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Accounting for Changes in the Homeownership Rate

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Abstract

After years of being relatively constant, the homeownership rate- a target for housing policy- has increased since 1995. This paper attempts to understand why the homeownership rate has been increasing by constructing a quantitative model and then using this model to evaluate explanations that have been offered to account for this increase. We find that the increase in the homeownership can be explained by innovations in the mortgage market that allows households to take a positive housing investment position with a much smaller downpayment.

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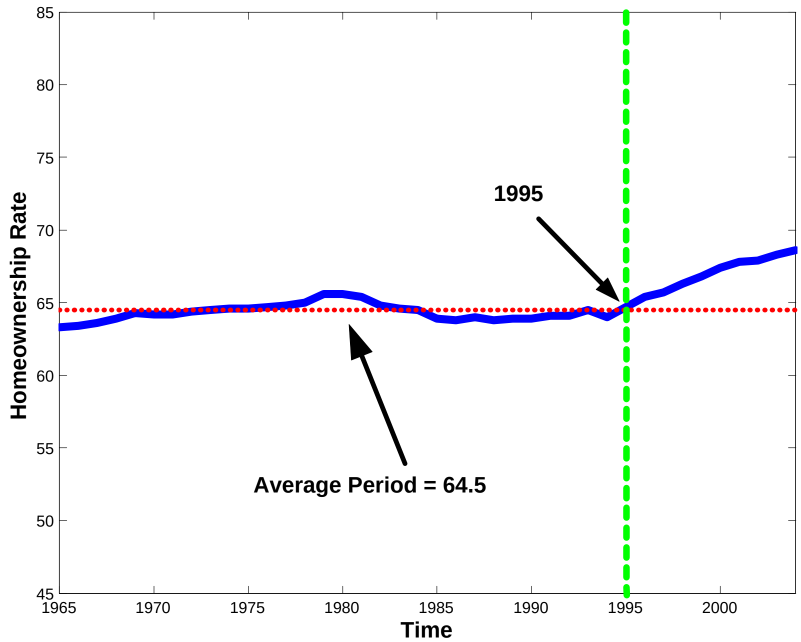
1 Introduction

The purchase of a house is the largest single consumer transaction for most households. This should not be a surprising fact given that housing policy in the United States has been directed toward enhancing homeownership. Mortgage interest payments and property taxes are deductible for individuals who itemize their personal income taxes. In addition, service flows from owner occupied housing are not taxed. The government plays an active role in the mortgage market through Government Sponsored Agencies such as Fannie Mae and Freddie Mac as well as various programs that subsidize the entry costs for individuals who want to buy a house for the first time.[1] Given the focus of policy on the homeownership rate, we present the time series of this rate since 1965 in Figure 1.

Figure 1: The Evolution of the Homeownership Rate



Two important facts seem apparent in this Figure. Until 1995, the homeownership rate seems to be stationary around 64 percent. After 1995, the

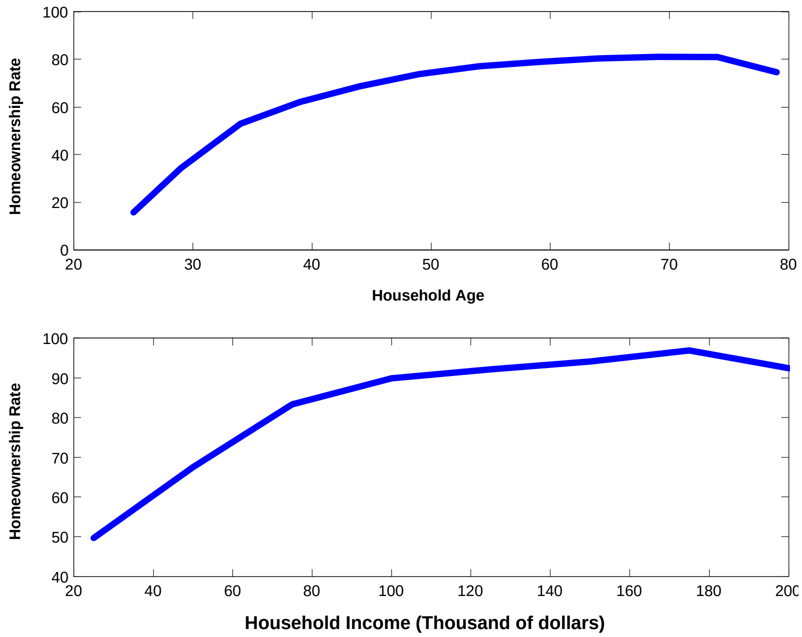
[1] For example, the Bush Administration sponsored the American Dream Downpayment Act which provides downpayment assistance, and has proposed a Zero-Downpayment Initiative for Federal Housing Administration (FHA) insured single-family mortgages for first time buyers.

homeownership rate steadily increases.[2] Glaeser and Shapiro (2002) have pointed out the constancy of the homeownership rate prior to 1996. Based on this fact, they have questioned the efficacy of the home interest rate mortgage deduction policy as means of increasing homeownership. They argue that the deductibility of the mortgage interest and property tax payments encourages homeownership by the wealthy, who are already homeowners. Implicitly, this policy fosters larger home purchases and not necessarily increases in the homeownership rate.

Given government policy toward homeownership, it is important to know the characteristics of households who not own a home. A simple way to accomplish this is to see how the homeownership rate varies by income and age. Figure 2 presents this information for 1995. We see that the homeownership rate is very low for young households. In fact, after age 40, this rate exceeds 60 percent. In terms of income level, households with income levels under $45,000 have rates under 60 percent. The information in Figure 2 indicates that increasing the homeownership rate for younger and poorer households will result in a large movement in the aggregate homeownership rate while increasing the homeownership rate for older and high income households will have a more marginal effect on the aggregate rate which seemly supports Glaeser and Shapiro's argument that current tax policy does not necessarily increase the homeownership rate.

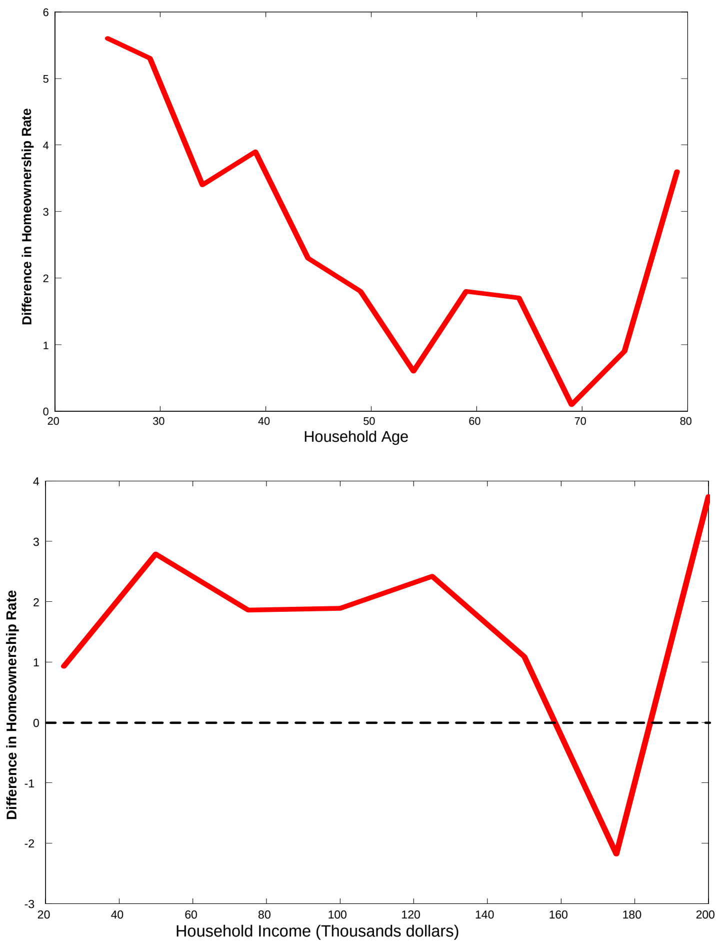
[2] We formally tested whether a break has occurred in the homeownership rate starting in 1995. We rejected the null hypothesis that no break was present at the five percent significance level.

Figure 2: Homeownership Rate by Age and Income



The other fact is that since 1995, the homeownership rate has been increasing. In Figure 3, we examine the difference in the homeownership rate distributions by age and income so we can identify where that largest changes in homeownership are occurring. In terms of age, the homeownership rate has increased for all age groups with the largest changes appearing in households under age 40. If homeownership rates are examined by income level, we find a general increase in the homeownership rate over all income level with the greatest homeownership increases occurring in income levels under $60,000. An increase in ownership rate of the young and lower income households is required if the overall homeownership rate is to increase. This leads to the question of what has caused the homeownership rate to increase.

Figure 3: Changes in the Homeownership Rate
Between 1995 and 2003



This paper attempts to answer the question of why the homeownership rate has been increasing in the United States. We provide an answer than account for the increase in the homeownership rate by constructing a quantitative model. This model is used to evaluate explanations.[3] The model has the following features: homeownership is part of the household's portfolio decision; life-cycle effects play a prominent role; rental and ownership

[3] The model has applications beyond the focus of this paper. We have used the model to evaluate the argument that current housing policy, especially the housing mortgage interest rate deduction policy favors the wealthy. See Chamber, Garriga, and Schlagenhauf (2004).

markets coexist; and households make the discrete choice of whether to own or rent as well as the continuous choice of what quantity of housing service flows to consume.

Our model is in the tradition of the theoretical construct developed by Henderson and Ioanides (1983). We employ an overlapping generation framework with production that allows us to explicitly consider life-cycle effects.[4] Households live a fixed number of years, which includes a retirement period, and maximize expected discounted utility over time subject to a sequence of budget constraints in an environment of uninsurable labor income uncertainty. The utility index depends on consumption goods and housing services. Households make decisions with respect to the consumption of goods, the consumption of housing services, and saving which can be in the form of either (real) capital and/or housing investment positions. Hence, the model stresses the dual role of housing as a consumption and investment good. The investment in housing differs from real capital in that a downpayment and mortgage are required, and changes in the housing investment position result in transaction costs. These latter costs associated with the adjustment of the housing position result in the infrequent changing of housing investment positions.

The housing durable good generates a flow of housing services that a household can choose to consume or rent to others. This implies the supply of rental housing is endogenously determined. The consumption of these service flows results in the depreciation of the housing stock. Since the depreciation on the housing stock depends on whether the service flows are consumed by the owners or renters, these costs must be explicitly recognized in maintenance expenses.

A market equilibrium is determined as interest rates and housing rental service rates adjust to clear the capital and rental markets. We employ techniques used in heterogeneous agent macroeconomic economies to solve our model. Once we have determined the (steady state) equilibrium, the empirical implications of the model are determined and compared with actual data. Only recently have computational techniques been developed so that dynamic models emphasizing tenure choice and residence spells could can be examined.

We use this model to see if we can account for the increase in homeownership. Three explanations are considered. An obvious possibility is

[4] Some of the other research that examines housing in a general equilibrium general equilibrium setting are Berkover and Fullerton (1992), Díaz and Luengo-Prado (2002), Fernández-Villaverde and Krueger (2002), Gervais (2002), Nakajima(2003), and Plantania and Schlagenhauf (2002).

the decline in the mortgage interest rate. The problem with this explanation is that mortgage interest rates started their decline in 1986 which is a decade before the homeownership rate started to increase. A second possibility is that buyer transaction costs have declined. FHA estimates buyer transaction costs have declined 195 basis points since the 1980's. Our model predicts an small impact in the homeownership rate as a consequence of a reduction in transaction costs. A third possible explanation is changes in government policy that make housing more affordable for first time buyers, or innovations in the financial markets that reduce the effective downpayment rate. Examples of latter possibility are an increase in the popularity of mortgage insurance or new loan products. We find that the explanation for the increase in the homeownership rate is likely innovations in the mortgage financial market.

This paper is organized into three sections. In the first section, we describe the model economy and define equilibrium. The second section explains how we estimate the model to the US economy. The third section examines possible explanations for the observed increase in the homeownership rate since 1996. The final section concludes.

2 The Model

2.1 Market Arrangements and the Mortgage Contract

In this economy, households have access to two assets to smooth out uncertainties. Households can invest in a riskless financial asset we will call capital and denote by $a' \in \mathcal{A}$ with a net return r, and/or in a housing durable good denoted by $h' \in \mathcal{H}$ with a market price p. The prime is used to denote future variables. The housing asset generates shelter services according to the a linear technology function $s = g(h') = h'$. Shelter services may be sold in a rental market at the rental price, R, per unit of shelter.

The decision to invest in housing necessitates a mortgage and a downpayment equal to ψ percent of the value of the house. The mortgage is taken for M periods and a payment is required in the first period the mortgage is in effect.[5] The decision to invest in housing requires initial borrowing of $B_M = (1-\psi)ph'$. The (effective) mortgage payment in a period depends on the housing position $h^{'}$,(and the amount borrowed B_M), the mortgage interest rate, r^m, the number of periods before the mortgage is paid off,

[5] A mortgage payment is made the period the mortgage is written because a household is able to purchase a home and consume the service flow from that house in the same period.

$n \in \mathcal{M} = (0, 1, ..., M)$, and policy toward the deductability of interest payments which we denote by τ_m. We summarize the mortgage contract is as a function of (h', n, r^m, τ_m). The net payment in period n is defined as $m(h', n, r^m, \tau_m)$ and is determined by the initial amount borrowed less the amount of interest payments that are deductible, or

$$m(h', n, r^m, \tau_m) = \lambda r^m B_M - D_M, \tag{1}$$

where $\lambda = \left[(1 + r^m) - \frac{1}{(1+r^m)^M}\right]^{-1}$ and $D_n = \tau_m [B_n r^m]$. Each period the mortgage contract requires a payment that can be decomposed into an interest payment and a principle payment. In any period n during the contract, the interest payment, I_n, is equal to the mortgage interest rate times the outstanding debt at the beginning of period, B_n. The principle payment in any period is defined as $\lambda r^m B_M - I_n$. After the payment of principle, the remaining principle, or outstanding debt is $B_{n-1} = B_n - [\lambda r^m B_M - I_n]$.

2.2 Households

Households are described by preferences, earnings capabilities and age. We index a household's age by $j \in \mathcal{J} = \{1, 2, ..., J\}$ where each household lives J periods with certainty. Household preferences are given by the expected value of a discounted sum of momentary utility functions:

$$E \sum_{j=1}^{J} \beta^{j-1} u(\varphi_j, c_j, s_j), \tag{2}$$

where β is the discount factor, c_j is the consumption of goods at age j, s_j is the consumption of housing shelter services at age j, and φ_j is an exogenous parameter that captures the evolution of the family size along the life-cycle. The utility function is neoclassical and satisfies the standard properties of continuity and differentiability.

A household is endowed with a fixed amount of time each period and they supply this endowment to the labor market inelastically until retirement at age $j^* < J$. Households differ in their productivity for two reasons - age and period specific productivity shocks. We define υ_j as the average labor productivity of an age j individual. A household also draws a period specific earnings component, ϵ, from a probability space, where $\epsilon \in \mathcal{E}$. The realization of the current period productivity component evolves according to the transition law $\Pi_{\epsilon,\epsilon'}$. Thus, a worker's gross labor earnings in a given period are $w\epsilon\upsilon_j$ where w is the market wage rate.

Workers face two taxes on labor income - a tax to fund retirement benefits, τ_p, and an income tax, τ_y. After tax labor income is simply $(1-(\tau_p+\tau_y))w\epsilon\upsilon_j$. During retirement, a household receives a retirement benefit from the government equal to $(1-\tau_y)\theta w$. The household's current period budget constraint depends on the household's exogenous income shock $\{\epsilon\}$, its beginning of period asset holding position a, the current housing position h, the length of the mortgage contract remaining n, the current age j, and the household decisions with respect to their consumption c, housing consumption s, asset position a', and housing position h', for the start of the next period. To better understand the household environment, we can think of the household as being in one of five situations with respect to housing.

Let us start by considering a household that does not have an investment position in housing, $h = 0$, and decides not to take a positive housing position in the next period, $h^{'} = 0$. We will define y as the income of the household. The income of a household that is not retired, $j < j^*$, depends on the after tax effective wage and the after tax earnings from the capital investment. If the household is retired, $j \geq j^*$, income depends of retirement benefits, θ, and the after tax earnings from their capital investment position. We can define the income on labor and nonhousing asset holding as:

$$y = \begin{cases} (1-(\tau_p+\tau_y))w\epsilon\upsilon_j + (1+(1-\tau_y)r)a, & if\ j < j^*, \\ (1-\tau_y)\theta + (1+(1-\tau_y)r)a, & if\ j \geq j^*. \end{cases}$$

Given this income, the household may buy consumption goods c, rent housing services at the cost Rs, and invest in capital a'. Thus, the budget constraint for the household who rented housing services in the prior period and continues to rent in the current period is:

$$c + a' + Rs \leq y. \tag{3}$$

The second case focuses on the household who rented in the previous period, $h = 0$, but decides to invest in housing, $h^{'} > 0$. This household has two sources of income. In addition to y, the investment in housing could also generate income if part of the services from the housing investment are made available to other households. This possibility is captured by the term $I_R R(g(h') - s)$ where the housing investment generates $g(h^{'})$ services, and I_R is an indicator function that captures the tax impact that is associated with renting out part of the housing investment.[6] More precisely, we define

[6] Henderson and Ioannides impose a contraint that a homeowner can not rent additional housing services beyond the services that result from the housing investment. We do not impose this constraint. Thus, the term $R(g(h^{'}) - s)$ could be negative. Our numerical analysis of the model indicates that this case never occurs.

I_R as:

$$I_R = \begin{cases} (1-\tau_y) \text{ if } & R(g(h') - s) > 0 \\ 1 \text{ if } & R(g(h') - s) \leq 0 \end{cases}$$

Income can be used to buy consumption goods, invest in real capital, purchase a house, make a payment on the loan used to finance the home purchase, and pay maintenance expenses. We assume all houses are financed with a mortgage where $m(h', n, r^m, \tau_m)$ denotes the period mortgage payment. The purchase of a house requires a downpayment of $\psi p h'$ and the payment of some transaction costs denoted by $\phi_B p h'$.

Owning housing also generates a maintenance expense. The actual maintenance expense depends on whether some of the housing services are rented to other individuals.[7] There is an implicit moral hazard problem in the renting of housing services to individuals who do not own the house - renters decide on how intensely to utilize a house, but may not actually pay the resulting costs. Assume two different efforts are available to maintain the dwelling $e \in \{e_L, e_H\}$. The depreciation rate of the housing stock depends on the effort $\delta(e)$. Since a homeowner understands the costs associated with utilization, an incentive exists to maintain the home, and thus they exert (high) effort to maintain the house. The depreciation rate for a homeowner is δ_O. However, we assume that landlords cannot observe the utilization rate or maintenance efforts of tenants. As a result landlords assume all renters will choose the low maintenance effort e_L. The depreciation rate associated with low effort is δ_R which will exceed δ_O. The moral hazard problem generates a kink on the consumer budget constraint on the point where households choose to consume all their housing services. The market rate for rental services will incorporate the moral hazard problem and renters have to pay a premium reflecting additional maintenance cost. In the absence of this problem, renting would be cheaper than owning in the model.[8]

In order to calculate the appropriate maintenance investment, the amount of housing that is subject to owner depreciation, δ_O, and the amount of the housing investment that is subject to renter depreciation, δ_R, must be known. Let $h_c(s)$ correspond to the amount of the housing that the indi-

[7]Henderson and Ioannides argue that there is an externality associated with the rental of housing services. The individual who consumes the services generated by a house decides on how intensely to utilize the house, but does not consider the associated costs if they are not the owner of the house. This assumes the mortgage contract can not be written to explicitly provide for such contingencies. In order to have rental housing services by non-homeowners, the renter must pay in terms of higher contract rents.

[8]Household preferences, financial incentives, or the allocation of control have also been used as arguments to explain why renting is more expensive than owning .

vidual requires given the decision to consume s housing services. If this amount is exceeds the services generated by the current housing investment position, $h^{'}$, some additional housing services must be rented. In this situation, the depreciation costs are determined by the owner's depreciation rate, δ_O, on $h^{'}$ units of housing.[9] On the other hand, if the individual decides to consume less than the amount of housing services generated from the investment position, the part of the housing position that the individual lives in, $h_c(s)$, depreciates at δ_O. The remaining part of the housing housing investment, $(h' - h_c(s))$, is rented to other individuals and depreciates at the rate δ_R. Hence, the maintenance expense depends on h' and h_c and we define a maintenance function $x(h', h_c)$ as

$$x(h', h_c) = \begin{cases} \delta_O p h', & if \ h_c(s) \geq h' \\ \delta_O p h_c(s) + \delta_R p[h' - h_c(s)], & if \ \ h_c(s) < h' \end{cases}$$

The budget constraint for this case is:

$$c + a' + (\varphi_B + \psi)ph' + m(h', M, r^m, \tau_m) + x(h', h_c) \leq y + I_R R(g(h') - s). \quad (4)$$

A third possible situation is the household that enters a period with a positive housing investment position, $h > 0$, and decides to sell off their entire investment position and rent housing services, $h' = 0$. [10] The budget constraint for this situation is:

$$c + a' + Rs \leq y + [(1 - \phi_s)ph - B_n]. \quad (5)$$

The budget constraint indicates two important features of the housing investment position. First, if the initial housing position is sold, the individual must rent housing services equal to Rs. Second, the sale of the house generates income, ph, minus any selling costs, ϕ_s, and remaining principle which we denote as B_n.[11]

The last two cases deal with a household that enters the period with a housing investment position, $h > 0$, and decides to continue to have a housing investment position, $h' > 0$. The critical issue is whether the household decides to change their housing position. If the household decides to maintain their housing position, $h = h'$, then the budget constraint is:

$$c + a' + m(h', n, r^m, \tau_m) + x(h', h_c) \leq y + I_R R(g(h') - s). \quad (6)$$

[9] If additional housing services are needed, these services must be rented from someone else who incurs the depreciation costs.

[10] In the last period, all households must sell h, rent housing services and consume all their assets, a, as a bequest motive in not in the model. In the last period, $h^{'} = a' = 0$.

[11] As our analysis will be conducted at the steady state, we do not have to allow for differences in purchase and selling prices.

In this situation, the household must make a mortgage payment if $n > 0$, and pays for maintence expenses. Income is dependent on the rental-leasing decision. It is important to note that in this model the consumption of housing service flows, and the investment decision are separated. Here, housing size is related to service flows, and not necessarily the stock of housing.

If the household decides to either up-size or down-size their housing investment position, (i.e., $h \neq h'$, $h > 0, h' > 0$), the budget constraint is more complicated.

$$\begin{aligned} & c + a' + (\varphi_B + \psi)ph' + m(h', M, r^m, \tau_m) + x(h', h_c) \\ \leq \quad & y + [(1 - \phi_s)ph - B_n] + I_R R(g(h') - s), \end{aligned} \tag{7}$$

This constraint accounts for the additional income from selling their home less transaction costs, $\phi_s h$, and remaining principle. Income may also be earned depending on the rental-leasing decision associated with the new housing position, $I_R R(g(h') - s)$. This income is used for consumption, capital investment, maintence expenses, and the costs associated with the new housing position. These costs include transaction costs, downpayment outlay, and the current period mortgage payment and are captured in the term $(\varphi_B + \psi)ph'$.

We can combine the various budget correspondences into one general budget constraint if we define several indicator variables. Let I_b be a indicator function that is equal to 1 if the household decides to invest in housing, and zero otherwise. Let I_d be a indicator function that is equal to 1 if the household decides to sell the current position h and is zero otherwise. If the household has a nonzero investment position in housing, it must decide whether to rent out some of the shelter services generated by the housing investment. We will define an indicator function I_L that takes on a value of 1 if the household decides to rent out (or lease) some of the shelter services generated by the housing investment, and zero otherwise. Given these definitions, the general budget constraint is:

$$\begin{aligned} & c + a' + I_b \left[(\varphi_B + \psi)ph' + m(h', M, r^m, \tau_m) \right] \\ & +(1 - I_b)m(h, n, r^m, \tau_m) \\ & +p[(1 - I_L)\delta_O h' + I_L(\delta_O s + \delta_R(h' - s)] \\ \leq \quad & y + I_R R(g(h') - s) + I_d \left[(1 - \varphi_s)ph - B_n \right]. \end{aligned} \tag{8}$$

2.3 The Production Sector

In this economy, a good, which can be used for consumption, capital or housing purposes, is produced by representative firm that attempts to maximize profits. The production technology in this sector is given by a constant return to scale Cobb-Douglas function

$$Y = f(K, N) \equiv K^{\alpha} N^{1-\alpha}$$

where $\alpha \in (0, 1)$ is capital's share of final goods output, and K and N are aggregate inputs of capital and labor, respectively. Capital depreciates at the rate δ each period. Given a competitive environment, the profit maximizing behavior of the firm yields the usual marginal conditions. That is,

$$r = \alpha K^{\alpha-1} N^{\alpha} - \delta \tag{9}$$

$$w = (1-\alpha) K^{\alpha} N^{-\alpha}. \tag{10}$$

The aggregate inputs of capital and labor depend on the decisions of the various individuals in the economy. From the household's problem, the state vector of each agent is determined by the asset position, a, housing position, h, periods remaining on the mortgage, n, idiosyncratic shock, ϵ, and age, j. Define the household's state by the vector $\Lambda \equiv \{a, h, n, \epsilon, j\}$, and denote Γ as the distribution of individuals over states. Aggregate labor input is defined as:

$$N = \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \epsilon \upsilon_j \Gamma(\Lambda) \tag{11}$$

Capital will be defined later.

2.4 The Financial Intermediary

The financial intermediary is a zero profit firm. The firm receives the deposits of the household, a', and pays a net interest rate on these deposits of r. The financial intermediary rents the capital deposits to the final goods sector and offers mortgages to the household sector. These mortgages generate payments each period.[12] In addition, financial intermediaries receive principle payments from those individuals who sell their home with an outstanding mortgage position. The balance sheet condition of the financial intermediary is:

[12] The spread between the mortgage rate and the return on capital is assumed to cover fixed costs.

Financial Intermediary Balance Sheet

Assets	Liabilities
Loans to firms	Deposits
Net mortgage loans	

2.5 The Government

In this economy, the government provides retirement benefits. We assume that this program is self-financed by taxing the labor income at the tax rate τ_p. The tax rate is set so that the revenue collected from employed individuals covers the cost of paying each retired individual the amount θw. Hence,

$$\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \theta I_\omega \Gamma(\Lambda) = \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} (1-I_\omega)\tau_p \epsilon \upsilon_j \Gamma(\Lambda). \tag{12}$$

where I_w is an indicator function that is equal to one when $j^* > J$, and zero otherwise.

In addition, the government taxes wage income, interest earnings on capital, and the services from housing investment. It also allows a deduction on mortgage interest payments, and purchases final goods.[13] Given this description, the government budget constraint is

$$\begin{aligned} G &= \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} (1-I_\omega)\tau_y w \epsilon \upsilon_j \Gamma(\Lambda) + I_\omega \tau_y \theta w \Gamma(\Lambda) \\ &+ \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \tau_y r a(\Lambda)\Gamma(\Lambda) \\ &+ \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} (1-I_R)R(g(h'(\Lambda)) - s(\Lambda))\Gamma(\Lambda) \\ &- \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \tau_M [r^m(1-\psi)h'(\Lambda)]\Gamma(\Lambda) \end{aligned} \tag{13}$$

where G represents the purchase of goods by the government from tax revenues. The first three terms on the right hand side of this equation measure income tax collection from wage, asset income, and leasing rental income, respectively. The last term measures the total value of the home mortgage deduction.

[13] If government goods enter the utility function in a seperable manner, then the purchases of government goods can be treated as goods that are destroyed each period.

2.6 The Equilibrium Conditions

This economy has three markets: the goods market, the asset market, and the rental of housing services market. The goods market equilibrium condition is:

$$\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} c(\Lambda)\Gamma(\Lambda) + \; I_K + I_H + G = f(K, N) - \Upsilon \tag{14}$$

where I_K investment in capital

$$I_K = (K' - (1-\delta)K),$$

I_H represents the investment housing goods,

$$\begin{aligned} I_H \quad = \quad & \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} h'(\Lambda)\Gamma(\Lambda) - [\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} h(\Lambda)\Gamma(\Lambda) - \\ & -\delta_O \int_{\mathcal{A}\times\mathcal{H}_{s(\Lambda)\geq h'(\Lambda)}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} h'(\Lambda)\Gamma(\Lambda) \\ & -\delta_R \int_{\mathcal{A}\times\mathcal{H}_{s(\Lambda)< h'(\Lambda)}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} h'(\Lambda)\Gamma(\Lambda)]. \end{aligned}$$

and Υ denotes transaction costs and is defined as:

$$\Upsilon = \int_{\mathcal{A}\times\mathcal{H}_{s(\Lambda)\geq h'(\Lambda)}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \varphi_S h(\Lambda)\Gamma(\Lambda) + \int_{\mathcal{A}\times\mathcal{H}_{s(\Lambda)\geq h'(\Lambda)}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \varphi_B h'(\Lambda)\Gamma(\Lambda)$$

The equation defining the investment in housing reflects the change in the housing capital stock less the depreciation in the initial housing stock due to depreciation from owners and renters.

The asset market equilibrium condition in this model is different from the asset equilibrium condition in most heterogeneous agent models because of the availability of mortgages. In this model, the capital stock must be equal to the total amount of capital deposits from households less the mortgage position of the households. In other words,

$$K = \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} a'(\Lambda)\Gamma(\Lambda) - \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} m(h', n, r^m, \tau_m)\Gamma(\Lambda) \tag{15}$$

This equation clearly shows that the financing of housing crowds out resources in the capital market.

The third market in the model is the rental of housing services market. Equilibrium in this market requires that the total demand for housings services must be equal to the amount of housing services generated by the relevant housing stock. This condition can be written as:

$$\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} s(\Lambda)\Gamma(\Lambda) = \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} g[h'(\Lambda)]\Gamma(\Lambda) \tag{16}$$

3 Stationary Equilibrium

We restrict ourselves to stationary equilibria. The individual state of the economy is denoted by $(a, h, n, \epsilon, j) \in \mathcal{A} \times \mathcal{H}\times\mathcal{M} \times \mathcal{E}\times\mathcal{J}$ where $\mathcal{A} \subset \mathbb{R}_+$, $\mathcal{H} \subset \mathbb{R}_+$, $\mathcal{M} \subset \mathbb{R}_+$, and $\mathcal{E} \subset\mathbb{R}_+$. For any individual, define the constraint set of an age j individual as $\Omega_j(a, h, n, \epsilon, j) \subset \mathbb{R}^4_+$ as all four-tuples (c, s, a', h') such that the budget constraint (9) is satisfied as well as the following non-negativity constraints hold:

$$c > 0, s > 0, a' \geq 0, h' \geq 0.$$

Let $v(a, h, n, \epsilon, j)$ be the value of the objective function of an individual with the state vector (a, h, n, ϵ, j) define recursively as:

$$v(a, h, n, \epsilon, j) = \max_{(c,s,a',h')\in\Omega_j} \left\{U(c, s) + \beta E[v(a', h', \max(0, n-1), \epsilon', j+1]\right\}$$

where E is the expectation operator conditional on the current state of the individual.

Definition 1 *A* ***stationary competitive equilibrium*** *is a collection of value functions* $v(a, h, n, \epsilon, j)$*:* $\mathcal{A} \times \mathcal{H} \times \mathcal{M} \times \mathcal{E} \times \mathcal{J} \to \mathbb{R}$*; decision rules* $a'(a, h, n, \epsilon, j)$*:* $\mathcal{A} \times \mathcal{H} \times \mathcal{M} \times \mathcal{E} \times \mathcal{J} \to \mathbb{R}_+$*, and* $h'(a, h, n, \epsilon, j) : \mathcal{A} \times \mathcal{H} \times \mathcal{M} \times \mathcal{E} \times \mathcal{J} \to \mathbb{R}_+$*; aggregate outcomes* $\{K,\ N,\ \epsilon\}$*; prices* $\{r, w, r^m, R\}$*; government policy variables* $\{\tau, \theta\}$*; and invariant distribution* $\Gamma(a, h, n, \epsilon, j)$ *such that*

(i) given prices, $\{r, w, r^m, p, R\}$*, the value function* $v(a, h, n, \epsilon, j)$ *and decision rules* $c(a, h, n, \epsilon, j), s(a, h, n, \epsilon, j), a'(a, h, n, \epsilon, j)$*, and* $h'(a, h, n, \epsilon, j)$ *solve the consumer's problem;*

(ii) given prices $\{r, w, r^m, p, R\}$*, the aggregates* $\{K,\ N,\ \epsilon\}$ *solve the firms' profit maximization problem by satistifying equations (9) and (10);*

(iii) the price vector $\{r, w, r^m, R\}$ *is consistent with the zero-profit condition of the financial intermediary;*

(iv) the goods market as defined by equation (14) clears;

(v) the asset market as defined by equation (15) clears;

(vi) the rental market as defined by equation (16) clears;

(viii) The retirement program is self-financing as stated by equation (12);

(ix) The government budget constraint expressed in equation (13) holds;

(x) letting T *be an operator which maps the set of distributions into itself aggregation requires*

$$\Gamma'(a', h', n-1, \epsilon', j+1) = T(\Gamma)$$

and T *be consistent with individual decisions.*

We will restrict ourselves to equilibria which satisfy $T(\Gamma) = \Gamma$.

4 Calibration and Estimation

We calibrate our model to reproduce some key properties of U. S. economy observed in 1995-96. Once our model is parameterized, we will evaluate the model and then illustrate how the baseline model can be used to address the question posed on the homeownership rate. Calibrating the model amounts to selecting parameters so that the statistics in the model economy are the same as those observed in the actual economy. We commence by specifying the relevant functional forms and certain institutional parameters. We then discuss the choice of calibration targets. Our estimation of remaining parameters will proceed as an exercise in exactly-identified Generalized Method of Moments.

4.1 Parameters Set in the Calibration

We select a period in our model to be three years. A individual starts their life at age 20 and lives till age 80. In terms of our model, individuals live 21 periods. Retirement is mandatory at age 65, (model period 16).

We assume that a household has preferences of the form:

$$u(c_j, s_j) = \frac{\left[\varphi_j c_j^{\gamma} s_j^{1-\gamma}\right]^{1-\sigma}}{1-\sigma}$$

Along with the discount rate, β, the preference parameters, σ, and γ, must be specified as well as φ_j which captures the evolution of the family size along the life-cycle. The values of β and γ will be estimated. We set the curvature parameter, σ, to 1.5 which consistent with the literature. We follow Rios-Rull (2001) in the construction of the family size variable. We use the 1995 Survey of Consumer Finances to identify the adult structure and number of children in a household. This data is employed to construct a family equivalence measure following Greenwood, Guner, and Knowles (2003).[14] The inverse of this variable is grouped by household head age and then a polynomial is fit to the data. We include this factor as the housing literature has identified that changes in family size may be an important factor in the housing tenure choice.

The technology parameters need to be specified for the aggregate production function. Parmeter α is set 0.35 so as to match national income accounts on the share of capital income in national income.[15] Since capital depreciates when used, we must specify the depreciation rate of capital, δ_K. The stock of housing depreciates over time. In this model we allow the depreciation rate of housing used by renters to differ from the depreciation rate of owner occupied housing for reasons previously discussed. This means the parameters δ_R and δ_O must be specified.

Five parameters capture institutional features of the housing market. The length of the mortgage, M, is set at 10 which corresponds to 30 years, and the downpayment requirement, Ψ, is set at twenty percent.[16] The transaction costs associated with buying and selling housing, ϕ_B and ϕ_S, are set at 3 and 6 percent. These are consistent with observed buying and selling fees. We allow for a wedge between the rate of return on capital and the

[14] The household equivalence measure is equal to $(1_{pj} + \eta x_j)^\zeta$ where 1_{pt} is an indicator variable for adult structure at age j where 1_{pt} is equal to 2 if the family structure is classified as married or equal 1 if not married. The variable x_j indicated the number of children in the household. The parameters η and ζ are set to 0.3 and -0.5 as in Greenwood, Guner, and Knowles(2003).

[15] We could have included this parameter as part of the estimation problem. We did not for two reasons. The value of this parameter is not controversial. In addition, the existing estimation problem which is embedded as part of the solution problem already stretches compuational feasibility.

[16] The 1995 *American Housing Survey* is employed in the specification of these parameters. We construct a dowmpayment fraction using data on value of home purchased and the amount borrowed on the first mortgage. A sample of 17,902 households is generated. The downpayment fraction for first time home purchases is 0.1979 while the fraction for households that previously owned a home is 0.2462. We set ψ corresponding to the first time homeowner downpayment fraction.

The data on length of mortgage is presented in the following table mortgage rate of three percent which is close to the difference between the a fixed and floating rate mortgage mortgage rates.

The specification of the stochastic idiosyncratic labor productivity process is extremely important because of the implications that this choice has for the eventual distribution of wealth. Storesletten, Telmer and Yaron (2001), STY, argue that the specification of labor income or productivity process for an individual household must allow for persistent and transitory components. Based on their empirical work, we specify $\log(\epsilon)$ to be

$$\log\left(\epsilon'\right) = \omega' + \varepsilon'$$

$$\omega' = \Theta\omega + v'$$

where $\varepsilon\tilde{}N\left(0, \sigma_\varepsilon^2\right)$ is the transitory component and ω is the persistent component. The innovation term associated with this component is $v\tilde{}N\left(0, \sigma_v^2\right)$. They estimate $\Theta = 0.935$, $\sigma_\varepsilon^2 = 0.01$, and $\sigma_v^2 = 0.061$. Fernández-Villaverde and Krueger (2000) approximate the STY formulation with a three state Markov chain using the Tauchen (1986) methodology. We use their reported values, except we adjust these numbers for the three year period horizon employed in the paper. As a result, the productivity values $\{1.71, 2.79, 4.53\}$ and the transition matrix

$$\pi = \begin{bmatrix} 0.52 & 0.37 & 0.11 \\ 0.29 & 0.42 & 0.29 \\ 0.11 & 0.37 & 0.53 \end{bmatrix}.$$

The invariant distribution associated with this transition matrix implies that an individual will be in the low or the high productivity state just under 31 percent of the time and the middle productivity state 38 percent of the time. The age-specific component of income is estimated from earnings data in the PSID.

The last issue we must examine is the social security system. Since we are primarily concerned with the behavior of working-age households, we

Mortgage Length	First Time Buyer	Repeat Buyer
0-5	3.16%	4.02%
6-10	6.42	6.51
11-15	17.93	21.09
16-20	6.29	7.23
21-25	4.42	4.97
26-30	61.79	56.17

Since most first time buyer use a thirty year mortgage, we spectify M to equa1 10.

choose to calibrate this system to match not benefits but rather taxes. We set $\tau = 0.153$, the average social security tax rate in the postwar US, and balance the budget by adjusting the level of benefits. Our inclusion of the government transfer program reduces the marginal utility of poor, retired household, and thus minimize possible distortions in the housing decisions of the elderly.[17]

4.2 Estimation Targets

The parameters that need to be estimated are the three depreciation rates, δ_K, δ_O, δ_R, the relative importance of consumption goods to housing services, γ, and the discount rate, β. We identify these parameter values so that the statistics in the model economy are the same as five statistics observed in the actual economy. Our calibration or estimation of the five parameters is an exercise in exactly-identified Generalized Method of Moments. One calibration target is the ratio of capital to gross domestic product which is equal 2.80 over the period 1958-2001. We define the capital stock in the U.S. economy as total private fixed assets plus the stock of durable goods as defined by the Bureau of Economic Analysis. A second calibration target is the ratio of the housing capital stock to the nonhousing capital stock . The housing capital stock is defined as the value of fixed assets in owner and tenant residential property. If this measure of the housing stock is subtracted from the previously defined measure for the capital stock for the economy, we find ratio of the housing stock to nonhousing capital stock to be 0.60. This data also comes from the BEA.

The next estimation target is the fraction of output that goes to investment in capital goods. This ratio for this period is 0.073. The fourth target is the fraction of output that is allocated to investment in housing. For the same period, this ratio is 0.032 where we define housing investment as investment in residential structures. The final target is the ratio of the number of square feet in owner-occupied housing to the number of square feet in rental housing. Data from the 1995 *American Housing Survey* indicates that this ratio is 4.25.

Using these calibration targets, we estimate the utility parameters β and γ to equal 0.932 and 0.790, respectively. The depreciation rate of capital, δ_K, is estimated to be 0.077. The depreciation rate on owner occupied housing, δ_0 is 0.063 while the estimated depreciation rate on rental housing, δ_R, is 0.078. The estimated parameters and calibration targets are summarized in

[17] However, it does counterfactually increase the rundown of assets after retirement.

Table 1. It is important to note that the estimation problem is not separate from the solution of the model. That is, we jointly solve estimation problem and model solution. In the appendix, we sketch how the computational algorithm.

Table 1: Calibration and Estimation of Model (Annualized Parameter Values)

Statistic	**Target**	
Ratio of wealth to gross domestic product (K/Y)	2.80	
Ratio of housing stock to capital stock (H/K)	0.60	
Housing Investment to Housing Stock ratio (x_H/H)	0.032	
Ratio owner-occupied to rental housing square feet	4.25	
Capital Investment to Output ratio (x_K/Y)	0.07	
Variable	**Parameter**	**Estimated Value**
Individual Discount Rate	β	0.977
Share of consumption goods in the utility function	γ	0.790
Depreciation rate of owner occupied housing	δ_O	0.063
Depreciation rate of rental housing	δ_R	0.078
Depreciation rate of capital stock	δ_K	0.077

5 Results

In this section, we evaluate the performance of the model before attempting to account for the increase in the homeownership rate since 1995. Obviously, we are interested in the aggregate homeownership rate generated by the model. In addition, we are interested in determining whether the model generates homeownership rate distributions by age similar to the distributions actually observed. These distributions are an important focus of the paper because of the stated public policy to increase the homeownership rate for low income families. We examine whether the share of (net) housing and assets in the household portfolio are consistent with observe portfolio patterns. Homeownership and rental positions by age are studied.[18] Once we establish that the model is a viable instrument for public policy, we then turn to the question of why the homeownership rate has increased since 1995.

[18] Other features of the model such a tenure and duration are discussed in Chambers, Garriga, and Schlagenhauf (2004).

5.1 Model Evaluation

5.1.1 Aggregate Magnitudes

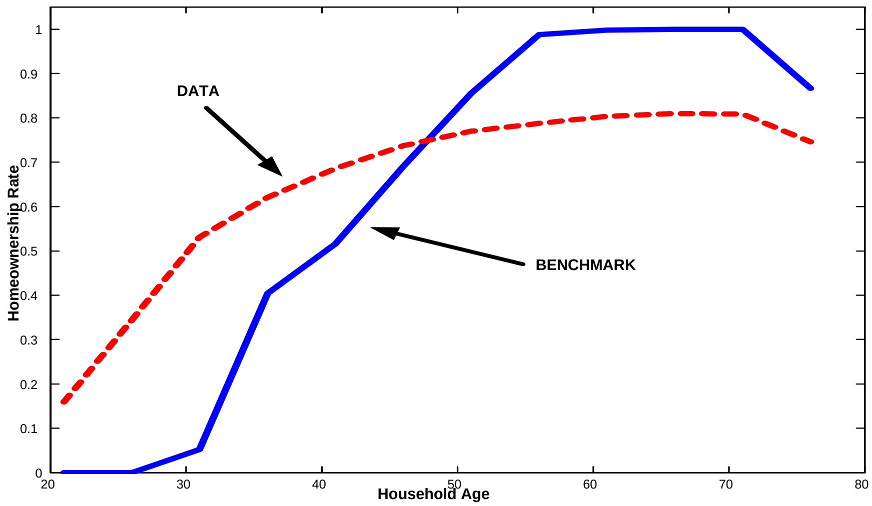
The initial question is whether the model generates reasonable aggregate behavior. One aspect of the aggregate behavior of the model we are interested in is the homeownership rate. Until 1995, the homeownership rate in the United States was 64.5 percent. The model generates a homeownership rate of 60.9 percent. Given some of the extreme financing assumptions that act against homeownership that we have imposed on the model, we are pleased with this aspect of the model. Another aggregate we are concerned with is whether the model finds a proper mix of rental and privately owned housing. The model is calibrated to generate the observed ratio of owner-occupied square feet to rental square feet. However, this does not tie down the distribution of the housing stock between rental units and owner-occupied units in the steady state. In 1995, the American Housing Survey indicates that 35 percent of the housing stock are rental units. Our steady state equilibrium finds that 39 percent of the housing stock are in rental units. Again, we find this an attractive outcome as the model is not calibrated to generate this distribution.

In equilibrium two prices - the rental price and the interest rate- are determined while the price of goods and housing are normalized to unity. We will focus on the interest rate and not the rental price of housing. Our equilibrium real interest rate in annualized terms is 11.2 percent. This interest rate is quite high compared to actual data. The value is high compared to values reported in the literature for this type of model. We believe the high interest rate is a result of two factors. The introduction of housing and the financing of this housing generates a "crowding-out effect" that does not occur in other models of this type. This is seen clearly by examining the asset market equilibrium condition (equation (15)). This effect is magnified since the model does not seem to generate enough of wealthy individuals.

In addition to examining the aggregate behavior of the model, the distributional behavior of the model also needs to be considered. For example, if the model replicated the observed homeownership rate, but not the homeownership rate over age cohorts or income groups, the appropriateness of the model for policy evaluation would have to be questioned. Figure 4 compares the distribution of the homeownership rate by age cohort generated by the model with the distribution observed in the 1995 American Housing Survey. The general pattern generated by the model is consistent with the pattern observed in the data. However, as seen in the Figure, the model underestimates the homeownership rate for younger households. This, no doubt, is partially attributed to the assumption that all agents face a twenty percent downpayment requirement. In the model, agents must accumulate the downpayment by saving, thus resulting in no homeownership until households are in their late twenties. Data indicates actual homeownership rates are around twenty percent for households in their late twenties.[19] After age forty-five, the model generates too much homeownership. Between age 55 and age 70, the model implies that every household will be a homeowner. Actual data indicates homeownership is near ninety percent. The lack of renters in this age range is a result of the incentives to hold housing and the earnings process that allows all individuals to be able to have a positive investment position in housing. In addition, the model abstracts from certain demographic features, (e.g., a change in marital status) that can result in an increase in movements into the rental market. The model indicates a decrease in the homeownership position at the oldest age levels. This is a result of the assumption that everyone dies at age 80 with certainty. We have also examined the relationship between income and homeownership rates. The findings, not surprisingly, are very similar to the relationship between age and homeownership. As a result, we do not present these results.

[19] A possible explanation for the model's failure to generate homeownership at the youngest age levels is that bequest or gifts are not considered in the model. The American Housing Survey inquires about the sources of funds for a downpayment. In 1995 only 4 percent of households reported gifts as a source of funds for the downpayment. For households under age 35, this percentage increases to 6.1 percent. For all households, 74 percent of the downpayment came from savings. Thus, the failure to account for bequests does not seem to be a critical assumption.

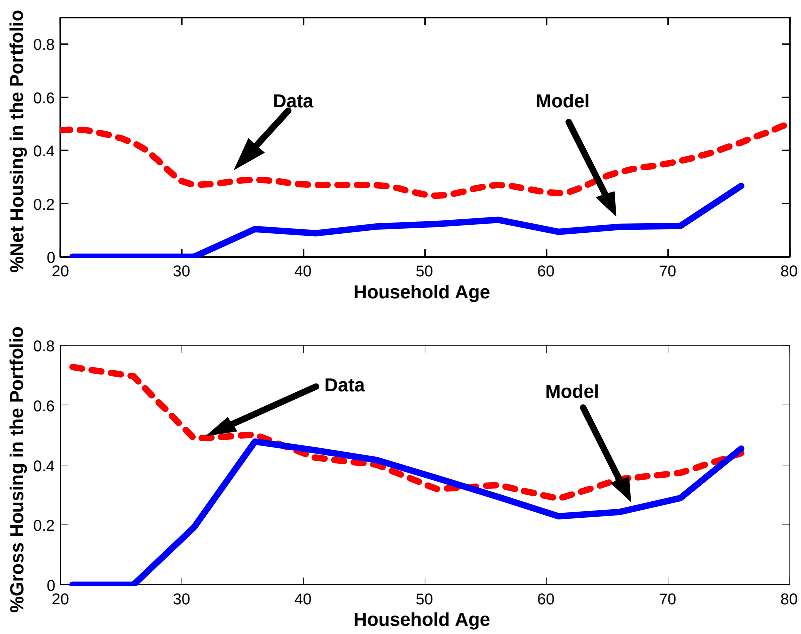
Figure 4: Behavior of the Homeownership Rate



Another check on the model is whether the asset allocation in the household's portfolio distribution replicates observed holding patterns. We used the 1995 Survey of Consumer Finances to calculate household portfolio values. We use the respondent's estimated value of their house adjusted for remaining principle to calculate the net housing investment position. Since the only other asset in the model is capital, we combine data on bond and stock holding to approximate this asset. Bonds are defined as bond funds, cash in life insurance policies, and the value of investment and rights in trusts or estates, while stocks are defined as shares of stocks in publicly held corporations, mutual funds, or investments trusts including stocks in IRA's. We use this data to calculate the fraction a household's portfolio in housing. We focus only on households that own a home. In Figure 5, we present the fraction of the household portfolio in housing by age cohort where housing value is calculated net of remaining mortgage debt. We also include in the same figure the gross housing value, eventhough the net value provides a better picture of household wealth. As can be seen in the upper diagram of Figure 5, data indicates the fraction of housing is relatively high, but declining as the youngest age cohorts skew their portfolio toward housing. This fraction declines as a household income increases and other asset investment becomes feasible. Between age 30 and age 60, the percent of the portfolio in (net) housing is relatively constant. This pattern is accounted for by the additional investment in assets and the decline in outstanding housing debt coupled with possible additional housing investment. The sharp increase in the role of housing in the portfolio is a result of older households reducing asset levels in order to maintain consumption levels. The literature suggests a "U-shaped" pattern when examining the relative importance of housing in the portfolio.[20] Prior to age 30, the model indicates housing does not enter the household portfolio. This is a direct result of the size of the downpayment constraint as well the failure to generate enough wealth so that a young household may enter the housing market. After age 30, the model generates households that include housing in their portfolio. The relative position of (net) housing in the portfolio is relatively constant until age 70 where it increases. It is also clear that another difference between the data and the model is that the model generates too low a fraction of (net) housing in the portfolio. The lower panel of Figure 5 explains the difference. In this panel, we examine gross housing in the portfolio. Except for the lack of ownership at the youngest ages, the model generates age holding patterns very similar to what is observed in the data. This suggests that the differences in the model generated data and actual data is primarily a result of the assumption that all housing investment must be financed with fixed downpayment and same mortgage contract. Our model does not allow a buyer to put a downpayment larger than twenty percent down. Data indicates that second time buyers have downpayments larger than twenty percent.

[20] Flavin, M. and T. Yamashita (2002) find similar holding patterns. Brueckner (1997) provides a theoretical explanation for this pattern.

Figure 5: Housing and The Financial Portfolio

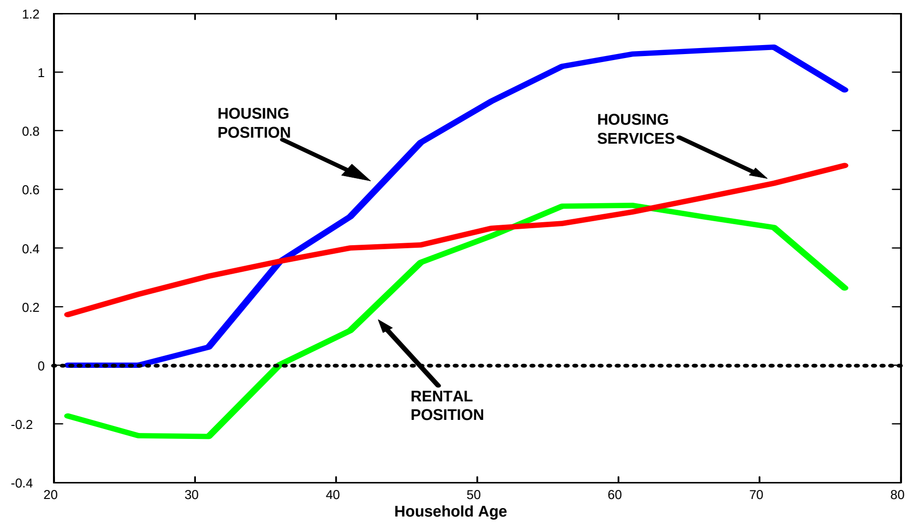


A third issue in evaluating the model is whether the model is generating reasonable net rental distributions. In Figure 6, we address this issue. The housing investment position generated by the model indicates a humped-shaped pattern with the largest housing position occurring after age 60. This reflects households buying larger houses as well as becoming landlords. The consumption of housing services, s_c, is relatively smooth and increasing.[21] The difference between the housing service position and the housing investment position indicates the rental position. Younger individuals are the renters, while older, and presumably richer, individuals are the landlords. The upward sloping housing service flow indicates that homeowners are inhabiting larger homes, indicating changes in the housing position do occur in the model. In general, these patterns are observed in the data.[22]

[21] We have compared the mean adjusted service flow of housing with the mean adjusted squared feet of owner-occupied housing and find that households housing position is understated in the model. More importantly, the model doen not capture the slight decline in mean adjusted housing position observed in the data.

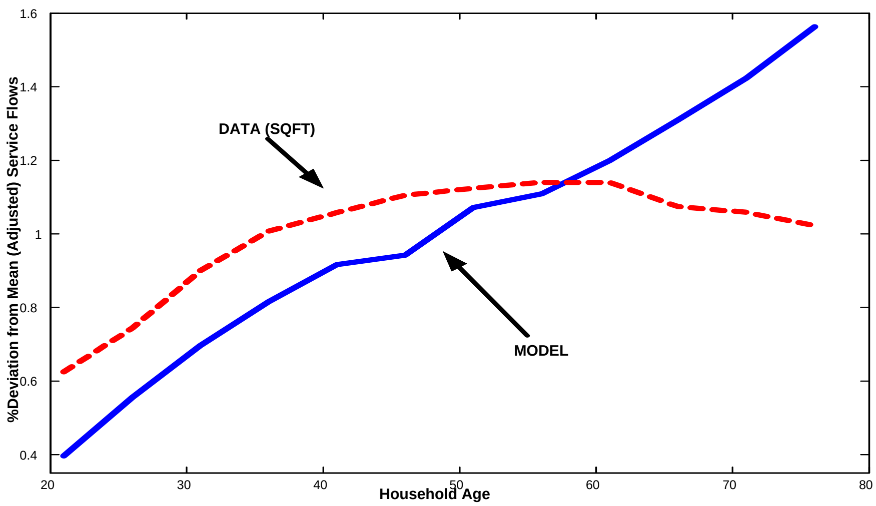
[22] For a more detailed analysis of the housing tenure decision, see Chambers, Garriaga, and Schlagenhauf (2004).

Figure 6: Housing and Rental Positions



In Figure 7, we examine the model from the perspective of the consumption of housing services. The American Housing Survey allows us the generate average housing size of owner occupied housing in terms of square feet by age cohort. We demean this data and use it as a measure of housing services consumed. The model allows us to calculate average housing services consumed by age where we have also demeaned this series. Prior to age 60, both series indicate that the consumption of housing services increase with age. However, the amount of housing services consumed is lower for households under age 60. After age 60, the model implies too much consumption of housing services as compared to data. This is a result of not having altruism in the model. Hence, households consume all the assets before age J.

Figure 7: Consumption of Housing Services



In sum, the model seems to be a reasonable caricature of an economy with housing. We will now turn our attention to an evaluation of possible explanations for the increase in the homeownership rate.

5.2 Accounting for the Increase in the Homeownership Rate

We now turn to the question of why has the homeownership rate increased? An obvious possibility is the lower mortgage rates. A second possibility is lower buying transaction costs. There have been some changes in housing policy that have been designed to reduce buying transaction costs. A third possibility is a decline in the downpayment requirement. This can be a result of changes in government housing policies.[23] Alternatively, financial market innovations in the mortgage market may have occurred which reduces the downpayment requirement. The development of mortgage insurance and combination loans are another possibilities. In this section, we will evaluate some of these explanations for the increase in the homeownership rate.

[23] The Bush Administration has claimed that the record high of a 68.8 percent occupancy rates is a direct result their policies to increase the number of minority homeowners. Some of the policy initiatives are the American Dream Downpayment Initiative Act, the Single-Family Affodable Housing Tax Credit, and the Self-Help Homeownership Opportunity (SHOP) program.

5.2.1 The Decline in Mortgage Rates

An obvious explanation is that the decline in mortgage rates allowed more individuals to purchase housing. The problem with this explanation is that the thirty-year mortgage interest rate generally declined since 1985. There was a period in the late 1990's where mortgage rates actually increased. The homeownership rate did not begin to increase until 1995-6. This suggests the decline in mortgage rates is not the likely explanation. Painter and Redfearn(2002) examine the role of interest rates in influencing long-run homeownership rates and find that interest rates play little direct role in changing homeownership rates[24]

5.2.2 A Decline in Transaction Costs (φ_B)

Another possibility is a decline in the buyers transaction costs. FHA publishes a series measuring the costs of fees and charges associated with FHA loans. Since 1985, fees have declined from approximately two percent of the purchase price to less than 0.5 percent of the purchase price. Part of this decline in buyer transactions is due to a number of private programs, such as the Nehemiah Program, the AmeriDream Downpayment Assistance program, the HART Action Resource Trust, Consumer Debt Solutions, and Partners in Charity, that have developed over the last decade to reduce closing costs.[25] In order to investigate the impact of reduction in transaction costs, we reduce the buying cost parameter from 0.03 to zero.

The result of this policy is to increase the aggregate homeownership rate to 62.7 while the annual real interest rate increases to 11.22 percent. This is an increase in the homeownership rate of 1.8 percent. The actual increase in

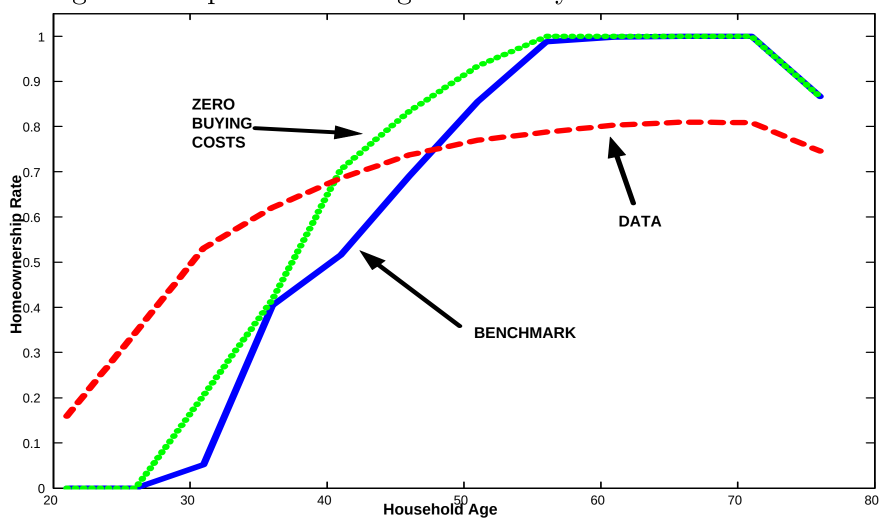
[24] Our model only allows steady state analysis. We could examine the impact of a decline in the wedge between the risk free rate and the mortgage interest rate which is a relative change in the return on the two assets. The wedge can be thought of as capturing the difference between the (long term) mortgage rate and a risk free government bond. Using the 30 year FHA mortage rate and the interest rate on a one year government bond (secondary market), we found no evidence that the spread changed since 1995. Although interesting, we do not examine the effect of a decline in the wedge in this paper..

[25] The Nehemiah program is especially interesting. The program provides gift funds for downpayments and closing costs to qualified homebuyers using an eligible loan program if the household can have one percent of the sales price of the house in the bank. The home buyer's loan can not result in a montly payment that exceeds 29 pecent of income for PITI. The seller makes a contribution to the Nehemiah Corporation for three percent of the sales price of the house which is restricted by the appraisal value, and a procssing fee of $499. The benefits to the seller include access to a widermarket of homebuyers and a reduced need to negotiate prices.

the homeownership rate between 1965 and 2003 is 3.6 percent. This suggests that a decline in transaction costs can not be the entire explanation.

What is the implication of a decline in the transaction cost associated with a home purchase? In Figure 8, we compare the homeownership rate by age for the model with zero buying costs with the benchmark model. As can be seen, zero buying costs do not allow households to buy a house sooner. The twenty percent downpayment assumption is a large enough wedge to keep households out of the market. However, around age 27, we do see increases in the homeownership rate. The interesting result is that the decline in buyer transaction costs results in an increase in homeownership between age 35 and age 55. Compared to the data, the model over predicts homeownership starting at age 40. In the benchmark model, the overprediction began in the late 40's. The model still under forecasts homeownership under age 40.

Figure 8: Impact of a Change in the Buyers Transaction Costs



5.2.3 A Decline in the Downpayment Requirement

A third possible explanation focuses on the downpayment requirement. Government programs have been developed to reduce the size of downpayment for first time, low income households. The Clinton Administration enacted policies through the Federal Home Administration (FHA) to have lower downpayment requirements with mortgage insured loans. The Bush Administration has developed the Zero-Downpayment Initiative for FHA to generate additional first time home buyers. These programs, no doubt, had a positive impact on the homeownership rate. However, during this period, financial innovations in the mortgage market occurred that allowed homeownership with minimal downpayments.

In Table 2, we present some data on the downpayment percentage from various samples of the American Housing Survey.

Table 2: Downpayment Percentages by Loan Type

	Type of Loan							
	1995		1999		2001		2003	
Type of Buyer	FHA	Other	FHA	Other	FHA	Other	FHA	Other
First-time	21.6%	29.8%	13.8%	22.1%	18.1%	24.5%	16.3%	24.1%
Repeat	22.0	33.3	16.7	24.3	22.4	29.1	26.5	28.5
Total	23.2	33.5	16.0	25.7	19.9	27.4	22.6	27.0

As can be seen, between 1995 and 1999 the downpayment percentage substantially declined. During this time, mortgage insurance became more popular which allowed individuals to enter the housing market without having the required twenty percent downpayment. All FHA loans required mortgage insurance if the loan-to-value ratio exceeds eighty percent. Mortgage insurance essentially allows the homeowner to trade off the size of the downpayment for a higher monthly payment until the loan-to-value rate declines to eighty percent. This seems a possible explanation and suggests government policy could have played an important role. However, as can be seen in Table 2, the downpayment ratio is higher in the 2001 and 2003 surveys. This suggests the answer can not be due entirely to an increase in the popularity of mortgage insurance.

During this time another innovation occurred in the mortgage financial markets that lessened the downpayments requirement and allowed for the avoidance of mortgage insurance. The "80-20" Combo loan and the "80-15-5" mortgage loan products became popular. The former program corresponds to the traditional loan-to-value rate of 80 percent using a second loan for the 20 percent downpayment. The "80-15-5" mortgage product requires a 5 percent downpayment provided by the home purchaser with the remaining 15 percent coming from a second loan. The second loan has an interest rate approximately 2 percent higher than the interest rate on the primary mortgage. Government sponsored mortgage agencies initiated the use of this product in the late 1990's and this mortgage product became popular in private mortgage markets between 2001 and 2002. Even ignoring tax considerations, this product dominates mortgage insurance. Table 3 examines the annual payment for a first time buyer under two different mortgage contracts. The first contract has a five percent downpayment with mortgage insurance. The second option is a combo loan of "80-15-5" variety. The calculations assume a thirty year loan with a fixed interest rate. The second mortgage is assumed a thirty year fixed loan with a two percent interest rate premium. We compare the cost of these two products for different interest rates and different marginal tax rates. Given our assumptions, we see that the annual payment associated with the "80-15-5" product is lower over all interest rates. For example, at a 5 percent mortgage interest rate and no tax benefit, the combination loan product saves the home purchaser approximately $500 in annual mortgage payments. The reason that the combination loan dominates a loan with mortgage insurance is that insurance premium is based on the full loan value. Tax considerations make the benefits from the combination loan product even greater due to the higher interest payments associated with this loan.

Table 3: A Loan with Mortgage Insurance vs. a Combo Loan

		Loan with Mortgage Insurance[1]		Combination Loan[2]	
Income Tax Rate	Mortgage Rate	Annual Payment	After Deduction Payment	Annual Payment	After Deduction Payment
.00	5%	$6,929	$6,929	$6,412	$6,412
.12	5%	6,929	6,359	6,412	5,806
.20	5%	6,929	5,979	6,412	5,402
.00	7%	8,405	8,405	7,906	7,906
.12	7%	8,405	7,607	7,906	7,072
.20	7%	8,405	7,075	7,906	6,516
.00	11%	11,677	11,677	11,203	11,203
.12	11%	11,677	10,423	11,203	9,913
.20	11%	11,677	9,587	11,203	9,053

Hence, it appears that a decline in the downpayment fraction as a result of innovations in the mortgage financing may be key to understanding why the homeownership rate has increased. Table 4 reports the response to the question inquiring about the source of the downpayment from the 1995 and 2003 American Housing Surveys. Focusing on households under age 35, we see that the importance of saving and and gifts declined in importance while the fraction fraction of first time buyers with no downpayment increased. These facts are consistent with an increase in popularity of combination loans. we also see an increase in the role of other borrowing. This likely reflects respondents use of the second loan included in the combo loan.

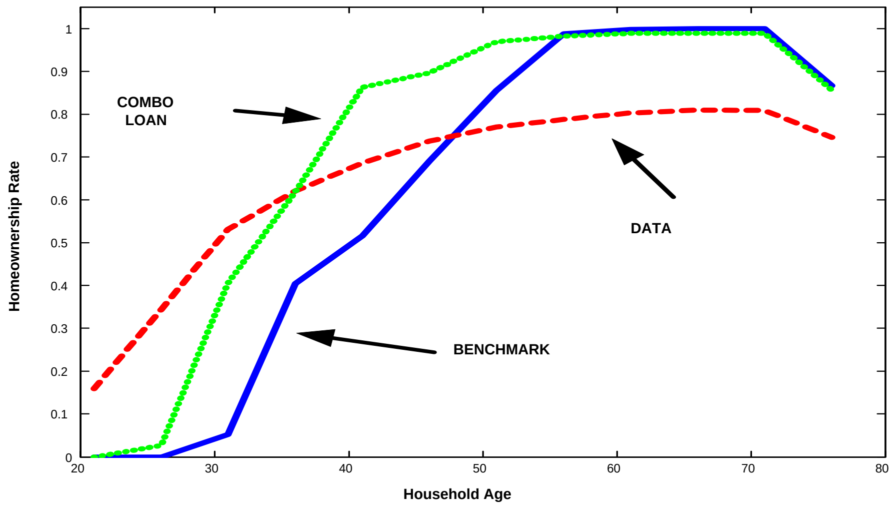
Table 4: Downpayment Sources for First-Time Buyers
(By Age)

	1995		2003	
	Total	<35	Total	<35
Savings	73.97	75.13	73.91	73.56
Sale Other Investment	0.68	0.74	0.91	0.81
Other Borrowing	4.68	3.24	5.31	4.99
Inheritance or Gift	4.00	6.10	3.95	4.22
Land Collateral	0.85	0.74	0.96	0.83
Other	5.85	5.36	5.21	5.5.3
No downpayment	9.97	8.70	9.74	10.06

In order to investigate financing innovations in the mortgage market, we introduce a the combo loan product into our model. That is, we lower the downpayment requirement to 5 percent and allow a second mortgage to be used for the remaining portion of the downpayment. We assume the interest premium on the second mortgage is two percent. Both mortgages have a thirty year duration. The aggregate implications of this change is to increase the homeownership rate to 71.0 percent, or an increase in the homeownership rate of 10.12 percent. Again, the actual change in the data is 3.6 percent, so this change substantially overstates the actual change. The equilibrium interest rate increases to 11.25 percent.

In Figure 9, we show how the homeownership rate changes by age cohort. The reduction in the downpayment requirement now allows younger households to take a housing investment position. Prior to age 35, this loan package allows younger households to enter the housing market. This part of the distribution is much closer to the distribution observed in the data and is an improvement over the performance of the benchmark model. For households greater that age 35, the combo loan product generates homeowner ship rates exceeding what is observed in the data. After age 55, the model generates housing behavior that is identical to the benchmark model. That is, all households have a positive position in housing. The model's overprediction of the homeownership rate is a direct result of the assumption that any household who want to take a position in housing must use this product. Higher downpayment fractions are not a choice variable. In sum, the decline in the downpayment percentage seems to be the key to understanding the increase in the homeownership rate.

Figure 9: Impact of a Change in the Downpayment Fraction



6 Conclusions

Since 1995, the homeownership rate has been steadily increasing after years of being relatively constant at 64.5 percent. Movements in the homeownership in the United States is important because of the stated policy to have a high homeownership rate. We examined possible explanations for the increase in this rate use a dynamic general equilibrium modeling the tradition of Henderson and Ioanides. The model has the following features: homeownership is part of the household's portfolio decision; life-cycle effects play a prominent role; rental and ownership markets coexists; and households make the discrete choice of whether to own or rent as well as the choice of what quantity of housing services to consume. We find that the model does reasonably match various data from 1996. As a result, we use the model to evaluate various explanations for the increase in the homeownership rate. We find the likely explanation for the increase in the homeownership rate is innovations in the mortgage financial market which essentially reduces the downpayment requirement for a (first-time) home-buyer.

Our evaluation of the model indicates a number of areas where more research is required. For example, the fact that every household owns a home after age 45 in the model while the homeownership rate never exceeds ninety percent in the data for these household requires additional study. The assumption that all households must have a fixed downpayment with a fixed duration loan may be important. The introduction of alternative mortgage contracts is an interesting extension. Finally, the assumption that housing and goods prices are one should be relaxed. This means moving to a multisector model. These are issues we are presently pursuing.

7 References

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8 Appendix: Computational Method

We discretize the state space by choosing a finite grid over capital, and the housing investment. We restrict optimal choices to lie on the grid for capital and housing investment. However, the choices for consumption and the consumption of housing services are continuous. The joint measure over assets, a, housing, h, periods remaining on the mortgage, n, income shock, ϵ, and age, j, which is denoted as Γ can then be represented as a finite-dimensional array.

The basic algorithm is as follows:

1. Given the estimation targets, guess the prices (r, R) and the parameter vector $(\beta, \gamma, \delta_K,\ \delta_O,\ \delta_R)$.

2. Compute K, w, and τ_p. N is determined by the invariant age-distribution Π.

3. Solve the household's problem to obtain the value function $v(a, h, n, \epsilon, j)$, and the decision rules $a'(a, h, n, \epsilon, j)$, $h'(a, h, n, \epsilon, j)$, $c(a, h, n, \epsilon, j)$, $s(a, h, n, \epsilon, j)$ starting with $v(\cdot, \cdot, \cdot, \cdot, J + 1) \equiv 0$.

4. Iterate on an initial distribution of idiosyncratic states until convergence. This step assumes that the distribution of a and h are only over a finite number of points and redistributes mass interatively. This step generates Γ to calculate relevant aggregates that are need to check the calibration targets and the two equilibrium conditions.

5. Check to see if calibration targets and equilibrium conditions hold for a given metric.

6. If not, update (r, R) and $(\beta, \gamma, \delta_K,\ \delta_O,\ \delta_R)$ and recalculate.

7. Iterate on $r, R, \beta, \gamma, \delta_K,\ \delta_O,\ \delta_R$, and Γ until convergence.