Housing Tenure and Investment Decisions*

Matthew Chambers
Department of Economics
Towson University
Towson, Maryland 21252

Carlos Garriga
Department of Economics
Florida State University
Tallahassee, Florida 32306

Don E. Schlagenhauf
Department of Economics
Florida State University
Tallahassee, Florida 32306

May 2004
(This version, August 2005)

Abstract

Why do households buy different size homes? Why do investors acquire rental property? In this paper we present a quantitative theory of housing to account for the basic facts in the owner-occupied and rental market. The theory emphasizes the determinants of tenure choice (renting vs owning) jointly with asset-housing investment decisions. Property owners decide the amount of housing services consumed and the amount supplied in the rental market. We find that the model generates aggregates and distributions along certain key dimensions that are consistent with the empirical evidence.

Keywords:
J.E.L. classification codes:

*We acknowledge the useful comments from Ed Prescott, José Víctor Ríos-Rull, and Gustavo Ventura. We are grateful to the financial support of Generalitat de Catalunya through grant SGR01-00029 and Ministerio de Ciencia y Tecnología through grant SEC2003-06080. Corresponding author: Don Schlagenhauf, Department of Economics, Florida State University, 246 Bellamy Building, Tallahassee, FL 32306-2180. E-mail: dschlage@mailer.fsu.edu. Tel.: 850-644-3817. Fax: 850-644-4535.

1 Introduction

In the United States, approximately two thirds of the housing units in the last decade are owner-occupied. For these households, the purchase of a house is the largest single consumer transaction, as well as a major component of a household's financial portfolio. For the remaining households, renting is the option. Despite the size and importance of this market, there is much less known about renters and the owners of rental property. [1]

This paper has two objectives. The first one is to determine the empirical regularities in the owner-occupied and rental markets. We study the determinants of tenure choice jointly with asset-housing investment decisions. These decisions encompases the consumer's choice of renting vs. owning, and the portfolio allocation decision between housing and non-housing assets. We also investigate why investors acquire rental property, and what determines the size distribution of landlords along various dimensions. It is important to determine the essential features and characteristics of these markets since they can provide guidance for the development of theoretical constructs. In contrast with most of the existing literature that employs a regression based approach to analyzes models of tenure and duration choice, our second objective is to present a quantitative equilibrium theory of tenure and housing investment that accounts for the stylized facts in the owner-occupied and rental property market.[2] One of the main advantages of the equilibrium approach is that emphasizes the jointness of all decisions and their interaction with market prices. On the other hand, a potential limitation is whether the complex institutions that exist in the housing area can be properly represented in the constraints of the various decision makers.

The quantitative housing model has the features that homeownership is part of the household's portfolio decision; that life-cycle effects play a prominent role; that rental and ownership markets coexist; and that households make the discrete choice of what quantity of housing service flows to consume and the amount to supply to the rental market. Consequently, the option value of owner-occupied housing is explicitly considered as part of the portfolio decision as the supply of housing services is linked to the market rental rate. We employ an overlapping generation framework where individuals face uninsurable labor income shocks due to the presence of borrowing constraints.[3] Households make decisions with respect to consumption, the amount of housing services consumed, as well as the amount (real) capital investment and housing investment to maximize expected discounted utility. The investment in housing durable goods differs from other form of savings in that a downpayment and mortgage are required, as well as transaction costs from buying and selling are incurred. These costs associated with the adjustment of housing 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 determining the supply of rental housing. That endogenously determines whether a household chooses to become a landlord. The consumption of housing services results in a depreciation of the housing stock. The maintance

[1] Dipasquale (1999) has pointed out the need for a better understanding of the various decisions that result in housing supply with a particular emphasis on the investor and landloard decisions.

[2] Some research has examined housing in a general equilibrium context. In the urban economics literature, some of the important references where housing choice has been couched in a general equilibrium framework are Artle and Varaiya (1978), Brueckner (1986, 1997), Hendershott and Won (1992), and Henderson and Ioannides (1987, 1989). Recently, more work has taken a macroeconomic approach. Brekovec and Fullerton (1992) constructed a static disaggregated general equilibrium model to study housing and portfolio choice as well as implications for tax policy. Davis and Heathcote (2005) develop a general equilibrium model to examine the macroeconomic implications of housing.

[3] Recently, some research on housing has been conducted in a dynamic general equilibrium framework with heterogeneous consumers and production. Examples are Chambers, Garriga and Schlagenhauf (2004), Díaz and Luengo-Prado (2003), Fernández-Villaverde and Krueger (2002), Gervais (2002), Nakajima (2004), and Platania and Schlagenhauf (2002).

cost required depend on whether service flows are consumed by the owner or renters. Housing and consumption/investment goods are endogenously produced by two different competitive sectors.

The model generates data that allows us to examine performance from a number of perspectives. We pay particular attention to how the model performs from an age and income perspective. That is, homeownership, housing size, and duration decisions are consistent with actual data in terms of age and income distributions. We also find that the portfolio decisions generated in the model match the distributions observed in micro data from either an age or income perspective. Lastly, the model is evaluated to determine whether it is able to generate landlord behavior consistent with the micro empirical evidence. We find that household rental psotions, either from an age or income perspective are consistent with the data observed in these micro data sets.

The rest of the paper is organized as follows. Section 2 presents a series of facts on housing that we have assembled from an examination of various data sets. In section 3, we describe a heterogeneous agent dynamic general equilibrium model. Next section presents some results for a baseline version of our quantitative model. Section 5 performs some sensitivity analysis on the most critical elements in the model. Section 6 concludes.

2 Empirical Evidence

In order to understand the role that the choice of shelter plays in the economy, some empirical facts need to be assembled. These facts serve as guide in the design of the quantitative model as well as identifying essential facts that can be used to evaluate the model. We are particularly interested in three areas: the role of housing in the household's portfolio; the housing tenure choice; and the decision to rent shelter services to other households which we will refer to as the landlord decision.

2.1 Housing and Household Balance Sheets

The literature has established that a model of housing must differentiate the decision to invest in housing from the decision to consume shelter services. As a result, we begin by examining the role that housing plays in the household's financial portfolio. In particular we would like to see if the fraction of housing in the portfolio varies over the life cycle. If the answer is affirmative, then our model must explicitly allow for age. To address this issue we constructed household balance sheets from the 1998 *Survey of Consumer Finances*. We define wealth as the sum of a household's holding of public stocks, private stocks, bonds, cash, and the value of housing less outstanding mortgages. We define the value of housing as the sum of the value of owner-occupied housing plus the value of other property used for residential purposes. The facts we report are similar to what has been reported in Brueckner (1997), Campbell and Cocco (2003), Cocco (2002), Davidoff (2002), Díaz and Prado-Luengo (2003), Flavin and Yamashita (2002), Goetzmann (1993) Li and Yao (2003) and Skinner (1994). Some of the important facts are:

- There are large wealth differences between homeowners and renters. In particular, homeowners have on average 6.5 time more non-housing wealth than renters.
- For a homeowner, the fraction of household wealth allocated to a housing investment position has a U-shape pattern by age with the lowest fraction occurring in the 51-55 age cohort.
- Housing has an important role in wealth accumulation over the life cycle as individuals who own a home tend to be richer.

- While mortgage debt peaks around the 36-40 age cohort, the average mortgage position remains high until the 56-60 age cohort indicating households change their investment position in housing.

2.2 The Tenure Decision

The U. S. Department of Housing and Urban Development (HUD) conducts a large survey on the Nation's housing stock - the *American Housing Survey* (AHS). We use various issues of this survey to assemble facts on the housing tenure decision. For our purposes, the key facts are:

- Approximately two-thirds of households own the home they occupy.
- The average size of an owner-occupied house is twice the size of a rental unit.
- The size distribution a rental units is much less variable than owner-occupied units.
- The average size of a house, measured in terms of square feet or market price, has an inverted-U pattern with younger and older households owning smaller and relatively less expensive houses.
- As individuals age, homeownership seems favored over the rental option. The percent of an age cohort that owns a home continues to grow until the 65-74 age cohort.
- As income rises, the mean and the variance of home size increases. This suggests that a model of housing should allow for sources of heterogeneity beyond age.
- Renters tend to be skewed towards the youngest age cohorts and the lower income deciles. However, some renting occurs over all age cohorts and income classes.

2.3 The Decision to Own Rental Property

Next, we examine a variety of empirical facts that surround the decision to become a owner of rental property (or a landlord). Because this particular decision has not been extensively studied, we will present the facts on this decision in more detail. In 1996, the Census Bureau conducted a survey named the *Property Owners and Managers Survey* (POMS), designed to learn more about rental housing stock and the providers of rental housing. The POMS sample size includes 16,300 units which were rented or vacant for rent with 90 percent of these properties being inside metropolitan areas. Among all units 79 percent are residential with the remaining being commercial. A rental unit, in this survey, is defined as a property rented for cash, and either occupied by someone other than the owner or vacant but available for rent. Two types of rental properties are included. The first type is the single-unit rental property which includes single-family detached or attached houses, condominium units, cooperative units, or mobile homes. The second type is multi-unit rental property which includes units in apartment complexes of various forms.

We use this survey to assemble two general type of facts. We need to determine the essential features in the landlord decision to provide guidance for the development of the model. In addition, we want to establish a set of facts that can be use for model evaluation. For instance, we would like to know how the distribution of landlords varies along some important dimensions such as income or age.

The first feature we are interested in is the ownership type. In particular, we need to investigate whether households or firms are the main holders of rental property. In Table 1, we examine ownership type by number of units of rental property.

Table 1: Ownership and Rental Property

Type of Owner	Total Units	Less than 5 Units	5 to 49 Units	50 or more Units
Individual Investor, husband/wife	86.3	89.9	74.4	30.6
Trustee for Estate	2.0	1.9	2.6	1.0
Limited Partnership	2.8	1.7	5.5	25.4
General Partnership	2.9	2.2	5.2	12.9
Real Estate Investment Trust	0.7	0.6	1.2	2.6
Real Estate Corporation	1.6	1.0	3.7	10.9
Other Corporation	1.3	0.9	3.0	5.7
Non-profit or Church	0.7	0.3	2.0	6.1

As can be seen in Table 1, individual investors own 86 percent of total units, and 30.6 percent own more than 50 units. POMS defines a noninstitutional owner to be individual investor (husband and wife), trustee for estate, limited partnership, and general partnership. The remaining are considered to be institutional owners. According to this definition non-institutional owners control 70 percent of the market. It is worth noting that real estate or other form of corporations have a share of 16.6 percent in the market for large appartment complexes, whereas other types of corporations and non-profit or church related institutions represent 6.1 percent of the market respectively.

The next issue to examine is how owners acquire rental property. Table 2 details how the property is financed.

Table 2: Financing of Acquired Rental Property

Financing Method	Frequency	Percent
Mortgage Financed	4,046	75.5
Collateralized Borrowing	186	3.5
Cash	784	14.6
Some other manner	343	6.4
Total	5,359	100

This table indicates that the vast majority (75 percent) of rental property is financed through a mortgage type loan, and not by a collateralized loan or cash. The fraction of acquisition using mortgages is even larger in the multiple-unit rental properties. POMS also indicates that a downpayment is part of the landlord's financing package. The main sources of the downpayment are bank cash deposits (61.6 percent), collateralized non property borrowing (8.3 percent), sale of other real estate (7.8 percent), and the sale of stocks and other savings vehicles (9.8 percent). Only 10 percent of the real estate acquisitions are not financed with a downpayment.[4] This evidence suggests that the decision to finance rental-occupied housing is similar to the financing decision of an owner-occupied unit.

We are also interested in the characteristics of individual landlords along several other dimensions. We find that the number of landlords increases with age and income. We find that the distribution of apartment units exhibits a hump over the life-cycle. Retired individuals mainatin a non-trivial position in the rental market. We also find that rental positions increase with income, although low income households maintain a non-trival position in the rental market. We find that the fraction of landlords that own less than five units decrease by income levels indicating that

[4]It is interesting to note that the American Housing Survey (1995) reports that 9.97 percent of first-time buyers do not use a downpayment.

wealthier landlords have increasing number of rental units. For instance, for the lowest income range this fraction is over 80 percent whereas for the highest income range it is below 25 percent. These facts suggest that relatively young and poor landlords own fewer units on average compared with middle-age or higher income landlords.

The POMS survey also inquires about the expected length and the motives for becoming a landlord. Forty-six percent of the owners of rental property expect to own for five years or more, while thirty nine percent have no plans to sell the property. In contrast, only fifteen percent plan to be a landlord less than five years. With respect to the motives, some of the reasons reported are for rental income, long-term capital gains, tax shelter, savings vehicle, and as a way to acquire residence for the household. Table 3 summarizes the importance of different motives over the entire sample and conditioned by income.[5]

Table 3: Reason to Own by Income

	Residence Self-Family	Rental Income	Long-Term Capital Gains	Pecautionary Savings
Overall Average	19.9	39.8	15.3	13.4
Income Range				
under $10,000	51.0	18.5	10.3	15.5
$10,000 to $30,000	47.6	25.5	7.3	15.7
$30,000 to $50,000	35.1	30.7	10.5	19.6
$50,000 to $75,000	25.7	35.8	11.4	19.9
$75,000 to $100,000	15.1	33.9	13.9	27.0
over $100,000	6.8	43.8	22.0	11.7

The rental income motive explains 39.8 percent of the motive while the desire for capital gains and savings accounts for 15.3 and 13.4 percent, respectively. Besides the importance of rental income for the household, roughly 20 percent of the landlords reported that the main reason to acquire rental property was to provide residence for the household. That is households use the rental market to have access and partially finance the investment in real estate. These households face a trade-off between the amount of housing services to consume and rent-out in the market.

We also find that the importance of the other motives vary by income ranges. In particular, the desire for capital-gains and/or rental income are the primary motives for high income households, whereas the pecautionary savings motive which includes retirement and future security increases with income.

In sum, some of the important facts pertaining to the rental market are:

- Households or non-institutional proprietors own most of the rental property. Institutional owners only hold 27 percent of the market.
- The size distribution of landlords is skewed with more than fifty percent of the landlords owning less than five units.
- Most of rental properties are acquired and financed through a mortgage type loan and not through bequests. This fact suggests that the financing decision for rental and owner-occupied property are essentially the same.

[5] In order to create this and the following tables, the sample of single units rental property is combined with the of properties with multiple units. In the following tables we do not use population weights. The reason is that we found the results were insensitive to weighting.

- The probability of being a landlord increases with age and income. A significant number of households have rental property in the income range between $10,000 and $50,000.
- The primary reason to own rental property is for the income from the rents, but other motives in order of importance are to provide residence for others in the family or household, the desire for capital gains, and using rental property as a savings device.

These findings suggests that a theory that ignores the presence of the rental market as part of the housing investment decision could miss an important margin, since it is used to participate in the owner occupied housing market and it is also used as an insurance device.[6]

3 A Baseline Economy

3.1 The Financial Intermediary

The financial intermediary is a zero profit firm which receives the deposits of the households, a' and offers mortgages to the homeowners and landlords. These mortgages generate revenues each period. In addition, financial intermediaries receive principal payments from those individuals who sell their home with an outstanding mortgage position. These payments are used to pay a net interest rate on these deposits, r.

The financial institution offers a uniform fixed payment mortgage instrument to all households that want to invest housing. The decision to purchase a house of size h and price p requires a downpayment equal to $\psi \in [0,1]$ percent of the value of the house. Consequently, households need take on debt equal to $D(0) = (1-\psi)ph$. Let r^m be the interest rate of a mortgage contract with maturity length N. At each period, t, a homeowner with a home loan faces a mortgage payment that depends on the price of housing, the housing size, length of mortgage, downpayment fraction, the mortgage interest rate, as well as the type of mortgage contract. We denote the mortgage payment at time t as being determined by the function $m_t(x)$ where x is defined by the set (p, h, ψ, N, r^m).

The payment can be decomposed into an amortization term, $A(t)$, that depends on the amortization schedule and an interest term $I(t)$ which depends on the payment schedule. According to American Housing Survey (AHS) and POMS, 91 percent of homeowners and 87 percent of landlords use fixed rate mortgages (FRM). This mortgage contract is comprised of an increasing amortization schedule of the principal, and a decreasing schedule for interest payments, so that the payment schedule is constant. That is,

$$m(x) = A(t) + I(t), \tag{1}$$

and satisfies

$$m(x) = \frac{r^m}{[1-(1+r^m)^{-N}]} D(0). \tag{2}$$

The contract front loads the interest rate payments and back loads the principle payments where

$$A_t = m(x) - r^m D(t).$$

The laws of motion for debt D and home equity e for a given period t are

$$D(t+1) = (1+r^m)D(t) - m(x), \qquad \forall t, \tag{3}$$

[6] If we condition by age (not shown in the table) we find that the self-family residence motive is U-shapped. The data shows that younger (29.1 percent) and older households (32.3 percent) rely on renting to finance the family shelter. Long-term capital gains has a decreasing importance over the life-cycle, whereas the income from rents and pecautionary savings motives are humped-shaped being relatively more important between age 55 and 65.

and

$$e(t+1) = e(t) + [m(x) - r^m D(t)], \qquad \forall t, \tag{4}$$

where $e(0) = 0$ denotes the home equity in the initial period.

3.2 Households

Households are indexed by their age, $j \in \mathcal{J} = \{1, 2, ..., J\}$ and live J periods with certainty. Consumers have preferences defined over consumption, c, and housing services, s, and are subject to labor earnings shocks $\epsilon \in \mathcal{E}$. Households can invest in two assets to smooth out uncertainties; 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 (relative) price p. The housing asset generates shelter services according to a linear function technology $s = g(h') = h'$. Shelter services may be sold in a rental market, in which case rental income is generated at the rate R per unit of shelter.

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 labor productivity of an age j individual. The age profile of average labor productivity is $\{\nu_j\}_{j=1}^{j^*}$. 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 is $w\epsilon\upsilon_j$ where w is the market wage rate. We define period income as

$$y(a, \epsilon, j; w, r) = \begin{cases} (1-\tau_p) w \epsilon \upsilon_j + (1+r)a, & if \quad j < j^*, \\ \theta + (1+r)a, & if \quad j \geq j^*. \end{cases} \tag{5}$$

where τ_p represents a payroll tax, and θ is the social security retirement benefit.

The household's current period budget constraint depends on the household's asset holdings, the current housing investment, the remaining length of the mortgage, a labor income shock, and the household's age. Individuals make decisions over consumption goods, housing services, and investments in assets and housing. We can isolate five possible optimization problems that the household solves given the housing investment state.

1. **Renter today** $(h = 0)$ **and renter tomorrow** $(h' = 0)$

   Consider a household that does not own a house at the start of the period, $h = 0$, and decides not to buy a house in the current period, $h^{'} = 0$. In other words, the individual decides to remain a renter. The optimization problem in this case is:

$$v(a, 0, 0, \epsilon, j) = \max_{(c,s,a') \in R_+} \left\{ u(c, s) + \beta \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', 0, 0, \epsilon', j+1) \right\}$$

$$s.t. \quad c + a' + Rs = y(a, \epsilon, j; w, r), \tag{6}$$

   where Rs denote the cost of housing services purchased in the rental market. Their is no restriction on the size of housing services rented. We assume households can only use a noncontingent claim to self insure against labor income shocks. In addition, short selling is precluded, $a' \geq 0$.

2. **Renter today** $(h = 0)$ **and homeowner tomorrow** $(h' > 0)$

In this case, we have a household who rented in the previous period, $h = 0$, but decides to take a positive position in housing, $h^{'} > 0$. The purchase of a house requires a downpayment ψ, as well as the payment of some transaction costs $\phi_b \in (0, 1)$. Hence, households must make an initial expenditure $(\psi + \phi_b)ph'$ to take a position in the housing market. The remaining value of the house is financed with a mortgage that requires payments each period, $m(p, h, \psi, N, r^m)$, for a total length of N periods. Formally:

$$v(a, 0, 0, \epsilon, j) = \max_{(c,s,a',h') \in R_+} \left\{ u(c, s) + \beta \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', h', N - 1, \epsilon', j + 1) \right\}$$

$$s.t. \quad c + a' + (\phi_b + \psi)ph' + m(p, h, \psi, N, r^m) + x(h', h_c) = y(a, \epsilon, j; w, r) + R(g(h') - s). \quad (7)$$

The decision to take an investment position in housing provides the household with the opportunity to earn another source of income. This source of income occurs if part of the housing services generated by the investment are leased to other households. This possibility is captures by the term $R(g(h') - s)$ where the housing investment generates $g(h')$ services. Owning a house leads to a maintenance expense that depends on the amount of housing services leased out, as well as services used by the owner. Hence, the maintenance expense depends on h' and the amount of home utilized by the homeowner h_c, and is summarize by a function $x(h', h_c)$.An implicit moral hazard problem is recognized by allowing the depreciation rate on owner occupied houses, δ_o, to differ from the depreciation rate on renter occupied houses, δ_r.

3. **Homeowner today** $(h > 0)$ **and renter tomorrow** $(h' = 0)$

A third case has the household entering a period with a positive housing investment position, $h > 0$, and deciding to rent, $h' = 0$. In the last period, we assume that all households must sell their housing position and rent housing services. The optimization problem for this situation is:

$$v(a, h, n, \epsilon, j) = \max_{(c,s,a') \in R_+} \left\{ u(c, s) + \beta \sum_{\epsilon' \in \mathcal{E}} \pi(\epsilon, \epsilon') v(a', 0, 0, \epsilon', j + 1) \right\}$$

$$s.t. \quad c + a' + Rs = y(a, \epsilon, j; w, r) + [(1 - \phi_s)ph - D(n)]. \quad (8)$$

In this specific case, the sale of the house generates income, ph, net of selling costs, $\phi_s \in (0, 1)$, and remaining principle $D(n)$ which depends on whether the mortgage has been paid off or not.[7]

4. **Homeowner today** $(h > 0)$ **and homeowner tomorrow** $(h' > 0)$

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 some housing investment position, $h' > 0$. The critical issue is whether the household decides to change their housing position.

(a) **Homeowner maintains housing size**

[7] As our analysis will be conducted at the steady state, other than the differences between buying and selling transaction costs, there are no differences in the purchase and selling prices of housing.

If the household decides to maintain their housing investment, $h = h'$, then the optimization problem is described by:

$$v(a,h,n,\epsilon,j) = \max_{(c,s,a',h')\in R_+} \left\{ u(c,s) + \beta \sum_{\epsilon'\in\mathcal{E}} \pi(\epsilon,\epsilon') v(a',h',n',\epsilon',j+1) \right\}$$

$$s.t. \quad c + a' + m(p,h,\psi,N,r^m) + x(h',h_c) = y(a,\epsilon,j;w,r) + R(g(h') - s). \tag{9}$$

where $n' = \max\{n-1, 0\}$. If $n = 0$, then we have $m(p,h,\psi,N,r^m) = 0$ or no mortgage payment as the mortgage has been paid-off. Otherwise, the household must make a mortgage payment when $n > 0$.

(b) **Homeowner changes housing size**

If the household decides to either up-size or down-size their housing investment position, (i.e., $h \neq h'$, $h > 0$,and $h' > 0$), the optimization problem is more cumbersome:

$$v(a,h,n,\epsilon,j) = \max_{(c,s,a',h')\in R_+} \left\{ u(c,s) + \beta \sum_{\epsilon'\in\mathcal{E}} \pi(\epsilon,\epsilon') v(a',h',N-1,\epsilon',j+1) \right\}$$

$$\begin{aligned} s.t. \quad & c + a' + (\phi_b + \psi)ph' + m(p,h,\psi,N,r^m) + x(h',h_c) \\ & = y(a,\epsilon,j;w,r) + R(g(h') - s) + [(1-\phi_s)ph - D(n)], \end{aligned} \tag{10}$$

This constraint accounts for the additional income from selling their home (net of transaction costs, $\phi_s ph$, and remaining principle), as well as the cost of buying a new home.

3.3 Characterization of the Renting-Leasing Decision

In this section, we show that the option value associated to being a landlord combined with the differential maintaince costs for homeowners and renters generates a kink in the budget constraint of property owners. The size of the kink depends on exogenous parameters like the maintaince spread $\triangle\delta = \delta_r - \delta_o > 0$, and endogenous variables like the cost of renting housing service flows R. To show it, we combine the various budget correspondences into one general budget constraint by defining 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:

$$\begin{aligned} c + a' + I_b \left[(\varphi_b + \psi)ph' + m(p,h,\psi,N,r^m) \right] & \\ + (1-I_b)m(p,h,\psi,N,r^m) + [(1-I_l)\delta_o ph' + I_l p(\delta_o s + \delta_r(h'-s)] & \\ = y(a,\epsilon,j;w,r) + R(g(h') - s) + I_d \left[(1-\varphi_s)ph - D(n) \right]. & \end{aligned}$$

For a given set of prices $\{R, r, w, r^m\}$ the budget constraint of a household who desires to either consume the services generated by their housing investment position or rent additional housing would occur when the indicator variable I_l is set to zero, or

$$c + Rs = \Phi_1 \equiv \Phi_0 - \delta_o ph',$$

where

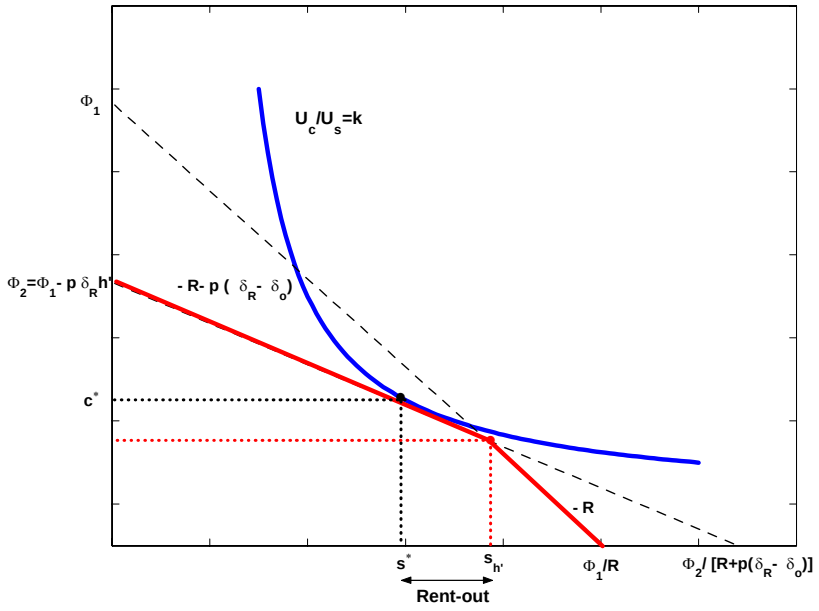
$$\Phi_0 \equiv y(a,\epsilon,j;w,r) + Rg(h') + I_d\left[(1-\varphi_s)ph - D(n)\right] \\ - I_b\left[(\varphi_b+\psi)ph' + m(p,h,\psi,N,r^m)\right] + (1-I_b)m(h,n,r^m,\tau_m) - a'$$

The budget constraint for the individual who wants to consume an amount of housing services smaller than the amount generated by the housing investment is, $(I_l = 1)$ is:

$$c + [R - p(\delta_r - \delta_o)]s = \Phi_2 \equiv \Phi_0 - \delta_r p h_2'.$$

The representation of this budget constraint in relation to the budget constraint for the household that does not supply housing services to the rental market is not obvious. The intercept for this budget constraint on the consumption axis is at $\Phi_2 < \Phi_1$ as long as $\delta_r > \delta_o$. The service flow intercept for the this latter case, $\Phi_2/[R - \triangle\delta)]$, is more problematic. We know that $R > [R - \triangle\delta]$ and $\Phi_1 > \Phi_2$. This means the s-intercept can be either to the left of or to the right of Φ_1.The situation where the s-intercept to the left of Φ_1 will always be dominated by entirely consuming the investment generated housing services and thus will be ignored. The combination of both cases is presented in Figure 1.

Figure 1: The Household Decision to Lease (Landlord)



As can be seen, the budget constraint for these two cases intersect at the point where consumption of housing services corresponds to the amount of services generated by the housing investment.

Consider a choice of housing service consumption greater than $s_{h'} = g(h')$ which occurs to the right side of the kink. Consequently, the household desires to rent additional housing services, making the budget constraint that allows to supply of rental services to be irrelevant. The other case occurs when the household chooses to become a landlord.

The relevant parts of the budget constraint for the household are represented by the bold lines. Hence, we bold the budget constraint corresponding to the renting of additional housing services. In the Figure 1, we show an example where the tangency between the budget constraint and the indifference curve occurs to the left of the kink. This means the household chooses to consume housing services less than what is generated by their housing investment. As a result, the amount

$s_{h'} - s^*$ is supplied to the rental market. This illustrates how the model endogenously allows for a rental market. The fact that the budget constraint is kinked with respect to the renting and leasing of housing services must be recognized in the computation of this model.

3.4 Firms

In this economy two goods are produced by a representative firm in each sector. One firm produces a good that can be used for consumption, or capital purposes, while the other firm produces new housing. Each firm employs a constant returns to scale Cobb-Douglas technology $F_i(K_i, L_i)$ where K_i and L_i denote the amount of capital and labor utilized by each sector. Aggregate capital and labor must be allocated between the two sectors.

3.5 Government

In this economy, the government provides unemployment benefits, θ. We assume the unemployment benefits program is self-financed by taxing employed individuals at the tax rate τ_p. In the baseline economy, we have not introduced any type of income tax or deductions for mortgage interest payments. These changes are straightforward and thus are not introduced into this proposal for the sake of simplicity. However, these changes are key to using this model as a public policy tool.

3.6 Equilibrium

In this model economy, 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 $\mathcal{A} \in \mathbb{R}_+$, $\mathcal{H} \in \mathbb{R}_+, \mathcal{M} \in \mathbb{R}_+$ and $\mathcal{E} \subset \mathbb{R}_+$. The aggregate state variables are $K \subset \mathbb{R}_+$ and $H \subset \mathbb{R}_+$.

Definition: *A stationary equilibrium is a collection of value functions* $v(a, h, n, \epsilon, j) : A \times H \times M \times E \times J \to R$; *decision rules* $a'(a, h, n, \epsilon, j) : A \times H \times M \times E \times J \to R_+$, *and* $h'(a, h, n, \epsilon, j) : A \times H \times M \times E \times J \to R_+$; *prices* $\{r, p, R\}$; *government policy variables* $\{\tau, \theta\}$; *and invariant distribution* $\Gamma(a, h, n, \epsilon, j)$ *such that*

1. *Given prices,* $\{r, p, R\}$, *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;solve the consumer's problem;*[8]

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

$$\begin{gathered} s.t. \qquad c + a' + I_b \left[(\varphi_b + \psi) p h' + m(p, h, \psi, N, r^m) \right] \\ +(1 - I_b) m(p, h, \psi, N, r^m) + \left[(1 - I_L) \delta_w p h' + I_L p (\delta_w s + \delta_r (h' - s)) \right] \\ = y(\epsilon, j, a; w, r) + I_R R(g(h') - s) + I_d \left[(1 - \varphi_s) p h - D_n \right]. \\ c > 0, \ s > 0, \ a' \geq 0, \ h' \geq 0. \end{gathered}$$

2. *The price vector* $\{r, w\}$ *is consistent with the zero-profit condition in each sector,*

[8] We have combined the various budget correspondences into one general budget constraint using 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.

3. *The consumption goods sector, housing sector, rental housing, asset, and labor market clear. Formally,:*

$$\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j c(\Lambda)\Gamma(\Lambda) + (K' - (1-\delta)K) = F_1(K_1, L_1) - \Upsilon$$

where μ_j represents the population weight of age cohort j and Υ denotes total transaction costs.[9]

$$I_H = F_2(K_2, L_2)$$

where I_H *represents the investment housing goods.*[10]

$$\int_{\mathcal{A}\times\mathcal{H}_{h'>0}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j s(\Lambda)\Gamma(\Lambda) + \int_{\mathcal{A}\times\mathcal{H}_{h'=0}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j s(\Lambda)\Gamma(\Lambda) = \overline{H},$$

$$\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j a'(\Lambda)\Gamma(\Lambda) = K_1' + K_2' + M,$$

$$N_1 + N_2 = \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j \epsilon \upsilon_j \Gamma(\Lambda)$$

4. *The retirement program is self-financing.*

5. *Let 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, and we restrict equilibria to satisfy $T(\Gamma) = \Gamma$.

4 Parameterization of the Model

In order to illustrate and evaluate the potential of our proposed model, the functional forms and parameters must be specified. Instead of specifying parameter values used in the literature, we estimate most of the parameters using an exactly-identified Generalized Method of Moments approach. That is, we solve for the parameters that are consistent with some key secular properties of U.S. economy. This estimation problem is embedded within the equilibrium solution of the model.

[9] Transition costs are defined as:

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

[10] Investment in housing goods is defined as:

$$I_H = \int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j h'(\Lambda)\Gamma(\Lambda) - [\int_{\mathcal{A}\times\mathcal{H}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j h(\Lambda)\Gamma(\Lambda) -$$
$$- \delta_o \int_{\mathcal{A}\times\mathcal{H}_{s(\Lambda)\geq h'(\Lambda)}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j h'(\Lambda)\Gamma(\Lambda) - -\delta_r \int_{\mathcal{A}\times\mathcal{H}_{s(\Lambda)<h'(\Lambda)}} \sum_{\mathcal{E}\times\mathcal{M}\times\mathcal{J}} \mu_j h'(\Lambda)\Gamma(\Lambda)],$$

Individual preferences over a composite consumption good are represented by a isoelastic utility function

$$u(C) = \frac{C^{1-\sigma}}{1-\sigma}$$

where $C = [\gamma c^{\rho} + (1-\gamma)s^{\rho}]^{\frac{1}{\rho}}$ and $\rho \leq 1$. In our benchmark case we set $\rho = 0$, so we have a Cobb-Douglas aggregator.

Each period in the model is taken to be three years.[11] A individual enters the labor force at age 20 and lives till age 83 (model period 21). Retirement is mandatory at age 65, (model period 15). Each household is born with an initial asset position. The distribution of initial assets is based on the asset distribution observed in 1998 *Panel Study on Income Dynamics* (PSID). Each income state was given their corresponding level of assets to match the nonhousing wealth to earnings ratio. Workers are assumed to have an inelastic labor supply, but the effective quality of the supplied labor depends on the stochastic income process. This process has two different components. The age-specific permanent component υ_j is calculated from earnings data in the PSID. The specification of the stochastic income component is based on Storesletten, Telmer and Yaron (2001). We discretize this income process into a five state Markov chain using the methodology presented in Tauchen (1986). The values we report reflect the three year horizon employed in the model. As a result, the efficiency values associated with each possible productivity value ϵ are

$$\epsilon \in \mathcal{E} = \{4.41, 3.51, 2.88, 2.37, 1.89\}$$

and the transition matrix is:

$$\pi = \begin{bmatrix} 0.47 & 0.33 & 0.14 & 0.05 & 0.01 \\ 0.29 & 0.33 & 0.23 & 0.11 & 0.03 \\ 0.12 & 0.23 & 0.29 & 0.24 & 0.12 \\ 0.03 & 0.11 & 0.23 & 0.33 & 0.29 \\ 0.01 & 0.05 & 0.14 & 0.33 & 0.47 \end{bmatrix}.$$

After retirement, households receive a social security transfer of θ. This transfer is assumed to be the same for all individuals. We set θ to be equal to a replacement ratio of thirty percent of average income and calculate the tax rate τ_p so as to make the retirement program self-financing.

In the housing market, we calibrate the transaction costs associated with buying and selling housing, ϕ_B and ϕ_S, to be 3 and 6 percent, respectively. These levels are consistent with observed buying and selling fees. We allow for a wedge between the rate of return on capital and the mortgage interest rate. We set the wedge to one and a half percent which is close to the difference between the 30 year treasury bond rate and the average rate for a 30 year fixed rate mortgage. We set the length of the mortgage, N, to 10 periods which corresponds to 30 years, and the downpayment requirement, Ψ, to ten percent[12]. We determine the minimum home size using the average size of the smallest 10 percent of homes in the AHS. For this set homes, we find that the ratio of house value to average labor income is 1.2. This value is used to set the smallest house size.

The seven parameters that need to be estimated are the depreciation rate for the capital stock, δ, the depreciation rate for rental units, δ_r, the depreciation rate for ownership units, δ_o, the capital income share in the production function of each sector, α_i, the relative importance of consumption

[11] Due to the model complexity, we have choosen to three year horizon rather than an annual horizon.

[12] It is important to note that the choice of the downpayment requirement does not alter the qualitative results presented later in the paper. Also, in recent years the average downpayment, as calculated from the AHS, has repeatedly dipped below 20%, and since this is supposed to serve as a minimum requirement, not the average, we believe that a 10% downpayment requirement is reasonable.

goods to housing services, γ, and the individual discount rate, β. The values of β and γ will be estimated, but the curvature parameter, σ, is set to 2.0. We identify these parameter values so that the statistics in the model economy are the same as six statistics observed in the actual economy.

We use the following targets. The first target is the ratio of capital to gross domestic product which is about 3.00 for 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 which is defined by the Bureau of Economic Analysis. A second 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. The third target is the capital income share of national income which equals 0.35. The fourth estimation target is the share of investment in capital goods to output. This share share is equal to 0.043. The fifth target is the fraction of output that is allocated to investment in housing. For our time period, this ratio is 0.032, where we define housing investment as investment in residential structures. All these data comes from the BEA. The final target is the number of square feet in owner-occupied housing relative to the number of square feet in rental housing. Data from the 1999 *American Housing Survey* indicates that this ratio is 4.25.

Given this targets, our estimated parameters are presented in Table 8. The implied targets generated by the model solution are within one percent error for all the observed targets.

Table 8: Estimation of Model (Annualized Values)

Statistic	**Target**	**Model**
Ratio of wealth to gross domestic product (K/Y)	3.00	3.006
Ratio of housing stock to capital stock (H/K)	0.60	0.599
Capital Share of Output Manufacturing Sector	0.35	0.35
Capital Share of Output Construction Sector	0.15	0.15
Housing Investment to Housing Stock ratio (x_H/H)	0.032	0.0319
Ratio owner-occupied to rental housing square feet	4.25	4.24
Ratio capital investment to GDP$(\delta K/Y)$	0.043	0.0431
Variable	**Parameter**	**Estimated Value**
Individual Discount Rate	β	0.964
Share of consumption goods in the utility function	γ	0.804
Share of capital income Manufactures	α_1	0.35
Share of capital income Construction	α_2	0.15
Depreciation rate of owner occupied housing	δ_O	0.022
Depreciation rate of rental housing	δ_R	0.090
Depreciation rate of capital stock	δ_K	0.067

5 An Evaluation of the Model

In order to highlight possible insights that can be drawn from the model as well as illustrate the potential public policy applications, we report on the performance of our model along several key dimensions. We are interested in examining both the aggregate and the distributional implications. Table 2 compares selected quantitative results implied by the model with data.

Table 2: Summary of Aggregate Results

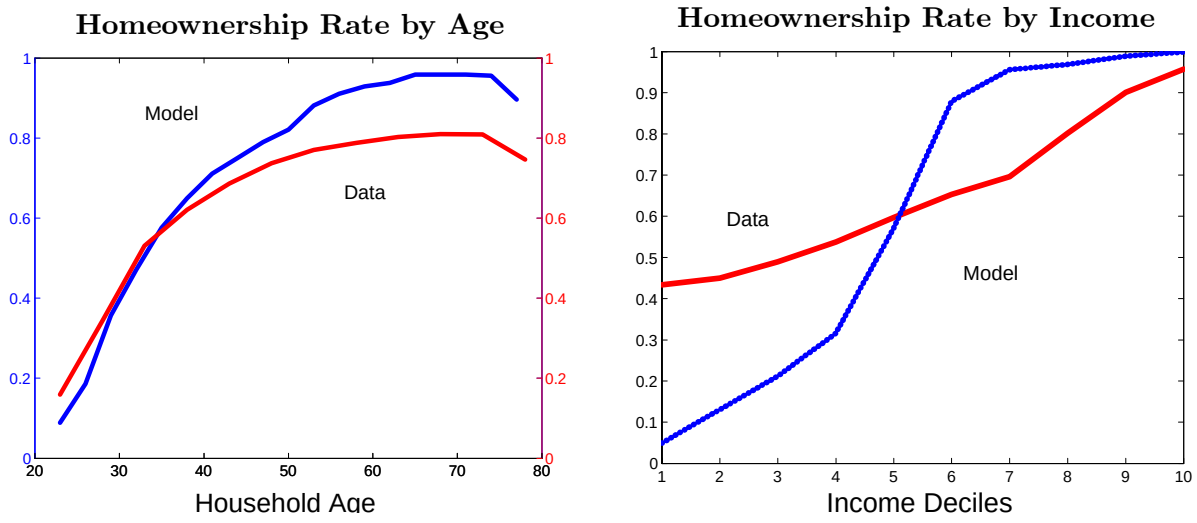
	Ownership Rate (over 25)	Ownership (under 35)	Avg. House Size[1]	Avg. Apart Size
Data	66.8%	39.7%	2,137	1,199
Benchmark Model	68.2%	30.0%	2,304	911

[1] Housing and rental units size are measured in terms of square feet.

The homeownership rate is a general measure of participation in the housing market. The average estimate for the U.S economy in the last decade is 66.8 percent while our quantitative model generates a rate of 68.2 percent. A related issue is whether the model generates a reasonable amount of young, or "first-time buyers". This is particularly important since the empirical evidence shows participation of relatively young households as a demanders of rental property. As can be seen, 39.7 percent of households under age 35 own houses. Our model generates a participation rate of 30 percent. Another dimension of interest is the size of average size of owner and rental occupied units in the United States. Data indicates that the average owner occupied house is 2,137 square feet whereas the model infers an average size of 2,304 square feet. In the rental market the model predicts the average apartment to be 911 square feet while the data indicates larger units. It is important to note that the average size for owner-occupied and rental have not been targets in the parameterization process, and are endogenously generated by the model. This aspect is particularly important, since this formulation separates the housing stock (physical investment) from service flows and both, demand and supply for owner-occupied housing and rental appartment are endogenous.

In addition to examining the aggregate performance of the model, the distributions generated need to be considered. The model ability to replicate observed distributions on various housing dimensions is important. Figure 1 compares the homeownership rate by age and income generated by the model with the distribution observed in the American Housing Survey in 1999.

Figure 1: Selected Distribution Implications

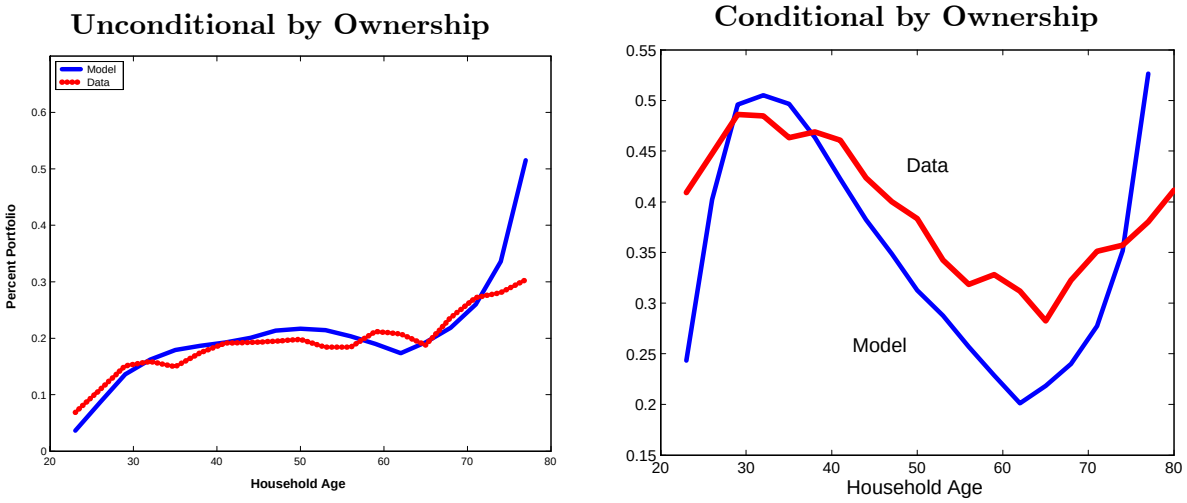


The general pattern generated by the model is consistent with the pattern observed in the data. However, as seen in the Figure, the model slightly underestimates the homeownership rate for younger households. After age thirty-five, the model over predicts homeownership participation. It is interesting to note that the model predicts households that rent in all age cohorts. This

divergenge with the data for household of fifty years of age and older can be due to several factors. First, the income process used might have some limitations in generating enough poor households, and eventually most household manage to save for the downpayment and acquiere owner-occupied housing. Second and maybe more important, the model abstracts from health and demographic shock , (i.e., changes in marital status) that can result in an increase in movements into the rental market. Consequently, in the absence of these shocks the model might give an accurate prediction on what the ownership rate would be. The model captures the increasing pattern of the homeownership rate by income deciles, but it underestimates the participation of the lowest deciles and overpredicts the participation of the wealthiest. This is probably a consequence of underestimating the ability of the poorer households to self-insure, and the absence of additional shocks for the wealthiest households.

We have stressed the importance of the investment aspect of the housing decision. Figure 2 presents data and model results on the relative importance of housing investment in the overall portfolio by age.

Figure 2: Housing and the Portfolio I



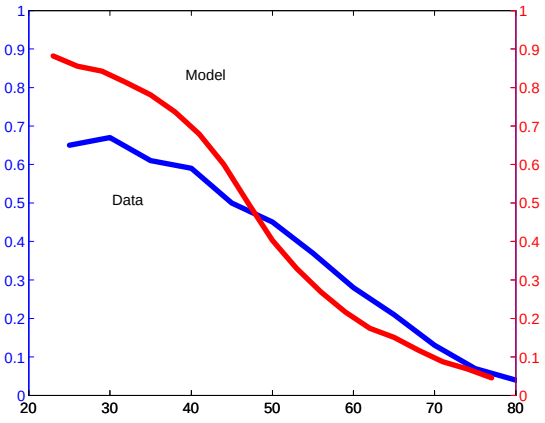
Our data is from the 1998 *Survey of Consumer Finances*. We use the respondent's estimated value of their house adjusted for remaining principle to calculate the net housing investment position. Since the only other asset in the model is capital, we combine data on bond and stock holding to approximate this asset.[13] The fraction of housing in the portfolio is calculated as net housing over net wealth**.** The first chart report the share of housing in the average households, since a large fraction of households below age 40 rent, the relative importance of housing for these cohorts is smaller than latter on. Around retirement age, the average households start to deaccumulate savings and that increases the role of housing in the portfolio in the later stages of the life cycle. The second chart shows the relative importance of housing in the portfolio only for those individuals that have an investment position in housing. The literature suggest the relative importance of housing in the portfolio should be capture by a "U-shaped" pattern that the model is able to replicate. Nonetheless, young homeowners in the model appear to have more nonhousing wealth than the data suggests. A similar phenomenon occurs prior to retirement age.

Next two figures displays the loan-to-value ratio (LTV ratio) and the ratio between non-housing assets for homeowners and renters for the model and the data.

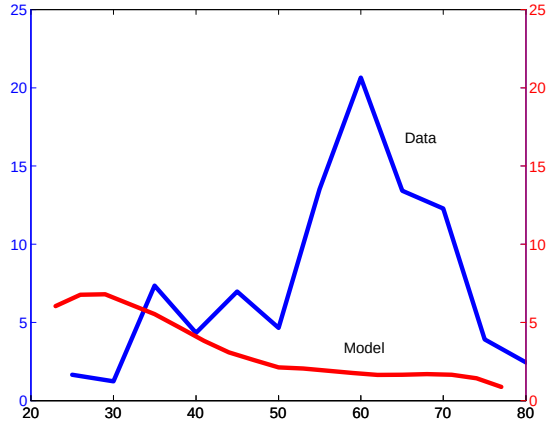
[13] Bonds are defined as bond funds, cash in life insurance policies, and the value of investment and rights in trusts or estates, while stocks are defined as shares of stocks in publicly held corporations, mutual funds, or investments trusts including stocks in IRA's

Figure 3: Housing and the Portfolio II

Loan to Value Ratio



Ratio between Homeowners and Renters Assets

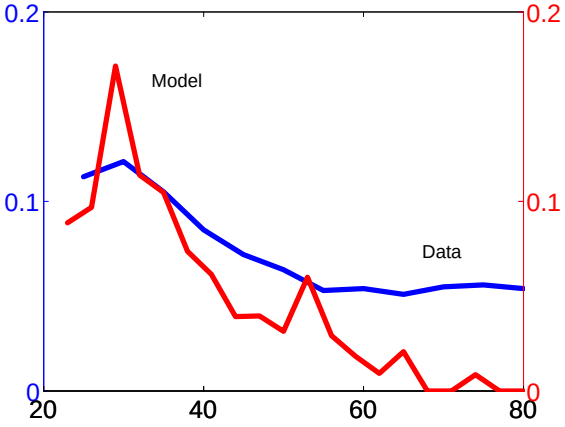


The model captures the decreasing patterns of LTV ratio observed on the data showing that on average households paid off the mortgage. This is property genereted by the life-cycle dimension of the model. Jeske and Krueger (2004) show that in a dynastic model with uninsurable labor income shocks and liquidity constraint, households target an optimal LTV ratio and never pay off the mortgage. The second chart shows that the differences between non-housing wealth between homeowners and renters in the data are much larger than in the model. According to 1998 SCF the average difference is around 6.5 times, whereas in the model it is only 2.2 time. The data predicts a larger dispersion over time than the model, but this is also a consequence of the large number of homeowners above age 50 predicted by the model. The largest differences in the model are associated to the early stages of the life-cycle.

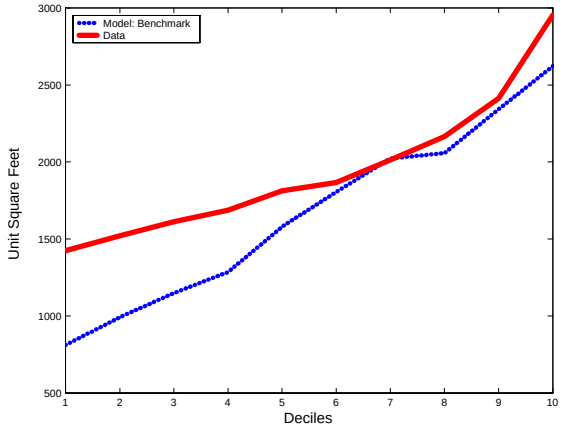
Next, we explore the model predictions with respect to first-time buyers and the distribution of square feet by income deciles.

Figure 3: Selected Distribution Implications

First-time Buyers



Average Square Feet by Income

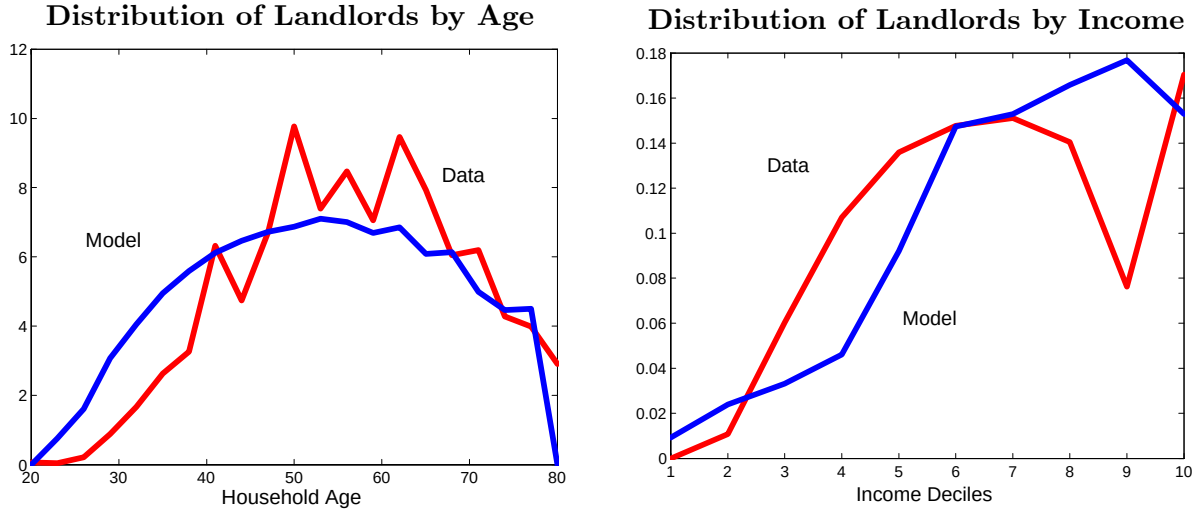


The model captures the decreasing pattern of the distribution of first-time buyers observed in the data. However, the fraction of first-time buyers predicted by the model is relatively lower. In the model, households that on average cannot afford to acquiere housing around retirement age will not choose to participate in the market. The second figure compares the average square feet

by income deciles. The model is able to replicate the observed increasing pattern, and captures large home size of the highest income deciles but underestimates the pattern for the lowest income households.

Because of the aforementioned analysis of the POMS data set, the decision to become a landlord is embedded in the households investment in housing decision. We briefly report on the model's distributional implications for this decision. In Figure 3, we compare the distribution of landlords implied by the model with *Property Owners and Managers Survey* (POMS) data by age and income.

Figure 4: Selected Distribution Implications



Overall, the model captures the general pattern observed in the data. The peak in the distribution of landlords is similar in both the data and the model. The primary difference between the model and the data is for households under age 55. However, the participation for younger cohorts is overstated and this explains why the average age for a landlord in the model (48 years) is lower than what is observed (56 years). A possible explanation is that the model does not allows for capital gains and the risk associated with being a landlord.

The other dimension we explore is how the participation decision varies with income. The data indicates that landlords exist in all income deciles, except the lowest decile. For example, the data suggests that 1 percent of the landlords come from the second lowest income decile. The observed distribution of landlords has a hump-shaped pattern with a peak occurring in the sixth or seventh income decile. The observed decline in participation at the ninth income decile is perplexing and is likely to be due to a statistical artifacts in the creation of the data. The distribution observed in the model is quite similar to what we observe in the data. The model generates a hump shaped distribution, however, the peak occurs at the ninth income decile. We see that the model predicts some participation in the rental market at the lowest income decile, although is very small. We under forecast participation between the second and sixth income deciles. The largest difference is at the fourth income decile with a 6 percent basis difference.

6 Model Extensions

The evaluation section suggests that the basic model performed quite well in terms of replicating key aggregates and certain distributions. Of course there are demensions of the model that need to studied in hopes of improving the model performance. In this section we want to focus on three areas. First the assumption of homothetic preference strongly ties together the consumption of

goods and the consumption of housing services. This results in some patterns, especially in the older age cohorts that are not attractive. Second, assumption such as a fixed downpayment or a fixed length mortgage made computation of the model easier, but possibly imposed some severe restrictions. Lastly, we model the decision to become a landlord as part of the household's portfolio choice. While this modelling choice was motivated by data considerations, it does add significantly complexity to solving the model. An alternative is to postulate a "stand-in" rental firm. We want to examine the implications of this simplication for predictions of the model keeping in mind that one purpose the to develop a framework that can be used for policy analysis purposes.

6.1 Non-Homothetic Preferences

Models with housing that allow for heterogeneous agents have assumed that these agents have homeothetic preferences. In our aforementioned model, we have assumed that preferences over the consumption of goods and housing services are Cobb-Douglas with constrant relative risk aversion. This assumption means that the consumption of goods and housing services have linear income expansion paths. This has the implication that as income increase both the consumption of both goods must increase, thus resulting in some unattractive results that contradicts the evidence. In this section we examine the performance of the model with a modified utility function.

$$U(c_i, s_i) = \frac{[(c_i - \bar{c}_i)^\gamma (s_i + \bar{s}_i)^{1-\gamma}]^{1-\sigma}}{1-\sigma},$$

These preferences imply that the income elasticity of demand for consumption goods is less than one, and for housing services is geater than one. The variable $\bar{c}_i$ can be interpreted as the level of subsistence consumption that can depend on the age i of an individual, where as $\bar{s}_i$ can be interpreted as positive effect from having shelter. By setting this variables to zero, we revert to the homothetic case.

6.2 Borrowing Constraints

In our model, any household who desires to have a housing investment position must use a mortgage contract with a fixed downpayment and fixed length. Households are not allowed to withdraw equity to self-insure against temporary income shocks. Households who have accumulated housing equity from a prior housing position are not allowed to use that equity to pay a larger downpayment fraction in a new housing position. Our mortgage assumption restrictions may have important implications. In this section, we examine the implications to modifications in the borrowing constraints. In particular, we allow households to borrow against the equity in the house. Hurst and Stafford (2004) examine this issue empirically. Using the characteristics of the mortgage contract (p, h, ψ, N, r^m), and the remaining periods to paid it off n, we can calculate the existing equity in the dwelling denoted by $e(n)$. Since equity loans or equity lines have a shorter maturity, we can assume that the cost of borrowing against equity in the house is the market interest rate, r. Therefore, households would be restricted to borrow up to the value of their equity in the house considering the initial downpayment ψph, that is $a' \geq -(\psi ph + e(n))$. In this formulation borrowing constraints are endogenous and depend on the equity accumulated in the investment position. This is different from the Fernández-Villaverde and Krueger (2001), Lustig and Van Nieuwerburgh (2004), and Nakajima (2003) who employ a collateralized loan constraint on the value of the property and avoid mortgage financing issues.

6.3 Too Many Landlords

Another modification affects the decision to rent part of the housing investment to other households. Adjustments costs associated with changes in the decision to rent out property should be considered. Our modeling of landlords add significant complexity to the computational problem. We want to examine the implications for various distributions of using the rental firm construct. This would simplify the computation of the model as the branches in the household problem associate with the supply of rental services to other households would be eliminated

7 Conclusions

[To be Completed]

8 References

References

[1] Aiyagari, S. R., (1994). "Uninsured Idiosyncratic Risk and Aggregate Saving." *Quarterly Review of Economics,*109: 659-84.

[2] Berkovec J. and D. Fullerton, (1992). "A General Equilibrium Model of Housing, Taxes and Portfolio Choice," *Journal of Political Economy*, 100(2): 390-429.

[3] Chambers, M., C. Garriga, and D. Schlagenhauf, (2004), "Accounting for Changes in the Homeownership Rate," Working paper, Florida State University.

[4] DiPasquale, D. (1999), "Why Don't We Know More Anout Housing Supply?," *Journal of Real Estate Finance and Economics*, 18:2, 9-23.

[5] Fernández-Villaverde, J. and D. Krueger,(2002) "Consumption and Saving over the Life-Cycle: How Important are Consumer Durables?" Working paper,University of Pennsylvania.

[6] Flavin, M. and T. Yamashita, (2002). "Owner-Occupied Housing and the Composition of the Household Portfolio Over the Life Cycle," *American Economic Review*, 92: 345-362.

[7] Gervais, M. (2002) "Housing Taxation and Capital Accumulation," *Journal of Monetary Economics*, 49:1461-1489.

[8] Goodman, A.C. (1995) "A Dynamic Equilibrium Model of Housing Demand and Mobility with Transaction Costs," *Journal of Housing Economics*, 4, 307-327.

[9] Goodman, A.C. (2002) "Estimating Equilibrium Housing Demand for 'Stayers'," *Journal of Urban Economics*, 51, 1-24.

[10] Greenwood, J., N. Guner, and J. Knowles.(2003). "More on Marriage, Fertility, and the Distribution of Income," *International Economic Review,* 44(3): 827-862.

[11] Grossman, S. J. and G. Laroque, (1990). "Asset Pricing and Optimal Portfolio Choice in the Presence of Illiquid Durable Consumption Goods," *Econometrica,* 58: 25-51.

[12] Haurin, D.R. and E. Chung, (1998). "The Demand for Owner-Occupied Housing: Implications from Intertemporal Analysis," *Journal of Housing Economics*, 7, 49-68.

[13] Haurin, D. R. and H.L. Gill, (2002). "The Impact of Transaction Costs and the Expected Length of Stay on Homeownership," *Journal of Urban Economics*, 51, 563-584.

[14] Henderson, J. V., and Y.M. Ioannides (1983), "A Model of Housing Tenure rida State University.

[15] Ríos-Rull, J.V. (1996). "Life Cycle Economies and Aggregate Fluctuations," *Review of Economic Studies, 63: 465-489.*

[16] Ríos-Rull, J.V. (2001). "Population Changes and Capital Accumulation: The Aging of the Baby Boom," unpublished paper, University of Pennsylvania.

[17] Shilling, J., C.F. Sirmans and J Dombrow.(1991) "Measuring Depreciation in Single-Family Rental and Owner-Occupied Housing" *Journal of Housing Economics* 1:368-383.

[18] Storesletten, K., C. I. Telmer, and A. Yaron (2003). "Asset Pricing with Idiosyncratic Risk and Overlapping Generations," *Journal of Political Economy,* forthcoming.