Explaining the Evolution of the U.S. Housing Market*

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Abstract

Over the past few decades, both the relative price of housing structures and the relative consumption of housing services to nondurables increased significantly in the U.S. This paper considers demand-side factors such as an increase in idiosyncratic earnings risk and a decline in housing transaction costs to explain the phenomenon. The increased earnings risk strengthens consumers’ precautionary saving motives. Combined with this, a decline in transaction costs encourages consumers to hold more housing assets. We build a general equilibrium model of housing and compare two steady states which correspond to 1967 and 2000 U.S. economies. Our model can replicate the increases in both the relative price of houses and the relative consumption of housing services to nondurables. The increased earnings risk is quantitatively the most important factor, yet the reduction in housing transaction costs also has a sizable impact on the rise in housing quantity.

Keywords: Housing Market, Idiosyncratic Earnings Risk, Precautionary Savings

JEL Classifications: E22, E31, G11, R21, R31
1 Introduction

Over the last 30 years, the U.S. housing market has grown in both its value and quantity. The relative price of residential investment rose by 28.65% between 1967 and 2000.\(^1\) For the same period, the relative consumption of housing services to nondurables has increased as Figure 2 shows. In order to explain the simultaneous increases in the relative price of houses and relative housing to nondurables consumption, we consider demand-side factors including increased earnings volatility and institutional changes in the U.S. housing market.

One may think that supply-side factors are equally important for the rise in both the relative price of houses and relative quantity of housing consumption. However, the standard housing literature is in contrast with this hypothesis. Following Ogaki and Reinhart (1998), many studies on the U.S. housing market have assumed unit elasticity of substitution between housing and nondurables consumption. Under this assumption, a rise in the relative price of residential structure caused by supply-side factors forces real consumption for housing services to decline relative to real nondurables consumption to the same extent, leaving the relative consumption of housing services to nondurables unchanged. Thus, without demand-side factors, one cannot reconcile the rise in the relative price of houses with increased relative housing to nondurables consumption.
The first demand-side factor considered in this paper is rising earnings risk, which has been well-documented in the labor literature (Gottschalk and Moffitt (1994); Gottschalk and Moffitt (2012); Heathcote et al. (2010)). We also explore the decline in housing transactions costs and the reduction in down payment requirements as additional driving forces behind the phenomenon. In an incomplete markets framework, the increased idiosyncratic earnings risk strengthens consumers’ precautionary saving motives. In addition, decreases in both housing transaction costs and down payment requirements cause consumers to increase the fraction of their assets invested in housing structures relative to non-residential assets. Both factors raise the demand for housing structure, leading to increases in both the relative price of residential investment and relative consumption on housing services to nondurables. This paper quantifies the contribution of each of these factors to the changes in U.S. housing markets over the past few decades.

For the quantitative analysis, this paper constructs a two-sector general equilibrium model with heterogeneous agents. In our model, consumers draw an idiosyncratic earnings shock in each period and can invest in non-residential capital and housing structures. The model introduces three distinct features of housing assets: i) housing transactions are costly; ii) housing assets have collateral values; and iii) consumers derive utility from housing services. We solve for two steady states of the model, which correspond to the U.S. economy in 1967 and in 2000, respectively, and compare changes in key housing variables between the two steady states with their data counterparts.

We find that our model can generate the simultaneous rise in both the relative price of residential investment and the relative consumption of housing services to nondurables. The increased earnings risk is quantitatively the most important factor in replicating the
motivating facts. The reduction in transaction costs also has a sizable impact on the increase in the housing quantity. Without a decline in the housing transaction costs, the increases in both the relative consumption of housing services to nondurables and residential investment to GDP ratio between the two steady states would be reduced by about 20%. In contrast, our model implies that the change in down payment requirements has little effect on the aggregate housing variables. The increased earnings risk also widens both earnings and wealth inequality as is consistent with the U.S. data. Our model accounts for more than half of the rise in the Gini coefficient for households’ net worth over the past four decades. Lastly, we consider a slower growth in construction total factor productivity (TFP) relative to other sectors as an additional change in the U.S. housing market. This improves the model fit for the relative price of housing, yet this change alone fails to generate the increase in the relative consumption on housing services to nondurables.

Rising U.S. housing prices in the late 20th century have actually been studied by many researchers including Glaeser et al. (2005), Gyourko et al. (2006), and Davis and Heathcote (2007). A common element in these papers is that residential land or housing is in fixed supply. Although this assumption helps explain a remarkable rise in housing prices in the U.S. data, it keeps these papers from reproducing the evolution of the quantity of U.S. housing structures.

Our paper is more closely related to a literature that empirically and theoretically examines the effects of demand-side factors on housing market. Mankiw and Weil (1989) and Martin (2006) claim that the growth in the house-buying population caused by the Baby Boom increased demand for housing, forcing housing prices to rise. Stein (1995) studies the role of down payment in housing purchases and shows that a decline in down payment
to purchase a new house generates a positive correlation between house prices and trading volume. Ortalo-Magné and Rady (2006) examine the effects of income shocks and credit constraints on housing dynamics and highlight a channel through which income shocks contribute to a positive correlation between house price and transactions. Favilukis et al. (2013) emphasize the role of increased credit supply, as a result of financial market liberalization, in explaining U.S. house prices for the past couple of decades. Nakajima (2005) considers a rise in earnings volatility as a main reason behind the rise in U.S. house prices, as we do in this study. However, he assumes that housing assets are as liquid as financial assets, whereas housing transactions are actually costly due to realtor fees, legal costs, etc. In our paper, we incorporate housing transaction costs into our framework and quantify their contributions to the increases in both housing prices and quantities separately from the contribution of the increased idiosyncratic earnings risk.

The mechanism explored in our study also has some implications for the increase in asset prices since the early 2000s. In this paper, we show that the increased earnings risk increases demand for housing structure, raising house prices beyond fundamental values. This is a plausible mechanism that leads to a housing boom. In a related study, Favilukis (2013) shows that the increased wage inequality, reduced costs in stock market participation, and relaxed borrowing constraints can jointly cause a stock market boom accompanied by a decline in the real interest rate. The increase in asset prices can also result from an interaction with foreign countries. Mendoza et al. (2009) present a mechanism that can cause increases in asset prices following financial integration of countries with different levels of financial markets development. In this case, countries with less developed financial markets accumulate foreign assets, raising asset prices and reducing the real interest rates of countries.
with more advanced financial markets. Favilukis et al. (2015) also point out a possibility that both a financial market liberalization and an inflow of foreign capital raise risk premia on housing assets and reduce interest rates.

This paper is organized as follows. In Section 2, we describe our two sector general equilibrium model with heterogeneous agents. Section 3 describes how we calibrate the model and Section 4 presents the main quantitative results. In Section 5, we explain the importance of a heterogeneous agents model with incomplete markets for our analysis and discuss the contribution of housing fundamentals to the rise in housing prices. This section also investigates the impact of TFP on the U.S. housing market and presents a sensitivity analysis. We then conclude in Section 6.

2 Model

Our model is a modification of Huggett (1993)’s and Aiyagari (1994)’s general equilibrium model with heterogeneous agents who have different productivity and live infinitely. There is a continuum of consumers of measure one. We compare two steady states which match up with the U.S. economy in 1967 and in 2000, respectively. We first describe preferences and the consumer’s problem and then we explain technology and the firm’s problem, concluding with a steady state equilibrium.

2.1 The Consumer’s Problem

Consumers consume both nondurable goods and housing services. Let $c$ and $h$ denote nondurable goods consumption and housing services consumption, respectively. Our model
abstracts from a tenure choice in such a way that every consumer is a homeowner. We make this choice because U.S. homeownership rate stayed roughly constant between 1967 and 2000 and therefore homeownership is not essential to understand the facts that motivated this paper. Consumers can invest in a claim $a$ for non-residential capital and a housing structure $h$. Savings on a claim for non-residential capital $a$ give consumers a rental rate $r$ of non-residential capital, and savings on a housing structure $h$ give them an increase of utility. Note that $h$ denotes both housing service consumption and a housing structure. Assume that there are $n$ discrete types of housing structures in this model economy: $h \in \{\bar{h}_1, \bar{h}_2, \ldots, \bar{h}_n\}$.

Let $q$ denote a price of housing structures and $\varphi$ a rate of transaction cost for a housing structure. Whenever consumers move from $h$ to $h'$, they should pay transaction costs $\varphi q |h' - h|$. Each consumer pays $q(1 - \delta_h)h$ as a maintenance cost of her housing structures at the end of each period, where $\delta_h$ is a depreciation rate for housing structures. There is no unsecured debt in this economy. A consumer can borrow up to $(1 - \theta)qh'$, where $\theta$ is a down payment requirement. Let $x$ denote a consumer’s idiosyncratic productivity which evolves according to $\log(x_{t+1}) = (1 - \rho_x)u_x + \rho_x \log(x_t) + \eta_{t+1}$ where $\eta_{t+1} \sim (0, \sigma^2_x)$. Consumers receive their labor income $wx$ in each period, where $w$ is the wage per efficiency unit of labor. The lifetime utility of a consumer is written as

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

where $\beta$ is a discount factor. Following Fernandez-Villaverde and Krueger (2010), we assume a unit elasticity of substitution between nondurable goods and housing service consumption, that is, the utility function in period $t$ is given by

$$u(c_t, h_t) = \frac{\{c_{t}^{1-\phi}h_{t}^{\phi}\}^{1-\gamma} - 1}{1 - \gamma}.$$
Given $q$, $w$, and $r$, a consumer solves

\[
V(a, h, x) = \max_{c, h'} \left\{ u(c, h) + \beta \mathbb{E}[V(a', h', x') | x] \right\}
\]

s.t. \( c + a' + qh' + \varphi q |h' - h| = wx + (1 + r)a + q(1 - \delta_h)h, \)

\[
a' \geq -(1 - \theta)qh',
\]

\[
h' \in \{\bar{h}_1, \bar{h}_2, \ldots, \bar{h}_n\},
\]

where $V(a, h, x)$ is a consumer’s value function.

[Put Figure 3 here]

### 2.2 The Firm’s Problem

There are two production sectors in this economy. One sector produces nondurable goods and the other sector produces housing structures. Let $f$ denote the nondurable goods sector and $h$ denote the housing sector. Let $L_i$ be aggregate labor hired by sector $i$, $K_i$ be aggregate capital hired by sector $i$, and $\lambda_i$ be TFP of sector $i$, where $i \in \{f, h\}$. The production function of 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 of housing services is written as

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

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

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A representative firm in the nondurable goods sector maximizes profit by solving

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

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

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

### 2.3 Steady State Equilibrium

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

1. Consumers optimize: given a set of prices $\{q, w, r\}$, $V(a, h, x)$ solves consumers’ Bellman equations, and $c(a, h, x), a'(a, h, x)$ and $h'(a, h, x)$ are the optimal policy functions.

2. Firms maximize profits:

$$w = F_1(L_f, K_f; \lambda_f) = qG_1(L_h, K_h; \lambda_h),$$

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

3. Nondurable goods market clears:

$$\int \{a'(a, h, x) + c(a, h, x) + \varphi q \mid h'(a, h, x) - h\} \, d\mu = F(L_f, K_f; \lambda_f) + (1 - \delta_k)\{K_f + K_h\}.$$

4. Housing structures market clears:

$$\int \{h'(a, h, x) - (1 - \delta_h)h\} \, d\mu = G(L_h, K_h; \lambda_h).$$
5. Factor markets clear:

\[ L_f + L_h = \int x \, d\mu, \]
\[ K_f + K_h = \int a \, d\mu. \]

6. Let \( T \) be the transition rule of the distribution of consumers \( \mu(a, h, x) \) implied by \( a'(a, h, x), h'(a, h, x) \), and the law of motion for \( x \). Then, \( \mu = T(\mu) \).

3 Calibration

This section explains how we set parameter values described in Table 1. In this model, the period length is equal to one year. Among parameters related to preferences, the coefficient \( \gamma \) of risk aversion is set to 2 based on common estimates for risk aversion in the literature. The weight \( \phi \) on utility from housing service consumption is 0.0819, which matches the total value of housing stock over aggregate output in 1967 of 1.0850. The discount factor \( \beta \) is chosen to be 0.9437 in order to match the equilibrium rate of return to capital in the 1967 economy, which was 0.04.

The idiosyncratic productivity process is set based on the estimated log residual earnings process using the Panel Study of Income Dynamics (PSID). We take male household heads’ earnings from the PSID data and regress log earnings on a time dummy, age, schooling, age\(^2\), schooling\(^2\), and age×schooling. The log earnings residual from this regression is assumed to follow an AR(1) process: \( \log(x_{i,t+1}) = \rho_x \log(x_{it}) + \eta_{i,t+1} \), where \( \eta_{it} \sim (0, \sigma^2_{xt}) \) and the variance \( \sigma^2_{xt} \) is allowed to vary over time. The initial value \( x_0 \) of the log earnings residual is assumed to be drawn from a time-invariant distribution such that \( \log(x_0) \sim (0, \sigma^2) \). We
estimate the persistence $\rho_x$, the variance $\sigma^2$ of the initial log earnings residual, and a time series of variances $\sigma^2_{x_t}$ of the persistent wage shock by minimizing distance between empirical covariances of the log earnings residuals and their theoretical counterparts. The details of the estimation procedure are described in Appendix I. Based on the estimates, the persistence $\rho_x$ of idiosyncratic productivity shocks is set to 0.9557. Comparing the initial variance of the wage shocks with its end point estimate, we find that the variance more than tripled over the sample period. To be conservative about the rise in the variance of the individual productivity shocks, we take the averages of the point estimates for the first half and the second half of the sample period, and use these values as the variances of wage shocks in our initial steady state and in the new steady state, respectively. The variances of idiosyncratic productivity shocks in 1967 and 2000 are then set at $\sigma^2_{x_{67}} = 0.0190$ and $\sigma^2_{x_{00}} = 0.0358$. In addition, the mean of $\log(x_t)$ in 2000 is calibrated by $-0.1472$ which makes aggregate labor in 2000 equal to that in 1967.

We normalize the TFPs of both nondurable goods and construction sectors to 1 in 1967. Following Chambers et al. (2009), the rate $\varphi$ of transaction cost and the down payment requirement $\theta$ are set to 0.06 and 0.2, respectively. The depreciation rates for capital $\delta_k = 0.0829$ and for housing structures $\delta_h = 0.0167$ are selected using data from the Bureau of Economic Analysis. Capital share $\alpha$ in nondurable goods sector is set to 0.36 and, following Davis and Heathcote (2005), capital share $\kappa$ in housing sector is set to 0.132. The lower bound of the house grid is set to $h_1 = 0.00001$. Using the fact that most people can have mortgage loans up to five times their annual income, we choose the upper bound of the house grid to be $h_n = 18.5743$. 


4 Results

This section begins by describing the results of the model economy where demand-side factors in the housing market change all at once. We then decompose the contributions of the demand-side factors to the changes in U.S. housing market by holding the value of one factor at a time constant at its initial level. Following this, we include a subsection discussing the model’s implications on the distribution of earnings and wealth.

4.1 Baseline Result

The initial steady state of the model economy is calibrated to the 1967 U.S. economy. Over the period of 1967 to 2000, there are three main changes that increase demand for housing services. Specifically, we consider a reduction in down payment requirements, a decline in housing transaction costs, and an increase in idiosyncratic earnings risk. Holding all other parameters constant, we solve a new steady state with these changes in the demand-side factors. Comparing this new steady state with the initial one is our baseline experiment.

Note that in this model, the price of housing structures is $q$ and the price of nondurable goods is 1. Thus, we calculate the GDP deflator of the model economy and use it to deflate the price $q$ of residential investment in the model so that the results of the model economies are comparable to their data counterparts. The GDP deflator $P = \frac{q^\phi}{\phi^\varphi(1-\phi)^{1-\phi}}$ of the model economy is obtained by solving the following cost minimization problem:

$$P = \min_{c,h} \{c + qh\}$$

s.t. $c^{1-\phi} h^\phi = 1$. 

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Table 2 presents the changes in key aggregate variables between 1967 and 2000, both in the U.S. data and in our model. The results show that the considered changes in the demand-side factors can replicate simultaneous increases in both the relative price $q/P$ of residential investment and the relative consumption $qH/C$ of housing services to nondurables. Without an increased demand for housing structure, one cannot replicate this pattern. The price index of housing structure increases by 3.32% relative to the overall price index in the model, which is about 12% of what we observe in the data. Later in this paper, we consider a fourth change in the U.S. housing market: a slower growth in construction TFP relative to other sectors. We find that this change strongly contributes to the rise in the relative price of houses. In contrast with the prices, the model overstates the rise in the ratio of housing services to nondurable consumption. The ratio increased by 24.32% in the model, while it rose by 4.34% in the data. This overstatement may be due to some missing factors that mitigate the impacts of the demand-side factors on demand for housing. For instance, incorporating the uncollateralized debt into the model may relax consumers’ credit constraints, which may cause consumers to be less responsive to the increased earnings risk or to the decline in down payment requirements.

Our model also qualitatively matches the changes in factor inputs. Between the 1967 and 2000 U.S. economies, the residential capital stock accumulated more rapidly than the GDP grew, while the share of labor employed in construction sector increased substantially. Our model can replicate both patterns. The strengthened precautionary saving motive induces consumers to build up a buffer stock of financial assets in the model, leading to an increase in the physical capital-to-output ratio almost as large as that seen in the data. The accumulated capital stock then makes labor more productive, increasing the real wage as is consistent with
the U.S. data.

4.2 Decomposing the Forces

In this section, we proceed by implementing a few counterfactual exercises to decompose the effects of the three demand-side factors in explaining the changes in U.S. housing market over 1967 to 2000. The first three exercises hold each of the three demand-side factors constant at its initial level and allow the other two factors to change. The results are presented in Table 3.

A decline in transaction costs of housing structure makes housing assets more liquid, inducing consumers with a strong precautionary saving motive to purchase more housing structures. Comparing the first two columns indicates how strong the effect of the reduced transaction costs has been in generating the simultaneous increase in both relative price of housing structures and the relative consumption on housing services. Without the reduction in housing transaction costs, the relative housing services to nondurable consumption would have increased slightly less than in the baseline experiment. Therefore, labor does not move from the nondurables sector to the construction sector as much as in the baseline experiment. The share of labor in the construction sector rises by about 16% with constant transaction costs, compared to 19.5% in the baseline result. In contrast with the quantity, the relative price of residential investment rises slightly more with no decline in housing transaction costs, in contrast to our intuition. The constant transaction costs reduce the increase in demand for housing structures compared to the baseline experiment, yet the change in supply drops even more. Thus, the relative price of housing goes up. Without a decline in the transaction
costs, consumers would rather save more through financial assets, increasing the aggregate capital stock in the economy compared to the baseline experiment. This larger aggregate capital stock raises the marginal product of labor, increasing the real wage in the economy.

The third column shows how much of the changes in key aggregate variables in the baseline experiment are attributable to the decrease in down payment requirements in U.S. housing market. The borrowing constraints tend to bind for households with lower earnings. Since a decrease in down payment requirements loosens borrowing constraints, it is likely to generate more demand for housing than decreasing transaction costs do. However, since borrowing constraints bind for only a small number of consumers in an economy with high level of average earnings, housing transaction costs are more important than borrowing limits when consumers buy a larger house. Thus, the reduction in down payment requirements has a negligible effect on the changes in both the relative price of houses and relative housing consumption.

The last column implies that the most important demand-side factor in explaining how U.S. housing market has changed between 1967 and 2000 is the rising earnings risk of U.S. households. By holding the variance of idiosyncratic earnings risk at its initial steady state value, the model fails to generate the simultaneous increases in both the relative price of houses and relative consumption of housing services. Without a stronger precautionary saving motive, the relative price of housing structures would have fallen, while the relative housing to nondurables consumption and residential investment rose only slightly. The model also deviates from the data in that it leads to counterfactual declines in both physical capital stock and real wage.

The results show that the stronger precautionary saving motive caused by the rising
earnings risk is critical in matching the increases in both the relative price of houses and relative housing consumption to nondurable goods consumption in the U.S. economy over the 1967-2000 period. Changes in housing transaction costs also have a significant effect on the relative housing to nondurables consumption, although their impact on the relative price of houses is small. On the other hand, the quantitative effects of the decline in down payment requirements on the U.S. housing market have been weak.

4.3 Implications on Wealth Distribution

The heterogeneous agents framework adopted in this study has implications on wealth distribution. Consumers face idiosyncratic earnings risks in every period, which fan out the distribution of earnings and wealth. This section examines whether our model is consistent with the changes in earnings and wealth distributions observed in the U.S. economy between 1967 and 2000.

To this aim, we calculate the Gini coefficients of households’ earnings, housing assets, and wealth in the initial and new steady states, along with their data counterparts. For the U.S. earnings and wealth distributions, we exploit data from the Survey of Consumer Finances, a triennial survey of U.S. households’ detailed financial information and demographic characteristics. Since the survey began in 1983, we rely on the Survey of Financial Characteristics of Consumers (SFCC) in 1962 for the initial steady state. The details of the sample selection criteria and the variables included in the analysis are presented in Appendix II.

Table 4 summarizes how the distributions of households’ earnings, housing assets, and wealth have changed in both the model and data. Although explaining the changes in
earnings and wealth distributions in the U.S. economy is not the main goal of this paper, our model is qualitatively consistent with the distributional changes in the data. We find that the distributions of earnings and wealth were more dispersed around 2000 than in the 1960s, in both the model and data. In the model, the earnings Gini coefficients rose by 35% between the two steady states, while it increased by 11% in the data. Note that the increase in earnings inequality in the model is solely due to the increased idiosyncratic earnings risk, estimated based on male earnings data from the PSID. To the extent that risk sharing within households has been reinforced, the model may overstate the effect of rising earnings risk of individuals on the distribution of household earnings.

The results show that the increased households’ earnings volatility definitely contributed to rising inequality in housing assets and wealth, yet the increases in the Gini coefficients of both housing assets and wealth are smaller than the increase in the earnings Gini. In the model, the Gini coefficient of housing asset increased by 26%, almost 10 percentage points smaller than the earnings Gini, and the wealth Gini rose by only 5%. This pattern also holds in the data.

Our model is also in line with a change in the average size of houses for the past few decades. According to the U.S. Census Bureau, the average square feet of floor area in new single-family houses completed in the U.S. rose by 36.5%, from 1,660 sqft to 2,266 sqft, between 1973 and 2000. Our model implies a 22% increase in the average size of houses between the two steady states, which explains more than 60% of the increase found in the data.
5 Discussion

This section begins with a discussion of why we need a model with heterogeneous agents and incomplete markets, and presents an exercise to decompose the change in house prices generated by the model into fundamental vs. non-fundamental values. We then examine a supply-side factor that appears to have contributed to the rise in U.S. house prices for the past few decades and present a sensitivity analysis.

5.1 Heterogeneous Consumers and Incomplete Markets

Since our main goal is to understand the changes in aggregate housing variables instead of distributional changes, one might think that a representative agent framework is sufficient for the analysis. In order to understand the role of heterogeneity of consumers in our quantitative exercises, we consider a model with a representative consumer. A representative consumer, given $q$, $w$, and $r$, solves

$$V(K, H) = \max_{C,H'} \{u(C, H) + \beta V(K', H')\}$$

s.t. $C + K' + qH' + \varphi q (H' - H)^2 = w + (1 + r)K + q(1 - \delta_h)H$,

where $C$ is nondurable goods consumption, $H$ denotes both housing services consumption and housing stock, $K$ is capital stock, and $V(K, H)$ is a consumer’s value function. Assume that the consumer has one unit of time in each period and is not subject to a borrowing constraint. By solving the steady state of this model, we obtain

$$\frac{qH}{C} = \frac{\beta \phi}{(1 - \phi)(1 - \beta + \beta \delta_h)}.$$
According to the equation, the ratio $\frac{q_H}{\bar{C}}$ of housing services consumption to nondurables consumption is determined by three model parameters, $\beta$, $\phi$, and $\delta_h$, in the steady state. It implies that this framework cannot generate the increase in the relative housing services to nondurable goods consumption without a change in the consumer’s preferences ($\beta$, $\phi$) or in the technology for maintaining housing structures ($\delta_h$). Consequently, a model with heterogeneous agents is essential to investigating the importance of increasing earnings risks and changing housing institutions in explaining the changes in the U.S. housing market.

5.2 Fundamental vs. Non-Fundamental Values of Housing

In a model with complete markets, changes in house prices are driven by expected growth in housing fundamentals, such as rents. However, in an incomplete markets framework, house prices are affected by non-fundamental values (for instance, collateral value) as well as fundamental values. Since incomplete markets play an essential role in generating the rise in house prices in our model, it is natural to ask how much of the rise is attributable to fundamental values vs. non-fundamental values. To answer this question, we compute a measure of house price relative to fundamental value defined by $\frac{q_t}{R_t}$, where

$$R_t \equiv \int \left[ \frac{w_2(c_t, h_t)}{u_1(c_t, h_t)} \right] d\mu = \int \left[ \frac{\phi c_t}{(1-\phi)h_t} \right] d\mu,$$

following Favilukis et al. (2015).

Table 5 presents percentage changes in the house price relative to housing fundamentals in the baseline experiment, together with the changes associated with each of the three demand-side factors held constant. Without a change in either housing transactions costs or down payment requirements, the increase in house price relative to its fundamental value is slightly smaller than that with changes in all three demand-side factors. In contrast, the increase in
the ratio of house price to housing fundamental with a constant earnings risk is only about one-eighth of that in the baseline results. The increased earnings risk induces consumers to save more for precautionary motives, pushing down the real interest rate. The results imply that this decline in the real interest rate is the most important driving force behind the deviation of house prices from housing fundamentals in our model. The effect of relaxed borrowing constraints on the deviation is fairly small. This conclusion is consistent with findings in a few previous studies including Kiyotaki et al. (2011) and Sommer et al. (2013). However, unlike these studies, Favilukis et al. (2015) find large effects of relaxed financing constraints. We view the lack of aggregate risk in our model as an important reason behind the discrepancy between their results and ours. In the presence of an aggregate risk, a decline in the real interest rate may lead to an increase in housing risk premium, so house prices may not increase as much as they would in a model without an aggregate risk. In addition, compared to Favilukis et al. (2015)’s model with finitely-lived agents, our infinitely-lived agents framework makes the borrowing constraints bind for a smaller number of consumers due to a larger buffer stock of precautionary savings, possibly understating the quantitative importance of the relaxed borrowing constraints on house price increases.

5.3 Role of TFP Growth

In addition to the demand-side factors examined in the main results, a lower TFP growth in the construction sector relative to other sectors can potentially explain a significant rise in housing prices over the past few decades. According to Haskell (2004), both the non-agricultural manufacturing and construction sectors have experienced increases in their TFP
between 1966 and 2003. However, the growth rate of nonagricultural manufacturing sector TFP is twice that of the construction sector. The Bureau of Labor Statistics data show that from 1987 to 2000, construction sector multifactor productivity has actually declined, although non-farm business sector multifactor productivity has risen as Figure 4 shows. Based on this evidence, we increase nondurable goods sector TFP from 1 to 1.2858, holding housing sector TFP constant at 1 and present the results in Table 6.

[Put Figure 4 here]

With this widening gap in TFP between construction and nondurable goods sectors, our model economy can generate a substantial increase in the price of housing structure. As the construction sector experiences a decline in its productivity relative to nondurable goods sector, the relative price of housing to nondurable goods rises by 37% between the two steady states, which is reasonably close to the 29% increase in the data. The higher TFP in the nondurable goods sector works in favor of labor, raising the real wage as in the data. Despite the success of the model in this dimension, the supply-side factor fails to match changes in various quantities in the data. The model generates counterfactual declines in both residential investment and housing structures with a reduction in the fraction of labor employed in the construction sector. The aggregate capital stock is also negatively affected unlike in the data, since households reduce their savings due to income effect caused by higher rates of return to capital and labor. These results reinforces the importance of the demand-side factors in explaining the changes in U.S. housing market.

We further investigate how the supply-side factor interacts with the demand-side factors by considering both types of changes simultaneously. The results are presented in the last
column of Table 6. The model results are qualitatively the same as what we observe in the baseline experiment. The main differences in quantitative results between this experiment and the baseline one is that the lower TFP in construction sector relative to nondurable goods sector raises the relative price of housing and real wage more significantly than in the baseline experiment. However, other quantities vary little with the additional supply-side factor. This implies that the reallocation of factor inputs between construction and nondurable goods sectors and the households’ portfolio choice between housing and financial assets are mainly affected by the demand-side factors.

5.4 Sensitivity Analysis

Our calibration assumes a unit elasticity between housing services and nondurables consumption. Under this assumption, the relative consumption of housing services to nondurables stays fixed in a representative agent framework, although the data shows this ratio increased in the U.S. over the past few decades. Our model shows that the increased demand for housing structure caused by the changes in households’ earnings risk and U.S. housing institutions can explain the increase in the ratio of housing services to nondurables consumption. In this section, we examine how robust our quantitative results are to the unit elasticity assumption between housing services and nondurables. Specifically, we run our model for two additional values of the substitution elasticity between housing services and nondurables consumption, 0.7 and 1.3, and compare the results with what we obtain from our baseline experiment. For each value of the elasticity, we recalibrate the utility parameter \( \phi \) and discounting factor \( \beta \) so that the model is still consistent with the total value of housing stock.
over aggregate output and the real interest rate in the benchmark model. Table 7 reports the recalibrated parameter values.

The results in Table 8 show that if the elasticity of substitution between housing service and nondurables consumption is reduced to 0.7, the main qualitative results with the unit elasticity carry through, although the quantitative changes in key aggregate variables are mitigated. The rising demand for housing services caused by the increased earnings risk and the changing housing institutions still increases both the relative price of housing structure and the relative consumption of housing services to nondurables as in the baseline results, yet the increases are smaller with the lower elasticity. The lower elasticity implies that consumers are less willing to substitute away from nondurables towards housing services for any given change that makes housing relatively more attractive than other assets. Consequently, given the same changes in households’ earnings risk, housing transaction costs, and down payment requirements, the demand for housing structures in this exercise rises by a smaller amount and encourages more investment in financial assets compared to the baseline results. As a result, the increases in both the relative price of housing and relative consumption of housing services to nondurables are smaller than in the model with unit elasticity, and the increase in aggregate capital stock is larger than in the model with unit elasticity. In the same spirit, both the residential investment relative to GDP and share of labor employed in construction sector rise by about 6 percentage points less than in the baseline results. The real wage also rises to a slightly lower level relative to its baseline value.

Suppose that the elasticity of substitution between housing service and nondurables is 1.3 instead. In contrast to the case in which elasticity is 0.7, consumers with an elasticity of 1.3 are more willing to substitute housing services for nondurables, given the same changes
in the demand-side factors. This results in a greater increase in both the relative price of houses and relative consumption of housing services to nondurables, compared to the unit elasticity. This also accompanies larger increases in the share of residential investment in GDP and the fraction of labor employed in construction sector. On the other hand, physical capital accumulation is discouraged relative to the benchmark results, while the increase in the real wage is slightly larger.

6 Conclusion

Over the past four decades, both the relative price of residential investment and relative consumption on housing services to nondurables increased significantly in the U.S. housing market. In order to explain this phenomenon, it is critical to consider demand-side factors since under the standard unit elasticity assumption, supply-side factors cannot generate the simultaneous rise in both variables. In this paper, we consider three demand-side factors as potential explanations behind the changes in U.S. housing market: i) an increase in earnings volatility, ii) a decline in housing transaction costs, and iii) a reduction in down payment requirements for house purchase.

The increased earnings risk strengthens households precautionary saving motive, increasing demand for housing assets as well as financial assets. Moreover, a decline in housing transactions costs makes housing assets more liquid, while a reduction in down payment requirements relieves borrowing constraints for those who purchase houses. Both factors provide households with additional incentives to increase their demand for housing assets. With these three factors fed in, our model can replicate the simultaneous increases in the
relative price of housing structure and relative housing services to nondurables consumption along with changes in other key macroeconomic variables. We also find that among them, the increase in households earnings risk is quantitatively the most important in explaining the changes in U.S. housing market. A supply-side factor such as a slower growth of TFP in the construction sector relative to other sectors fails to explain the main changes in the U.S. housing market, with the exception of the increase in the relative price of housing structures.

Notes

1See Figure 1.

2Recent papers such as Chambers et al. (2009) and Li (2005) indicate that technological progress in the mortgage market, including development of credit scoring and home equity loans, has lowered both down payment requirements and transaction costs significantly in the U.S. housing market.

3There are various papers which analyze the U.S. housing market by using a general equilibrium model with heterogeneous agents. Rios-Rull and Sanchez-Marcos (2008), and Diaz and Luengo-Prado (2010) reproduce the distribution of housing and non-housing wealth. Chambers et al. (2009) argue that technological progress in the mortgage market explains more than half of the increase in homeownership since 1994. Hryshko et al. (2010) show that rising house prices enhance homeowners’ consumption smoothing. Although the main goal of our study is to understand the changes in the aggregate housing variables, we also discuss distributional implications of our model in Section 4.

4As Figure 3 shows, U.S. homeownership rate changed little until the late 1990s when it
began to rise.

5 The output corresponds to the GDP minus the housing services consumption. The housing asset is public and private residential fixed asset.

6 In a representative agent model, the parameter $\phi$ is related to the ratio of housing services to nondurable consumption such that the ratio equals\footnote{\cite{kahn2009}} $\frac{\beta \phi}{(1-\phi)(1-\beta+\beta \delta_h)}$. However, in an incomplete markets model like ours, the ratio is no longer fixed.

7 The depreciation rate for capital $\delta_k = 0.0829$ is set by the average of historical-cost depreciation of private non-residential fixed assets over historical-cost net stock of private non-residential fixed assets from 1967 to 1996. Similarly, using the average of historical-cost depreciation of private residential fixed assets over historical-cost net stock of private residential fixed assets from 1967 to 1996, we choose the depreciation rate for housing structures $\delta_h = 0.0167$.

8 This quantitatively small effect of the relaxed borrowing constraints is partly due to our model setup based on infinitely lived agents. Compared to an overlapping generations (OLG) model, infinitely-lived agents accumulate more precautionary savings and hence the borrowing constraints are likely to bind for a smaller number of agents.

9 In a complete markets model, the relative price of housing $q/P$ is given by $[R/ (r + \delta_h)] / P$. Based on this formula, we calculated the complete markets’ version of the relative price of houses and compare it with that in our model. We find that the relative price is 0.9483 in our model, 5\% higher than that in a complete markets model. The gap between the two is partly due to a lower real interest rate in our model caused by large precautionary savings and partly due to collateral value of housing.

10 Kahn (2009) argues that the elasticity of substitution between housing consumption and
nondurables consumption is less than one.

References


Table 1: Parameter Values

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\gamma$</td>
<td>Coefficient of risk aversion</td>
</tr>
<tr>
<td>$\phi$</td>
<td>Weight on utility from housing service consumption</td>
</tr>
<tr>
<td>$\beta$</td>
<td>Discount factor</td>
</tr>
<tr>
<td>$\rho_x$</td>
<td>Persistence of idiosyncratic productivity shock</td>
</tr>
<tr>
<td>$\sigma_{x67}^2$</td>
<td>Variance of idiosyncratic productivity shocks in 1967</td>
</tr>
<tr>
<td>$\sigma_{x00}^2$</td>
<td>Variance of idiosyncratic productivity shocks in 2000</td>
</tr>
<tr>
<td>$v_{x00}$</td>
<td>Mean of log($x_t$) in 2000</td>
</tr>
<tr>
<td>$\varphi$</td>
<td>Rate of transaction cost</td>
</tr>
<tr>
<td>$\theta$</td>
<td>Down payment requirement</td>
</tr>
<tr>
<td>$\delta_k$</td>
<td>Depreciation rate for capital</td>
</tr>
<tr>
<td>$\delta_h$</td>
<td>Depreciation rate for housing structures</td>
</tr>
<tr>
<td>$\alpha$</td>
<td>Capital share in nondurable good sector</td>
</tr>
<tr>
<td>$\kappa$</td>
<td>Capital share in housing sector</td>
</tr>
<tr>
<td>$\bar{h}_1$</td>
<td>The lower bound of house grid</td>
</tr>
<tr>
<td>$\bar{h}_n$</td>
<td>The upper bound of house grid</td>
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Table 2: Changes in Key Variables between 1967 and 2000: Data vs. Model (Unit: %)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data</th>
<th>Model</th>
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</thead>
<tbody>
<tr>
<td>$\Delta q/P$</td>
<td>28.65 %</td>
<td>3.32 %</td>
</tr>
<tr>
<td>$\Delta qH/C$</td>
<td>4.34 %</td>
<td>24.32 %</td>
</tr>
<tr>
<td>$\Delta qI_{residl}/Y$</td>
<td>4.48 %</td>
<td>19.65 %</td>
</tr>
<tr>
<td>$\Delta L_h/L$</td>
<td>13.35 %</td>
<td>19.50 %</td>
</tr>
<tr>
<td>$\Delta K/Y$</td>
<td>8.17 %</td>
<td>10.24 %</td>
</tr>
<tr>
<td>$\Delta w/P$</td>
<td>17.22 %</td>
<td>5.47 %</td>
</tr>
</tbody>
</table>


Table 3: Decomposition of the Effects of the Demand-Side Factors (Unit: %)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
<th>Demand-Side Factor Held Constant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Transaction Cost $\varphi$</td>
<td>Down Payment $\theta$</td>
</tr>
<tr>
<td>$\Delta q/P$</td>
<td>3.32</td>
<td>3.44</td>
</tr>
<tr>
<td>$\Delta qH/C$</td>
<td>24.32</td>
<td>20.92</td>
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<tr>
<td>$\Delta q_{resid}/Y$</td>
<td>19.65</td>
<td>16.09</td>
</tr>
<tr>
<td>$\Delta L_h/L$</td>
<td>19.50</td>
<td>15.98</td>
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<tr>
<td>$\Delta K/Y$</td>
<td>10.24</td>
<td>10.71</td>
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<tr>
<td>$\Delta w/P$</td>
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<td>5.66</td>
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</table>

Table 4: Earnings and Wealth Distribution: Gini coefficients in the Model and Data

<table>
<thead>
<tr>
<th>Variables</th>
<th>Initial steady state</th>
<th>New steady state</th>
<th>Change</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Model</td>
<td>Data</td>
<td>Model</td>
</tr>
<tr>
<td>Earnings (E)</td>
<td>0.31</td>
<td>0.47</td>
<td>0.42</td>
</tr>
<tr>
<td>Housing (H)</td>
<td>0.31</td>
<td>0.63</td>
<td>0.39</td>
</tr>
<tr>
<td>Wealth (W)</td>
<td>0.61</td>
<td>0.76</td>
<td>0.64</td>
</tr>
</tbody>
</table>


- Housing assets (H) include market value of primary and vacation/seasonal residences for family use and wealth (W) is defined by net worth, i.e., assets minus debts. Detailed information about the data is available in Appendix II.
### Table 5: Changes in House Price Relative to Fundamental Value (Unit: %)

<table>
<thead>
<tr>
<th>Demand-Side Factor Held Constant</th>
<th>Transaction Cost $\varphi$</th>
<th>Down Payment $\theta$</th>
<th>Idiosyncratic Risk $\sigma_x$</th>
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<tr>
<td>Baseline</td>
<td>23.99</td>
<td>20.82</td>
<td>23.60</td>
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</tbody>
</table>

### Table 6: The Role of TFP in Explaining Changes in U.S. Housing Market (Unit: %)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data</th>
<th>Baseline</th>
<th>TFP↑</th>
<th>Baseline +TFP↑</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta q/P$</td>
<td>28.65</td>
<td>3.32</td>
<td>36.75</td>
<td>41.30</td>
</tr>
<tr>
<td>$\Delta qH/C$</td>
<td>4.34</td>
<td>24.32</td>
<td>24.14</td>
<td></td>
</tr>
<tr>
<td>$\Delta q_{resid}/Y$</td>
<td>4.48</td>
<td>19.65</td>
<td>19.48</td>
<td></td>
</tr>
<tr>
<td>$\Delta L_h/L$</td>
<td>13.35</td>
<td>19.50</td>
<td>19.34</td>
<td></td>
</tr>
<tr>
<td>$\Delta K/Y$</td>
<td>8.17</td>
<td>10.24</td>
<td>10.25</td>
<td></td>
</tr>
<tr>
<td>$\Delta w/P$</td>
<td>17.22</td>
<td>5.47</td>
<td>44.03</td>
<td>52.92</td>
</tr>
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</table>
Table 7: Sensitivity Analysis: Recalibrated Parameter Values

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
<th>Elasticity = 0.7</th>
<th>Elasticity = 1.3</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\phi$</td>
<td>0.0819</td>
<td>0.0866</td>
<td>0.0791</td>
</tr>
<tr>
<td>$\beta$</td>
<td>0.9437</td>
<td>0.9436</td>
<td>0.9437</td>
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Table 8: Sensitivity Analysis (Unit: %)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Data</th>
<th>Baseline</th>
<th>Elasticity = 0.7</th>
<th>Elasticity = 1.3</th>
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</thead>
<tbody>
<tr>
<td>$\Delta q/P$</td>
<td>28.65</td>
<td>3.32</td>
<td>3.05</td>
<td>3.42</td>
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<tr>
<td>$\Delta qH/C$</td>
<td>4.34</td>
<td>24.32</td>
<td>18.46</td>
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</tr>
<tr>
<td>$\Delta q_{\text{resid}}/Y$</td>
<td>4.48</td>
<td>19.65</td>
<td>13.76</td>
<td>25.17</td>
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<tr>
<td>$\Delta L_h/L$</td>
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<td>10.24</td>
<td>10.62</td>
<td>10.03</td>
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<tr>
<td>$\Delta w/P$</td>
<td>17.22</td>
<td>5.47</td>
<td>5.24</td>
<td>5.53</td>
</tr>
</tbody>
</table>
Figure 1: Relative Price of Residential Investment (Source: Bureau of Economic Analysis)
Figure 2: Housing Services Consumption over Nondurables (Source: Bureau of Economic Analysis)

- Nondurables are defined by nondurables and services consumption minus housing services consumption.
Figure 3: Homeownership Rate in the U.S. (Source: U.S. Census Bureau)
Figure 4: Multifactor Productivity Indexes (Source: Bureau of Labor Statistics)
Appendix (For Online Publication)

Appendix I. Estimation of Earnings Process

We use data from the Panel Study of Income Dynamics (PSID) to estimate the earnings process. The estimated process for log residual earnings is used to calibrate the idiosyncratic productivity risk in the model.

**Data:** The PSID is a longitudinal survey of the representative sample of U.S. households in 1968. We use the surveys over the 1968-2007 period to estimate the earnings process. Beginning in 1997, the survey was conducted biennially, thus we use a total of 35 surveys. Our sample only includes men to avoid any issues associated with changing selection in female labor force participation. We restrict the sample to male heads of household between the ages of 25 and 59, who reported educational attainment, are not self-employed, and participated in the labor market (i.e., worked at least 260 hours), but worked no more than 5840 hours last year. We use head of household’s labor income in the past year as our measure of earnings. Our sample also excludes observations with topcoded earnings or hourly wages less than half the federal minimum wage per hour, where hourly wage is obtained by dividing the annual labor income by past year’s total annual hours worked. The resulting sample is an unbalanced panel.

**Estimation:** We model the log individual earnings as

The log earnings residual $\log(x_{i,t+1})$ is assumed to follow an AR(1) process:

$$\log(x_{i,t+1}) = \rho_x \log(x_{i,t}) + \eta_{i,t+1},$$
where $\rho_x$ is the persistence and $\eta_{it} \sim (0, \sigma_{x, it}^2)$ is a shock whose variance $\sigma_{x, it}^2$ varies over time. The initial value of the log earnings residual is drawn from a time-invariant distribution: $x_1 \sim (0, \sigma^2)$. We assume that variables, $\eta_{it}$ and $x_1$ are orthogonal and i.i.d. across individuals.

We estimate a parameter vector $\Phi$, which includes two time-invariant parameters, $\rho$ and $\lambda$, and a set of time-varying parameters $\{\lambda_t\}_{t=1967}^{2000}$. Since the PSID are available biennially starting in 1997, we estimate a total of 34 parameters. We have less information available to estimate the variances of the persistent wage shocks for more recent years, thus we use surveys after 2000 to improve our estimation although we do not estimate the variances for those years. Specifically, we use the data from the surveys after 2000 to construct covariances between years before and after 2000, as is done in Heathcote et al. (2010).

For each sample year $t$, we construct 10-year adjacent age cells from ages 29 to 54 such that, for instance, the age group 29 consists of those aged 25 to 34 years. We then compute the empirical autocovariance, $\tilde{g}_{a,t,n}^e$, of all possible orders for each age/year $(a, t)$ cell in our PSID sample using log wage residuals $\tilde{x}_{it}^e$ from the first-stage regressions:

$$
\tilde{g}_{a,t,n}^e = \frac{1}{I_{a,t,n}^e} \sum_{i=1}^{I_{a,t,n}^e} \tilde{x}_{it|a,a=a}^e \cdot \tilde{x}_{i,t+n|a,a=a}^e, \quad n \geq 0,
$$

where $I_{a,t,n}^e$ is the number of observations for $n$th order autocovariance for age/year $(a, t)$ cell in skill group $e$. We then pick the parameters $\hat{\Phi}^e$ that minimize the equally weighted distance between this empirical autocovariance matrix and its theoretical counterpart:

$$
\hat{\Phi}^e = \arg \min_{\Phi^e} \left[ \tilde{G}^e - G^e(\Phi^e) \right]' I \left[ \tilde{G}^e - G^e(\Phi^e) \right],
$$

where $\tilde{G}^e$ is a stacked vector of empirical autocovariances, $G^e(\Phi^e)$ is the theoretical counterpart, and $I$ is an identity matrix.
Appendix II. Earnings and Wealth Distribution

In order to examine the model’s implications on the distribution of earnings and wealth, we exploit the Survey of Consumer Finances (SCF). The SCF is a triennial survey on household finances that provides detailed information on households’ income, assets, and liabilities. Unfortunately, the SCF is not available before 1983. Therefore, we exploit the Survey of Financial Characteristics of Consumers (SFCC) in 1962 for the initial steady state of the model calibrated to 1967 U.S. economy, while comparing the earnings and wealth distribution in the 2001 SCF with that in the new steady state of the model. Both surveys over-sample relatively wealthy households to improve the precision of the estimates for wealth and correct for a relatively higher nonresponse rate among wealthy households. Using both surveys, we measure household earnings and wealth.

Variables: We construct measures of earnings and wealth following Rodriquez et al. (2002). All variables are measured at the households level. Earnings (E) is labor income plus a fraction of business income attributable to labor. Labor income is wages and salaries received in the past calendar year in both the 1962 SFCC and 2001 SCF. Business income includes income from sole proprietorship or profession, partnership, and farm in the 1962 SFCC, and includes income from professional practices, businesses, and farm sources in the 2001 SCF. The fraction of business income attributable to labor is determined based on the samplewide ratio of labor income to the sum of labor and capital income. Capital income includes dividend income, interest income, net income from rents and royalties, capital gains or losses from sale of securities and other assets, and income from trusts and estates in the 1962 SFCC, and 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 in the 2001 SCF.

Wealth (W) is defined by net worth, i.e., assets minus debts. Assets (A) 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 stocks; cash and call money at the stock brokerage; all annuities; trusts and managed investment accounts; vehicles; net cash value of life insurance policies; pension assets accumulated in accounts from current main job; total amount of loans owed to the households, and other assets. Residential assets or housing assets (H) are the current market value of primary residence, vacation homes and other residence for family use, owned by the household in the 1962 SFCC and the current market value of primary residence, not used for farming/ranching or investment, and the value of seasonal/vacation residence, and time-share ownership in the 2001 SCF. The net value of business assets is the market value of businesses plus debts owed by the businesses to the household minus debt owed by the household to the businesses. Pension assets in the 1962 SFCC include profit-sharing plans and retirement plans that could be withdrawn, whereas they include amounts accumulated in pension plans on the main job, tax-deferred savings, other pension or saving plan, and other future pension accounts in the 2001 SCF.

Debts (D) include: housing debts on primary residence and other residence for family use; debts on investment real estates; installment debt; non-installment debt; other debts in the 1962 SFCC. In the 2001 SCF, debts include: housing debts, such as mortgages, home equity loans, and lines of credit; other residential and investment property debts; credit card debts; installment and non-installment loans; loans taken against pensions; margin loans;
other miscellaneous debts. For all statistics, we use corresponding weights.

Our sample consists of households with positive earnings, i.e., \( E > 0 \). Since 1989, the SCF imputes missing data using multiple methods and publish five implicants. For the 2001 SCF, we average all variables across the implicants.