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11 A Reexamination of Tax Distortions in General Equilibrium Models

Don Fullerton and Roger H. Gordon

General equilibrium models of the United States economy have grown much more realistic in the last few years (the late 1970s and early 1980s), becoming more disaggregated and using more recent and extensive data on differences in behavior among individual consumers and producers. Serious attempts have been made using these models to simulate the effects of several proposed tax changes, including integration of the corporate with the personal income tax and replacement of the income tax with a consumption tax. However, in attempting to capture the effects of the government on the economy, these models have generally assumed for simplicity that marginal tax rates equal the observed average tax rates and that marginal benefit rates are zero.

The main purpose of this paper is to derive improved estimates of various marginal tax rates and to take into account certain offsetting marginal benefits. We use the general equilibrium tax model of Fullerton, Shoven, and Whalley (1978, 1980, hereafter FSW) as a starting point for this remodeling effort. Most important, we include in the model recent theories developed in Gordon (1980) concerning the effects of combined corporate and personal taxes on firms' financial and capital intensity decisions. We also apply the same theoretical approach to the modeling

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of governmental financial and capital intensity decisions. This approach takes explicit account of uncertainty, the flexibility of corporate financial policy, and inflation. In addition, we briefly reexamine the modeling of the property tax, unemployment insurance, workmen's compensation, and social security.

To test the importance of the above changes in the modeling of government-induced distortions, we resimulate the effects of the integration of corporate with personal income taxes. We find, contrary to FSW, that the welfare gains of lessening tax distortions through integration are more than offset by the welfare losses resulting from raising tax rates on labor income in order to replace lost revenue. This result is particularly strong because FSW included only intertemporal and interindustry allocation welfare gains, whereas we allow further welfare gains from eliminating the tax distortion which favors debt finance.

The organization of the paper is as follows. In section 11.1 we reexamine some of the marginal distortions created by the various taxes on labor. In section 11.2 we describe our modeling of the effects of corporate and personal taxes on firms' financial and investment decisions. We also describe here the construction of the data needed to calculate the new industry-specific marginal costs of capital. Section 11.3 describes a few other adjustments in the model made necessary by the change in the modeling of taxes on capital income. Finally, section 11.4 describes the simulation procedure and the results from our resimulation of corporate tax integration using our revised general equilibrium model.

11.1 Changes in the Modeling of Tax Distortions on Labor Income

While FSW carefully measure the size of the various taxes that apply to labor income, they ignore the fact that higher tax payments are often associated with larger transfer receipts. In particular, benefits are closely associated with tax payments in the social security program, in unemployment insurance, and in workmen's compensation. The taxes from these programs are distorting only to the degree that marginal taxes differ from marginal benefits. We discuss each of these programs in turn.

We do not attempt to take into account in this paper other transfer programs, such as food stamps, public housing, and AFDC, where benefits also create an implicit tax on labor income. We model these transfers as though they are paid in a lump-sum fashion, as did FSW. As a result, we may underestimate the welfare costs of increases in tax rates on labor income.[1]

1. This underestimation of welfare losses from the replacement tax serves to strengthen our result that this welfare loss more than offsets welfare gains from integration, as discussed below.

11.1.1 Social Security

The effect of current labor supply on future social security benefits is very complicated, as described in Blinder, Gordon, and Wise (1980). The present value of marginal benefits arising from further work will exceed marginal taxes for older men (at least as old as sixty-five) but will probably fall short of marginal taxes for the very elderly, for younger workers, and for most women. However, we have insufficient information to capture this diversity of net distortions. We would need to know the sex composition and age of workers in each industry as well as individuals in each consumer group. Instead, in the simulations below, we assume that the average net distortion from social security is zero, on the assumption that those facing a net subsidy come close to counterbalancing those who face a net tax. Since we therefore omit from the model the diverse distortions on individual labor supply created by social security, we may further underestimate the welfare costs of tax increases on labor income.

11.1.2 Unemployment Insurance

Most state unemployment insurance programs use a reserve ratio formula to set the firm's tax rate. This formula tries to ensure that the tax payments made by the firm just match the benefits received by its former workers. When this happens, workers anticipate future benefits equal in value to the taxes they currently pay, so the program should not distort labor supply decisions. For a discussion of the law and some remaining distortions, see Brown (1980).

However, state unemployment insurance programs also set a maximum and minimum tax rate on each firm. When a firm is at such a constraint, its workers should anticipate receiving either more or less in benefits, on average, than they currently pay in taxes, implying a net tax or subsidy. The degree to which this happens does differ systematically by industry. Becker (1972) examined the net transfers among industries in several states during the 1950s and 1960s and calculated a net tax or subsidy rate for many industries.[2] The appendix describes how we obtain labor tax rates for our industry classification from Becker's classification. Table 11.1, column 1, reports the resulting net unemployment insurance tax rates by industry.

11.1.3 Workmen's Compensation

The final change we made was to assume that workmen's compensation programs are nondistorting. While such programs are normally mandated by the government, the cost of the program to each firm is typically

2. For a discussion of the interindustry labor misallocations and general equilibrium incidence effects caused by this tax/subsidy system, see McLure (1977).

Table 11.1 **Data Used in Calculating Tax Rates**

	Labor Tax Rate	t_p*	γ	δ_c	k	d	d_x
All Industries	.002	.005	.399	.079	.021	.036	.004
(1) Agriculture. forestry, and fisheries	−.035	.020	.159	.168	.039	.058	.020
(2) Mining	−.006	.010	.258	.096	.021	.054	.016
(3) Crude petroleum and gas	−.006	.021	.173	.107	.012	.013	−.010
(4) Construction	−.023	.009	.080	.110	.020	.094	.056
(5) Food and tobacco	−.004	.008	.253	.073	.061	.057	.020
(6) Textile, apparel, and leather	−.008	.015	.435	.092	.005	.213	.167
(7) Paper and printing	.009	.010	.268	.096	.043	.106	.059
(8) Petroleum refining	.008	.002	.194	.081	.037	.005	−.019
(9) Chemicals and rubber	.007	.006	.169	.079	.038	.081	.040
(10) Lumber, furniture, stone, clay, and glass	−.005	.007	.273	.111	.094	.081	.042
(11) Metals and machinery	.008	.009	.160	.095	.035	.064	.026
(12) Transportation equipment	.011	.050	.433	.108	.057	.117	.078
(13) Motor vehicles	.006	.003	.255	.092	.046	.039	.005
(14) Transportation, communication, and utilities	.006	.010	.497	.058	.035	.051	.013
(15) Trade	.007	.012	.313	.098	.025	.053	.015
(16) Finance and insurance	.012	.005	.605	.067	.049	.079	.041
(17) Real estate	.004	.0	.787	.057	.001	.009	−.016
(18) Services	.008	.013	.503	.102	.011	.042	.006

*Note that t_p is half of the average property tax payment rate in each industry except real estate.

negotiated with a private insurance company. Competition among insurance companies implies that expected taxes and benefits ought to be equal for each firm. There are a few public programs, but these correspond closely in form to the private programs, and should therefore be nearly nondistorting as well.

11.2 Tax Distortions Affecting Firms' Financial and Investment Decisions

In the FSW model, corporate financial policy is exogenous, while capital intensity decisions are distorted by a marginal tax rate set equal to the observed average tax rate on capital income, calculated separately by industry. The average tax rate in each industry is set equal to the ratio of corporate, personal, and property tax payments in 1973 to capital income in that year. Capital is then allocated such that the rate of return to capital net of taxes and depreciation is equated in all industries.

This approach conveniently abstracts from the many detailed provisions of the United States tax law. However, it has many problems. Most immediately, the measured average tax rate depends critically on the measure for true earnings to capital. This latter number is difficult to calculate appropriately in any year and varies greatly from year to year. This variation implies that there is substantial measurement error in the calculated tax rates. In this paper, we instead model the tax law directly and calculate the cost of capital implied by the prevailing market interest rate and the existing tax law. While this procedure requires many new data in order to characterize the tax law by industry, it does not require capital income and tax payment figures, which can fluctuate sharply from year to year.

A more important reason for our remodeling, however, is that the explicit model of the effect of taxes on capital intensity decisions implies that marginal tax distortions differ dramatically from average tax rates, even if all figures can be measured without error. In this model, the government shares in the risk in the return to capital since its tax revenue is stochastic. The benefits to the firm of transferring to the government some of the risk in the return to its capital is not taken into account when calculating an average tax rate. This offsetting benefit turns out to be very important.

In addition to explicitly modeling a firm's capital intensity decisions, we model simultaneously how taxes affect the firm's optimal financial policy.[3] We assume that firms choose a debt-equity ratio which minimizes their cost of capital, trading off the tax advantages of debt against bankruptcy or other leverage-related costs. These leverage-related costs

3. For an earlier introduction of an endogenous debt-equity decision into a Harberger (1962) style general equilibrium model, see Ballentine and McLure (1981).

are real costs which profit-maximizing firms will choose to bear in order to save taxes and are part of the distortion costs created by the existing taxes on capital income.

In our model of both financial and capital intensity decisions, we explicitly model both uncertainty and inflation. The basic model, a generalization of the capital asset pricing model, is developed in Gordon and Bradford (1980).[4] It is further analyzed in Gordon and Malkiel (1980) and in Gordon (1980). In the next two sections, we briefly describe how in this model corporate financial and capital intensity decisions depend on the tax law.

11.2.1 Modeling of Corporate Financial Decisions

The tax law treats the returns to bonds and equity differently. First, only payments to bondholders are deductible from the corporate tax base. Counterbalancing this, however, the personal income tax is generally higher on income from bonds, since much of the income from equity is in the form of capital gains, which are taxed more lightly. Let $(1 - \alpha)$ represent the effective personal tax rate on nominal income earned from stocks, $(1 - \alpha_b)$ the effective personal tax rate on interest income from bonds, τ the corporate tax rate, and r the nominal interest rate paid on bonds. Then if the firm were to issue another dollar of debt and use the proceeds to repurchase a dollar of equity (holding the capital stock unchanged), the change in after-tax income to investors would be $\alpha_b r - \alpha r(1 - \tau)$. The new bondholder receives $\alpha_b r$ after taxes while the remaining equityholders lose only $\alpha r(1 - \tau)$ after both corporate and personal income taxes (when they pay the interest on the extra debt). Gordon and Malkiel (1980) show that for plausible values of α and α_b, the expression $r(\alpha_b - \alpha(1 - \tau))$ is positive, which implies that investors as a group can save on taxes by any and all increases in the firm's debt-capital ratio.

While replacing equity with debt is advantageous for tax reasons, a higher debt-capital ratio also implies a higher probability of default.

4. This version of the capital asset pricing model allows for an arbitrary variation in tax rates across investors and across types of return (e.g. interest payments versus capital gains). The key assumptions underlying the model are: (1) investors care only about the mean and the variance in the return on their portfolio, (2) only returns taxed at capital gains rates are stochastic, (3) capital gains are taxed at accrual, (4) there are no short sales constraints, and (5) the tax law allows for full loss offset. The latter assumption, as stated, is clearly false. A firm with tax losses has the ability, however, to carry losses backward and forward to other tax years, and it has the option to merge with a firm with taxable profits. Moreover, we are concerned with the marginal investment and not necessarily the marginal firm. Most of these marginal investments will be undertaken by preexisting firms that are, on average, profitable. Any loss on such a marginal investment would only serve to reduce the taxable profits of such a firm. We assume that, given these possibilities, full loss offset is a reasonable first approximation.

Bankruptcy and the threat of bankruptcy create real costs.[5] The firm's debt-capital ratio is in equilibrium when the increase in expected leverage-related costs resulting from replacing a dollar of equity with a dollar of debt just offsets the tax savings from using a dollar of debt instead of equity. Let γ represent the firm's debt-capital ratio, and let $c(\gamma)$ represent the increase in expected leverage-related costs borne by investors as a group from having an extra dollar of debt when the initial debt-capital ratio is γ.[6] Then in equilibrium γ is chosen such that $r(\alpha_b - \alpha(1 - \tau)) = c(\gamma)$. One would expect that $c(0) \approx 0$ and $\partial c/\partial\gamma > 0$. If there were no tax distortion favoring debt, this formula implies that the firm would use only equity finance and thus avoid all bankruptcy risk.

Leverage-related costs include more than just direct litigation costs in bankruptcy. As Warner (1977) and Gordon and Malkiel (1980) show, litigation costs themselves are very small. When the firm faces the possibility of bankruptcy, however, it also faces distorted investment incentives, as described in Myers (1977). When considering a risky investment, equityholders ignore the higher probability of losses to existing debtholders. Since equityholders receive any gains but pass large enough losses onto bondholders, they face distorted investment decisions. Though debtholders would presumably charge for these costs ex ante, distorted investment incentives would remain and equityholders would bear the costs of this inefficiency. In addition, labor costs can rise, since employees would be reluctant to remain in a job with an uncertain future. The function $c(\gamma)$ is intended to capture all such leverage-related costs.

Let D^* represent the amount of debt chosen to finance the capital stock K, and let $\gamma^* = D^*/K$. Then, since $c(\gamma)$ measures the marginal leverage costs of using a dollar more debt, $\int_0^{D^*} c(D/K)dD$ measures the total leverage cost borne by the firm's investors. If we assume that $c(\gamma)$ has the functional form $c(\gamma) = a\gamma^e$, then in equilibrium the total costs from having D^* of debt would be

$$\text{(1)} \qquad \frac{a\gamma^{*e}D^*}{e+1} = \frac{rD^*(\alpha_b - \alpha(1-\tau))}{e+1}.$$

This expression provides a measure of the privately borne costs resulting from the tax distortion favoring debt finance.[7]

However, any extra expenses arising from a higher debt-capital ratio, e.g. resources spent negotiating and monitoring an agreement, would be deductible from the corporate tax base. These net of corporate tax costs

5. If there were no bankruptcy costs but merely a transfer of risk to bondholders, then the firm still would have the incentive to move to all debt finance, as shown in Modigliani and Miller (1963).

6. The form of the function $c(\gamma)$, and so the optimal value of γ, will vary by firm.

7. To the extent that others are hurt but cannot charge the firm for their costs, even ex ante, this measure is an underestimate of the private costs of leverage.

would then also reduce the individual's personal tax base. Therefore the expression for private leverage costs $c(\gamma)$ represents only $\alpha(1-\tau)$ percent of the total (social) extra leverage-related costs resulting from replacing a dollar of equity with a dollar of debt. Total before-tax leverage-related costs can then be approximated by

$$\frac{rD^*(\alpha_b - \alpha(1-\tau))}{\alpha(1-\tau)(e+1)}.$$

In the simulations of proposed tax changes, we will calculate the change in this estimate of leverage-related costs. This change represents an efficiency gain (or loss) resulting from changing the tax distortion which presently favors debt finance.

11.2.2 Modeling of Capital Intensity Decisions

Corporate capital intensity decisions will depend on the cost of finance when the firm is using this optimal debt-capital ratio. We assume that the capital stock of a corporation is in equilibrium when investors are willing to pay just a dollar for the returns from an additional dollar of capital. Consider a type of investment where the returns are nonstochastic. Then the investment would be pursued using debt finance (with the capital as security), since there would be no leverage-related costs offsetting the tax advantage of debt. When the return to an investment is risky, however, the optimal percent of debt, γ^*, used in financing it will be lower because the firm will trade off the tax advantages of debt against the costs arising from the higher risk of default. If the return from new investment is just as risky as the return from existing capital, we would expect that the appropriate γ^* for the new capital would equal the existing γ for the firm as a whole. We will assume that these conditions hold, so that the marginal γ equals the average γ.

To be willing to finance a project, equity- and debtholders must receive at least the risk-free return after taxes, plus enough to compensate them for the risk that they bear. Define δ_c as the total after-tax risk premium required by corporate equity- and debtholders together on the return from each dollar they invest in the project. By definition, δ_c includes any leverage-related costs. Also, let r_z be the before-tax risk-free interest rate, and let ρ_c be the project's expected rate of return gross of both taxes and depreciation. Then, in equilibrium, the marginal investment ought to earn a ρ_c such that

(2) $$\alpha(1-\tau)(\rho_c - \gamma r) + \alpha_b \gamma r = \alpha_b r_z + \delta_c.$$

The first term on the left-hand side measures the return to equityholders after taxes, and the second term measures the after-tax return to debtholders. This implies that

$$\rho_c = r_z \frac{\alpha_b}{\alpha(1-\tau)} - \gamma r \frac{\alpha_b - \alpha(1-\tau)}{\alpha(1-\tau)} + \frac{\delta_c}{\alpha(1-\tau)}. \tag{3}$$

The right-hand side of this equation in effect measures the before-tax rate of return to the investment required by the market. Note that, at the optimal debt-capital ratio, this expression is minimized.[8]

This derivation ignores many complications, however. Suppose that, for each industry, d is the geometric rate of economic depreciation of capital, and d_x is the constant geometric rate of depreciation for tax purposes that implies the same discounted present value of tax deductions as the more complicated tax law. Suppose that k is the effective rate of the investment tax credit, and t_p is the effective rate of state and local property tax (net of benefits) on the capital stock. Suppose also that π is the expected inflation rate. When all these additional factors are introduced, the equilibrium value of ρ_c will satisfy[9]

$$\rho_c = d + t_p + (1-k) r_z \frac{\alpha_b}{\alpha(1-\tau)} + \frac{\delta_c(1-k)}{\alpha(1-\tau)} - \gamma r \left[\frac{\alpha_b - \alpha(1-\tau)}{\alpha(1-\tau)}\right] + \frac{\tau(d-d_x)}{1-\tau} - \frac{\pi}{(1-\tau)}. \tag{4}$$

Here, ρ_c is a *real* rate of return, while r and r_z are *nominal* risky and risk-free interest rates, respectively.

This formula is basically a generalization of the well-known formula for the cost of capital in Hall and Jorgenson (1967). If uncertainty is ignored (so $\delta_c = 0$ and $r = r_z$), if personal and property taxes are ignored (so $\alpha = \alpha_b = 1$ and $t_p = 0$), if inflation is ignored (so $\pi = 0$), and finally, if the possibility of debt finance is ignored (so $\gamma = 0$), the above formula simplifies to

$$\rho_c = \frac{d + r(1-k) - \tau d_x}{1-\tau}. \tag{5}$$

This formula now differs from that in Hall-Jorgenson only because the decision under consideration here is to invest a dollar now and then maintain a dollar of capital in place through later investments to offset depreciation. Hall-Jorgenson, in contrast, consider only whether to invest a dollar now.[10] Each of the generalizations included here changes the degree to which taxes affect the equilibrium marginal product of capital. In some cases they change it greatly.

8. Differentiating the right-hand side with respect to γ and equating to zero implies that $r(\alpha_b - \alpha(1-\tau)) = d\delta_c/d\gamma$. This equation is just the equilibrium condition for an optimal debt-capital ratio derived above, where $d\delta_c/d\gamma$ corresponds to $c(\gamma)$.

9. See Gordon (1980) for a derivation.

10. Hall-Jorgenson also describe tax depreciation allowances in terms of their present value Z rather than the equivalent constant flow d_x.

Now consider the capital stock of a noncorporate firm in the same setting. It will be in equilibrium when the nominal return (after depreciation and taxes) equals the after-tax return on a risk-free asset plus enough to compensate for the risk. Define δ_{nc} as the after-tax risk premium required by noncorporate proprietors in each industry on the return from each dollar they invest, and define m as the proprietor's personal marginal tax rate. Then, ρ_{nc} will satisfy

$$\text{(6)} \qquad \frac{1}{1-k}(\rho_{nc} + \pi - t_p - d) - \frac{m}{1-k}(\rho_{nc} - d_x - t_p) = r_z(1-m) + \delta_{nc}.$$

Solving for ρ_{nc}, we find

$$\text{(7)} \qquad \rho_{nc} = d + t_p + (1-k)r_z + \frac{\delta_{nc}(1-k)}{1-m} + \frac{m}{1-m}(d - d_x) - \frac{\pi}{1-m}.$$

In these equations, we have assumed that the proprietor finances the capital himself. If he obtains extra funds from another party with the same marginal tax rate, then the equation continues to hold, whether the proprietor borrows from the other individual or makes him a partner in the business. Since there is no tax advantage to debt finance here, debt will only be used when it creates no leverage-related costs. Also, since the proprietor's personal assets, as well as the business's assets, can be put up as collateral, debt can be kept riskless, and presumably free of leverage costs, much more easily here than in the corporate sector.

We modified equation (6) slightly for the real estate industry, which includes both rental and owner-occupied housing. For owner-occupied housing, there is basically no personal income tax on the returns to the investment, though t_p continues to be deductible, implying that in equilibrium

$$\text{(8)} \qquad \frac{1}{1-k}(\rho_{nc} + \pi - d - t_p(1-m)) = r_z(1-m) + \delta_{nc}.$$

The above analysis of noncorporate investment is also not quite appropriate for rental housing. We ignore any taxation of inflationary capital gains in other noncorporate business on the presumption that the gains would be realized sufficiently rarely, except at death when they would be tax free. In rental housing, however, gains are realized much more frequently. If g equals the effective capital gains tax rate, then the equilibrium condition becomes

(9)
$$\frac{1}{1-k}(\rho_{nc}+\pi-d-t_p)-\frac{m}{1-k}(\rho_{nc}-d_x-t_p)$$
$$-\frac{g\pi}{1-k}=r_z(1-m)+\delta_{nc}.$$

To obtain ρ_{nc} for the real estate industry as a whole, we took a weighted average of the equilibrium values for rental and owner-occupied housing. For weights, we used the sizes of the capital stock in each sector.[11]

In order to apply the above theory to the FSW general equilibrium model, several further assumptions must be made. Each industry will be characterized by its own values for d, d_x, k, and δ_{nc}, the risk premium when there are no leverage costs. In effect, the inherent riskiness and durability of capital assets used by each industry will be taken to be exogenous. The corporate sector in each industry will also be characterized by its observed values for γ and δ_c. However, corporate financial policy (γ) will be endogenous in the model, as will be the size of the leverage cost component of δ_c. A later section derives expressions for the inherent risk component of δ_c, which will remain constant, and the leverage cost component of δ_c, which varies with γ. When tax changes are simulated, these parameters γ and δ_c will vary systematically from their observed values.

The values for these industry-specific parameters, together with the market parameters r_z, r, π, τ, α, and α_b, determine a value of ρ_c for each industry. The same industry and market parameters are used along with a proprietor's tax rate m to determine a value of ρ_{nc} in each industry. We then take a weighted average of ρ_c and ρ_{nc}, using as weights the relative sizes of the corporate and noncorporate capital stocks in that industry. The percent of capital in each industry used by incorporated firms is assumed to be exogenous.[12] The resulting industry-wide value for the marginal product of capital we denote by ρ.

Given the market interest rates r and r_z, we have a separate value of ρ for each industry. Given the rest of the model, these values for ρ imply a desired capital stock for each industry. The sum over all industries of these desired capital stocks equal the total demand for capital. In each equilibrium simulation, the solution algorithm finds an r_z such that this

11. There are no explicit estimates for the proportion of housing capital that is owner-occupied. Using numbers from the *Statistical Abstract*, we multiplied the number of homeowners by the median value of owner-occupied homes, and then divided by the value of the total housing stock. These figures reveal that, although approximately 65% of households own their own homes, 85% of the value of housing stock is owner-occupied.

12. Too little is known about the responsiveness to tax parameters of the decision to incorporate to model this decision explicitly.

total demand for capital just equals the available supply of capital.[13] The supply of capital in each period is fixed, but the endogenous savings response of one period is used to appropriately augment the capital stock for the next equilibrium in the sequence. This process is described in more detail below.

11.2.3 Derivation of Data Required to Calculate ρ

In order to use the above procedure to calculate the equilibrium marginal product in each industry, many new data are needed. In this section, we describe how we calculate each of the needed variables. We calculate data values for 1973 in order to be comparable with the FSW model.

Property Tax Rates (t_p)

In FSW, the property tax is modeled as a distorting proportional income tax on capital. The benchmark tax rate on any industry is set equal to the observed property tax payments relative to net capital income in that industry. Since owner-occupied housing is included in the housing industry, this modeling applies to household as well as commercial and industrial payers of property taxes.

In the above derivation, the property tax was modeled instead as a proportional tax on the value of the capital stock. However, the appropriate value of t_p is not clear. The average tax rate can readily be calculated by taking the ratio of property tax payments to the value of the capital stock in each industry. However, local public expenditures financed by the property tax provide some offsetting benefits. Tiebout (1956), McGuire (1974), and Hamilton (1976) take both benefits and taxes into account and develop a set of assumptions under which the property tax on residential property is nondistorting. It is just a price at which households can purchase local public goods. The assumptions underlying this conclusion are strong. For example, they rule out any spillover of benefits across community lines. They also require a large number of communities, yet the population of each community must be sufficiently large that further expansion entails congestion costs which just offset the gains from sharing the costs of public expenditures with more people. In this paper, however, we will accept the Tiebout hypothesis for households as a first approximation. Specifically, we assume that the effective property tax rate in the housing industry is zero.[14] However, we do report briefly below

13. We assume that the bond risk premium $r - r_z$ equals a given preset value in all contexts. It would have been preferable to allow it to vary by industry and across simulations. Lacking the information necessary to do this seriously, we did not attempt to do it at all. Fortunately, sensitivity analysis indicates that the value of the risk premium $r - r_z$ has very little effect on the value of ρ.

14. The application of the Tiebout model to the property tax depends critically on the availability of zoning regulations (see Hamilton 1976). The argument does not apply to state and local income (wage) taxes, where zoning is not available to enforce the creation of

on a simulation where half of property taxes on housing are treated as distorting.

Application of the Tiebout hypothesis to commercial and industrial property seems less convincing. A defense of this application is developed in Fischel (1975) and White (1975). The essence of the argument is that if communities compete to obtain commercial and industrial property, then the property tax payments and the benefits will, in equilibrium, be set such that the community is indifferent to whether or not a new firm enters. As a result, a profit-maximizing firm will choose the most efficient location. Its tax payments may go not only to finance the benefits it receives but also to compensate the community for the noise, pollution, or congestion that it creates. In this setting it seems plausible to assume that the tax is nondistorting.

However, once a firm has located and is considering additional investment, it has lost its bargaining position with the community. To relocate, the firm would incur large fixed costs. The community may have some inhibition about exploiting captive firms. Some firms may indeed leave, and certainly new firms would as a result be more reluctant to enter. Yet in this context there is certainly less competitive pressure to equate additional taxes with additional benefits.

Because of the ambiguity of the theory, we ran two sets of simulations. In one simulation, all property tax payments were exactly offset by benefits. In the other simulation, half of nonresidential tax payments were assumed to be offset by benefits while all of residential tax payments were assumed to be offset by benefits. Together the two simulations provide a sensitivity test of the importance of the treatment of the property tax. The effective tax rates t_p used in the second case are reported in column 2 of table 11.1. These parameters equal half of the observed property tax divided by the capital stock in that industry.

Corporate Debt-Capital Ratios (γ)

Gordon and Malkiel (1980) used data from the COMPUSTAT[15] tape to estimate the ratio of the market value of debt to the market value of debt plus equity. This calculation included firms with securities traded on the New York Stock Exchange, on the American Stock Exchange, and over the counter. Only economy-wide figures were reported in that paper. Here, we used the same procedure to calculate the ratio separately for each of our eighteen private industries.[16] The resulting figures for 1973 are reported in column 3 of table 11.1.[17]

communities with homogeneous income as well as homogeneous tastes for public services. We therefore continue to treat state and local income taxes as distorting taxes.

15. COMPUSTAT is a data set compiled by Standard and Poor Corporation containing balance sheet information on many publicly traded corporations.

16. Only the book value of debt is reported on the COMPUSTAT tape. We used figures from von Furstenburg, Malkiel, and Watson (1980) on each industry's average ratio of

Risk Premiums (δ_c *and* δ_{nc})

Consider a particular security s, with an expected after-tax return $\bar{r}_s$, where the overbar indicates expectations. The capital asset pricing model implies that the risk premium $\bar{r}_s - \alpha_b r_z$ ought to equal $\beta_s(\bar{r}_m - \alpha_b r_z)$, where $\bar{r}_m$ is the expected after-tax return on the market portfolio, and β_s is the covariance of r_s and r_m, divided by the variance of r_m. The risk premium can be measured either directly, by using $\bar{r}_s - \alpha_b r_z$, or it can be measured indirectly, by estimating β_s for that security and multiplying by the expected risk premium on the market portfolio

Here, in estimating δ_c, we have chosen the indirect method to measure the risk premium on equity in each industry and the direct method to measure the risk premium on bonds. The risk premium δ_c appropriate for a dollar invested in corporate capital in each industry is then the sum of the risk premium on γ dollars of debt and the risk premium on $(1 - \gamma)$ dollars of equity.

To calculate each industry's risk premium on equity, we proceeded by first estimating the β for a value-weighted portfolio of the equity from all firms in the industry which were traded publicly on the New York Stock Exchange. The estimation was done over the period 1969–73 using the Center for Research in Securities Prices monthly returns data. The market portfolio was taken to be a value-weighted portfolio of the equity from *all* firms traded on the New York Stock Exchange. The risk premium on the equity in each industry is then this estimate of β times the expected excess return on the market portfolio, which Merton (1980) estimates to be 0.1075.[18]

Lacking information about how the risk premium on bonds varied by industry, we assumed a common risk premium of $\alpha_b(r - r_z)$, which equals 0.0246 using the parameter values discussed below. The value of δ_c was then set equal to $0.1075(1 - \gamma)\beta + 0.0246\gamma$ in each industry. Implicitly we assume here that the potential new capital in an industry is equally as risky as the existing capital. The resulting values for δ_c by industry are reported in column 4 of table 11.1.

The value of δ_{nc} ought to differ from that for δ_c for two major reasons. First, given present tax law, investment will be riskier in the corporate sector where tax incentives favor debt. For noncorporate investment, no taxes are saved through debt rather than "equity" finance, so there is no

market value to book value of debt to construct figures for the market value of debt for each firm on the tape. When the ratio of the market value of debt to the book value of debt was not available for a specific industry, we applied the economy-wide ratio to the firms of that industry.

17. The debt-value ratio, as calculated here, will differ slightly from the debt-capital ratio used in the theory, however. In particular, a dollar raised in the market is sufficient to purchase $1/(1 - k)$ dollars of capital yet is valued in the market at a dollar. Therefore the calculated debt-value ratio would equal $\gamma/(1 - k)$, where γ is the debt-capital ratio.

18. We used the estimates from Merton's model 3, estimated over the time period 1962–78.

tax incentive to accept real leverage-related costs.[19] Therefore the risk premium on a noncorporate investment ought to be smaller than that on an otherwise equivalent corporate investment since it ought to be free of leverage-related costs.

To estimate the additional leverage cost arising from investment in one more dollar of corporate capital, assume that leverage costs are proportional to the size of the capital stock for any firm, holding γ constant. The marginal leverage costs would then equal the expression for privately borne leverage costs derived earlier, divided by the size of the capital stock, or

$$\frac{\gamma r(\alpha_b - \alpha(1-\tau))}{e+1}.$$

Without the tax distortion favoring debt, the corporate risk premium would be smaller by this amount.

A second reason for δ_{nc} to differ from δ_c is that the government absorbs a different percent of the risk from investment in each sector. The risk borne by investors on a dollar investment would differ between the sectors, even if the inherent[20] riskiness of the investment were the same, because the tax rates differ. Because of taxes, the risk borne by corporate investors is only $\alpha(1-\tau)$ percent of the total risk in the return to corporate capital. Similarly, noncorporate investors bear only $(1-m)$ percent of the total risk in the return on their capital.

We assume that these are the only two reasons why δ_{nc} differs from δ_c. In particular, we assume that noncorporate capital is just as risky as corporate capital, leverage costs aside, and that noncorporate investors charge the same risk premium per unit risk that they bear as do corporate investors.[21] We then conclude that

$$\delta_{nc} = \frac{1-m}{\alpha(1-\tau)}\left(\delta_c - \frac{\gamma r(\alpha_b - \alpha(1-\tau))}{e+1}\right). \tag{10}$$

In the simulations, we will assign to the investment in each industry a constant inherent risk premium δ equal to $\delta_{nc}/(1-m)$. (This measure corrects for the fact that only $(1-m)$ percent of noncorporate risk is borne privately and does not include any leverage costs.) The risk premium appropriate for privately borne risk in the noncorporate sector will then be simply $(1-m)\delta$. Only if the proprietor's tax rate changes in a

19. There may be other reasons besides taxes to prefer debt finance, however.

20. By "inherent risk," we refer to risk associated with the capital asset, regardless of financing and regardless of taxes.

21. Noncorporate investors may not have the same ability to spread risk, however, since their securities are not publicly traded, so they may require a larger risk premium. The tax system may discourage incorporation where risk bearing is more efficient, but we ignore this tax distortion and assume that the risk premium required per unit risk is indeed the same.

simulation would the noncorporate risk premium change. Similarly, the corporate risk premium for privately borne risk will be set equal to

$$\delta_c = \alpha(1-\tau)\delta + \frac{\gamma r(\alpha_b - \alpha(1-\tau))}{e+1}. \tag{11}$$

Thus, if the tax incentive favoring debt is reduced, the leverage cost component of δ_c will decline.

Investment Tax Credit Rates (k)

After an April 1969 repeal, the investment tax credit (ITC) was reintroduced in 1971. It allowed any corporate or noncorporate business to subtract from its tax bill 7% (4% for public utilities) of its eligible investment expenditures, defined as equipment with at least a seven year useful life. One-third credit was allowed for assets with three to five year lives and two-thirds credit for five to seven year lives. The 7% statutory rate was increased to 10% in 1975 and subsequently made permanent. The parameter k in above formulas, however, refers to an effective ITC rate on all investment (including inventories and plant as well as equipment). It ought to take into account all limitations, carry-forward, and carry-back provisions. Because the proportion of investments which are eligible for the credit, or for different fractions of the credit, will vary by industry, the effective ITC rate k will also vary by industry.

In order to estimate this effective ITC rate in each industry, we looked at the dollar value of credit taken in a particular year relative to that year's total investment. Because the credit taken in 1973 may not reflect the credit which eventually accrued to 1973 investments, we took the average of the effective rates in 1973 and 1974.[22] We thus tried to obtain a "steady state" rate which accounts for carry-forwards and carry-backs. The appendix provides details concerning how the data were obtained. The resulting figures for the effective ITC rates appear for each industry in table 11.1, column 5.

Economic Depreciation Rates (d)

The above formulas require eighteen annualized rates of depreciation for the industries defined in this model. Several other studies[23] have estimated rates of depreciation using various assumptions and various investment disaggregates, but none is immediately applicable for our purposes. Some studies, however, provide dollar values of economic depreciation for industry definitions similar to ours. Using time series on investment by industry, we can estimate geometric annual rates of depreciation for use in this model.

22. These are the two years for which the best data were available. The same 7% credit rate applied from 1971 to 1975.

23. See, for example, Christensen and Jorgenson (1969) and Hulten and Wykoff (1980).

Looking at a particular industry, suppose that ED_i is the dollar figure for economic depreciation in the ith year during the period 1972 to 1974. The sources for data on ED are described in the appendix. We then tried to find that geometric depreciation rate on all prior investments in that industry which would be most consistent with the observed values ED_i. Let I_t^R represent gross real investment undertaken in year t, in year i dollars. Then, if there were geometric depreciation at rate d, economic depreciation in year i would equal

$$ED_i^{pr} = \sum_{t=0}^{\infty} d(1-d)^t I_{i-t}^R.$$

Here, the superscript "pr" indicates the predicted, in contrast to the actual, ED_i.

One problem, of course, is that investment data by industry were not available prior to 1947. The small effect of pre-1947 investment can be approximated by assuming that investment in all years before 1947 grew at the same rate μ. We estimated μ to be 0.027 for all nonresidential investment and 0.021 for residential investment from aggregate data available over the period 1929 to 1947. If these two categories of real investments did grow at these rates before 1947 and if the same depreciation rate applied in all years before 1947, then the depreciation on pre-1947 investments in 1972 would be

$$(12) \qquad d\int_{26}^{\infty} I_{1947}^R e^{-\mu(t-26)} e^{-dt}\, dt = \frac{dI_{1947}^R e^{-26d}}{\mu + d},$$

where 26 is the number of years between 1946 and 1972. In general, then, we approximated ED_i^{pr} by

$$(13) \qquad ED_i^{pr} = \frac{dI_{1947}^R e^{-d(i-1947+1)}}{\mu + d} + \sum_{t=0}^{i-1947} dI_{i-t}^R (1-d)^t.$$

We then chose that value of d for each industry which minimized the sum of squared differences between the observed and predicted ED_i during the period 1972–74. The appendix provides information about the sources of the data and further details about the procedure. The eighteen resulting economic depreciation rates d are reported in table 11.1, column 6.

Tax Depreciation Rates (d_x)

Above formulas used d_x as the effective constant nominal depreciation allowance for tax purposes per dollar of maintained capital. We estimated this concept by starting with the assumption that the tax law allows exponential depreciation at an annual rate d' based on historical cost. (Derivation of the value of d' which best approximates the actual tax code is described below.)

In the situation of equation (4), we consider an additional dollar of investment which is maintained in nominal terms through subsequent replacement investment at the rate $(d - \pi)$. Exponential depreciation for tax purposes at rate d' on this maintained investment will generally not result in a constant stream of allowances. Though d' may remain constant, the remaining basis for tax purposes does not. In particular, the basis in the first year is one dollar, while the basis in the second year is $(1 - d') + (d - \pi)$. The second year basis will not equal one dollar if $d \neq d' + \pi$. The inflation rate enters here since tax depreciation is based on historical cost. Since the basis is nonconstant, depreciation allowances of d' times the bases are also nonconstant.

As shown in Gordon (1980), the value of d_x, which is constant over time and which implies the same present value of deductions for corporations as the nonconstant d' stream, would satisfy

$$d_x = d' \frac{(d - \pi) + r_z(1 - \tau)}{d' + r_z(1 - \tau)}. \tag{14}$$

(For noncorporate firms, the same expression applies, except that τ is replaced by m.) We therefore can solve for d_x on the basis of figures for d' and other data.[24]

Analogous to the economic depreciation rates d, the tax depreciation rates d' are estimated from IRS depreciation data and time series on investment. Looking at a particular industry, suppose that TD_i is the dollar figure for tax depreciation in the ith year between 1972 and 1976. We then solved for the geometric depreciation rate d' that best approximates the observed tax depreciation allowances TD_i, using a procedure similar to that used in solving for d. If I_t measures the nominal investment in a given industry which occurred in year t, then d' was chosen so as to minimize

$$\sum_{i=1972}^{1976} (\mathrm{TD}_i - \mathrm{TD}_i^{\mathrm{pr}})^2, \tag{15}$$

where

$$\mathrm{TD}_i^{\mathrm{pr}} = \sum_{t=0}^{i-1947} d'_{i-t} I_{i-t} (1 - d'_{i-t})^t + \frac{d'_{1947} I_{1947} \exp(-d'_{1947}(i - 1947 + 1))}{\mu + d'_{1947}}.$$

Here, d'_t is a function of time since the relevant tax law changed several times during the period. Also, μ here refers to the growth rate for nominal investment prior to 1947, estimated to be 0.057 for nonresidential investment and 0.059 for residential investment. In the appendix, we

24. In the simulations, d' is kept constant while d_x varies due to changes in r_z, τ, or m.

describe how I_t and d_t' were obtained. The eighteen resulting effective constant tax depreciation rates d_x for 1973 appear in column 7 of table 11.1.

Proprietors' Marginal Tax Rates (m, g)

The parameter m represents the average personal marginal tax rate paid by proprietors in the noncorporate sector. In principle, this marginal tax rate should vary by industry, but we found no data capable of providing such information. Instead, we used the NBER TAXSIM programs to calculate economy-wide average marginal tax rates for business income, supplemental schedule income, partnership income, and small business corporation profits. We then set m equal to 0.365, the weighted average of the average marginal tax rates for each category of income.[25]

The parameter g represents the effective capital gains tax rate on rental housing. By 1973 tax law, only half of capital gains is taxable. We assumed in addition that the postponement of the tax payment until realization halves the effective tax rate. We therefore assumed that $g = 0.25m = 0.091$.

Other Parameter Values $(r_z, e, \alpha, \alpha_b, r, \pi, \tau)$

There remain several economy-wide parameters that need to be estimated for 1973. For r_z, the nominal before-tax risk-free interest rate, many economists have used the Treasury bill rate, which equaled 0.07 in 1973. While Treasury bills are not risky in nominal terms, they are risky in real terms. Lacking any better estimate, we assumed the risk premium in the Treasury bill interest rate was 0.02, implying a risk-free interest rate of 0.05. As a sensitivity test, we also report results for a 0.07 risk-free rate.

We estimated e using time series data for γ and the market interest rate. According to the theory developed in section 11.1, the debt-capital ratio will be in equilibrium when $c(\gamma) = a\gamma^e = r(\alpha_b - \alpha(1-\tau))$. This implies that

$$\log(\gamma) = \frac{1}{e}\log\left(\frac{\alpha_b - \alpha(1-\tau)}{a}\right) + \frac{1}{e}\log(r). \tag{16}$$

If a, e, α_b, α, and τ are all constant across time, e can be estimated by regressing $\log(\gamma)$ on $\log(r)$ and a constant term using time series data, and taking the inverse of the estimated coefficient of $\log(r)$. Gordon and Malkiel (1980) provide yearly data on γ for the period 1958–78. For r, we

25. In calculating capital income in each category to use as weights, we followed the Treasury Department procedure of assuming that only 30% of business income, partnership income, and small business corporation income is really return to capital, the rest being return to labor. We would like to thank Daniel Feenberg for performing these calculations for us.

used a yearly commercial paper rate. When we regressed log (γ) on log (r), we obtained

$$\log(\gamma) = \underset{(0.19)}{-2.44} + \underset{(0.116)}{0.557}\log(r),$$

where standard errors are in parentheses under the coefficient estimates.[26] We therefore used $1/0.557 = 1.79$ as an estimate for e.

Next, consider α and α_b, the personal tax parameters for equity and bonds. There is no need to estimate each parameter separately since it is only their ratio α_b/α which matters in any of the computations.[27]

Let us consider then the problem of measuring the ratio α_b/α. The first problem faced is that the tax treatment of the returns to equity depends on whether the returns take the form of dividends or capital gains. It is not clear how to proceed since economists do not yet have a good explanation for why dividends are paid, given their unfavorable tax treatment (see Black 1976). By repurchasing shares, a firm can create a dollar in capital gains in lieu of paying a dollar in dividends, and presumably would do so if capital gains were valued more highly by the market. Since firms do pay dividends, we assume that the market does value dividends and capital gains equally. In fact, Gordon and Bradford (1980) estimate the value in the market of dividends versus capital gains and find that the market value of a dollar of dividends does not differ systematically from the market value of a dollar of capital gains. That is, dividends must provide some other advantage which offsets their tax disadvantage. We therefore assume that the effective tax rate on equity is the capital gains tax rate.

The ratio α_b/α thus measures the value in the market of a dollar of interest payments relative to a dollar in either dividends or capital gains. According to the derivation in Gordon and Bradford (1980), this ratio is a weighted average of the valuation each investor gives to interest relative to capital gains.[28] The weights are proportional to the investor's wealth and inversely proportional to a measure of his risk aversion. We there-

26. Of course, if any of the terms assumed to be constant had varied significantly over time, then the estimate of e could be biased. Probably the most important problem is that any increase in the riskiness in the economy during the period would have caused the function $c(\gamma)$ to shift upward, raising the parameter a. If this had occurred, our estimate of e should be too high, implying that our estimate of leverage costs may be too small.

27. The only place where α appears alone is in the term $\delta_c/[\alpha(1-\tau]$. However, δ_c, while defined to be the after-tax risk premium, is estimated in this paper as in others by using before-personal-tax data. The resulting estimate therefore equals δ_c/α directly, avoiding any need for a separate estimate of α.

28. Some authors, e.g. Miller (1977), have constructed models with sharp clientele effects, where α_b/α would equal the marginal tax rate of the marginal individual investing in bonds rather than stocks. All other individuals specialize in either bonds or stocks. However, in a model with uncertainty and no short sales constraints, as in Gordon and Bradford (1980), all investors will hold some amount (positive or negative) of both types of investment, so that everyone is a marginal investor.

fore calculated an estimate for α_b/α directly from the twelve consumer groups of the FSW model by taking a weighted average of their relative valuations of interest and capital gains. In doing so, we made the following assumptions: (1) risk preferences do not vary across consumers, (2) the effective tax rate on capital gains is one-eighth of the tax rate on interest,[29] and (3) only 70% of an individual's investments are taxable. According to 1973 *Flow of Funds* data, approximately 30% of savings were in pensions, IRA accounts, or other tax-free vehicles. The implied value of α_b/α was 0.82.

The remaining parameters r, π, and τ were directly observable. We set $r = 0.08$ and $\pi = 0.05$,[30] on the basis of the data for 1973 appearing in the *Economic Report of the President*. We set $\tau = 0.48$, the statutory tax rate in 1973.

11.3 Other Changes to the Fullerton, Shoven, and Whalley Model

11.3.1 Modeling of Government Enterprises and General Government

The FSW model includes not only the eighteen private sectors described above but two government sectors as well. One, government enterprises, includes government-run business activities, mainly the post office and TVA. This sector was modeled like the other private industries except that it received a large output subsidy from general government. The other sector, general government, captures the remaining activities of government. We need to calculate equilibrium values for ρ for these two "industries" comparable to those which characterize the other eighteen industries to help determine the demand for capital. Unfortunately, we do not have available the same quality of information for these two sectors.

We assume that government enterprises are cost-minimizing industries which meet all demand at the output prices dictated to them by higher levels of government. We assume therefore that they invest until the real marginal product of their capital is just high enough to cover depreciation, the real risk-free interest rate, and a suitable risk premium δ_G. Formally, we assume that $\rho = r_z - \pi + d + \delta_G$.[31] Lacking any independent information about d in this industry, we assume that it equals the weighted average of the values in the eighteen private industries, where

29. Only one-half of capital gains was taxable in 1973. In addition, the effective tax rate is approximately halved due to the postponement of tax payments until realization. We assume it is about halved again due to the markup of the basis at death and due to the selective realization of capital losses sooner than capital gains.

30. While π represents the expected inflation rate, we set it equal to the observed rate on the assumption of myopic expectations.

31. This equation can be derived from equation (7) by setting $\delta_{nc}/(1 - m)$ equal to δ_G, and setting k, t_p and m equal to zero.

the weights are the sizes of the capital stock in each industry. To construct an estimate for δ_G, we first calculate for each private industry the value of the risk premium on a dollar of capital that would prevail if there were no leverage costs (as with noncorporate investments) and if all risk were borne by the private sector. This risk premium would equal $\delta_{nc}[(1 - k)/(1 - m)]$.[32] We then took the weighted average of these values over the eighteen private industries.

General government includes all remaining activities of government. It receives revenue from the various taxes and from selling its endowment of capital on the market. Part of the total revenue is earmarked for lump-sum transfers to each consumer group. The benchmark transfers are based on data for welfare, government retirement, food stamps, and similar programs.[33] As prices change in a simulation, government maintains the same real payments in transfers to each group.

General government also purchases each of the nineteen producer goods (eighteen private industry outputs and government enterprises output), plus capital and labor. In doing so, it is assumed to maximize a Cobb-Douglas utility function whose arguments are these nineteen producer goods plus capital and labor.

The question here is the appropriate measure for the cost of capital to government. Since most of the capital used in general government is used in state and local governments,[34] we model capital intensity decisions in this sector as if they were entirely local public decisions.

The capital intensity of a community's public sector is in equilibrium when the (assumed) homogeneous residents in that community are indifferent to adding an extra dollar of capital. The community must also decide whether it is cheaper to finance its capital stock directly through property taxes or indirectly through the municipal bond market. The key tax factors in determining the equilibrium ρ here are: (1) property tax payments are deductible from taxable personal income if the residents itemize, (2) the interest rate paid on debt is the municipal bond rate, and (3) there is no tax on the "profits" of the sector.

In calculating the equilibrium marginal product of capital in the local public sector, let us assume that γ percent of an additional dollar of capital investment under consideration would be financed by debt. Let n equal the effective personal marginal tax rate at which residents deduct

32. The extra term $(1 - k)$ enters because $\delta_{nc}/(1 - m)$ measures the risk premium required for all the risk resulting from a dollar invested in a firm. But this investment buys $1/(1 - k)$ dollars of new capital.

33. While the former (FSW) model includes social security and unemployment compensation payments as part of the government's lump-sum transfers, our model assumes these net out at the industry level.

34. According to the figures in Musgrave (1980), 72% of the capital stock in this sector is owned by state and local governments.

property taxes.[35] Then the community must put up $1 - \gamma$ through taxes to finance the nondebt part of the one dollar investment, at an after-tax cost of $(1 - n)(1 - \gamma)$.

Let ρ represent the dollar value in each period to residents in the community of the marginal product of this dollar investment. Also, let r_f be the nominal (tax-free) municipal bond interest rate at which the community borrows. Then, as a result of this investment, residents receive an implicit net nominal return equal to $\rho - \gamma r_f(1 - n) - (d - \pi)r_f/r$.[36] Bondholders receive γr_f before and after taxes.

Together the community and the bondholders have invested $(1 - n)(1 - \gamma) + \gamma$ dollars and must absorb together the risk in the return from the investment. Because of this risk, they demand a suitable risk premium δ_G which we assume equals the risk premium for government enterprises. Bondholders would require a risk-free return of r_{fz}, the risk-free municipal bond rate, while members of the community would require an after-tax risk-free return of $\alpha_b r_z$. Together they therefore would require a return on their investment of $(1 - n)(1 - \gamma)\alpha_b r_z + \gamma r_{fz} + \delta_G$.

Therefore in equilibrium

$$\rho - \gamma r_f(1 - n) - (d - \pi)r_f/r + \gamma r_f = (1 - n)(1 - \gamma)\alpha_b r_z + \gamma r_{fz} + \delta_G. \tag{17}$$

We find solving for ρ that

$$\rho = (d - \pi)r_f/r + (1 - n)\alpha_b r_z - \gamma((1 - n)\alpha_b r_z + n r_f - r_{fz}) + \delta_G. \tag{18}$$

The required value for ρ is lower when γ is larger. Therefore the community would use only debt finance unless marginal leverage costs are sufficiently large. We will assume that $\gamma = 1$, implying that $\rho = (d - \pi)r_f/r + r_{fz} - n r_f + \delta_G$. The equilibrium ρ here is lower than that for government enterprises because of both the income tax deductibility of property tax payments and the availability of municipal bond interest rates.

35. This rate n is equal to the personal marginal tax rate if (homogeneous) residents in the community itemize and is equal to zero if they do not itemize. In the calculations, we use a weighted average value for n, as described below.

36. This expression captures the annual flows to community residents when they make a municipal investment, maintained in nominal terms through the reinvestment of $(d - \pi)$ each year. This subsequent capital loss and reinvestment is also assumed to be financed by issuing municipal bonds, generating an after-tax interest expense in each future year of $(d - \pi)r_f(1 - n)$. We then need the present value of these costs in the year the capital loss takes place. Because individuals could have made nonmunicipal investments with an after-tax return $r(1 - n)$, their relevant discount rate is $r(1 - n)$. The present value of the stream of interest payments $(d - \pi)r_f(1 - n)$, in the year of the capital loss itself, is $(d - \pi)r_f/r$.

Similarly, property taxes paid to cover other local government expenses are deductible from the federal personal income tax. In particular, the after-tax cost of hiring one more dollar of labor services is only $(1 - n)$ dollars. We therefore include an n percent factor subsidy to labor in this industry. Current expenditures on any of the nineteen commodities also cost $(1 - n)$ percent of the market price.[37]

In order to calculate values for ρ and the labor factor subsidy in this industry, we need values for d, δ_G, r_f, r_{fz}, and n. We set d and δ_G equal to the same weighted averages used for government enterprises.

We also assumed that municipal bond interest rates are a given fraction θ of the interest rates on taxable bonds, so that $r_f = \theta r$ and $r_{fz} = \theta r_z$. Gordon and Malkiel (1980) measure θ to be 0.75.

In calculating a value for n, several steps were involved. First, according to the NBER TAXSIM file, the weighted average marginal tax rate in 1975 for those who itemized and deducted property tax payments was 0.260. In making this calculation, an individual's tax rate was weighted by the size of his property tax payments.[38] We assume that the same rate applied in 1973. However, not all property owners itemize. Using unpublished data from the National Income Division of the Commerce Department along with the figures from the TAXSIM file, we infer that only 44.8% of property taxes paid on residential property was in fact deducted from taxable income. This implies that the average marginal value of n equals $(0.448)(0.260) = 0.117$.

This calculation, however, ignores the possibility that industrial and commercial property may pay part of the costs of additional local public services. In fact, only two-thirds of property tax receipts come from residential property. When considering the effective property tax rate on business investment in earlier sections, we decided to explore the two alternative assumptions that (1) benefits completely offset taxes at the margin, and (2) firms (except in real estate) receive benefits which offset half of their property taxes. In the first scenario, we set $n = 0.117$ because households are subsidized in their local public good "purchases" by the deductibility of their property taxes. Households receive no further subsidy or benefits from taxing businesses, because competitive pressure prevents communities from collecting any tax from firms without paying for commensurate benefits to them.

In the second scenario, however, half of industrial property taxes are left for services to residential property. (The other half of the revenues from business property are used to provide services to the firms.) Con-

37. One might argue, however, that these implicit subsidies to local public expenditures are to a degree Pigovian subsidies which correct for the spillover of benefits to other communities. To that degree, they are nondistorting. In this paper, however, we assume that these subsidies are distorting.

38. We would like to thank Daniel Feenberg for performing these calculations for us.

sider, for the moment, \$1.20 of local property tax revenue. One-third, or \$0.40, on average would be paid by businesses. They would receive \$0.20 in benefits, which leaves exactly \$1.00 for residential benefits. Residents then would pay only \$0.80 for a dollar of benefits, at a cost of \$0.80 $(1 - 0.117) =$ \$0.707 after taxes. We therefore use $(1 - 0.707) = 0.293$ for n when simulating the second scenario.

11.3.2 Measurement of Initial Capital Stocks

In the FSW model, net corporate earnings (NCE) after taxes and after depreciation were assumed to be proportional to the true capital stock (i.e. to equal rK, where r is the same for all industries). Therefore NCE/r provided a measure of the capital stock in each industry.[39]

According to the model in this paper, the size of corporate earnings relative to the underlying capital stock will depend on many factors such as the risk premium, tax versus true depreciation rates, etc. However, expected gross corporate earnings (GCE) before taxes and before depreciation ought to equal $\rho_c K$. In section 11.2.2 ρ_c was defined as the cost of capital gross of taxes and depreciation; it varies by industry. We therefore used GCE/ρ_c as a measure of the corporate capital stock in each industry.

Here, GCE was defined to equal the sum of

1. corporate profits, from the *Survey of Current Business (SCB)* corrected for the inventory valuation adjustment,
2. corporate capital consumption allowances, from the *SCB*,
3. corporate interest payments, from unpublished data of the Commerce Department's National Income Division (NID), and
4. corporate rental payments. Rents paid by industry were available from NID, and we divided these into corporate and noncorporate payments in the same proportions that the sums of other earnings were divided in each industry.

The same procedure will not work for the noncorporate sector since earnings there are also in part labor income of the proprietors. Instead we assumed that within any industry capital consumption allowances are proportional to the capital stock. We then multiplied our estimate of the corporate capital stock in each industry by the ratio of noncorporate to corporate capital consumption allowances in that industry to produce an estimate of the noncorporate capital stock. This logic helps provide estimates of initial (1973) labor income in the noncorporate sector. If $K_{nc}\rho_{nc}$ is equal to before-tax earnings of capital and GPE is gross proprietor's earnings, then GPE $- K_{nc}\rho_{nc}$ equals imputed labor income. Here, GPE is defined to equal the sum of noncorporate profits (from the *SCB*), noncorporate capital consumption allowances (from NID), in-

39. Interest payments and rental payments are included in NCE so as to capture the return to bond- and landowners as well as equityowners.

terest paid (from NID), and rents paid. Noncorporate rents were imputed by the above procedure. If this residual for labor in 1973 turned out to be negative, we assumed there was measurement error and used zero for the initial noncorporate labor in that industry.

For the two government sectors, we used estimates from Musgrave (1980) for the size of the 1973 capital stocks.

11.3.3 Measurement of Capital Income before and after Taxes

The FSW model defined total capital income net of tax and depreciation to equal the sum of corporate profits, capital consumption adjustment, net interest paid, net rents paid, and noncorporate returns to capital. In the new model, we set total capital income equal to $K(\rho - d)$. The major differences from the old procedure are: (1) depreciation is measured by the calculated dK rather than by reported capital consumption allowances with capital consumption adjustment, and (2) noncorporate capital income is in effect measured by $K_{nc}(\rho_{nc} - d)$ rather than by the reported data for noncorporate capital income.[40]

Let t_k equal the average capital tax rate. We initially set t_k equal to the ratio of observed 1973 capital taxes to before-tax capital income $K(\rho - d)$. In simulations, net capital income then equals $K(\rho - d)(1 - t_k)$ and capital tax revenue equals $K(\rho - d)t_k$. Calculation of the benchmark equilibrium replicates observed capital taxes in 1973, while appropriate changes in t_k (together with changes in τ, k, d', etc.) allow simulation of counterfactual equilibria.

11.3.4 Savings Incentives

While the procedure described above provides estimates for the capital stock in the initial equilibrium, the capital stock in the next period will equal this initial capital stock plus net savings undertaken during the initial period by the twelve separate consumer groups. The capital stock in later periods will follow in a similar fashion. While we devoted much effort in this paper to improving the modeling of investment decisions (by taking account of uncertainty and the optimal form of finance), we made few changes to the assumptions about individual savings decisions found in the earlier model.

In the FSW model, individuals in each consumer group $j = 1,12$ choose to save some income to finance future consumption C_f. They allocate the rest to a subutility function H which is defined over fifteen consumption goods X_i and leisure l. The fifteen X_i consumption goods enter a Cobb-

40. Data are available only for total noncorporate income I and for the number of noncorporate workers L. FSW set the noncorporate wage rate w equal to the observed average wage rate from the corporate part of that industry, then set initial (1973) noncorporate capital income equal to $I - wL$. In this paper, we instead calculate a net rate of return to capital $\rho_{nc} - d$, then set initial noncorporate labor income equal to $I - K_{nc}(\rho_{nc} - d)$.

Douglas function with preference parameters λ_i as exponents. Specifically, each of the twelve consumer groups will be characterized by a nested CES utility function

$$(19) \qquad U_j = U_j\left[H\left(\prod_{i=1}^{15} X_i^{\lambda_i}, l\right), C_f\right].$$

As in the FSW model, we use 0.15 for the uncompensated labor supply elasticity of each group with respect to its net of tax wage. This parameter is used to set the elasticity of substitution for the inner nest, between consumption goods and leisure. Unlike the FSW model, however, we cannot use a savings elasticity with respect to the real after-tax interest rate. In our model, this rate will normally be negative. Instead, we use 12.3 as the uncompensated savings elasticity with respect to one plus the real after-tax interest rate. This parameter is used to set the elasticity of substitution for the outer nest, between present and future consumption. The 12.3 figure was derived from Boskin's (1978) equation (2). Boskin estimated that $\log C = A - 1.07R$, where C is consumption, R is the real net of tax interest rate, and A represents other variables in his equation. But therefore $\log C \approx A - 1.07 \log (1 + R)$. It then follows that

$$\frac{1+R}{S}\,\frac{\partial S}{\partial(1+R)} = 1.07\frac{C}{S}.$$

In 1973, the ratio of total consumption to net savings was 11.5, from the *Economic Report of the President*. We then used (1.07)(11.5) = 12.3 for the elasticity of S with respect to $1 + R$ in all periods for all consumer groups. In spite of many objections to Boskin's estimation procedure, we felt there was no good alternative. Saving is then converted immediately into investment demand for producer goods.

A remaining issue is the determination of the net of tax real market interest rate faced by each group. As in the FSW model, we assume that individuals put a fixed fraction of their (marginal) savings into pensions, Keogh and IRA accounts, and life insurance. We assume that such savings earn the market rate of return free of taxes. On the basis of *Flow of Funds* data for 1973, we set this fraction equal to 0.3. The remaining 70% of their savings is then invested either in taxable bonds or in tax-free municipal bonds. The return on taxable bonds is taxed at a constant personal tax rate m_j which ranges from 0.01 to 0.40 across the twelve consumer groups. Each individual can therefore earn a real net of tax risk-free[41] rate of return on his savings equal to $0.3r_z + 0.7 \max(r_{fz}, (1 - m_j)r_z) - \pi$. In this expression r_{fz} represents the risk-free

41. We assume that savers respond to the real net of tax risk-free rate of return. Although they can obtain a higher real after-tax return by accepting risk, this premium is not inherently part of the return to savings. It is a return to accepting risk.

municipal bond rate. In the initial simulations, we set $r_{fz} = 0.75r_z$, on the basis of the results in Gordon and Malkiel (1980).

11.3.5 The Benchmark Equilibrium

The FSW model, as used here, consists of eighteen producer industries, fifteen consumer goods, twelve consumer groups, plus the two government sectors. Before the model can be simulated, production and utility functions and their parameters must be specified. The overall strategy is to choose remaining parameters such that the model will calculate an equilibrium that exactly replicates the consistent benchmark data set.

Each industry in the FSW model is characterized by either a constant elasticity of substitution or a Cobb-Douglas production function. Substitution elasticities are chosen from the best estimates in the available literature. The size of each industry's capital stock is calculated as described in section 11.3.2. The size of the benchmark demand for labor in the corporate sector is measured by the size of the labor payments in that industry in 1973, as reported in the *SCB*. The demand for labor in the noncorporate sector is measured as gross income of the industry minus our estimate for the gross return to capital, $\rho_{nc}K_{nc}$.

As in the FSW model, the parameters in the production function were then selected such that the optimal capital-labor ratio would equal the ratio which was in fact chosen, and such that the output produced using these factors would equal the observed 1973 output. In doing so, the rental cost of capital was set equal to the calculated equilibrium rate $\rho - d$ for that industry. The cost of a standardized unit of labor was set equal to one plus the effective unemployment compensation tax rate reported in column 1 of table 11.1. Various federal excise taxes and indirect business taxes were modeled as output taxes for each of the eighteen industries.

As in equation (19) above, each consumer group has a nested utility function over future consumption, leisure, and fifteen commodities. The innermost nest is a Cobb-Douglas utility function over the fifteen consumer goods. The λ_i coefficients were chosen so as to replicate observed relative expenditures on these commodities. In doing so, expenditures were measured gross of state and local sales taxes. In the next nest, there is a CES function by which the consumer chooses between these commodities and leisure. Weights were chosen such that individuals will choose to work forty hours out of a potential seventy hours at their net of tax wage rate. In the outer nest of equation (19), individuals choose between current and future consumption.

Similarly, general government has a Cobb-Douglas utility function over the nineteen producer goods plus capital and labor.[42] The param-

42. We use this aggregate function to capture the utility created by government expenditures, rather than having government expenditures enter directly into production functions

eters in this function were selected such that optimal demands for goods, given market prices, would equal actual demands in 1973.

Finally, the foreign sector is modeled by the assumption that the net value of exports less imports for each producer good is constant. This simple treatment closes the model, maintains zero trade balance, and allows easy calculation of trade quantities given prices.[43]

Because the data set for this model comes from many different sources, the figures are often inconsistent. For example, Treasury data on various forms of capital income of consumers differs from Commerce Department data on industry payments for capital. In such cases, the data on one side of the account were judged to be of superior quality and the other data were adjusted to match. All reported industry and government uses of factors were accepted, so consumers' factor incomes and expenditures were scaled to match. Reported tax receipts and transfers were accepted, so government expenditures were scaled to balance the budget. The nearly balanced actual budget of 1973 luckily makes this treatment more reasonable. Similar adjustments ensure that supply equals demand for all goods and factors.

The above assumptions guarantee that the model simulation in the initial period will replicate the 1973 figures. The dynamic model is derived assuming that the 1973 benchmark equilibrium lies on a steady state growth path. Observed saving behavior and the capital endowment are translated into an annual growth rate for capital, and this growth rate is also attributed to effective labor units. The benchmark sequence of equilibria is then calculated by maintaining all tax rates and preferences fixed, increasing labor exogenously, and allowing saving to augment capital endowments over time.[44] By construction, this sequence will have constant factor ratios and constant prices. In simulations of revised tax policies, labor growth is exogenous while capital growth depends on the savings response to new tax rates and interest rates.

11.4 Model Simulations

11.4.1 Simulation Procedure

A variant of Scarf's (1973) algorithm is used to solve for each equilibrium. A new dynamic sequence of the economy results from a change in

or each consumer group's utility function. Because we always hold government utility constant in the simulations described below, this treatment will not affect our estimates of changes in consumer welfare attributable to tax policy changes.

43. Goulder, Shoven, and Whalley (chapter 10 of the present volume) suggest that the results may be sensitive to this assumption.

44. We assume that the relative wealth of the twelve consumer groups remains unchanged over time. While the groups save different proportions of income, the unmodeled movement of individuals across our twelve groups over time ought to maintain the initial wealth distribution.

initial conditions, such as a change in the tax law. In each equilibrium period of the sequence, demand will equal supply for all producer goods and factors, and each industry will have zero profits. Both capital and labor are assumed to be homogeneous and freely mobile across industries. In addition, as described below, we adjust personal income tax rates so as to produce a government revenue at each date which provides the same utility to government given the new market prices as it had in the same period of the benchmark equilibrium sequence. We make this assumption so that in the simulations we can focus on the changes in utility that individuals derive from private activities, holding constant the utility that individuals implicitly derive from public activities.

Simplex dimensions are required only for w, r_z, and the additive surtax rate on the personal income tax. Knowledge of these values is sufficient to evaluate the behavior of all agents. Producer-good prices are based on factor prices and zero profits, while consumer-good prices are based on producer-good prices.

A complete set of prices, quantities, incomes, and allocations is calculated for every equilibrium. A revised tax equilibrium can be compared to the benchmark equilibrium to provide a direct examination of the effects of the proposed tax changes.

In describing the effects of any proposed tax change, we also calculate the equivalent variation in each period. This is the lump-sum dollar amount that would have to be transferred to individuals in the benchmark equilibrium so as to give each consumer group the utility that they would have in the revised tax equilibrium. One complication in calculating this equivalent variation is that tax changes cause a change in the amount of risk and leverage costs, yet these costs do not appear explicitly in the model:[45] our individual utility functions implicitly include the utility provided from spending the risk premiums but do not explicitly subtract for the disutility of bearing risk.

However, by assumption, the risk premiums δ_c or δ_{nc} measure the cost to the individuals of bearing what risk is left after taxes from their investments. In addition, the government bears risk since its tax revenue is uncertain, yet costs of risk bearing do not appear in the government utility function either. We assume in this paper that individuals ultimately bear this risk in proportion to their wealth and find it just as costly to bear as risk they receive directly.[46] In each simulation, we then measure the

45. Corporations take account of leverage costs when making investment decisions at the margin, but these costs are never actually subtracted from firms' profits.

46. Diamond (1967) provides a formal argument for this assumption. Also, we assume that individuals view the risk they bear indirectly as a lump-sum tax, even though we apply this "tax" in proportion to their (initial) wealth. We could have distributed the lump-sum tax in proportion to (initial) income, but the results would be very similar. The difference between these two procedures is only a lump-sum redistribution, which has general equilibrium effects only to the degree that individual preferences for commodities differ.

time pattern of consumption that each consumer group would have had, everything else equal, if it did not receive the risk premium appropriate for all the risk in the return on its capital (including that borne by the government) but also bore no risk. Since we have then standardized utility at the point where there is no risk, we can directly compare utilities across simulations. The reported values for the equivalent variation refer to this standardized measure for utility.[47]

11.4.2 Tax Distortions on Capital in the Initial Equilibrium

In our initial simulations with the model, we left all tax rates at their observed values in 1973, thereby replicating the historical equilibrium. The results from this simulation provide us with a benchmark from which we can examine the welfare effects of several proposed tax changes.

The key element that characterizes each of the simulations that we undertake is the function relating the market interest rate r_z to the equilibrium marginal product of capital ρ in each industry. The formula used in calculating ρ in the initial equilibrium was derived in section 11.2. The equilibrium ρ is a weighted average of the values of ρ_c and ρ_{nc} characterizing corporate and noncorporate investment.

In the first three columns of table 11.2, we report the equilibrium values by industry for

$$s_c \equiv \rho_c + \pi - d - \frac{\delta_c(1-k)}{\alpha(1-\tau)}, \tag{20}$$

$$s_{nc} \equiv \rho_{nc} + \pi - d - \frac{\delta_{nc}(1-k)}{1-m},$$

and their weighted average by industry, defined as s. Here, we assume that the property tax is nondistorting. Each of these figures represents the nominal return required by investors in that industry before any taxes but after depreciation. These returns are measured net of compensation for the riskiness in the return and net of any leverage costs. As such, they also represent the nominal social marginal product of the investment, net of the social costs from depreciation, risk, and leverage costs.[48]

Were there no corporation tax, the risk-free nominal return on corporate capital s_c ought to equal the risk-free nominal market interest rate

47. The FSW model calculated the discounted sum of this stream of equivalent variations to obtain a present value of welfare gains. The proper discount rate, however, is the real after-tax interest rate, which in our model is negative. The present value of any stream of gains or losses would then be infinite. Instead, we report the stream directly.

48. We assume that risk borne by the government has the same social cost as risk remaining in the private sector, as would be implied by efficient risk spreading. The risk terms in equation (20) then do indeed correct for the social costs of the risk created by the marginal investment. We also assume that the measure of leverage costs included in δ_c captures the social costs of leverage. If the government bears risk more cheaply, then there is a social benefit from taxes on capital income because of the resulting redistribution of risk.

Table 11.2 **Nominal Risk-free Returns to Capital Net of Depreciation**

	No Property Tax				With Property Tax	
	Base			Revise	Base	Revise
	s_c	s_{nc}	s	s_c	s_c	s_c
All Industries*	.036	.032	.034	.040	.044	.048
(1) Agriculture, forestry, and fisheries	.049	.033	.035	.041	.069	.061
(2) Mining	.045	.034	.041	.041	.055	.051
(3) Crude petroleum and gas	.036	.026	.035	.039	.057	.060
(4) Construction	.053	.034	.047	.041	.062	.049
(5) Food and tobacco	.042	.031	.042	.039	.050	.047
(6) Textile, apparel, and leather	.046	.040	.046	.045	.061	.060
(7) Paper and printing	.051	.039	.051	.043	.061	.053
(8) Petroleum refining	.035	.025	.035	.037	.037	.039
(9) Chemicals and rubber	.051	.036	.051	.042	.057	.048
(10) Lumber, furniture, stone, clay, and glass	.041	.031	.040	.038	.048	.045
(11) Metals and machinery	.049	.033	.048	.040	.058	.049
(12) Transportation equipment	.036	.033	.036	.040	.086	.089
(13) Motor vehicles	.040	.030	.040	.038	.043	.041
(14) Transportation, communication, and utilities	.033	.033	.033	.041	.043	.051
(15) Trade	.042	.034	.040	.041	.054	.053
(16) Finance and insurance	.028	.032	.028	.040	.033	.044
(17) Real estate	.010	.032	.030	.039	.010	.039
(18) Services	.033	.034	.033	.042	.046	.055
(19) Government enterprises†	.050	.050	.050	.050	.050	.050
(20) General government	.037	.037	.037	.037	.026	.026

*Averages are calculated over eighteen private industries. All s_c use benchmark corporate capital as weights. The s_{nc} column uses benchmark noncorporate capital as weights, and s uses benchmark total capital as weights.

†Government sectors are neither corporate nor noncorporate. We show their s values for purposes of comparison.

$r_z = 0.05$. This equivalence would hold even if there were a (comprehensive) personal income tax on the nominal return from all forms of saving. Had we just used the simplified modeling of the corporate tax as a flat tax rate on the nominal return to corporate capital, as did Harberger (1962), then s_c would equal $r_z/(1 - \tau)$ or 0.096 with our parameters. In sharp contrast, the equilibrium values of s_c reported in table 11.2 are not only well below 0.096 but also mostly below 0.05. In fact, the weighted average value of s_c over all industries is only 0.036. Using the formula for ρ_c in equation (4), we can reexpress s_c (without the property tax) as

$$s_c = r_z\left(\gamma + (1 - k - \gamma)\frac{\alpha_b}{\alpha(1-\tau)}\right) - \gamma(r - r_z)\left(\frac{\alpha_b}{\alpha(1-\tau)} - 1\right) - \frac{\tau\pi}{1-\tau} + \frac{\tau(d - d_x)}{1-\tau}. \tag{21}$$

The following factors, identifiable in this formula, account for the surprisingly low value for s_c.

1. Equityholders require an after-corporate-tax return of only $\alpha_b r_z/\alpha$, not r_z, since the personal income tax on the alternative risk-free asset earning r_z exceeds the personal tax rate on corporate equity. This lowers s_c from $r_z/(1 - \tau)$ to $\alpha_b r_z/[\alpha(1 - \tau)]$, which equals 0.079.

2. The use of debt finance has multiple effects. First, the required nominal risk-free rate of return on debt before corporate taxes is only $r_z = 0.05$. Since on average 40% of capital is financed by debt, s_c is thereby lowered to $(0.079)(0.6) + (0.05)(0.4) = 0.067$.[49] Second, α_b percent of the risk premium on bonds is received by bondholders after tax, while only $\alpha(1 - \tau)$ percent of the risk remains on the investment after taxes. This exchange is favorable to investors, lowering s_c by another 0.007.

3. The inflationary capital gains component of the nominal return s_c is not subject to the corporate tax. This lowers the equilibrium value of s_c by $\tau\pi/(1 - \tau) = 0.055$.

4. Partially offsetting this, the effective tax depreciation rate d_x is below the economic depreciation rate d due to depreciation at historical cost in the tax law. This raises s_c on average by 0.033.

5. Finally, the availability of the investment tax credit lowers the equilibrium s_c by 0.002.

The equilibrium values of the noncorporate s_{nc} are also normally below r_z because of the above explanations 3 and 5, more than offsetting

49. Also, leverage costs per unit capital are raised to 0.007, as implied by equation (11), though this does not show up in equation (21) since s_c is net of leverage costs.

explanation 4. The nominal equilibrium return to all capital s is on average only 0.034 (in column 3 of table 11.2).

The equilibrium marginal time preference rate of individuals will also be well below r_z because of the personal income tax. The weighted average marginal time preference rate[50] for our twelve consumer groups turns out to be 0.043. Therefore, while individuals require a return of 0.043 on their savings, the resulting investment produces a net return of only 0.034. An implicit government subsidy of 0.009 makes up the difference. Tax distortions therefore result in an inefficiently large amount of savings and investment. (When we assume that the property tax is half distorting in industries other than real estate, there will still be a small net subsidy to savings and investment.)

If this distortion is negative, though small, why is so much tax revenue collected on the return to capital from both the corporate and personal income taxes? The explanation for this apparent puzzle is that most (in fact more than all according to our figures) of the taxable expected return is the risk premium. Yet while a significant percent of the risk premium is taxed away, the same percent of the risk (standard deviation) is absorbed by the government through risky tax revenues. According to the capital asset pricing model, investors demand a risk premium proportional to the amount of risk that they bear. Investors are therefore indifferent when they lose to the government a given percent of both the risk premium and the risk, so their behavior is undistorted. The government is just charging the market price for the risk that it absorbs. Since the risk premium is positive, however, expected tax revenues will be positive.

Even if the saving-investment distortion is small, however, other tax distortions remain. First, the variation of the numbers in column 3 of table 11.2 implies an intersectoral misallocation of capital across industries, as emphasized in Harberger (1962). In addition, saving is misallocated across individuals because of the variation in after-tax rates of return across investors. (Efficiency requires the same marginal time preference rate for each investor, and thus the same available after-tax rate of return). Also, as always, labor supply decisions are distorted because of the personal tax. Finally, in our initial simulation, yearly leverage-related costs are estimated to equal 0.7% of the value of the corporate capital stock, or 0.6% of GNP. This is hardly an insignificant figure.

11.4.3 Modeling of the Proposed Tax Revision

The model in this paper is used to evaluate the general equilibrium effects of integrating corporate and personal taxes. Detailed descriptions

50. The marginal time preference rate for consumer group j was assumed to equal $(0.3r_z + 0.7\max(r_{fz}, (1 - m_j)r_z))$, the risk-free after-tax return to savings. Thirty percent of (marginal or average) savings are assumed here to be untaxed.

of such proposals can be found in McLure (1975, 1979). Under the full integration proposal, as modeled in Fullerton, King, Shoven, and Whalley (1980, 1981), the corporate tax would be eliminated. Instead, corporate earnings would be included in the personal income tax base of each of the shareholders in proportion to their holdings and would be taxed at ordinary personal income tax rates.[51]

Several changes must be made in the model to capture the effects of this tax change. First, equation (4) relating ρ_c and r_z changes substantially. Corporate profits would now be taxed at each investor's ordinary tax rate, regardless of corporate financial decisions. Since the tax distortion favoring debt finance is thereby eliminated, γ goes to zero. There is now no offsetting advantage to counterbalance the leverage costs arising from debt finance. As a result, leverage-related costs go to zero as well.

After integration, the corporation would be treated for tax purposes as if it were a partnership. The only reason why ρ_c now differs from ρ_{nc} is that the average marginal tax rates of corporate and noncorporate investors differ.[52] We previously estimated that the marginal tax rate of noncorporate investors equaled 0.365. Let m_c equal the average marginal tax rate of corporate investors after integration. We set

$$m_c = 0.7 \sum_{j=1}^{12} w_j m_j ,$$

which equals 0.1948. Here, the m_j are the marginal tax rates of the twelve consumer groups and the w_j are the proportions of consumer wealth held by each group.[53] We continue to assume that only 70% of capital income is taxable.

The s_c after corporate tax integration can therefore be obtained from the s_{nc} formula in equation (20), with $m = 0.365$ replaced by $m_c = 0.1948$.[54] The resulting figures, reported in column 4 of table 11.2, are calculated under the assumption that r_z remains unchanged at 0.05, to ensure comparability with the other figures in table 11.2. (In the simulations, as r_z changes, all the s will change in response.) Note that tax integration will not affect the equilibrium value of s_{nc}, holding r_z constant.

51. The major purpose of this paper is to investigate, for integration of corporate and personal taxes, the sensitivity of estimates to different model specifications. Rather than look at several types of integration (including partial plans or dividend relief) under one model specification, we find it more useful to look at one type of integration under several model specifications. For more discussion of partial integration plans, see McLure (1979) or Fullerton, King, Shoven, and Whalley (1981).

52. These marginal tax rates differ if individuals who choose to form their own businesses differ systematically from those who invest in financial securities.

53. This formula for m_c follows from the derivation of the Gordon and Bradford (1980) model on the assumption that individuals are equally risk averse at the margin.

54. An equivalent procedure, actually used in our calculations, uses equation (4) for ρ_c, sets τ to 0.1948, and sets α_b to $1. - 0.1948 = 0.8052$. Together, these changes imply that $\gamma = 0$ and that leverage costs go to zero.

We find that the new values for s_c exceed the (new and old) values for s_{nc}. Investing in real capital is advantageous during inflation since inflationary capital gains escape full taxation. This advantage is greater in the noncorporate sector, where the marginal tax rate is greater. (Use of historical cost depreciation is more of a disadvantage when marginal tax rates are greater, but this effect is not as important.)

The relation between the values for s_c before and after integration is more complicated. The advantage to investing in real capital, where inflationary capital gains escape full taxation, declines with integration since the ordinary marginal tax rate on the return to capital declines. Offsetting this, however, the required before-tax risk-free nominal return on equity-financed capital was $(\alpha_b r_z)/[\alpha(1 - \tau)]$ before integration, while the required return declines to r_z after integration, regardless of the form of finance.

When we assume that property taxes are half distorting in all industries except housing, the equilibrium values for s_c, s_{nc}, and s, with or without integration, all go up by the values for t_p reported in column 2 of table 11.1. In columns 5 and 6 of table 11.2 we report explicitly the resulting values for s_c before and after corporate tax integration.

In addition to recalculating the values for s, we need to calculate how government revenues change each period as a result of corporate tax integration. Clearly, corporate tax revenues go to zero. However, corporate earnings, whether retained or paid out as dividends, become fully taxable under the personal income tax.[55] The new average tax rate on capital income t_k' is set equal to the ratio of these revised capital taxes to the capital income $K(\rho - d)$ in the benchmark equilibrium. These new taxes include only property tax payments (when relevant) and personal income tax payments as they would be with no corporate tax but with full personal taxation of all corporate earnings. (These personal income tax payments will be referred to as the personal factor tax.) Tax revenue from taxation of capital income in the revised equilibrium will then equal $t_k' K'(\rho' - d)$, where primes denote the values in the revised equilibrium.

We simulated corporate tax integration under several sets of assumptions in order to test the sensitivity of the results to the different specifications. Table 11.3 summarizes the parameter values assumed in each of the simulations. The basic simulation, summarized as case 1 in the table,

55. For income effects of taxation in this model, we use features from the FSW model. In the benchmark equilibrium, only 96% of dividends are taxable, to account for the $100 dividend exclusion in 1973. Retained earnings were assumed to generate equivalent accrued capital gains, but these are taxed on a deferred basis at preferential rates. Accounting for taxation of purely nominal capital gains, however, FSW use 73% as the proportion of retained earnings subject to full personal rates. Integration changes both of these latter proportions to one. Also in the benchmark, individuals reduce their personal tax base by 30% of savings, the amount contributed to pensions, Keogh accounts, and IRA accounts. This remained unchanged under integration.

Table 11.3 **Summary Information for the Different Cases Considered**

	Benchmark	Case 1	Case 2	Case 3	Case 4
Identifier	...	Central	No property tax	r_z = .07	Lump-sum equal yield
Tax changes					
α_b	.8222	.8052	.8052	.8052	.8052
τ	.48	.1948	.1948	.1948	.1948
t_k*	$\frac{\text{CIT}+\text{PFT}(+\text{PT})}{\text{capital income}}$	$\frac{\text{PFT}' + \text{PT}}{\text{capital income}}$	$\frac{\text{PFT}'}{\text{capital income}}$	$\frac{\text{PFT}' + \text{PT}}{\text{capital income}}$	$\frac{\text{PFT}' + \text{PT}}{\text{capital income}}$
Sensitivity analysis					
t_p	As appropriate for comparison	Real estate: nondistorting others: half	All non-distorting	Real estate: nondistorting others: half	Real estate: nondistorting others: half
r_z	As appropriate for comparison	.05	.05	.07	.05
Extra tax for equal yield†	...	Add scalar to personal rates	Add scalar to personal rates	Add scalar to personal rates	Lump-sum tax on individuals

*CIT = corporate income tax, PFT = personal factor tax (explained in the text), PT = property tax. Only the distorting parts of observed 1973 property tax revenues are added to the numerator. For case 2, no PT is in the numerator of either base or revised average tax rates. PFT′ indicates a changed PFT (see text).

†See text for descriptions.

assumes that half of the property tax was distorting in all industries except real estate, where it was assumed to be nondistorting.

In order to make up for lost tax revenue in this simulation, we assumed that all personal tax rates would be raised by a uniform scalar amount. This scalar increase in tax rates was chosen in each period so that government had just enough revenue to attain the utility level that it had in the same period of the benchmark sequence. In particular, we added the same scalar to the following tax rates: m_j, the personal tax rates of the twelve consumer groups ($j = 1,12$); m, the personal tax rate of proprietors; m_c, the personal tax rate of corporate owners with integration; n, the implicit rate of subsidy for purchase of local public goods; and $1 - r_{fz}/r_z$, the implicit tax rate on municipal bonds.

Each of the other simulations represents a slight variation from this central case simulation. In the second simulation, we assumed that the property tax was nondistorting in all industries. In this case property tax revenues are deleted from government revenues in both base and revised simulations. Property taxes are implicitly treated as benefit payments for public "consumer goods" or intermediate inputs in production.

In the third simulation, we set the risk-free rate to 0.07, the Treasury bill rate in 1973. This change affected the parameterization of the benchmark equilibrium, which was carried through to the new revised equilibrium.

Finally, in the fourth simulation, we assumed that any extra tax revenue needed to maintain government utility is raised through a lump-sum tax on individuals. The amount of extra tax paid by each group is proportional to its original after-tax income, but the extra tax has no price effects. While this case is unrealistic, it allows us to isolate the effects of changing the tax distortions on capital income. (With additions to personal income tax rates, there are further distortions in labor-leisure choices.)

11.4.4 Simulation Results

Tables 11.4–11.6 present some of the information from our simulations of corporate and personal tax integration. As a basis of comparison, we extended the consistent 1973 benchmark economy to a sequence of seven equilibria spaced five years apart. Each equilibrium is proportionately larger than the previous one, with all values growing at the steady state rate. For a revised case, the first period has the same total capital as in the benchmark. The endogenous savings response determines capital stock in the six subsequent periods, again spaced five years apart. With disproportionate growth, however, we need to interpolate values for intervening years. For each variable, we calculate the annual growth rate implied by its values from two successive periods. This rate is applied to

Table 11.4 **Equivalent Variations Relative to National Income for Each Year from Integration of Corporate and Personal Taxes**

	(EV/NI)			
Year	Central Case (1)	No Property Tax Case (2)	r_z = .07 Case (3)	Lump-sum Equal Yield Case (4)
1	−.0001	−.0003	−.0025	.0040
2	−.0002	−.0003	−.0025	.0041
3	−.0003	−.0003	−.0025	.0041
4	−.0004	−.0004	−.0024	.0042
5	−.0005	−.0004	−.0024	.0043
6	−.0006	−.0005	−.0024	.0043
7	−.0006	−.0005	−.0024	.0044
8	−.0006	−.0005	−.0023	.0044
9	−.0006	−.0005	−.0023	.0044
10	−.0007	−.0005	−.0023	.0044
11	−.0007	−.0005	−.0023	.0044
12	−.0007	−.0005	−.0023	.0044
13	−.0007	−.0005	−.0023	.0044
14	−.0007	−.0005	−.0023	.0044
15	−.0007	−.0005	−.0023	.0044
16	−.0007	−.0005	−.0023	.0044
17	−.0007	−.0005	−.0023	.0044
18	−.0007	−.0005	−.0023	.0044
19	−.0007	−.0005	−.0023	.0044
20	−.0007	−.0006	−.0023	.0044
21	−.0007	−.0006	−.0023	.0044
22	−.0007	−.0006	−.0023	.0044
23	−.0007	−.0006	−.0023	.0044
24	−.0007	−.0006	−.0023	.0044
25	−.0007	−.0006	−.0022	.0044
26	−.0007	−.0006	−.0022	.0044
27	−.0007	−.0006	−.0022	.0044
28	−.0007	−.0006	−.0022	.0044
29	−.0007	−.0006	−.0023	.0044
30	−.0007	−.0006	−.0023	.0044
31	−.0007	−.0006	−.0023	.0044

the value from the first of those periods to obtain values for each year between them.

Table 11.4 presents equivalent variations for all thirty-one years, each measured relative to national income in the corresponding year of the benchmark simulation. The seven actual equilibrium calculations are reflected in years 1, 6, 11, 16, 21, 26, and 31, while other years' values are obtained using interpolated data.

Table 11.5 **Key Variables Relative to the Benchmark, Over Five Year Periods, for Integration of Corporate and Personal Taxes (revise value/base value)**

	Time Period	Consumption	Saving	Capital Stock	Risk-free Interest Rate
1. Central case	1	1.0016	.9657	1.0000	.9745
	2	.9982	.9798	.9924	1.0039
	3	.9974	.9831	.9906	1.0110
	4	.9972	.9839	.9902	1.0126
	5	.9972	.9841	.9901	1.0130
	6	.9972	.9841	.9901	1.0131
	7	.9972	.9841	.9901	1.0131
2. No property tax case	1	1.0009	.9750	1.0000	.9870
	2	.9985	.9847	.9945	1.0071
	3	.9980	.9871	.9931	1.0121
	4	.9978	.9877	.9928	1.0133
	5	.9978	.9878	.9927	1.0135
	6	.9978	.9879	.9927	1.0136
	7	.9978	.9879	.9927	1.0136
3. $r_z = .07$ case	1	.9983	1.0078	1.0000	1.0320
	2	.9991	1.0050	1.0018	1.0275
	3	.9993	1.0043	1.0023	1.0263
	4	.9993	1.0041	1.0024	1.0259
	5	.9993	1.0039	1.0025	1.0259
	6	.9994	1.0044	1.0025	1.0261
	7	.9994	1.0039	1.0026	1.0256
4. Lump-sum equal yield case	1	.9994	1.0189	1.0000	1.0111
	2	1.0013	1.0110	1.0042	.9952
	3	1.0017	1.0092	1.0052	.9917
	4	1.0018	1.0088	1.0054	.9909
	5	1.0018	1.0087	1.0054	.9907
	6	1.0018	1.0087	1.0054	.9907
	7	1.0018	1.0087	1.0054	.9907

Table 11.5 summarizes results by looking at just a few key variables in each of the seven periods. Each entry is the ratio of the revise-case value to the base-case value of the same period. A capital stock ratio less than one, for example, does not imply reduced capital stock over time; it only implies less capital than in the growing benchmark sequence.

Table 11.6 shows the reallocation of the fixed total capital stock in the first period. The entry for each industry is the percent change in capital used in the first period of the revised sequence from the first period of the base sequence.

Integration of the corporate income tax with the personal income tax may seem like a dramatic change in the tax law. Indeed, Fullerton, King, Shoven, and Whalley (1980, 1981) find significant welfare gains from

Table 11.6 Reallocation of Capital with Corporate and Personal Tax Integration: Percent Change from the Benchmark Use of Capital for Each Sector

Industry	Central Case (1)	No Property Tax Case (2)	r_z = .07 Case (3)	Lump-sum Equal Yield Case (4)
(1) Agriculture, forestry, and fisheries	−.282	−.311	−.549	.364
(2) Mining	1.492	1.710	3.479	2.648
(3) Crude petroleum and gas	−.844	−.814	.445	.314
(4) Construction	3.551	3.928	6.610	5.390
(5) Food and tobacco	3.747	3.833	4.712	3.439
(6) Textile, apparel, and leather	3.955	4.151	6.151	4.009
(7) Paper and printing	5.169	5.348	7.105	5.446
(8) Petroleum refining	−.538	−.579	.210	.343
(9) Chemicals and rubber	6.889	7.027	8.687	6.854
(10) Lumber, furniture, stone, clay, and glass	1.752	1.946	4.265	3.162
(11) Metals and machinery	3.173	3.511	5.635	4.573
(12) Transportation equipment	1.316	1.681	3.688	1.683
(13) Motor vehicles	2.217	2.270	4.246	3.187
(14) Transportation, communication, and utilities	1.249	1.055	4.537	.336
(15) Trade	2.526	2.577	3.981	2.610
(16) Finance and insurance	−1.075	−1.573	2.012	−2.212
(17) Real estate	−.934	−1.298	−2.206	−1.763
(18) Services	.156	−.078	1.228	−.178
(19) Government enterprises	−.453	−.700	−1.581	−.104
(20) General government	−1.009	−.537	−1.897	−.271

integration. However, the results here indicate that the effects on the economy would be very modest. Except when revenues are replaced by a lump-sum tax, table 11.4 shows that the tax change results in a very slight *drop* in the utility from current consumption of commodities and leisure during at least the first thirty years after the tax change.

Net welfare losses occur with integration when the revenue is replaced by raising personal tax rates, because the labor-leisure distortion is exacerbated.[56] This overall loss occurs in spite of welfare improvements on three other margins.

First, integration eliminates the distortion favoring debt finance, removing the leverage costs that were 0.6% of benchmark national income.

Second, interindustry welfare gains follow along the lines of previous Harberger-type analyses, as indicated in the last two columns of table 11.2. The generally high required rates of return in manufacturing are lowered, while the low required rates of return in real estate and petroleum refining are raised.

Third, there are welfare effects on the intertemporal allocation of consumption. Table 11.2 shows that the average s_c is a bit higher with integration, whether or not the property tax was modeled as distorting. Integration reduces the small net subsidy to the risk-free return on savings, discussed in an earlier section. These three welfare effects are summarized in the fourth simulation of table 11.4, where revenue losses with integration are recovered through lump-sum taxes. Together they imply a slight welfare gain from integration alone. Without changing personal tax rates, labor supply remains basically unchanged. If personal tax rates have to rise, however, the first three columns of table 11.4 indicate a net welfare loss from integration. We find that the resulting drop in labor supply creates the largest welfare effect. We probably underestimate the welfare cost of this drop in labor supply because we ignore some existing distortions to labor supply created by various transfer programs such as food stamps and AFDC. In the first period of the central case, labor supply drops by 1.4% in response to the 0.026 rise in marginal tax rates. The figures for the second and third cases are very similar.

In the third case, where $r_z = 0.07$ in the benchmark equilibrium, the equivalent variation figures are even less favorable. It turns out that the benchmark intersectoral misallocation of capital and the intertemporal savings-investment distortion are slightly smaller in this case. The smaller gains from integration on those margins are offset by the same size loss from raising personal tax rates, for a larger net loss overall.

Because of the drop in labor supply with a fixed initial supply of capital, capital-labor ratios rise in the first period in all sectors except general

56. When personal income tax rates are raised, the interpersonal allocation of savings is further distorted, as are local public goods decisions.

government. In order to encourage this increase in capital-labor ratios, the cost of capital must fall. The last two columns of table 11.2 show that with no change in interest rates, integration would imply a higher cost of capital on average. Therefore the market interest rate must fall initially, as seen in table 11.5. The lower interest rate causes a fall in savings. The resulting reduction in the growth rate of the capital stock allows r_z to rise back up slightly above 0.05.

When $r_z = 0.07$, however, the tax change tends to increase the cost of capital relatively less (since lowering $(\alpha_b r_z)/[\alpha(1 - \tau)]$ to r_z becomes more important). In this simulation, interest rates have to rise to offset the stronger investment incentive resulting from the tax change. Note also that when labor supply does not fall, as when lump-sum taxes are used to replace lost tax revenue, the story is reversed. Interest rates initially rise in order to maintain an unchanged capital-labor ratio. The resulting savings rate is sufficiently high, however, that interest rates must fall later to create demand for all the resulting capital.

Capital-labor ratios do not rise uniformly, however. Capital is reallocated slightly across sectors in response to the tax change, as shown for the first period in table 11.6. Capital tends to leave the industries that are little affected by the tax changes: government,[57] the primarily noncorporate industries (1 and 17), and, to a lesser degree, industries which are heavily debt financed initially (16, 17, and 18). The major impetus for this reallocation of capital is the change in s_c resulting from the tax change, but many other factors are also involved. Included among these other factors are the relative size of the corporate sector, the relative size of the drop in leverage costs, and varying factor substitution elasticities in each industry.

We also see from table 11.5 that current consumption (of both commodities and leisure) falls eventually except when lump-sum taxes are used to replace lost revenue. In cases 1 and 2, this fall in consumption results mainly from the fall in potential output caused by the fall in the capital stock. In case 3 it results from the rise in interest rates which shifts income into savings. These current consumption figures are less interesting than the eqivalent variation figures, however, since they do not control for the amount of risk bearing. Note that risk bearing increases initially (in spite of the elimination of leverage costs) because of the reallocation of capital toward riskier industries.

In addition to these four simulations, we ran several others, not reported here, which produced very similar results. In particular, the assumption that property taxes on housing are also half distorting made almost no difference to the results. Also, raising extra tax revenues

57. Capital tends to leave general government in part because as personal income tax rates rise, its relative prices for labor and commodities (which are proportional to $(1 - n)$) fall more than does the cost of capital.

through a proportional rather than an additive increase in all personal tax rates made little difference.

11.5 Conclusions

Previous versions of the FSW model have assumed that marginal tax rates equal average tax rates and that government expenditures are nondistorting. In this paper we have reexamined the modeling of many of these marginal tax and benefit distortions. Particular attention was paid to the modeling of the effect of taxes on financial and investment decisions of corporations and local public governments.

We found that average tax rates provide a poor characterization of government-created distortions. In the cases of the social security, unemployment insurance, and workmen's compensation programs, we have argued that individuals receive extra government benefits which would come close to offsetting any extra taxes they pay on the margin, as well as on average. We also argued that recipients of capital income receive benefits which largely compensate them for the taxes they pay and often more than compensate them. However, this compensation comes in a subtle form: these recipients are able to reduce some of the risk in the return on their investments by transferring it to the government through risky tax revenue. We also found that the tax distortion favoring corporate use of debt rather than equity finance is quite costly from a social point of view.

Our results also emphasize the importance of using a general equilibrium model to evaluate welfare effects in a second-best world. The current model simultaneously accounts for tax distortions in corporate financial decisions, in the interindustry (and private versus government) allocations of labor and capital, in the intertemporal allocation of consumption, and in the labor/leisure choice of individuals. Concentration on only some of these distortions can give a very misleading view of the effects of integrating the corporate income tax with the personal income tax. In particular, we find that the extra distortion costs caused by raising personal income tax rates to restore government revenue more than offset the efficiency gains from changing the method of taxing income from corporate capital through corporate tax integration.

Appendix
Construction of Industry-specific Data
Yolanda Kodrzycki Henderson

This appendix describes the procedures for obtaining four data series: unemployment insurance tax rates, investment tax credit rates, economic depreciation rates, and tax depreciation rates.

Unemployment Insurance Tax Rates

In the above simulations, we required the net (of benefit) unemployment insurance tax rates for 1973 for eighteen private industries. These industries are for the most part aggregations of two to three SIC two-digit industries in manufacturing, and broader classifications (e.g. wholesale and retail trade) outside of manufacturing. Becker's (1972) data for unemployment insurance benefit and tax rates, on the other hand, came from sixteen state employment security agencies for various combinations of years and industries (see his tables A.5 to A.9). He has provided information for 1961, 1967, and the 1957–67 average. Industry detail included broad classifications such as "manufacturing" and "wholesale and retail trade," selected two-digit industries, and selected three-digit industries. Typically, data for a particular industry were available for only a few states and not all time periods.

In view of the discrepancies between required and available data, we computed the net tax rate for each industry from the 1957–67 sample and the 1967 sample. The unweighted average from the two samples was taken as the estimate for the industry. If the FSW industry consisted of several two-digit industries, this procedure was applied to each two-digit industry, and the average of these tax rates was used as the FSW industry tax rate. There were two exceptions to this general procedure caused by lack of industry information. For the two mining industries, petroleum and natural gas and other mining, we used the same estimate, the one available for their total. For petroleum refining, we averaged estimates for two other nondurable industries, chemicals and rubber and paper and printing.

Effective Investment Tax Credit Rates

To compute the investment tax credit rates, we divided the dollar amount of the credit taken in each industry by the level of investment in that industry. Because we were calculating effective rates, investment included purchases of structures and the change in inventories, even though these types of investment are not eligible for the ITC. We were

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forced to aggregate corporate and noncorporate data because there was no separate information about investment in these two sectors. This procedure is appropriate in that the same statutory rates apply to both sectors, but may be inaccurate if the type of investment differs between the corporate and noncorporate sectors of an industry.

Tables on the investment tax credit by industry appear in the Internal Revenue Service *Statistics of Income, Corporation Income Tax Returns*, but the ITC for sole proprietors and partners does not appear in the *Statistics of Income* publications for these returns. Unpublished data on the 1973 noncorporate ITC were made available by the Treasury Department, and we used the assumption of a constant ratio of noncorporate to corporate ITC in each industry to estimate the noncorporate ITC for 1974. These data were then aggregated to our industry definitions for each of the two years.

Our principal source for data on fixed investment by industry was the Commerce Department's survey of expenditures for new plant and equipment by United States business, as reported in the *Survey of Current Business (SCB)*. Supplementary unpublished data were provided by the Bureau of Economic Analysis (BEA) of the Commerce Department. The coverage of this survey was satisfactory for our manufacturing industries and for transportation, communications, and utilities. Information on other industries was inadequate for various reasons: agricultural business and housing are excluded entirely from the survey, some service industries are omitted, and investment in mining is underreported because capital expenditures for unsuccessful mineral explorations are expensed rather than being included as an investment on company books. As a result, we used several different procedures for obtaining investment in these remaining industries. For real estate, we used the National Income and Product Accounts (NIPA) figures for residential investment. This omits the relatively small nonresidential investment by this industry (brokers' offices), but we were not able to find information on this component. For agriculture, we used NIPA data on investment in agricultural machinery and nonresidential farm structures. Agricultural machinery is only part of the equipment purchased by farmers, and the rest (tractors, trucks, automobiles, etc.) is not broken down between agricultural and nonagricultural uses on an annual basis. We scaled up our estimate of equipment spending to total agricultural equipment in both years using information from the 1972 capital flow table (CFT) of BEA. For the remaining industries, we used the CFT data for 1972, multiplied by growth rates for the closest corresponding category from the 1973 and 1974 investment surveys.

Inventory investment estimates for agriculture and trade came directly from the *SCB* (tables 1.1 and 5.8, respectively). For other industries, we added together the book value change in inventories and the inventory valuation adjustment (IVA). BEA provided unpublished data for the IVA (consistent with table 6.16 of the *SCB*) for each of our industries for 1973. The 1974 IVAs were estimated using growth rates in the IVA for broad industry classifications (such as "durable manufacturing") from table 5.8 of the *SCB*.[58] The change in the book value of inventories came from the Census Bureau's monthly report on Manufacturers' Shipments, Inventories, and Orders, available from Data Resources, Inc. In some cases, it was necessary to impute data for two-digit manufacturing industries and nonmanufacturing industries. This was done using information on the size of the industry as measured by investment in the 1972 CFT, as well as information on inventory change in table 5.8 of the *SCB*.

Economic Depreciation Rates

As described in section 11.2.3 above, economic depreciation rates were found for each industry by calculating the rate that was most consistent with the dollar value of economic depreciation for the period 1972 to 1974 and the stream of investment through 1974.

For economic depreciation in twelve two-digit and three-digit manufacturing industries, we used the "variant C" estimates of Coen (1980), which are provided through 1974. For agriculture and real estate we used the Commerce Department's capital consumption allowances with capital consumption adjustment from the *SCB*, tables 1.13, 6.15, and 6.24. Estimates of economic depreciation rates were not available for more than these fourteen industries, but a procedure to extend depreciation rates to other industries is described below.

The data for nominal fixed investment described in the previous section (on investment tax credit rates) were extended back to 1947, and the price deflator for fixed investment from the National Income Accounts was used to convert those figures to constant dollars for the appropriate year ($i = 1972, 1973, 1974$). This was not possible for all industries, however. The investment survey data described in the previous section were available from Data Resources, Inc., for sixteen two-digit industries since 1947 (including the twelve manufacturing industries). For the real estate industry, we were able to use the NIPA data discussed in the previous section. For agriculture, we had investment in agricultural machinery since 1947, but information on nonfarm structures was available only back to 1958. We extended the latter to 1947 by assuming that it was 0.77 of the former, a figure based on the ratios for 1958, 1959, and 1960.

We still had to account for the (small) amount of the capital stock in

58. Both tables 5.8 and 6.16 of the *SCB* provide data on the inventory valuation adjustment, but are taken from different sources. Table 5.8 estimates are used in the product side of the GNP accounts, while table 6.16 estimates are used for the income side. See the *SCB* for further detail on the concepts.

1972 to 1974 that was the result of investment prior to 1947. Using NIPA data, we estimated that real nonresidential fixed investment increased at a 2.7% rate between 1929 and 1947, and real residential investment at a 2.1% rate, and applied these aggregate growth rates as described in the text.

Using the above information, we computed economic depreciation rates for fourteen industries. Some of the eighteen FSW industries correspond exactly to these industries. Some are aggregates of these available industries, and we computed economic depreciation rates for these aggregates.

For industries for which we had no depreciation data, we inferred information on the durability of their capital stock from data on their relative purchases of structures and equipment, as reported in the 1972 BEA CFT, which was available for all of our disaggregated industries. We used our estimated depreciation rates for available two-digit and three-digit industries, agriculture, and real estate in a regression on the ratios of equipment to total plant and equipment (and the square of that ratio). This regression gave us a predictive equation for depreciation rates of other two-digit industries based on *their* ratios of equipment to total plant and equipment. If one of the model's industries was entirely unrepresented in the available depreciation rate estimates, we used the predicted rate based on its 1972 CFT data. If part of an industry was represented in the available depreciation rate estimates, we used that estimate in combination with a prediction for the other part, weighting by the value of the capital stock in 1972 in each section of the industry.

Since a published estimate of the capital stock was not available for each two-digit industry, we estimated each capital stock ourselves. In particular, if d is our estimate for the economic depreciation rate in a particular industry, if μ is the estimated growth rate in real investment in that industry during the period 1947 to 1972, and if I^R is the real gross fixed investment in the industry in 1972, then the capital stock in the industry in 1972 is approximated by

$$K = \int_0^\infty I^R e^{-\mu t} e^{-dt} dt = \frac{I^R}{\mu + d}.$$

Where an industry's growth rate of investment was unavailable, we used a growth rate based on more aggregated data (e.g. manufacturing).

Tax Depreciation Rates

The methodology for computing tax depreciation rates was similar to the methodology for economic depreciation: we searched for the rate in each industry that was consistent with observed depreciation allowances and investment streams. The data for depreciation allowances came from the IRS *Statistics of Income* for both corporate and noncorporate enterprises, by industry. For real estate and agriculture, we used *SCB* tables 6.15 and 6.24. The rates for industries for which investment data were missing were derived in a manner similar to the economic depreciation rates, by regressions using the ratio of equipment to total investment.

The main difference in the methodology from that for economic depreciation rates was that we accounted for major changes in tax laws regarding depreciation allowances. In particular, prior to 1954, firms could use straight-line depreciation based on Bulletin F lifetimes. In 1954, double declining balance or sum of the years' digits methods of tax depreciation were introduced, and in 1971, tax lifetimes were reduced by 20% through the asset depreciation range (ADR) system. In each of these periods, therefore, the tax depreciation rate was different. We proceeded by calculating how the effective geometric depreciation rates would differ among these periods for a representative asset with a fourteen year tax lifetime prior to ADR. Suppose investment in this asset had been growing continuously at the nominal rate $\mu = 0.07$ (calculated by regressing the log of the NIPA total fixed nonresidential investment from 1947 to 1976 on time). Then under the double declining balance formula, tax depreciation deductions in year i would be

$$\mathrm{TD}_i = \int_0^{T/2} \frac{2}{T} I_i e^{-2t/T} e^{-\mu t} dt + \int_{T/2}^{T} \frac{2}{T} I_i e^{-(2/T)(T/2)} e^{-\mu t} dt,$$

where I_i is nominal investment in year i. The equivalent geometric depreciation rate would be that rate d' which would have implied the same size of tax deductions. With geometric depreciation, tax deductions would have been

$$\mathrm{TD}_i = \int_0^{\infty} d' I_i e^{-d't} e^{-\mu t} dt.$$

When we equate these two formulas and use $T = 14$ and $\mu = 0.07$, the only remaining unknown is d'. We therefore conclude that the effective depreciation rate for this representative asset would have been 0.162 for the period 1954–70. After 1971, when T was reduced by 20%, the effective rate implied by the above formulas increased to 0.205.

In contrast, with straight-line depreciation, tax deductions would have been

$$\mathrm{TD}_i = \int_0^{T} \frac{1}{T} I_i e^{-\mu t} dt.$$

Therefore the effective geometric depreciation rate for this representative asset prior to 1954 would have been 0.123.

On the basis of these results, we assumed in our calculations that if the effective geometric depreciation rate d' was available on investments made since 1971, then the rate $0.789d'$ was available during the period 1954–70, and the rate $0.600d'$ during the period prior to 1954.[59] We recognize that our procedure omits the effects of many other revisions during the period both in Treasury Department rulings and in the degree to which firms took advantage of the available rulings. A more thorough procedure, for example, might use information from Vasquez (1974) on the proportion of investment that was depreciated by the faster methods allowed following the 1954 and 1971 changes in the law. Our procedure should effectively capture the basic differences in the tax treatment of depreciation among the various industries, which is what we needed.

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59. Note that 0.162/0.205 equals 0.789, while 0.123/0.205 equals 0.600.

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Comment Charles E. McLure, Jr.

Fullerton and Gordon's objective in this paper is to develop a descendent of the Fullerton-Shoven-Whalley (FSW) general equilibrium model and use it to simulate the effects of integration of the income taxes. Their primary contribution lies in the attempt to incorporate in the model an improved description of corporate and noncorporate financial policy. A more realistic description of corporate financial policy is, of course, necessary if one is to analyze adequately the effects of integration, one primary benefit of which is neutrality toward corporate financial policy. This modification allows the authors to incorporate in their analysis the government's sharing in risk initially taken in the private sector. By comparison, most of the previous empirical attempts to implement the Harberger model, such as those by FSW, have examined a riskless world. Fullerton and Gordon also employ the same basic theoretical framework to analyze the financial decisions of government enterprises and of general government. A distinctly subsidiary effort involves consideration of marginal benefits of public spending as potential offsets to marginal taxes.

One must be impressed with the ambitiousness of what Fullerton and Gordon have attempted in the analysis reported here. To some extent they have "only" brought together and included in their model disparate threads of literature in public and corporate finance. Of course, this is a major undertaking in itself. But in other cases—especially in the analysis of government activities—they have had to attempt entirely new analyses of largely unexplored problems in order to flesh out their model.

While one must commend Fullerton and Gordon for their daring, it is not clear that they have been uniformly successful in all their pioneering efforts, or even in their eclecticism. Most of my remarks will focus on what I perceive to be shortcomings of Fullerton and Gordon's analysis rather than on the many manifest contributions of this paper.

Tax-induced Leverage

Fullerton and Gordon go well beyond earlier attempts to incorporate the financial decisions of firms in general equilibrium models. In particular, much is made—and properly so—of the public's sharing of risk, including that of bankruptcy, through the tax system. It is here that Fullerton and Gordon's major contribution lies. Yet one must note several deficiencies in their analysis.

First, the authors choose to illustrate the capability of their model by

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examining full integration under the partnership approach. This is a useful exercise; since so much has been made of the potential welfare gains from eliminating the distortions of corporate financial structures induced by the unintegrated taxation of corporate equity income, it is good to know that these gains would be roughly offset if revenues lost in integration were made up by raising taxes that further distort the labor-leisure choice. But one must wish that the authors had also examined the effects of providing only relief from double taxation of dividends, since complete integration is commonly agreed to be administratively difficult, if not impossible, and very unlikely to occur. That would, of course, be much more complicated to model, since it would necessitate addressing head-on the crucial question of the treatment of tax preferences.

Second, one cannot adequately model tax effects on decisions in the important petroleum industry without considering (*a*) tax preferences peculiar to that industry, such as the depletion allowance and the expensing of intangible drilling costs, and (*b*) the foreign tax credit. (See McLure 1979, chapters 4 and 6.) The effect of the preferences in reducing average tax rates in this industry is well known; but what is the effect at the margin? (Harberger 1966 included petroleum in the noncorporate sector in his two-sector analysis of the efficiency effects of capital taxes.)

One cannot fault Fullerton and Gordon for choosing not to consider foreign tax issues in detail. But in the petroleum industry the existence of surplus foreign tax credits (FTC) implies that domestic activities in this industry effectively carry a marginal tax rate near zero. These omissions become especially important when one considers integration of the income taxes. Would integration, if complete, involve passing the preferences and the foreign tax credit through to individual shareholders, or would the preferences and FTC be eliminated? If dividend relief were at stake, how would these tax preferences and the FTC be treated?

A number of minor points must be noted about Fullerton and Gordon's treatment of leverage costs and risk:

The calculation of industry-specific risk premiums on equity seems inconsistent with the use of a common risk premium for debt. One wonders how likely it is that risk premiums on the two types of securities issued in the same industry would not be highly correlated. I am disappointed that the authors felt it necessary to use a common risk premium for the bonds of all industries.

Fullerton and Gordon go to great lengths to tell elaborate stories about leverage in the corporate and government sectors. By comparison, they assume only equity finance in the noncorporate sector. Their brief discussion of this in a footnote leaves the reader wanting a more complete explanation.

Fullerton and Gordon assume that capital is just as risky at the margin as is existing capital, so that the optimal debt-capital ratio is the same for marginal investment as for prior investments. But this seems quite unlikely.

Through their assumption of uncertainty and no constraint on short sales the authors reject various theories that imply clientele effects and justify the repeated use of weighted averages of tax rates. Given the existence of constraints on short sales one must wonder whether much of the paper should not be recast in terms of (for example) marginal tax rates of marginal investors rather than averages of marginal tax rates. This is especially relevant since their approach forces Fullerton and Gordon to assume that the marginal personal tax rates of investors in the corporate and noncorporate sectors are not affected by integration. It is thought by some that existing patterns of ownership of assets reflect current taxation and that they—and related marginal tax rates—would change in response to integration.

Tax-exempt organizations play no role in this analysis, except as conduits for the saving of individuals. Is that appropriate, or should these organizations be assumed to have investment objectives of their own? Does the answer differ, depending on whether pension funds, universities, or foundations are concerned?

Benefit Taxation

Fullerton and Gordon claim that they model the distorting effects of government activity more accurately than do FSW by considering marginal increases in benefits that may offset marginal increases in taxes. This is clearly a worthwhile objective, since little is to be gained from treating taxes that are linked directly to benefits as distortionary levies. However, I find part of their discussion of which taxes are offset by benefits at the margin inadequate and some of their decisions on the matter arbitrary and questionable.

Fullerton and Gordon treat personal and corporate income taxes and various indirect taxes as "real" taxes. By comparison, they assume that the residential property tax only reflects benefits of public services. Thus they do not treat it as a distortionary tax. Though I would argue that this conclusion is not totally accurate, it is probably closer to the truth than the polar opposite assumption that residential property taxes buy nothing. Whether it can be said that nonresidential property taxes are also benefit taxes is unclear. Personally, I doubt it. But the authors' argument that once investment has been made nonresidential capital can be taxed by local governments with relative impunity seems oddly inconsistent with the instantaneous equilibration implicit in their formal model of capital allocation. On the other hand, since property taxes are deductible in calculating federal income tax liability, the pressure on local governments to provide a quid pro quo for property taxes paid is less than in the absence of deductibility.

Fullerton and Gordon argue that competition between states and localities will assure that property taxes merely reflect benefits. But I am not sure that they should limit the argument to property taxes, especially since the apportionment formulas used in state corporate income taxes to allocate total income among states ordinarily give a weight of one-third to property in the state. Similarly, why are all state and local indirect taxes and personal income taxes treated as unrequited levies rather than benefit taxes? Though the formal conditions required for an assumption of benefit taxation are less fully met in these instances than in the case of property taxes, I believe that some of the same economic forces that lead to classification of residential property taxes as benefit taxes would probably also lead to qualitatively similar results for general sales taxes and income taxes. Finally, Fullerton and Gordon treat all excises as taxes that increase production costs, even though the most important of these, the levies on motor fuels, are arguably benefit taxes levied for the construction and maintenance of highways.

In short, what Fullerton and Gordon have done to extend the FSW model by incorporating recent work on taxes and corporate financial policy is impressive and important. By comparison, their treatment of the benefit offsets to taxation is more debatable. This is especially unfortunate, since they tend to give these more questionable assumptions equal billing with their important work on tax-induced effects on financial policy and the public sharing of private risk.

Having said all that, one wonders whether it really matters. After all, the conceptual experiment being simulated is the replacement of one tax with another. Since the tax change under examination would almost certainly affect corporate financial policy, incorporating the financial decision in the model is crucial. But the taxes involved in the experiments in differential analysis are not said to be benefit taxes. Thus it appears on a priori grounds that it would make very little difference for tax incidence how the taxes that may be benefit taxes are treated. On the other hand, since welfare effects are proportional to squares of distortions, the same cannot necessarily be said of them. At several points the authors provide useful sensitivity analysis of how welfare effects depend on their treatment of property taxes.

The Government Sector

Fullerton and Gordon are forced by their desire for completeness, as well as by methodological necessity, to consider explicitly two components of the public sector, government enterprises and general government. There are, however, questionable aspects of both treatments.

The Fullerton and Gordon treatment of government enterprise does not involve including in their model standard results from the literature on government enterprises. Rather, it is simply a mechanical adaptation of their private-sector modeling of risk taking and investment. While one cannot necessarily expect a full-blown theory of public enterprise, one must be a bit uneasy about casually assuming that public firms follow so closely in the assumed footprints of private firms. Particularly troublesome is the modeling of leverage costs; though public enterprises rarely founder, the risk of bankruptcy in the public sector may not be negligible, and it may be different in kind from that in the private sector. Thus it seems unlikely that correcting the average private risk premium to abstract from risk of bankruptcy gives an accurate estimate of the appropriate risk premium to use for either government enterprises or general government.

The Fullerton and Gordon treatment of general government is even more questionable. First, it may be true that 72% of all government capital occurs in the state and local area. But through its budget deficits and the need to refinance the national debt the federal government generates enormous demands for financial capital. Beyond that, the treatment of governmental demand for labor in the model is sketchy, at best.

Second, Fullerton and Gordon assume, without adequate justification, that government revenues adjust so that government utility, given by a Cobb-Douglas function, remains constant, despite tax-induced changes in relative prices. This approach is questionable on several grounds. Most basically, the notion that government derives utility directly, rather than meeting the demands of consumers and producers for public services, is quite extreme. Moreover, it is inconsistent to treat much of general government (especially local government financed by property taxes) as supplying goods and services in response to benefit-related taxes, without including those goods and services in the utility functions of households or in the production functions of firms. Finally, except under very special assumptions, the assumption that government's utility remains constant when taxes are changed is not a satisfactory shortcut to assuming that the utility individuals receive from government services remains constant.

A final extreme assumption that deserves attention is the fixing of the real value of transfers in the face of tax-induced changes in consumer prices. As Browning (1978; Browning and Johnson 1979) has shown, this assumption can have dramatic effects on results of incidence analysis. But whether it is defensible is another issue. One must wonder whether this assumption is significantly more innocuous in the present context of analysis of the welfare costs of taxation.

Other Matters

The treatment of personal saving behavior seems rather odd. Fullerton and Gordon seem to be saying that individuals allocate a given percentage of saving to pensions, Keogh plans, and related tax preferred savings vehicles and then allocate the rest of saving between taxable and tax-exempt securities on the basis of the rate of return. This description of behavior is suspect on several counts. First, why do they choose this partioning between fixed allocations and allocations that depend on rates of return? Is the first split really independent of tax considerations?

Fullerton and Gordon employ a standard 70–30 split between taxable and exempt forms of saving. But some forms of exempt saving, such as IRAs, have statutory dollar limits. Thus one wonders if this split is appropriate at the margin. If it is not, the use of weights of 70% and 30% in calculating the average of marginal tax rates of investors is inappropriate. Finally, does it matter whether "pensions" are defined benefit plans or defined contribution plans? I can imagine that the individual may have considerable discretion over whether to invest in the latter. But I doubt that the same discretion exists so far as defined benefit plans are concerned.

Fullerton and Gordon deal quite summarily with what appears to be a major problem, cases in which their calculation of the demand for labor in the noncorporate sector produces a negative number. They apparently get around this by aggregating corporate and noncorporate labor and capital in each industry before inserting their values into the production function. Such an approach does, of course, imply a rather strange theory of production at the firm level.

It is surprising that after making so much fuss over the difference between average and marginal tax rates Fullerton and Gordon do not provide more information about differences in these rates. It would be interesting, for example, to know (*a*) how average and marginal tax rates differ, for each industry, (*b*) the primary sources of the differences, and (*c*) how much the difference makes for the effects of the tax changes under examination.

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