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The Allocation of Capital Between Residential and Nonresidential Uses: Taxes, Inflation and Capital Market Constraints

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ABSTRACT

We have constructed a simple two-sector model of the demand for housing and corporate capital. Economic growth and an increase in the inflation rate were then simulated with a number of model variants. The model and simulation experiments illustrate both the tax bias in favor of housing and the manner in which the increase in inflation between 1965 and 1978 magnified it. The existence of capital-market constraints offsets the bias against corporate capital, but it introduces a sharp, inefficient reallocation of housing from less wealthy, constrained households to wealthy households who do not have gains on mortgages and are not financially constrained.

DURING THE PAST DECADE, the United States has been plagued by a declining rate of productivity growth. Many have attributed this phenomenon to a sharp slowdown in the growth of the capital/labor ratio in the industrial sector, and others have advanced a wide variety of policies, under the broad umbrella of reindustrialization, to increase business investment and reverse the downward trend in productivity. Some policies are intended to promote savings and thus total capital information. Others are designed to shift the composition of capital formation from residential to nonresidential use. A primary rationale for the shift policies is the argument that the United States has overinvested in residential capital in the 1970s. More specifically, many have contended that the current tax system is biased in favor of residential capital and that this bias has been reinforced by the acceleration of inflation during the past decade and a half.[1] The bias takes the form of declining real user costs or investment hurdle rates for housing vis-à-vis business investment and results in households occupying housing units of too great quantity or quality.

In spite of this apparent bias, the composition of investment in the United States does not seem to have been altered significantly in favor of residential uses. In fact, the reverse appears to have occurred (see Grebler [6] and Feldstein

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[1] Diamond [2] and Villani [24] have documented the decline in the real user cost of owner-occupied housing; Hendershott and Hu [10, 12] have emphasized the decline relative to real user costs for nonresidential capital. Hendershott and Shilling [14] argue that the Economic Recovery Tax Act of 1982 should reduce this bias substantially.

[3]). Between 1965 and 1978, the nonresidential private capital stock rose by 70 percent in real terms, while the residential stock rose by only 47 percent (Musgrave [17, pp. 60 and 64]).[2] One explanation for this is that factors other than the tax bias have been operating to lower the share of residential investment in total capital formation: for example, the income elasticity of the demand for housing is less than unity so that we would expect the share of housing in GNP to decline over time as real income grows. It may also be argued that the model underlying the derivation of the tax-inflation bias is incomplete in that it does not incorporate two factors which tend to dampen increases in efffective housing demand. First, the existence of fixed-rate mortgages and the capital gains earned on them during periods of rising interest rates may have dissuaded optimizing households from changing (increasing) their effective housing demand even in the face of increasing tax advantages (Hendershott and Hu [13]). Second, lender's restrictions on debt payment-income ratios may have significantly reduced the demand for housing both by less wealthy households that move (in order to achieve real income gains) and by newly formed households during periods of rising inflation and interest rates (Kearl and Mishkin [15]). The primary goal of the present paper is to illustrate how a low income elasticity and capital-market constraints could have offset the effect of the inflation-induced relative decline in the real user cost of housing on the accumulation of residential capital.

With this goal in mind, we have constructed a simple two-sector simulation model of the demand for housing and corporate (nonhousing) capital. The model incorporates the existing tax structure, introduces portfolio balance relations for households, and specifies risk premia required to hold risky assets. To allow for the operation of capital-market constraints, households are partitioned into the wealthy and the less wealthy; the former lend to both the latter and businesses. The model simultaneously determines the risk-free debt rate, risk premia on mortgages, corporate equities and housing, and the allocation of a growing capital stock among corporate capital, housing of the wealthy, and housing of the less wealthy. The model is parameterized so as to make it roughly comparable to the American economy in the middle 1960s.

Sections III–V contain the results of a variety of simulation experiments. The basic experiment is a 55 percent increase in real income (the growth between 1965 and 1978) and an increase in the inflation rate from one to seven percent. Section IV introduces an endogenously-determined real housing price and a mechanism for incorporating an exogenous increase in the real housing price. The impact of capital-market constraints on housing demand of the less wealthy is developed in Section V. A summary concludes the paper.

I. The Model

Output and the Demands for Capital

Consider an economy in which there are two goods - housing and nonhousing. Housing services are produced by using only residential capital, and the non-

[2] Part of the extraordinary growth in nonresidential capital is the result of mandated pollution control investment. Gross pollution control outlays between 1966 and 1978 were $49 billion (1972 dollars) and "account for" 7 of the 70 per cent increase (Hendershott and Hu [10, Table 1, p. 93]).

housing good is produced by nonresidential capital and labor via a Cobb-Douglas production function

$$Y = \gamma_k K^{\alpha_k} L^{1-\alpha_k} = \gamma_k^* K^{\alpha_k} \tag{1}$$

where Y is the level of nonhousing output; L is the labor force; and K is the quantity of nonresidential capital employed. Because γ_k and L are treated as exogenous and do not appear elsewhere in the model, $\gamma_k L^{1-\alpha_k}$ can be consolidated into γ_k^*. The demand for nonresidential capital is determined by equating the value of its marginal product to its user cost:

$$K = \alpha_k Y/c_k \tag{2}$$

where c_k is the user cost of nonresidential capital, and the k subscript denotes parameters and variables relevant to nonresidential capital.

Assume that each unit of housing capital produces one unit of housing services.[3] The quantity of housing services demanded by each household is assumed to be ε elastic with respect to the income of the household and $-\eta$ elastic with respect to the implicit rents per unit of housing and thereby the user cost of housing capital. Assuming that households have identical tastes, the individual housing demand equations are

$$H^n = \alpha_h (D^n)^\varepsilon (c_h^n)^{-\eta} \tag{3}$$

where H^n denotes the demand for housing services by the nth household; D^n its disposable income; c_h^n the real user cost per unit of housing stock; and the h subscript denotes parameters or variables relating to residential or housing capital. As discussed below, c_h^n is household specific because of differences in income (and thus personal tax rates) and wealth (and thus portfolio compositions and risk premiums).

The total demand for housing is equal to ΣH^n. Assuming that there is perfect mobility of capital between residential and nonresidential uses, we can write

$$W_r = K + \Sigma H^n \tag{4}$$

where K is the quantity of nonresidential capital as determined in Equation (2), and W_r is the real stock of wealth of the economy and will be treated as exogenous in the basic model. The total value of wealth, on the other hand, is equal to

$$W = qK + p\Sigma H^n \tag{5}$$

where q is the ratio of the market value of nonresidential capital to its replacement cost and p is the real price of housing (the ratio of the price of housing to the price of nonhousing goods, the latter being treated as the numeraire). Initially $q = p = 1$, so $W = W_r$.

Portfolio Balance and Risk Premiums

Consider for simplicity a situation in which there are only two types of households, the wealthy and the nonwealthy. Assets of wealthy households

[3] We make the simplifying assumption that no labor is employed in the production of housing services. Similarly, we assume that no capital is employed in the production of government services.

include corporate bonds (B), corporate equity (E), mortgages issued by less wealthy homeowners (M), and housing. The aggregate balance sheet for these identical wealthy households can be expressed as

$$B + E + M + H^W = W^W \tag{6}$$

The wealth and housing of the two classes of households are differentiated by superscripts W (for wealthy) and N (nonwealthy). The bonds are assumed to be risk free.

The quantity of risky assets demanded by a wealthy household relative to its total wealth is assumed to equal the ratio of the difference between the expected rate of return on that asset and the risk-free rate to the product of the risk aversion parameter and the variance of the return on that asset:[4]

$$\frac{J^W}{W^W} = \frac{r_{ja} - i_a}{R\sigma_j} \qquad \text{or} \tag{7}$$

$$r_{ja} = i_a + \rho_j \qquad \text{for } j = E, M \text{ and } H, \tag{7'}$$

where i_a is the after-tax nominal return on the risk-free asset, J^W is the quantity demanded of the jth risky asset, r_{ja} is its after-tax expected nominal return, and σ_j the variance of this return, R is the common risk-aversion parameter and $\rho_j = R\sigma_j(J^W/W^W)$ is the after-tax risk premium required on the jth asset. Bond holdings are derived residually from Equation (6). Nonwealthy households hold only housing.

Nonwealthy households and corporations finance their capital by issuing debt and equity. If b is the ratio of debt to the market value of firms and v is the same for households, then the market clearing equations are[5]

$$B = bqK$$

$$E = (1 - b)qK$$

$$M = vpH^N$$

The balance sheet identity for the nonwealthy households is

$$W^N = (1 - v)pH^N \tag{8}$$

For simplicity, we can rewrite (6) as

$$W^W = W - W^N \tag{6'}$$

The Real User Costs of Capital

We are now ready to detail the user costs of capital. Taking into account the deductibility of nominal interest cost, differences between tax and economic depreciation, and the differential taxation of earnings and capital gains, we can write the real user cost of corporate capital as

$$c_k = bi + \left(\frac{1 - b}{1 - \tau}\right)r_k - \frac{\pi_k}{1 - \tau} + \delta_k + \frac{\tau}{1 - \tau}(\delta_k - \delta_k^*) + \tau_k^p \tag{9}$$

[4] See Friend and Blume [5] and Slemrod [22]. All covariances are assumed to be zero.

[5] Corporate financial behavior is treated as exogenous. Extrapolation from Slemrod's simulation experiments [22] suggests that this will not significantly influence results.

where π_k is the expected rate of change in the price of corporate capital, δ_k is the true depreciation rate of capital, δ_k^* is the depreciation rate allowed by tax law, τ is the corporate tax rate, and τ_k^p is the rate of property tax applied to corporate capital.[6] The nominal equity rate paid by corporations is r_k and differs from the after-tax equity rate received by shareholders, r_{ka}, by the taxes (at the personal level) on dividend income and on increases in share values resulting from retention of corporate earnings and inflation. Letting γ be the portion of real earnings (including real gains at the expense of debtors) paid out, θ be the common personal income tax rate and μ_k the capital gains tax rate, the relationship between r_{ka} and r_k is given by

$$\begin{aligned} r_{ka} &= \gamma(1-\theta)(r_k-\pi_k)+(1-\mu_k)[(1-\gamma)(r_k-\pi_k)+\pi_k] \\ &= (1-x)r_k+\gamma(\theta-\mu_k)\pi_k \end{aligned} \tag{10}$$

with $x=\gamma\theta+(1-\gamma)\mu_k$. Using equations (10), (7′), and the equilibrium relation $\rho_E=R\sigma_E qK/W^W$, we have

$$r_k=\frac{1-\theta}{1-x}i-\frac{\gamma(\theta-\mu_k)}{1-x}\pi_k+\frac{1}{1-x}\frac{R\sigma_E qK}{W^W} \tag{11}$$

where $(1-\theta)i=i_a$ and i is the before-tax risk free rate. Finally, the tax saving per unit of capital from depreciation can be expressed as

$$\tau\delta_k^*=\tau\delta_k=t_1-t_2\pi_k \tag{12}$$

where $t_1>0$ reflects short tax lives and the availability of accelerated depreciation methods (with zero inflation, tax depreciation exceeds economic depreciation) and $t_2>0$ acknowledges the use of historic, rather than r-replacement cost. Substituting (11) and (12) in (9) yields

$$c_k=\alpha_1 i+\alpha_2 qK/W^W-\alpha_3\pi_k+\alpha_4 \tag{9′}$$

where

$$\begin{aligned} \alpha_1 &= b+(1-b)(1-\theta)/[(1-x)(1-\tau)] \\ \alpha_2 &= (1-b)R\sigma_E/[(1-x)(1-\tau)] \\ \alpha_3 &= [1-t_2+\gamma(1-b)(\theta-\mu_k)/(1-x)]/(1-\tau) \\ \alpha_4 &= \delta_k+\tau_k^p-t_1/(1-\tau) \end{aligned}$$

We now turn to the user cost for housing. Under current tax law, homeowners are not required to pay tax on either the real imputed rents or nominal capital gains earned from their houses, nor are they allowed to deduct any depreciation in computing tax liabilities. Thus the real user cost of capital for the two types of households is given by

$$c_h^n=[r_{ha}^n-\pi_h+\delta_h+(1-\theta)\tau_h^p] \tag{13}$$

where r_{ha}^n is the after-tax debt rate plus a housing risk premium, $\rho_H^n=R\sigma_H pH^n/W^n$, and the other symbols are as defined above except that they now apply to

[6] See Hendershott [9] and Hendershott and Hu [10] for more detailed discussions of the material in this paragraph.

housing. Thus

$$c_h^n = p(\beta_1^i + \beta_2 \frac{pH^n}{W^n} - \pi_h + \beta_3) \tag{13'}$$

where $\beta_2 = 1 - \theta$; $\beta_2 = R\sigma_H$; and $\beta_3 = \delta_h + (1-\theta)\tau_h^p$.

The quoted mortgage rate wealthy households charge the less wealthy equals the sum of the risk-free rate, a mark up to compensate for expected default losses, and a risk premium $\rho_M/(1-\theta)$. The mark up, m, is

$$\begin{aligned} m &= m_1(v - v_0) + m_2(v - v_0)^2 \qquad & v > v_0 \\ &= 0. & v \leq v_0 \end{aligned} \tag{14}$$

Below a critical level of the loan-to-value ratio, v_0, the risk associated with housing investment is borne completely by the homeowners, and thus the mortgage rate they pay is equal to the risk-free rate. If the loan-to-value ratio exceeds this value, a part of the risk is shared by lenders, and consequently compensation for expected default loss will be built into the quoted rate.

Taxes, Government Spending, and Disposable Income

Government spending is assumed to equal taxes paid by households (TX_h) and corporations (TX_k). Taxes of corporations are the sum of income and property taxes or

$$TX_k = \tau[\alpha_k Y - (\delta_k^* + bi + \tau_k^p)K] + \tau_k^p K \tag{15}$$

which allows for the deductibility of (tax) depreciation, interest, and property taxes. Households pay income, property and capital gains taxes

$$\begin{aligned} TX_h = \theta[(Y - \delta_k K - TX_k - RE) - \tau_h^p p(H^W \\ + H^N)] + \tau_h^p p(H^W + H^N) + \mu_k(RE + \pi_k qK) \end{aligned} \tag{16}$$

The first term in brackets is the sum of labor, dividend, and net interest income ($\delta_k K$ is depreciation and RE is retained earnings).[7]

Retained earnings equal corporate earnings after taxes (EAT) plus the erosion of the real value of corporate debt, $b\pi_k qK$, less dividends which under our earlier assumption equal $\gamma(\text{EAT} + b\pi_k qK)$. Because $\text{EAT} = \alpha_k Y - (\delta_k + bi)K\text{-}TX_k$, we can write

$$RE = (1-\gamma)[\alpha_k Y - (\delta_k + bi)K - TX_k + b\pi_k qK] \tag{17}$$

Finally, household disposable income, D, is the sum of all factor payments received less taxes paid:

$$D = Y - \delta_k K - TX_k - RE - TX_h \tag{18}$$

[7] Net interest income is corporate interest paid under the assumption that there is no government debt. There is no need to differentiate between household interest paid and received because all households are assumed to be in the same tax bracket.

II. Model Summary and Parameterization

The basic model with prices (p and q) constant consists of 14 equations. After replacement of the sectoral wealth endowments, W^W and W^N, with wW and $(1 - w)W$ respectively, where w is the wealthy's fraction of total wealth and is exogenous because p and q are, these equations are:

$$Y = \gamma_k^* K^{\alpha_k} \tag{1'}$$

$$K = \alpha_k Y / c_k \tag{2}$$

$$W_r = K + H^W + H^N \tag{4'}$$

$$(1 - w)W = (1 - v)pH^N \tag{8}$$

$$c_k = \alpha_1 i + \alpha_2 qK/wW - \alpha_3 \pi_k + \alpha_4 \tag{9'}$$

$$c_h^W = p(\beta_1 i + \beta_2 \frac{pH^W}{wW} - \pi_h + \beta_3] \tag{13W}$$

$$c_h^N = p[\beta_1 i + \beta_2 \frac{pH^N}{(1 - w)W} - \pi_h + \beta_3] \tag{13N}$$

$$m = m_1(v - v_0) + m_2(v - v_0)^2 \qquad v > v_0, \text{ otherwise } m = 0 \tag{14}$$

$$TX_k = \tau\alpha_k Y - \{[\tau\delta_k + t_1 - (1 - \tau)\tau_k^p] + \tau bi - t_2\pi_k\}K \tag{15}$$

$$TX_h = \theta Y - (\theta\delta_k - \mu_k\pi_k)K - \theta TX_k - (\theta - \mu_k)RE + (1 - \theta)\tau_h^p p(H^W + H^N) \tag{16}$$

$$RE = (1 - \gamma)\alpha_k Y - (1 - \gamma)TX_k - [(1 - \gamma)(\delta_k + bi) - (1 - \gamma)b\pi_k]K \tag{17}$$

$$D = Y - RE - TX_k - TX_h - \delta_k K \tag{18}$$

$$H^W = \alpha_h(yD)^\epsilon(c_h^W)^{-\eta} \tag{3W}$$

$$H^N = \alpha_h[(1 - y)D]^\epsilon(c_h^N)^{-\eta} \tag{3N}$$

The last two equations, where y is the portion of income accruing to the wealthy and is exogenous, are applications of Equation (3). The basic model determines income (Y); the three user costs (c_k, c_h^W, and c_h^N); the three capital quantities (K, H^W and H^N); household and business taxes (TX_h and TX_k); retained earnings (RE); disposable income (D); the risk-free rate (i); the housing loan-to-value ratio (v); and the mark-up on the mortgage rate (m).

In view of our interest in explaining the allocation implications of high inflation over the past decade, a natural starting point is to set the initial values of the system roughly at their actual values in the middle 1960s. In particular, let the initial inflation rate be one percent and initial risk-free financing rate be 4 percent. Moreover, expected inflation rates for corporate and housing capital are assumed to be equal. The values of K, H, and Y are all initialized at 500 (billion dollars), their approximate 1965 values.[8]

[8] The values of K and H are from Musgrave [17, pp. 60 and 64]. Income excludes government output (purchases of goods and services) and the value of housing services produced and is from the

Elsewhere [12] we have discussed the implications of inflation for resource allocation when there are heterogenous income groups in different marginal tax brackets. To isolate the wealth effect from the income effect, we assume here that all households earn the same income and pay the same tax rate. They differ from each other only by the initial wealth they possess. One-half of the households are taken to be wealthy and the other half less wealthy in the sense described below ($y = 0.5$).

The various tax, depreciation, and financing parameters are as follows. Tax rates: $\tau = 0.52$, $\theta = 0.3$, $\mu_k = 0.04$, $\tau_k^p = 0.012$, $\tau_h^p = 0.018$; economic and tax depreciation rates: $\delta_k = 0.10$, $\delta_h = 0.025$, $t_1 = 0.01$, and $t_2 = 0.2$; payout and financing rates: $\gamma = 0.4$, $b = 1/3$, and $v = 0.8$. With slightly over half of the housing debt-free, the average loan-to-value ratio for all housing is just under 0.4, the actual ratio for the United States. Discussions regarding the other parameters are contained in Hendershott and Hu [10, 11] and Hendershott [9].

There are four risk parameters in the model: $R\sigma_E$, $R\sigma_H$ and $R\sigma_M$, along with portfolio shares, determine ρ_E, ρ_H, and ρ_M, and m_1 and m_2, along with ρ_M, v and v_0 determine m. For $R\sigma_E$, we use 0.12. This is consistent with a risk-aversion parameter of 3 and an after-tax expected variance of 0.04. The housing variance, σ_H, is set at 0.004, and ρ_M is set at $10m\sigma_H$. We set $m_1 = -0.0057$, $m_2 = 0.0715$, and $v_0 = 0.6$. These values result in a pattern of differences in mortgage rates with different loan-to-value ratios that approximates the observed differences in mortgage commitment rates for level-payment, fixed-rate mortgages with v's of 0.5, 0.75, 0.8, 0.9, and 0.95.[9] Given the above parameter values, the coefficients in the corporate user cost Equation (9′) are $\alpha_1 = 1.4691$, $\alpha_2 = 0.1947$, $\alpha_3 = 1.8354$, and $\alpha_4 = 0.09117$. Those in the housing user cost equations are $\beta_1 = 0.7$, $\beta_2 = 0.012$, and $\beta_3 = 0.0376$.

The elasticity of the demand for housing with respect to the rental price or real user cost is assumed to be -0.5. Polinsky and Ellwood [18] report an elasticity of -0.7, while Hanushek and Quigley [7] estimate it to be -0.4. Rosen's [20] mean price elasticity was -0.97, but the estimate was of a translog function where the elasticity declined in absolute value as the real user cost fell. Moreover, his data were for 1970, when the housing real user cost had not yet been fully reduced by inflation. Estimates of the elasticity of housing demand with respect to income range from unity to 0.75 (Rosen [20]). We use the value 0.85.

Lastly, simultaneous solution of Equations (1), (2), (4′), (8), (9′), (13W), (13N), (15), (16), (17), (18), (3W), and (3N) then yields the remaining values: $\alpha_k = c_k = 0.2332$, $\alpha_h = 1.0864$, $w = 0.95828$, $c_h^W = 0.05925$, $c_h^N = 0.11560$, $H^W = 291.39$, $H^N = 208.61$, $TX_k = 30.04$, $RE = 18.93$, $TX_h = 128.05$, and $D = 272.98$.

The initial balance sheets of the three sectors are listed in Table I. Wealthy households have a well-balanced asset portfolio with between 17 and 35 per cent (number in parentheses) in each of the four assets: bonds, equities, mortgages, and housing.

Economic Report of the President. To simplify the analysis, all business is assumed to take the corporate form, land and inventories are ignored, and all housing is assumed to be owner occupied.

[9] To illustrate, the mortgage rates for 70, 80, and 90 per cent loans, respectively, exceed that on 60 per cent loans by 1½, 17, and 47 basis points.

Table I

The Initial Balance Sheets of the Three Sectors[a]

Wealthy Households

Bonds	166.7	(17)		
Equities	333.3	(35)		
Mortgages	166.9	(17)		
Housing	291.4	(30)	Wealth	958.3

Less Wealthy Households

Housing	208.6 (500)	Mortgages	166.9	(400)
		Wealth	41.7	

Corporations

		Bonds	166.7
Capital	500	Equities	333.3

[a] The numbers in parentheses are percentages of sectoral wealth.

III. Economic Growth and Inflation: Fixed Relative Prices

Table II presents the initial values of the key variables (Column 1) and various simulation results. All simulations are cumulative. To illustrate, the pure inflation simulation (Column 3) includes the impact of growth (Column 2), and so on. Only the first two simulations are discussed in this section.

We begin with a simulation to determine how the variables would have been affected by economic growth of roughly the magnitude observed between 1965 and 1978; more specifically, γ is increased by 50 (by 43 per cent). In this simulation, both the inflation rate and risk-free interest rate are held constant at their 1965 values of one and four per cent, respectively. The model is altered to determine the increase in real wealth, W_r, rather than the risk-free rate. The results are fairly straightforward: capital (wealth in this case) grows by 52.4 per cent, the increase is allocated more heavily towards nonresidential owing to its assumed greater income elasticity, the user costs change little (those for corporate capital and housing of the less wealthy rise and fall, respectively, because of movements in their risk premia owing to shifts in portfolio shares), and all income flows rise by about 60 per cent.

Column (3) reports the result of both growth and an increase in expected inflation (both general and housing) from one to seven percent. In this simulation, we have continued the increase in γ and forced the increase in wealth to be the 52.8 per cent increase deduced in the first simulation. The model now determines the risk-free rate, rather than W_r. This rate rises by nearly 8 percentage points. The ratio of the increases in the risk-free and inflation rates is 1.32. This is a weighted average of the increases necessary to leave the real user costs of corporate ($\alpha_3/\alpha_1 = 1.25$) and housing (1.43) capital constant, where the former is weighted twice as heavily as the latter because the elasticity of corporate capital with respect to the real user cost is twice as large as the elasticity of housing. The necessary increases depend on the taxation of income from corporate and housing capital at both the personal and, for the former, corporate levels. To illustrate, the necessary ratio for housing is simply $1/(1 - \theta)$. Owing to the heavier taxation of returns on corporate equities than on housing, the user cost for corporate capital rises relative to that for housing, and corporate and housing capital now rise by roughly equal amounts (because all capital stocks and sectoral wealths grow by similar amounts, changes in risk premia are negligible). That is, the tilt away from housing during a period of growth, owing to an income elasticity less than unity, is largely offset by the impact of an increase in inflation and the more favorable tax treatment of housing.

The increase in inflation also has a number of impacts on real income flows relative to the pure growth case. First, business taxes decline owing to the decline in output and the greater value of nominal interest deductions which more than offsets the reduced real value of tax depreciation based on historic cost. Second, retained earnings fall relatively more because a portion of real gains at the expense of debtors is paid out. Third, household taxes (and thus government spending) rise owing to the taxation of nominal interest and nominal increases in share prices at the personal level.

Table II

Simulation Results

	(1) Initial Values	(2) Growth	(3) Growth and Inflation	(4) (3) + Relative Housing Inflation	(5) (4) + Mortgage Capital Gains	(6) (5) + Mortgage Payment Constraint
			Changes in Values			
Risk-Free Rate (%)	4.00	0.00	7.89	9.40	8.99	8.52
Loan-to-Value Ratio (%)	80.00	−0.5	−.03	−21.6	−18.2	−19.6
Real User Costs (%)						
Corporate Capital	23.31	0.27	0.64	1.50	1.06	0.56
Housing of Wealthy	5.92	−0.01	−0.48	−0.24	−0.64	−1.09
Housing of Nonwealthy	11.56	−0.14	−0.57	−2.48	−2.59	−3.36
Real Asset Price of Housing	1.00	0.00	0.00	0.39	0.39	0.38
			Percentage Changes in Values			
Quantities (Billions, 1965)						
Corporate Capital	500.0	56	53	46	50	54
Housing of Wealthy	291.4	48	52	47	53	61
Housing of Nonwealthy	208.6	49	50	63	49	31
Wealth	1000.0	52	52	80	80	79
Income Flows (Billions per year)						
Business Product	500.0	58	57	56	57	58
Household Taxes	128.1	58	62	64	65	66
Business Taxes	30.0	60	57	55	55	54
Retained Earnings	18.9	60	49	47	47	47
Disposable Income	273.0	58	56	54	55	56

IV. Variable Real Prices

In the above simulations, the real price of housing was held constant, and the expected housing inflation rate was set equal to the general expected inflation rate. In fact, the real price of housing - the ratio of the price of a constant quality house to the CPI net of shelter - rose by 40 percent between 1965 and 1979, and households likely built this real rise into their expectations. In the following simulations, a finite supply price elasticity is incorporated into the model; a shift parameter is introduced into the housing supply function; and expected house price inflation is assumed to exceed general expected inflation.

Two major model changes are necessary. First, Equation (4′) is replaced by

$$W_r = \frac{K}{\lambda_1} + \frac{1}{\lambda_2}\left[\frac{1}{1+s}\left(\frac{H^W + H^N}{H_0}\right)^s + \frac{s}{1+s}\left(\frac{H_0}{H^W + H^N}\right)\right](H^W + H^N) \qquad (4'')$$

which implies that

$$p = \frac{\partial W_r/\partial(H^W + H^N)}{\partial W_r/\partial K} = \frac{\lambda_1}{\lambda_2}\left(\frac{H^W + H^N}{H_0}\right)^s \qquad (19)$$

where H_0 is the initial stock of housing. The coefficient s is the inverse of the supply elasticity of housing. λ_1 and λ_2 are introduced in (4″) to allow for productivity change in the nonhousing and housing sectors respectively, and they are equal to unity in the absence of technical progress. Technical progress in the nonhousing industries can be considered as an exogenous increase in γ_k in Equation (1). However, because of the assumption of a Cobb-Douglas production function, it can be expressed in terms of the "capital augmenting" rate and translated into an increase in λ_1. λ_2 is likewise introduced. As can be seen from (19), the ratio λ_1/λ_2 is the exogenous shift factor in the supply function of housing. There is some empirical evidence that the efficiency increase in nonhousing industries exceeded that in the construction industry between 1965 and 1978 (Hendershott [8, Table 6]). As a result, there has been an exogenous increase in real construction costs (Grebler [6, Exhibit 7]). In the remaining experiments, we shall raise λ_1 to 1.125 and lower λ_2 to 0.9, thereby abstracting from the growth considerations already accounted for; thus the exogenous increase in p will be from 1.0 to 1.25 or 25 per cent.[10] Simultaneously, the expected housing inflation rate will be raised by 2½ percentage points more than the general expected rate, i.e., by 0.085 rather than 0.06.[11]

The second major change follows from the fact that the endogenization of p requires the endogenization of the wealth variables: W, W^W, and W^N. Three equations are added:

$$W = qK + p(H^W + H^N) \qquad (5')$$

$$W^W = W - W^N \text{ and} \qquad (6')$$

$$W^N = (1 - w)W^* + (p - p_0)H^N \qquad (20)$$

[10] The relative changes in λ_1 and λ_2 are calibrated such that the average of the reciprocals of their levels is unity. Thus the changes leave W_r unchanged at the initial values of corporate capital and housing.

[11] The 2½ per cent compounded for 13 years implies a 38 per cent increase in real house prices.

where W^* is the wealth level from the growth simulation (1524). Also wW and $(1 - w)W$ are replaced by W^W and W^N respectively, wherever the former appear in the model.

In this simulation, the supply price elasticity has been set equal to 4 (s = 0.25).[12] As a result, the real house price rises by 14 per cent plus the 25 per cent exogenous increase [see Column (4)]. The increase in the real housing price provides wealthy and less wealthy households with roughly equal dollar real capital gains because their simulated housing is roughly equal. However, the total wealth gain as a percentage of initial wealth is much greater for the highly levered, less wealthy households, 372 per cent versus 68 per cent for the wealthy. This leads to sharp decreases in the loan-to-value ratio (to 58 per cent) and in the housing risk premium (by nearly 4 percentage points) for the less wealthy households.

While the increase in real house price tends to raise the real user cost for housing, higher expected house price inflation acts to lower it. The net result is a fall in this user cost. The fall is especially large for the less wealthy owing to the fall in the risk premium. Thus the increase in the risk-free rate necessary to equilibrate the market for capital goods is greater than in the absence of relative housing inflation, and capital accumulation is tilted from nonresidential to residential. Relative to the pure growth simulation and to the observed 47 per cent increase in residential capital between 1965 and 1978, the calculated accumulation is about five percentage points too high owing to the sharp rise in housing of the less wealthy. The relative decline in nonresidential capital leads to a relative fall in business product and thus to relative drops in business taxes and retained earnings. Household taxes rise further, in spite of a decline in income owing to the higher interest rate and, especially, the increase in house values.

Another price changed drastically between 1965 and 1978: the market value of corporations declined by 30 per cent relative to the replacement cost of their assets. How this decline would be analyzed in our simulation model depends on the cause of the decline. If it is due to the interaction of inflation and taxation or to valuation errors, the q in Equations (5′), (6′), and (9′) would be reduced from 1.0 to 0.7. On the other hand, if the decline in q is due to a reduction in the productivity of existing capital caused by, say, extraordinary unanticipated changes in factor prices and/or government regulations, then K in Equations (1′) and (2) should be replaced by qK, and the decline in q would also work through these equations.[13] In the former case, the risk premium on corporate capital would decline owing to a fall in the share of the wealth of the wealthy in corporate securities, and thus the user cost for corporate capital would fall. The reverse would be true for housing of the wealthy. Other things being equal, capital formation would be tilted towards nonresidential capital. In the latter case, the

[12] Two recent estimates of this elasticity are 9 (Smith [23, p. 401]) and 2 (Poterba [19, p. 11]). We take 4 as the operational value. Whether the increase in price is exogenous or endogenous is irrelevant to the results. Thus the choice of the supply elasticity is irrelevant as long as the real increase in the price of housing is constrained to equal around 40 per cent.

[13] For a comparison and critique of the various views regarding the decline in the market value of corporations, see Hendershott [9] who concludes that a decline in the productivity of existing capital stock must have played a major role. Baily [1] makes a strong case for the decline in productivity.

decline in q would lead directly to an offsetting rise in K.[14] A difficulty with these analyses is that a decline in q might well produce an increase in the expected variance of equity returns or a rise in the equity risk-aversion parameter relative to that on other assets (see Malkiel [16]). Thus α_2 increases, c_k tends to rise, and capital formation could be tilted away from nonresidential capital (at least in the case where the productivity of existing capital has not declined sharply). Given the uncertainties regarding how the decline in q should be implemented and even its directional impact on capital allocation, no simulation with this change has been run.

V. Capital Market Effects

The above analysis would be complete if nonwealthy households financed their housing with one-period, price-level adjusted loans. In fact, households have traditionally employed long-term, fixed-nominal rate mortgages as the financing instrument, and lenders have apparently rejected some loan requests on the grounds that the household's current income was too low relative to its contemplated interest expenses. Each of these phenomena tends to lower housing demand during a period of rising nominal interest rates.

Rising nominal interest rates induce capital losses for holders of existing long-term securities and capital gains for those with the outstanding debt. If the debt were not linked to particular assets, then the gains could be realized by relinquishing the debt for less than face value. If the debt (mortgage) is linked to a particular asset (house) but is fully assumable by new owners of the house, then at least some of the gain could be realized by selling the house at greater than market price. For nonassumable mortgages, however, the gain can only be realized over time by maintaining the low rate mortgage and staying in the house to which it is attached. Thus, mortgage capital gains could be a strong incentive against households "trading up" in response to increases in real income and decreases in the price of housing services (user cost).[15] In the next simulation, some of the less wealthy households are assumed to have maintained their existing financing and housing. With n being the fraction of non-moving, less wealthy households, the model changes made are the substitution of

$$H^N = (1 - n)\alpha_h[(1 - y)D]^\epsilon(c_h^N)^{-\eta} + nH_0^N \tag{3N'}$$

for Equation ($3N$) and the replacement of the vpH^N term in Equation (8′) with $vp(H^N - nH_0^N) + v_0^* p_0 n H_0$ and of H^N/W^N in (14′) with $(H^N - nH^N)/[(1 - n)W^N]$.[16] We set $n = 0.25$ and $v_0^* = 0.4845$.[17]

[14] Thus, some of the extraordinary growth in the nonresidential capital stock referred to in the introduction could be attributable to measurement error; the replacement cost is overstated because the productivity of the capital is overstated.

[15] These gains decline in real terms over time as amortization occurs and inflation takes its toll (Hendershott and Hu [13]). Thus this incentive eventually disappears.

[16] A second-order wealth effect owing to the change in the market value of "old" mortgages has not been accounted for. Because interest rates rose, debtors (the less wealthy) gain at the expense of creditors (the wealthy).

[17] v_0^* is the loan-to-value ratio after 13 years, assuming an initial value of 0.8 and mortgage rate of 0.04172 (the 0.04 risk-free rate plus m).

The results of this simulation are listed in Column (5). Because one-quarter of the less wealthy households do not alter their housing and financing, the increase in the risk-free rate is less. Because all user costs are lower, the corporate capital stock and the housing of the wealthy and the less wealthy who move are all greater than in the case where all households refinance. The datum in the table for the housing of less wealthy in Column (5) declines relative to Column (4) because of the quarter of households that simply maintain their existing housing. The impact of the nonmovers is more on the allocation of housing among households than on the allocation between residential and nonresidential capital.

A number of recent empirical studies suggest that nominal, as well as real, mortgage rates affect housing demand [4, 8, 15, 21]. The most straightforward cause of this result is the well-known cost/income limit that lenders impose on borrowers. Housing costs, excluding utilities, are the sum of outlays for maintenance, property taxes, and mortgage payments. In terms of our earlier symbols, the ratio of nonutility housing costs (HC) of the nonwealthy households that move to their labor income (Y^*) is:

$$\frac{HC}{Y^*} = \left[\delta_h + \tau_h^p + v\,\frac{r_m(1 + r_m)^{25}}{(1 + r_m)^{25} - 1}\right]\frac{p(H^N - nH_0^H)}{Y^*} \tag{21}$$

where $Y^* = (1 - y)(1 - n)(1 - \alpha_k)Y$, r_m is the mortgage rate on a 25 year level-payment mortgage, and the term multiplying v is the annual mortgage payment on a one dollar mortgage. Using the initial values of the variables, the ratio is 0.10. For the purposes of the paper, we specify the limit allowed by lenders to be 0.16.[18]

When Equation (21), after setting the left-side equal to 0.16, is solved for v using the values of i, ρ_M, H^N and Y from the simulation of the increase in inflation, a value of 45 per cent is obtained. That is, mortgage payments and other costs rise so high relative to income that lenders (wealthy households) would be willing to extend only 73 per cent (45/62) of the mortgage debt desired by less wealthy households who move. The credit shortfall is $44 billion (0.62-0.45 times $258 billion where the latter is the housing demand, in the absence of the credit limit, of less wealthy households who move). In the absence of more innovative financing instruments, such as graduated payment, price-level adjusted or shared appreciation mortgages, these households are simply unable to purchase the desired housing.

To incorporate this credit limit into the analysis, we replace the equation for the desired housing demand of less wealthy households with Equation (20) after setting the left-hand side equal to 0.16. In effect, this equation determines the loan-to-value ratio, and the quantity of housing held is derived from the balance

[18] The imposition of the credit-market constraint in the simulations is an admittedly crude attempt to approximate the real world. On the one hand, the limit on the housing costs/income ratio assumed to be imposed by lenders, 0.16, is too low. On the other hand, the calculations assume that all households owned houses in 1965 and reaped 40 per cent real capital gains since then. As a result, the desired loan-to-value ratio declined from 80 per cent to 58 per cent. In reality, many less wealthy households are of a more recent vintage and have not participated in these real capital gains. For these households the desired loan-to-value ratio is 80 per cent or higher and thus the credit market constraint is far more binding than that based on our analysis.

sheet constraint of these households. The results from a simulation of the revised model are listed in Column (6) of Table II. The loan-to-value ratio declines by 1½ percentage points relative to Column (1), and the increase in the risk-free interest rate is half of a percentage point less. Because "rationing" of less wealthy households occurs, a smaller increase in interest rates and in the user cost for corporate capital is needed to equilibrate the capital market. While the user cost for nonwealthy households falls sharply, it is irrelevant; the lender credit limit restricts their housing demand.

The net impact of the capital-market constraints is to offset the aggregate impact of the tax-inflation bias on the allocation of capital between residential and nonresidential uses; the increases are very close to those obtained in the pure growth simulation. However, the impact on the two household classes is far different from that in the growth simulation. In the former, the housing of the two classes increased proportionately; in the latter, the growth in housing of the wealthy is more than twice as great as that of the less wealthy because the capital-market constraints only impinge on those with mortgage debt.

The above analysis does not "show" that the two constraints reduced housing demand equally or that the effects offset the tax-inflation bias. The impact of one of the constraints could have been stronger than we have simulated and that of the other weaker. Also, the income elasticity of the demand for housing might be lower than 0.85, in which case the combined impact of the credit-market constraints must have been less.[19] The above analysis is simply indicative of how the various factors influence the effective demand for housing and the allocation of capital between residential and nonresidential uses.

VI. Summary

We have constructed a simple two-sector model of the demand for housing and corporate capital. Increases in the labor force (or technology) and the inflation rate were then simulated with a number of model variants. The model and simulation experiments illustrate both the tax bias in favor of housing and the manner in which inflation magnifies it. More specifically, prior to the acceleration of inflation the user cost net of depreciation (or the investment hurdle rate) for corporate capital exceeded that for housing (average of wealthy and nonwealthy) by 7½ percentage points; after the acceleration the difference was over 10 percentage points.[20] Our best estimate is that this increase, *ceteris paribus*, raised

[19] In fact, we strongly suspect that we have overstated the impact of these constraints. Most mortgages issued prior to 1970 were assumable. Further, many young traditional husband-wife families overcame the mortgage-payment constraint by postponing child raising and moving family income forward in time. The labor force participation rate rose far more sharply between 1965 and 1975 for young women with husbands present than for those without. For 20–24 year olds, the participation rate rose from 37% to 57% (husbands present) versus 59% to 65% (others). For 25–44 year olds, the comparison is 36% to 50% (husband prersent) versus 67% to 69% (others).

[20] By assumption, the net user costs for housing are equal on a risk-adjusted basis. The risk spread between the adjusted (equating ρ_h^i to ρ_k) user costs for corporate and housing capital rose from 4 percentage points initially to 5 percentage points in the full inflation simulation. Efficient allocation of capital requires that the net risk-adjusted user costs be equal.

the accumulation of residential capital during the 1966–78 period by 10 per cent and lowered the accumulation of nonresidential capital by nearly 20 per cent.

On the other hand, the predominate use of the level-payment, fixed-rate mortgage instrument during a period of rising nominal interest rates could have limited the increase in housing demand. Those with large outstanding mortgages reaped capital gains. This would act as a deterrent to "trading up" to the extent that the mortgage was less than fully assumable. Those with little accumulated wealth (first-time homebuyers) might find the desired mortgage-payment to income ratio to be greater than that permitted by lenders. This, too, would restrict effective housing demand. While the operation of these credit-market constraints acted to offset the bias against the accumulation of nonresidential capital, they tended to introduce an inefficient distribution of residential capital between the wealthy and less wealthy.

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