0.00	1.96	0.00	−12.18
Skill price, college human capital	0.00	−1.31	0.00	3.38
Skill price, high-school human capital	0.00	−0.01	0.00	4.65
Stock of physical capital	−15.07	−0.79	86.50	19.55
Stock of college human capital	22.41	2.82	−15.77	1.85
Stock of high-school human capital	−9.94	0.90	1.88	0.08
Stock of college human capital per college graduate	3.04	2.55	−4.08	1.72
Stock of high-school human capital per high-school graduate	1.84	1.07	−5.23	0.16
Fraction attending college	18.79	0.26	−12.18	0.13
Aggregate output	−0.09	1.15	15.76	4.98
Aggregate consumption	−0.08	0.16	7.60	3.66
Mean wage, college graduate	3.39	2.60	0.12	6.96
Mean wage, high school graduate	2.44	2.44	0.25	6.82
Standard deviation, log wage	4.09	1.56	−1.94	0.69
College/high-school wage premium[a]	1.92	−0.45	3.10	0.18

Notes: In the progressive case, we allow for a progressive tax on labor earnings but assume a 15-percent flat tax on capital. In the flat-tax regime, we hold the tax on capital fixed at 15 percent but assume that the tax on labor income is flat. Balancing the budget yields a tax rate on labor income of 7.7 percent. In the consumption-tax reform, only consumption is taxed at a 10-percent rate. PE = partial equilibrium; GE = general equilibrium.

[a] The college/high-school wage premium measures the difference in mean log wage rates between college graduates and high-school graduates with ten years of work experience.

College attendance rises dramatically as the higher earnings associated with college graduation are no longer taxed away at higher rates. The amount of post-school on-the-job training also increases for each skill group (as measured by the stocks of human capital per worker of each skill). The aggregate stock of high-school human capital declines, while the aggregate stock of college human capital increases as a result of the rise in college enrollment. The college–high-school wage differential increases slightly as does another widely used measure of inequality, the standard deviation of log wages. The effects of reform on aggregates of consumption and output are modest at best. However, capital formation is greatly reduced as the tax code now favors human capital compared to the benchmark economy.

In general equilibrium, the effects of the reform on skill formation are, in general, qualitatively similar, but they are greatly diminished. The effects on aggregate consumption and output are weak, as they are in the partial-equilibrium case. Furthermore, the negative effects of the reform on physical capital are muted, since the return to capital increases. The rise in the after-tax interest rate chokes off skill investment. Per capita post-school on-the-job training accumulation still increases for both skill groups, although the increase is dampened compared to the partial-equilibrium case. Aggregate stocks of both high-school and college human capital now rise, since college enrollment increases much less. The distinction between partial equilibrium and general equilibrium is especially striking for the fraction attending college. Though not shown in the table, college attendance increases only for the most able, whereas in the partial-equilibrium case, it increases for all ability groups. Changes in skill prices and interest rates virtually offset the removal of the disincentives of progressive taxes on schooling enrollment. The college–high-school wage differential (at 10 years of experience) now declines slightly, and the increase in the standard deviation of log wages is less. In general equilibrium, the increase in the standard deviation is smaller, because skill prices adjust and because higher after-tax interest rates flatten wage profiles.

Next, consider a move to a flat consumption tax. This reform is more pro-capital and is less favorable to human capital. It raises output, capital, and consumption more than a flat-tax reform, and it reduces the aggregate stock of high-skill human capital and the stock of human capital per worker for each skill group. The fraction attending college declines. The reform raises wage inequality as measured by the college–high-school wage premium but lowers it as measured by the standard deviation of log wages.

In general equilibrium, this reform is slightly less favorable to human-capital formation than the flat tax, since the after-tax rate of return on capital rises more. College attendance increases slightly, but the increase is concentrated among the least and most able persons. Wage inequality increases slightly by both conventional measures. Real wages rise for both skill groups. The effect is greater than in the flat-tax reform. This is due to a larger increase in capital under proportional consumption taxation. Since capital is a direct complement with both forms of human capital, the increase in capital raises skill prices about equally for both skill groups. The greater increase in real wages in this case is not due to a larger increase in per capita human-capital accumulation within skill groups.

When we introduce deductibility of tuition in both reforms and preserve revenue-neutrality, there is virtually no effect on skill formation (or anything else) in general equilibrium. This is consistent with our other work in which we show that general-equilibrium effects of tuition subsidies are small. The lessons from partial-equilibrium analyses are substantially misleading guides in analyzing the effects of tax and tuition policy on skill formation. Changes to proportional taxation are unlikely to have large effects on skill formation or output. A change to a flat consumption tax has the largest effect on output, consumption, and real wages, but it also slightly raises wage inequality. These conclusions also hold for open-economy simulations in which the interest rate is set in world markets. They are robust to a variety of tax schedules and empirically grounded parameter estimates.

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