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 housing services consumption relative to nondurables increased significantly in the U.S. This paper explores demand-side factors such as an increase in idiosyncratic earnings risks and changes in housing institutions as potential explanations for the phenomenon. We build a general equilibrium incomplete markets model of housing and compare two steady states which correspond to the 1967 and 2000 U.S. economies. Our model can generate the simultaneous increase in the relative price of houses and housing services consumption relative to nondurables. We find that the increased earnings risks are crucial in replicating this pattern.

Keywords: Housing Market, Idiosyncratic Earnings Risks, 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, as shown in Figure 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 increase in the relative price of houses and housing services consumption relative to nondurables, we explore demand-side factors largely supported by previous literature, including increased idiosyncratic earnings risks and institutional changes in the U.S. housing market.[1]

[Put Figure 1 here]

[Put Figure 2 here]

One may think that supply-side factors, such as a slower growth in the construction sector TFP compared to other sectors, are equally important for the rise in both the relative price of houses and the 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 nondurable consumption. Supply-side factors change the relative price and quantity of houses in the opposite directions. Thus, given the unit elasticity assumption, they cannot explain the rise in the relative price of houses accompanied by the increased housing relative to nondurable consumption.

In this study, we build a two-sector general equilibrium model with heterogeneous agents.[2] In our model, consumers draw an idiosyncratic earnings shock in each period and can invest in non-residential capital (or financial assets) and housing structures for self-insurance. The model introduces three distinct features of housing assets relative to financial assets: i) housing transactions are costly, so housing assets are illiquid (whereas financial assets are liquid); ii) housing assets have collateral values; iii) consumers derive utility from housing services consumption. The initial steady state of the model is calibrated to the 1967 U.S. economy. We then solve for a new steady state that includes three demand-side changes in housing markets supported by the previous literature: i) an increase in idiosyncratic earnings risks; ii) a decline in housing transaction costs; iii) a reduction in down payment requirements for housing purchases. By comparing the two steady states, we quantify the role of these demand-side factors in explaining the U.S. housing market over the 1967 to 2000 period.

Our results show that these demand-side factors can generate the simultaneous increase in the relative price of houses and housing services consumption relative to nondurable consumption observed in the data. By decomposing the contributions of the three demand-side factors to changes in the housing market, we find that the increased earnings risks are critical in explaining the phenomenon under study. Under incomplete markets, a rise in earnings risks causes households with a precautionary saving motive to increase savings for self-insurance primarily through liquid financial assets. This increases the aggregate non-residential capital stock and then decreases the equilibrium real interest rate. As the real interest rate declines, households find housing assets relatively more attractive in that their return, the marginal utility of housing services consumption, is higher than that of financial assets. Consequently, the demand for housing structures increases, ultimately leading to a simultaneous increase in the relative price of housing structures and housing services to nondurable consumption observed in the data.

On the other hand, institutional changes in the U.S. housing market without increased idiosyncratic earnings risks fail to explain this phenomenon, mainly due to a general equilibrium effect. Our model implies that a decline in housing transaction costs induces consumers to substitute housing assets for financial assets because housing assets become more liquid. This reduces the aggregate capital stock, increasing the equilibrium real interest rate. The higher real interest rate raises the cost of production of firms, more for capital-intensive nondurables production relative to housing production. Consequently, the nondurables sector reduces capital more than the construction sector, making the marginal product of labor in the construction sector larger than in the nondurables sector. Labor then moves from the nondurables sector to the construction sector, which increases housing production. Our model shows that the increased supply of housing structures dominates the initial increase in the demand caused by a decline in transaction costs, and thus the relative price of housing structures decreases as opposed to what is observed in the data.

If down payment requirements decline with no other changes in the housing market, consumers with binding credit constraints in the initial steady state increase their housing assets, so their household debt increases. The increased demand for credit raises the equilibrium real interest rate. The higher interest rate not only increases supply of houses as described above, but also reduces demand for housing structures. This is because given the larger debt, households suffer from the increased interest payments more.[3] We find that the reduced demand for houses dominates the increased supply, leading to counterfactual declines in both the relative price of houses and housing services relative to nondurable consumption.

There are many previous studies including Glaeser et al. (2005), Gyourko et al. (2006), and Davis and Heathcote (2007) on rising U.S. housing prices in the late 20th century. A common element in these papers is that there is a fixed supply of residential land or housing. Although this assumption helps explain the 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 markets. 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 payments in housing purchases and shows that a decline in down payments 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, to explain U.S. house prices for the past couple of decades.

The mechanism explored in our study also has implications for the increase in asset prices since the early 2000s. In this paper, we show that the increased earnings risks raise demand for housing structures, 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 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 the 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. There is a continuum of consumers of measure one.

2.1 The Consumer's Problem

Consumers derive utility from both nondurable goods consumption c and housing services consumption h. Our model abstracts from housing tenure choice in such a way that every consumer is a homeowner. We make this choice because the U.S. homeownership rate stayed roughly constant between 1967 and 2000[4] and therefore homeownership is not essential to understand the facts that motivated this paper.

[Put Figure 3 here]

Consumers can invest in a claim a for non-residential capital and a housing structure h. Note that h denotes both housing services consumption and a housing structure. A rental rate of non-residential capital is denoted by r. We assume that there are n discrete types of housing structures in this model economy: $h \in \{\overline{h}_1, \overline{h}_2, \cdots, \overline{h}_n\}$. Let q denote the relative price of housing structures to nondurables. Whenever consumers move from h to h', they should pay transaction costs $\varphi q \left| h' - h \right|$, where φ is a rate of transaction cost for a housing structure. Each consumer pays $q\delta_h h$, the maintenance cost of her housing structures at the end of each period, where δ_h is depreciation rate for housing structures. There is no unsecured debt in this economy. A consumer can borrow up to $(1-\theta)qh'$, where θ is a down payment requirement. A consumer's idiosyncratic productivity x evolves according to $\log(x_{t+1}) = (1-\rho_x)\upsilon_x + \rho_x \log(x_t) + \eta_{t+1}$, where $\eta_{t+1} \backsim (0, \sigma_x^2)$. 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 β 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

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

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

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

$$h' \in \{\overline{h}_1, \overline{h}_2, \cdots, \overline{h}_n\},$$

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

2.2 The Firm's Problem

There are two production sectors in this economy. A nondurable goods sector, denoted by f, produces nondurable goods and a construction sector, denoted by h, produces housing structures. Let L_i be aggregate labor hired by sector i, K_i be aggregate capital hired by sector i, and λ_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 the construction sector is written as

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

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

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

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

where δ_k is the depreciation rate for non-residential capital. Similarly, a representative firm in the construction 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 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. The nondurable goods market clears:

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

4. The 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 $\mathbb{T}$ 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, $\mu = \mathbb{T}(\mu)$.

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 γ of risk aversion is set to 2 based on common estimates for risk aversion in the literature. The weight ϕ on utility from housing services consumption is 0.0113, which matches housing services consumption relative to nondurables[5] in 1967 of 0.1989.[6] The discount factor β is chosen to be 0.9413 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 head of household's earnings from the PSID data and regress log earnings on a time dummy, age, schooling, age^2, schooling^2, and age$\times$schooling. The log earnings residual of household i from this regression is assumed to follow an AR(1) process: $\log(x_{i,t+1}) = \rho_x \log(x_{i,t}) + \eta_{i,t+1,}$ where $\eta_{i,t} \backsim (0, \sigma^2_{x,t})$ and the variance $\sigma^2_{x,t}$ 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 $\log(x_0) \backsim (0, \sigma^2)$. We estimate the persistence ρ_x, the variance σ^2 of the initial log earnings residual, and a time series of variances $\sigma^2_{x,t}$ of persistent wage shocks by minimizing distance between empirical covariances of the log earnings residuals and their theoretical counterparts.[7]

Based on the estimates, the persistence ρ_x of idiosyncratic productivity shocks is set to 0.9550. 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 then 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 given by $\sigma^2_{x,67} = 0.0188$ and $\sigma^2_{x,00} = 0.0367$. In addition, the mean of $\log(x_t)$ in 2000 is set to -0.1542, which equates aggregate labor in 2000 to that in 1967.

We normalize the TFPs of both nondurable goods and construction sectors to 1 in 1967. 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.[8] Capital share α in nondurable goods sector is set to 0.36 and, following Davis and Heathcote (2005), capital share κ in the construction sector is set to 0.132. The lower bound of the house grid is $\overline{h}_1 = 0.00001$. 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 $\overline{h}_n = 18.5743$.

Lastly, we parameterize changes in transaction costs and down payment requirements based on the previous literature and relevant data. Following Chambers and Simonson (1989) and Rosenthal (1988) that use 6% and 7% of house value as housing transaction costs, we set the rate of transaction cost in the initial steady state to $\varphi_{67} = 0.06$. A more recent paper by Haurin and Gill (2002) estimates transaction costs to between 4% and 5% of house value in 1992. Li (2005), and Chambers et al. (2009) suggest a significant decline in housing transaction costs in the past few decades in the U.S housing market. In addition, according to the federal housing finance agency, initial fees and charges associated with conventional single-family mortgages declined from about 0.9% of the purchase price in the late 1960s to about 0.5% in the early 2000s. Based on these estimates in the literature and empirical evidences, we choose $\varphi_{00} = 0.03$ for the new steady state. As for down payment requirements, we refer to the national average loan-to-value ratios in conventional single family mortgages published by the federal housing finance agency. The ratio decreased from about 27% in the late 1960s to about 20% in the late 1990s. Since the ratio tends to be above down payment requirements, we pick 20% as our down payment requirements in the initial steady state. Considering the 7% point decline in the ratio and other financial innovations relieving the burden of down payments, we choose 10% as down payment requirements in the new steady state.

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 isolate the contribution of each demand-side factor to the changes in the U.S. housing market, which is followed by a discussion of 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. The new steady state corresponds to 2000. We consider three demand-side changes that occurred in the U.S. housing market between 1967 and 2000: i) an increase in idiosyncratic earnings risks; ii) a decline in housing transaction costs; iii) a reduction in down payment requirements. Holding all other parameters constant, we solve a new steady state with all these changes incorporated. 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 $P = \frac{q^\phi}{\phi^\phi (1-\phi)^{1-\phi}}$ of the model economy is obtained by solving the following cost minimization problem:

$$P = \min_{c,h} \ \{c + qh\}$$
$$\text{s.t.} \ \ c^{1-\phi} h^\phi = 1.$$

The first two columns of Table 2 present 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 the simultaneous increase in both the relative price q/P of residential investment and the relative consumption qH/C of housing services to nondurables. Without demand-side factors, one cannot replicate this pattern.

The price index of housing structures increases by 4.60% relative to the overall price index in the model, which is about 16% of what we observe in the data. In contrast with the prices, the model overstates the rise in the ratio of housing services to nondurable consumption. The ratio increased by 35.04% 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, introducing an uncollateralized debt into the model may relax consumers' credit constraints, causing consumers to be less responsive to the increased earnings risks or to the decline in down payment requirements.

Our model is also qualitatively consistent with the changes in factor inputs. Between the 1967 and 2000 U.S. economies, residential investments increased more rapidly than GDP growth, while the share of labor employed in the construction sector rose substantially. Our model can replicate both patterns. In our model, an increase in earnings risks induces households with a precautionary saving motive to build up a large buffer stock of financial assets, leading to a large increase in the capital to output ratio. The accumulated capital stock then makes labor more productive, increasing the real wage. Both implications of the model are consistent with what we observe in 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 the U.S. housing market over 1967 to 2000. In each exercise, we unplug all exogenous changes but one driving force. Specifically, Ex 1 examines the effect of the increased earnings risks, while Ex 2 studies the impact of the decline in housing transaction costs. Lastly, Ex 3 considers an economy where down payment requirements have declined with no other changes. Note that each experiment incorporates the effect of changing prices, that is, the general equilibrium effect (GE). For each experiment, we present the partial equilibrium (PE) results as well by holding all prices constant at their initial steady state levels. The results are summarized in Table 2.

The columns associated with Ex 1 show that the increased earnings risks are responsible for almost all changes in housing markets implied by the baseline results. As households' earnings risks increase, households under incomplete markets attempt to increase savings for self-insurance. This effect is more pronounced through financial assets because housing assets are illiquid. In a partial equilibrium where the real interest rate stays constant, the aggregate capital to output ratio more than doubles as shown in the PE results. Housing assets also increase, although not as much as financial assets as shown in a smaller increase in $\frac{qI_{residl}}{Y}$ than in $\frac{K}{Y}$. With a constant real interest rate, both residential investments and the labor share in the construction sector increase by about 21%. Since housing assets are used for both saving and consumption, the housing services consumption increases slightly more than the nondurable consumption as the 1.3% increase in housing services relative to nondurable consumption indicates.

In the general equilibrium, the large buffer stock of non-residential capital reduces the equilibrium real interest rate. As the real interest rate declines, the rate of return to housing assets, which is the marginal utility of housing services consumption, exceeds that of financial assets. If the difference between the two rates of return is large enough, households substitute housing assets for financial assets despite the illiquidity of housing assets. This increases demand for housing structures, which leads to a simultaneous increase in the relative price of houses and housing services relative to nondurable consumption. The quantity of housing structures increases more than the non-residential capital does, as the GE column presents. Particularly, the rise in the relative price of houses in our baseline result is exclusively attributable to the increased earnings risks. With the general equilibrium effect incorporated, the aggregate capital to output ratio and real wage increase by 13.67% and 7.44%, respectively.

Ex 2 examines the effect of a decline in housing transaction costs. A reduction in housing transaction costs makes housing assets more liquid, encouraging households with a buffer stock of savings to substitute housing assets for financial assets in their asset portfolio. The PE column indicates how housing market variables change with the reduced housing transaction costs in a partial equilibrium. The substitution from financial assets towards housing assets increases housing services relative to nondurable consumption by 2.37%, while it reduces the aggregate capital to output ratio by 0.24%. Since the demand for housing structures increases, the construction sector expands. Thus, both the residential investment relative to GDP and the labor share in the construction sector increase in the PE.

In the general equilibrium, the reduction in the non-residential capital stock increases the real interest rate. Facing a higher real interest, firms in both sectors attempt to substitute labor for capital, which is more pronounced in the more capital-intensive nondurables production. As a result, the marginal product of labor falls more rapidly in the nondurables sector compared to the construction sector, and hence labor moves from the nondurables sector to the construction sector. Our model implies that this labor reallocation increases supply of housing structures more than the demand rises with a reduction in housing transaction costs. Consequently, both the relative residential investments to output and the labor share in the construction sector increase more in the GE than in the PE, while the relative price of houses drops.

We find that quantitative effects of the reduced transaction costs are small. Housing services consumption changes little relative to nondurables, and the relative price of houses declines only slightly. The rise in the real interest rate also induces households to switch back to financial assets, reducing the drop in the aggregate capital stock in the GE compared to the PE. However, it is not enough to reverse the original substitution from financial assets towards housing assets, so the aggregate capital to output ratio declines compared to the initial steady state. This results in a decline in the real wage as well. The reduction in housing transaction costs generates a 2.37% increase in the relative housing services consumption to nondurables, which is about 7% of the baseline prediction, yet it cannot explain the rise in the relative price of houses.

The last two columns (Ex 3) of Table 2 report the effects of the decrease in down payment requirements on key aggregate variables. A decline in down payment requirements relaxes borrowing constraints, encouraging households, particularly those financially constrained in the initial steady state, to borrow more to increase their housing assets or support nondurable goods consumption. Without a change in the real interest rate (PE), the increased demand for housing assets among poorer households causes the relative housing consumption to nondurables to rise by 0.10%. This accompanies increases in both the residential investment relative to output and the labor share in the construction sector.

The increased demand for credit raises the equilibrium real interest rate in the general equilibrium. The higher interest rate causes labor to move from the nondurables sector to the construction sector as in Ex 2. On top of that, the overall increase in household debt makes households suffer more from the increased interest payments, discouraging them from raising their housing assets. Our result implies that the latter impact dominates the expansion of housing supply. Consequently, both the relative price of housing structures and housing services consumption relative to nondurables decline, as shown in the GE column. However, their quantitative effects on both the relative price and quantity of housing structures are fairly small.[9]

In summary, the results imply that the increased earnings risks are critical in explaining the increase in both the relative price of houses and housing services relative to nondurable consumption observed in the U.S. economy. We also find that changes in housing transaction costs or down payment requirements cannot generate a simultaneous increase in the relative price and quantity of housing structures, and that their quantitative effects on the U.S. housing market are small.

4.3 Implications on Wealth Distribution

The heterogeneous agents framework adopted in this study has important implications on earnings and wealth inequality. Consumers face idiosyncratic productivity shocks in every period, which increases earnings and wealth inequality. 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. We then compare their changes between the two steady states with their data counterparts. For the U.S. household earnings and housing asset distributions, we exploit data from the PSID. Earnings include the earnings of the household head and his wife. The PSID asks homeowners the present value of house in every survey. The answer to the question is our measure of housing assets. Unfortunately, data on wealth in the PSID is available for selective years only, beginning in 1984. Thus, we take data on wealth 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.[10]

Table 3 summarizes how the distributions of households' earnings, housing assets, and wealth have changed in both the data and model. Although explaining the changes in earnings and wealth inequality is not the main goal of this paper, our model is consistent with the distributional changes in the data. First, the earnings Gini coefficient increased by 27.58% in the data, while it rose by 35.48% in our model. Note that the earnings process in our model is estimated based on male earnings in the PSID data, whereas the earnings Gini coefficient from the data is based on household earnings (the earnings of both the head of household and his wife). A slight overstatement of the increased household earnings inequality in the model hints that risk sharing within households may have been reinforced over the sample period in the data. The results also show that the increased earnings risks of households contributed to rising inequality in housing assets and wealth. In the model, the Gini coefficient of housing assets and wealth increased by 39.13% and 3.13.%, respectively, while in the data, they rose by 23.29% and 7.74%, respectively.

Our model is also in line with the 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 32% increase in the average size of houses between the two steady states, which explains about 88% of the increase observed 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

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

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

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 $\frac{qH}{C}$ of housing services consumption to nondurable consumption is determined by three model parameters, β, ϕ, and δ_h, in the steady state. This implies that this framework cannot generate an increase in the relative housing services to nondurable goods consumption without a change in the consumer's preferences (β, ϕ) or in the technology for maintaining housing structures (δ_h). Consequently, a model with heterogeneous agents is essential for 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. Since incomplete markets play a crucial 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 versus 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 the implicit rent $R_t \equiv \int \left\{\frac{u_2(c_t,h_t)}{u_1(c_t,h_t)}\right\} d\mu = \int \left\{\frac{\phi c_t}{(1-\phi)h_t}\right\} d\mu$, following Favilukis et al. (2015).[11]

Table 4 presents percentage changes in the house price relative to housing fundamentals in the baseline experiment, together with a change associated with each of the three demand-side factors. In the baseline model, the ratio of house price to housing fundamentals increases by 40.27%. By plugging one exogenous change at a time, we find that the deviation of house price from housing fundamentals in our baseline model is mainly attributable to the increased earnings risks. If earnings risks increase, the ratio rises by 34.34%, which is 85% of the baseline change. In Section 4, we show that the increased earnings risks cause the equilibrium real interest rate to decline, which leads to an increase in the demand for housing structures. Thus, both the relative price of housing structures and the relative housing services to nondurable consumption increase, raising the house price to housing fundamentals ratio.

Compared with the increased earnings risks, the effect of institutional changes in the U.S. housing market on the rise in the house price to housing fundamentals ratio is fairly small. A decline in housing transaction costs increases the ratio by 2.69%. A reduction in down payment requirements decreases the house price relative to housing fundamentals by 0.08%, as it reduces both the relative price of houses and housing services relative to nondurable consumption. These small quantitative effects are consistent with findings in a few previous studies including Kiyotaki et al. (2011) and Sommer et al. (2013). Unlike these studies, Favilukis et al. (2015) find a large effect of relaxed financing constraints on the house price to rent ratio. We view the lack of aggregate risks in our model as a potential explanation behind the discrepancy between their results and ours. In the presence of an aggregate risk, not only does the real interest rate, but also the housing risk premia affect house prices. In case that a decline in the real interest rate accompanies a business cycle risk that increases housing risk premia, house prices do 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 borrowing constraints bind for a smaller number of consumers due to a larger buffer stock of precautionary savings. This difference may explain the small impact of the relaxed borrowing constraints on the house price in our model compared to theirs.

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 nonagricultural 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, the construction sector multifactor productivity has declined, although the non-farm business sector multifactor productivity has risen as Figure 4 shows. Based on this evidence, we increase the TFP of the nondurable goods sector from 1 to 1.2858, holding the construction sector TFP constant at 1. Table 5 presents the results.

[Put Figure 4 here]

With this widening gap in TFP between the construction and nondurable goods sectors, our model economy generates a substantial increase in the price of housing structures. As the construction sector experiences a decline in its productivity relative to the nondurable goods sector, factors of production move from the construction sector to the nondurables sector.

As a result, the supply of housing structures declines, which increases the relative price of housing to nondurable goods by 40.08% between the two steady states. 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 terms of the house price and the real wage, it fails to match changes in other 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. These results reinforce the importance of the demand-side factors in explaining the observed changes in the U.S. housing market.

We further investigate how the supply-side factor interacts with the demand-side factors by considering both sides of changes simultaneously. The results are presented in the last column of Table 5. The model results are qualitatively the same as the baseline results. The main difference in quantitative results between this experiment and the baseline one is that the lower TFP in the construction sector relative to the 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.

5.4 Sensitivity Analysis

Following Ogaki and Reinhart (1998), many studies on the U.S. housing market have assumed a unit elasticity of substitution between housing services and nondurable consumption. Our study is not an exception. Under this assumption, an increase in the relative price of houses reduces the quantity of housing services consumption relative to nondurables by the same amount. This leaves the relative value of housing services consumption to nondurables unchanged. However, Kahn (2009) argues that the elasticity of substitution between housing consumption and nondurable consumption is less than one. Thus, we examine how robust our quantitative results are to the unit elasticity assumption in this section. Specifically, we run our model with two different values, 0.7 and 1.3, for the substitution elasticity between housing services and nondurable consumption, and compare the results with our baseline result. For each value of elasticity, we recalibrate the utility parameter ϕ and discounting factor β so that the model is consistent with housing services consumption relative to nondurables and the real interest rate in the 1967 U.S. economy, respectively. Table 6 reports the recalibrated parameter values.

The results in Table 7 show that the main qualitative results with unit elasticity carry through with these two other values of the elasticity. Regardless of the elasticity value, our model can generate a simultaneous increase in the relative price of houses and housing services relative to nondurable consumption. The construction sector expands in terms of the residential investment to GDP ratio and the labor share in the construction sector. It also accompanies a rise in the aggregate capital to output ratio and the real wage. Quantitative changes in the key aggregate variables vary with the value of the elasticity, yet the relative price of houses changes little.

If the elasticity of substitution between housing service and nondurable consumption is reduced to 0.7, consumers are less willing to substitute away from nondurables towards housing services for any given changes that make housing relatively more attractive than other assets. Consequently, given the same changes in the demand-side factors considered, the demand for housing structures in this exercise rises by a smaller amount, relative to the baseline results. As a result, the increase in the relative consumption of housing services to nondurables, the residential investment to GDP ratio, and the labor share in the construction sector decline by more than 20%, compared to the baseline results. Both the relative price of housing structure and the real wage increase less, and the capital to output ratio rises more than in the baseline model. However, their quantitative differences are fairly small.

To the contrary, if the elasticity is increased to 1.3, consumers are more willing to substitute housing services for nondurables, given the same changes in the demand-side factors. The last column in Table 7 indicates that the larger elasticity of substitution expands the construction sector more than unit elasticity, increasing the relative housing services to nondurable consumption, the relative residential investment to GDP, and the labor share in the construction sector by more than 20%. However, other variables stay almost unchanged, compared to the baseline results.

6 Conclusion

Over the past four decades, both the relative price of houses and housing services consumption relative to nondurables increased in the U.S. Supply-side factors cannot explain this fact because they move the price and quantity in the opposite directions. This study explores demand-side factors including an increase in earnings risks and institutional changes in the U.S. housing market as potential explanations for this phenomenon.

Under incomplete markets, the increased earnings risks induce households to accumulate more assets for self-insurance, particularly through more liquid financial assets. However, as the equilibrium real interest rate declines with the increased aggregate capital stock, the pattern is reversed. Households compare the marginal utility of housing services consumption with the real interest rate in determining their asset portfolio. Thus, the lower interest rate causes households to substitute housing assets for financial assets. This increased demand for housing structure is quantitatively important in explaining the simultaneous increase in both the relative price of houses and the housing services to nondurable consumption ratio.

We find that the decline in housing transaction costs and down payment requirements fail to explain the phenomenon under study. Both institutional changes induce agents to increase housing assets and reduce financial assets. However, this causes the equilibrium real interest rate to rise, ultimately leading to a counterfactual decline in the relative price of housing structures. We also find that 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. Our model also has implications on wealth inequality. The increased earnings risks lead to rising earnings, housing assets, and wealth inequality, consistent with the data.

Notes

[1]The increased earnings risk has been well-documented in the labor literature (Gottschalk and Moffitt (1994); Gottschalk and Moffitt (2012); Heathcote et al. (2010)). Recent 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.

[2]There are many studies that 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 the homeownership rate 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.

[3]Chambers et al. (2009) also find that a decline in down payment requirements reduces homeownership in a similar context.

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

[5]Nondurables are defined by nondurables and services minus housing services consumption. Data on nondurables and services consumption, and housing services are from the National Income and Product Account (NIPA) published by the Bureau of Economic Analysis (BEA).

[6]In a representative agent model, the parameter ϕ is related to the ratio of housing services to nondurable consumption such that the ratio equals $\frac{\beta\phi}{(1-\phi)(1-\beta+\beta\delta_h)}$. However, in an incomplete markets model like ours, the ratio is different from this.

[7]The details of the estimation procedure are described in Appendix I.

[8]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 $\delta_h = 0.0167$

[9]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.

[10]The details of the sample selection criteria and the variables included in the analysis are presented in Appendix II.

[11]In a complete markets model, the relative price of housing q/P is given by $\left[R/\left(r+\delta_h\right)\right]/P$. 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 1.2047 in our model, 6% 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 the collateral value of housing.

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Table 1: Parameter Values

Parameters		Values
γ	Coefficient of risk aversion	2
ϕ	Weight on utility from housing service consumption	0.0113
β	Discount factor	0.9413
ρ_x	Persistence of idiosyncratic productivity shock	0.9550
$\sigma^2_{x,67}$	Variance of idiosyncratic productivity shocks in 1967	0.0188
$\sigma^2_{x,00}$	Variance of idiosyncratic productivity shocks in 2000	0.0367
$\upsilon_{x,00}$	Mean of $\log(x_t)$ in 2000	-0.1542
δ_k	Depreciation rate for capital	0.0829
δ_h	Depreciation rate for housing structures	0.0167
α	Capital share in nondurable good sector	0.36
κ	Capital share in construction sector	0.132
$\overline{h}_1$	The lower bound of house grid	0.00001
$\overline{h}_n$	The upper bound of house grid	18.5743
φ_{67}	Rate of transaction cost in 1967	0.06
φ_{00}	Rate of transaction cost in 2000	0.03
θ_{67}	Down payment requirements in 1967	0.2
θ_{00}	Down payment requirements in 2000	0.1

Table 2: Changes in Key Aggregates between 1967 and 2000: Data vs. Model (Unit: %)

Variables	Data	Baseline	Ex 1		Ex 2		Ex 3	
			PE	GE	PE	GE	PE	GE
$\Delta q/P$	28.65	4.60	0.00	4.63	0.00	-0.01	0.00	-0.01
$\Delta qH/C$	4.34	35.04	1.34	30.33	2.37	2.37	0.10	-0.10
$\Delta qI_{residl}/Y$	4.48	29.08	21.34	24.53	2.35	2.39	0.08	-0.08
$\Delta L_h/L$	13.35	29.02	21.30	24.50	2.35	2.40	0.07	-0.07
$\Delta K/Y$	8.17	13.56	127.53	13.67	-0.24	-0.03	-0.21	-0.02
$\Delta w/P$	17.22	7.39	0.00	7.44	0.00	-0.01	0.00	-0.01

- q : house price, P : GDP deflator, H : aggregate housing stock, C : aggregate consumption for nondurables, I_{residl} : residential investment, L_h : aggregate labor hired by the construction sector, L : aggregate labor, K : aggregate capital stock, Y : output, w : wage.

- Ex 1 unplugs all exogenous changes but for the increased earnings risks and Ex 2 considers the effect of a decline in housing transaction costs. Ex 3 indicates the effect of a reduction in down payment requirements. The results in columns titled "PE" capture partial equilibrium results with all prices held constant at their initial steady state levels, while those in columns titled "GE" incorporate the general equilibrium results.

- Source of U.S. Data: Bureau of Economic Analysis, and Bureau of Labor Statistics.

Table 3: Earnings and Wealth Distribution: Gini Coefficients in the Data and Model

Variables	Initial steady state		New steady state		Change (%)	
	Data	Model	Data	Model	Data	Model
Earnings (E)	0.27	0.31	0.35	0.42	27.58	35.48
Housing (H)	0.32	0.23	0.40	0.32	23.29	39.13
Wealth (W)	0.76	0.64	0.82	0.66	7.74	3.13

- Source of U.S. Data: Panel Study of Income Dynamics (PSID) 1968 through 2001, Survey of Financial Characteristics of Consumers (SFCC) in 1962, Survey of Consumer Finances (SCF) 2001.

- Data on earnings (E) and housing assets (H) are taken from PSID. Earnings are household earnings, which is the sum of head's and wife's earnings. Housing assets indicate the present value of house of homeowners. The Gini coefficients for earnings and housing assets in the initial and new steady states are the averages for the initial 5 years and last 5 years of our sample period. Wealth (W) is defined by net worth, i.e., assets minus debts and data on wealth are taken from SFCC 1962 and SCF 2001. Detailed information about the data is available in Appendix II.

Table 4: Changes in House Price Relative to Fundamental Value (Unit: %)

Baseline	Demand-side factor considered		
	Idiosyncratic risk σ_x	Transaction cost φ	Down payment θ
40.27	34.34	2.69	-0.08

Table 5: The Role of TFP in Explaining Changes in the U.S. Housing Market (Unit: %)

Variables	Data	Baseline	TFP$\uparrow$	Baseline +TFP$\uparrow$
$\Delta q/P$	28.65	4.60	40.08	46.53
$\Delta qH/C$	4.34	35.04	-0.76	33.46
$\Delta qI_{residl}/Y$	4.48	29.08	-0.72	27.56
$\Delta L_h/L$	13.35	29.02	-0.72	27.52
$\Delta K/Y$	8.17	13.56	-0.01	13.55
$\Delta w/P$	17.22	7.39	47.53	58.44

Table 6: Sensitivity Analysis : Recalibrated Parameter Values

Variables	Baseline	Elasticity = 0.7	Elasticity = 1.3
ϕ	0.0113	0.0049	0.0173
β	0.9413	0.9412	0.9413

Table 7: Sensitivity Analysis (Unit: %)

Variables	Data	Baseline	Elasticity = 0.7	Elasticity = 1.3
$\Delta q/P$	28.65	4.60	4.55	4.61
$\Delta qH/C$	4.34	35.04	27.07	42.70
$\Delta qI_{residl}/Y$	4.48	29.08	21.31	36.38
$\Delta L_h/L$	13.35	29.02	21.27	36.35
$\Delta K/Y$	8.17	13.56	13.68	13.48
$\Delta w/P$	17.22	7.39	7.36	7.38

Figure 1: Relative Price of Residential Investment (Source: Bureau of Economic Analysis)

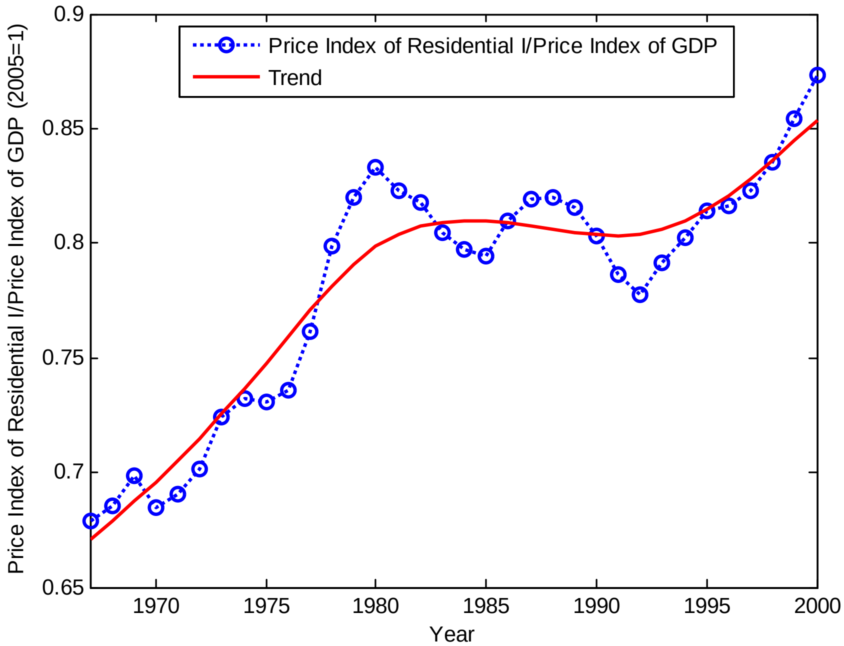
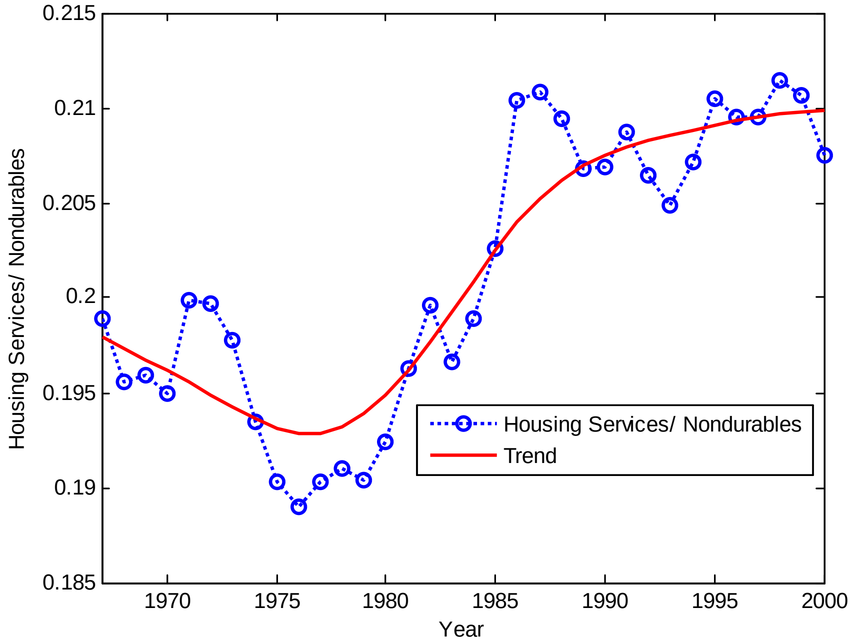


Figure 2: Housing Services Consumption over Nondurables (Source: Bureau of Economic Analysis)



- Nondurables are defined as nondurables and services consumption minus housing services consumption.

Figure 3: Homeownership Rate in the U.S. (Source: U.S. Census Bureau)

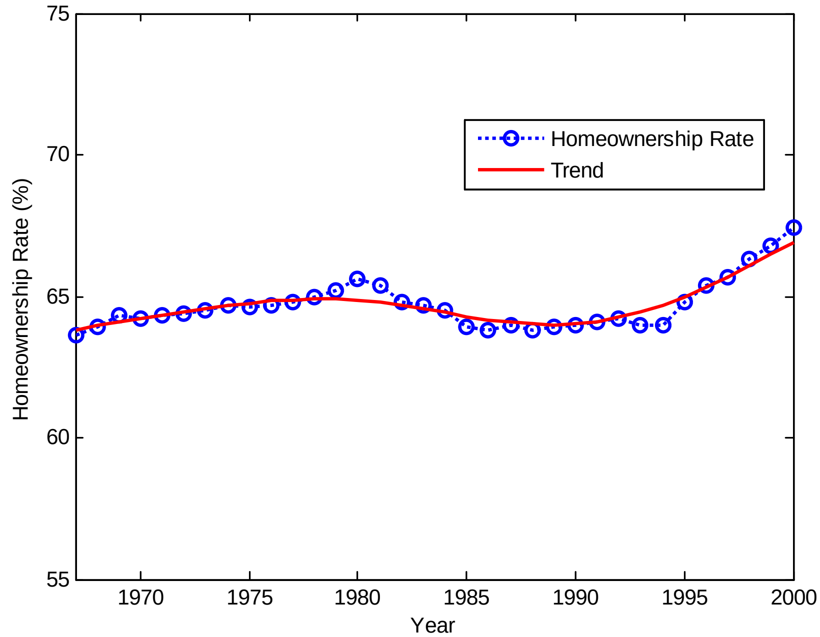
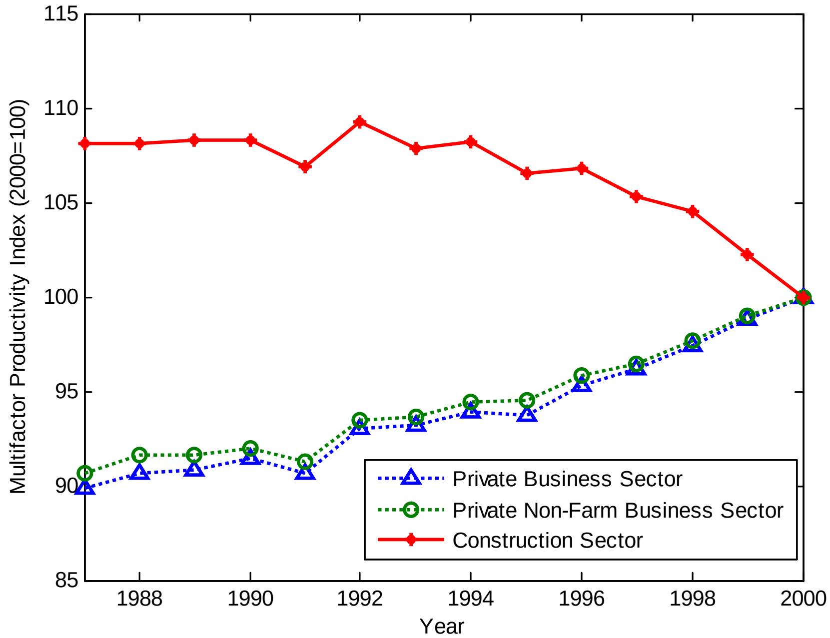


Figure 4: Multifactor Productivity Indexes (Source: Bureau of Labor Statistics)



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 consists of male head of households 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 $\log(x_{t+1})$ is assumed to follow an AR(1) process:

$$\log(x_{i,t+1}) = \rho_x \log(x_{i,t}) + \eta_{i,t+1},$$

where ρ_x is the persistence and $\eta_{it} \sim (0, \sigma^2_{x,t})$ is a shock whose variance $\sigma^2_{x,t}$ 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, $\eta_{i,t}$ and x_1 are orthogonal and i.i.d. across individuals.

We estimate a parameter vector Φ, which includes two time-invariant parameters, ρ and λ, and a set of time-varying parameters $\{\lambda_t\}_{t=1967}^{2000}$. Since the PSID is 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, $\widehat{g}^e_{a,t,n}$, of all possible orders for each age/year (a, t) cell in our PSID sample using log wage residuals $\widehat{x}^e_{i,t}$ from the first-stage regressions:

$$\widehat{g}^e_{a,t,n} = \frac{1}{I^e_{a,t,n}} \sum_{i=1}^{I^e_{a,t,n}} \widehat{x}^e_{i,t}\big|_{a_{it}=a} \cdot \widehat{x}^e_{i,t+n}\big|_{a_{it}=a}, \quad n \geqslant 0,$$

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

$$\widehat{\Phi}^e = \arg\min\nolimits_{\Phi^e} \left[\widehat{G}^e - G^e(\Phi^e)\right]' I \left[\widehat{G}^e - G^e(\Phi^e)\right],$$

where $\widehat{G}^e$ 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 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 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 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 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 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 implicates. For the 2001 SCF, we average all variables across the implicates.