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A GENERAL EQUILIBRIUM MODEL OF TAXATION WITH ENDOGENOUS FINANCIAL BEHAVIOR

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A General Equilibrium Model of Taxation with Endogenous Financial Behavior

ABSTRACT

This paper presents and utilizes a new general equilibrium simulation model of capital income taxation. Its chief advantage over existing models of the effects of taxation is that it recognizes that agents may adjust their financial behavior in response to changes in the way that capital income is taxed. By integrating a structural treatment of portfolio choice and financial markets into a standard multi-sector model of taxation, the model can trace the general equilibrium impact of these financial adjustments and calculate the tax-induced changes in the allocation of factors and output as well as the distributional effects of any tax change.

The model is used to simulate the impact of completely indexing the tax system for inflation. The results indicate there would be significant financial adjustment in response to indexing. A large shift in the distribution of private risk bearing accompanies a slight reallocation of the capital stock away from owner-occupied housing toward its other uses and a substantial change in the ownership of the housing stock by income class. All in all, indexing the tax system of an economy like the U.S. in 1977 seems to lead to an efficiency gain, slightly hurts the lowest income classes, and substantially improves the welfare of the highest income groups. The simulation results should, however, be considered tentative due to uncertainty about the values of several parameters and the relatively simple formulations of the determinants of portfolio choice and the U.S. financial structure.

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I. Introduction

This paper presents and utilizes a new general equilibrium simulation model of capital income taxation. Its chief advantage over existing models of taxation is that it recognizes that agents may adjust their financial behavior in response to changes in the way that capital income is taxed. The model can trace the general equilibrium impact of these financial adjustments and calculate the tax-induced changes in the allocation of factors and production as well as the distributional effects of any tax change.

The paper is organized as follows. Section II provides as background a brief review of the important antecedent literature. In Section III I describe the structure of the model, while in Section IV the parameterization and control solution of the model is detailed. Section V uses the model to simulate the general equilibrium impact of changing the present system of taxing capital income under inflation to a perfectly indexed tax system. Some concluding remarks are made in Section VI.

II. Review of the Literature

General equilibrium analysis of the effects of taxation began with the static, two-sector, two-factors-of-production model of Harberger [1959, 1962, 1966].[1] In the original version of the model, two competitive industries employ two factors which are perfectly mobile between the sectors, but are fixed in total supply; the factors are paid a return which, including taxes paid, is equal to their respective marginal products. All consumers (and the government by implication) have identical homothetic preference functions as to the two goods. This formulation allows one to account directly for the interdependence among all product and factor markets.[2]

The Harberger model is especially suited for the analysis of differential taxation of either final outputs or factors. The effect of a differential tax on factor returns and the commodity price ratio is shown to depend on the relative factor intensity of production in the two sectors, the substitutability of factors in production, and the extent of demand substitutability. If all consumers and the government do not have identical homothetic preference functions, then any shifting of income among these groups would also have repercussions for relative prices since the composition of aggregate demand would change. The personal incidence of a differential tax depends on the personal distribution of factor endowments and consumption preferences. If all individuals have identical factor endowments, then any changes in factor returns have no income distributional effect from the sources of income side. If consumption preferences do not vary, then relative price variations do not have any distributional implications from the uses of income side.

Harberger's methodology was to solve the general equilibrium system analytically, making the problem tractable by assuming linearity or using a local approximation, and by limiting the dimensions of the problem. Shoven and Whalley [1972] showed that such a general equilibrium system could be solved explicitly without simplifications, using an appropriate solution algorithm. A variety of functional forms for production and demand functions could then be specified. The comparative static effects of a tax change are found by simply comparing the pre- and post-change equilibria. The flexibility of this method of solution allowed Shoven and Whalley to disaggregate the general equilibrium model more extensively than had been previously attempted. Disaggregation of production allows a more detailed calculation of the inter-sectoral misallocation caused by, for example, differential factor tax application. Disaggregation of consumers groups permits a detailed assessment of changes in the personal distribution of income.

In the most recent use of this technique, 16 consumer goods (counting saving as one such good) are distinguished. Using input-output information, a vector of consumer goods is translated into a vector of 19 produced goods, which in turn are produced by labor and capital. Twelve consumer classes are distinguished on the basis of differing marginal personal tax rates, factor endowments, and consumption preferences. Although it is larger, the Fullerton-Shoven-Whalley[3] model has the same basic structure as the simple Harberger model.

Some recent research, though, has focussed on a number of potentially important aspects of the capital income tax environment which are outside the scope of a Harberger-type model. For example, one characteristic of the Harberger-type models is that in an equilibrium situation all individuals face the same relative rates of tax on capital placed in the various sectors. The pattern of marginal products of capital is such that the after-tax rates of return on capital in all sectors are equal for all individuals; each individual can be thought of as owning a proportionate share of all the economy's capital goods. Note that this kind of equilibrium would be impossible if the relative rates of tax on capital goods differed for different individuals. Feldstein and Slemrod [1978] point out that this is in fact the case in the U.S., where there is (i) progressive personal taxation with marginal rates ranging from below the corporate rate to above the corporate rate, and (ii) the opportunity to substantially reduce personal taxation through corporate retained earnings. In this situation corporate-source capital income may be taxed more or less heavily than non-corporate capital income depending on one's tax bracket. If corporate equity and other capital income sources were perfect substitutes for other than tax reasons, then we would expect to observe that in equilibrium any individual would invest entirely in corporate equity or enitrely in the alternative asset, but never both; this specialization will occur whenever the relative tax on two types of investment differs for different groups. In order to explain the observed tendency for investors to hold diversified portfolios, an explicit portfolio balance relationship is required.

Ideally, a model should specify the sources of risk in the economy, individuals' attitude toward risk-bearing (expressed in the form of cardinal utility functions), and the opportunities for portfolio diversification. In such a model, portfolios will differ by consumer class. Therefore, for certain problems it may be incorrect to assume that all capital owners bear the burden of tax changes identically.

The work of Stiglitz [1973] and King [1974], building on the classic paper of Modigliani and Miller [1958], made clear that any analysis of corporation taxation must consider the financial flexibility that corporations have. Interest paid to debt-holders is deductible from corporate taxable income, and dividends are taxed differently than retained earnings so that the effective tax on equity earnings depends on the capital structure and the payout policy of the corporation. When Harberger and Shoven-Whalley calculate the total effective tax on corporate-source capital income, they consider the financial structure of the sector, but when the effects of a tax change are simulated, financial policy is assumed to be unaffected.[4] Papers by Ballentine and McLure [1978] and Feldstein, Green, and Sheshinski [1979] have investigated the effects of corporation income tax in a world of flexible corporate financial policy, but neither posed the question in a general equilibrium model with differentially taxed wealth owners and several production sectors.

This concludes the overview of the important antecedent literature. The research since Harberger may, it seems, be divided into two categories. The first category features highly stylized, usually partial equilibrium, models that focus on one aspect of capital income taxation, such as the implications of a progressive tax system or the role of corporate financial decisions. In the second category is the work of Shoven and his collaborators, where a large general equilibrium model is constructed as a framework for the analysis of a wide range of taxation issues. However, the Shoven model, being fundamentally identical to the smaller Harberger model, inadequately treats several of the important issues raised in the first group of papers. The remainder of this paper is devoted to the development of a new model which is general equilibrium in the tradition of the second category of research, but can also offer insight into the issues raised by the first category of the recent literature.

III. Description of the Model

III.1. Distinguishing Characteristics

In this section, the structure of the general equilibrium model with financial behavior (GEFB) is presented. Before proceeding to a more detailed discussion of its features, its distinguishing characteristics are briefly noted here.

1. Explicit treatment of riskiness. Income from capital is not certain, and individuals are risk-averse. Individuals allocate their wealth among the available asset types on the basis of optimal portfolio considerations.
2. Portfolio choice under progressive taxation. Since different agents face different tax rates, they will hold different portfolios.[5] Thus, for incidence results, it is not generally true that all capital owners will be identically affected to the extent that they own capital.
3. Endogenous tax rates. An individual's marginal tax rate is not fixed, but rather depends on the amount of his taxable income. This is an important consideration in the decision of how much financial leverage to acquire, since the marginal tax saving from borrowing declines with greater borrowing in a progressive tax system.
4. Tax-exempt bonds. These securities are a potentially significant outlet for the wealth of high tax bracket individuals, and are included in the available asset menu.
5. Rental and owned housing. The capital income from these two ways of consuming housing are subject to very different taxation schemes. In

this model the two types of housing are treated separately.

6. Corporate financial policy. The importance of the ability to alter corporate financial decisions in response to the tax environment has already been noted. The GEFB model can accomodate endogenous corporate decisions in a number of ways.

III.2. Risk, Risk Aversion, and Portfolio Choice

Each agent in the economy is endowed with a fixed amount of capital goods and a fixed amount of labor in efficiency units. The capital goods may be used in the production of goods for sale or in the production of housing services to be consumed by the owner. Labor is inelastically hired out to firms in return for a wage.

The production functions of all goods other than owner-occupied housing are stochastic. The stochastic element, though, refers only to the contribution to production of the capital input; thus the marginal product of labor is certain.[6]

In the standard Harberger model, the individual implicitly faces a two-stage decision process. In the first stage, his endowment of factors is allocated in order to maximize the flow of income, or, equivalently, wealth at some point in time. In the second stage, the income flow is allocated among consumption goods in order to maximize utility. In the GEFB model, a similar but modified two-stage decision process is envisioned. In the first stage, the individual constructs a portfolio to maximize the expected utility of the stream of income, or, equivalently, the expected utility of some future period's wealth. Once the uncertainty is resolved and actual income is revealed, the income is allocated among consumption goods to maximize the utility obtained.

The following special form of the first-stage maximand will be considered:

$$\bar{y} - \beta\frac{V}{K}$$

where $\bar{y}$ is the expected flow of after-tax income, β is a tradeoff coefficient, V is the variance of after-tax income, and K is the capital endowment. This formulation has the desirable feature that the portfolio demand functions implied by its maximization are identical to the optimal rules for an individual who has only capital income and is faced with a frictionless capital market and an infinitesimal planning horizon.[7]

In the second stage, realized income is allocated among the consumption goods. Since only homothetic utility functions are considered, maximizing the expected utility of income in the first stage also maximizes the expected utility of consumption.

III.3. Model Structure

In this section the overall structure of the model will be laid out. In subsequent sections, more detailed attention will be paid to certain sectors of the model and their parameterization.

The economy's agents are considered to consist of nine stylized types, each representing a different income class. The agents vary in their (fixed) endowment of capital and labor as well as their preferences for consumption goods. All individuals are assumed to have the same coefficient of risk aversion. Because there is a progressive tax system, the different categories of individuals, called "income groups" for convenience, will have different marginal tax rates and the after-tax riskiness of assets will also differ among individuals.

The model has production functions for each of four goods: food, rental housing, owner-occupied housing, and a composite good produced by corporations. Each income class has a demand function for each good, which depends on real income, relative prices, and the tastes of the income group.

There are asset demand functions of each class for each of six assets: food-sector capital, rental housing, owner-occupied housing, corporate equity, taxable debt, which is assumed to be riskless, and tax-exempt debt, which has some uncertainty of return. These functions are derived from the first-order conditions for the maximization of expected utility, and include as arguments the capital endowment, the after-tax expected real rate of returns on the available assets, the after-tax variance-covariance structure, and the degree of risk aversion. The tax system is assumed to regard net losses symetrically with net gains, and the marginal tax rate is assumed constant in the calculation of after-tax variances and covariances.

There are market-clearing equations for all assets and all goods. The supply equations of different assets have different characteristics. For housing and food-sector capital, the supply simply equals the capital stock used in production. For corporate equity, asset supply is the equity-capital ratio, which is endogenous, multiplied by the corporate capital stock. The supply of tax-exempt debt is fixed by state and local governments, and is exogenous to the model. The supply of taxable debt is the sum of the exogenously given supply of federal government debt and the amount of corporate debt, which is equal to the corporate debt-capital ratio times the corporate capital stock. Since both the debt-capital ratio and the corporate capital stock are endogenous, the total supply of taxable debt is also endogenous. The market-clearing equations for goods simply state that demand equal production.

The model also includes equations for the allocation of labor to sectors (equalization of marginal revenue product), factor supply identities, and determination of real income and taxable income by income group. There is also a corporate earnings exhaustion equation, which ensures that total corporate earnings net of corporation income tax accrue either to corporate debt holders or to equity holders.

The basic structure of the model is thus similar to the standard general equilibrium model of taxation, except that the simple capital allocation equations are replaced by explicit portfolio demand equations and market clearing equations for each of several financial assets. Other distinguishing aspects of the model are discussed further below.

III.4. Endogenous Tax Rates

The total tax liability and marginal tax rates in the various kinds of income are calculated by appropriately reducing the income flows of the group to a per tax return basis, calculating taxable income, and applying the actual pattern of tax brackets and rates that were applicable in 1977.[8] Taxable income differs from real income in a number of significant ways. First of all, certain deductions and exemptions are allowed. The average value of all such deductions and exemptions other than for interest and property tax payments is considered to be fixed and is entered as a subtraction from income. The amount of allowable deductions for interest and property tax paid is endogenously determined using the simulated portfolios.[9] Second, nominal interest received rather than real interest received (and paid) is included in taxable income. Third, the imputed income from owned housing is not included in taxable income, though a small fraction of the nominal rise in housing values due to inflation is included in order to reflect the partial taxation of capital gains on residences. Similarly, a fraction of the inflation-induced capital gains on other assets is included.[10] The income from equity, after corporation tax, is only partially included in taxable income to reflect the fact that retained earnings are virtually exempt from personal taxation. The fraction included in taxable income is equal to $d + (1 - d)c$, where d is the payout ratio and c is the ratio of the effective tax on capital gains to the tax on dividends. The value of c will be less than one due to the exclusion of one-half of long-term capital gains, the value of the deferral of tax payments until realization of the gain, and the opportunity to avoid tax by bequeathing appreciated stock. For present purposes the value of c is taken to be one-eighth. The income from state and local securities is not part of the taxable income. Finally, there is an addition to individual taxable income (for rental housing and food-sector capital owned) and to corporation taxable income (for corporate capital) to reflect the mismeasurement of capital income due to historical cost depreciation and certain inventory accounting methods. Since depreciation on owner-occupied housing is not deductible from taxable income, inflation does not thereby cause any additional tax to be paid due to consuming owned housing services.

Once the total taxable income is determined, the marginal tax rate on a dollar of taxable income (call it "t") is calculated by referring to the tax tables. The real after-tax rate of return earned by the ith asset is then equal to $r_i - t(r_i^\tau)$, where r_i is the before-tax real rate of return and r_i^τ is the addition to taxable income from holding one dollar of the ith asset. For all the reasons mentioned above r_i^τ may differ from r_i . For example, the after-tax real rate of return to holding a nominal debt security is $r_B - t(r_B + \Pi)$, since a dollar of debt yields $r_B + \Pi$ (the nominal interest rate) of taxable income.

III.5. Tax-Exempt Bonds

In the model there is a fixed supply of debt issued by state and local governments, the interest from which is exempt from federal income taxation. They are presumed here to be risky assets, though they are significantly less risky than corporate equity, rental housing, or food-sector capital.

Individuals cannot borrow at the tax-exempt interest rate; that is, they must hold a non-negative quantity of these securities. An important question is whether individuals can simultaneously hold tax-exempt bonds and receive a tax deduction for interest paid on their outstanding borrowing. The tax law states that individuals cannot borrow for the express purpose of buying tax-exempt bonds and still claim the interest expense as a deduction. However, it is possible for an individual to deduct interest payments while at the same time holding tax-exempt debt. The IRS position is apparently that whenever an outstanding obligation is not directly connected with a personal or business loan, it will be inferred that its purpose is to carry tax-exempt assets, and therefore its interest expense will be disallowed as a tax deduction. However, the Tax Court and other courts have ruled that in order to be disallowed the debt and the tax-exempt property must somehow be related in purpose.[11]

For present purposes what is needed is an operational rule which approximately captures the reglations' effective limitation on interest expense deductions when a portfolio includes tax-exempt bonds. We have chosen the rule that the IRS will disallow that fraction of any individual's interest deductions equal to the ratio of the value of tax-exempt bonds to total net wealth. Under this rule, the net cost of borrowing depends on the amount of wealth invested in tax-exempt bonds; also, the after-tax return of tax-exempt bonds depends on how leveraged one's portfolio is.

III.6. Housing

It is assumed that the housing sector produces housing services from capital with no labor input. Though the omission of labor is certainly a stylization of the production process, it is not an unwarranted exaggeration. Aaron [1972] notes that housing services require the combination of more capital per unit of labor than does any major category of consumer or investment goods. Using a detailed input-output matrix, Fullerton, King, Shoven, and Whalley [1978] calculate the capital-labor ratio of producing housing services to be approximately 20 times higher than the economy-wide capital-labor ratio, and 15 times higher than any other major sector.[12]

It is further assumed that the services from rented housing and the services from owner-occupied housing are considered by consumers to be distinct commodities. In actuality, though their characteristics tend to differ, the distinction is not absolute. Which type of housing will be chosen by a given family unit (they may in many cases effectively be mutually exclusive commodities), and the quantity consumed given that choice, will depend on tastes as well as the relative price of rented versus owner-occupied housing. If all the individuals within an income group are aggregated, the aggregate relative consumption of the two types of housing services may be represented as a smooth function of the relative price of the two goods and the distribution of tastes within the class (see Rosen and Rosen [1980]).

The set of available assets includes rented and owner-occupied housing. It is assumed that the production of services from rental housing capital is subject to stochastic influences, and the production of services from owner-occupied housing is not stochastic. In expected value terms, the two production functions are identical. The model then has a market clearing equation for rental housing, where the sum of the nine income groups' demand for it as an asset must equal the stock necessary to supply the rental services demanded by consumers at the equilibrium relative prices. For owner-occupied housing, the situation is somewhat different. For each income class, there is an additional constraint that the desired stock must produce a flow of services equal to the amount of services demanded by that class. Thus, there is implicitly a separate market for each class in which each individual rents the housing services from himself. For each class, there is a shadow price of consuming housing. This price has three components: (i) the pecuniary income foregone through holding capital in housing rather than another asset, (ii) the cost of maintenance and depreciation, and (iii) any attendant tax liabilities or rebates.

III.7. The Government Sector

One function of the government is relative price stabilization. In the absence of government intervention, the market-clearing pattern of relative prices would depend on the state of the world that obtains. In this economy, though, the government maintains stocks of all commodities, and pledges to defend a particular relative price structure by buying all production at these prices and selling that amount of each commodity such that these announced prices support markets that clear. The relative price structure that the government supports is the one that would obtain if realized production was equal to the expected value of production in each sector. Of course which prices are supported depends on the allocation of capital and labor by sector. This arrangement leads to market clearing with no intervention necessary if the expected value of all sector's production obtain, and which may require some use of the government's commodity stocks if they do not. Note that by doing this the government does not insulate agents from the production uncertainty, but rather confines the effects of the uncertainty to incomes, while making relative prices nonstochastic.[13]

The government must also collect taxes to finance its expenditure, which has three components. The first is spending on goods and services, which is fixed. The second component is interest payments, which vary according to the equilibrium interest rates on government debt. The third component is the cost of the price supports discussed above. Since uncertain capital income comprises part of the tax base, total tax revenue is also uncertain. The government constructs its tax schedules so that the expected value of its tax revenues equals its expenditure commitments. Any divergence of actual tax revenues from this expected value is made up by a special tax levied in proportion to the value of each agent's tax liability.

When the economic environment changes so that expected revenues no longer equal desired expenditure, the government alters the tax rate schedules to reestablish the equality. Thus the expected value of the stochastic tax transfers will always be zero.

III.8. Corporate Financial Policy

Corporate financial policy represents another dimension of possible behavioral response to changes in the tax environment. Modigliani and Miller [1958] demonstrated the irrelevance to firm market value of corporate financial decisions in the absence of taxes, and speculated that financial flexibility would allow firms to avoid any corporation income tax by issuing debt instead of equity and to avoid any tax on dividends by retaining earnings within the corporation. Much recent work, some of which was alluded to earlier, has re-examined the interaction between capital income taxation and corporate finance taking into account, among other things, the personal taxation of debt interest, the effective capital gains tax on retained earnings, and progressive taxation.

In Slemrod [1980][14] I discuss several methods of introducing the financial flexibility of corporations into a GEFB model. Because of the lack of a consensus about just what characterizes a capital market equilibrium in the environment described above, no simple procedure will be completely satisfactory. Nevertheless, in that work I utilized a procedure which is in the spirit of several theoretical treatments of corporate financial behavior in the presence of taxes and is consistent with the econometric evidence concerning financial policy behavior. I will briefly describe in turn the procedure, its theoretical justification, and the relevant econometric evidence.

The suggested procedure is to set both important corporate financial decisions (debt-equity and payout) to be functions of critical "tax cost" values. Behind this procedure is a theory which envisions the corporation maximizing its value by balancing the net tax advantages of its financial structure with the other costs and benefits of the policy. For debt-equity policy, the cost that offsets the tax advantages of debt may be real bankruptcy costs or agency costs. For dividend policy, the tax advantages of retained earnings must be balanced against the transactions cost of receiving income in the form of capital gains, the signalling value of dividends, constraints on firm growth, and the law which inhibits the unwarranted accumulation of funds within the corporation.

One common element of these non-tax factors is the difficulty of quantifying them and explicitly relating their magnitude to the financial policies chosen. Rather than arbitrarily constructing such measures, I instead use econometrically estimated responses of financial policy to the tax cost of the policies involved. The presumption is that these measured responses are the result of an optimal balancing of tax considerations with the other implications of the financial decision.

The estimated responsiveness of the debt-equity ratio comes from King [1978], where he finds an elasticity of 0.8 with respect to the tax cost variable $t_c(1-t_B)^A$, where t_c is the rate of corporation income tax and $(1-t_B)^A$ is a weighted average of (one minus) the marginal tax rate of equity holders. This value measures the cost of raising new capital through debt versus new share issue. The estimated responsiveness of the payout ratio is taken from Slemrod [1980], where the work of Brittain [1966] was updated.

The estimated elasticity of the payout ratio with respect to the tax cost of dividends, $(t_D - t_{RE})^A$ (the weighted average of the difference in the tax rate on dividends minus the effective tax rate on retained earnings), was found there to be -0.79.

IV. Parameterization and the Control Solution

IV.1. Parameterizing the Model

The model is parameterized to represent a stylized U.S. economy of the year 1977. That year is chosen because it is the most recent year for which detailed tax return information is available. Unfortunately, though, the best information available about certain key values refers to earlier years. Thus, it is often necessary to update and adjust data to represent the 1977 situation.

One crucial set of values for which the best data available is severely outdated is the distribution of wealth. The most accurate source for this as well as for the structure of portfolios by income and wealth class remains the Federal Reserve Board's Survey of Financial Characteristics of Consumers (SFCC), which refers to year-end 1962. The SFCC disaggregates the wealth and portfolio information into nine income classes. In order to obtain a wealth distribution for 1977, it is assumed here that the relative distribution of wealth by real income class has not changed since 1962. The SFCC income classes are thus inflated by a factor of three, which is approximately the factor by which per capita disposable personal income rose between 1962 and 1977.[15] The resulting nine income classes for the 1977 model are as follows: \$0-\$9,000, \$9,000-\$15,000, \$15,000-\$22,500, \$22,500-\$30,000, \$30,000-\$45,000, \$45,000-\$75,000, \$75,000-\$150,000, \$150,000-\$300,000, and over \$300,000. The nine stylized individuals in the economy represent average individuals of each of these income classes. The relative distribution of wealth among these classes is assumed to be the same as the relative distribution among the equivalent 1962 classes.[16]

Under the model's assumptions the relative gross remuneration of labor will equal the relative endowment of labor in efficiency units. To approximate this distribution, I use the 1977 Statistics of Income measure of wages and salaries received by taxpaying units in each income class, supplemented by adding one-half of the net return to business, profession, farm, and partnership as an approximation to the labor input share in self-employment.[17] The resulting distribution of labor is given in Table A-1 of the Appendix.

In order to obtain the value of total private wealth, the ratio of private wealth to labor units as of 1962 was calculated and then applied to the total labor endowment in 1977. That procedure yielded 4.24 billion units, or $4.24 billion worth, of private wealth.[18] As mentioned above, the distribution of that wealth is determined according to the relative ownership of wealth from SFCC. The resulting wealth distribution is also shown in Table A-1 of the Appendix.

Because the utility function of each class is assumed to be Cobb-Douglas, knowing the share of consumption that goes to each good is sufficient for parameterizing the function. The source for spending shares is the Bureau of Labor Statistics' Consumer Expenditure Interview Survey, 1972-73. The income classes delineated in the survey are inflated to refer to 1977.[19] The food share is computed as the ratio of expenditure on food at home to current consumption expenditures; the rental housing share is the ratio of expenditure on rented dwellings to current consumption expenditures. The appropriate share for owner-occupied housing cannot be straighforwardly obtained from the expenditure survey, since the true cost of this behavior is not correctly measured. To obtain the true cost of owner-occupied housing, I apply a conversion factor to the reported spending equal to the ratio of actual spending to reported spending.[20] The highest income bracket for which results are reported in the expenditure survey is $50,000 and over ($75,000 and over in 1977 dollars). This blurs any possible distinction in the consumption preferences of the top three income classes. Rather than use the reported expenditure shares of the over $75,000 group for all of the top three classes (and implicitly assume an income elasticity of one in this range), the shares of spending of the top three classes are found by extrapolating the share of the sixth income class to higher incomes using estimated income elasticities.[21] The resulting shares for food, rental and owned housing and, as a residual, the corporate good, are displayed in Table A-2 of the Appendix.

The effective corporation income tax rate is calculated by dividing 1977 corporate profits without inventory valuation or capital consumption adjustment into total 1977 corporate profits tax liability; this yields a value of .41.

The property tax rate of .0154 is calculated by dividing total property tax payments in 1975 ($51.49 billion) by total assessed value of property in that year ($1063.9 billion) and applying an estimated percentage of assessed value to market value (.327).[22]

The aggregate corporate debt-equity ratio of .721 is calculated by dividing the flow of funds estimate of the 1977 value of corporate debt by the value of corporate equity ($749.7 billion divided by $1039.5 billion).

The payout ratio of .544 is found by dividing dividend payments in 1977 by corporate profits after inventory valuation and capital consumption adjustment ($42.1 billion divided by $77.3 billion).

The anticipated rate of inflation is taken to be 6 per cent, which is the average annual increase in the CPI between 1975 and 1977.

The mismeasurement of corporate taxable income due to inflation is calculated to be .00515 dollars of additional taxable income per dollar of corporate capital for each percentage point of inflation. For example, a six per cent rate of inflation will cause a \$46.35 billion ($.00515 \times 6 \times 1.5 \times 10^{12}$) overstatement of corporate profits on a corporate capital stock valued at \$1.5 trillion. This coefficient was calculated using estimates of the overstatement of taxable profits taken from Feldstein and Summers [1979] and values of corporate fixed capital and inventories. The desired coefficient, call it d, should make the equation $E = d\pi K_c$ correct, where E is the profit overstatement, π is the inflation rate, and K_c is the value of corporate capital. Solving for d, $\frac{E}{\pi K_c}$ comes to .00512 for 1977, and as an average over the period 1970 to 1977, comes to .00519. I therefore use .00515 to represent d for corporate capital as well as food-sector capital and rental housing capital.

Since most government securities are not directly held by households, the appropriate value of these stocks in a model with no financial institutions is problematic. I have chosen values of \$100 billion of state and local securities, \$200 billion of federal government securities. These values are approximately 1.25 times the reported household holdings of these assets in 1977.

The measure of risk aversion, β, is taken to be three for all income groups. This value was chosen since equilibria calculated using this value yielded simulated risk premiums consistent with observed magnitudes, and because it is compatible with some recent research.[23] There is little empirical basis for choosing the variance-covariance structure of the assets. For these simulations I will assume all covariances to be zero, and the average after-tax variances of the assets to be .07 for corporate equity, .05 for rental housing, .12 for food-sector capital, and .02 for tax-exempt bonds. Of course the methodology can handle any variance-covariance structure, including one with non-zero off-diagonal elements.

The exponents on capital input in the Cobb-Douglas production functions are set at .207 for the corporate sector and .111 for the food-related sector.

IV.2. The Control Solution

With this parameterization, the model is solved for an equilibrium solution using a modified Gauss-Seidel algorithm. The equilibrium values of some of the key variables are presented in Table 1. Note that the expected real returns given in the table are net of any corporation income and property tax payments, but are before personal tax payments. The choice of simple function specifications and realistic parameters makes it impossible to reproduce exactly all the actual 1977 prices and allocations. It is reassuring, though, that the model solution yields an allocation of factors, production, and relative prices which is close to what the actual 1977 economy looked like.

The calculated expected rates of return are compatible with actual observations. The actual 1977 nominal interest rate on corporate debt was .080 for Aaa bonds and .090 for Baa-rated bonds, compared to the model result of .104. The difference may be attributed to the model's anticipated inflation rate of 6 per cent, which may be an overestimate of actual long-term inflation expectations in that year. The predicted nominal rate on tax-exempt bond is .061, compared to Standard and Poor's yield index in 1977 of .056, again a slight overestimate. The expected real rate of return to equity that the model calculates is .106. That is somewhat higher than the average annual rate of return on the Standard and Poor's composite index of New York Stock Exchange equities over the period 1926-1977, which is .081.[24] However, .106 is substantially higher than the realized real rate of return on equities in the decade preceding 1977. All in all, .106 seems a not too unreasonable though perhaps optimistic reading of the expected return on equity in 1977.

The equilibrium solution includes the portfolio holdings of each income class. This information is not reproduced in detail here, though some

TABLE 1

EQUILIBRIUM VALUES OF KEY VARIABLES IN SIMULATED 1977 ECONOMY

Expected real rate of return on Corporate Equity	.106
Expected real rate of return on Food-Sector Capital	.082
Expected real rate of return on Rental Housing	.090
Expected real rate of return on Taxable Debt	.044
Expected real rate of return on Tax-Exempt Debt	.001
Corporate Capital Stock	1489.8
Corporate Equity	865.6
Food-Sector Capital Stock	260.0
Rental Housing Stock	770.5
Owner-Occupied Housing Stock	1418.1

Note: All rates of return are net of any corporation income tax and property tax payments, but are before payment of any individual income tax liability.

characteristics deserve note. As expected, the ownership of equity is skewed toward the higher income classes. The top three income classes (over $75,000 income), which are presumed to account for 27% of private wealth, own 43.9% of the equity. This is consistent with available data on dividends received, which indicate that these classes get approximately 37% of all dividends.[25] Owner-occupied housing is much less concentrated among the higher income classes, with 79.5% of the stock owned by taxpaying units of $45,000 or less in income. The ownership of tax-exempt securities is limited to the top two classes. The lower seven classes own positive amounts of riskless debt, while the top two classes are net borrowers of funds. In fact, these highly-taxed classes have a debt position amounting to 26.2% of their net wealth.

V. An Indexed Tax System - Simulation Results

V.1. Constant Corporate Financial Policy

As is well known by now, the U.S. system of taxing capital income is decidedly non-neutral with respect to inflation. The problem arises because in the presence of inflation real capital income is mis-measured. Nominal interest received is treated as income with no deduction for the real loss in the value of the principal. Similarly, nominal interest payments are fully deductible. Increases in nominal asset value that do not correspond to real value increases are subject to capital gains tax if and when these gains are realized. Also, historical cost depreciation rules and certain inventory accounting methods lead to an overstatement of real net earnings.[26]

The mismeasurement of capital income does not uniformly apply to all assets. Thus inflation alters the pattern of real after-tax rates of return available. This in turn causes a readjustment of portfolios and a shift in the allocation of capital to production sectors, which affects the pre-tax return on assets. The tax penalty (or benefit) from the mismeasurement of capital also varies depending on the marginal tax rate of the agents involved. Extra corporate taxable income due to inflation is subject to the corporation income tax rate, as are the extra deductions of nominal interest payments. For individuals, the tax cost varies with their tax bracket. Thus, the overall impact of inflation depends on the tax-induced distortion of rates of return and agents' financial response to these distortions. Clearly a general equilibrium analysis is well-suited to this type of problem.

An indexed tax system would eliminate the distortionary effects of inflation by correctly measuring real capital income.[27] In order to simulate the effects of indexing, the GEFB model is re-solved for the equilibrium that would obtain in the presence of a zero rate of inflation. This effectively eliminates any mismeasurement of capital income. Since the equilibrium under an indexed tax system will be identical to the equilibrium under an unindexed tax system which has a zero rate of inflation, the simulation results can be interpreted in either of two ways. The difference between the two equilibria can be seen as either the effect of an indexed tax system, or as the effect of six per cent inflation under an unindexed tax system.

With no adjustment in tax rates, the total federal tax revenue declines due to indexation by $28.2 billion, from $228.3 billion to $199.1 billion.[28] This decrease consists almost entirely of a $27.8 decrease in individual income tax liability. The other component is a surprisingly small $0.4 reduction in corporation income tax paid. This small change is the net result of a few offsetting factors. First, the elimination of the excess tax due to historical cost depreciation and inventory accounting methods outweighs the elimination of the deductibility of the inflation premium in nominal interest deductions, amounting to a $3.7 billion tax saving. The increase in the amount of corporate capital is approximately offset by the decrease in the marginal product of capital. What largely offsets the $3.7 billion tax saving is a large decline in the real riskless interest rate. The reduced value of interest deductions due to this change causes the corporate tax bill to increase by over $2 billion. The combination of these factors yields the small increase in corporate income tax liability.

In order to compare two tax systems with equal total yield, tax rates must be raised under indexation. In the results reported below, all individual income tax rates were multiplied by an identical factor; brackets were unchanged as was the corporation income tax rate. This procedure required a

21.1 percent increase in all personal tax rates, raising the first marginal tax rate to .170 and the highest marginal rate to .848. This equal-yield procedure is a crucial element in the simulation results reported below, since alternative rate adjustments to make up the lost revenue would undoubtedly change the distributional impact of indexing, and could also affect its allocational implications.

The equilibrium solution under an indexed tax system is partially characterized in Table 2. There is a substantial change in the pattern of rates of return in the economy. First of all, there is a large decline in the real rate of return on riskless debt, from .044 to .035. Since inflation in an unindexed tax system increases the personal taxation of debt relative to equity, indexation relieves this excess taxation and thereby increases the positive demand for riskless debt by the lower-taxed classes, and also decreases the desired leverage of the high income, high tax rate classes. Since the excess supply of riskless debt by agents other than individuals is virtually fixed (government borrows a fixed amount, and corporations borrow a fixed proportion of a slightly changing total capital stock), the real rate of return on riskless debt must fall in order to clear its market. The real rate of return on equity rises from .106 to.114, indicating that the net effect of indexation is to render equity a relatively less attractive investment, requiring a higher rate of return in equilibrium. That the extra tax burden due to inflation is greater for debt than for equity is clearly evidenced by the fact that the premium equity earns over debt is .062 without indexing, and increases to .079 under indexation or, equivalently, in the absence of inflation.

Another striking shift in the pattern of rates of return is the sharp increase in the equilibrium yield on tax-exempt securities, which earn a real rate of return of .0012 in the unindexed inflationary economy but whose real return would be .0236

TABLE 2

EQUILIBRIUM VALUES OF KEY VARIABLES IN INDEXED ECONOMY

		Change from Unindexed Equilibrium
Expected real rate of return on Corporate Equity	.114	+.008
Expected real rate of return on Food-Sector Capital	.082	.000
Expected real rate of return on Rental Housing	.088	-.002
Expected real rate of return on Taxable Debt	.035	-.009
Expected real rate of return on Tax-Exempt Debt	.025	+.024
Corporate Capital Stock	1490.2	+0.4
Corporate Equity	865.8	+0.2
Food-Sector Capital Stock	259.2	-0.8
Rental Housing Stock	775.4	+4.9
Owner-Occupied Housing Stock	1413.7	-4.4

in the indexed, or non-inflationary, equilibrium. The differential between the real return on taxable and tax-exempt debt decreases from .0428 to only .0102 in the indexed equilibrium. The explanation here is quite straightforward. The issuers of tax-exempt debt benefit from the mismeasurement and subsequent overtaxation of the real return on taxable debt; this enables them to sell debt to high-tax bracket individuals while offering nearly a zero real return. When this mismeasurement is eliminated, state and local governments must increase their real interest payments by more than two percent in order to have their outstanding debt willingly held.

These changes in the pattern of real returns are accompanied by substantial shifts in the portfolios of the income groups. Since the tax advantages to the highly taxed groups of equity relative to debt diminish under indexing, the concentration of equity holdings might be expected to decline. This does in fact occur, with the proportion of equity held by the top three income classes falling from 43.9% to 37.5%. Another striking change in the portfolios of the high income groups is the sharp decline in the amount of owner-occupied housing held. Remember with nominal interest payments fully deductible from taxable income, the opportunity cost of housing becomes very low under inflation in an unindexed system. Individuals in high tax brackets respond by holding large amounts of owner-occupied housing. Under indexing, even though the real rate of interest declines, the opportunity cost of owned housing services increases significantly for individuals in high tax brackets. In response, the amount of wealth put into owner-occupied housing under indexing is just 69% of what it would be under an unindexed system for the highest two income groups. On the other hand, the low income groups experience a decline in the cost of owned housing services, since the decline in the real interest rate more than compensates for the reduced value of interest paid tax deductions. In response, they increase the amount that they hold.

The decline in the high income groups' holdings of equity and owner-occupied housing is offset primarily by a decline in their indebtedness and slightly by increases in the position in the other risky assets. As noted above, in the unindexed six percent inflation equilibrium, the top two income classes borrowed an amount equal to 26.2% of their net wealth; in the equilibrium under indexing the borrowing is reduced to 9.9% of net wealth.

According to this simulation, the allocational impact of indexing would be minimal, causing a slight decrease in the amount of capital in the owner-occupied housing, largely at the expense of rental housing. This aspect of the simulation results is especially sensitive to the specification of the model; in fact, in earlier versions of this model (see Slemrod [1980]) indexing caused a much larger shift of capital away from owner-occupied housing. This earlier result seems consistent with intuition, since indexing eliminates the deductibility of nominal interest payments, and thus apparently raises the cost of housing. Although in a model of this complexity it is difficult to trace a result to a particular aspect of the model, the absence of such a shift in the present version seems due to the following facts. First of all, the substantially lower real rate of interest under indexation means that, for the lower-taxed groups who make up the bulk of owner-occupied housing demand, the opportunity cost of owned housing declines. In fact, a comparison of the two equilibria shows that the five lowest income groups find owned housing less expensive in the indexed equilibrium; these five groups own about 85% of all owned-housing. Thus the ownership of housing shifts from high income to low income individuals, but the total does not significantly decrease. A second reason is the fact that the increased tax rates under indexation tend to lower the cost of owned housing to all individuals, especially the highly-taxed groups who experience the greatest absolute tax rate increase. Since this increases the value of deducting interest payments from taxable income, the effect is to increase the demand for owned housing.

The welfare effects of indexing are presented in Table 3. The numbers in the first column refer to the dollar compensation that must be paid before the resolution of the uncertainty in order to make the non-indexed inflationary situation indifferent to the indexed situation. The usual index number problem applies here, since the value of the required compensation depends on whether it is to be paid (or received) in the pre-indexing or post-indexing situation. The values represented in Table 3 are the simple average of these two compensation figures.

TABLE 3

SIMULATED WELFARE EFFECTS DUE TO INDEXING

Income Class	Welfare Change ($billions)	Welfare Change as a Percentage of Pre-Indexing Income
$0- 9,000	-0.38	-0.15
9- 15,000	-1.48	-0.60
15- 22,500	-3.35	-1.06
22,500- 30,000	-2.09	-0.90
30- 45,000	+0.10	+0.08
45- 75,000	+0.93	+1.24
75- 150,000	+3.71	+8.02
150- 300,000	+6.82	+42.78
More than 300,000	+2.13	+28.93
Total	+6.39	+0.48

The simulation results indicate that a system of indexation, with lost revenue made up by adjusting all personal tax rates upward by a multiplicative factor, would cause an increase in welfare for the highest five income groups, and a decrease in welfare for the lowest four income groups, with the dividing income level being approximately $30,000 in annual income. Without an explicit social welfare function to balance the gains and losses, it is impossible to say whether this would be a desirable change to make. However, the sum of the compensation values is clearly positive ($6.4 billion, or about one-half of one percent of national income adjusted for the disutility of risk) indicating that a compensation system could be arranged so that indexation would be a Pareto-optimal improvement. In that sense, indexation would reduce the distortionary cost of the tax system. Note that this result does not consider any dynamic efficiency effects of indexation.

There are several aspects to this increase in efficiency. First, there is a small efficiency gain from the slight shift of capital away from owner-occupied housing, which is over-supplied due to the tax advantages it receives even in the absence of inflation. Second, indexation tends to reduce the dispersion in the cost of owner-occupied housing, and thus reduces the inefficiency that results from individuals facing different prices for the same good. In the unindexed inflationary economy, the total cost of owner-occupied housing ranged from \$.094 per unit of housing service (where one unit of service is produced by one unit of capital) to the lowest income group to \$.029 for the highest taxed group. In the indexed equilibrium, the range of prices is \$.085 to \$.047. Thus the owner-occupied housing stock is more efficiently distributed under indexation, as there is less incentive for the high income groups to borrow in order to hold housing.

A third source of the efficiency gain under indexation is the improved allocation of risk-bearing. Since after-tax risk premiums are not the same for all individuals, risk is not borne optimally. Inflation in an unindexed system exacerbates this problem since it widens the dispersion of risk premia, due to its differential impact on risky and riskless assets. Thus under indexing, this dispersion is reduced and risk is borne more efficiently.

The pattern of the distributional impact of inflation also has several sources. First, indexation tends to reduce the total taxation of capital income. In order to make up the lost revenue, all personal tax rates were increased. Since labor income comprises the bulk of personal taxable income, the indexing scheme is accompanied by a not insignificant shift in the tax burden from the high income classes to the low income classes, who have a much higher relative endowment of labor versus capital. Thus the lowest four income classes, the ones who apparently suffer under indexation, find their federal tax burden increased by $6.44 billion under the indexed system, or an increase of 8.8%.

The highest two income classes of course face the highest increase in tax rates under the general tax increase scheme, but their reduced taxable income under indexation almost entirely cancels out this effect, so that in the end they pay only $0.93 billion more in federal taxes, just 3.1% of their initial tax payments. However, it is important to keep in mind that the increased tax rates also serve to reduce the after-tax variance of their risky capital investments. This plus the fact that under indexation these two classes hold a much less levered portfolio implies that the disutility from risky income is substantially lower in their optimal portfolios under indexation. These individuals also substitute income-earning assets for a large chunk of their owner-occupied housing, the marginal utility of which was very low. Finally, the top two classes benefit greatly from the increased real return earned by tax-exempt securities, which are held almost exclusively by these individuals. The increase in their real yield from .001 to .025 provides a transfer of approximately $2.4 billion from the general public to these two classes.

At this point it is important to alert the reader that the results of these simulations are meant to be illustrative of the kind of analysis this kind of model can provide. The results are not seen as the final word on the effects of indexation on the U.S. economy, owing to our lack of knowledge about certain of the parameters and functional forms of the model, and also to the sensitivity of the results to certain aspects of the model itself. For example, sensitivity analysis not reported here indicates that the allocational impact of indexation is sensitive to the modelling of the housing sector and the distributional implications depend on the kind of equal-yield tax adjustment that is assumed to be used as well as the relationship of the after-tax variance of assets to the marginal tax rate. This model has a multitude of dimensions to which sensitivity analysis could conceivably be applied. This warning is meant to serve as a less cumbersome substitute to reporting these results.

V.2. With Responsive Corporate Financial Policy

Now the simulation of an indexed tax system is repeated, this time allowing corporations to adjust their financial policy in response to the changing tax environment. An earlier section discussed the methodology to be used in calculating the corporate behavioral response. Note that the optimal financial policy on which this methodology is based is independent of the rate of inflation, and is therefore unaffected by indexing.[29] Nevertheless, although the indexing (or inflation) itself does not matter, certain changes in the economy caused by the indexation scheme may cause corporations to alter their financial decisions. Changes in the ownership of equity by income class will alter the tax cost of a given financial policy; indexation tends to reduce the concentration of equity ownership among the higher income classes, and thus reduce the tax advantage of debt and retentions. Other relevant factors are any changes in the marginal tax rates on dividends, debt interest, and capital gains. These changes may result either from changes in the taxable income of the individuals or from changes in the tax rate schedule needed to keep total tax revenues unchanged. The net effect of these influences will determine the direction and magnitude of the corporate financial response.

The simulation results indicate that there would be very little adjustment in corporate financial policy. The ownership of equity shifts toward individuals with lower marginal tax rates, but the upward adjustment of all tax rates to maintain equal yield offsets that to a large extent. In the indexed equilibrium, the aggregate corporate debt-capital ratio falls from .419 to .378, and the payout ratio does not change at all.

The equilibrium looks very similar to that which is depicted in Table 2. The only significant difference is that the real rate of return on equity is .108 instead of .114. This difference is due to the fact that with a reduced debt-equity ratio equity shares are less risky and therefore earn a lower risk premium in equilibrium.

The distributional implications of indexing are also not substantially changed by allowing corporations financial flexibility. The shift toward equity and away from debt would be expected to benefit the higher-taxed individuals, for whom the retention of earnings at the corporate level has a sheltering effect, at the expense of the lower-taxed individuals. This is exactly the pattern that the simulation results reveal. The top two income classes benefit even more from indexing than Table 3 indicates, and the lower seven classes fare slightly less well than that table suggests. In all cases, since the corporate financial adjustment is not large, the difference in results is not great; for that reason, the detailed results are not presented here.

VI. Concluding Remarks

This research demonstrates the feasibility of integrating a structural treatment of portfolio choice and financial markets with the standard multi-sector general equilibrium model of taxation. The model developed here takes account of the unsurprising fact that when there are changes in the taxation of capital income, individuals will adjust their financial behavior in response. A correct understanding of the effects of a tax change, including its implications for total tax revenue, the allocation of production, and the distributional impact, requires consideration of the general equilibrium impact of this financial behavioral response.

The GEFB model is used to simulate the impact of a completely indexed tax system. The simulation results should not be regarded as disposing of the policy questions involved, owing to uncertainty about the values of several parameters and the relatively simple formulations of the determinants of portfolio choice and the U.S. financial structure. Nevertheless, the simulation results point to significant financial adjustment in response to indexation or, conversely, to inflation in an unindexed economy. A significant shifting of the location of private risk-bearing accompanies a slight reallocation of the capital stock away from owner-occupied housing toward its other uses and a substantial change in the ownership of this stock by income class. All in all, indexing the tax system of an economy like the U.S. in 1977 seems to lead to an efficiency gain, slightly hurts the lowest income classes, and substantially improves the welfare of the highest income groups.

Further research is needed for a more complete understanding of the relationship between taxation on the one hand and financial behavior and markets on the other hand. The role and behavior of financial institutions should be integrated into the modelling of individuals' behavior presented here.[30] The dynamic implications of introducing financial behavior into tax models is also a promising topic for future investigation.

Appendix

TABLE A-1

ENDOWMENT OF CAPITAL AND LABOR BY INCOME CLASS, 1977

Income Class	Capital (billion)	Labor (billion)
$ 0- 9,000	440.3	140.2
9- 15,000	405.8	186.7
15- 22,500	572.0	259.6
22,500- 30,000	611.4	187.0
30- 45,000	615.7	111.7
45- 75,000	447.0	63.1
75-150,000	517.3	35.5
150-300,000	463.7	11.4
More than 300,000	162.7	6.2
Total	4238.5	1001.4

TABLE A-2

SHARES OF SPENDING ON FOOD, RENTAL, AND OWNED HOUSING

Income Class	Food	Rental Housing	Owned Housing
$ 0- 9,000	.206	.152	.070
9- 15,000	.176	.114	.059
15- 22,500	.167	.070	.081
22,500- 30,000	.159	.044	.095
30- 45,000	.145	.028	.091
45- 75,000	.128	.023	.085
75-150,000	.101	.020	.085
150-300,000	.076	.018	.085
More than 300,000	.058	.016	.085

FOOTNOTES

1 For earlier uses of this type of model, see Meade [1955] and Johnson [1956].

2 For a discussion of the relative merits of general versus partial equilibrium analyses of taxation, see McLure [1975].

3 The later versions of the model are the work of Don Fullerton, Shoven, and Whalley.

4 In Fullerton, King, Shoven, and Whalley [1979], corporations can adjust their dividend policy in environments where dividends get preferential tax treatment, but only the extreme alternative of 100 percent payout is considered.

5 Compare this to the result of standard general equilibrium models that all individuals hold exactly the same mix of capital goods, which is clearly counterfactual.

6 An example of such a production function is $Q = K^{\gamma}L^{1-\gamma} + \theta K$, where θ is stochastic.

7 In the case of a portfolio choice between one risky and one riskless asset, the demand for the risky asset is given by:

$$K_E = \frac{K(r_E - r_B)}{2\beta V_E}$$

where E refers to the risky asset and B to the riskless asset. The coefficient β is proportional to Pratt's measure of relative risk aversion. The generalization to many assets is straightforward. See Friend and Blume [1975].

8 Since the discontinuous marginal tax rates of the actual tax system cause problems for the solution algorithm, a smooth approximation of the tax table is used.

9 Of course not all taxpayers itemize deductions. To reflect this fact, the average exogenous deduction amount is calculated including the standard deduction for itemizers, and only a percentage of property tax and interest payments are allowed as additional deductions. The percentage is chosen to approximate the fraction of such payments which are made by itemizers, and varies by income class.

10 Nominal capital gains on all assets other than corporate equity are assumed to be equal to the rate of inflation. The real value of corporate stock also increases to the extent that earnings are retained within the corporation.

11 See Internal Revenue Service Proceedings 72-18 and James [1979].

12 Aaron and others have pointed out that although the production of housing services is capital-intensive, production of the housing stock itself is relatively labor-intensive; of all the major private sectors of the economy, only finance and insurance had as high a fraction of direct labor requirements. Analysis of this issue would require expanding the model to include the demand for and production of capital goods; this looms beyond the scope of current research aims.

13 Two considerations motivate the introduction of this role for government. The first is that in the absence of such a role, the individual must consider the covariation between asset returns and relative prices in making his portfolio decision. This is a significant complication the assumption of no relative price uncertainty avoids. Second, and related, in the presence of price uncertainty there is some ambiguity about how "risky" an asset is. As Stiglitz [1969] has pointed out, even if the real output from an investment were perfectly certain, fluctuations in outputs of other commodities would still make the given investment risky, since both its relative price and the marginal utility of income would vary. Under certain conditions a sector with no technological uncertainty may experience greater uncertainty in return than an industry which does have a stochastic production function. Assuming no price uncertainty avoids this ambiguity.

14 See pp. 69-97 for a more detailed treatment of the issues raised in this section, and for alternative treatments of financial policy in this model.

15 The exact factor of increase is 2.92.

16 In Harberger's original treatment and in the subsequent Shoven _et al._ papers, the unit of capital was defined as that amount which (in the assumed equilibrium) earned one dollar of income net of all taxes. This procedure is perfectly consistent with their model which ignores the differential riskiness

of capital, since then it is a condition of equilibrium that the net return of each unit of capital be equalized. However, when risk (and any other) differences in particular forms of capital are recognized, this procedure is no longer valid. For example, the quantity of risky capital which produces a given expected net return will be less than the required quantity of riskless capital.

The long run equilibrium condition that would be observed in a world with differential riskiness of capital is that each unit of capital be valued the same. Since capital can move between sectors, any difference in value would be incompatible with equilibrium. Thus, I have chosen to represent a unit of capital as that quantity which in 1977 was valued at one dollar.

[17] This is an imperfect measure of the appropriate return to labor since it does not include employer contributions for social insurance programs.

[18] A more direct method of calculating private wealth yields a similar figure. The 1977 net stock of fixed non-residential capital was valued by the Bureau of Economic Analysis at $1.616 billion, residential capital at $1.713 billion, and inventories at $0.506 billion, for a total of $3.835 billion. The value of federal, state, and local securities held by households was reported by the Federal Reserve Board to be $0.234 billion, while the amount held by private domestic non-government agents was $0.680 billion.

Since the procedure for precisely calculating private wealth in our stylized model without financial institutions is not obvious, it must suffice to show that a synthetic calculation using these figures will yield a number not far from the $4.24 billion used in the model.

19 The 1972-3 brackets are inflated by a factor of 1.5, which is approximately the factor of increase in per capita disposable personal income between 1977 and 1972-3. (The figure for 1977 is $6017 and the average of 1972 and 1973 is $4061).

20 The primary components of spending on owned dwellings as recorded by the Consumer Expenditure Survey are interest on mortgages, property taxes, and expenses for maintenance. This is a highly imperfect measure of the real cost of owned housing services, since it ignores the opportunity cost of any equity in the house, the tax deductibility of mortgage payments and property taxes, the depreciation of the stock, and any increase in the nominal value of the house. The reported cost of owned housing and the actual cost may be compared at follows:

Reported Cost: $H[\gamma(r_B+\pi) + M + t_p]$

Actual Cost: $H[r_B - t(r_B+\pi) + M + D + t_p(1-t)]$

Here H is the value of the house, γ is the debt-capital ratio, r_B is the real riskless interest rate, π is the anticipated rate of inflation, M is the maintenance rate, D is the rate of depreciation, t_p is the property tax rate, and t is the marginal rate of personal income tax.

By using estimated values of these parameters, we can find the ratio of actual cost to reported cost for each income group. For γ we use the ratio of the value of outstanding household home mortgages to the net value of residential housing in 1972, which is 0.527. We set r_B to be .03, π at .045, M at .0125, D at .0225 and t_p at .0154. Using these values we find that:

$$\frac{\text{Actual Cost}}{\text{Reported Cost}} = \frac{.0804 - .0904t}{.0674}$$

By using the average marginal tax rate for people in each income class, we can compute the conversion ratio above. This ratio applied to the CES reported share of spending on owned dwellings yields the numbers reported in Table A-2.

21 The income elasticity of food is taken to be .51, as estimated by Houtthaker and Taylor [1970]. The income elasticities of rental and owner-occupied housing in the upper income classes are assumed to be .70 and 1, respectively. These numbers are compatible with the findings of Rosen [1978] that the income elasticities of rental and owned housing were both .76, given tenure choice, but that the probability of being an owner increased with income.

22 The source for the property tax payments and total assessed value is Facts and Figures on Government Finance (The Tax Foundation, 1977). The assessment ratio is from the 1972 Census of Governments.

23 A value for β of three is comparable to a coefficient of relative risk aversion of six. This is consistent with the recent findings of Friend and Hasbrouck [1980], although earlier research (see Friend and Blume [1975]) found values on the order of two.

24 This calculation is derived by updating the average nominal rate of return for 1926-1971 presented in Friend and Blume [1975], and subtracting the average annual increase in the consumer price index over the period.

25 Since the higher income brackets tend to own lower dividend-yielding stocks, 37% of dividends received is certainly compatible with owning (at least) 43.9% of all stock.

26 As time passes, inflation also pushes taxpayers into higher personal tax brackets, increasing both marginal and average tax rates. This dynamic aspect of an unindexed tax system is not treated in this exercise in comparative statics.

27 The details of an indexing system need not concern us here.

28 For this exercise the shortfall in revenue is made up by a levy on individuals that is proportional to their federal tax payments and is assumed to have no substitution effects.

29 King [1978], pp. 111-112, shows that in models with one type of investor, no bankruptcy costs, and no constraints on individual portfolios, the conditions determining whether a firm should prefer debt or equity are unaffected by the rate of inflation. However, this formulation is not compatible with the existence of an optimal debt-equity ratio, either for the firm or for the economy as a whole. In models of capital market equilibrium which feature optimal non-extreme financial policies, the rate of inflation may have a direct impact on the equilibrium financial structure of the firm and/or economy. (See for instance Auerbach and King [1980] and Gordon [1980]). However, at the moment there is no econometric evidence on the

relationship between inflation and financial structure that can be invoked in this simulation model, and explicitly modelling the conditions which lead to an interior equilibrium, such as constraints on borrowing or the existence of bankruptcy costs, is beyond the scope of this present study.

30 A first step toward a model with financial institutions is made in Slemrod [1980], pp. 165-204.

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