NBER WORKING PAPER SERIES

INTRODUCING RISKY HOUSING AND ENDOGENOUS TENURE CHOICE INTO PORTFOLIO-BASED GENERAL EQUILIBRIUM MODELS

Patric H. Hendershott

Yunhi Won

Working Paper No. 3114

NATIONAL BUREAU OF ECONOMIC RESEARCH
1050 Massachusetts Avenue
Cambridge, MA 02138
September 1989

The authors thank Harvey Galper and Eric Toder for their intellectual inputs and the Brookings Institution and the Department of Housing and Urban Development for their financial support. This paper is part of NBER's research program in Taxation. Any opinions expressed are those of the authors not those of the National Bureau of Economic Research.

NBER Working Paper #3114
September 1989

INTRODUCING RISKY HOUSING AND ENDOGENOUS TENURE CHOICE INTO PORTFOLIO-BASED GENERAL EQUILIBRIUM MODELS

ABSTRACT

Portfolio-based general equilibrium models are useful for analyzing the interaction between the structure of individual tax rates and the way particular assets are taxed, for considering the role of differential tax rules and risk in determining household portfolio choices, and for addressing distributional questions. Unfortunately, current versions of these models give housing short shrift; owner housing is assumed to be riskless, rental housing is not a separately identifiable asset, and tenure choice is of necessity exogenously determined. This paper shows how these models can be extended to incorporate a full housing subsector and uses an extended version of the Galper-Lucke-Toder (GLT) model to analyze the impact of the 1986 Tax Act.

The interest rate impacts of the extended model are similar to those of GLT: a sharp decline in the fully taxable rate (just over a percentage point), a noticeable fall in the corporate equity rate (two-thirds of a point) and increases in the returns on noncorporate equity and tax-exempt bonds. The capital stock effects are different owing to endogenous tenure choice, the riskiness of owner housing, and the smaller initial holdings of owner housing by high income households. The owner housing stock increases by 3 percent, the increase coming roughly 50/50 from rental housing and state and local capital. The homeownership rate rises by one-half percentage point, virtually all of the increase occurring for households with incomes under $30,000. The small utility gains, $14 billion, are roughly comparable to those of the GLT model. While most of the gains go to high income households, other households also gain, unlike the results originally reported in GLT, which contained computational errors.

Patric H. Hendershott
Faculty of Finance
The Ohio State University
321 Hagerty Hall
1775 College Road
Columbus, OH 43210
(614) 292-0552

Yunhi Won
School of Public Policy and Management
The Ohio State University
321 Hagerty Hall
1775 College Road
Columbus, OH 43210
(614) 292-0552

Many changes in tax policy have widespread effects on the economy, with particular impacts on specific economic sectors, on the means of financing the capital stock of those sectors, and on households in their capacities as both suppliers of finance to capital-using sectors and consumers of these sectoral outputs. The analysis of such policy changes requires general equilibrium models that can consider this range of issues in a comprehensive yet understandable framework.[1]

Although all general equilibrium tax models share the common characteristic of viewing the economy as a system of interrelated product and factor markets in which prices equilibrate supplies and demands, it is useful to distinguish between two types of such models in the academic literature: portfolio-based models and nonportfolio-based models. Nonportfolio-based models include most notably the work of John Shoven, John Whalley, and their colleagues.[2] These models deal fundamentally with the taxation of real assets only and translate all income taxes to the taxation of real capital employed by various sectors. Although useful for many purposes, some of which are beyond the scope of portfolio models, this approach cannot consider differences between the taxation of financial and real assets.

Portfolio-based models -- such as those developed by Slemrod (1983 and 1985) and by Galper, Lucke, and Toder (1987 and 1988) -- treat separately the taxation of financial assets in the hands of households and the taxation of real assets at the entity or corporate level. Thus these models can analyze the interaction between the structure of individual tax rates and the way

particular assets are taxed, can consider the roles of differential tax rules and risk in determining household portfolio choices, and can address distributional questions. In a broader sense, a portfolio-based approach realizes more of the potential of general equilibrium models by incorporating financial markets into the analytical framework.

While the existing Galper-Lucke-Toder (GLT) model contains considerable detail on household financial behavior and tax liabilities, housing is given rather short shrift. Owner housing is assumed to be a riskless asset, rental housing is not a separately identifiable asset, and tenure choice is of necessity exogenously determined. This paper extends their model to incorporate a full housing subsector and uses the extension to analyze the impact of the 1986 Tax Act.

We begin with a brief description of the existing GLT model and then show how it is modified to include risky housing and tenure choice. Section III reports simulation results and contrasts them with those of GLT. A final section summarizes our results and makes some suggestions for future research.

I. The Galper-Lucke-Toder Model[3]

The Galper-Lucke-Toder model is designed to capture the interaction between differential tax treatments among assets and differences in marginal tax rates among taxpayers. The particular assets each household holds in its portfolio will reflect the pretax yields on and tax treatment accorded alternative assets, the riskiness of these assets, and the household's own tax status and aversion to risk. At the same time, household portfolio choices will influence market yields that in turn determine the costs of capital to sectors issuing assets. These costs determine tangible capital allocations and assets supplied to households. Thus, the structure of the GLT model emphasizes the simultaneous interaction among household portfolio choices, business financing, and real investment in tangible capital.

The capital using sectors in the GLT model are the corporate and noncorporate business sectors (both of which produce marketable goods and services), state and local governments, and 800 separate household "sectors" that produce in-kind services from owner-occupied homes and from consumer durables. Each of these sectors finances the capital it employs in production by issuing financial assets that are absorbed in household portfolios. The financial assets that households can acquire are: (1) taxable bonds, (2) corporate equities, (3) shares of noncorporate business, and (4) tax-exempt bonds. Capital is also used directly by households to produce services from owner-occupied homes and consumer durables.

The supply of financial assets issued to households depends on both the demand for capital services in each sector and the way in which the capital stock of that sector is financed. The sectoral demands for capital services, including those used directly in the household sector, are unit elastic functions of the real costs of capital. The particular financial assets issued to households vary by capital-using sector. Corporations issue corporate equity, taxable bonds, and to a limited degree, tax-exempt bonds. The corporate debt-equity ratio is determined by an optimizing equation in which corporations balance the net tax benefits of debt finance against leverage costs that vary directly with the share of capital that is debt-financed. Noncorporate enterprises issue shares in unincorporated business, and state and local governments issue tax-exempt bonds. In addition, the Federal government issues a fixed amount of taxable bonds to finance the national debt.

These financial assets are held by the 400 sample households, weighted to represent the entire taxpaying population and disaggregated by labor income, capital income, tax filing status (single or married), and itemization status under prel986 tax law. Households, solving a problem of portfolio choice under uncertainty, allocate their fixed wealth among financial assets and household

sector capital (owner-occupied homes and consumer durables). Demands for financial assets vary directly with their after-tax expected return and inversely with their after-tax variance, and demands for consumer durables and homes vary inversely with their opportunity costs (in most cases, the after-tax interest rate).

The model contains a fairly detailed representation of the tax law. Each sample household confronts the actual rate schedule for joint or single returns, as applicable; tax liabilities are computed directly based on gross income flows, exclusions, excess itemized deductions (if positive), and personal exemptions. Taxable income includes all the income from wages and taxable bonds, but excludes a portion of income from corporate equity and noncorporate capital and all the income from tax-exempt bonds, owner-occupied homes, and consumer durables. The fractions of corporate equity income and noncorporate capital income included in the personal income tax base are parameters of the model. The separate corporate level tax is also represented in the model and affects the relationship between the rate of return on corporate capital before all taxes and rates of return to individuals who hold debt and equity of corporations. The corporate income tax is described by two parameters--the statutory corporate tax rate and the percentage of corporate economic income included in the corporate tax base.

The net amount of each asset demanded by households is equal to the amount supplied by capital-using sectors and the federal government. The model solves simultaneously for the value of physical capital in each productive sector, the share of corporate capital that is debt-financed (debt-capital ratio), the composition of each household's portfolio of financial and physical assets, rates of return on all assets, and after-tax income and taxes paid by each household (including each household's allocated share of any corporate income taxes).

When the parameters that represent the tax law are changed, the model solves for a new configuration of total capital stocks, household portfolio holdings, and interest rates. (Aggregate supplies of capital/wealth and labor are assumed to be fixed.) In the new equilibrium, financial asset holdings and rates of return are again consistent with a single set of real capital stocks and costs of capital in each capital-using sector. The solution to a simulation also implies, for each household in the model, new values of pretax income, taxes paid, after-tax income, and income adjusted for the riskiness of the household's portfolio.

II. Risky Housing and Tenure Choice

Extension of the GLT model to incorporate a full housing sector is described in four parts. First is specification and reconciliation of the investment and consumption demand for owner housing. Next follows determination of the prices for rental and owner housing and then of the tenure choice decision. Parameterization changes required for the extended model are then described.

A. Investment and Consumption Demands for Owner Housing

In the GLT model, three risky assets exist: corporate equity, noncorporate equity and tax-exempt debt. With zero covariances between returns, the utility maximizing shares of household j's wealth in the kth risky asset can be expressed as

$$s_k^j = \frac{(1-a_k t^j) i_k - (1-b^j t^j)(i_{tx} + p) - TRANS_k^j}{m_1^j m_2^j m_k^j \sigma_k^2 (1-a_k^* t^j)^2 w^j}, \qquad (1)$$

where i_k is the expected pretax return, σ_k^2 the expected variance, t^j the household's marginal tax rate, i_{tx} the yield on risk-free bonds, m_1^j is the household's degree of risk aversion, m_2^j represents the household's utility per

dollar of expected income, m_k^j is the degree of risk aversion on the specific risky asset relative to the base risky asset (the lowest m_k^j for each j is unity), a_k^* is the share of variance included in the tax base, $TRANS_k^j$ reflects the impact of the variance in government tax revenues owing to the variance in revenues from asset k on household j's demand for asset k, and p is the property tax rate. The a_k are the shares of income included in the tax base; b^j equals zero if the household has negative holdings of taxable bonds and does not itemize, and unity otherwise.

Our extension adds two risky assets, owner and renter housing. The investment demand for owner housing comes from an equation like (1), but without the $TRANS_k^j$ term and with pretax returns on owner housing varying across households, both because the tax rate on owner housing is effectively zero (pretax returns are also after tax returns and thus the opportunity cost of these returns varies across households). Multiplying through by W^j and simplifying based on the nontaxation of income from owner housing, households j's investment demand is:

$$OH_I^j = \frac{i_h^j - (1-b^j t^j)(i_{tx}+p)}{m_1^j m_2^j m_h^j \sigma_h^2}. \qquad (1a)$$

This equation can be rewritten as

$$i_h^j = (1-b^j t^j)(i_{tx}+p) + m_1^j m_2^j m_h^j \sigma_h^2 OH_I^j, \qquad (1a')$$

where the second term is the risk premium (ρ^j) required for investment in owner housing.

In the GLT framework, household j's housing consumption demand or expenditures is a constant, $\overline{EXPH}^j$. Further, the real return on owner housing, i_h^j - INFL (the expected inflation rate), times the quantity of owner housing

equals the share of these expenditures going to the direct suppliers of owner housing capital (as opposed to suppliers of replacement capital). Thus

$$(i_h^j - INFL)OH_C^j = B_o^j EXPH^j, \tag{2}$$

where OH_C^j is the quantity of owner housing required to satisfy households j's consumption demand and B_o^j is the constant share of expenditures received by direct suppliers. Solving for the quantity of housing,

$$OH_C^j = \frac{B_o^j \overline{EXPH}^j}{i_h^j - INFL}. \tag{2a}$$

Figure 1 illustrates how the investment and consumption demands for owner housing are reconciled for each individual owner household.[4] The upward sloping schedule plots the investment demand (supply of capital services), equation 1a; the downward sloping schedule indicates the quantity of housing consistent with the consumption demand, equation 2a. The household will choose the quantity OH^o that simultaneously satisfies both demands. Similarly situated households (same bt and p) will choose different levels of owner-occupied housing if they have different levels of risk aversion (the slope of the OH_I schedule will be steeper for the more risk averse-household) or different inflation expectations (the vertical intercept of the OH_I schedule will be lower for the household with higher expectations). That is, owner households with greater investment demands (less risk averse or higher inflation expectations) will choose to invest in and consume more owner-occupied housing.[5]

B. The Prices of Owner and Rental Housing

In general, prices adjust so that the quantity of housing services supplied equals those demanded. That is, the product of the price of housing and the quantity of services supplied must equal nominal expenditures. Housing services, both owner and rental, are presumed in the GLT model to be produced by both the existing stock of the relevant housing capital and the corporate output, X_{COR}, used to "maintain" the stock at an undepreciated value

$$QS = K^{B} X_{COR}^{(1-B)}, \tag{3}$$

where B is the share of the rental cost that represents a return to direct suppliers of housing capital and 1-B is the share going to suppliers of replacement production.[5]

For owner housing of household j, equilibrium implies

$$P_o^j K_O^{j\,B_o^j} X_{COR,O}^{j\,(1-B_o^j)} = \overline{EXPH}^j, \tag{4}$$

where o and O denote owner housing and P_o^j is the price for the jth owner. Substituting from equ. 2a for $K_O^j (=OH_C^j)$ and from equ. 1a' for i_h^j and solving

$$P_o^j = \left(\frac{(1-b^j t^j)(i_{tx}+p) + \rho^j - INFL}{B_o^j} \right)^{B_o^j} \left(\frac{\overline{EXPH}^j}{X_{COR,O}^j} \right)^{1-B_o^j}. \tag{4a}$$

Because $b^j t^j$ and ρ^j vary by household, P_o^j does also. With $B_o^j = 1$, $b^j = 1$ and $\rho^j = 0$, P_o^j equals the more familiar $(1-t^j)(i_{tx}+p) - INFL$.

For rental housing, a single market-clearing price P_r exists. Equality between supply and demand for rental space requires

$$P_r K_R^{B_r} X_{COR,R}^{(1-B_r)} = \Sigma h_r^j \overline{EXPH}^j, \tag{5}$$

where r and R denote rental housing, h_r^j is the number of renting households in cell j, and the summation is over all renting households. The demands for capital services are unit elastic functions of the net (of depreciation) rental costs in GLT. Thus

$$K_R = B_r \Sigma h_r^j \overline{EXPH}^j / (i_r - INFL), \tag{6}$$

where i_r is the pretax return on investment in rental housing. Substituting (6) into (5) and solving for price,

$$P_r = \left(\frac{i_r - INFL}{B_r}\right)^{B_r} \left(\frac{\Sigma h_r^j \overline{EXPH}^j}{X_{COR,R}}\right)^{1-B_r} \tag{5a}$$

C. Tenure Choice

Like the GLT model, our extension contains numerous sample household cells, weighted to represent the entire taxpaying population. Some fraction of each of these cells owns their residence and the remainder rents. Renters and owners in the same household cell are assumed to have the same exogenous balance sheet items (wealth and pensions) and noncapital income components (labor income and transfer payments), as well as the same risk aversion parameters (m_1^j and m_k^j). The households in a given cell that own do so because their taste for ownership (distaste or lack of skills in maintenance) is greater (less) than that of households who rent.

Let the probability of household j owning equal the probability that U_o U_r, where U_o is utility as an owner and U_r as a renter. GLT specify utility generally as:

$$U^j = m_o(1-e^{-m_1^j V^j}) \tag{7}$$

where m_o is a constant, m_1^j is the degree of risk aversion, and V^j is a Cobb-Douglas function of outputs consumed. More specifically,

$$V^j = Y^j \text{PROD}_i \left(\frac{v_i^j}{P_i^j} \right)^{v_i^j},$$

where P_i^j is the price of the ith composite good and v_i^j is the share of household j income spent on this output ($\Sigma_i v_i^j = 1$). (The PROD term is household j's utility per dollar of expected income, m_2^j.) We modify the utility function only slightly to allow the utility obtained from owner-housing to depend on the specific characteristics (tastes) of the household. We introduce the specific characteristic effect (J^j) by multiplying V^j in the exponent in equation 7 by e^{J^j}, where J is zero for renters. As a result, e^{J^j} multiplies the denominator of equation 1a and thus also appears in 1a'.

If we assume that m_o and m_1^j are equal for owners and renters in a fundamental cell, then

$$\text{Prob}\,(U_o^j) > \text{Prob}\,(U_r^j) \text{ implies } \text{Prob}\,(V_o^j e^{J^j}) > \text{Prob}\,(V_r^j).$$

Under simplifying assumptions this implies

$$\ln(h_o^j/h_r^j) = \ln(V_o^j e^{J^j}) - \ln(V_r^j)$$

$$= \ln\left[Y_o^j \text{ PROD}_i \left(\frac{v_{oi}^j}{p_{oi}^j} \right)^{v_{oi}^j} \right] + J^j - \ln\left[Y_r^j \text{ PROD}_i \left(\frac{v_{ri}^j}{p_{ri}^j} \right)^{v_{ri}^j} \right].$$

$$= -\ln(P_o^j/P_r)^{v_h^j} + J^j - \Sigma\left[\ln\left(\frac{v_{oi}^j}{p_{oi}^j}\right)^{v_{oi}^j} + \ln\left(\frac{v_{ri}^j}{p_{ri}^j}\right)^{v_{ri}^j}\right], \qquad (8)$$

where h_o^j and h_r^j, respectively, are the numbers of owners and renters in cell j, v_h^j is the housing consumption share, assumed to be equal for owners and renters in the jth fundamental cell, and the summation is over all other goods and services. This summation changes little in the simulations; the change in P_o^j/P_r is the dominant source of changes in ownership.

The P_o^j in equation 8 differs slightly from that in equation 4a. The i_h^j in 4a depends on the household's marginal tax rate as in equation 1a', but the tax rate relevant to tenure choice depends on the total tax saving from owning relative to renting (Hendershott and Slemrod, 1983). More specifically this tax rate is computed as

$$\tau^j = (TAX_r^j - TAX_o^j)/(i_{tx} + p)OH^j, \qquad (9)$$

where TAX_r^j and TAX_o^j, respectively, are the taxes the household would pay as a renter and owner, assuming the house were completely debt financed. The P_o^j in equation 8 is computed by replacing t^j in equation 1a' with the τ^j from equation 9 and substituting the result into equation 4a.

D. Parameterization

This extension requires developing a new sample of representative household cells in which the ownership fraction and rental housing holdings of the cells are known. A number of items not available to GLT were obtained in the process, such as the taxable pension income and transfer payments (social security and unemployment compensation broken out separately) of the cells. Households in the Treasury Department's 1983 data file were disaggregated by

labor income (7 classes), capital income (7 classes), and three filing statuses (single, joint and other household head), giving a total of 147 sample cells. We originally attempted to obtain a further breakdown by age (head under 30, age 30 to 44, age 45 to 64, and over age 64), but this proved unsuccessful.

Basic Statistics of Income and Flow of Funds Balance Sheet data were used to establish control totals for income and wealth data. Table 1 indicates the aggregate balance sheet items used by GLT and in this extension. Most of the data are close, reflecting only minor data revisions, but three areas of differences are worth noting. First, GLT treat the sum of all finance and the rest of the world as an endogenous wealth-maximizing private pension sector (the exceptions being exogenous investments of IRAs in taxable bonds and of commercial bank taxable debt in tax-exempt assets). We divide finance and rest of the world into pensions and an exogenous other sector and further separate government from private pensions (with all of government pensions being invested in taxable bonds). Thus our private pension sector endogenously invests 37 percent of its funds (1985 values) in equities, while GLT's conglomerate sector invests 13 percent in equities. Our exogenous sector holds $254 billion in tax-exempt bonds, $187 billion in taxable bonds and supplies net equities equal to their sum, $442 billion.

The second difference is in the treatment of household issues of tax-exempt debt, of which $81 billion was outstanding at the end of 1985. This debt consists largely of mortgage revenue bonds, which ideally would be treated like business issues of industrial development bonds, i.e., as an exogenous debt issue constrained by government regulations. Unfortunately, though, we don't know which of our households issued the tax-exempt debt. As a second best solution, we treat this debt as fully taxable debt (and reduce the

exogenous sector holdings of tax-exempts to balance the markets); GLT treated this debt as state and local government debt financing state and local government tangible capital.

Third, GLT have only $1280 billion of federal debt, while we have $1424 billion (and as a result they have a correspondingly larger personal debt number and smaller total household wealth). This is important because when fully taxable rates decline in the 1986 Tax Act simulations, the debt service saving of the Federal government is proportional to its outstanding debt. The modified GLT column in Table 1 will be discussed when the simulation results are reported.

GLT specify pretax expected rates of return and variances on all assets. We have maintained their assumptions where possible, and where not possible have attempted to make assumptions consistent with theirs. A case in point is our division of their noncorporate capital, which has an expected return of 16.48 percent, a variance of 8 percent and an inclusion (in the taxable income base) rate of 20 percent for both return and variance, into rental housing and nonhousing components. We assume that: the inclusion rate on nonhousing-noncorporate capital income was zero prior to 1986 and is one-quarter of that of rental housing under the 1986 Tax Act; the inclusion rate on rental housing under both laws is such that the weighted average of the nonhousing and rental housing rates equals the GTL values for both laws, where the rental housing weight is 0.461 (its share in 1985 noncorporate capital); the pretax variances of rental housing and nonhousing income, respectively, are 5 and 10 percent; and the risk-adjusted after-tax rates of return on rental housing and nonhousing noncorporate capital were equal for households in the 40 percent tax bracket and their weighted average (again 0.461 weight for rental housing) equalled that for GLT's total noncorporate capital. With these assumptions, the prel986 pretax expected returns for rental housing and nonhousing,

respectively, were 14.43 percent and 17.80 percent, the prel986 inclusion rate for rental housing was 0.434, and the inclusion rates under 1986 law are 0.21 for nonhousing and 0.84 for rental housing.

The introduction of owner housing as a risky asset requires specifying pretax returns and variances on owner housing for each household cell, as well as aversion factors for each cell to the riskiness of the return to owner housing. For each risky asset, GLT assumed equal expected pretax returns and variances across households. Different risk aversion parameters were then computed so as to equate model household quantities demanded to observed household holdings. Differences in household expected pretax yields and variances undoubtedly exist, but GLT had no way of inferring them. Because these differences should not vary systematically with household income, wealth, etc, the GLT procedure should not introduce any distortion into subsequent model simulation results.

For owner-housing, however, assuming equal pretax returns is inappropriate because owners in higher tax brackets should systematically invest greater amounts in owner housing than should owners in lower brackets, driving pretax returns on housing of the former below those of the latter. To handle this problem, we modify the general GLT procedure and assume equal owner-housing risk-aversion factors (m_n^j), as well as variances, for all households. Given these values and the observed quantity of owner-housing held by the owner fraction of each cell, equation la is solved for the expected pretax return. These returns tend to decline with household income, as we would expect.

The single variance for owner housing is set equal to half the 4 percent variance for rental housing. The lower variance follows from the less volative income stream an owner receives from his own house relative to that he

would receive from rental housing because, as the owner occupier, he has control over vacancies and depreciation. The single risk aversion parameter for all owners is that which gives housing consumption shares for owners from equation 2 such that the sum of the demands for rental housing (renters and owners in the same cell have the same housing consumption share) equals the supply (equation 5 holds). That is, the risk aversion parameter is that which gives a general level of expected returns to owner housing such that equilibrium in the rental housing market exists.

As noted earlier, renters and owners in the same cell have the same exogenous balance sheet items, noncapital income components, risk aversion parameters, and marginal utility of income. As a result, the demand curves by owners and renters in the same cell for tax-exempts, equities, rental housing, and nonhousing noncorporate capital will be identical functions of after-tax yields. With equal after-tax yields, the shares of wealth in these assets would be equal; the owner-housing of the owner cell would be exactly matched by lesser holdings of taxable bonds. These wealth shares will not be identical, however, because the tax rates, and thus after-tax returns, of owners and renters in the same cell differ, sometimes markedly, due to the ownership of the former.

Switching portfolios creates problems in the calculation of tenure choice tax rates (the τ in equation 9). Occasionally renters pay lower taxes than owners due to shifts in portfolio shares when tenure status is altered, i.e., some τ^j are negative. These have little meaning, however, because the change in tenure status has affected the household's risk as well as after-tax income. To circumvent this problem, we compute separate τ^j for those shifting from owning to renting and from renting to owning, in both cases altering fully taxable debt by the dollar change in owner housing (holding all other portfolio items constant), and calculate the cell's τ^j as a weighted average of the two.

III. Simulation Results

Our results are reported, and compared with those of GLT, in four parts. First, we discuss budgetary effects -- the impact on private tax and federal interest payments. Because the 1986 Tax Act gains revenue in both the GLT and extended models, modified 1986 Tax Acts, where the 1986 tax rates (individual and corporate) are cut sufficiently to generate revenue neutrality, are also analyzed. Second, we report impacts on pretax yields and the allocation of real capital stocks. Third, we provide some detail on the impact on homeownership and the quantity of owner housing demanded. Because ownership responses are available in only the extended model, no comparisons are given. Last, we contrast the impact of the two models on after-tax income and welfare.

In order to make the simulations more comparable, we have altered the GLT model in three respects. First, we have changed their treatment of the finance and rest of the world sectors to conform with ours. Second, we have increased their federal debt number from $1280 billion to our $1424 billion (and made offsetting adjustments to household personal debt and wealth). Third, we have changed their treatment of household outstanding tax-exempt debt to conform to ours, i.e., their debt is lowered by $81 billion. The resulting modified GLT balance sheet items are shown in the third column of Table 1.

A. Impacts on Tax Revenues, Pretax Rates of Return and Capital Stocks

Static and dynamic budgetary effects are reported in Table 2 for both the GLT and extended models. The GLT model was parameterized so that the 1986 Tax Act was revenue neutral in a static sense (but allowing for households to shift out of IRAs and banks to shift out of tax exempts). A $26 billion household tax cut is almost matched by an increase in corporate taxes, including those of financial corporations induced by reduced financial institutional arbritrage between taxable and tax-exempt markets. In the extended model, the Federal government gains $7 billion in revenue because the household tax cut is one-

sixth less and the nonfinancial corporate tax increase is one-tenth more. The dynamic revenue gains are roughly $20 billion greater in both models. While the business tax increase is greater, owing to lower interest deductions, the major effect is that of the reduction in the fully taxable debt rate (see Table 3) on the federal debt service. In both models federal interest payments decline by about $14 billion.

To allow calculations of the welfare consequences of a tax change, it is necessary that the change be revenue neutral. A modified, revenue-neutral 1986 Tax Act is obtained by reducing the individual and corporate tax rates proportionately by enough to achieve neutrality. For the GLT model, all tax rates are reduced by 5.5 percent (e.g., the 15 percent rate is lowered to 14.175). For the extended model, the percentage cut is a larger 7.8 percent because the dynamic revenue gain under the 1986 Act was a larger amount ($26.7 billion versus $21.6 billion). Results are then reported for both the 1986 Tax Act and the modified Acts (those with lower rate schedules).

The impacts on pretax rates of return and capital stocks are listed in Table 3. Our GLT results are close to those they report, although the return declines for fully taxable bonds and corporate equity are 5 to 10 basis points greater and the increase in the tax exempt rate is 10 basis points less. The extended model gives a 10 basis point smaller decline in the fully taxable rate for the 1986 Tax Act, but a similar decline for the Modified Act. In fact, the only noticeable differences in the Modified Act simulations is a nearly 20 basis point increase in the tax-exempt rate in the extended model (the average return on noncorporate equity -- rental housing and nonhousing noncorporate equity in the extended model -- increases by about the same in the two models). The 6 basis point smaller decrease in the total cost of corporate capital in

the extended model reflects our inclusion of property taxes in the model; the cut in the corporate tax rate decreases the corporate property tax burden per dollar of corporate capital.

Most of the differences in capital stocks follow directly from the differences in rates of return. Because their rates of return are higher in the revised model (with exogenous tenure) relative to GLT, state and local capital is five percent less and corporate and noncorporate capital are one percent less. The most striking difference, though, is the three percent increase in owner housing (exogenous tenure) in the revised model versus a negligible decline in GLT. This is due to different initial allocations of owner housing across income classes in the two models and is discussed in the next section. Looking at the last column in Table 3, the Tax Act should reallocate roughly equal amounts of noncorporate and state and local capital to owner-housing.

B. Homeownership and Owner Housing

Detail on homeownership and owner housing is provided in Table 4. The table indicates how the actual and modified Tax Acts affect the tenure choice tax rates, the homeownership rate, and the quantity of owner housing demanded for households in six income ranges (no cell has income under $10,000) and for the total household population. The observed ownership rate is about flat at 55 percent for the first two income classes and then rises with income, reaching a peak of 89 percent.

What happens to ownership depends on what happens to the price of owning relative to the price of renting, P_o^j/P_r. The increased taxation of rental housing (increase in the inclusion rate, a_r) raises P_r, but the sharp decrease in the fully taxable debt rate acts to lower the price of renting. On net, the pretax return, i_r, rises by about 3 percent and so does P_r. The decline in the interest rate lowers P_o^j, but the decline in the tenure choice tax rate raises

the price of owning. On average, P_o^j falls by about 5 percent, giving a 8 percent decrease in P_o^j/P_r and thus an increase in homeownership of one half percentage point. However, P_o^j falls by decreasing amounts as income rises because the tenure-choice tax rate falls by increasing amounts. In fact, for the highest income households, the decline in the tax rate more than offsets the impact of the decline in interest rates, and P_o^j rises slightly, leaving P_o^j/P_r, and thus the ownership rate, unchanged. On the other hand, the tenure-choice tax rate barely rises for the lowest two income group, so P_o^j falls steeply and the ownership rate increases by three-quarters percentage point. The results are similar for both the actual and modified Tax Acts.

Ignoring changes in tenure choice, the quantity of housing demanded will vary with changes in both interest rates and the marginal tax rate. The decline in the fully taxable bond rate raises the demand for housing, but the decrease in marginal tax rates lowers it. Again we see the effect of small tax rate reductions for lower income households and larger reductions for higher income households. The latter demand less housing (the highest class close to 20 percent less), while the former demand more. It is this difference between changes in the after-tax interest rates for low and high income households, combined with the different initial distributions of owner-occupied housing across income classes in the two models, that explains why owner-occupied housing rises in the extended model simulation but not in the GLT simulation. In the GLT model, nearly 12 percent of owner housing is initially held by the 0.7 percent of households with incomes above $200,000. In the extended model, the 1.1 percent of households with such incomes (pensions and transfer income are included in the extended data) hold only 5 percent of owner housing. Thus in the extended model the aggregate impact of high income households demanding

less housing is less than in GLT and the aggregate impact of lower income households demanding more is greater. On net, then, demand rises by three percent.

C. Welfare Effects

Table 5 presents changes in welfare under the modified Tax Act for both the GLT and extended models. Because our income classes are not comparable to those of GLT (our incomes are higher due to the inclusion of pension and transfer income), we report only the total impact and the split between households with above and below $200,000 in income. We report both the total change in welfare (risk-adjusted income), in billions of dollars and as a percent of base income, and the components due to changes in after-tax income, risk, and relative prices.[6]

Our GLT numbers for total welfare gains are only slightly higher than those reported by GLT -- $17 billion versus $13 billion -- but the distribution of the gains is markedly different. They report a $25 billion gain for the highest income households versus a $12 billion loss for other households. In contrast, we have a $10 billion smaller gain for the highest income households and a small gain for other households.

The differences, it is clear, come from the risk component; while our total gain from better risk sharing is almost identical to theirs, we have a much smaller gain for the above $200,000 class and a far smaller loss for other households. The differences stem from two programming errors in the utility calculation subroutine. First, when GLT calculate the variance of after-tax income from equity, they miss a square term for after-corporate tax variance. Putting the square term back in the model causes a $5.4 billion increase in utility from changes in risk, almost all of which accrues to the highest income class which is relatively heavily invested in corporate equities. Second, GLT include the entire variance of after-tax income, rather than half, in the

utility calculation (see footnote 6). This correction cuts the gain in utility from the risk factor by half for both those with income above $200,000 and those with income below.

Small differences between the utility gain numbers for GLT and our extended model also exist. In particular, our calculations provide a $3 billion smaller gain, all of which comes from the highest income class experiencing a smaller gain in after-tax income. This results from the lower elasticity of owner housing with respect to the return on owner housing in a model with risky owner housing. This elasticity equals $i_h^j/(i_h^j - INFL)$. With owner housing not risky (the GLT model), the denominator is small and the elasticity large. With risky owner housing, i_h^j is higher and the elasticity is lower. In the extended model, owner housing of the highest income class declines by less than two percent of their portfolio versus over 10 percent in GLT, the difference largely showing up in greater holdings of fully taxable bonds in the GLT model.

Another significant difference in the utility results is the larger after-tax income gain and smaller relative price gain (owing to changes in m_2) of those with incomes under $200,000. The latter difference seems to be due to our division of cells between owners and renters. For lower income households, the decline in P_o raises m_2. For GLT, the weight applied to this increase is 100 percent because all household cells are owner cells. In the extended model, the weight is less than 100 percent, especially less (55 percent) for the two lowest income cells. With a smaller weight, the gain from changing relative prices is less. The reduced gains from changing relative prices is roughly offset by a gain in after-tax income resulting from the lower elasticity of owner housing in the model with risky owner housing (see the previous paragraph) and the fact that owner housing of moderate income households increases.

III. Conclusion

The major components of this extension of the GLT model were consideration of owner housing as a risky asset, treatment of rental housing as a separately identifiable asset, and introduction of tenure choice as an endogenous decision. These changes were made, and the 1986 Tax Act and modified revenue-neutral Tax Act were simulated.

The impact of introducing tenure choice is clear: interest rates, capital stocks, and household utility are not changed greatly. Pretax rates of return are one or two basis points higher (except for rental housing which is four basis points lower), the stocks of owner and rental housing are, respectively, raised and lowered by about three-quarters of a percentage point, and utility is increased by about 0.1 percent of after-tax income. The reason tenure choice does not matter a great deal is that tenure choice changes little. The aggregate homeownership rate rises by a half percentage point or only one percent. Moreover, tenure changes are concentrated in lower income/wealth households. A wealth-weighted aggregate ownership rate rises by only half as much as the unweighted aggregate rate. Another possible reason, to which we return shortly, is the assumption of zero covariance between the returns on ownership housing and other assets (especially rental housing).

The major impact of making owner housing risky is a decrease in the elasticity of the demand for owner housing with respect to its own rate of return. This elasticity equals $i_h^j/(i_h^j - \text{INFL})$ and when owner housing is not risky the denominator is quite small and thus the elasticity large. The lower elasticity in the extended model does not have a dramatic effect in the simulations because the Tax Act of 1986 lowers i_h^j for some households (lower income) and raises it for others (high income). In some alternative policy simulations, e.g., removing the home mortgage interest deduction, the lower elasticity of the risky housing model would have an important effect.

The interest rate impacts of the extended model are similar to those of GLT: a sharp decline in the fully taxable rate (just over a percentage point), a noticeable fall in the corporate equity rate (two-thirds of a point) and increases in the returns on noncorporate equity and tax-exempt bonds. The capital stock effects are different owing to endogenous tenure choice, the riskiness of owner housing, and the smaller initial holdings of owner housing by high income households. The owner housing stock increases by 3 percent, the increase coming roughly 50/50 from rental housing and state and local capital. The homeownership rate rises by one-half percentage point, virtually all of the increase occurring for households with incomes under $30,000. The small utility gains, $14 billion, are roughly comparable to those of the GLT model. While most of the gains go to high income households, other households also gain, unlike the results originally reported in GLT, which contained computational errors.

A number of model extensions/revisions seem in order. First, an alternative to assuming zero covariance of the expected pretax returns on owner and rental housing should be developed and analyzed because returns on these two assets are almost certainly positively correlated. At the extreme, the covariance could be assumed to be unity. Differences in the two polar cases would indicate the potential importance of this parameter.

A second extension is to reassess the inclusion rates (a_K and a_K^*) of GLT. The GLT levels for corporate and noncorporate capital were not changed to reflect slower realizations of capital gains in response to the substantial increase in the capital gains tax rate (and cut in tax depreciation allowances) in the 1986 Tax Act. Moreover, the negative impact of passive loss rules on rental housing (an increase in the inclusion rate on variance?) was not

incorporated. Also, the relationship between the inclusion rates and the expected inflation rate needs to be spelled out so that simulations can be run at expected inflation rates other than 3½ percent.

Finally, one might give further thought to modelling the components of the Tax Act relating to the tax-exempt market (restrictions on IDB financing and on commercial bank tax arbitrage) and to the deductibility of household personal interest payments (and to possible future changes in the deductibility of home mortgage interest). And one might broaden the overall scope of the model to include international capital flows and endogenous real wages.

Footnotes

[1] For a discussion of the use of general equilibrium models in analyzing tax and trade issues, see John B. Shoven and John Whalley (1987). For an evaluation of what we have learned from these models, see John Whalley (1988).

[2] See, for example, Charles Ballard, Don Fullerton, John Shoven, and John Whalley (1985).

[3] This section draws heavily on Galper, Lucke and Toder (1988).

[4] A significant controversy exists over whether housing demand is best viewed from the consumption or investment perspective (Henderson and Ioannides, 1987). If first and second homes are taxed identically, this analysis determines the total demand for owner housing.

[5] GLT assume that owner housing is produced without labor but that rental housing (part of noncorporate capital) is produced with labor. To keep symmetry between owner and rental housing, we assume that both are produced without labor.

[6] With substitution of $m_2^j Y^j$ for V^j in equ. 7 and the assumption that Y is normally distributed with mean $E(Y^j)$ and variance σ^{j2}, it can be shown that maximizing U is equivalent to maximizing

$$E(Y^j) - m_1^j m_2^j \sigma^{j2}/2,$$

This expression is used to divide changes in welfare among its income (E(Y)), risk (σ^2), and price (m_2) components.

References

Charles Ballard, Don Fullerton, John Shoven, and John Whalley, General Equilibrium Analysis of U.S. Tax Policies, Chicago: University of Chicago Press, 1985.

Harvey Galper, Robert Lucke, and Eric Toder, "Taxation Portfolio Choice, and the Allocation of Capital: A General Equilibrium Approach," Brookings Discussion Papers in Economics, March 1986.

_____, "Revenue Effects and Portfolio Behavior: A Simulation of the Tax Reform Act of 1986," National Tax Association-Tax Institute of America, Proceedings of the Seventy-Ninth Annual Conference, 1987.

_____, "A General Equilibrium Analysis of Tax Reform," in Aaron, Galper and Pechman (eds.), Uneasy Compromise, The Brookings Institution, Washington, D.C., 1988.

Patric H. Hendershott and Joel Slemrod, "Taxes and the User Cost of Capital for Owner-Occupied Housing", Journal of the American Real Estate and Urban Economics Association, Winter, 1983.

J.V. Henderson and Y.M. Ioannides, "Owner Occupancy: Investment vs. Consumption Demand," Journal of Urban Economics, 21,2, 1987.

John B. Shoven and John Whalley, "Applied General Equilibrium Models of Taxation and Trade," Journal of Economic Literature, 1987.

Joel Slemrod, "A General Equilibrium Model of Taxation with Endogenous Financial Behavior," in Behavioral Simulation Methods in Tax Policy Analysis, edited by Martin Feldstein, Chicago: University of Chicago Press (for NBER), 1983.

_____, "A General Equilibrium Model of Taxation that Uses Micro-Unit Data: With an Application to the Impact of Instituting a Flat-Rate Income Tax," in New Developments in Applied General Equilibrium Analysis, edited by John Piggott and John Whalley, Cambridge: Cambridge University Press, 1985.

John Whalley, "Lessons from General Equilibrium Models," in Aaron, Galper and Pechman (eds.), Uneasy Compromise, The Brookings Institution, Washington, D.C., 1988.

Figure 1: Reconciliation of the Investment and Consumption Demands for Owner Housing by a Specific Household

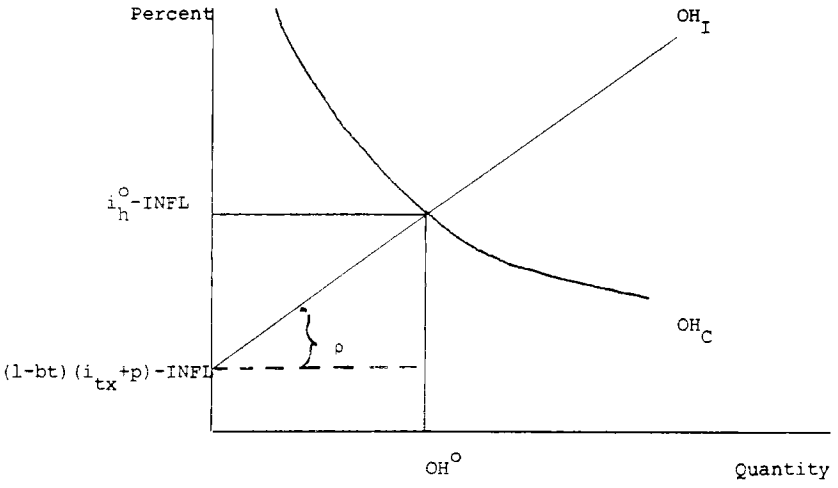

Table 1
Aggregate Balance Sheet Items: 1985 Levels ($billions)

	GLT	EXTENDED	Modified GLT
Total Household Wealth	12105	11886	12168
Held directly by households	9918	9852	10061
Taxable bonds	3296	3145	3296
Corporate equity	1771	1857	1771
Non-corporate capital	2426	2283	2426
Business debt	-789	-811	-789
Tax-exempt bonds	379	310	379
Household sector capital	4724	4803	4724
Homes	3329	3416	3329
Consumer durables	1395	1387	1395
Personal debt	-1890	-1735	-1746
Held by intermediaries	2188	2034	2107
Private pensions and life insurance	1970	1657	1752
Taxable bonds	1684	1047	1146
Corporate equity	286	610	606
Federal pensions (taxable bonds)	-	159	137
IRAs and Keoghs (taxable bonds)	218	218	218
Total Capital Stocks	12105	11886	12168
Corporate capital	3084	2934	3084
Non-corporate business capital	2426	2283	2426
Rental housing	--	1052	--
Other	--	1231	--
State and local capital (equals tax exempt debt)	592	442	511
Owner-occupied housing	3329	3416	3329
Consumer durables	1395	1387	1395
Federal (equals taxable debt)	1280	1424	1424
Corporate Financing Ratios:			
Taxable debt	0.293	0.268	0.293
Tax-exempt debt	0.040	0.042	0.040
Corporate equity	0.667	0.690	0.667
Exogenous Sector			
Taxable tax-exempt bonds (asset & liab.)	336	254	255
Taxable bonds (asset) and corp. equity (liab.)	0	441	320

Table 2

Budgetary Effects

	Impact of Tax Reform Act			
	Static Effect		Dynamic Effect	
	GLT	PHH	GLT	PHH
Change in individual taxes	-26.4	-22.1	-24.3	-20.6
Change in taxes of nonfinancial corporations	19.6	22.5	24.5	27.1
Change in taxes of fin. inst. (reduction in	6.7	6.6	7.0	7.0
Change in all taxes subsidy)	0.2	7.1	7.2	13.5
Change in federal interest payments	0	0	-14.3	-13.3
Change in budget	-0.2	7.1	21.6	26.7

	Impact of Modified Reform			
	Static Effect		Dynamic Effect	
	GLT	PHH	GLT	PHH
Change in individual taxes	-45.9	-46.4	-42.6	-43.5
Change in taxes of nonfinancial corporations	15.1	16.5	20.4	21.4
Change in taxes of fin. inst. (reduction in	6.8	6.9	7.2	7.2
Change in all taxes subsidy)	-24.1	-23.1	-15.2	-14.9
Change in federal interest payments	0	0	-15.3	-14.9
Change in budget	-24.1	-23.1	0.2	0.0

Table 3

Impact of Tax Reform on Pretax Yields and Capital Stocks

	Initial Value	Impact in GLT		Impact in Revised Model of		
		1986 Act	Modified Act	1986 Act	Modified Act Fixed Tenure	Modified Act Variable Tenure
Before-tax Rates of Return (%)						
Taxable Bonds	8.00	-1.01	-1.08	-0.93	-1.08	-1.05
Corporate Equity	11.28	-0.80	-0.67	-0.82	-0.70	-0.68
Tax-exempt Bonds	6.00	0.20	0.23	0.34	0.39	0.41
Corporate Capital	13.61	0.02	-0.08	0.14	-0.05	-0.02
Rental Housing	14.43	0.18	0.18	0.36	0.37	0.33
Nonhousing Noncorporate	17.80			0.03	0.04	0.05
Capital Stocks (bil. of $)						
Corporate	2934	-6	25	-39	14	6
State and Local	442	-37	-43	-53	-60	-63
Nonhousing Noncorporate	1231	-33	-34	-3	-4	-5
Rental Housing	1052			-45	-33	-42
Owner Housing	3416	43	-11	116	82	102
Consumer Durables	1387	33	62	25	11	1
Aggregate Ownership Rate (%)	59.9					
Tax Exempts Held by Banks	254	-155	-155	-154	-154	-154
Corporate Debt-Capital Ratio	.310	-0.027	-0.031	-0.030	-0.038	-0.038

Table 4

Impact on Homeownership and Owner Housing

Income Class (000 of $)	Wealth (trillions)	Weight (mils HH)	Tenure Choice Tax Rate (%)			Homeownership Rate (%)			Owner Housing Demanded (bil $)			
				Impact of			Impact of			Impact of		
			Initial	Tax Act	Modified	Initial	Tax Act	Modified	Initial	Tax Act	Modified Fixed Tenure	Modified Varying Tenure
10-20	0.7	30.0	4.4	-0.0	-0.4	55.1	0.8	0.8	582	23	21	28
20-30	1.6	20.0	9.6	-2.1	-2.9	53.9	0.6	0.6	527	64	57	72
30-50	2.0	20.0	23.7	-4.4	-5.9	66.2	0.2	0.2	755	33	29	29
50-100	3.9	17.5	26.8	-4.8	-6.5	76.2	0.2	0.1	1118	42	28	27
100-200	1.7	2.3	34.9	-9.6	-11.6	82.7	0.0	0.0	256	-15	-19	-20
200 plus	2.0	1.0	39.6	-16.6	-18.5	88.8	0.0	0.0	177	-31	-34	-35
Totals	11.9	91.4	25.8	-6.7	-8.3	62.3	0.5	0.5	3416	116	82	102

Table 5
Changes in Welfare under Modified Tax Reform Act of 1986

	Components of Welfare Change								Percentage of base-case after-tax income	
	After-tax Income		Risk		Relative Prices		Total Welfare*			
	Orig.	Rev.	Orig.	Rev.	Orig.	Rev.	Orig.	Rev.	Orig.	Rev.
GLT										
Under $200,000	-4.4	-1.0	-14.4	-5.0	7.3	8.9	-12.0	2.2	1.7	1.7
Over $200,000	4.0	4.3	21.7	12.2	0.2	-1.2	25.2	14.9	7.8	5.0
Total	-0.4	3.3	7.3	7.2	7.5	7.7	13.2	17.1	0.5	0.6
Expanded Model										
Under $200,000	3.3		-5.1		4.8		2.5		0.1	
Over $200,000	1.0		11.9		-1.0		11.6		4.6	
Total	4.3		6.8		3.8		14.1		0.5	

* Includes minor interaction effect.