Rising Earnings Risks and Wealth Distribution with Housing*

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Abstract

Since the early 1980s, U.S. earnings risks have increased significantly, while many innovations in the U.S. housing market reduced housing transaction costs, and down-payment requirements. Using a general equilibrium incomplete-markets model with heterogeneous households, we quantify the effects of these changes in the U.S. labor and housing markets on the wealth composition between illiquid housing and liquid financial assets. We find that these changes increase the homeownership rate and the proportion of houses in household wealth among poor households, leaving housing inequality unchanged. This result is consistent with our observation around the year 2000 in the U.S. data.

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1 Introduction

Many studies document that the increase in U.S. earnings inequality during the 1980s and 1990s is largely attributable to a rise in earnings risks.[1] Over the same period, many innovations in the U.S. housing and financial markets have reduced housing transaction costs and downpayment requirements.[2] According to standard economic theory, increased earnings risks may cause households to reduce the share of illiquid assets, such as housing assets, in their asset portfolio.[3] In contrast, the decline in housing transaction costs and downpayment requirements increase the liquidity of housing assets, counteracting the impact of the increased earnings risks. In this study, we examine the net quantitative effect of these changes in the U.S. labor and housing markets on household wealth distribution with housing and consumer welfare.

To achieve this, we build a two-sector general equilibrium incomplete-markets model where households are subject to idiosyncratic earnings shocks. In this model, households consume nondurables and housing services from either owned or rented housing. These households make a portfolio choice between financial and housing assets. Housing assets differ from financial assets in that houses can be used as collateral and that households incur transaction costs if they trade housing structures, which makes housing structures less liquid than financial assets.

This model economy is calibrated to the 1983 U.S. economy using both data on household wealth from the survey of consumer finances (SCF) and individual income data from the panel study of income dynamics (PSID).[4] We then feed estimated increases in the vari-

[1] See Gottschalk and Moffitt (1994), Katz and Autor (1999), Moffitt and Gottschalk (2008), and Heathcote, Perri, and Violante (2010).

[2] See Chambers, Garriga, and Schlagenhauf (2009) and Li (2005).

[3] For instance, Kimball (1993) shows that uninsurable risks may result in a reduction in the share of other risky assets in asset portfolio. Illiquid assets such as housing structures could be viewed as risky assets. Thus, an increase in earnings risks is likely to reduce the share of housing assets in household asset portfolio.

[4] The SCF is the household-level data on various asset and liability components. As the SCF corrects for

ance of earnings shocks from the PSID and declines in both housing transaction costs and downpayment requirements supported by the related literature into the model, and solve for a new steady state. Comparing this new steady state with the initial steady state helps us identify the impact of these exogenous changes on the distribution of household wealth as well as key macroeconomic variables in the long run. We also implement decomposition exercises to understand the mechanism through which each of these exogenous driving forces affect the model economy. Lastly, we discuss the welfare implication of the increased earnings risks and the institutional changes in the U.S. housing market.

We find that the increase in earnings risks together with declines in both housing transaction costs and downpayment requirements generates little change in housing inequality, accompanied by unequal changes in the homeownership rate, and the share of housing assets in household wealth by wealth level. As earnings become more volatile, households substitute liquid financial assets for illiquid housing assets. This reduces the demand for housing assets, especially among poorer households vulnerable to earnings shocks because of a smaller buffer stock of precautionary savings. Naturally, the housing wealth inequality worsens. On the other hand, a decline in housing transaction costs increases the liquidity of housing structures, while a reduction in downpayment requirements relaxes borrowing constraints. These institutional changes in the housing market help poorer households purchase more houses, reducing the housing wealth inequality. These two counteracting effects leave housing inequality unchanged.

If we relate housing assets to wealth, the model indicates that both the homeownership rate and the share of housing assets in wealth increase significantly among households in the lower wealth quintiles. The homeownership rate increases by 9% ∼19% points for households in the lowest wealth quintile, while the share of housing assets in their wealth almost doubles. These results are broadly consistent with our findings in the U.S. data around the year 2000.[5]

different non-response rates by wealth level, we can obtain unbiased wealth distributions using this data set. However, the SCF lacks a panel dimension for household income. Thus, we use the PSID to estimate the time-varying variance of income shocks.

[5]Explaining the housing boom in the mid-2000s and the financial crisis afterwards, is outside the scope

Among the three exogenous forces, rising earnings risks are responsible for most of the aggregate outcome. However, reduced transaction costs and declining downpayment requirements play an important role in accounting for changes in the homeownership rate and the share of housing assets in household wealth by wealth level. We find that the increased earnings risks combined with decreases in housing transaction costs and downpayment requirements reduce consumer welfare by 9.69% in units of per-period consumption.[6] The institutional changes in the housing market are welfare-improving, yet this effect is not large enough to offset the welfare loss from more volatile earnings.

Our work relates to a vast finance literature on household portfolio choice in the presence of housing. This literature tends to address how the presence of housing affects the share of risky assets in household portfolio theoretically (Flavin and Yamashita (2002); Chetty and Szeidl (2007)) or empirically (Cocco (2005); Yao and Zhang (2005); Raj Chetty and Szeidl (2017); Vestman (2019)). Unlike these studies, we focus on household portfolio choice between liquid and illiquid assets and how it is adjusted in response to changes in either earnings risks or housing institutions. Therefore, our study complements this literature. This study is closely related to Guiso, Jappelli, and Terlizzese (1996), who explore the impact of income risk and borrowing constraints on the proportion of risky and illiquid assets in household portfolio choice. They empirically support the mechanism elaborated in our study, where uninsurable income risk and future liquidity constraints force households to hold a lower share of illiquid and risky assets.

This paper is also a part of a literature that attempts to reproduce the distribution of housing and non-housing wealth in the U.S. economy using a general equilibrium model

of this study. This study focuses on the long-term distributional impact of the increased earnings risks combined with institutional changes in the U.S. housing market rather than the cause of the recent housing boom.

[6] An alternative method to measure changes in the distribution of welfare is to use micro-level data for household consumption. For instance, Krueger and Perri (2006) examine the evolution of household consumption inequality using data from the Consumption Expenditure Survey (CEX). The quality of consumption data is critical to this approach. Aguiar and Bils (2015) note that the CEX does not represent the trend in the U.S. aggregate consumption expenditures as effectively in recent years as in the beginning years of the survey, and propose a method to correct this problem.

with heterogeneous agents. Ríos-Rull and Sánchez-Marcos (2008) consider a model with different size houses and liquid assets to replicate important features of U.S. earnings and wealth distributions. Díaz and Luengo-Prado (2010) build a model with illiquid houses and collateral constraint to account for the observed wealth composition between housing and financial assets in the U.S. We extend the model in Díaz and Luengo-Prado (2010) by separating housing production from final goods production, which makes it possible to address the model's implications for the relative price of house. Using this model, our study explores how the composition of household wealth and consumer welfare change in response to rising earnings risks and institutional changes in the U.S. housing market.

Lastly, this paper is related to several recent studies that provide a quantitative analysis of the U.S. housing market using a macroeconomic model. Both Kiyotaki, Michaelides, and Nikolov (2011) and Sommer, Sullivan, and Verbrugge (2013) use a dynamic equilibrium model of housing, where idiosyncratic labor income shocks and financing constraints play an important role in housing choice. Favilukis, Ludvigson, and Nieuwerburgh (2017) study a general equilibrium model of housing with aggregate business cycle risk and bequest heterogeneity in preferences. These studies exploit these models to examine the impacts of different factors on the increase in U.S. house prices. Although we use a general equilibrium model of housing similar to these studies, we focus on changes in the wealth composition rather than house prices. This paper is also close to Seok and You (2019) that attempt to explain the evolution of the U.S. housing market between 1967 and 2000 using the same exogenous changes in the U.S. labor and housing markets as this study considers. We extend the model used in Seok and You (2019) by incorporating a house rental market to address the implication of the model for homeownership, and elaborate more on the distributional implications of the model.

This paper is organized as follows: In Section 2, we illustrate a two-sector general equilibrium incomplete-markets model with heterogeneous agents. Section 3 describes the calibration of the model economy. We present the main quantitative results in comparison with data counterparts in section 4, and discuss the model's welfare implications in section 5. We then conclude in section 6.

2 Model

Our model is a modification of the model developed in Díaz and Luengo-Prado (2010).[7] We extend their model by considering two sectors, nondurables and housing sectors, explicitly. There is a continuum of infinitely-lived agents of measure one. We begin by describing the consumer's problem, followed by the production technology and the firm's problem. We then define a steady state equilibrium for this model economy.

2.1 Households

Households consume both nondurable goods and housing services. Let c be nondurable goods consumption and d be housing services consumption. Households either rent a housing structure g or own a housing structure h, and obtain housing services d from the house. An indicator for home ownership, I, is 1 if a household owns a house $(h' > 0, g = 0)$ or 0 otherwise $(h' = 0, g > 0)$. If a household owns a house, she enjoys housing services equal to the quantity of the owned housing structure. If a household is a renter instead, the housing services she consumes are the quantity of the rental housing structure times χ, which captures a difference in the housing services from rented housing compared with owned housing.[8] Following Fernandez-Villaverde and Krueger (2005), we assume the unit elasticity of substitution between nondurable goods and housing services consumption. The utility function in period t is then given by

$$\begin{aligned} u(c_t, d_t) &\equiv \frac{\{c_t^{1-\phi} d_t^{\phi}\}^{1-\gamma} - 1}{1-\gamma}, \\ d_t &\equiv I_t h_{t+1} + \chi \left(1 - I_t\right) g_t. \end{aligned}$$

[7] Díaz and Luengo-Prado (2010) incorporate housing structures in Huggett's (1993) and Aiyagari's (1994) general equilibrium model with heterogeneous agents subject to idiosyncratic labor productivity shocks.

[8] For computation, we consider n discrete grids for housing structures, $h, g \in \{\overline{h}_1, \overline{h}_2, \cdots, \overline{h}_n\}$.

The lifetime utility is written as

$$\sum_{t=0}^{\infty} \beta^t u(c_t, d_t),$$

where β is a discount factor.

Each household maximizes its lifetime utility subject to a budget constraint and a borrowing constraint. The value function for the household is given by:

$$V(a,h,x) = \max_{I,c,a',h',g} \{u\left(c, Ih' + \chi\left(1-I\right)g\right) + \beta\mathbb{E}[V(a',h',x')|x]\}$$

$$\text{s.t.} \quad c + a' + qh' + Rqg + q\tau\left(h,h'\right) = wx + (1+r)a + q(1-\delta_h)h,$$

$$a' \geq -(1-\theta)qh',$$

$$I \in \{0,1\}; h' > 0, g = 0 \text{ if } I = 1; h' = 0, g > 0 \text{ if } I = 0,$$

$$\tau\left(h,h'\right) \equiv \begin{cases} \phi_s(1-\delta_h)h + \phi_b h', \text{ if } h \neq h' \\ 0, \text{ if } h = h' \end{cases},$$

$$\log(x_{t+1}) = (1-\rho_x)\upsilon_x + \rho_x \log(x_t) + \eta_{t+1}, \eta_{t+1} \backsim (0,\sigma_x^2).$$

Let x be a household's idiosyncratic productivity, which evolves according to $\log(x_{t+1}) = (1-\rho_x)\upsilon_x + \rho_x \log(x_t) + \eta_{t+1}$, where $\eta_{t+1} \backsim (0,\sigma_x^2)$. A household receives labor income wx in each period, where w is the wage per efficiency unit of labor. Let q be the per-unit price of housing structures. There are two types of assets available for a household's savings: a financial asset a and a housing structure h. Savings in financial assets give consumers a rental rate of non-residential capital r, and savings in a housing structure give them an increase in utility. In addition, let ϕ_b denote the rate of transaction cost for buying a housing structure, and ϕ_s be that for selling a housing structure. This implies that whenever households buy or sell a housing structure, they have to pay transaction costs $q\tau\left(h,h'\right)$, where $\tau\left(h,h'\right) \equiv \varphi^s(1-\delta_h)h + \varphi^b h'$, if $h \neq h'$ and 0, if $h = h'$. Each homeowner pays $q(1-\delta_h)h$, as maintenance cost at the end of each period, where δ_h is the depreciation rate for housing structures. Each renter pays Rqg as rent. There is no unsecured debt in this economy. A homeowner can borrow up to $(1-\theta)qh'$, where θ is the downpayment requirement, and a renter cannot borrow.

2.2 Firms

There are two production sectors in this economy. One sector produces nondurable goods and the other produces housing structures. Let f denote the nondurable goods sector and h denote the housing sector. Let L_i be total labor hired by sector i, K_i be total capital employed by sector i, and λ_i be the total factor productivity (TFP) of sector i, where $i \in \{f, h\}$. The production function for nondurable goods is then given by:

$$F(L_f, K_f; \lambda_f) = \lambda_f L_f^{1-\alpha} K_f^{\alpha}.$$

The production function in the housing sector is given by:

$$G(L_h, K_h; \lambda_h) = \lambda_h L_h^{1-\kappa} K_h^{\kappa}.$$

We assume that the housing sector is more labor intensive than the nondurable goods sector, that is, $\alpha > \kappa$.

A representative firm in the nondurable goods sector solves

$$\max_{L_f, K_f} \left\{ F(L_f, K_f; \lambda_f) - wL_f - (r + \delta_k) K_f \right\},$$

where δ_k is the depreciation rate for non-residential capital. Similarly, a representative firm in the housing sector solves

$$\max_{L_h, K_h} \left\{ qG(L_h, K_h; \lambda_h) - wL_h - (r + \delta_k) K_h \right\}.$$

2.3 Financial Institution

A risk-neutral financial institution takes households' financial assets A, and either converts them into non-residential capital K or buys rental properties G without paying transaction costs. This institution rents non-residential capital to firms and rental properties to households. The depreciation rate δ_g for rental properties is assumed to be greater than that for housing structures, δ_h.[9] The financial institution solves

$$W(A) = \max_{A',K,G} \left\{ A' + rK + RqG - (1+r)\,A - \delta_g qG + \frac{1}{1+r} W(A') \right\}$$
$$\text{s.t.} \quad A = K + qG.$$

2.4 Steady State Equilibrium

A recursive steady state equilibrium is a value function $V(a,h,x)$, a set of optimal policy functions $\{c(a,h,x),\ I(a,h,x),\ a'(a,h,x),\ h'(a,h,x),\ g(a,h,x)\}$, a set of aggregate inputs $\{L_f, L_h, K_f, K_h\}$, a set of prices $\{q,w,r,R\}$, and a distribution of households $\mu(a,h,x)$, such that:

1. Households optimize: given a set of prices $\{q,w,r,R\}$, $V(a,h,x)$ solves the households' Bellman equation, and $c(a,h,x), I(a,h,x), a'(a,h,x), h'(a,h,x)$ and $g(a,h,x)$ are optimal policy functions.

2. Firms maximize profits:

$$w = F_1(L_f, K_f; \lambda_f) = qG_1(L_h, K_h; \lambda_h),$$
$$r = F_2(L_f, K_f; \lambda_f) - \delta_k = qG_2(L_h, K_h; \lambda_h) - \delta_k,$$

   where F_j represents the first derivative of function F with respect to the jth input.

3. The aggregate financial asset is:
$$A = \int a \; d\mu.$$

4. The aggregate non-residential capital stock is:

$$K = A - qG.$$

[9] This is consistent with our observation in the data. The Bureau of Economic Analysis (BEA) publishes historical-cost depreciation of private residential fixed assets by type of occupants. According to the statistics, the depreciation rate for owner-occupied housing structures is lower than that for renter-occupied ones.

5. The no-arbitrage condition is satisfied:

$$R = r + \delta_g.$$

6. The nondurable goods market clears:

$$\int \{c(a,h,x) + q\tau\left(h, h'(a,h,x)\right)\}\, d\mu + \delta_k K = F(L_f, K_f; \lambda_f).$$

7. The housing structures market clears:

$$\int \{h'(a,h,x) - (1-\delta_h)h\}\, d\mu + \delta_g G = G(L_h, K_h; \lambda_h).$$

8. The housing rental market clears:

$$\int \{g(a,h,x)\}\, d\mu = G.$$

9. Factor markets clear:

$$L_f + L_h = \int x\, d\mu,$$
$$K_f + K_h = K.$$

10. Let $\mathbb{T}$ be the transition rule for the distribution of households $\mu(a,h,x)$ implied by $a'(a,h,x)$, $h'(a,h,x)$, and the law of motion for x. Then, $\mu = \mathbb{T}(\mu)$.

3 Calibration

This section describes how we choose values for the model parameters. The initial steady state of our model economy is calibrated to the 1983 U.S. economy, because the Survey of Consumer Finances that we use to describe U.S. wealth distribution with housing, are available beginning from 1983. We begin by explaining the setting of the model parameters for preferences and technologies. We then elaborate the procedure to determine the values of parameters governing the earnings process and housing institutions.

3.1 Preferences and Technology

A set of parameters for household preferences are set based on the previous literature and relevant data moments. One period in the model is a year. We set the constant relative risk aversion (CRRA) parameter γ to 2, following the standard practice in the literature.[10] The time discount factor β is set to 0.9303, so that the annual interest rate is 4.0% in the initial steady state. We pick the parameter $\phi = 0.103$, determining the importance of housing services relative to nondurables for household utility, to match the ratio of the sum of private and government residential housing stocks to the output of 1.19 from the Bureau of Economic Analysis (BEA) in 1983. We set parameter $\chi = 1.0577$,[11] which governs housing services from a rental unit, by targeting the U.S. homeownership rate of 65.88% in 1983.

On the production side, we set the capital share of income in the non-housing sector, α, to 0.28, by targeting the aggregate capital stock to output ratio of 3.15 in 1983, again, from the BEA. The capital share in the housing sector κ is set to 0.132, as in Davis and Heathcote (2005). The TFP in the non-housing sector, λ_f, is normalized to 1. In the U.S. data, the construction sector productivity has shown little growth since the early 1960s. Thus, we assume that the TFP in the housing sector remains constant over time. The housing sector TFP, λ_h, is set to 1.30, so that the model matches the relative price of residential investment in 1983. The depreciation rate for capital, δ_k, is set to 0.0963, which is the average ratio of the historical-cost depreciation of private non-residential fixed assets to the historical-cost net stock of private non-residential fixed assets between 1983 and 1995, from the BEA. The BEA also publishes the historical-cost depreciation of private residential fixed assets by type of occupants. Based on these data, we set the depreciation rates of owned housing and rental housing to $\delta_h = 0.0265$ and $\delta_g = 0.0320$, respectively. Table 1 summarizes these parameter values.

[10] This value for the relative risk aversion implies that the intertemporal elasticity of substitution is less than 1 (i.e., the income effect is greater than the substitution effect).

[11] The parameter χ is calibrated to a value greater than 1. However, the depreciation rate for renter-occupied housing structures is higher than that for owner-occupied ones. The latter dominates the former in our parameterization; therefore, homeownership is still preferred to renting.

3.2 Earnings Process and Housing Institutions

The remaining parameters of the model relate to earnings risks and housing institutions. The PSID is a natural choice for estimating the earnings shock process, because it is a longitudinal survey of a representative sample of U.S. individuals. One drawback of the PSID is that it underrepresents very wealthy households because of their high nonresponse rates, and hence, underestimates the net worth of the U.S. population. Unlike the PSID, the SCF, a triennial survey with detailed information about household income, assets, and liabilities, oversamples wealthier households to overcome this problem, accurately representing the U.S. earnings and wealth distribution.[12] However, the SCF lacks a panel dimension.

As an alternative, we use the panel data of earnings from the PSID, and the distribution of earnings and wealth from the SCF to calibrate the earnings shock process in the model. Specifically, we introduce a star group, similar to Castañeda, Díaz-Giménez, and Ríos-Rull (2003) and Díaz and Luengo-Prado (2010). Households in our model are classified into two groups: regular (bottom 99% of the earnings distribution) and superstars (top 1%). We assume that the log earnings of all regular households follow an AR(1) process, $\log x_{t+1} = \rho_x \log x_t + \eta_{t+1}$, where $\eta_t \sim N(0, \sigma^2_{x,t})$.[13] The variance of the earnings shocks is allowed to vary over time.

The earnings process for these regular households are estimated using the PSID data. We take earnings data for male household heads from the PSID, and regress the log earnings on a time dummy, age, age^2, schooling, and age$\times$schooling. We then use the log earnings residuals from this regression to calculate the covariances of all possible orders. We estimate the persistence ρ_x, and the time-varying variance $\sigma^2_{x,t}$ of earnings shocks by minimizing the distance between these empirical covariances of the log earnings residuals and their

[12] The main advantage of the SCF over the PSID is that the SCF oversamples wealthy households by combining a conventional area probability sample with a sample of relatively wealthy households. As non-response rates to questions about wealth are typically higher among wealthier households than others, this oversampling enables the SCF to represent the U.S. wealth distribution fully, whereas the PSID underrepresents the top end of the wealth distribution. Juster, Smith, and Stafford (1999) show that the PSID understates home equity, compared to the SCF, and the downward bias increases with the level of wealth.

[13] The initial value $\log x_0$ is drawn from a time-invariant Normal distribution, i.e. $\log x_0 \sim N(0, \sigma^2)$.

theoretical counterparts. Based on the estimates, we set $\rho_x = 0.955$ and $\sigma^2_{x,1983} = 0.0279$[14] in the initial steady state. We approximate this earnings process for regular households using five discrete values of earnings shocks based on the Rouwenhorst method.[15]

We assume that a regular household can become a superstar with probability π_1, regardless of their current state. Conversely, a superstar household can become a regular one with probability π_2. We use one grid for the earnings shock for superstar households and assume that this superstar earnings grid is ω times the highest earnings shock of regular households. These three free parameters, π_1, π_2, and ω, are calibrated by targeting the percentage of superstar population, the Gini indices of earnings and wealth for all households in the 1983 SCF. The percentage of superstar population is set at 1%. Using the 1983 SCF data, we calculate earnings by combining wage and salary income with a fraction of business income that is attributable to labor and wealth (or net worth) by subtracting total liabilities from total assets, following Rodriquez, Díaz-Giménez, Quadrini, and Ríos-Rull (2002). Our sample is restricted to those with positive labor earnings. For this sample, the Gini coefficients for earnings and wealth are 0.42 and 0.74, respectively. Table 2 presents the earnings grids used for the computation.

Lastly, we parameterize housing transaction costs and downpayment requirements based on related studies and data. Chambers and Simonson (1989) estimate that transaction costs are about 6% of housing value. Rosenthal (1988) uses 7% housing transaction costs for his analysis, using a housing model. Based on these values, we set the selling rate of transaction costs at $\phi_s = 0.06$ in the initial steady state, and the buying transaction cost at $\phi_b = 0$.[16] As for downpayment requirements, we refer to the national average loan-to-price ratios in conventional single family mortgages published by the Federal Housing Finance Agency (FHFA). The loan-to-price ratio continued to increase from the 1970s, reaching about 75%

[14] The variance of the earnings shocks is the average of the point estimates for 10 years around 1983.

[15] We follow Kopecky and Suen (2010) for a detailed procedure to implement the Rouwenhorst method.

[16] Housing transaction costs can refer to many components such as taxes, mortgage fees, selling commissions, moving expenses, and the cost of leaving a neighborhood. We integrate all these components into housing selling transaction costs, and assume that there is no transaction cost when households purchase houses

in 1983. This suggests that the average downpayment ratio was about 25% in 1983. As downpayment requirements are not binding for all households, we pick $\theta = 0.20$ as our downpayment requirements in the initial steady state.

4 Results

This section presents our main quantitative results. We begin by describing the initial steady state, which is followed by the main experiment, which incorporates changes in the U.S. labor and housing markets. We also report results from decomposition exercises.

4.1 The Benchmark Economy

Our benchmark economy is the initial steady state of the model calibrated to the 1983 U.S. economy. Table 3 presents the main distributional features of the benchmark economy together with their data counterparts from the 1983 SCF. Numbers in the first four lines in each panel represent the fractions of the corresponding variable held by households belonging to five quintiles of that particular variable. For instance, the number in the first earnings quintile indicates the proportion of total earnings in the economy held by the first earnings quintile.

As we calibrate the earnings process in the model by targeting the Gini coefficients for earnings and wealth (0.42 and 0.74) in the 1983 SCF, the model accurately replicates earnings and wealth inequality in the data. We further decompose wealth into housing and financial assets, as in Díaz and Luengo-Prado (2010). Housing assets are the value of owned houses,[17] while financial assets represent the remainder of total wealth (net worth minus housing assets). In the benchmark model, housing wealth is more equally distributed than total wealth, but more concentrated than earnings. The model also generates a more unequal distribution of financial assets than wealth. These features in the model are consistent with our observations in the data.[18]

[17] In the SCF, housing assets are defined as the value of principal and secondary residences.

[18] Gini coefficients for houses and financial assets in the model (0.55 and 0.89) do not match their data

The model, by construction, matches the aggregate homeownership rate in the 1983 U.S. economy. The benchmark economy also replicates the increasing pattern of homeownership rate with wealth observed in the data. In the benchmark economy, there are no homeowners in the lowest wealth quintile, while 97.28% of households in the 5th wealth quintile are homeowners. In the data, a large gap still exists in homeownership rates between the lowest and the highest wealth quintile, although it is less dramatic than in the model; only 7.51% of households in the lowest wealth quintile are homeowners, while this homeownership rate is 95.39% for households in the 5th wealth quintile. We also report the share of housing assets in total wealth (H/W) by wealth in Table 3, to see the variation in the importance of houses in household asset portfolio by wealth. In the benchmark model, the importance of houses in total wealth declines as the level of wealth increases. Housing wealth forms 189.25% of the total wealth for households in the bottom two wealth quintiles, whereas this proportion falls to 20.84% for households in the 5th quintile. We observe the same pattern in the 1983 SCF data too. The share of housing assets in wealth reduces from 107.63% for the bottom two wealth quintiles to 35.30% for households in the 5th wealth quintile.

4.2 The Effects of Three Exogenous Shocks

This section presents our main quantitative exercises about the effect of three exogenous changes in the U.S. labor and housing markets on key statistics of interest. We then bring it to the data to see the consistency in the quantitative result with our observations in the data.

counterparts (0.63 and 1.06) exactly. This is because the model abstracts from other important determinants of housing and financial assets, for instance, unsecured debt, demographic factors, taxes, and so on. Despite this limit, we choose this model because it is the most parsimonious one that can address the effect of increased earings risks and major institutional changes in the housing market on homeownership rates and the proportion of housing assets in household wealth across wealth levels.

4.2.1 Baseline Results

For a baseline experiment, we solve for a new steady state with increased earnings risks, reduced housing transaction costs, and relaxed downpayment requirements, and compare it with the benchmark economy. For this, it is necessary to reparameterize the earnings process, housing transaction costs, and downpayment requirements so that they accurately reflect the changes in the U.S. labor and housing market since the 1980s. As for the increased earnings risks, we exploit our estimates for the variance of earnings shocks from the PSID. As described in the calibration section, we take the earnings of male heads from the PSID, and estimate the time-varying variances of the innovation in the AR(1) process using earnings residuals. The point estimates for these variances increased significantly since the early 1980s.[19] As a conservative measure for the rise in the earnings risks, we use the average of the estimated variances of the earnings shocks for 10 years around 2000, as the variance of earnings shocks for regular households in the new steady state of the model.

Finding values for parameters governing housing institutions in the new steady state is less straightforward; therefore, we refer to the related literature. Many studies claim that several innovations have reduced transaction costs in the U.S. housing market since the early 1980s. Haurin and Gill (2002) estimate transaction cost to be between 4% and 5% of house value in 1992, which is 1% or 2% points lower than what Chambers and Simonson (1989) and Rosenthal (1988) suggest for the previous decade. Li (2005) and Chambers, Garriga, and Schlagenhauf (2009) also present empirical evidence supporting a significant decline in housing transaction costs since the 1980s. We also find similar evidence. For instance, the initial fees and charges associated with 30-year fixed-rate mortgages was about 2.2% of the purchase price in 1983 and it declined to 1.8% in 1995, according to Freddie Mac. Based on these studies and empirical evidence, we reduce the transaction costs from $\phi_s = 0.06$ in the benchmark economy to $\phi_s = 0.04$ in the new steady state. Lastly, the downpayment requirement in the new steady state is set based on loan-to-value ratios in the data. According

[19] We present the point estimates for variances of earnings shocks in the Appendix.

to the Federal Housing Finance Agency (FHFA), the national average loan-to-value ratios in conventional single family mortgages increased from 75% in 1983 to about 80% towards the end of 1990s, implying that the downpayment ratio was about 20% in the late 1990s. As the downpayment requirement is not binding for all households, we choose the downpayment requirement of $\theta = 0.15$ in the new steady state. Table 4 summarizes these parameter values.

Table 5 presents the distribution of earnings, housing assets, and wealth together with the homeownership rate and the housing to wealth ratio by wealth quintile for both the benchmark economy and the new steady state. An increase in earnings risks make household earnings fluctuate more over time, naturally leading to larger cross-sectional earnings inequality. Consistent with this prediction, the earnings inequality is higher in the new steady state than in the benchmark economy. The Gini index for earnings increases from 0.42 in the benchmark economy to 0.48 in the new steady state.

Unlike the change in the earnings Gini coefficient, the Gini index for housing wealth changes little. However, we find that this constant Gini coefficient for housing wealth masks a significant change in the distribution of housing assets across wealth level. First, the homeownership rate increases substantially among the lower wealth quintile in the baseline experiment, while that for higher wealth quintiles stays roughly constant. Homeownership rates for the first and the second wealth quintile increase by 9.32% points and 19.04% points ($= 51.35\% - 32.35\%$), respectively. The increased homeownership among poorer households causes the aggregate homeownership rate to rise from 65.73% to 71.26% in the baseline experiment. Second, the share of housing assets in total household wealth also increases substantially among poorer households. For households that belong to the bottom 40% of the wealth distribution, the housing to wealth ratio increases from 189.25% to 323.32% in the baseline experiment, whereas that for the highest wealth quintile increases only slightly from 20.84% to 22.65%.

These unequal changes in housing assets by wealth level are due to the interaction of the precautionary saving motive and the increase in the liquidity of housing assets. More volatile earnings cause households to increase a buffer stock of precautionary savings while adjusting their asset portfolio by reducing the share of illiquid housing assets. Homeownership rates and housing to wealth ratios would then decline. This effect appears severer for poorer households that have a minimal buffer stock of savings in the first place, thereby, increasing housing inequality. However, the decline in housing transaction costs and downpayment requirements enhance the liquidity of housing assets, and hence, increase the demand for housing structures, especially among poorer households. The general equilibrium effect also seems at work. According to Table 9, the large capital stock accumulated through the precautionary behavior of households in the baseline experiment reduces the real interest rate to 3.38%. This implies a large drop in the rate of return to financial assets to wealthier households and a reduction in interest payment for housing debt to poorer households. The demand for housing assets can then rebound because of the general equilibrium effect. Ultimately, the housing stock to GDP ratio increases from 1.21 in the benchmark economy to 1.30 in the new steady state, which implies that these effects are quantitatively important.

In contrast, the inequality in financial assets and total wealth actually improves with the increase in earnings risks and the changes in housing institutions. As earnings become more volatile, households accumulate more financial assets for a precautionary savings motive. This implies a reduction in debt among poorer households. In contrast, wealthier households reduce the share of financial assets in their portfolio as the liquidity of housing structures improves. This portfolio adjustment by wealthier households is reinforced if the rate of return to financial assets declines because of the general equilibrium effect. These changes cause financial assets to be more equally distributed in the new steady state than in the benchmark economy. This change in the distribution of financial assets, combined with the increase in housing wealth among poorer households, contributes to the decline in wealth inequality.

4.2.2 Comparison to U.S. Data

This section compares the model's results with our observations in the data. As the U.S. economy is going through a transitional phase, it is challenging to identify the long-term impact of rising earnings risks and declining housing transaction costs and downpayment requirements. However, we find that the model is consistent with recent trends in the distribution of earnings and housing assets and in the wealth composition of households by wealth level in the U.S.[20]

Table 6 presents the Gini indices for earnings and housing assets and homeownership rates in the baseline experiment, along with their data counterparts from the SCF for years around 2000.[21] We find that U.S. earnings inequality increased sharply between 1983 and around 2000, while housing inequality increased slightly over the same period. The Gini index for U.S. household earnings increased from 0.42 in 1983 to 0.50 in 2004. The model captures most of this increase in earnings inequality in the data. On the other hand, a comparison of the Gini index for 1983 with that for 1998 indicates that housing inequality changed little over this period in the data. The Gini coefficient for housing assets increased afterwards and reached 0.67 in 2004; however, this increase is smaller than that of earnings inequality. Our baseline result is broadly consistent with these patterns of economic inequality.

We also find that the change in the aggregate homeownership rate in the data is well in line with the model's result. The homeownership rate increased from 65.88% in 1983 to 68.65% in 1998 and 70.64% in 2004. In the baseline experiment, which incorporates all three exogenous changes in the U.S. labor and housing markets, the homeownership rate increased to 71.26%.

In Table 7, we compare the model's implications for the homeownership rate and the wealth composition with their data counterpart from the 1998 SCF. In the baseline experiment, changes in the homeownership rate are not uniform across wealth quintiles. The higher the wealth quintile of households, the smaller the increase in the homeownership rate. The data confirms the same qualitative pattern. Between 1983 and 1998, the homeownership

[20] As we abstract from non-collateralized debt in the model, it cannot generate the level and the change in inequality for financial assets that we observe in the data. Thus, we focus on the distribution of earnings and housing assets when comparing the model's result with its data counterpart.

[21] We do not go beyond 2004 because the model misses out on a mechanism that can explain the housing boom in the mid-2000s and the financial crisis afterwards. As Table 9 shows, the model does not generate a large increase in the relative price of housing structures.

rate for households in the bottom two wealth quintiles increased by 5∼6% points, while that for higher wealth quintiles slightly declined.

This pattern is closely related to an increase in the share of housing assets in household wealth, especially among poorer households. In the model, the aforementioned three exogenous changes raised the housing to wealth ratio significantly for households in the lower wealth quintiles. This ratio for the bottom two wealth quintiles almost doubled in the baseline experiment. However, for the highest wealth quintile, this ratio stayed roughly constant. Our observation in the data is also consistent with this result. The housing to wealth ratio for the bottom two wealth quintiles more than doubled between 1983 and 1998 in the SCF, while this ratio declined from 35.30% to 27.95% for the highest wealth quintile.

We find that the model's result concerning the effect of rising earnings risks, declining transaction costs, and reduced downpayment requirements is broadly consistent with our observation in the U.S. data. Naturally, one would ask how much of these changes in the distribution of housing assets, homeownership, and the wealth composition are attributable to each of these three exogenous driving forces. We answer this question in the next section.

4.3 Decomposition

Identifying the role of each exogenous driving force in the baseline experiment requires decomposition exercises. Here, we plug in one exogenous change at a time to the benchmark economy and solve for a new steady state.

4.3.1 Rising Earnings Risks

How would an increase in earnings risks affect household portfolio choice? What would be its aggregate implication? To answer these questions, we solve for a new steady state with a larger variance for earnings shocks ($\sigma_x^2 = 0.0394$ in this experiment, $\sigma_x^2 = 0.0297$ in the benchmark economy), as in the baseline experiment, holding all other parameters constant at their initial steady state levels. In other words, we shut down any changes in housing transaction costs and downpayment requirements in the baseline experiment. Panel (b) of

Table 8 presents the results of this experiment.

Earnings shocks place ex ante identical households in different positions of the earnings distributions and an increase in the variance of earnings shocks is the only source of a change in the earnings inequality. Thus, the new steady state indicates the same increase in the earnings inequality as in the baseline experiment.

More interesting is how the distribution of housing wealth and the wealth composition change in response to the increase in earnings risks. More volatile earnings concentrate the distribution of housing assets. This effect is quantitatively large. The Gini coefficient of housing assets rises from 0.55 in the benchmark economy to 0.78 in this experiment. As earnings risks increase, households attempt to build up a larger buffer stock of precautionary savings. Households achieve this by substituting liquid financial assets for illiquid housing assets. In this process, many poor households, whose wealth is primarily housing assets, give up homeownership. In the new steady state with larger earnings risks, households that belong to the bottom 60% of the housing asset distribution are renters.[22] This reduces the aggregate homeownership rate to 36.19%. If we examine the homeownership rate by wealth quintile, it is clear that the increased earnings risks cause the homeownership rate to decline more dramatically among poorer households.

However, larger earnings risks do not necessarily result in an increase in wealth inequality. The Gini index for household wealth actually declines slightly from 0.76 in the benchmark model to 0.73 in the new steady state. This appears attributable to a decline in financial asset inequality. In response to the rise in earnings risks, households increase their precautionary savings in the form of financial assets. This effect is more pronounced among poorer households who tend to be closer to the borrowing limit. The increased stock of financial assets combined with a decline in homeownership reduces the housing-to-wealth ratio for all

[22] If we sort households by wealth level, the homeownership rate for households in the lowest wealth quintile is 0.17%, not zero. This is because of some lucky households that draw very good productivity shocks. As earnings become more volatile, the good productivity shock is much better than what it was before the variance of earnings shock increased. As the productivity shock is persistent, these lucky households can afford to purchase houses, although they have the lowest level of wealth.

households, while this change is more drastic for poorer households. For households in the lowest two wealth quintiles, the share of housing assets in their wealth declines from 189.25 in the benchmark economy to 37.02 in the new steady state.

In contrast, the share of housing assets changes little among households in the highest wealth quintile. This appears attributable to the general equilibrium effect mentioned earlier. Table 9 implies that most of the decline in the real interest rate in the baseline experiment is due to the increase in earnings risks. In response to the drop in the rate of return to financial assets, wealthier households increase the share of housing assets, almost cancelling out the initial decrease in their housing assets.[23] Overall, these changes in the portfolio choice of households due to the increased earnings risks reduce financial asset inequality significantly, and hence, decrease wealth inequality, despite the higher concentration of housing assets.

4.3.2 Declining Housing Transaction Costs

To evaluate the effect of declining housing transaction costs on the economy, we reduce the parameter ϕ_s from 0.06 in the benchmark model to 0.04, and compute a new steady state, holding all other parameters the same as in the benchmark economy. Panel (c) of Table 8 presents the result. Without a change in earnings risks, the earnings distribution stays unchanged. In contrast, the decline in housing transaction costs slightly reduces the concentration of housing assets, while resulting in a higher concentration of financial assets. The Gini index for housing assets declines from 0.55 to 0.52, and the financial asset Gini increases from 0.89 to 0.92.

Intuitively, lower transaction costs make housing assets more liquid, inducing households to hold a larger fraction of their assets in the form of housing assets. As housing assets are available with lower transaction costs in the new steady state, the aggregate homeownership rate increases, and housing assets become more equally distributed. If households are sorted

[23] In this experiment, the ratio of housing structures to GDP increases, although the proportion of housing assets in household weath decline in all wealth quintiles. This seemingly contradictory phenomenon is because in this experiment, compared with the benchmark economy, more houses (relative to GDP) are produced, but total wealth increases even more with the large accumulation of financial assets.

by wealth level, we see that this change in household portfolio choice contributes to a decline in wealth inequality. The lowest wealth quintile still consists of renters, yet, homeownership rates in the second to the fourth wealth quintiles are larger than their counterparts in the benchmark economy. This accompanies a significant increase in the housing to wealth ratio for poorer households.

However, the inequality in financial assets moves in the opposite direction. Given that poorer households tend to purchase houses by making a smaller downpayment than the purchase price, the increased homeownership among these households implies that they have more debt than in the benchmark economy. Consequently, financial assets become more dispersed. These opposing changes in the distribution of housing and financial assets caused by lower transaction costs offset each other, leaving the wealth Gini coefficient unchanged.

4.3.3 Lower Downpayment Requirements

As the final decomposition exercise, we solve for a model economy with lower downpayment requirements, $\theta = 0.15$. All other parameters are held constant, as in the benchmark economy. Panel (d) of Table 8 shows that a decline in downpayment requirements reduces housing inequality significantly, while only slightly affecting the distribution of financial assets. The housing Gini coefficient declines from 0.55 in the benchmark economy to 0.49 in the new steady state.

As collateralized borrowing is the only way of having debt in this economy, the lower downpayment requirement relaxes the borrowing limits for all households. This institutional change affects borrowing-constrained households the most. Households in the bottom housing asset quintile still do not own a housing structure. However, housing assets in all other quintiles, except for the highest housing quintile increased, with larger change for households in the lower housing quintiles. Thus, housing assets are less concentrated with reduced downpayment requirements. In the new steady state, the fraction of total housing structure held by the highest housing asset quintile is 48.12%, 6.25% points lower than that in the benchmark model. If we sort households by wealth level, the homeownership rate for the second wealth quintile increases from 32.35% to 40.00%, while that for higher wealth quintiles does not change much.[24]

If we sort households by wealth level, we can observe an interesting pattern in the allocation of housing assets. Although the relaxed downpayment requirements enable poorer households to own housing structures, the shares of housing assets in household wealth actually decrease for all wealth quintiles. This is because household wealth increases to a larger extent than housing assets. The decline in the downpayment requirement increases household debt, which raises the real interest rate. In response to the higher real interest rate, poorer households reduce the size of housing structures, while holding homeownership. The higher real interest rate also means that the rate of return on financial assets is higher, inducing wealthier households to invest more in financial assets. Consequently, the share of housing assets in household wealth declines, despite the rise in homeownership rate. Overall, without much change in financial asset inequality, more equal distribution of housing assets leads to a decline in the wealth Gini coefficient from 0.76 to 0.74.

5 Welfare Analysis

We now examine the welfare implications of three exogenous shocks, including rising earnings risks, declining housing transaction costs, and reduced downpayment requirements. Note that households in the model economy derive utility from a composite consumption good ($c^{1-\phi}d^{\phi}$) of non-housing consumption and housing service. We define the welfare change from these exogenous shocks as the percentage increase in the per-period composite consumption good required to make households in the benchmark steady state derive the same lifetime utility, as in the new steady state with these exogenous shocks. We also compute the welfare

[24] Apart from these distributional effects, the relaxed downpayment requirements do not significantly affect key aggregate variables such as house prices. Unlike our study, Favilukis, Ludvigson, and Nieuwerburgh (2017) find a significant role of the relaxed financing constraints in explaining the housing boom in the U.S. before the Great Recession. This difference in the impact of borrowing constraints is due to the lack of aggregate business cycle risk in our model. Extending our model by adding aggregate risks to address business cycle implications is outside the scope of this study.

change caused by each of these three exogenous changes in U.S. labor and housing markets.

Table 10 indicates that rising earnings risks, combined with institutional changes in the housing market, reduces the average household welfare by 9.69% in units of per-period consumption. Most of this welfare loss is attributed to rising earnings risks. If earnings become more volatile, households find it more difficult to smooth consumption over time. Rising earnings risks only reduce household welfare by 10.21%.

In contrast, declines in either housing transaction costs or downpayment requirements make households better off. As the liquidity of housing assets improves, households gain welfare of 0.11%, while relaxed borrowing constraints through a reduction in downpayment requirements increases household welfare by 0.36%. Despite their welfare-improving effects, the welfare loss from rising earnings risks is dominant. Thus, the aggregate household welfare declines by 9.69% with these three exogenous changes.

6 Conclusion

This study examines the combined effect of rising earnings risks and institutional changes in the housing market on the wealth composition of U.S. households, focusing on the role of housing assets. A large body of literature documents an increase in the U.S. cross-sectional earnings inequality since the early 1980s, largely attributed to rising earnings volatility. Over the same period, many innovations occurred in the U.S. housing market that reduced both housing transaction costs and downpayment requirements. As earnings and housing assets are key determinants of household wealth and welfare, we examine the impact of these changes in the U.S. labor and housing markets on the wealth composition of households, and the distributions of earnings and housing assets. For this, we develop a two-sector incomplete market general equilibrium model with heterogenous agents.

Incorporating these three exogenous driving forces, the model generates little change in housing inequality accompanied by unequal changes in homeownership and housing to wealth ratio by wealth level. As earnings risks rise, households attempt to build a larger buffer stock of precautionary savings in the form of liquid financial assets, while reducing the share of illiquid housing assets in their asset portfolio. On the other hand, reduced housing transaction costs and downpayment requirements increase the liquidity of housing structures and relax borrowing constraints, encouraging households to purchase more housing structures. The former effect increases housing inequality, while reducing both homeownership rates, and the share of housing assets in household wealth. In contrast, the latter causes housing inequality to decline, while increasing both the homeownership rate and the share of housing assets, especially, among poorer households. These counteracting effects result in little change in overall housing inequality with large increases in homeownership and housing to wealth ratios among poorer households. We find that these results are consistent with recent trends in the U.S. data based on the SCF.

The model also has important welfare implications. Declines in housing transaction costs and downpayment requirements increase aggregate welfare by 0.11% and 0.36%, respectively. These welfare gains definitely mitigate the negative welfare impact from rising earnings risks. However, the effect of rising earnings risks is dominant: with these three exogenous changes, the aggregate welfare declines by 9.69%.

This study focuses on the long-run impact of rising earnings risks and institutional changes in the U.S. housing market on wealth composition and distributions of housing and wealth. We leave the examination of the effect of these changes during the transition as a future research topic.

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Appendix I. Data

To study household finances, we construct measures of wealth using data from the Survey of Consumer Finances (SCF) in 1983 and 1995. Following Rodriquez, Díaz-Giménez, Quadrini, and Ríos-Rull (2002), we define labor earnings (E) as labor income plus a fraction of business income attributed to labor. Labor income is wages and salaries received for the past calendar year, and business income includes income from professional practices, businesses, and farm sources. The fraction of business income attributable to labor is determined by the samplewide ratio of labor income to the sum of labor and capital income. Capital income includes non-taxable investments such as municipal bonds, other interest income, dividends, net gains or losses from the sale of stocks, bonds, and real estate, and net rent, trusts, or royalties.

Wealth (W) is defined by the net worth of the households, that is, assets minus debts. The assets (A) are real and financial assets of all kinds. Specifically, the assets include residential assets and other real estates; net value of businesses; land contracts and notes; checking accounts; certificates of deposit, and other banking accounts; IRA/Keogh accounts; money market accounts; mutual funds; bonds and stock; cash and call money at the stock brokerage; all annuities; trusts and managed investment accounts; vehicles; net cash value of life insurance policies; pension plans accumulated in accounts; total amount of loans owed to households, and other miscellaneous assets. The net value of business assets is the net equity value of business plus debts owed by the business to the household minus debt owed by the household to the business. Among the assets considered above, we define the current value of principal residence and other residential properties, as housing (H). In the 1983 SCF, the current value of home (total gross value of primary residence if a household owns or is buying home) is available in aggregate form. In the 1995 SCF, we further exploit the information on the portion of primary residence not used for farming/ranching or investment, in determining the housing assets. Pension assets include pensions from current jobs only.

The debts (D) include housing debts, such as mortgages and home equity loans; other residential property debts; lines of credit; debt on land contracts and notes; credit card debts; installment and non-installment loans; loans taken against pensions; margin loans; other debts. Installment and non-installment loans are available in aggregate form in the 1983 SCF, whereas in the 1995 SCF, the authors compute it using home improvement loans, vehicle loans, education loans, and other consumer loans. Loans taken against pensions and margin loans are not separately available in the 1983 SCF. However, we believe that the total installment and non-installment debts include those, if any. We use the relevant weights for all statistics reported in this study. In the 1995 SCF, the revised Kennickell-Woodburn consistent weight was exploited to calculate all statistics. To be consistent with this weight, we use the extended income FRB weight recommended for a full sample, including the sample of relatively wealthy households.

The full sample consists of households with positive earnings, that is, $E > 0$. Households with positive housing assets ($H > 0$) are defined as homeowners. Beginning in 1989, the survey provides five implicates using multiple imputation technique. For our analysis, we average all variables across the implicates.

Table 1: Calibrated Parameters

Parameter		Value	Source or Target
		Preference and Technology	
γ	CRRA parameter	2.0	Previous literature
β	Time discount factor	0.9303	Real interest rate of 4.0%
ϕ	Housing services consumption share	0.103	Housing to Output ratio of 1.19 from BEA
χ	Utility from renting	1.0577	Homeownership rate of 65.88%
α	Capital share in non-housing sector	0.28	Total Capital to Output ratio of 3.15 from BEA
κ	Capital's share in housing sector	0.132	Davis and Heathcote (2005)
λ_f	TFP in non-housing sector	1	Normalization
λ_h	TFP in housing sector	1.30	Relative price of residential investment of 0.84
δ_k	Capital depreciation rate	0.0963	Historical-cost depreciation of private non-residential fixed assets from BEA
δ_h	Regular housing depreciation rate	0.0265	Historical-cost depreciation of owner-occupied private residential fixed assets from BEA
δ_g	Rental housing depreciation rate	0.0320	Historical-cost depreciation of tenant-occupied private residential fixed assets from BEA
		Earning Process	
ρ_x	Persistence of earnings process	0.955	Estimates from the PSID
σ_x^2	Volatility of earnings shocks	0.0279	Estimates from the PSID
π_1	Prob. from regular to superstar	0.0005	Proportion of superstar households
π_2	Prob. from superstar to regular	0.0099	Earnings Gini index
ω	Earnings shock of a superstar relative to the highest grid for a regular household	9	Wealth Gini index
		Housing Institutions	
ϕ_s	Selling transaction costs	0.06	Chambers and Simonson (1989)
ϕ_b	Buying transaction costs	0.00	Normalization
θ	Downpayment requirements	0.20	Downpayment ration published by FHFA

Table 2: Household Earnings Process

Earnings shock					
0.3242	0.5694	1.000	1.7562	3.0842	27.7578
Transition Matrix					
0.9125	0.0840	0.0029	0.0000	0.0000	0.0005
0.0210	0.9140	0.0630	0.0015	0.0000	0.0005
0.0005	0.0420	0.9145	0.0420	0.0005	0.0005
0.0000	0.0015	0.0630	0.9140	0.0210	0.0005
0.0000	0.0000	0.0029	0.0840	0.9125	0.0005
0.0099	0.0099	0.0099	0.0099	0.0099	0.9505

Table 3: Household Earnings and Wealth Distribution in 1983: All Households

	Quintiles					Gini
	1st	2nd	3rd	4th	5th	Coeff.
Data - SCF 1983 (Homeownership: 65.88%)						
Earnings, E	3.56	10.47	16.44	24.65	44.83	0.42
Houses, H	0	1.50	14.66	23.01	60.84	0.63
Financial assets, A	−10.45	−0.07	1.81	7.88	100.83	1.06
Wealth, W	0.19	2.20	6.89	15.15	75.57	0.74
Owners by W (%)	7.51	45.34	87.83	95.27	95.39	
H/W	107.63		103.93	80.46	35.30	
Benchmark Model (Homeownership: 65.73%)						
Earnings, E	6.86	10.63	13.92	20.24	48.35	0.42
Houses, H	0.00	3.32	19.61	22.70	54.37	0.55
Financial assets, A	−3.10	0.06	1.76	12.17	89.11	0.89
Wealth, W	0.03	0.97	5.99	15.32	77.69	0.76
Owners by W (%)	0.00	32.35	97.28	96.39	97.28	
H/W	189.25		99.91	44.16	20.84	

Note: Housing assets from the SCF indicate the value of principal and secondary residences, and financial assets represent the remainder of household wealth. Renters are included in the calculation of housing assets, homeownership rates, and H/W ratios.

Table 4: Parameterization for Changes in the Exogenous Driving Forces

	Interpretation	Benchmark	New Steady State
σ_x^2	Volatility of earnings shocks	0.0279	0.0394
φ^s	Selling transaction costs	0.06	0.04
θ	Downpayment requirements	0.20	0.15

Table 5: Combined Effects of All Three Exogenous Changes

	Quintiles					Gini
	1st	2nd	3rd	4th	5th	Coeff.
Benchmark (Homeownership: 65.73%)						
Earnings, E	6.86	10.63	13.92	20.24	48.35	0.42
Houses, H	0.00	3.32	19.61	22.70	54.37	0.55
Financial assets, A	−3.10	0.06	1.76	12.17	89.11	0.89
Wealth, W	0.03	0.97	5.99	15.32	77.69	0.76
Owners by W (%)	0.00	32.35	97.28	96.39	97.28	
H/W	189.25		99.91	44.16	20.84	
$\sigma_x^2 \uparrow$, $\phi_s \downarrow$, $\theta \downarrow$ (Homeownership: 71.26%)						
Earnings, E	5.50	9.27	12.67	19.92	52.64	0.48
Houses, H	0.00	5.73	18.38	22.14	53.74	0.54
Financial assets, A	−2.52	0.22	2.99	14.59	84.73	0.84
Wealth, W	0.13	1.81	6.94	16.96	74.15	0.72
Owners by W (%)	9.32	51.39	99.19	96.43	98.11	
H/W	323.32		85.03	40.83	22.65	

Table 6: Comparing Baseline Results from the Model with Data Counterparts

	Data (SCF)				Model	
Gini Coeff.	1983	1998	2001	2004	BM	$\sigma_x^2 \uparrow, \phi_s \downarrow, \theta \downarrow$
E	0.42	0.49	0.52	0.50	0.42	0.48
H	0.63	0.64	0.67	0.67	0.55	0.54
Homeowners (%)	65.88	68.65	68.79	70.64	65.73	71.26

Note: Gini coefficients and the homeownership rate for years 1998, 2001, and 2004 are taken from Table 8 in Díaz and Luengo-Prado (2010).

Table 7: Distributional Changes in the Model and the Data

	Quintiles				
	1st	2nd	3rd	4th	5th
	Owners by W (%)				
SCF 1983	7.51	45.34	87.83	95.27	95.39
SCF 1998	13.41	51.63	86.56	91.95	94.15
BM	0.00	32.35	97.28	96.39	97.28
$\sigma_x^2 \uparrow$, $\phi_s \downarrow$, $\theta \downarrow$	9.32	51.39	99.19	96.43	98.11
	H/W				
SCF 1983	107.63		103.93	80.46	35.30
SCF 1998	257.79		113.63	76.08	27.95
BM	189.25		99.91	44.16	20.84
$\sigma_x^2 \uparrow$, $\phi_s \downarrow$, $\theta \downarrow$	323.32		85.03	40.83	22.65

Table 8: Decomposing the Effects of Three Exogenous Forces

	Quintiles					Gini
	1st	2nd	3rd	4th	5th	Coeff.
	Panel (a) Benchmark (Homeownership: 65.73%)					
Earnings, E	6.86	10.63	13.92	20.24	48.35	0.42
Houses, H	0.00	3.32	19.61	22.70	54.37	0.55
Financial assets, A	−3.10	0.06	1.76	12.17	89.11	0.89
Wealth, W	0.03	0.97	5.99	15.32	77.69	0.76
Owners by W (%)	0.00	32.35	97.28	96.39	97.28	
H/W	189.25		99.91	44.16	20.84	
	Panel (b) $\sigma_x^2 \uparrow$ (Homeownership: 36.19%)					
Earnings, E	5.50	9.27	12.67	19.92	52.64	0.48
Houses, H	0.00	0.00	0.00	21.36	78.64	0.78
Financial assets, A	−0.39	1.43	6.25	15.71	77.00	0.75
Wealth, W	0.10	1.74	6.49	15.82	75.86	0.73
Owners by W (%)	0.17	13.53	28.42	49.22	89.22	
H/W	37.02		21.64	23.67	20.42	
	Panel (c) $\phi_s \downarrow$ (Homeownership: 72.54%)					
Earnings, E	6.86	10.63	13.92	20.24	48.35	0.42
Houses, H	0.00	7.02	19.11	21.59	52.27	0.52
Financial assets, A	−4.17	−0.13	1.28	11.31	91.71	0.92
Wealth, W	0.04	1.16	5.80	14.96	78.04	0.76
Owners by W (%)	0.00	64.21	100.00	100.00	97.18	
H/W	254.88		103.61	48.90	20.98	
	Panel (d) $\theta \downarrow$ (Homeownership: 68.36%)					
Earnings, E	6.86	10.63	13.92	20.24	48.35	0.42
Houses, H	0.00	5.22	21.03	25.63	48.12	0.49
Financial assets, A	−2.77	0.07	2.03	12.46	88.21	0.88
Wealth, W	0.04	1.23	6.40	16.13	76.20	0.74
Owners by W (%)	0.00	40.00	99.31	97.53	94.57	
H/W	165.93		94.79	43.56	16.28	

Note: Renters are included in the calculation of housing assets, homeownership rates, and H/W ratios.

Table 9: Key Aggregate Variables in Various Steady States

	Homeownership Rate	Interest Rate	Housing Price	H/Y
Benchmark	65.73%	4.00%	0.840	1.21
$\sigma_x^2 \uparrow, \phi_s \downarrow, \theta \downarrow$	69.98%	3.38%	0.848	1.30
$\sigma_x^2 \uparrow$	36.26%	3.46%	0.847	1.27
$\phi_s \downarrow$	72.54%	3.97%	0.840	1.22
$\theta \downarrow$	68.36%	4.08%	0.839	1.21

Table 10: Welfare Changes Compared to the Benchmark Economy

	Welfare
$\sigma_x^2 \uparrow, \phi_s \downarrow, \theta \downarrow$	-9.69%
$\sigma_x^2 \uparrow$	-10.21%
$\phi_s \downarrow$	0.11%
$\theta \downarrow$	0.36%