# Constructing the Post-War Housing Boom*

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**Abstract**

The postwar witnessed the largest housing boom in recent history. The objective of the paper is to develop a quantitative equilibrium model of tenure choice to analyze the key determinants in the co-movement between home ownership and house prices in this period. The parameterized model is consistent with key aggregate and distributional features observed in the 1940 U.S. economy and is capable of accounting for the boom in homeownership in 1960. Demographics, income risk, and government intervention in housing finance are important determinants in the homeownership rate, but have relatively small effect in house prices. Increases in the cost of construction, driven by improvements in the relative productivity of the non-housing sector are the key driver of house price movements.

**Keywords:** Housing finance, first-time buyers, life-cycle

**J.E.L.:**E2, E6

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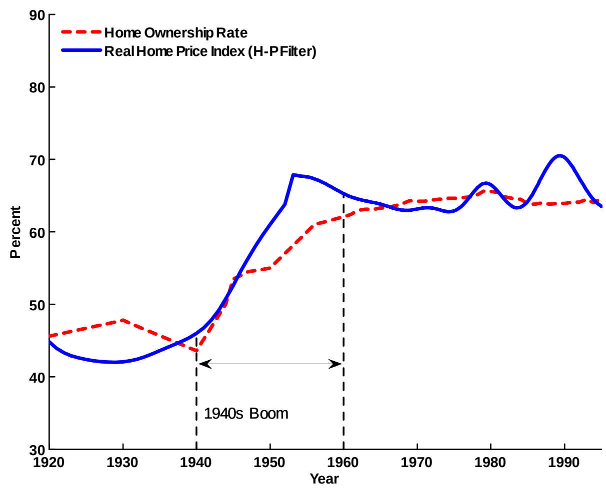
# 1 Introduction

The collapse of housing markets in the United States has been central in the recent financial crisis. One needs to go back to the Great Depression to find a similar impact from the housing sector in the economy. The housing boom had been fueled by substantial innovations in housing finance that modified central features of mortgage loans (i.e. repayment structure and downpayment) resulting in a sizeable expansion of credit and home ownership. Since 1965 the home ownership rate hovered around 64%, but during the 2000s boom it peak at 69.0%.[1] From a historical perspective, the recent expansion ownership is small compared to the that started in the postwar period. Figure 1 summarizes the evolution of the homeownership rate and real house price index in the U.S. in the period 1920-2000. Between 1940 and 1960, the fraction of households that own the home they occupy increased from 43 to 62%, with significant contribution from younger homeowners. During this period, the real value of homes had a stable appreciation that increased property values by 35%. Between these two periods the home ownership rate remained fairly constant. The postwar housing boom was fueled by a large construction activity. In the 1950s, residential investment as a fraction of GDP rose to 7.3%.

**Figure 1: House Prices and Home Ownership: U.S.(1920-2000)**




The sources of the housing boom and the positive co-movement of house prices and home ownership during this period have been an issue of contention. Some attribute the increase to economic forces (i.e., productivity growth and schooling), non-economic forces (i.e., changes in the demographic structure and life expectancy), and government policy (i.e., housing policy). For example, Kain (1983) and Katona (1964) both argue that the increase in home ownership is due to an increase in real income. Chevan (1989) argues that changes in income and demographic age composition explain more than half of the growth in home ownership between 1940 and 1960. Some proponents argue that the government played a large role shaping the future of the housing market and the

[1] Chambers, Garriga, and Schlagenhauf (2009) studied this period and found that mortgage innovation in the form of highly levered and variable interest payment mortgages were a key factor in accounting for the increase in the homeownership rate.

mortgage industry through different programs and tax exemptions. Yearn (1976) argues the explanation is in federal policies that made mortgage funds available with low initial payments, for longer durations, and at lower interest rates. For example, Rosen and Rosen (1980) estimate that about one-fourth of the increase in home ownership between 1949 and 1974 was a result of benefits towards housing embedded in the personal income tax code. Hendershott and Shilling (1982) support this claim by finding that the decline in the cost of owning a home relative to the cost of renting during the period 1955 to 1979 was due to income tax provisions. He points to the easy monetary policy of the Federal Reserve System in the 1940 and the increase in the availability of mortgage funds from Federal Housing Administration (FHA) and the Veterans Administration (VA). Shiller (2007) argues that the postwar boom was substantially the result of new government policies to encourage home ownership after the surge if mortgage defaults during the Great Depression in the 1930s. Fetters (2010) has estimated that VA's policy of making zero downpayment mortgage loans available to veterans returning from World War II and the Korean War after 1946 accounts for a ten percent increase in home ownership.

The objective of the paper is to develop a quantitative model to analyze the key determinants in the co-movement between home ownership and house prices in the postwar housing boom. The model allows economic agents to make optimal decisions in an environment that reflects the relevant economic and institutional conditions. The approach permits the different factors to dynamically interact and provides a laboratory to study the changes in economic conditions, government regulation, and factor prices. The strategy to decompose the quantitative importance is a three step process. The first one is the model parameterization to be consistent with key aggregate and distributional features in the U.S. in 1940. The second step holds the fundamental parameter constant (preferences and technology) and let's all the relevant factors change determining the model contribution to the total change in 1960. The third step isolates the contribution of each factor by reverting its value to the 1940s. Each step is consistent with solving the equilibrium in the model (markets and government resource constraint). An additional advantage of the methodology is that permits the conduction of counter factual experiments. This paper follows the tradition of Cole and Ohanian (2000,2004), Hayashi and Prescott (2002), Ohanian (2009), and Perri and Quadrini (2002) that use quantitative techniques to study historical episodes.

It is important to understand the relative importance of these factors. There are current proposals to reform America's housing finance market by regulating loans and reducing the role of government intervention.[2] The lessons learn from this historical episode could provide guidance on reforming housing markets and housing finance. The aforementioned research has attempted to measure the importance of a factor in a regression based framework that holds other potential factors constant. Therefore the extrapolation of the findings to the whole economy could be challenging because most of these factors interact with each other.

[2] The Administration's plan is based a reduction of the role of the government housing finance (mainly the Government Sponsored Enterprises), an increased consumer protection and transparency for investors, improved underwriting standards, and other critical measures. The plan also calls for targeted and transparent support to creditworthy but underserved families that want to own their own home, as well as affordable rental options.

The model is a two-sector version of the model used in Chambers, Garriga, and Schlagenhauf (2012). In the economy, households face uninsurable labor income risk, life uncertainty, and borrowing constraints. Individuals purchase consumption of goods and housing services, and investment in capital and/or housing. The purchase of housing services is intertwined with tenure and duration decisions. Housing is a lumpy investment that requires a down payment, long-term mortgage financing, and receives preferential tax treatment. Mortgage loans are available from a financial sector that receives deposits from households and also loans capital to private firms. The model uses a homeowners-based rental market, hence the house price to rental price ratio is endogenously determined. The goods sector produces consumption and non-residential investment. The construction sector produces residential investment. The government implements a housing policy, collects revenue with a progressive income tax system.

The baseline model can rationalize the positive co-movement of homeownership and house prices observed. More specifically, the model accounts for 98 percent increase in ownership and 82 percent of the change in house prices. All the factors considered play a significant role. The model suggests that productivity is essential for house prices whereas changes in housing demand represent a smaller contribution. Demographics, changes in income risk, and government intervention in housing finance play are important determinants of ownership.

This paper is organized into five sections. Section 2 discusses the evidence of the housing boom in the period 1930-60. Section 3 presents a simple equilibrium model of tenure choice to illustrate the key drivers in the co-movement between house prices and ownership. Section 4 presents the quantitative model, whereas Section 5 discusses the parametrization of the model. The quantitative analysis is conducted in Section 6, and the final section concludes.

# 2 Evidence on the Housing Boom:1930-1960

The economic environment changed substantially between 1935 and 1960. In the late 1930s and early 1940s, the economy was recovering from the Great Depression. Beyond the economic recovery, the economic environment changed due to a number of institutional changes that occurred in as policy responses to the Great Depression. The literature has suggested a number of factors that may account for the large increase in the home ownership rate. This section describes the economic and institutional environment between 1930 and 1960. The presentation of this historical background should provide the motivation for factors being offered as an explanation. These are divided by factors related to government intervention in housing markets and the expansion of assistance programs with other economic factor and demographic changes.

## 2.1 Determinants of House Prices (To be completed)

- Describe the data
- Drivers of house prices

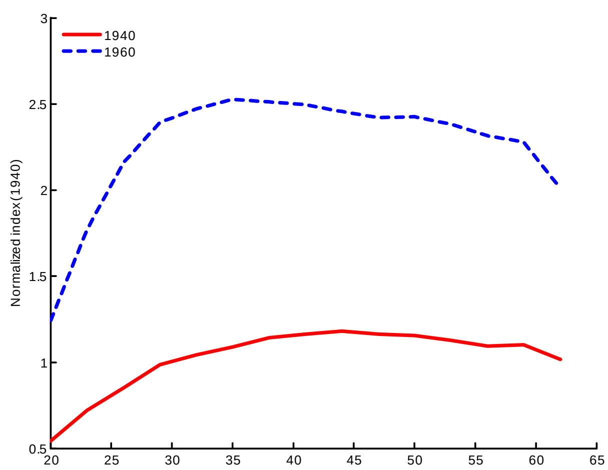
- Construction costs
- Labor costs
- Financing costs

## 2.2 Determinants of Homeownership

In order to understand the increase in the homeownership rate and house prices, a brief review of changes in labor income, demographics, mortgage finance and interest rates, as well as fiscal policy is in order so that the role that institutional changes can be properly understood.

**Income:** In 1940 real GDP was 101.4 billion (in 1940 prices). By 1960, real GDP increased by a factor of 2.4 to 243.3 billion (1940 prices). If real per capita GDP is examined so that population growth can be considered, per capita real GDP increases by a factor of 1.77. A third way to measure the change in income is to examine the change in per capita wage income. For this same period, wage income per capita increased by a factor of 2.6.[3] While an increase in real income is important, it is equally important to see how wage income changed over the life cycle. A problem that plagues economic historical analysis is the lack of panel data. As a result, we are forced to rely on Census data from 1940 and 1960 to construct (real) wage income as well as wage efficiency indices by age cohort. Figure 4 presents these indices for 1940 and 1960. As can be seen, the wage efficiency indices for 1960 are much higher for all age groups in 1960. More importantly for home ownership, a steep increase in the wage efficiency index occurs between ages 20 and 35. In addition, the peak in wage efficiency seems to have shifted toward younger cohorts in 1960 when compared to 1940. These wage developments suggest workers could acquire the funds needed to invest in housing earlier in their life cycle in 1960 than in 1940. These facts suggest that income could certainly be an important factor in the explanation of the increase in home ownership.

**Figure 2: Wage Efficiency Indices: 1940 and 1960**

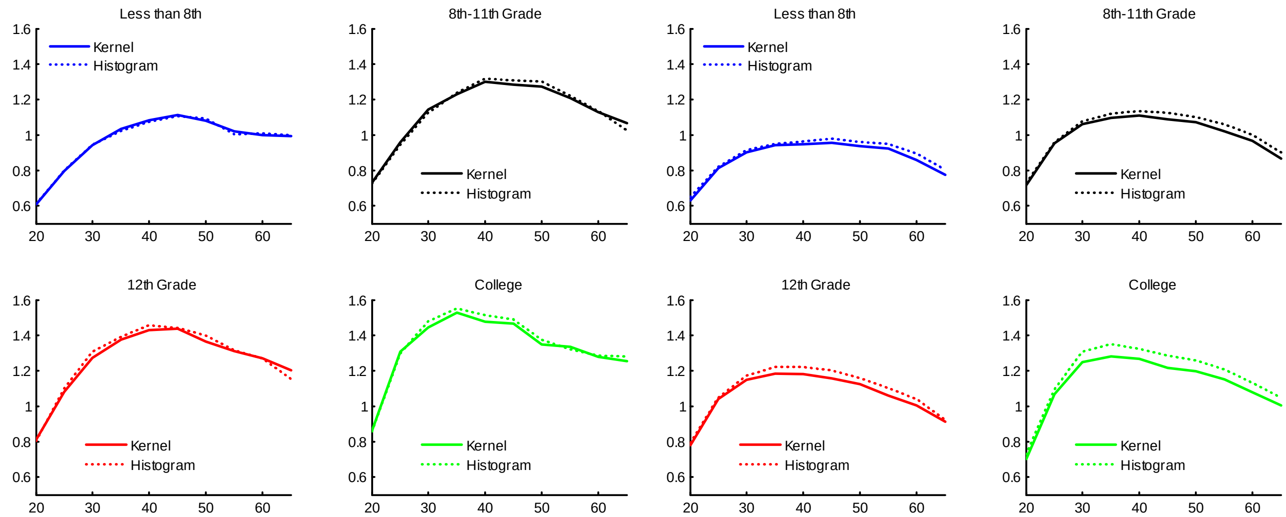



[3] Wage income is defined as total compensation of employees plus .65 of proprietors'income. Wage income is expessed in 1940 prices. To convert this into a per capita value, we divide by total employment.

An increase in labor income does not necessarily translate into an increase in home participation. The cost of funding the home purchase as well as the cost of the home are equally important factors. Case-Shiller has constructed home price indices for the period 1935 to 1960. Their data suggests that home prices increased 41.4 percent over this 25 year period. This increase is less than the increase in real income which suggests that there was an increase in the affordability of housing over this time frame.

**Figure 3: Income Profiles**

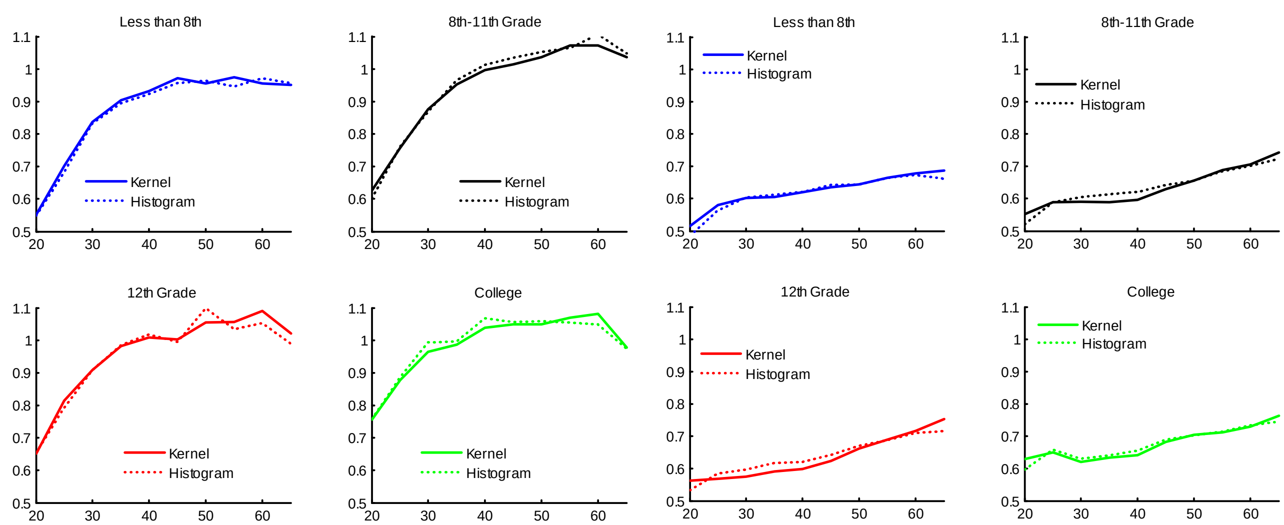
**1940** **1960**




There is an important reduction of income risk between these two periods. As I mention early, this could be due to the reduced number of entries for the Census in 1940. We have to be somewhat cautious when making statements.

**Figure 4: Standard Deviation of Income**

**1940** **1960**




**Demographics:** Demographers, such as Chevan (1989), suggest social norms towards housing changed over this period . In the context of the model framework, the demographic factors are restricted to changes in the cohort size and survival rates. These changes have the potential to favored home ownership. Certain age cohorts tend to have higher home ownership rates than other cohorts. Did the size of age-specific cohorts that are correlated with high home ownership rates increase over this period? In Table 1, data on home ownership rates by age from 1930, 1940 and 1960, as well as cohort size in 1940 and 1960 are presented.

**Table 1: Historical Age Cohort, Survival Rates, and Home Ownership**

| | | Home ownership by Age | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | **Total** | **20-25** | **26-35** | **36-45** | **46-55** | **56-65** | **66-75** | **76-82** |
| 1930 | 48.1 | | 37.5 | 48.5 | 57.7 | 65.1 | 69.7 | 70.1 |
| 1940 | 42.7 | | 33.5 | 42.1 | 51.0 | 57.5 | 60.3 | 62.3 |
| 1960 | 62.5 | | 56.2 | 68.1 | 69.5 | 69.3 | 69.8 | 67.2 |
| | | **Relative Size of Age Cohort[1]** | | | | | | |
| 1940 | | 0.13 | 0.27 | 0.21 | 0.19 | 0.12 | 0.07 | 0.02 |
| 1960 | | 0.10 | 0.21 | 0.21 | 0.18 | 0.14 | 0.10 | 0.04 |
| | | **Conditional Survival Probabilities** | | | | | | |
| 1940 | | 0.986 | 0.969 | 0.949 | 0.898 | 0.798 | 0.609 | 0.4828 |
| 1960 | | 0.993 | 0.986 | 0.971 | 0.927 | 0.840 | 0.677 | 0.568 |

[1] The relative size is based on age 20 through age 82

Source: U.S. Life Cycle Tables. and U.S. Census Bureau

The highest home ownership rates occur in age cohorts older than age 36. The fraction of the population in the 20-25 and 26-35 age cohorts is smaller in 1960. More importantly, in 1940 57.5 percent of the population was between age 36 and 65, while in 1960 62.6 percent of the population was accounted for by this cohort. Since the age 36-65 age cohorts tend to have higher home ownership rates, this evidence suggest that demographic trends could be a factor in an explanation for the large increase in the home ownership rate in 1960. A simple way to test this conjecture is to perform a decomposition of the home ownership rate. The aggregate ownership rate for a given year $t$ can be expresses as $\Pi_t = \sum_{i \in I} \mu_t^i \pi_t^i$, where $\mu_t^i$ is population weight for households of type $i$ in period $t$, and $\pi_t^i$ denotes the ownership rate for individuals of type $i$ in period $t$. The contribution of a factor can be roughly estimated by appropriately holding the other factors constant, and then calculating a hypothetical aggregate rate. The data from *Public Use Microdata Samples* (PUMS) for 1940 and 1960 provide the complete information to perform the decomposition. For example, the effect of demographic changes on the home ownership rate can be estimated by holding the participation behavior of year 1940 constant and using the population weights of 1960. Table 2 summarizes the implied homeownership rates for different combinations of population structures and individual participation behavior.

**Table 2: Actual and Hypothetical Ownership Rate**

| Expression | Ownership Rate | Total Change |
|---|---|---|
| $\sum_{i \in I} \mu^i_{1940} \pi^i_{1940}$ | 44.53 | |
| $\sum_{i \in I} \mu^i_{1960} \pi^i_{1960}$ | 65.57 | 21.04 |
| $\sum_{i \in I} \mu^i_{1960} \pi^i_{1940}$ | 47.47 | 2.94 |
| $\sum_{i \in I} \mu^i_{1940} \pi^i_{1960}$ | 62.13 | 17.60 |

Data Source: United States Public Use Microdata Samples (PUMS)

The simple decomposition shows that when the participation rates for the different cohorts remain at their 1940 level but the cohort sizes are changed to 1960, the implied ownership rate increases from 44.5 to 47.5 percent. This implies that demographic changes alone account for 14 percent of the total increase of the observed home ownership. This type of demographic changes, as reflected in the population cohort weights, do not seem to be a primary factor. To estimate the effect of changes in participation rates, the population structure observed in 1940 can be held constant and the participation rates set to their 1960 values. Under this set of assumptions the implied ownership rate is 65.6 percent and account for 84 percent of the increase in the observed aggregate. The total effect also includes a small positive covariance term that amounts to 2.4 percent.

A second demographic consideration is the survival rates of households in the two periods. The idea is that if survival rates are higher in one period than a previous period, a household may be more likely to invest in housing. In Table 1, we present survival rates for the designated cohorts. These survival rates measure the probability of being alive at beginning age in the next cohort given you are alive at the beginning of the current cohort. Clearly, life expectancy increased significantly between 1940 and 1960. This is a possible channel for demographic considerations to impact home ownership that has not been stressed in the empirical literature

**Regulation of Housing Finance, Assistance Programs, and Tax Provisions:** Over this period, a number of changes occurred in the mortgage market that could account for the rising home ownership rate. In 1900, mortgage lenders consisted of mutual savings banks, life insurance companies, savings and loan associations and commercial banks. Mutual savings banks were the dominate lender, while commercial banks played a small role.

After 1900 the importance of mutual saving banks declined while life insurance companies and savings and loans associations substantially increased their market shares. Commercial banks did not become a dominant lenders until after World War II. The real that commercial banks were a relatively unimportance source of mortgage funds is a result if the National banking Act. This Act made real estate loans inconsistent with sound banking practise. Hence, any commercial bank mortgage loans were restricted to State chartered banks. In 1913, the Federal Reserve Act liberalized restrictions that limited participation in the mortgage market on national banks. As a result, the importance of commercial banks in this market steadily increased.

Perhaps a more important change occurred in the structure of the mortgage contract. Loan-to-value ratios, length of contract, and contract structure as related to amortization were changing. A common belief is that mortgage interest loans were non-amoritizing in the period 1920 to 1940. In other words, the mortgage contract can be characterized as a short term balloon type contract with high down payment. Grebler, Blank, and Winnick (1956) examine data from life insurance companies, commercial banks, and savings and loans and find that partially amortizing loans did exist in the period 1920-1950. Between 1920 and 1940, approximately fifty percent of mortgage loans issued by commercial banks were unamortized contracts. For life insurance companies, approximately 20 percent in the period 1920-1934 were non-amoritizing while the percent of non-amoritizing loans for saving and loans associations did not exceed 7 percent of this same period. However, over the period 1940-1946, Saulnier (1950) reports that 95 percent of mortgage loans issued by saving and loan associations were fully amortizing. Over approximately the same period, Behrens (1952) claims 73 percent of loans issued by commercial banks were fully amortized and Edward (1950) finds 99.7 if saving and loan association contracts were fully amortized.

However, the belief that mortgage contracts in the early years were of short duration and with low loan-to-value ratio is accurate. In Table 2, mortgage durations are presented for loans originated by saving and loan associations, commercial banks, and saving and loan associations. As can be seen, for the period 1920 to 1930, the average duration was between 6 and 11 years. After 1934, the length of mortgages increased and started to approach 20 year mortgages. This was especially true for mortgages offered by life insurance companies. Loan-to-value ratios also changed over this period. For the 1920-34 subsample, loan-to-value rations were around 50. After 1934, loan-to-value ratios began to increase, and by 1947 this ratio started to approached 80 percent.

**Table 3: Properties of Mortgage Contracts between 1920 and 1950 (Yearly Average)**

| | **Mortgage Duration** | | | **Loan-to-Value Ratio** | | |
|---|---|---|---|---|---|---|
| Period | Life Insurance Companies | Commercial Bank | S & L Associations | Life Insurance Companies | Commercial Bank | S & L Associations |
| 1920-24 | 6.4 | 2.8 | 11.1 | 47 | 50 | 58 |
| 1925-29 | 6.4 | 3.2 | 11.2 | 51 | 52 | 59 |
| 1930-34 | 7.4 | 2.9 | 11.1 | 51 | 52 | 60 |
| 1935-39 | 16.4 | 11.4 | 11.4 | 63 | 63 | 62 |
| 1940-44 | 21.1 | 13.1 | 13.1 | 78 | 69 | 69 |
| 1945-47 | 19.5 | 12.3 | 14.8 | 73 | 75 | 75 |

Source: Data for life insurance companies is from R. J. Sailnier, Urban Mortgage Lending by Life Insurance Companies, National Bureau of Economic Research, 1950, for commercial banks is from C. F. Behrens, Commercial Bank Activities in Urban Mortgage Financing, National Bureau of Economic Research, 1952, and saving and loan association is from J. E. Morton, Urban Mortgage Lending: Comparative Markets and Experience, Princeton University Press, 1956.

An obvious question is why did mortgage contracts start to change after 1934? Prior to 1930, there was little federal involvement in housing except for land grants as exemplified by the 1862 Homestead Act. The Great Depression changed government's role in residential housing. As a result of the foreclosure problem that coincided with the 1929 collapse, Congress responded initially with Home Loan Bank Act of 1932. This Act brought thrift institutions under the Federal regulation umbrella. The Home Owners Loan Act Bank (1933) and the 1934 National Housing Act were passed. These Acts were designed to stabilize the financial system. The National Housing Act established the Federal Housing Administration(FHA) which introduced a government guarantee in hopes of spurring construction.[4] The FHA home mortgage was initially a 20-year, fully amortizing loan with a maximum loan-to-value ratio of 80 percent. Carliner (1989) argues that the introduction of this loan contract influenced the behavior of existing lenders, thus partially explaining the data trends presented in Table 2. The contract took time to be implemented as state laws limiting loan-to-value ratios had to be modified. The FHA also added restricted design, construction and underwriting standards. These government programs, that were part of "New Deal" legislation, are thought to have increased homeowner participation.

A second government policy that could impact home ownership, especially after 1950, was federal guarantees for individual mortgage loans. Because of the treatment of veterans after World War I, Congress passed the Servicemen's Readjustment Act of 1944, or the "GI Bill."[5] This program was a benefit to veterans. Initially no downpayments were required on the theory that soldiers were not paid enough to accumulate savings and did not have an opportunity to establish a credit rating. Here are the relevant aspects of this program. Under the original VA loan guarantee program, the maximum amount of guarantee was limited to 50% of the loan, and not to exceed $2000. Loan durations were limited to 20 years, with a maximum interest rate of 4%. These ceilings were eliminated when market interest rates greatly exceeded this ceiling. The VA also set the price of the home. Because of rising house prices in 1945 the maximum amount of the guarantee to lenders was increased to $4,000 for home loans. The maximum maturity for real estate loans was extended to 25 years for residential homes. In 1950, the maximum amount of guarantee was increased to 60% of the amount of the loan with a cap of $7,500. The maximum length of a loan was lengthened to 20 years.

Were these programs quantitatively significant? In Table 3, the value of FHA and VA mortgage are reported as well as the relative importance of these mortgages in the total home mortgage market. While these government mortgage programs took a while to have an impact, by 1940, FHA and VA mortgages accounted for 13.5 percent of mortgages, and by 1945 these mortgages accounted for nearly a quarter of mortgages. In 1950 the home mortgage share of FHA and VA mortgages was 41.9 percent. The increased role of these government programs is due to the growth of VA mortgage contracts. Between 1949 and 1953, VA mortgage loans averaged 24.0 percent of the market. Clearly, these statistics suggest the VA mortgage program may have had a significant effect on home ownership and seem to support Fetters(2010) claim that the VA program lead to a 10

[4] Marriner Eccles (1951), who was a central figure in the development of the FHA made it clear the the main intent of the program was "pump-priming" and not reform of the mortgage market.

[5] A "veteran" mean an individual served at least 90 days on active duty and was discharged or released under conditions other than dishonorable. Service time was much higher some an individual who was in the military, but not on active duty. For World War II active duty was between September,1940 to July 1947. The Korean conflict was the period June, 1950 to January 1955.

percent increase in the home ownership rate.

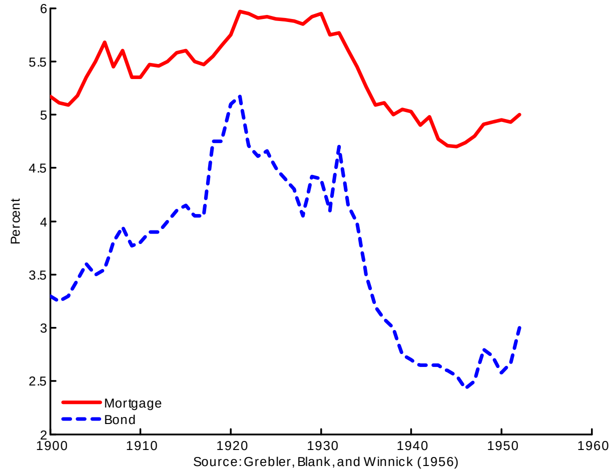
**Table 4: The Role of Government Mortgage Debt for Home Mortgages: 1935 to 1953 (in millions)**

| | FHA | VA | Combined | Total Home Mortg. | FHA and VA Home Mortg. (% total) |
|---|---|---|---|---|---|
| 1936 | $12 | | 12 | | |
| 1936 | 203 | | 203 | 15,615 | 1.3 |
| 1937 | 594 | | 594 | 15,673 | 3.8 |
| 1938 | 967 | | 967 | 15,852 | 6.1 |
| 1939 | 1755 | | 1755 | 16,402 | 10.7 |
| 1940 | 2349 | | 2349 | 17,400 | 13.5 |
| 1941 | 3030 | | 3030 | 18,364 | 16.5 |
| 1942 | 3742 | | 3742 | 18,254 | 20.5 |
| 1943 | 4060 | | 4060 | 17,807 | 22.8 |
| 1944 | 4190 | | 4190 | 17,983 | 23.3 |
| 1945 | 4078 | $500 | 4578 | 18,534 | 24.7 |
| 1946 | 3692 | 2,600 | 6292 | 23,048 | 27.3 |
| 1947 | 3781 | 5,800 | 9581 | 28,179 | 34.0 |
| 1948 | 5269 | 7,200 | 12469 | 33,251 | 37.5 |
| 1949 | 6906 | 8,100 | 15006 | 37,515 | 40.0 |
| 1950 | 8563 | 10,300 | 18863 | 45,019 | 41.9 |
| 1951 | 9677 | 13,200 | 22877 | 51,875 | 44.1 |
| 1952 | 10770 | 14,600 | 25370 | 58,188 | 43.6 |
| 1953 | 11990 | 16,100 | 28090 | | |

Source: Grebler, Blank, and Winnick (1956), p243.

The important changes in the mortgage market could have implications for mortgage interest rates. Unfortunately, mortgage interest rate are more difficult to find for this period. Grebler, Blank, and Winnick (1956, Table O-1, p. 496) report a mortgage rate series for Manhattan between 1900 and 1953 as well as a bond yield. As can be seen in Figure 3, the mortgage interest rate was 5.11 percent in 1900, while the bond yield was 3.25.

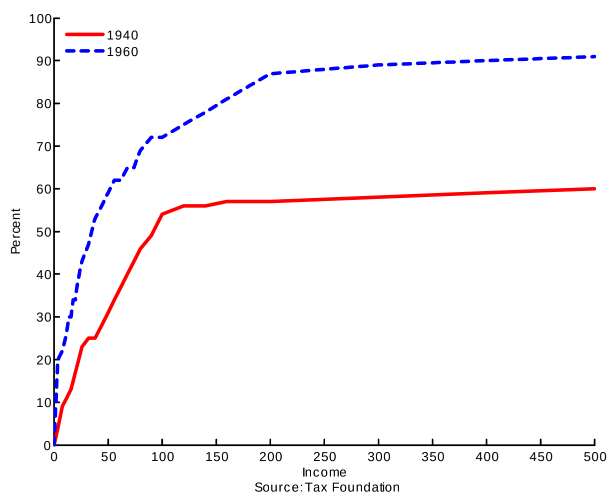
**Figure 5: Bond and Mortgage Rates: 1900-1953**




Between 1900 and 1930, both interest rates had an increasing trends (see Figure 2). After 1930 mortgage interest rates declined from 5.95 percent down to around 4.9 percent. This partially reflected an easy money policy clearly seen in the large decline in bond yields over this period. Some economic historians have used this information to argue that an easy money policy played a large role in the increase in home ownership., but it could also be due to the elimination of regional lending and a more homogeneous credit market.

Rosen and Rosen (1980) have argued that tax policy changes introduced an incentive to purchase homes. The Tax Foundation has constructed marginal tax rates by income level for 1935 and 1960. In Figure 3, the marginal taxes for each year is presented. As can be seen, marginal tax rate were substantially lower in 1935.

**Figure 6: Marginal Tax Rates in 1935 and 1960**




Source: Tax Foundation (http://www.taxfoundation.org)

In fact, the highest marginal tax rate in 1935 was 63 percent for tax households earning $2 million or more. In 1960, the top marginal rate was 91 percent for households over $200,000. Figure 3 shows evidence that fiscal policy code have fostered an increase in the home ownership rate. On the margin, the increased tax rates give home ownership a greater preference in the tax code give the deductibility of mortgage interest.

# 3 Equilibrium Model of Tenure Choice

Using a deterministic static equilibrium problem, this section establishes the basic forces that determine the co-movement between homeownership and house prices. The quantitative analysis developed in the next section develops a dynamic version of this model and incorporates additional features to quantify the relative importance of the various drivers discussed in the literature.

Consider a two-sector economy that produces consumption goods and housing. The agents are ex-ante heterogeneous in their labor ability $\varepsilon \in [\underline{\varepsilon}, \overline{\varepsilon}]$, where the ability distribution is uniform $\varepsilon \tilde{} U(\underline{\varepsilon}, \overline{\varepsilon})$. There are three commodities in the model. Consumption goods is perfectly divisible, $c \in R_+$, housing is a discrete good with only one type of homes available, $h \in \{0, \overline{h}\}$.[6] Each individual can supply labor efficiency units of labor, $\varepsilon$, to each sector but in equilibrium they should be indifferent on where to work. Preferences over consumption bundles $(c, h)$ are represented by a utility function $u(c, h) = c(\gamma + h)$, where the parameter $\gamma > 0$ can be interpreted as a reservation value for rental housing. As $\gamma \to 0$, owner-occupied housing is more desirable. Each sector has access to linear technologies where labor is the only input, $C = z_c N_c$, and $H = z_h N_h$ where the terms $A$ and $Z$ represent the relative productivity of each sector.

**Consumer problem:** The optimization problem for the consumer is

$$\begin{aligned} v(\varepsilon) = \max_h \{ & u^r(c^r, 0), u^o(c^o, \overline{h}), \\ s.t. \qquad & c^o = w\varepsilon - (p\overline{h} + \phi), \\ & c^r = w\varepsilon, \end{aligned}$$

where $w$ represents the income from wages, $p$ is the house price, and the price of consumption goods is been normalized to one. The term $\phi$ represents an exogenous transaction cost associated to buying a house measured in terms of consumption goods. The optimal decision rule determines a cut-off level of ability necessary to purchase owner-occupied housing. For the specified preferences and under the necessary assumptions for an interior solution, the threshold of homeownership, $\varepsilon^*$, is characterized by

$$\varepsilon^* \geq \frac{p}{w}(\gamma + \overline{h}) + \frac{\phi}{w\overline{h}}.$$

In the model, the determinants of ownership are the cost of housing relative to income, $p/w$, the minimum size available, $\overline{h}$, transaction costs, $\phi$, and the reservation value of rental housing, $\gamma$.[7] The comparative statics are straight forward. Increases in the house price, minimum size, transaction costs, and reservation utility from renting increase the

[6] The implicit assumption is that renters consume zero housing and homeowners consume a positive amount. It is direct to extend the model to allow the purchases of different size homes, but introduces unnecessary notation.

[7] When the transaction cost is proportional to the value of the house. The budget constraint of the buyer is slightly different $c^o = w\varepsilon - (p + \phi)\overline{h}$ and the homeownership threshold is $\varepsilon^* \geq \frac{(p+\phi)}{w}(\gamma + \overline{h})$.

income threshold, whereas a wage increase decreases it. These variables summarize the main drivers that according to the literature changed the homeownership rate between 1940 and 1960. To calculate the equilibrium threshold of ownership, it is necessary to determine the house price and wages. Each sector has a competitive market and firms need to hire workers to produce goods. The total employment is determined by aggregation of abilities across individuals, $N = \int_{\underline{\varepsilon}}^{\overline{\varepsilon}} \varepsilon f(\varepsilon) d\varepsilon = (\overline{\varepsilon} + \underline{\varepsilon})/2$.

**Goods sector:** The consumption goods sector solves

$$\max_{N_c} z_c N_c - w N_c,$$

and implies that wages equal the marginal product (cost) of labor, $w = z_c$.

**Housing sector:** The housing sector solves a similar problem

$$\max_{N_h} p z_h N_h - w N_h.$$

The equilibrium house price is determined by the ratio of marginal costs of production, $p = z_c/z_h$. Replacing the equilibrium prices, the threshold for homeownership is given by

$$\varepsilon^* \geq \frac{(\gamma + \overline{h})}{z_h} + \frac{\phi}{z_c \overline{h}}.$$

Each sector level of production has to be consistent with these prices. The notion of competitive equilibrium is formalized below.

**Equilibrium:** *Given $\phi$, a competitive equilibrium are decision rules $\{\widehat{c}(\varepsilon), \widehat{h}(\varepsilon), N_c, N_h\}$ and prices $\{p, w\}$ that solve i) the consumer problem, ii) firms in each sector maximize profits, and iii) markets clear*

- *Labor market:*

$$N_c + N_h = N.$$

- *Goods market:*

$$\int_{\underline{\varepsilon}}^{\overline{\varepsilon}} \widehat{c}(\varepsilon) f(\varepsilon) d\varepsilon + \phi \int_{\varepsilon^*}^{\overline{\varepsilon}} f(\varepsilon) d\varepsilon = z_c N_c.$$

- *Housing market:*

$$\int_{\varepsilon^*}^{\overline{\varepsilon}} \widehat{h}(\varepsilon) f(\varepsilon) d\varepsilon = z_h N_h.$$

The total demand for housing is unchanged aside from the different cut-off point that depends on the fixed cost.

$$H(p) = \widehat{h} \frac{(\overline{\varepsilon} - \varepsilon^*(p))}{(\overline{\varepsilon} - \underline{\varepsilon})} = \frac{\widehat{h}}{(\overline{\varepsilon} - \underline{\varepsilon})} \left[ \overline{\varepsilon} - \frac{(\gamma + \overline{h})}{z_h} - \frac{\phi}{z_c \overline{h}} \right],$$

and for the goods total demand

$$C(p) = \frac{A(\overline{\varepsilon} + \underline{\varepsilon})}{2} - p\widehat{h} \left[ \frac{\overline{\varepsilon} - \varepsilon^*(p)}{\overline{\varepsilon} - \underline{\varepsilon}} \right]$$

The house price has to effects in the demand for goods. Holding constant the faction of homeowners, as the price increases the aggregate demand of consumption goods falls. However as the price increases, the fraction of individuals the are homeowners all $\partial\varepsilon^*(p)/\partial p < 0$. The employment across sectors is given by

$$N_h = \frac{\widehat{h}}{z_h(\overline{\varepsilon} - \underline{\varepsilon})}\left[\overline{\varepsilon} - \frac{(\gamma + \overline{h})}{z_h} - \frac{\phi}{z_c\overline{h}}\right],$$

and

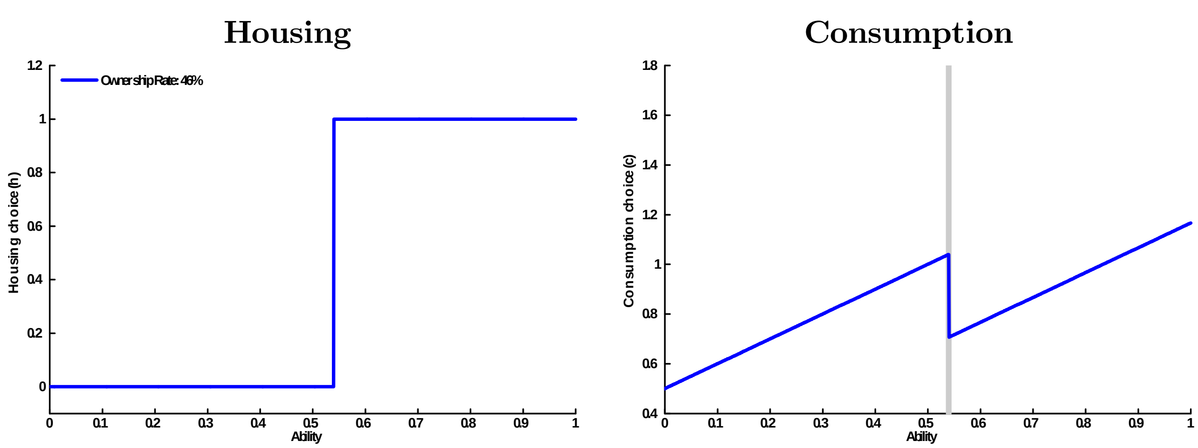
$$N_c = \frac{(\overline{\varepsilon} + \underline{\varepsilon})}{2} - \frac{\overline{h}}{z_h(\overline{\varepsilon} - \underline{\varepsilon})}\left[\overline{\varepsilon} - \frac{(\gamma + \overline{h})}{z_h} - \frac{\phi}{z_c\overline{h}}\right]$$

where this condition clearly satisfies the aggregation, $N_c = N - N_h$.

**Comparative statics:** The closed form solution of the model makes the comparative statics are very simple. This section illustrates some of the mechanism that operate in the quantitative model. The optimal decision rules have been calculated under parameterization designed to match the home ownership rate in 1940 around 45 percent. In particular, $z_c = 1$, $z_h = 3$, $\gamma = 2.12$, $\overline{h} = 1$, $\underline{\varepsilon} = 0.5$, and $\overline{\varepsilon} = 1.5$.

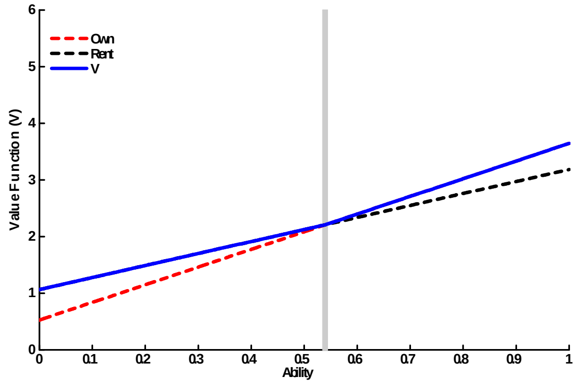
The optimal policy functions for housing and consumption are not convex. The consumption function exhibits a discrete jump, after the purchase the consumption level drops and then slowly increases.

**Figure 6: Optimal Decision Rules**




Despite the drop in consumption, the value function for home owners is higher than those that can only afford to rent.

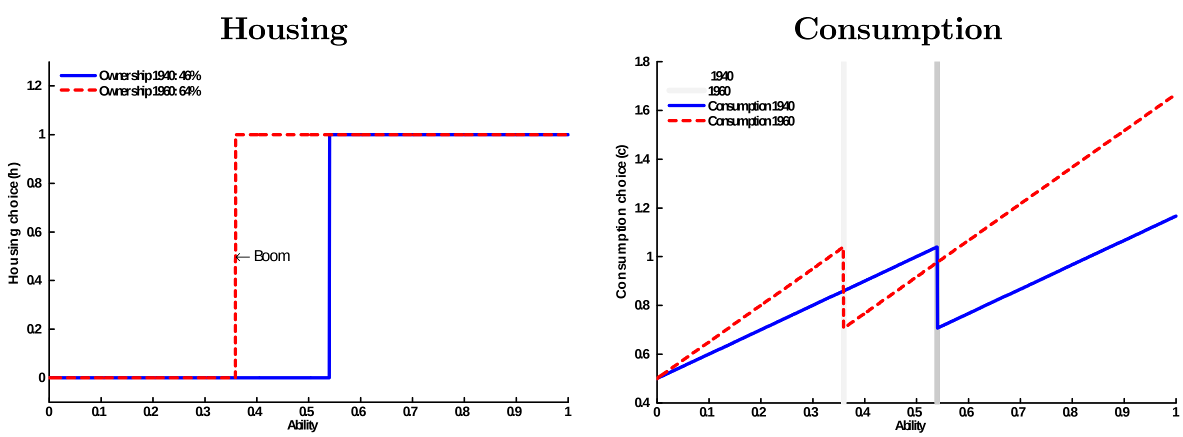
**Figure 7: Optimal Value Function**




Beyond the threshold, the marginal utility of consumption drops, and the household is better off buying a home. For low income households, the home is too expensive and requires a large sacrifice in consumption that provides suboptimal utility.

One way to simulate the housing boom between 1940 and 1960 is to assume that upperbound on the distribution of ability ($\overline{\varepsilon}$) increases from 1.5 to 2. In this case there is a larger number of individuals earning above threshold's income. The result is a new cut-off rule and a larger fraction of individuals becoming homeowners.

**Figure 8: Change in Decision Rules: 1940 vs 1960**




The higher income increases the number of individuals above the cut-off, and increases the consumption across all income levels. The home ownership rate increases from 46 percent to 64 percent. In this example, the price of housing has remained constant. To discuss the co-movement between house prices and homeownership could be sufficient to increase $z_c$ and simultaneously reduce the transaction costs of housing, $\phi$.

**Extension to multiple inputs:** In this model the production of homes only used labor inputs. In a more general framework, the production of homes requires additional inputs such as equipment, materials. A generalization with a constant returns to scale technology with multiple inputs is direct. Consider the case where housing is produced using a technology $F(K_h, N_h, X_h) = z_h K_h^a N_h^b X_h^{1-a-b}$ where $K_h$ represents capital, $N_h$

represents labor, and $X_h$ represent other construction inputs. Let $r$ represent the rental cost of capital, and $q$ the cost of construction inputs. The optimality condition determines the relative price of homes as a function of the marginal cost of construction

$$p = \frac{1}{z_h a^a b^b (1-a-b)^{(1-a-b)}} (r)^a (w)^b (q)^{(1-a-b)}$$

In this framework, the price of houses is entirely determined by fundamentals. Any changes in economic conditions will affect relative costs of construction and move house prices. The empirical evidence presented in Section 2 seems to suggest that a log-linearized version of this expression

$$\log(p) = \log\left(\frac{1}{z_h a^a b^b (1-a-b)^{(1-a-b)}}\right) + a\log(r) + b\log(w) + (1-a-b)\log(q) + \epsilon$$

accounts for the majority of the change in house prices between 1940 and 1960.

# 4 Quantitative Model

The model is three sector overlapping generations economy with housing and long-term mortgages. The economy consists of households, a final goods-producing sector, a construction sector producing homes, a rental property sector, a mortgage lending sector, and the government.

## 4.1 Households

**Age Structure.** The economy is populated by life-cycle households that are *ex-ante* heterogeneous. Let $j$ denote the age of an individual and let $J$ represent the maximum number of periods an individual can live. At every period, an individual faces mortality risk and uninsurable labor earning uncertainty. The survival probability, conditional on being alive at age $j$, is denoted by $\psi_{j+1} \in [0,1]$, with $\psi_1 = 1$, and $\psi_{J+1} = 0$. Earnings uncertainty implies that the individual is subject to income shocks that cannot be insured via private contracts. As usual in this class of models annuity markets for mortality risk are absent. The lack of these insurance markets creates a demand for precautionary savings to minimize fluctuations in consumption of goods and housing.

**Asset Structure.** Individuals have access to a portfolio of two assets to mitigate income and mortality risk. A financial asset denoted by $a'$ with a net return $r$ and a housing durable good denoted by $h'$ with a market price $p$ where the prime is used to denote future variables. This assumption simplifies the problem because households do not need to anticipate changes in house prices. A housing investment of size $h'$ can be thought of as the number of square feet in the house. A house of size $h'$ yields $s$ services.[8] If a household does not invest in housing, $h = 0$, the household is a renter and must purchase housing services from a rental market. The rental price of a unit of housing services is $R$.

[8]For the sake of simplicity, we assume a linear relationship between house and services generated. In other words, $s = h'$.

**Mortgage Contracts.** Housing investment is financed through long-term mortgage contracts. These contracts have a general recursive representation. Consider the expenditure associated with purchase of a house of size $h$ (i.e. square feet ) with a unit price $p$ (per square feet). In general, a mortgage loan requires a downpayment equal to $\chi$ percent of the value of the house. The amount $\chi ph$ represents the amount of equity in the house at the time of purchase, and $D_0 = (1-\chi)ph$ represents the initial amount of the loan. In a particular period, $n$, the borrower faces a payment amount $m_n$ (i.e., monthly or yearly payment) that depends on the size of the original loan $D_0$, the length of the mortgage, $N$, and the mortgage interest rate, $r^m$. This payment can be subdivided into an amortization, (or principal) component, $A_n$, which is determined by the amortization schedule, and an interest component $I_n$, which depends on the payment schedule. That is,

$$m_n = A_n + I_n, \qquad \forall n. \tag{1}$$

where the interest payments are calculated by $I_n = r^m D_n$.[9] An expression that determines how the remaining debt, $D_n$, changes over time can be written as

$$D_{n+1} = D_n - A_n, \qquad \forall n. \tag{2}$$

This formula shows that the level of outstanding debt at the start of period $n$ is reduced by the amount of any principal payment. A principal payment increases the level of equity in the home. If the amount of equity in a home at the start of period $n$ is defined as $H_n$, a payment of principal equal to $A_n$ increases equity in the house available in the next period to $H_{n+1}$. Formally,

$$H_{n+1} = H_n + A_n, \qquad \forall n, \tag{3}$$

where $H_0 = \chi ph$ denotes the home equity in the initial period.

Prior to the Great Depression the typical mortgage contract was characterized by no amortization and a balloon payment at termination. A balloon loan is a very simple contract in which the entire principal borrowed is paid in full in last period, $N$. The amortization schedule for this contract can be written as:

$$A_n = \begin{cases} 0 & \forall n < N \\ (1-\chi)ph & n = N \end{cases}.$$

This means that the mortgage payment in all periods, except the last period, is equal to the interest rate payment, $I_n = r^m D_0$. Hence, the mortgage payment for this contract can be specified as:

$$m_n = \begin{cases} I_n & \forall n < N \\ (1+r^m)D_0 & n = N \end{cases},$$

where $D_0 = (1-\chi)ph$. The evolution of the outstanding level of debt can be written as

$$D_{n+1} = \begin{cases} D_n, & \forall n < N \\ 0, & n = N. \end{cases}.$$

[9] The calculation of the mortgage payment depends on the characteristics of the contract, but for all contracts the present value of the payments must be equal to the total amount borrowed, $D_0 \equiv \chi ph = \sum_n^N m_n/(1+r)^n$.

With an interest-only loan and no changes in house prices, the homeowner never accrues additional equity beyond the initial downpayment until the final mortgage payment is made. Hence, $A_n = 0$ and $m_n = I_n = r^m D_0$ for all $n$. In essence, the homeowner effectively rents the property from the lender and the mortgage (interest) payments are the effective rental cost. As a result, the monthly mortgage payment is minimized because no periodic payments toward equity are made. A homeowner is fully leveraged with the bank with this type of contract. If the homeowner itemizes tax deductions, a large interest deduction is an attractive by-product of this contract.

After the Great Depression, FHA sponsored a new mortgage contract characterized by a longer duration, lower downpayment requirements (i.e., higher loan-to-value ratios), and self-amortizing with a mortgage payment comprised of both interest and principal. This loan product is characterized by a constant mortgage payment over the term of the mortgage, $m \equiv m_1 = ... = m_N$. This value, $m$, must be consistent with the condition that the present value of mortgage payments repays the initial loan. That is,

$$D_0 \equiv \chi p h = \sum_n^N \frac{m}{(1+r)^n}.$$

If this equation is solved for $m$, we can write $m = \lambda D_0$, where $\lambda = r^m[1-(1+r^m)^{-N}]^{-1}$. Because the mortgage payment is constant each period, and $m = A_t + I_t$, the outstanding debt decreases over time $D_0 > ... > D_N$. This means the fixed payment contract front loads interest rate payments,

$$D_{n+1} = (1+r^m)D_n - m, \qquad \forall n,$$

and, thus, back-loads principal payments, $A_n = m - r^m D_n$. The equity in the house increases each period by the mortgage payment net of the interest payment component, $H_{n+1} = H_n + [m - r^m D_n]$ every period.

**Household Income.** Household income varies over the life-cycle and depends on whether the household is a worker or a retiree, the return from savings and transfer programs, and the income generated from the decision to rent property when a homeowner. Households supply their time endowment inelastically to the labor market and earn wage income, $w$, per effective unit of labor. Household's productivity depends on an age component, $\upsilon_j$, and a transitory age-dependent idiosyncratic component $\epsilon_j$ drawn from a age-specific probability distribution $\Pi_j(\epsilon_j)$. For an individual younger than $j^*$, labor earnings are then $w\epsilon_j\upsilon_j$. Households of age $j^*$ or older receive a social security transfer that is proportional to average labor income, and is defined as $\theta$. Pretax labor earnings are defined as $y_w$, where

$$y_w(\epsilon, j) = \begin{cases} w\epsilon_j\upsilon_j, & \text{if } j < j^* \\ \theta, & \text{if } j \geq j^* \end{cases}.$$

A second source of income is available to households who invest in housing and decide to rent part of their investment. A household that does not to consumes all housing services, $h' > d$, can pay a fixed cost $\varpi > 0$ is paid, and receive rental income $y_R(h', d)$

$$y_R(h', d) = \begin{cases} R(h'-d) - \varpi, & \text{if } h' > d \\ 0, & \text{if } h' = d \end{cases}$$

Saving and transfers provide an additional sources of income. Households with positive savings receive $(1+r)a$. The transfers are derived from the households that die with positive wealth. The value of all these assets is uniformly distributed to the households that remain alive in an equal lump sum amount of $tr$. The (pre-tax) income of a household, $y$, is simply

$$y(h', a, \epsilon, d, j) = y_w(\epsilon, j) + y_R(h', d) + (1+r)a + tr$$

The various income sources generate a tax obligation of $T$, which depends on labor income, $y_w$ , net interest earnings from savings, $ra$, rental income, $y_R$, less deductions that are available in the tax code, $\Omega$. Examples of deductions could be the interest payment deduction on mortgage loans or maintenance expenses associated with tenant-occupied housing. Total tax obligations are denoted as

$$T = T(y_w(\epsilon, j) + ra + y_R(h', d) - \Omega).$$

**Preferences.** Individual preferences rank goods (consumption and housing) according to a momentary utility function $u(c, d)$. This function satisfies the usual properties of differentiability and Inada conditions.

**The Household Decision Problem.** A single household budget constraint can not be easily written for this problem. The reason is that the households makes tenure decisions. In each period a renter could purchase a home, or a homeowner could change the size of their house or even become a renter. Hence, the household's budget constraint depends on the value of the current state variables. The relevant information at the start of the period is the level of asset holding, $a$, the housing investment, $h$, the mortgage counter, $n$, and age, $j$. To simplify notation, let $x = (a, h, n, j)$ summarize the household's state vector. A household could face a number of budget constraints depending on the tenure decision. Individuals make decisions over consumption goods, $c$, housing services, $d$, and investment in assets, $a'$, and housing, $h'$. Table 3 summarizes the five distinct decision problems that a household must solve.

**Table 5: Basic Structure of the Model**

| | |
|---|---|
| **Current renter:** $h = 0$ | Continues renting $h' = 0$ |
| | Purchases a house $h' > 0$ |
| **Current owner:** $h > 0$ | Stays in house: $h' = h$ |
| | Change size (Upsize or downsize): $h' \neq h$ |
| | Sell and rent: $h' = 0$ |

The state variables of the consumer problem are characterized by their asset holding, $a$, investment position in housing, $h$, mortgage debt, $b$, mortgage choice, $z$, the idiosyncratic income shock, $\epsilon$, age, $j$, and the purchase price of the property, $P$. Formally, the household state is summarized by $s = (a, h, b, z, \epsilon, j; P)$. Next, we formally describe the household optimization problem for each case. We start with problem of an individual that starts as a renter, and then we consider the decision problem of the individual that starts as a homeowner.

- **Renters:** A household that begins the period renting and has the option of continue renting ($h' = 0$) or purchase a house ($h' > 0$). The discrete choice problem is given by
$$v(a, 0, 0, 0, \epsilon, j; P) = \max\{v^r, v^o\}.$$
  - **Continue renting:** The value associated to continue renting is determined by the choice of consumption, $c$, housing services, $d$, and asset holdings, $a$, that solve
$$v^r(a, 0, 0, 0, \epsilon, j; P) = \max_{c,d,a'} \left\{u(c, d) + \beta_{j+1} E_{\epsilon'}[v(a', 0, 0, 0, \epsilon', j + 1; P')]\right\},$$
$$\begin{aligned} s.t. \quad c + a' + Rd &= y + (1 + r)a, \\ a' &\geq 0. \end{aligned}$$
    Notice that the restriction in the choice set indicates that asset markets are incomplete since individuals only have access to an uncontingent asset and borrowing via this asset is precluded.
  - **Purchase a house:** When an individual that rents purchases a house solves a different problem with a larger number of choices. This decision problem solves
$$v^o(a, 0, 0, 0, \epsilon, j; P) = \max_{\substack{c,d,a' I_r \in \{0,1\} \\ z' \in \mathcal{Z}}} \left\{u(c, d) + \beta_{j+1} E_{\epsilon'}[v(a', h', b', z', \epsilon', j + 1; P')]\right\},$$
$$\begin{aligned} s.t. \quad c + a' + (\phi_b + \chi(z'))ph' + i(z')b' &= y(I_r) + (1 + r)a, \\ b' &= (1 - \chi(z'))ph', \\ a' \geq 0,\ P' &= p. \end{aligned}$$
    In this formulation the interest payments are prepaid, so when the home is foreclosed the homeowner only defaults on the outstanding principal. The initial interest

  The choice of whether to continue renting or purchase a home is determined by the highest value between $v^r(s)$ and $v^o(s)$. When $v^r(s) > v^o(s)$ the individual continues to rent otherwise becomes a homeowner.

- **Owners:** The decision problem for an individual that starts the period owning a house ($h > 0$) has more choices. The homeowner can choose to stay in the house ($h' = h$), purchase a different house ($h' \neq h$), or become a renter ($h' = 0$). In addition, anytime that the homeowner chooses to sell the property, the transacted price is subject to the capital gains shock, $\xi \in \Xi$, and can choose to foreclose the property.

$$v(a,h,b,z,\epsilon,j;P) = \max\{v^m, v^e, v^b\}.$$

The different value functions are calculated by solving three subproblems.

– **Stay same house:** The value function associated to stay in the same house is given by

$$v^m(a,h,b,z,\epsilon,j;P) = \max_{\substack{c,d,a' I_r \in\{0,1\} \\ z'\in\mathcal{Z}}} \left\{u(c,d) + \beta_{j+1} E_{\epsilon'}[v(a',h,b',z,\epsilon',j+1;P')]\right\},$$

$$\begin{aligned} s.t. \quad c + a' + ph' + b + i(z')b' &= y(I_r) + (1+r)a + b' + ph', \\ b' &= g(b,z,P), \\ a' &\geq 0,\ P' = P \end{aligned}$$

**The case of prepayments:** When prepayment options are available, the law of motion for mortgage debt allows an inequality, $b' \geq g(b,z,P)$. In this situation, the borrow must pay the recommended amount of debt, $b'$, but the bank allows larger payments to contribute to principal. Given our timing of interest prepayment, a reduction of the debt also reduces the cost of financing and increases the future contributions of principal by shortening the length of the mortgage contract. When prepayment is not an option, the length of the loan is determined by the specifics of each contract, $N(z)$.

– **Sell current property and rent or buy:** For the individuals that choose the sell the current property, $h$, the default option becomes available, $V^d(\varphi_d)$. Among those that sell, some individuals prefer to exit the housing market and rent property where $v^e$ represents their value function, and others prefer to buy a different size house $h' \neq h$ (larger or smaller than the previous one) where the term $v^b$ represents their value function. It is important to note that the capital gain shock is realized after the selling decision has been made. For the individuals that sell and rent we solve

$$v^e(a,h,b,z,\epsilon,j;P) = \max_{c,d,a',\varphi_d,I_r\in\{0,1\}} E_{\xi,\epsilon'}\left\{u(c,d,\varphi_d) + \beta_{j+1} v(a',0,0,0,\epsilon',j+1;P')\right\},$$

$$\begin{aligned} s.t. \quad c + a' + b + Rd &= y(I_r) + (1+r)a + V^d(\varphi_d) \\ V^d(\varphi_d) &= \begin{cases} 0 & \text{when } \varphi_d = 1 \\ (1-\phi_s)p\xi h - b & \text{when } \varphi_d = 0 \end{cases}, \\ b' &= 0,\ a' \geq 0,\ P' = p. \end{aligned}$$

The individual that purchases a different house size, $h' \neq h$, solves

$$v^b(a,h,b,z,\epsilon,j;P) = \max_{\substack{c,d,a',\varphi_d,I_r\in\{0,1\} \\ z'\in\mathcal{Z}}} E_{\xi,\epsilon'}\left\{u(c,d,\varphi_d) + \beta_{j+1} v(a',h',b',z',\epsilon',j+1;P')\right\},$$

$$
\begin{aligned}
s.t. \quad & c + a' + (\phi_b + \chi(z'))ph' + i(z')b' = y(I_r) + (1+r)a + V^d(\varphi_d), \\
& V^d(\varphi_d) = \begin{cases} 0 & \text{when } \varphi_d = 1 \\ (1-\phi_s)p\xi h - b & \text{when } \varphi_d = 0 \end{cases}, \\
& b' = (1-\chi(z'))ph', \\
& a' \geq 0,\ P' = p.
\end{aligned}
$$

## 4.2 Mortgage Lending Sector

The financial intermediary is a zero-profit firm. This firm receives deposits from households, $a'$, and uses these funds to make loans to firms and households. Firms acquire loans of capital to produce goods, and households use long-term mortgages to finance housing investment. This formulation does not derive the optimal mortgage contract from the model primitives. It takes the contract structure available during a period as given and imposes the mortgage structure as a constraint. Conditional on the legal lending arrangements, lenders provide credit and receive flows of payments to maximize profits. In addition, financial intermediaries receive principal payments from those individuals who sell their homes with an outstanding mortgage position, as well as the outstanding principal of individuals who unexpectedly die.[10]

## 4.3 Construction Sector

The stock of new homes is produced by a competitive real estate construction sector. Producers manufacture housing units using a Cobb-Douglas technology $\Gamma(K_h, L_h) = z_h K_h^{\alpha_h} L_h^{1-\alpha_h}$. The optimization problem of the representative firm in the construction sector is given by

$$
\begin{aligned}
\max_{K_h, L_h} \; & pI_H - (r+\delta_h)K_h - wL_h, \\
s.t. \quad & I_H = \Gamma(K_h, L_h).
\end{aligned}
$$

In competitive factor markets all sectors have to yield the same return. The first-order condition of the housing sector determines that the equilibrium house price must satisfy

$$
p = \widetilde{z}_h (r+\delta_h)^{\alpha_h} (w)^{1-\alpha_h},
$$

where $\widetilde{z}_h = 1/z_h \alpha_h^{\alpha_h}(1-\alpha_h)^{1-\alpha_h}$. The house prices is determined by the marginal cost of the the inputs used to produce one unit of housing. In this model, changes in the price of housing are entirely driven by changes in fundamentals.

New residential investment is added to the existing housing stock as either new units or as repairs of the existing stock. The aggregate law of motion for housing investment is

$$
I_H = (1+\rho_n)H' - H + \varkappa(H, \delta_o, \delta_r),
$$

[10] The formulation of the market clearing condition derived from zero profit on the lender side is available in an appendix available from the authors upon request.

where $\rho_n \geq 0$ represents the population growth rate. The depreciation of the housing stock $\varkappa(H, \delta_o, \delta_r)$ depends on utilization (i.e., owner- vs. tenant-occupied housing). The larger the size of the rental market, the larger the investment in housing repairs. If the depreciation rate is the same for owner-occupied and rental housing, $\delta_o = \delta_r$, then residential investment is linear in the stock, or $\varkappa(H, \delta_o, \delta_r) = \delta H$. All the aspects of the supply side of the market can be controlled by changing the technological parameter $z_h$. For example, shortages of materials can be capture by a decline in $z_h$, whereas innovations in the process of producing homes (i.e., Levittown on the East Coast) would be an increase in $z_h$.

## 4.4 Goods Sector

A representative firm produces a good in a competitive environment using a constant returns to scale Cobb-Douglas production function, $F(K_g, L_g) = z_g K_g^{\alpha_g} L_g^{1-\alpha_g}$, where $K_g$ and $L_g$ denote the amount of capital and labor used by the sector, and the term $\alpha_g$ represents the capital-income share. The aggregate resource constraint is given by

$$C + I_K + G + \Upsilon = F(K_g, L_g), \tag{4}$$

where $C$, $I_K$, $G$, and $\Upsilon$ represent aggregate consumption, capital investment, government spending, and transactions costs (i.e., resources used in the transaction of homes and leasing tenant-occupied property).[11]

## 4.5 Government Activities

In this economy, the government regulates markets by imposing particular lending arrangements on the mortgage loan market. It also provides tax provisions toward housing. In addition to these passive regulatory roles, the government plays a more active role through other programs. First, retirement benefits are provided through a pay-as-you-go social security program. Social security contributions are used to finance a uniform transfer upon retirement that represents a fraction of average income. Second, exogenous government expenditure is financed by using a nonlinear income tax scheme. The financing of government expenditure and social security is conducted under different budgets. Finally, the government redistributes the wealth (housing and financial assets) of individuals who die unexpectedly. Both housing and financial assets are sold and any outstanding debt on housing is paid off. The remaining value of these assets is distributed to the surviving households as a lump-sum payment.

## 4.6 Stationary Equilibrium

In the model, a stationary equilibrium includes optimal decisions that are a function of the individual state variables, prices, market clearing conditions, and a distribution over the state space $\Phi(x)$ that are constant over time.[12]

[11] The definitions for aggregate housing investment and total transaction costs appear in the appendix.

[12] A formal definition of the recursive equilibrium is available from the authors.

# 5 Quantitative Analysis

## 5.1 Parameterization

The objective of the paper is to quantify the role of government policy in housing markets during 1940-1960. During this period many other important changes occurred that could account for the large increase in the homeownership rate. In order to measure the role of government policy toward housing, other important factors must be incorporated into the model. Otherwise, the model could missmeasure the role of government policy. The methodology used in this paper incorporates the key factors that have been mentioned in the literature but focuses on counterfactual experiments pertaining to government housing policy. The change in ownership rates that occurs in these experiments allows us to quantify the importance of government housing policies over this period.[13]

The parameterization technique is based on moment estimation to replicate key properties of the U.S. economy between 1935 and 1940. This period is chosen to minimize the potential structural effects on the housing market due to the National Housing Act. While this act was passed in 1934, the substantive effects of this legislation did not begin to impact housing markets until late in the1930s. Some of the parameters are taken directly from data or other empirical work.

**Population Structure:** A period in the model corresponds to five years. An individual enters the labor force at age 20 (model period 1) and lives a maximum of 83 years (model period 14). Mandatory retirement occurs at age 65 (model period 11). The survival probabilities $\{\psi_{j+1}\}$ are from the National Center for Health Statistics, *United States Life Tables* (1935, 1940). The initial size of a cohort, $\mu_{ij}$, is endogenously determined by the share of these individuals at age 25 or younger and the population growth rate.

**Functional Forms:** The utility functions is CES specified as

$$u(c,d) = \frac{[\gamma c^{-\rho} + (1-\gamma)d^{-\rho}]^{-\frac{1-\sigma}{\rho}}}{1-\sigma},$$

where the parameters $\gamma, \sigma$, and $\rho$ need to be determined. The parameter $\sigma$ is set to 2, and the intertemporal elasticity of substitution is taken from the range of estimates in the literature and set to 1. The parameters $\gamma$, which measures the relative importance of consumption to housing services, and the discount rate $\beta$ are estimated. The first parameter, $\gamma$, is estimated to be consistent with a housing-to-consumption ratio of 0.180. The individual discount rate is determined to match a capital-output ratio for 1935 which was 2.54. The capital stock is defined as private fixed assets plus the stock of consumer durables less the stock of residential structures (to be consistent with the capital stock in the model). Output is gross domestic product (GDP) plus an estimate of the service flow from consumer durables less the service flow from housing.

Both productive sectors use a Cobb-Douglas technologies. The construction sector has a capital share $\alpha_h = 0.12$ and the goods sector's value is $\alpha_g = 0.3$. These values are based on average values on National Income and Product Accounts (NIPA) data for 1940-50. The depreciation rate in the goods sector is $\delta_g = 0.05$, whereas the depreciation

[13] The details of the full decomposition overall factors for the ownership rate are provided in a companion paper (see Chambers, Garriga, and Schlagenhauf , 2011).

of the construction sector and the relative productivities are parameterized to match the observed sectoral allocation of capital and labor, and the relative size of construction in the aggregate economy.

**Income Endowments:** A household's income depends on its education level, $i$. Four exogenous education levels are available: (1) fewer than 8 years of education, (2) 8 years of education, (3) fewer than 12 years of education, and (4) 12 or more years of education. For each education level, a household's income has two components; one is deterministic and the other is stochastic. These values of these components are constructed from Public Use Microdata Samples (PUMS) for the 1940 and 1960 Censuses. The deterministic, or life-cycle component, $\upsilon_{ij}$, is generated using the average salary and wage income by age and education. A polynomial is fit to age-specific averages per education to smooth this component. The determination of the uncertain component hinges on the available data. The reliance on Census data (which restricts data availability to once every ten years) does not allow the estimation of a serially correlated income process.[14] Our strategy is to assume the stochastic component, $\epsilon_{ij}$, is independent and identically distributed over education and age. This component of income, along with the associated probabilities, is estimated using a kernel density estimation for every age cohort, $\Pi_{ij}(\epsilon_{ij})$, for the cross section of individuals. Since the unit in the model is the household, the estimation considers only households that work full-time. Therefore, the model captures the dispersion of labor income for a given education. The initial distribution of ex-ante types is 0.11 for fewer than 8 years of education, 0.20 for 8 years of education, 0.43 for fewer than 12 years of education, and 0.25 for 12 or more years of education.

**Family Size:** The size of the average household family is constructed using Census data for the relevant years. Since the baby boom takes place during this period, the goal is to allow for the effects of changing household family size in the demand for owner-occupied housing. In a more detailed theory, changes in institutional arrangements could affect fertility decisions. In the model, the demographic structure is taken as exogenously determined and does not depend on education types.

**Government and the Income Tax Function:** In 1940, the U.S. Social Security program was in its infancy. The payroll tax rate for a worker was 1 percent of wage income. In addition, wage income for payroll tax purposes was capped at $3,000. The model uses a 30 percent replacement rate.

The income tax code in 1940 differentiated wage income from total net taxable income, which is equal to wage and interest income less interest payments such as mortgage interest payments. Each household receives an earned income credit. This credit is equal to 10 percent of wage income as long as net income is less than $3,000. If net income exceeds $3,000, the credit is calculated as 10 percent of the minimum of wage income or total taxable income. The tax credit is capped at $1,400. In addition to the earned income credit, each household received a personal exemption of $800. If these two credits are subtracted from total net taxable income, adjusted taxable income is determined. The

[14] Storesletten, Telmer, and Yaron (2004) find that income shocks have a persistent component even when you condition on all the observables. Their finding is based on a sample of household data over many periods from the Panel Survey on Income Dynamics. Other recent works (e.g., Castaneda, Diaz-Giminez, and Rios-Rull(2003) find that a smaller persistent component is needed once ex-ante heterogeneity is considered. Their model is constructed to generate the observed income and wealth differences.

actual tax schedules for 1940 and 1960 are programed to determine a household's tax obligation. The tax functions for 1940 and 1960 are summarized in Figure 3. For the 1940 tax code, the marginal tax rate is 0.79 which is applicable to income levels exceeding \$500,000. In 1940, an income tax surcharge is equal to an additional 10 percent must be included in the income tax obligation. The documentation for the 1940 tax code is the Internal Revenue Service and the Tax Foundation. To ensure that the income tax function generates the proper amount of revenue for 1940, an adjustment factor must be added to the tax code. This parameter can be considered as adding an intercept to the tax function. If too much revenue is generated, this parameter, $\tau_0$, can be reduced. This factor is estimated by targeting the personal income tax revenue-to-GDP ratio. In 1935, this ratio was 0.01.

**Housing:** In the baseline model, homeowners have two mortgages choices: a short-duration balloon loan restricted to 10 years with a 50 percent down payment and a 20-year FRM with a 20 percent down payment. Formally, $\chi(1) = 0.5$ and $\chi(2) = 0.2$. The transaction costs from buying and selling property are $\phi_s = 0$ and $\phi_b = 0.06$. The minimum house size, $\underline{h}$, is estimated to be consistent with the set of specified targets. The values $\delta_o$ and $\delta_r$ are from Chambers, Garriga, and Schlagenhauf (2009), where the annual depreciation rates for owner and tenant-occupied housing are $\delta_o = 0.0106$ and $\delta_r = 0.0135$, respectively.

**Wealth Endowments:** Bequests appear to have been an important source of homeownership for young households in 1940. Table 6 presents IRS data on real estate bequests in both 1940 and 1960.[15]

**Table 6: Real Estate Bequests in the United States (1940-1960)**

| Year | Returns | Gross Bequest Value(\$) | Mortgages and Debts(\$) | Net Bequest Value(\$) |
|---|---|---|---|---|
| 1940 | 16,156 | 2,649,492,000 | 229,866,000 | 2,419,626,000 |
| 1960 | 52,070 | 2,857,330,000 | 690,038,000 | 1,867,292,000 |

Source: Internal Revenue Service, Historical Data

Although the number of returns tripled between 1940 and 1960, the total gross value of real estate bequests grew by less that 10 percent. However, the amount of outstanding debt on bequeathed real estate more than tripled in the same 20-year period. As a result, the net value of real estate bequests actually dropped by 23 percent between 1940 and 1960. The apparent importance of real estate bequests in 1940 requires the introduction of an additional parameter $W_0$ to the model. This parameter represents the percentage of age 1 households that receive a bequest of a minimum size home. The percentage is adjusted so that the model generates a homeownership rate for young households is similar to that found in the data. The value of transfers from accidental death is adjusted to equal the amount of housing bequests to individuals.

[15] The data in Table 5 are from the U. S. Treasury Department, Bureau of Internal Revenue, Statistics on Income for 1940, Part 1. These data are compiled from individual income tax returns, taxable fiduciary income and defense tax returns, and estate tax returns prepared under the direction of the Commissioner of Revenue by the statistics section, income tax unit. A similar document is used for 1960.

The estimation of the set structural parameters for 1940 is based on an exactly identified method of moments nested with the computation of equilibrium. The results are summarized in Table 7 and the estimated parameters are within 1 percent error for all the observed targets.

**Table 7: Parameterization of Model**

| **Target** | **Data** | **Model** |
|---|---|---|
| Ratio of Capital Stock to GDP | 2.54 | 2.68 |
| Ratio Housing to Consumption | 0.18 | 0.16 |
| Ratio capital investment to GDP | 0.11 | 0.08 |
| Homeownership Ratio | 0.45 | 0.44 |
| Income Tax Revenue to GDP | 0.01 | 0.01 |
| Ratio of Capital in Residential Inv. to Total Capital | 0.018 | 0.019 |
| Ratio of Housing to Capital | 0.46 | 0.47 |
| Ratio of Housing Investment to Housing | 0.07 | 0.07 |

Source: NIPA Data

## 5.2 Baseline Economy in 1940

The model can be evaluated from various perspectives. The objective is to measure the performance by considering the homeownership rate statistics for the various years and age groups. As Table 8 shows, the homeownership rate in 1930 was 48.1 percent, whereas after the Great Depression it was reduced to 42.7. Since the baseline model attempts to focus on the home ownership rate prior to the impact of the National Housing Act, the targeted homeownership rate is 43.5 percent.

**Table 8: Home Ownership by Age (%)**

| | **Data** | | **Model** |
|---|---|---|---|
| **Age** | **1930** | **1940** | **1940** |
| **25-35** | 20.0 | 19.1 | 13.0 |
| **36-45** | 48.5 | 42.1 | 42.5 |
| **46-55** | 57.7 | 51.0 | 59.2 |
| **56-65** | 65.1 | 57.5 | 69.8 |
| **Total** | 48.1 | 42.7 | 43.5 |

Source: US. Census Bureau

Since the aggregate homeownership rate is an estimation target, it not surprising that the baseline model generates a number close to the selected moment. The age-specific homeownership rates also can be used to evaluate the model. The model captures the hump-shaped behavior observed in the data. The lowest homeownership rate is for the youngest age cohort; this pattern is apparent in 1930 and 1940 with the difference that homeownership rates are higher in 1930. The model does generate a pattern by age cohort consistent with the Census estimates. The model also makes predictions about mortgage holdings. Table 9 summarizes some aggregate statistics about housing finance.

**Table 9: Housing Finance (%)**

| Statistics | Model 1940 |
|---|---|
| **Homeownership rate** | 43.5 |
| **No Mortgage (%)** | 81.7 |
| **Mortgage loan (%)** | 16.3 |
| **Share balloon (5 year)** | 100.0 |
| **Share FRM (20 year)** | 0.0 |

It is difficult to find micro data for specific mortgage contracts, but there is some indirect evidence that balloon was the predominant mortgage contract. The model is consistent with this observation. The model does not allow to refinance by rolling over the balloon loan, as a result the majority of the homeowners do not have a mortgage.

## 5.3 Modeling the Economy in 1960

The strategy to model the economy in 1960 is to maintain constant the fundamental structural parameters (preferences and technology) and adjust the relevant institutional factors. The relevant factors that changed between 1940 and 1960 are summarized as follows: i) Demographics and education types: Include changes in the survival probabilities and family structure. It also considers the distribution of education types is adjusted with the fraction of individuals with college education increases from 25 to 30 percent and the fraction of individuals with high school was reduced from 43 to 38 percent. The remaining types are essential unchanged. ii) Labor income process: The income process is adjusted with changes in the efficiency profile by education, the distribution of the i.i.d. idiosyncratic income component, and the productivity of the goods sector is increased to capture the real changed in the level of income. iii) Housing finance: The set of mortgage contracts remains unchanged, but the maturity of the FRM is extended from 20 to 30 years and the spread between the mortgage interest rate and the risk-free rate is reduced from 2.53 to 1.63 percent in annual terms, and iv) Government policy and income taxation: Replace the income tax code from the 1940s to the 1960s. The new tax code is more progressive and with higher tax brackets, however, the marginal effect housing investment is amplified (see Chambers, Garriga, and Schlagenhauf, 2009, for more details about housing policy).

The equilibrium implications of the changes are summarized in Table 10. The model economy for 1960 captures can rationalize the positive co-movement of homeownership and house prices observed.

**Table 10: Ownership and Prices in 1960**

| **Data** | **1940** | **1960** | **Δ** |
|---|---|---|---|
| Ownership Rate (%) | 42.7 | 62.5 | **19.8** |
| House Price Index | 100 | 134 | **34.5%** |
| **Model** | | | |
| Ownership Rate (%) | 43.5 | 63.1 | **19.6** |
| House Prices | 100 | 128 | **28.0%** |

More specifically, the model accounts for 98 percent increase in ownership and 82 percent of the change in house prices. It is important to note that these are endogenous variables, not a result of estimating the parameters for 1960. The model has implications for the age distribution of homeownership. Table 11 summarizes the compositional differences across age groups between both periods in the data and the model.

**Table 11: Model Prediction for Homeownership Rate 1940-60**

| | **Data (%)** | | | **Model (%)** | | |
|---|---|---|---|---|---|---|
| | **1940** | **1960** | **Difference** | **1940** | **1960** | **Difference** |
| **25-35** | 19.1 | 56.2 | 37.1 | 13.0 | 38.7 | 25.7 |
| **36-45** | 42.1 | 68.1 | 26.0 | 42.5 | 72.6 | 30.1 |
| **46-55** | 51.0 | 69.5 | 18.5 | 59.2 | 71.8 | 12.6 |
| **56-65** | 57.5 | 69.3 | 11.8 | 69.8 | 73.5 | 3.7 |
| **Total** | 42.7 | 62.5 | 19.8 | 43.5 | 63.1 | 19.6 |

Source: US. Census Bureau

The model captures the relevant changes in homeownership across age groups. Despite the small differences in levels, the change between both periods in the model and data is quite similar. The data suggests that the increase happens across all ages, and the model captures this feature. Consistent with the data, the largest increases occur for the youngest cohorts. These individual have a very different income process with lower risk and have access to different housing finance arrangements. Overall, this model provides a useful laboratory to assess the drivers of the construction boom between 1940 and 1960.

## 5.4 Decomposition of the Housing Boom in 1940-60

The model captures the co-movement between homeownership and house prices. In this section, we use our model, calibrated to the 1935-40 period, to conduct a series of counterfactual experiments so that the relative importance of various explanations of the increase in homeownership can be measured. This examination considers the change in the dempographic structure of the economy, the increase in real income, and the change in government policy in the form of innovations in mortgage finance and federal tax law. To isolate the effects for each single factor, the model parameters are set at their estimated value for 1940, but all institutional variables are set at 1960 values. Then, each factor is individually set to the 1940 level and a new equilibrium is calculated. This allows to obtain the relative contribution of each component. Since the model is nonlinear, one should not expect the sum of the relative contributions to add to the total.

1. **Demographics:** Demographers, such as Chevan (1989), argue that demographic factors are the key to understanding the large increase the participation in housing. In order to examine this argument, we replace the 1940 survival,the relative age cohort sizes, and family structure with their counterparts in 1960. The model suggests that the 1960 demographic structure would have resulted in the aggregate participation rate increasing to 58.6 percent and an increase in housing prices of 7.6 percent. In the discussion of Table 1, we pointed out that in 1940 57.5 percent of the population was between age 36 and 65, while in 1960 62.6 percent of the population was accounted for by this cohort. Since the age 36-65 age cohorts tend to have higher home ownership rates, it should not be surprising that demographics played a role. However, this factor is not the key to understand the increase in house prices.

**Table 12: Contribution Demographics**

| | **Ownership** | | | **House Prices** | |
|---|---|---|---|---|---|
| **Benchmark** | **1960** | Δ | Share(%) | %Δ | Share(%) |
| Data (1960) | 62.5% | 19.8 | | 34.5 | |
| Model (1960) | 63.1% | 19.6 | | 28.0 | |
| | | | | | |
| **1960 Model with 1940** | | | | | |
| Demographics (All) | 58.6% | 15.1 | 23.0% | 25.6 | 7.6 |
| Population Shares | 61.1% | 17.6 | 10.2% | 26.3 | 5.1 |
| Family Structure | 62.3% | 18.8 | 4.1% | 26.3 | 5.1 |

2. **Income:** Between 1935 and 1960 wage income changed significantly. Over this period real wage income increased by a factor of 2.25. The pattern of the age-specific earning 0.8effect changes and the idiosyncratic age-specific shocks lead to a slight increase in variance. Holding all other institutional factors at their 1940 levels, when the 1960 wage income structure is introduced into the model, the aggregate home ownership rate increases.

**Table 13: Contribution of Income**

| | **Ownership** | | | **House Prices** | |
|---|---|---|---|---|---|
| **Benchmark** | **1960** | Δ | Share(%) | %Δ | Share(%) |
| Data (1960) | 62.5% | 19.8 | | 34.5 | |
| Model (1960) | 63.1% | 19.6 | | 28.0 | |
| | | | | | |
| **1960 Model with 1940** | | | | | |
| Income | 48.3% | -14.8 | 14.3% | 0.8 | |

The change in income dominates all other possible factors. In Figure 2, the wage efficiencies for 1940 and 1960 are presented. The level change clearly indicates that more households can afford housing. In addition the steepness of the wage efficiency measures between age 20 and 35 are much more pronounced in 1960. This means more first time households are likely to find home ownership a viable alternative to renting as they able to accumulate wealth at a faster pace.

3. **Government regulation**

   (a) **Innovations in housing finance:** Chambers, Garriga, Schlagenhauf (2009) found that mortgage market innovation was the key factor in explaining the increase in the home ownership rate between 1996 and 2005. The introduction of highly leverage loans with graduated mortgage payments were found to be important as these contracts attracted first-time buyers into the housing market. By 1960, fixed mortgage contracts had become more levered as the loan-to-value ratio increased and the duration of the mortgage contract lengthened. It seems that the mortgage contact innovation between 1935 and 1960 could be a key factor. To investigate this possibility, we replaced the 1935 balloon contract with a 1960 mortgage type contract. The home ownership rate change is presented in Table 8.

**Table 14: Innovations in Housing Finance**

| | **Ownership** | | | **House Prices** | |
|---|---|---|---|---|---|
| **Benchmark** | **1960** | $\Delta$ | Share(%) | %$\Delta$ | Share(%) |
| Data (1960) | 62.5% | 19.8 | | 34.5 | |
| Model (1960) | 63.1% | 19.6 | | 28.0 | |
| | | | | | |
| **1960 Model with 1940** | | | | | |
| 20year FRM | 62.6% | 19.1 | 2.5% | 26.2 | 5.4 |
| Int. rate wedge | 58.1% | 14.6 | 25.5% | 26.5 | 4.3 |

   In contrast to the 1996-2005 period, mortgage innovation, ceteris paribus, resulted in a decrease in home ownership rate to 41.0 percent from 45.4 percent. This is a very different result that was found in the United States from after 1994. Why? If everyone was forced to use a fixed rate contract with 20% down, the mortgage payment would increase as principal payments are included in the monthly payment. Given the wage efficiency index in 1940 was lower and more uniform than in 1960, household could not afford to take advantage of the leverage features available in a fixed rate mortgage.[16]

   (b) **Tax structure:** Rosen and Rosen (1980) argue that twenty-five percent of the increase in home ownership between 1949 and 1974 was a result of the benefits

[16] We also experiment with the effect of lower the downpayment requirement to 5 percent. A move leveraged mortgage contract would result in a higher homeownership rate. However, the homeownership rate would only increase to 43.5 percent

to housing that were included in the tax code. We have documented that the tax code is more progressive in 1960 than the code in 1940. This change is a result of the need for increased revenue to finance World War II and the Korean War. The benefits from the mortgage interest deduction are enhanced when the tax rates became more progressive. We examine the role of the changing tax structure by replacing the 1935 tax structure with the 1960 tax structure. The results of this counter factual experiment are presented in Table 9.

**Table 15: Tax Structure**

| | **Ownership** | | **House Prices** |
|---|---|---|---|
| **Benchmark** | **1960** | $\Delta$ | $\%\Delta$ |
| Data (1960) | 62.5% | 19.8 | 34.5 |
| Model (1960) | 63.1% | 19.6 | 28.0 |
| | | | |
| **1960 Model with 1940** | | | |
| Tax Structure | 74.3% | 30.8 | 30.1 |

If the 1940 tax structure existed in 1960, home ownership rates would have declined to 74.3 percent house prices increase.

# 6 Conclusions

The postwar housing boom lead the largest and most sustained increase in homeownership and house prices. Most of the existing literature focuses on one of the variables, but does not provide a unified theory where homeownership and house prices are jointly determines. The objective of this paper is to consider the different explanations using a quantitative general equilibrium model of tenure choice. The model is capable or rationalizing the majority of the increase in homeownership and house prices. The model suggests that all the factors discussed in the literature contributed positively to the co-movement puzzle. Demographics, income risk, and government intervention in housing finance are important determinants in the homeownership rate, but have relatively small effect in house prices. Increases in the cost of construction, driven by improvements in the relative productivity of the non-housing sector are the key driver of house price movements.

# 7 References

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