Unemployment, Financial Frictions, and the Housing Market*

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Abstract

We develop and calibrate a two-sector, search-matching model of the labor market augmented to incorporate a housing market and a frictional goods market. The labor market is divided into a construction sector and a non-housing sector, and there is perfect mobility of unemployed workers across sectors. In the frictional goods market households, who lack commitment, finance random consumption opportunities with home equity loans. The model can generate multiple steady-state equilibria across which housing prices are negatively correlated with unemployment. Relaxing lending standards typically reduces unemployment, but it can have non-monotonic effects on housing prices and supply. It also leads to a reallocation of workers across sectors, the direction of which depends on firms' market power in the goods market. Quantitatively, we find that innovations that generate an increase in home equity-based borrowing of the same magnitude as the one observed during the 90's explain a reduction in the steady-state unemployment rate between 1/2 and 1 percentage point depending on the calibration strategy.

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1 Introduction

A recent development in household finance is the increased availability of consumer loans collateralized with residential properties.[1] According to Greenspan and Kennedy (2007) expenditure financed with home equity extraction represented 3.13% of disposable income in 1991 and increased to 8.29% in 2005. Mian and Sufi (2009) estimate that the average U.S. homeowner extracted 25 to 30 cents for every dollar increase in home equity from 2002 to 2006.[2] These changes to consumers' access to credit affect employment in industries producing goods that are purchased with consumer loans. For instance, Haltenhof et al. (2012) find that between 2007 and 2010 the decline in home equity extraction explains a 10 percent decline in employment in the durable goods industries.[3] Similarly, Mian and Sufi (2012) argue that household finance can affect the labor market through an aggregate demand channel that has caused the loss of four millions jobs from 2007 to 2009.

The objective of this paper is to construct a model to investigate analytically and quantitatively the mechanisms through which financial frictions impair the functioning of the labor market in the long run—abstracting from short-run adjustments and fluctuations. We will be addressing questions such as: If home equity-based borrowing were to revert to its level at the beginning of the 90's due to tightened lending standards, what would be the change in the "natural" rate of unemployment? Alternatively, if financial innovations and deregulation keep making housing assets more liquid, by how much more can equilibrium unemployment and housing prices be affected? Can policies favoring homeownership affect the labor market through the home equity-based borrowing channel?

[1] Dugan (2008) explain the increase in home equity loans by the fact that underwriting standards have been relaxed to help more people to qualify for loans. Ducca et al. (2011) attribute the steady increase in average loan-to-value ratios in the U.S. to two financial innovations: the development of collateralized debt obligations and credit default swap protection. Abdallah and Lastrapes (2012) document a constitutional amendment in 1997-98 in Texas that relaxed severe restrictions on home equity lending. Prior to 1997 lenders were prohibited from foreclosing on home mortgages except for the original purchase of the home and home improvements.

[2] Mian and Sufi (2009) argue that the extracted money was not used to pay down debt or purchase new real estate but for real outlays. Using household level data for the U.K., Campell and Cocco (2007) find that a large positive effect of house prices on consumption of old households who are homeowners—the house price elasticity of consumption can be up to 1.7—and an effect that is close to zero for the cohort of young households who are renters. Moreover, they find that consumption responds to predictable changes in house prices, which is consistent with a borrowing constraint channel.

[3] Haltenhof et al. (2012) study various lending channels during the Great Recession and find that "household access to loans matters more for employment than firm access to loans". As another example, Abdallah and Lastrapes (2012) find that Texas retail sales at the county and state levels increased significantly after an amendment relaxing severe restrictions on home equity lending.

The model we will use to answer these questions is a two-sector version of the Mortensen-Pissarides (1994) framework augmented to incorporate a housing market and a goods market with explicit financial frictions. In each period, frictional labor and goods markets open sequentially, as in Berentsen, Menzio, and Wright (2011). The frictional labor market is divided into a construction sector where firms produce houses and a general sector where firms produce consumption goods. A fraction of the consumption goods are sold on a decentralized retail market where firms and consumers search for each other and both have some market power. Households, who do not have access to unsecured credit, can use their home as collateral to finance idiosyncratic spending shocks. Therefore, homes have a dual role: (i) They provide housing services that can be traded competitively in a rental market; (ii) They also provide liquidity services by serving as collateral for consumer loans in the decentralized goods market. The model is summarized in Figure 1.

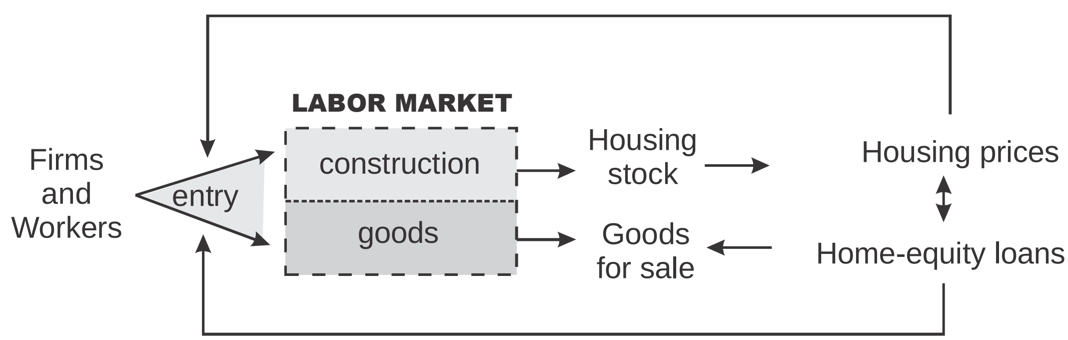

Figure 1: Sketch of the model

An increase in households' access to home equity-based borrowing affects the economy through two main channels. First, households have a higher borrowing capacity when random consumption opportunities occur, which raises firms' expected revenue in the goods market. This effect is akin to a positive productivity shock in the general sector. Second, financial innovations affects the demand for homes and, via market clearing, their production and price. These changes in the stock of housing can amplify the initial shock to households' borrowing capacity.

In order to build some intuition for these two effects we describe first an economy where housing goods are illiquid—there is no home equity extraction. The model is a two-sector Mortensen-Pissarides model. An increase in firms' productivity in the consumption-good sector leads to a reallocation of labor away from the construction sector, higher housing prices, and lower unemployment. In contrast an increase in the marginal utility for housing services leaves unemployment unchanged but it leads to a reallocation of labor toward the construction sector. In the long run the higher demand for homes is met by a higher stock of housing while housing prices stay constant.

Next, we isolate the home equity-based borrowing channel by shutting down the construction sector and by assuming a fixed supply of homes. If housing assets are scarce or lending standards sufficiently tight, then housing prices exhibit a liquidity premium, i.e., homes are priced above the discounted sum of their future rents. There are conditions on fundamentals under which the economy has multiple steady-state equilibria across which unemployment and home prices are negatively correlated. Intuitively, firms' decision to open vacancies in the retail sector depends positively on households' borrowing capacity and hence home equity. But households' demand for homes as collateral also depends positively on the aggregate activity in the retail sector, thereby creating strategic complementarities between households' and firms' decisions.

In the context of the model with a fixed housing stock we provide a first qualitative answer to our earlier questions. First, a new regulation that increases the eligibility of homes as collateral raises the housing liquidity premium and it reduces unemployment. Second, a relaxation of lending standards through higher loan-to-value ratios also reduces unemployment but it has an ambiguous effect on housing prices. Third, a policy that favors homeownership tightens credit constraints due to the scarcity of collateral provided by the fixed housing stock, which leads to higher home prices but lower unemployment.

Finally, we re-open the construction sector, so that the supply of homes is endogenous, and we consider two polar cases that will allow us to identify the conditions under which the unemployment rate is affected by aggregate demand: a "competitive" case where firms have no market power in the retail market and a "monopoly" case where firms have all the market power. In the "competitive" case housing prices, which are determined by the relative productivities in the two sectors, are unaffected by financial innovations. Relaxing lending standards does not affect unemployment but it leads to a reallocation of workers toward the construction sector. In the "monopoly" case housing assets are priced at their "fundamental" value—the discounted sum of the rental rates. An increase in the eligibility of homes as collateral, in loan-to-value ratios, or in the rate of homeownership, reduces aggregate unemployment, increases housing prices, and drives workers away from the construction sector.

To conclude our analysis we calibrate the model to the U.S. economy over the period 2000 to 2012. The calibration of the labor market is standard based on targets coming from the Jobs Opening and Labor Turnover Survey (JOLTS). In addition we adopt two key targets: the ratio of household equity-financed expenditure to disposable income from Greenspan and Kennedy (2007), and the ratio of the aggregate housing stock to GDP based on the Flow of Funds. Our experiments consist in both tightening and relaxing different notions of lending standards, such as loan-to-value ratios and the eligibility of homes as collateral. The general finding is that changes in lending standards can have a significant long-run effect on the labor market and unemployment. More specifically, consider a change in regulation that would reduce the share of home-equity financed consumption to disposable income from 5% (in the ballpark of the 2001 level) to 2.5% (close to the 1991 level). This could raise the aggregate unemployment rate by more than half a percentage point in the long run, under a rather conservative calibration strategy, and by about a full percentage point under a calibration strategy used in the business cycle literature to account for the volatility of unemployment. Moreover, we show that these effects are nonlinear and asymmetric: relaxing lending standards reduces the unemployment rate by at most half a percentage point. The impact on housing prices is typically modest due to our focus on steady states with perfect mobility across sectors, allowing the stock of housing to adjust.

1.1 Related literature

There is a related literature studying unemployment and financial frictions. Wasmer and Weil (2004) extend the Mortensen-Pissarides model to incorporate a credit market where firms search for investors in order to finance the cost of opening a vacancy. Petrosky-Nadeau and Wasmer (2013) and Petrosky-Nadeau (2013) calibrate the model and show that financial frictions matter quantitatively for the propagation of productivity shocks to the labor market. Our model differs from that literature in that credit frictions affect households, they take the form of limited commitment and lack of record-keeping instead of search frictions between lenders and borrowers, and a frictional goods market is formalized explicitly. These differences are relevant for the following reason. As previously mentioned, both Haltenhof et al. (2012) and Mian and Sufi (2012) found that the role of household finance is of first-order importance to explain employment changes following the Great Recession. By formalizing explicitly the goods market and its frictions our model captures the "aggregate demand" channel emphasized by Mian and Sufi (2012).

Our paper is also related to the literature on unemployment and money. Shi (1998) constructs a model with frictional labor and goods markets where large households insure their members against idiosyncratic risks in both markets. Berentsen, Menzio, and Wright (2011) have a related model where individuals endowed with quasi-linear preferences readjust their money holdings in a competitive market that opens periodically as in Lagos and Wright (2005).[4] In Rocheteau, Rupert, and Wright (2007) only the goods market is subject to search frictions but unemployment emerges due to indivisible labor.[5] In all these models credit is not incentive feasible because of the lack of record keeping and fiat money plays a role to overcome a double-coincidence of wants problem in the goods market. Our model adopts a similar structure as in Berentsen, Menzio, and Wright (2011) but we add a construction sector and a housing market, and we introduce home equity-based borrowing in the decentralized goods market. Our emphasize on housing assets is warranted by the fact that housing wealth represents about one half of total household net worth (Iacoviello, 2012) and this wealth has become more liquid over time.

The macroeconomic implications of the dual role of assets as collateral have been explored in a series of papers, starting with Kiyotaki and Moore (1997). Applications to the recent financial crisis include Midrigan and Philippon (2011) and Garriga et al. (2012) based on standard neoclassical models. Our formalization follows the search-theoretic approach to liquidity and financial frictions, including Ferraris and Watanabe (2008), Lagos (2010, 2011), and Rocheteau and Wright (2013). In addition we formalize a two-sector frictional labor market and unemployment.[6] Finally, our focus is on the long-run effects of financial innovations and

[4] Rocheteau and Wright (2005, 2013) extended the Lagos-Wright model to allow for the free entry of sellers/firms in a decentralized goods market. This free-entry condition was reminiscent of the one in the Pissarides model. Berentsen, Menzio, and Wright (2011) tightened the connection to the labor search literature by requiring that firms search for indivisible labor in a market with matching frictions before entering the goods markets.

[5] Petrosky-Nadeau and Wasmer (2011) study the effect of search frictions in the goods market for the dynamics of labor demand in a Mortensen-Pissarides environment. Time-varying goods market congestion and prices in their model propagate the effects of productivity shocks on the incentives to hire workers.

[6] In Rocheteau and Wright (2013) the asset used as collateral is a Lucas tree. He, Wright, and Yu (2013) reinterpret the model as one where the asset enters the utility function directly. As we show in this paper, provided that there is a rental market for homes the two interpretations are equivalent.

not on business cycles fluctuations.

The first search model to account for sectoral reallocation is Lucas and Prescott (1974). In this model sectoral labor markets are competitive and workers' mobility across sectors is limited. Models in which sectoral labor markets have search frictions include Phelan and Trejos (2000) and Chang (2012). Relative to this literature our model explains workers' reallocation across sectors by changes in financial conditions.

Finally, there is a literature linking households' transitions in the labor and housing markets. For instance, Rupert and Wasmer (2012) explain differences in labor market mobility between U.S. and Europe by differences in commuting costs. Head, Allen and Huw Lloyd-Ellis (2011) develop a model with search frictions in both housing and labor markets. Karahan and Rhee (2012) consider a two-city model where the low mobility of highly leveraged homeowners reduces the reallocation of labor. None of these models study the joint determination of housing prices and unemployment in liquidity-constrained economies.

2 Environment

The set of agents consists of a $[0, 1]$ continuum of households and a large continuum of firms. Time is discrete and is indexed by $t \in \mathbb{N}$. Each period of time is divided into three stages. In the first stage, households and firms trade indivisible labor services in a labor market (LM) subject to search and matching frictions. In the second stage, they trade consumption goods financed with home equity-based borrowing in a decentralized market (DM). In the last stage, firms sell unsold inventories, debts are settled, wages are paid, households trade assets and housing services in a competitive market (CM), and unemployed workers make mobility decisions. We take the consumption good traded in the CM as the numéraire good. The sequence of markets in a representative period is summarized in Figure 2.

The lifetime utility of a household is

$$\mathbb{E} \sum_{t=0}^{\infty} \beta^t \left[\upsilon(y_t) + c_t + \vartheta(d_t) \right], \tag{1}$$

where $\beta = 1/(1 + r) \in (0, 1)$ is a discount factor, $y_t \in \mathbb{R}_+$ is the consumption of the DM good, $c_t \in \mathbb{R}$ is the consumption of the numéraire good (we interpret $c_t < 0$ as production), and d_t is the consumption of housing

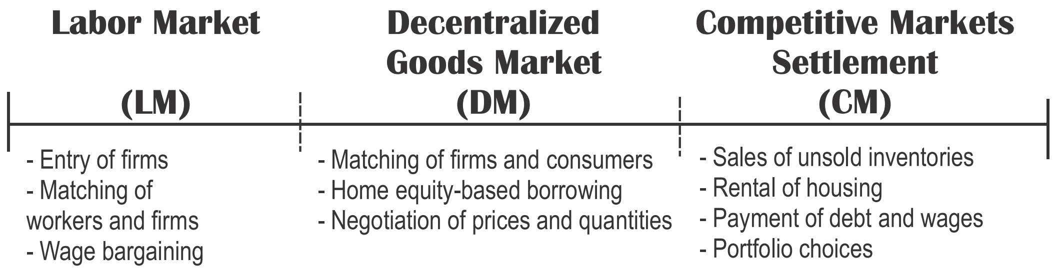

Figure 2: Timing of a representative period

services.[7] The utility function in the DM, $v(y_t)$, is twice continuously differentiable, strictly increasing, and concave, with $v(0) = 0$, $v'(0) = \infty$, and $v'(\infty) = 0$. We denote $y^* > 0$ the quantity such that $v'(y^*) = 1$. The utility for housing services is increasing and concave with $\vartheta'(0) = \infty$ and $\vartheta'(\infty) = 0$.

There are two sectors in the economy denoted by $\chi \in \{g, h\}$: a general sector producing perishable consumption goods ($\chi = g$), and a sector producing durable housing goods ($\chi = h$). Firms are free to enter either sector. Each firm is composed of one job. In order to participate in the LM at t, firms must advertise a vacant position, which costs $k^\chi > 0$ units of the numéraire good at $t - 1$.[8]

The measure of matches between vacant jobs and unemployed households in the LM is given by $m^\chi(s^\chi, o^\chi)$, where s^χ is the measure of job seekers in sector χ and o^χ is the measure of vacant firms (openings). The matching function, m^χ, has constant returns to scale, and it is strictly increasing and strictly concave with respect to each of its arguments. Moreover, $m^\chi(0, o^\chi) = m^\chi(s^\chi, 0) = 0$ and $m^\chi(s^\chi, o^\chi) \leq \min(s^\chi, o^\chi)$. The job finding probability of an unemployed worker in sector χ is $p^\chi = m^\chi(s^\chi, o^\chi)/s^\chi = m^\chi(1, \theta^\chi)$ where $\theta^\chi \equiv o^\chi/s^\chi$ is referred to as labor market tightness. We assume that $\lim_{\theta^\chi \to +\infty} m^\chi(1, \theta^\chi) = 1$, i.e., the job finding probability approaches one when market tightness goes to infinity. The vacancy filling probability for a firm in sector χ is $f^\chi = m^\chi(s^\chi, o^\chi)/o^\chi = m^\chi(1/\theta^\chi, 1)$. We assume that $\lim_{\theta^\chi \to 0} m^\chi(1/\theta^\chi, 1) = 1$, i.e., the vacancy filling probability approaches one when market tightness goes to zero. An existing match in

[7] We do not impose the nonnegativity of c in the CM. If $c < 0$, the household produces the numéraire good. One can impose conditions on primitives so that c is non negative. Alternatively, one can interpret $c < 0$ as a reduction in the household's illiquid wealth (i.e., wealth that cannot serve as collateral in the DM) or as borrowing across CMs under full enforcement.

[8] An alternative assumption is that recruiting is labor intensive (instead of goods intensive). See, e.g., Shimer (2010). In our context our assumption implies that changes in lending standards and financial frictions do not affect the cost of hiring, such as wages of workers in human resources. Also, our focus is not on the very long run where all income and productivity flows are proportional to productivities.

sector χ is destroyed at a beginning of a period with probability σ^χ.

The employment in sector χ (measured after the matching phase at the beginning of the DM) is denoted n^χ and the economy-wide unemployment rate (measured after the matching phase) is u. Therefore,

$$u_t + n_t^g + n_t^h = 1. \tag{2}$$

Unemployed workers in the CM of period t can choose in which sector to look for a job in the following LM at no cost.[9] Therefore,

$$u_t = s_{t+1}^g + s_{t+1}^h. \tag{3}$$

A household who is employed in sector χ receives a wage in terms of the numéraire good, w_1^χ, paid in the subsequent CM. (We assume, and verify later, that the wage does not depend on households' portfolios.) A household who is unemployed after the matching phase receives an income in terms of the numéraire good, w_0^χ, interpreted as the sum of unemployment benefits and the value of leisure.

Each filled job in the consumption-good sector produces $\bar{z}^g \geq y^*$ units of a good that is storable within the period. These goods can be sold and consumed both in the DM and in the CM where they are perfect substitutes to the numéraire good. So the opportunity cost of selling $y \in [0, \bar{z}^g]$ in the DM is y.

The aggregate stock of real estate at the beginning of a period is denoted A. Each filled job in the construction sector produces $\bar{z}^h$ units of housing that are added to the existing stock at the end of the period. Housing goods are durable, and each unit of a housing good generates one unit of housing services at the beginning of the CM. These services can be traded in a competitive housing rental market at the price R. Following the rental market and the consumption of housing services, housing assets depreciate at rate δ.

While all households can rent housing services, we assume that households are heterogenous in terms of their access to homeownership. Only a fraction, μ, of households can participate in the market and purchase real estate. Participating households are called *homeowners* while non-participating households are called

[9] In a follow-up project devoted to the dynamics of the model we introduce a costly mobility decision. A household from sector χ who is unemployed can make a human capital investment, $i \in [0, 1]$, in order to migrate to sector χ' with probability i. The (convex) cost of this investment in terms of the numéraire good is $\Phi(i)$. The assumption $\Phi'(0) = 0$ guarantees that at a steady state households are indifferent between the two sectors.

renters. The market for homeownership opens after the rental market, and housing assets are traded at the price q.

The DM goods market involves bilateral random matching between retailers (firms) and consumers (households).[10] Because each firm corresponds to one job, the measure of firms in the goods market is equal to the measure of employed households in the general goods sector, n^g. The matching probabilities for households and firms are $\alpha = \alpha(n^g)$ and $\alpha(n^g)/n^g$, respectively. We assume $\alpha' > 0$, $\alpha'' < 0$, $\alpha(n^g) \leq \min\{1, n^g\}$, $\alpha(0) = 0$, $\alpha'(0) = 1$ and $\alpha(1) \leq 1$. These search frictions capture random spending opportunities for households and will generate a precautionary demand for liquid assets. Moreover, the endogenous frequency of trading opportunities, $\alpha(n^g)$, generates a link between the labor market and the DM goods market: in economies with tight labor markets households experience more frequent trading opportunities.

Households in the DM cannot commit. Therefore, firms are willing to extend credit to households only if the loan is collateralized with some assets. In order to formalize home equity extraction we assume that the only (partially) liquid asset in the DM is housing.[11] The limited collateralizability of housing assets is formalized as follows. First, there is a probability, $1 - \nu$, that the housing assets of a homeowner are not accepted as collateral. The partial eligibility of the asset captures the idea that the seller cannot authenticate or assess all housing assets in the economy. We assume that if the seller cannot recognize the quality of an asset, he will not accept it as collateral.[12] Second, in accordance with Kiyotaki and Moore (2005), a household who owns a units of housing as collateral can borrow only a fraction of the value of its assets. More specifically, the household can borrow $\rho a\,[q(1-\delta) + R]$, where $q(1-\delta) + R$ is the discounted value of

[10] Diamond and Yellin (1985, 1990) adopt a related formalization of the goods market, where the retail market is formalized by a matching process between inventories and consumers. The assumption of random bilateral matching and bargaining has several advantages. First, the description of a credit relationship as a bilateral match is more realistic. Second, the existence of a match surplus that can be partially captured by firms creates a stronger channel from home-equity-based consumption and firm's productivity. Third, the idiosyncratic risk generated by the matching process is isomorphic to household's preference shocks. In our context the frequency of those shocks is endogenous and depends on the state of the labor market.

[11] One could introduce multiple liquid assets, e.g., by following the methodologies in Li, Rocheteau, and Weill (2012) or Nosal and Rocheteau (2013). Also, one could assume that the repayment of unsecured debt can be enforced up to some limit, $\bar{b}$. For a model of unemployment with unsecured debt, see Bethune et al. (2013). Here we want to focus on home equity-based borrowing exclusively, and hence we assume that the consumption financed with other means of payment takes place in the CM. As a result we will calibrate the DM consumption to correspond to the share of consumption financed with home equity extraction as given by Greenspan and Kennedy (2007).

[12] A similar assumption is used in Lagos (2010) and Lester, Postlewaite, and Wright (2012), among others. For microfoundations for this constraint, see Lester, Postlewaite, and Wright (2012). In practice there are many criteria for a property to be eligible for a home equity loan or for a borrower to qualify for such a loan. For instance, some lenders require that the home is the primary resident of the homeowner while others don't, and qualification is typically based on borrower's credit score and income.

home (the CM price of homes net of depreciation and augmented of the rent), and $\rho \in [0,1]$ captures the limited pledgeability of assets. The parameter, ρ, is a loan-to-value ratio which represents various transaction costs and informational asymmetries regarding the resale value of homes.[13] In case the consumer defaults on the loan, the producer can seize the collateral at the beginning of the CM (before it is rented). We restrict our attention to loans that are repaid within the period in the CM, i.e., the debt is not rolled over across periods.

3 Equilibrium

In the following we characterize an equilibrium by moving backward within a period from the household's portfolio problem in the competitive housing and goods markets (CM), to the determination of the home-equity loan contract in the retail goods market (DM), and finally the entry of firms and the determination of wages in the labor market (LM). We focus on steady-state equilibria where real quantities and real prices are constant over time and the two sectors are active.

3.1 Housing and goods markets

Consider a household at the beginning of the CM who owns a units of housing and has accumulated b units of debt to be repaid in the current CM and denominated in the numéraire good. Let $W_e^{\chi}(a,b)$ denote its lifetime expected discounted utility in the CM , where $\chi \in \{h,g\}$ represents the sector in which the household is employable, and $e \in \{0,1\}$ is its employment status ($e=0$ if the household is unemployed, $e=1$ if it is employed). Similarly, let $U_e^{\chi}(a)$ be a household's value function in the LM. The household's problem can be written recursively as:

$$W_e^{\chi}(a,b) = \max_{c,d,a',\chi'} \left\{ c + \vartheta(d) + \beta U_e^{\chi'}(a') \right\} \tag{4}$$

$$\text{s.t.} \quad c + b + Rd + qa' = w_e^{\chi} + [q(1-\delta) + R]\, a + \Delta. \tag{5}$$

[13]Microfoundations for such resalability constraints are provided in Rocheteau (2011) based on an adverse selection problem and in Li, Rocheteau, and Weill (2012) based on a moral hazard problem. In both settings loan-to-value ratios emerge endogenously and depend on the discrepancy between the values of the asset used as collateral in different states as well as the costs to misrepresent the characteristics of an asset.

The first term between brackets in (4) is the utility of consumption; the second term is the utility of housing services; the third term is the continuation value in the next period. Thus, from (4)-(5), the household chooses its consumption, c, housing services, d, its sector of employment, χ', and real estate holdings, a', in order to maximize its lifetime utility subject to a budget constraint. The left side of the budget constraint, (5), is composed of the household's consumption, the repayment of the debt (recall that the debt accumulated in the DM is repaid in the following CM), the payment of the rent for housing services, and its end-of-period holdings of housing. The right side is the household's income associated with its employment status, w_e^χ, the value of its real estate net of depreciation and augmented for the rental payment, $[q(1-\delta)+R]a$, and the profits of the firms, Δ. A household can move to a different sector, $\chi' \neq \chi$, only if it is unemployed.

Substitute c from (5) into (4) to obtain

$$\begin{aligned} W_e^\chi(a,b) &= [q(1-\delta)+R]\,a - b + w_e^\chi + \Delta + \max_{d\geq 0}\{\vartheta(d) - Rd\} \\ &\quad + \max_{\chi',a'}\left\{-qa' + \beta U_e^{\chi'}(a')\right\}. \end{aligned} \tag{6}$$

In the case where the household does not have access to homeownership the choice of asset holdings is restricted to $a' = 0$. (The homeownership status is left implicit when writing the value functions.) From (6) W_e^χ is linear in the household's wealth, which includes its real estate and its labor income net of the debt incurred in the DM; the choice of real estate for the following period, a', is independent of the household's asset holdings in the current period, a. Finally, the quantity of housing services rented by the household solves $\vartheta'(d) = R$, where d is independent of both the household's housing wealth and its employment status.

The expected discounted profits of a firm in the general sector in the CM with x units of inventories (the difference between the $\bar{z}^g$ units of good produced in the LM and the y units sold in the DM), b units of household's debt, and a promise to pay a wage w_1^g, are

$$\Pi^g(x,b,w_1^g) = x + b - w_1^g + \beta(1-\sigma^g)J^g. \tag{7}$$

The firm's x units of inventories are worth x units of numéraire good; the household's debt, b, is worth b units of numéraire good. So the total value of the firm's sales within the period is $x+b$. In order to compute the period profits we substract the wage promised to the worker, w_1^g. If the firm remains productive, with probability $1-\sigma^g$, then the expected discounted profits of the firm at the beginning of the next period are J^g. The expected discounted profits of a firm in the construction sector are

$$\Pi^h(w_1^h) = \bar{z}^h q - w_1^h + \beta(1-\sigma^h)J^h. \tag{8}$$

A firm in the housing sector produces $\bar{z}^h$ units of housing that are sold at the end of the CM at the price q.

3.2 Home equity loan contract

We now turn to the retail goods market, DM. Consider a match between a firm and a household holding a units of housing assets. A home equity loan contract is a pair, (y, b), that specifies the output sold to the household, y, and the size of the loan (expressed in the numéraire good) to be repaid by the household in the following CM, b.[14] The terms of the contract are determined by bilateral bargaining. We use a simple proportional bargaining rule (Kalai, 1977) according to which the household's surplus from a match is equal to $\eta/(1-\eta)$ times the surplus of the firm, where $\eta \in [0, 1]$, and the trade is (pairwise) Pareto efficient.[15] Therefore, the solution is given by:

$$(y, b) \in \arg\max_{y,b} \left[\upsilon(y) + W_e^{\chi}(a, b) - W_e^{\chi}(a, 0)\right] \tag{9}$$

$$\text{s.t.} \quad \upsilon(y) + W_e^{\chi}(a, b) - W_e^{\chi}(a, 0) = \frac{\eta}{1-\eta}\left[\Pi^g(\bar{z}^g - y, b, w_1^g) - \Pi^g(\bar{z}^g, 0, w_1^g)\right] \tag{10}$$

$$b \le \rho\left[q(1-\delta) + R\right]a. \tag{11}$$

According to (9)-(10) the surplus of the household is defined as its utility if a trade takes place, $\upsilon(y) + W_e^{\chi}(a, b)$, minus the utility it obtains if the firm and the household fail to reach an agreement, $W_e^{\chi}(a, 0)$. The surplus of the firm is defined in a similar way. The problem (9)-(10) is subject to the borrowing constraint, (11), according to which the household can only borrow against a fraction of its housing assets.

[14] We could allow the debt to be repaid across multiple periods as follows. We could consider a loan contract where in each CM the household repays $\kappa = [1 + r - \varrho(1-\alpha)]\, b/(1+r)$, and the loan contract is terminated if one of the following two events occurs: an exogenous signal is realized at the end of the CM with probability $1-\varrho$; the household receives a new opportunity to consume in the DM with probability α. So if $\varrho = 0$ the debt is never rolled over whereas if $\varrho = 1$ the debt is rolled over until the next shock occurs. The expected discounted value of this loan contract is b.

[15] The proportional bargaining solution provides a tractable trading mechanism to divide the match surplus between the household and the firm. It has several desirable features. First, it guarantees the value functions are concave in the holdings of liquid assets. Second, the proportional solution is monotonic (each player's surplus increases with the total surplus), which means households have no incentive to hide some assets. These results cannot be guaranteed with Nash bargaining (see Aruoba, Rocheteau and Waller 2007). Dutta (2012) provides strategic foundations for the proportional bargaining solution.We also considered a competitive trading mechanism, but this mechanism did not perform well quantitatively.

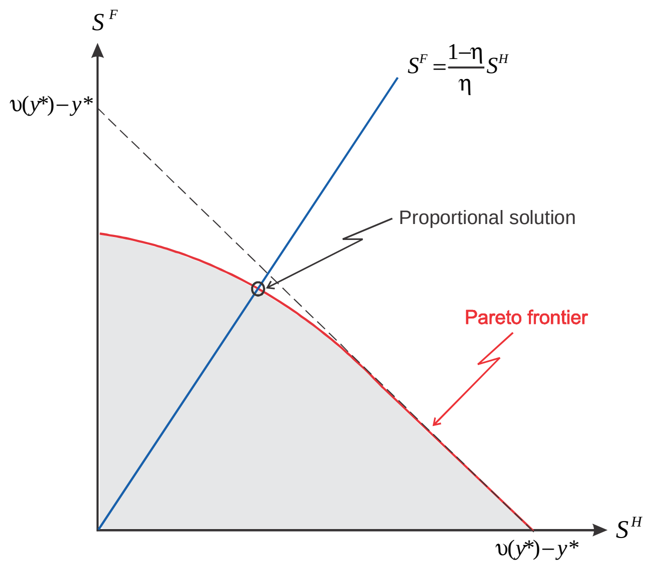

Figure 3: Bargaining and home-equity loan contract.

In Figure 3 we represent graphically the solution to the bargaining/contracting problem, where S^F indicates the surplus of the firm and S^H the surplus of the household. Notice that the Pareto frontier of the bargaining set is concave, and it is linear when the match surplus is maximum, i.e., $y = y^*$.[16] Moreover, the Pareto frontier shifts outward, closer to the dashed line, when the household's borrowing capacity increases. This happens if the household owns a larger quantity of housing, a, if housing prices are larger, or if financial frictions are lower, i.e., ρ is higher. Graphically, the solution is at the intersection of the Pareto frontier and the line indicating the division of the match surplus between the household and the firm.

Using the linearity of W_e^{χ} and Π^g, and after some simplifications (see Rocheteau and Wright, 2013, for details), the bargaining solution becomes

$$y = \arg\max_{y} \eta \left[\upsilon(y) - y \right] \tag{12}$$

$$\text{s.t.} \quad b(y) \equiv (1-\eta)\, \upsilon(y) + \eta y \leq \rho \left[q(1-\delta) + R \right] a. \tag{13}$$

From (12) output is chosen to maximize the household's surplus, which is a fraction of the total surplus of the match, taking as given the non-linear pricing rule, (13). According to (13) the price of one unit of DM

[16]For the derivation of this Pareto frontier, see Aruoba, Rocheteau, and Waller (2007, Section 3.1).

output in terms of the numéraire good is $1 + (1-\eta)[v(y)/y - 1]$, which is decreasing with y. The solution to the bargaining problem is $y = y^*$ if $b(y^*) \leq \rho[q(1-\delta)+R]a$ and $b(y) = \rho[q(1-\delta)+R]a$ otherwise. So provided that the household has enough borrowing capacity, agents trade the first-best level of output. If the borrowing capacity of the household is not large enough, either because the household doesn't own enough housing wealth or the loan-to-value ratio is too low, the household hits its borrowing constraint and its DM consumption is less than the first-best level.

The expected discounted utility of a household in the DM holding a units of housing assets is

$$\begin{aligned} V_e^\chi(a) &= \alpha\nu\left\{v\left(y\right) + W_e^\chi\left[a, b(y)\right]\right\} + (1-\alpha\nu)\, W_e^\chi(a,0) \\ &= \alpha\nu\eta\left\{v\left[y(a)\right] - y(a)\right\} + \left[q(1-\delta)+R\right]a + W_e^\chi(0,0), \end{aligned} \tag{14}$$

where y depends on the household's housing wealth as indicated by the bargaining problem, (12)-(13). According to the first equality in (14), the household is matched with a firm in the retail goods market with probability $\alpha(n^g)$. With probability ν the seller accepts the housing assets of the buyer as collateral. In that event the household purchases y units of output against a promise to repay $b(y)$ units of numéraire good. The second equality in (14) follows from the linearity of W_e^χ.

3.3 Labor market

The description of the labor market corresponds to a two-sector version of the Pissarides (2000) model with perfect mobility of workers across sectors.

Households. Consider a household with a units of housing assets who is employed in sector χ at the beginning of a period. Its lifetime expected utility is

$$U_1^\chi(a) = (1-\sigma^\chi)V_1^\chi(a) + \sigma^\chi V_0^\chi(a), \quad \chi \in \{h, g\}. \tag{15}$$

With probability, $1-\sigma^\chi$, the household remains employed and offers its labor services to the firm in exchange for a wage in the next CM. With probability, σ^χ, the household loses its job and becomes unemployed. In this event the household will not have a chance to find another job before the next LM in the following period. Substituting $V_1^\chi(a)$ and $V_0^\chi(a)$ by their expressions given by (14),

$$U_1^\chi(a) = \alpha\eta\nu\left[\upsilon\left(y\right) - y\right] + \left[q(1-\delta) + R\right]a + (1-\sigma^\chi)W_1^\chi(0,0) + \sigma^\chi W_0^\chi(0,0), \tag{16}$$

where $y = y(a)$ is the DM consumption as a function of the household's housing wealth, a. The household enjoys an expected surplus in the goods market equal to the first term on the right side of (16). The second term is the value of the household's housing wealth. The last two terms are the household's continuation values in the CM depending on its labor status.

The expected lifetime utility of an unemployed household with a units of housing looking for a job in sector χ is

$$U_0^\chi(a) = p^\chi V_1^\chi(a) + (1-p^\chi)\,V_0^\chi(a). \tag{17}$$

An unemployed household in sector χ finds a job with probability p^χ in which case its continuation value is V_1^χ; with complement probability, $1-p^\chi$, the household remains unemployed, in which case its continuation value is V_0^χ. Substituting $V_e^\chi(a)$ by its expression given by (14),

$$U_0^\chi(a) = \alpha\eta\nu\left[\upsilon\left(y\right) - y\right] + \left[q(1-\delta) + R\right]a + W_0^\chi(0,0) + p^\chi\left[W_1^\chi(0,0) - W_0^\chi(0,0)\right]. \tag{18}$$

Equation (18) has a similar interpretation as (16).

Firms. Free entry of firms means that the cost of opening a vacancy incurred in the CM must equalize the discounted expected value of a filled job times the vacancy filling probability, i.e., $k^\chi = \beta f^\chi J^\chi$ (assuming there is entry in sector χ), where J^χ is the expected discounted profits of a filled job in sector χ measured at the end of the LM. It solves:

$$J^h = \Pi^h(w_1^h) \tag{19}$$

$$J^g = \frac{\alpha(n^g)}{n^g}\mu\nu\Pi^g\left[\bar{z}^g - y, b(y), w_1^g\right] + \left[1 - \frac{\alpha(n^g)}{n^g}\mu\nu\right]\Pi^g(\bar{z}^g, 0, w_1^g). \tag{20}$$

According to (20) a firm in the consumption goods sector is matched with a household with probability $\alpha(n^g)/n^g$; this household is a homeowner with probability μ; its home is eligible as collateral with probability ν. In that event the firm sells y units of goods for a promise to repay $b(y)$ units of numéraire. With complement probability the firm sells all its output, $\bar{z}^g$, in the CM. From (7)-(8) and (19)-(20) we obtain the following recursive formulation for the value of a firm:

$$J^{\chi} = z^{\chi} - w_1^{\chi} + \beta(1 - \sigma_{\chi})J^{\chi}, \tag{21}$$

where z^{χ} is the firm's expected revenue in both the DM and CM expressed in numéraire goods, i.e.,

$$z^g = \frac{\alpha(n^g)}{n^g}\mu\nu(1-\eta)\left[\upsilon(y) - y\right] + \bar{z}^g \tag{22}$$

$$z^h = \bar{z}^h q. \tag{23}$$

From (21) the value of a filled job is equal to the expected revenue of the firm net of the wage plus the expected discounted profits of the job if it is not destroyed, with probability $1 - \sigma^{\chi}$. The revenue of the firm in (22) corresponds to the expected surplus of the firm in the DM plus the output sold in the CM if the firm does not find a consumer in the DM. The firm enjoys a fraction, $1 - \eta$, of the match surplus in the DM if it meets a consumer, with probability $\alpha(n^g)/n^g$. The size of the match surplus depends on the DM output, which depends on the borrowing capacity of the household. In (22) we assume (and verify later) that all homeowners hold the same quantity of housing wealth, irrespective of their labor status, and hence can purchase the same quantity of output, y.

Wage. The wage is determined according to the following rent sharing rule: $V_1^{\chi} - V_0^{\chi} = \lambda^{\chi}J^{\chi}/(1-\lambda^{\chi})$, where $\lambda^{\chi} \in [0,1]$ is the household's bargaining power in the labor market of sector χ. (This rule is consistent with both Nash and Kalai bargaining.) From (14) the surplus of a household from being employed, $V_1^{\chi}(a) - V_0^{\chi}(a) = W_1^{\chi}(0,0) - W_0^{\chi}(0,0)$, is independent of the household's asset holdings. Therefore, we will assume that the household holds its optimal level of assets at a steady state and we will omit this argument in the value functions. The firm's surplus, J^{χ}, is given by (21). From (6), (14), and (15) the value of an employed household solves

$$V_1^{\chi} = w_1^{\chi} + \varpi + \beta\left[(1-\sigma^{\chi})V_1^{\chi} + \sigma^{\chi}V_0^{\chi}\right], \quad \chi \in \{h, g\}, \tag{24}$$

where

$$\varpi = \alpha\nu\eta\left[\upsilon(y) - y\right] + (R - \delta q)\,a + \max_{d\geq 0}\{\vartheta(d) - Rd\} + \Delta. \tag{25}$$

From the first two terms on the right side of (24) the period utility of an employed household is the sum of the wage paid by the firm, the expected surplus in the DM goods market, the return on its real estate net of depreciation, the utility of housing services net of the rental cost, and firms' profits. The third term on the right side of (24) describes the transitions in the next LM. With probability $1-\sigma^{\chi}$ the household remains employed in the following period and enjoys the discounted utility βV_1^{χ}; with complement probability, σ^{χ}, the household loses its job and its discounted utility is βV_0^{χ}. Substract V_0^{χ} on both sides to obtain the surplus of an employed worker,

$$V_1^{\chi} - V_0^{\chi} = \frac{w_1^{\chi} + \varpi - (1-\beta)V_0^{\chi}}{1-\beta(1-\sigma^{\chi})}. \tag{26}$$

From (21) and (26) the total surplus of a match, $\mathbb{S}^{\chi} \equiv V_1^{\chi} - V_0^{\chi} + J^{\chi}$, is equal to:

$$\mathbb{S}^{\chi} = \frac{z^{\chi} + \varpi - (1-\beta)V_0^{\chi}}{1-\beta(1-\sigma^{\chi})}. \tag{27}$$

From the bargaining solution, $V_1^{\chi} - V_0^{\chi} = \lambda^{\chi}\mathbb{S}^{\chi}$, which from (26) and (27) implies the following expression for the wage:

$$w_1^{\chi} = \lambda^{\chi} z^{\chi} + (1-\lambda^{\chi})\left[(1-\beta)V_0^{\chi} - \varpi\right]. \tag{28}$$

The wage is a weighted average of the firm's expected revenue, z^{χ}, and the worker's reservation wage defined as $(1-\beta)V_0^{\chi} - \varpi$.

By the same reasoning as the one used to obtain (24), the expected discounted utility of an unemployed household at the beginning of the LM is

$$V_0^{\chi} = w_0^{\chi} + \varpi + \beta\left[V_0^{\chi} + p^{\chi}\left(V_1^{\chi} - V_0^{\chi}\right)\right]. \tag{29}$$

From the bargaining solution, $V_1^{\chi} - V_0^{\chi} = \lambda^{\chi} J^{\chi}/(1-\lambda^{\chi})$; from free entry, $J^{\chi} = k^{\chi}/\beta f^{\chi}$. Therefore, from (29), the worker's reservation wage can be expressed as

$$(1-\beta)V_0^{\chi} - \varpi = w_0^{\chi} + \frac{\lambda^{\chi}}{1-\lambda^{\chi}}\theta^{\chi} k^{\chi}. \tag{30}$$

Substitute the expression for the reservation wage given by (30) into (28) to obtain

$$w_1^{\chi} = \lambda^{\chi} z^{\chi} + (1-\lambda^{\chi})w_0^{\chi} + \lambda^{\chi}\theta^{\chi} k^{\chi}. \tag{31}$$

The wage is a weighted average of firm's revenue, z^χ, and household's flow utility from being unemployed, w_0^χ, augmented by a term proportional to firms' average recruiting expenses per unemployed, $\theta^\chi k^\chi$. Relative to the standard Pissarides model the firm's revenue is endogenous and will depend on frictions in the DM market and housing prices.

Sectoral reallocation From (6) and (18) the choice of asset holdings of an unemployed is independent of the sector in which he is looking for a job. Therefore, assuming the two sectors are active, the condition of free mobility across sectors is simply $U_0^g = U_0^h$. From (17) and the surplus sharing rule, $\beta p^\chi \left(V_1^\chi - V_0^\chi\right) = \lambda^\chi \theta^\chi k^\chi/(1-\lambda^\chi)$,

$$U_0^g - U_0^h = V_0^g - V_0^h + \beta^{-1}\left(\frac{\lambda^g}{1-\lambda^g}\theta^g k^g - \frac{\lambda^h}{1-\lambda^h}\theta^h k^h\right) = 0. \tag{32}$$

Using an equation analogous to (24) for the unemployed, $V_0^\chi = w_0^\chi + \varpi + \beta U_0^\chi$, the free-mobility condition, (32), becomes

$$\beta w_0^g + \frac{\lambda^g}{1-\lambda^g}\theta^g k^g = \beta w_0^h + \frac{\lambda^h}{1-\lambda^h}\theta^h k^h. \tag{33}$$

Unemployed workers are indifferent between the two sectors if the discounted income when unemployed, βw_0^χ, augmented by the worker's expected surplus from finding a job, $\lambda^\chi \theta^\chi k^\chi/(1-\lambda^\chi)$, are equal across sectors. If sectors are symmetric in terms of income when unemployed, $w_0^g = w_0^h$, bargaining powers, $\lambda^g = \lambda^h$, and costs of opening vacancies, $k^g = k^h$, then (33) reduces to $\theta^g = \theta^h$, all sectors have the same market tightness.

Market tightness. Market tightness is determined by the free-entry condition (assuming there is entry), $\beta f^\chi J^\chi = k^\chi$, where J^χ is given by (21). Substituting w_1^χ by its expression from (31) into (21),

$$\frac{(r+\sigma_\chi)k^\chi}{m^\chi\left(\frac{1}{\theta^\chi},1\right)} = (1-\lambda^\chi)\left(z^\chi - w_0^\chi\right) - \lambda^\chi \theta^\chi k^\chi. \tag{34}$$

The financial frictions in the DM affect firms' entry decision in the consumption good sector through z^g. If credit is more limited, then households have a lower payment capacity, which reduces z^g. As z^g is reduced, fewer firms find it profitable to enter the market.

3.4 Housing prices

In order to determine the demand for real estate from homeowners substitute $U_e^{\chi}(a)$ given by (16) and (18) into (6)—noticing that only the first two terms on the right sides of (16) and (18) depend on a and are independent of χ and e—to obtain

$$\max_{a \geq 0} \left\{ - \left[(r+\delta)q - R \right] a + \alpha\eta\nu \left[\upsilon(y) - y \right] \right\}, \tag{35}$$

where y is given by the solution to the bargaining problem in the DM goods market, (12)-(13). According to (35) households choose their holdings of housing in order to maximize their expected surplus in the DM net of the cost of holding these assets. The cost of holding housing is equal to sum of the rate of time preference and the depreciation rate, $r+\delta$, net of the rent-to-price ratio, R/q. Because the problem in (35) is independent of the labor market status of the household, as captured by e and χ, both employed and unemployed households irrespective of the sector in which they are employable (provided they have access to homeownership) will hold the same quantity of housing assets.[17]

From the bargaining problem in the DM, (12)-(13), $dy/da = \left[q(1-\delta) + R \right] \rho / b'(y)$ if $\rho \left[q(1-\delta) + R \right] a < b(y^*)$, and $dy/da = 0$ if $\rho \left[q(1-\delta) + R \right] a > b(y^*)$. Therefore, the first-order condition associated with (35), assuming an interior solution, is

$$q = \frac{R + \mathcal{L}(n^g, y)}{r+\delta}, \tag{36}$$

where we define the liquidity premium for housing assets as

$$\mathcal{L}(n^g, y) = \left[(1-\delta)q + R \right] \alpha(n^g)\nu\rho\eta \left[\frac{\upsilon'(y) - 1}{b'(y)} \right]. \tag{37}$$

From (36) the price of one unit of housing is equal to the discounted sum of its future rental prices and liquidity premia where the discount rate is the rate of time preference augmented by the depreciation rate. The liquidity premium, $\mathcal{L}$, measures the increase in the household's surplus in the DM from holding an additional unit of housing.

[17] If $r+\delta = R/q$, then households are indifferent between all as such that $\left[(r+\delta)q - R \right] a \geq b(y^*)$. In that case we focus on symmetric equilibria where homeowners hold the same asset holdings.

3.5 Definition of equilibrium

We now provide a definition of a steady-state equilibrium for our economy. The population of households is divided according to (2) and (3), i.e.,

$$u = 1 - n^g - n^h \tag{38}$$

$$u = s^g + s^h. \tag{39}$$

The flow of jobs destroyed in sector χ must equal the flow of jobs created in that sector,

$$\sigma^\chi n^\chi = m^\chi(1, \theta^\chi)s^\chi, \quad \chi \in \{g, h\}. \tag{40}$$

Market tightness is the solution to (34), i.e.,

$$\frac{(r + \sigma_\chi)k^\chi}{m^\chi\left(\frac{1}{\theta^\chi}, 1\right)} + \lambda^\chi\theta^\chi k^\chi = (1 - \lambda^\chi)\left(z^\chi - w_0^\chi\right), \quad \chi \in \{g, h\}, \tag{41}$$

where z^χ solves (22)-(23). Workers' mobility across sectors implies (33), i.e.,

$$\beta w_0^g + \frac{\lambda^g}{1 - \lambda^g}\theta^g k^g = \beta w_0^h + \frac{\lambda^h}{1 - \lambda^h}\theta^h k^h. \tag{42}$$

Clearing of the housing market implies the quantity of assets held by homeowners is $a = A/\mu$. From (12)-(13) the quantities traded in the DM solve

$$b(y) = \min\left\{\frac{\rho\left[q(1-\delta) + R\right]A}{\mu}, b(y^*)\right\} \tag{43}$$

From (6) and the clearing of the rental housing market, $d = A$, the rental price of housing solves

$$R = \vartheta'(A). \tag{44}$$

Housing prices solve (36), i.e.,

$$q = \frac{\vartheta'(A) + \left[(1-\delta)q + \vartheta'(A)\right]\alpha(n^g)\nu\rho\eta\left[\frac{\upsilon'(y)-1}{b'(y)}\right]}{r + \delta}. \tag{45}$$

Finally, the stock of housing that depreciates is equal to the production of new houses, i.e.,

$$\delta A = n^h \bar{z}_h. \tag{46}$$

Definition 1 *A steady-state equilibrium is a list,* $\{n^\chi, s^\chi, u, \theta^\chi, q, y, R, A\}$*, that solves (38)-(46).*

4 Sectoral reallocation and home equity-based borrowing

Financial innovations or regulations that raise households' borrowing capacity affect the economy through firms' productivities in the consumption goods and housing sectors, (22) and (23), and through the size of the liquidity premium on housing prices, (37). In order to better understand the mechanics of the model we will first isolate the effects of sector-specific shocks on the reallocation of jobs by shutting down home equity-based borrowing. Second, we will isolate the home equity-based borrowing channel by assuming a fixed supply of housing assets and by shutting down the construction sector. Finally, we will conclude this section by having two active sectors, and hence an endogenous supply of housing, and home equity-based borrowing together. We will focus on limiting economies where the gains from trade in the DM are captured by one side of the market (either households or firms).

4.1 Sectoral reallocation

In this example we assume that the two sectors are symmetric in terms of matching technologies, entry costs, incomes when unemployed, bargaining weights, and separation rates, i.e., $m^g = m^h = m$, $k^g = k^h = k$, $w_0^g = w_0^h = w_0$, $\lambda^h = \lambda^g = \lambda$, and $\sigma^g = \sigma^h = \sigma$. Sectors only differ in their productivity, $\bar{z}^\chi$. From (42), and assuming that both sectors are active, $\theta^g = \theta^h = \theta$ so that households enjoy the same surplus in both sectors. From (34) market tightness solves

$$\frac{(r+\sigma)\,k}{m\left(\theta^{-1},1\right)} + \lambda\theta k = (1-\lambda)\left(z^g - w_0\right). \tag{47}$$

We shut down the home-equity based borrowing channel by setting $\rho = 0$ so that housing assets are illiquid and cannot be used to finance consumption in the DM. In the absence of liquidity considerations the model is similar to the textbook Mortensen-Pissarides model with an additional sector for the production of homes.

The model is solved as follows. From (43) $\rho = 0$ implies $y = 0$ and, from (22), $z^g = \bar{z}^g$, so that productivity in the goods sector is exogenous. From (34) $\theta^g = \theta^h$ implies $\bar{z}^g = \bar{z}^h q$. Housing prices, $q = \bar{z}^g/\bar{z}^h$, adjust so that labor productivity in all sectors are equalized. Market tightness is uniquely determined by (47). Moreover, $\theta > 0$ if and only if $(1-\lambda)\left(\bar{z}^g - w_0\right) - (r+\sigma)\,k > 0$. From (36) the rental price of housing is $R = (r+\delta)q = (r+\delta)\bar{z}^g/\bar{z}^h$ and from (44) the stock of housing is $A = \vartheta'^{-1}(R) = \vartheta'^{-1}\left[(r+\delta)\bar{z}^g/\bar{z}^h\right]$. The stock of housing increases with the productivity in the construction sector, and it decreases with the real interest rate, the depreciation rate, and the productivity in the consumption good sector. The size of the housing sector is determined by (46), $n^h = \delta A/\bar{z}^h = \delta\vartheta'^{-1}\left[(r+\delta)\bar{z}^g/\bar{z}^h\right]/\bar{z}^h$. The size of the goods sector is obtained from (38), $n^h + n^g = 1 - u$, where from (38)-(40) $u(\theta) = \sigma/\left[m(1,\theta)+\sigma\right]$. Both sectors are active if $n^h < 1 - u$, i.e.,

$$\frac{\delta\vartheta'^{-1}\left[(r+\delta)\bar{z}^g/\bar{z}^h\right]}{\bar{z}^h} < \frac{m(1,\theta)}{m(1,\theta)+\sigma}. \tag{48}$$

From (47) θ is increasing with $\bar{z}^g$ for all $\bar{z}^g > w_0 + (r+\sigma)\,k/(1-\lambda)$, and hence the right side of (48) is increasing in $\bar{z}^g$. The left side of (48) is decreasing in $\bar{z}^g$. So there is a threshold, Z$> w_0 + (r+\sigma)\,k/(1-\lambda)$, for $\bar{z}^g$ such that the previous inequality holds with an equality. For all $\bar{z}^g >$Z, $n^g > 0$.

Proposition 1 ***(No home-equity extraction)*** *Suppose that $\rho = 0$ and (48) holds. There exists a unique steady-state equilibrium with $n^h > 0$ and $n^g > 0$. Comparative statics are summarized in the following table:*

	$\bar{z}^g$	$\bar{z}^h$	λ	w_0	σ	k	ϑ'
θ	+	0	-	-	-	-	0
n^g	+	+/-	-	-	-	-	-
n^h	-	+/-	0	0	0	0	+
u	-	0	+	+	+	+	0
q	+	-	0	0	0	0	0
A	-	+	0	0	0	0	+

In Figure 4 we represent graphically the determination of the equilibrium. The curve labelled JC (for job creation) indicates the aggregate level of employment, $n^h + n^g = 1 - u(\theta)$. As it is standard in the Mortensen-Pissarides model, an increase in labor productivity ($\bar{z}^g$) moves the job creation curve outward while an increase in worker's bargaining power (λ), income when unemployed (w_0), and firm's recruiting cost (k) move the job creation curve inward. The curve labelled NH (for n^h) indicates the level of employment in the construction sector. If labor productivity in the goods sector ($\bar{z}^g$) increases, then NH moves downward, while if the marginal utility of housing services (ϑ') increases, then NH moves upward.

We have seen from (22) that a financial innovation that increases households' borrowing capacity raises firms' productivity in the goods sector. An increase in the productivity in the consumption goods sector, $\bar{z}^g$, leads to higher market tightness and lower unemployment. This is the standard effect from a positive productivity shock in the Mortensen-Pissarides model. Labor mobility across sectors guarantees that productivities are equalized: employment increases in the consumption goods sector but decreases in the construction sector. As a result of the decline of the supply of housing assets, rental rates and housing prices increase. In Figure 4 the JC curve moves outward while the NH curve moves downward.

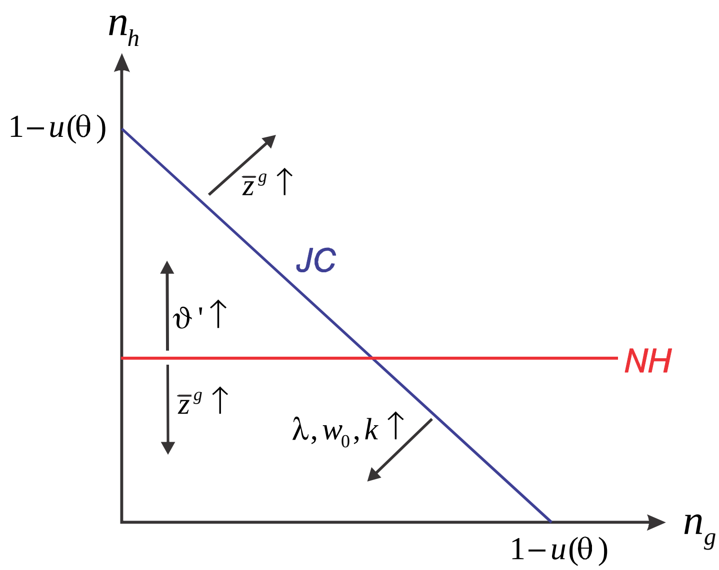

Figure 4: Equilibrium with no equity extraction

A second effect from a financial innovation that allows households to use homes as collateral is to increase the marginal value of housing assets for homeowners. As a first pass—before we study this effect explicitly in the next section—we consider an increase of the marginal utility for housing services, ϑ'. The productivities in the two sectors are unchanged. Therefore, market tightness and unemployment are unaffected. Graphically, the curve JC does not shift. The increase in the demand for housing services generates a reallocation of labor toward the construction sector. Graphically, the curve NH moves upward. In the long run the stock of housing increases.

Finally, consider an increase in the productivity of the construction sector, $\bar{z}^h$. Housing prices decrease to keep labor productivity unchanged. Hence, in Figure 4 the job creation curve, JC, is unaffected. The direction of the sectoral reallocation effect is ambiguous. If the price-elasticity of the demand for housing services is large, $\left|\vartheta'/\vartheta'' A\right| > 1$, then the stock of houses adjusted by productivity, $A/\bar{z}^h$, increases. In this case there is a reallocation of labor from the consumption goods sector to the construction sector. (See the proof of Proposition 1.) Graphically, the curve NH moves upward. In contrast, if the demand for housing services is relatively inelastic, $\left|\vartheta'/\vartheta'' A\right| < 1$, then productivity gains in the construction sector lead to labor reallocation towards the consumption goods sector. Graphically, the curve NH moves downward. In the knife-edge case where $\vartheta(d) = \ln d$, then employment in the construction sector is $n_h = \delta / \left[(r+\delta)\bar{z}^g\right]$, which is independent from the productivity in the construction sector.

4.2 Home equity-based borrowing

In order to isolate the home-equity based borrowing channel we now consider the case of a one-sector economy with a fixed stock of housing, A. We set the depreciation rate to $\delta = 0$ and we omit all the superscripts indicating the sector $\chi = g$.

We first show that a steady-state equilibrium can be summarized by two equations that determine market tightness, θ, and housing prices, q. From (22) and (47) market tightness solves

$$\frac{(r+\sigma)\,k}{m\left(\theta^{-1},1\right)} + \lambda\theta k = (1-\lambda)\left\{\frac{\nu\alpha\left[n(\theta)\right]}{n(\theta)}\mu(1-\eta)\left[\upsilon\left(y\right) - y\right] + \bar{z} - w_0\right\}, \tag{49}$$

where $n(\theta) = m(1,\theta)/\left[m(1,\theta)+\sigma\right]$ is an increasing function of θ with $n(0) = 0$, and y is determined by (43). We impose the following inequality:

$$\nu\mu(1-\eta)\left[\upsilon\left(y^*\right) - y^*\right] + \bar{z} - w_0 > \frac{(r+\sigma)k}{1-\lambda}. \tag{50}$$

Condition (50) guarantees that there is a positive measure of firms participating in the labor market if households are not liquidity constrained. Let $\bar{q}$ be the housing price above which homeowners have enough wealth to purchase y^* in the DM, i.e., $\left(\bar{q}+R\right)\rho A/\mu = b(y^*)$ if $R\rho A/\mu < b(y^*)$ and $\bar{q} = 0$ otherwise. For all $q > \bar{q}$, $y = y^*$ and $\theta = \bar{\theta}$, where $\bar{\theta}$ is the unique solution to (49) with $y = y^*$. In this case the liquidity provided by the housing stock is abundant and homeowners can trade the first-best level of output in the DM. In contrast, for all $q < \bar{q}$, liquidity is scarce and $y < y^*$ is increasing with q so that (49) gives a positive relationship between θ and q (provided that $\theta > 0$). Intuitively, higher housing prices allow households to finance a higher level of DM consumption, which raises firms' expected revenue and therefore the entry of firms in the labor market. The condition (49) is represented by the curve JC (job creation) in Figure 5.

Let us turn to the determination of housing prices. From (36) with $\delta = 0$ the price of housing solves

$$rq = \vartheta'(A) + \left[q + \vartheta'(A)\right] \alpha \left[n(\theta)\right] \nu\rho\eta \left[\frac{\upsilon'(y) - 1}{b'(y)}\right]. \tag{51}$$

If $\theta = 0$, then $\alpha\left[n(\theta)\right] = 0$ and homes are priced at their "fundamental" value, $q = q^* = \vartheta'(A)/r$. Suppose $q^* \geq \bar{q}$, i.e., the fundamental price of housing is large enough to allow households to finance y^* in the DM. This condition can be reexpressed in terms of fundamentals as

$$\vartheta'(A)A \geq \frac{r\mu b(y^*)}{(1+r)\,\rho}. \tag{52}$$

If (52) holds, then $q = q^*$ and $\theta = \bar{\theta}$.

Suppose next that $q^* < \bar{q}$, i.e., (52) does not hold. From (51) there is a positive relationship between housing prices and market tightness.[18] If the labor market is tight, then households have frequent trading opportunities in the DM. As a consequence, they have a high value for the liquidity services provided by homes and $q > q^*$ increases. As θ tends to infinity, q approaches some limit $\hat{q} > q^*$. The condition (51) is represented by the curve HP (housing prices) in Figure 5.

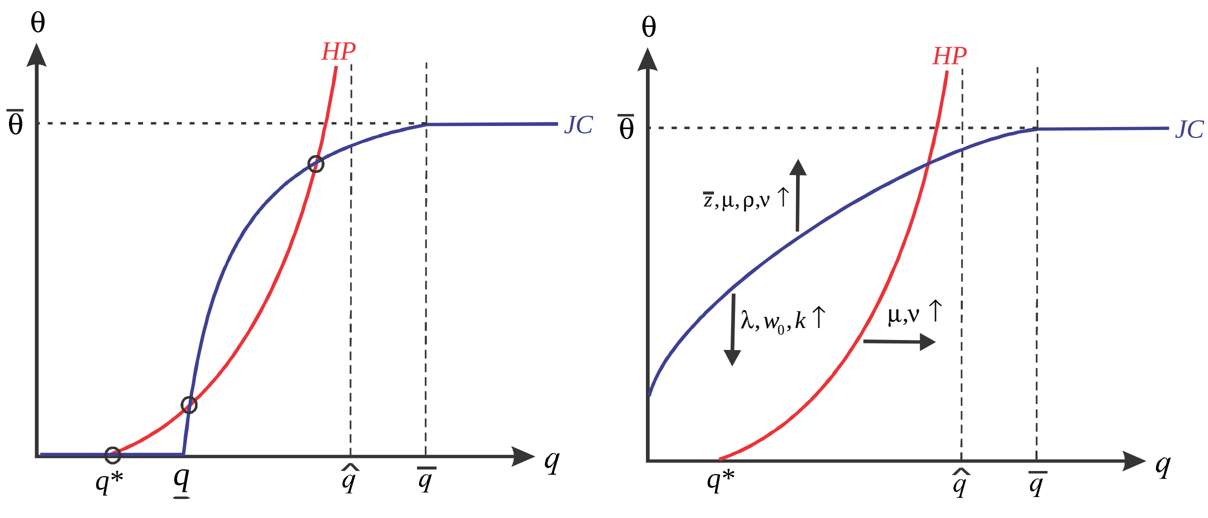

Figure 5: Fixed supply of housing. Left: Multiple steady-state equilibria. Right: Comparative statics.

[18] To see this, notice that (51) can be rewritten as $\left[rq - \vartheta'(A)\right] / \left[q + \vartheta'(A)\right] = \alpha\left[n(\theta)\right]\nu\rho\eta\left[\upsilon'(y) - 1\right]/b'(y)$, where $\left[\upsilon'(y) - 1\right]/b'(y)$ is decreasing in y and y is increasing with q. So the left side of the equality is increasing in q while the right side is decreasing in q. An higher value of market tightness raises the right side, which leads a higher value for q.

As shown in Figure 5 the two equilibrium conditions, (49) and (51), are upward sloping. So a steady-state equilibrium might not be unique. In order to illustrate the possibility of multiple equilibria, assume

$$\nu\mu(1-\eta)\left\{\upsilon\left[y(q^*)\right]-y(q^*)\right\}+\bar{z}-w_0 \leq \frac{(r+\sigma)k}{1-\lambda}. \tag{53}$$

Under (53) there is an equilibrium with an inactive labor market, $\theta = 0$, where homes are priced at their fundamental value, $q = q^*$. Indeed, if $q = q^*$, then firms do not open vacancies and, as a consequence, homes have no liquidity role. There are also an even number of equilibria (possibly zero) with $\theta > 0$ and $q > q^*$.[19] To see this, let $\underline{q} > q^*$ denote the value of q such that the solution to (49) is $\theta = 0$. For all $q \in \left(q^*, \underline{q}\right)$ and all $q > \hat{q}$ the curve JC is located to the right of the curve HP. So if there is a solution with $q \in \left(\underline{q}, \hat{q}\right)$, then there are multiple solutions. In the left panel of Figure 5 we represent a case with two active equilibria. Across equilibria there is a negative correlation between home prices and unemployment. The intuition for the multiplicity of equilibria goes as follows. Suppose that firms anticipate that housing prices will be high. They find it profitable to open vacancies because they anticipate that they will be able to sell their output to homeowners with a large borrowing capacity. But if there is a large number of firms in the DM households are willing to bid housing prices up to benefit from the collateral services that homes provide. Therefore, housing prices exhibit a large liquidity premium in accordance with firms' initial belief. By the same logic, if firms anticipate low housing prices, they open few jobs, the DM is not very active, and households are not willing to pay high prices for homes. We summarize our results in the following proposition.

Proposition 2 ***(Fixed supply of housing)*** *Suppose (50) holds.*

1. *If $\vartheta'(A)A \geq r\mu b(y^*)/\left(1+r\right)\rho$, then there is a unique steady-state equilibrium with $q = q^* = \vartheta'(A)/r$, $y = y^*$, and $\theta = \bar{\theta} > 0$.*

2. *Suppose $\vartheta'(A)A < r\mu b(y^*)/\left(1+r\right)\rho$.*

    (a) If (53) fails to hold, then $q > q^*$, $y \in (0, y^*)$, and $\theta > 0$ at any steady-state equilibrium.

[19] To see that there are parameter values for which multiplicity of steady-state equilibria can occur, consider the case where $\vartheta'(A)$ approaches 0, i.e., the asset is a fiat money. The asset pricing equation, (51), becomes $r = \alpha\left[n(\theta)\right]\nu\rho\eta\left[\upsilon'(y)-1\right]/b'(y)$. As r approaches 0, for all $\theta > 0$ the asset price approaches $\bar{q}$, the level such that $y = y^*$. This means that for r sufficiently low the HP curve will be located underneath the JC curve for some q in $(\underline{q}, \bar{q})$. For a similar argument, see the model of fiat money with free-entry of producers of Rocheteau and Wright (2005).

(b) If (53) holds, then there is an inactive equilibrium, $q = q^*$ and $\theta = 0$, and an even number of active equilibria with $q > q^*$, $y \in (0, y^*)$, and $\theta \in \left(0, \bar{\theta}\right)$.

The comparative statics at the highest active equilibrium, if it exists, are given by:

	$\bar{z}$	λ	w_0	σ	k	ν	ρ	μ
θ	+	-	-	-	-	+	+	+
u	-	+	+	+	+	-	-	-
q	+	-	-	-	-	+	+/-	+

When investigating the comparative statics we assume that $\vartheta'(A)A < r\mu b(y^*)/(1+r)\rho$, i.e., the supply of housing is scarce in the sense that homeowners do not have enough housing wealth in order to finance y^*. Consider first a productivity shock that raises $\bar{z}$. An increase in productivity moves the JC curve upward, i.e., for a given q a larger number of firms have incentives to participate in the market. The housing-pricing curve, HP, is unaffected, so both labor market tightness and housing prices increase while unemployment decreases. Recall that the effective productivity of the firm measured in terms of the numéraire good is $z = \frac{\nu\alpha[n(\theta)]}{n(\theta)}\mu(1-\eta)\left[\upsilon(y) - y\right] + \bar{z}$. Therefore,

$$\begin{aligned}\frac{\partial z^{ss}}{\partial \bar{z}} &= 1 + \overbrace{\frac{\{\alpha'\left[n(\theta^{ss})\right] n(\theta^{ss}) - \alpha\left[n(\theta^{ss})\right]\}}{\left[n(\theta^{ss})\right]^2}\nu\mu(1-\eta)\left[\upsilon\left(y^{ss}\right) - y^{ss}\right] n'(\theta^{ss})\frac{\partial \theta^{ss}}{\partial \bar{z}}}^{\text{congestion effect } (-)} \\ &\quad + \overbrace{\frac{\alpha\left[n(\theta^{ss})\right]}{n(\theta^{ss})}\mu(1-\eta)\left[\upsilon'\left(y^{ss}\right) - 1\right]\frac{\partial y^{ss}}{\partial q}\frac{\partial q^{ss}}{\partial \bar{z}}}^{\text{Home equity-based borrowing effect } (+)},\end{aligned}$$

where the superscript ss indicates steady-state equilibrium values. So an increase in $\bar{z}$ has a negative congestion effect on productivity since the rate at which firms are able to sell their output in the DM decreases. But there is a positive home equity-based borrowing effect because households have more equity in their home, and hence they can buy a larger quantity of output from firms in the DM. In the special case where $\alpha(n) = n$, i.e., each firm meets a consumer in the DM, then the negative congestion effect disappears and the home equity borrowing channel amplifies the initial shock on firm's productivity.

Consider next a financial innovation that increases the eligibility of homes as collateral. Formally, an increase in ν moves the HP curve to the right because the liquidity premium of homes goes up; it moves the

JC curve upward as the frequency of sale opportunities in the DM increases. Consequently, market tightness and housing prices increase, and unemployment decreases.

Lax lending standards can also take the form of high loan-to-value ratios. An increase in ρ moves the JC curve upward because households can borrow a larger amount against their home equity, which allows firms to sell more output in the DM. But an increase in ρ has an ambiguous effect on the home-pricing curve, HP. On the one hand, holding the marginal utility of DM consumption constant, households are willing to pay more for housing wealth because they obtain larger loans when their home is used as collateral to finance their DM consumption. On the other hand, the fact that households hold more liquid wealth implies that the wedge between υ' and the seller's cost, one, is reduced, which leads to a reduction in the size of the liquidity premium. Suppose, for instance, that y is close to y^*. The second effect will dominate and an increase in ρ will reduce the liquidity premium on homes. Suppose next that υ is linear, with $\upsilon' > 1$, so that the size of the liquidity premium is constant. Then the first effect dominates and an increase in ρ raises home prices.

Finally, consider an increase in the fraction of households who have access to homeownership, μ. An increase in μ moves the HP curve to the right because the quantity of assets held by homeowners, A/μ, decreases, which tightens the liquidity constraint in the DM. To determine the effects of an increase in μ on the job creation condition we rewrite the firm's expected surplus,

$$\mu(1-\eta)\left[\upsilon(y)-y\right]=\mu\left[-y+(q+R)\frac{\rho A}{\mu}\right]=-\mu y+(q+R)\rho A,$$

where, from (43), $\mu y=\omega$ solves $(1-\eta)\mu\upsilon(\omega/\mu)+\eta\omega=(q+R)\rho A$. From the strict concavity of υ it follows that $\omega=\mu y$ is a decreasing function of μ. Therefore, as μ increases the firm's expected surplus increases and the JC curve moves upward. So higher access to homeownership generates higher housing prices, higher market tightness, and lower unemployment.

4.3 Sectoral reallocation induced by financial innovations

We now allow for both home-equity financing and an endogenous supply of housing. As in our first example, the two sectors are assumed to be symmetric in terms of matching technologies, entry costs, incomes when unemployed, bargaining weights, and separation rates. Moreover, we assume a logarithmic utility function for housing services, i.e., $\vartheta(A) = \vartheta_0 \ln(A)$. From (44) the rental price of homes is then $R = \vartheta_0/A$. In order to derive analytical results we consider two special cases for the pricing protocol in the DM: a "competitive" case where firms have no market power to set prices; a "monopoly" case where firms can set prices (or terms of trade) unilaterally.[20]

The "competitive" case. Suppose first that firms have no bargaining power in the DM, $1 - \eta = 0$. Following the same reasoning as in Section 4.1, the model can be solved recursively. From (22) the firm's productivity in the non-housing sector is $z^g = \bar{z}^g$. From (41) and (42) the mobility across sectors implies $\bar{z}^h q = \bar{z}^g$, i.e., $q = \bar{z}^g/\bar{z}^h$. Market tightness, which is determined by (47), is not affected by the availability of home-equity loans. The size of the housing sector is $n^h = \delta A/\bar{z}^h = \delta q A/\bar{z}^g$, and the size of the non-housing sector is $n^g = 1 - u(\theta) - n^h$. An active goods market, $n^g > 0$, requires that $Aq \in [0, [1 - u(\theta)]\, \bar{z}^g/\delta)$. From (45) Aq solves

$$\frac{(1+r)\, Aq}{(1-\delta)Aq + \vartheta_0} = 1 + \nu\alpha \left(1 - u(\theta) - \frac{\delta q A}{\bar{z}^g}\right) \rho \left[\upsilon'(y) - 1\right], \tag{54}$$

where from (43), $y = \min\{\rho\,[Aq(1-\delta) + \vartheta_0]/\mu, y^*\}$. The left side of (54) is increasing in Aq from 0 when $Aq = 0$ to $(1+r)\,[1-u(\theta)]\,\bar{z}^g/\{(1-\delta)\,[1-u(\theta)]\,\bar{z}^g + \delta\vartheta_0\}$ when $Aq = [1-u(\theta)]\,\bar{z}^g/\delta$. The right side is decreasing from $+\infty$ when $Aq = 0$ to 1 when $Aq = [1-u(\theta)]\,\bar{z}^g/\delta$. Therefore, an equilibrium with both sectors being active exists and is unique if the left side of (54) evaluated at $Aq = [1-u(\theta)]\,\bar{z}^g/\delta$ is greater than the right side of (54), one, i.e.,

$$[1-u(\theta)]\,\bar{z}^g > \frac{\delta\vartheta_0}{r+\delta}. \tag{55}$$

This condition requires that the productivity in the goods sector, $\bar{z}^g$, is high enough. The determination of Aq is represented in Figure 6 where the right-hand side of (54) is denoted RHS and the left-hand side of (54) is denoted LHS. The steady-state solution for the supply of housing in terms of numéraire good is denoted $(Aq)^{ss}$.

[20] Our "competitive" case should be distinguished from the notion of competitive search where it is assumed that contracts are posted before matches are formed and search is directed. For this concept of equilibrium in a related model, see Rocheteau and Wright (2005).

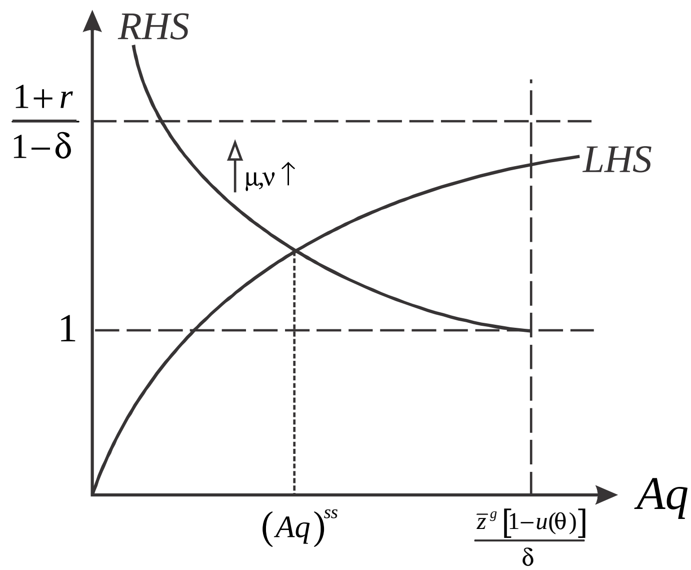

Figure 6: Supply of housing

If liquidity is abundant, $\rho\left[Aq(1-\delta)+\vartheta_0\right]/\mu \geq y^*$, agents can trade the first best in the DM, $y = y^*$, and from (54) $Aq = \vartheta_0/(r+\delta)$. The condition for such an equilibrium with unconstrained credit is $(1+r)\vartheta_0/(r+\delta) \geq \mu y^*/\rho$.

Suppose in contrast that liquidity is scarce, $(1+r)\,\vartheta_0/(r+\delta) < \mu y^*/\rho$. Higher values for μ or ν increase the right side of (54). So Aq and $n^h = \delta q A/\bar{z}^g$ increase. See Figure 6. Hence if the eligibility for home equity loans increases, or if homeownership increases, then labor is reallocated from the general sector to the construction sector. For these two experiments changes in financial frictions affect the composition of the labor market, but aggregate employment and unemployment are unchanged.

In contrast a change in the loan-to-value ratio, ρ, has an ambiguous effect on NH. To see this suppose first that there is no restriction on the use of homes as collateral, the loan-to-value ratio is $\rho = 1$. Households have enough wealth to purchase y^* if $Aq \geq (\mu y^* - \vartheta_0)/(1-\delta)$. In this case, there is no liquidity premium on home prices, $q = \vartheta_0/A(r+\delta)$. If ρ decreases by a sufficient amount, then the liquidity constraint binds and the DM consumption falls below its efficient level, $y < y^*$. In this case, housing assets pay a liquidity premium, $q > \vartheta_0/A(r+\delta)$, and employment in the construction sector increases. As ρ approaches 0, housing assets are illiquid, Aq returns to its fundamental value, $\vartheta_0/(r+\delta)$, and n^h returns to its value when liquidity is abundant. This result shows that a change in lending standards can have non-monotonic effect on the relative sizes of the two sectors.

The "monopoly" case. We now consider the opposite case where households have no bargaining power in the DM goods market, $\eta = 0$. Since households do not enjoy any surplus from their DM trades, the asset price has no liquidity premium, $q = \vartheta_0/A(r+\delta)$. Households are indifferent in terms of their holdings of housing, so we focus on symmetric equilibria where all homeowners hold A/μ. To simplify the analysis further, assume that the matching function in the DM is linear, $\alpha(n) = n$, so that all firms are matched with one household, $\alpha(n)/n = 1$. The productivity in the goods sector is

$$z^g = \mu\nu \left[\upsilon\left(y\right) - y\right] + \bar{z}^g, \tag{56}$$

where from (43), $\upsilon(y) = \min\left\{\rho\left[Aq(1-\delta)+\vartheta_0\right]/\mu, \upsilon(y^*)\right\}$. Provided that a trade occurs in the DM, with probability $\mu\nu$, the firm receives the whole surplus of the match. Assuming $(1+r)\vartheta_0/(r+\delta) < \mu\upsilon(y^*)/\rho$, households do not own enough housing assets to trade the efficient output level in the DM. In this case,

$$\upsilon(y) = \frac{\rho\vartheta_0(1+r)}{\mu(r+\delta)}. \tag{57}$$

If the LM is active, then market tightness is determined by (47) and (56)-(57),

$$\frac{(r+\sigma)\,k}{m(\theta^{-1},1)} + \lambda\theta k = (1-\lambda)\left\{\mu\nu\left[\frac{\rho\vartheta_0(1+r)}{\mu(r+\delta)} - \upsilon^{-1}\left(\frac{\rho\vartheta_0(1+r)}{\mu(r+\delta)}\right)\right] + \bar{z}^g - w_0\right\}. \tag{58}$$

An increase in the loan-to-value ratio, ρ, in the acceptability of homes as collateral, ν, or in homeownership, μ, raises market tightness and aggregate employment.

As before the mobility across sectors implies that $q = z^g/\bar{z}^h$. The size of the housing sector is determined by $n^h = \delta A/\bar{z}^h = \delta qA/z^g = \delta\vartheta_0/(r+\delta)z^g$. Therefore, $n^g = 1 - u(\theta) - n^h$. An equilibrium with an active goods market exists if

$$u(\theta) + \frac{\delta\vartheta_0}{(r+\delta)z^g} < 1, \tag{59}$$

where θ is the solution to (58) and z^g is given by (56)-(57). Condition (59) will be satisfied if $\bar{z}^g$ is sufficiently large. In contrast to the case where households have all the bargaining power in the DM, a reduction in financial frictions (i.e., an increase in ρ, ν, and μ) leads to a reallocation of workers from the construction sector to the goods sector. In the context of Figure 4, the NH curve moves downward and the JC curve moves outward as ρ, ν, or μ increase.

We summarize the results above in the following proposition.

Proposition 3 ***(Financial innovations in two limiting economies.)*** *Assume* $\vartheta(A) = \vartheta_0 \ln(A)$.

1. *Suppose* $\eta = 1$. *If (55) holds, then an equilibrium with two active sectors exists and is unique. If liquidity is scarce,* $(1+r)\,\vartheta_0/(r+\delta) < \mu y^*/\rho$, *an increase in the acceptability of collateral,* ν, *or homeownership,* μ, *has no effect on unemployment but it raises employment in the construction sector,* n^h, *and reduces employment in the goods sector,* n^g.

2. *Suppose* $\eta = 0$, *and* $\alpha(n) = n$. *If (59) holds, then an equilibrium with two active sectors exists and is unique. If liquidity is scarce,* $(1+r)\vartheta_0/(r+\delta) < \mu\upsilon(y^*)/\rho$, *an increase in the acceptability of collateral,* ν, *the loan-to-value ratio,* ρ, *or homeownership,* μ, *increases market tightness,* θ, *aggregate employment,* $1-u$, *and housing prices,* q, *but it reduces employment in the construction sector,* n^h.

5 Calibration and Quantitative Results

We now turn to the quantitative evaluation of the long run effects of financial innovations and regulations—such as changes in loan-to-value ratios, ρ, in eligibility criteria for home equity loans, ν, and access to homeownership, μ—on the labor and housing markets by calibrating our economy to the United States.

5.1 Calibrating the Labor Market

The basic unit of time is a month.[21] The economy is calibrated to the U.S. averages over the period 2000:12 to 2012:9, the longest sample available using the Jobs Opening and Labor Turnover Survey (JOLTS) of the Bureau of Labor and Statistics (BLS).[22]

[21] We chose a short unit of time to target transition probabilities in the labor market (in particular vacancy filling probabilities). Even though in the model households repay their loans every period, we reinterpret the model as one where households can stagger the repayment of their loans over multiple periods, and we will choose the average duration between two trading opportunities in the DM to be consistent with the average maturity of home lines of credit.

[22] See Davis et al. (2010) for a discussion of the JOLTS data. The data we use are: Total Separations rate - Total Nonfarm (Fred II series I.D. JTSTSR); Total Separations rate - Construction (Fred II series I.D. JTU2300TSR).

The average job destruction rates from the JOLTS over this period were 6.1% per month in the construction sector, $\sigma^h = 0.061$, and 3.6% per month in the non-farm sector, $\sigma^g = 0.036$. The job finding probabilities are computed from (40) as $p^\chi = \sigma^\chi n^\chi / s^\chi$. The BLS Establishment Survey provides construction and non-farm employment, E^h and E, respectively, as well as aggregate and construction-industry unemployment numbers, U and U^h, respectively.[23] We use this information to compute the shares of employment in each sector, as $n^\chi = E^\chi/(E+U)$ for the period 2000:12 to 2012:9, along with the shares of unemployment. The results are reported in Table 1. Finally, we target a value $f^g = 0.7$ for the job filling probability in the general sector, corresponding to the value in Den Haan et al. (2000). For the job filling probability in the construction sector we target $f^h = 0.85$, in accordance with the evidence in Davis et al. (2010). Given p^χ and f^χ labor market tightness is simply $\theta^\chi = p^\chi / f^\chi$.

Table 1: U.S. Employment, Unemployment and Job Finding Rates, 2000-2012

	Aggregate	Construction	Non-Construction
Employment share:			
$n^\chi = E^\chi/(E+U)$	93.15%	4.67%	88.47%
Unemployment share:			
$s^\chi = U^\chi/(E+U)$	6.85%	0.71%	6.14%
Job finding rate			
$p^\chi = \sigma^\chi n^\chi / s^\chi$		0.40	0.51

Notes: See Appendix for details on data sources.

The matching function takes a Cobb-Douglas specification, $\bar{m}^\chi (o^\chi)^{1-\epsilon^\chi} (s^\chi)^{\epsilon^\chi}$, with $\bar{m}^\chi > 0$ and $\epsilon^\chi \in (0,1)$. We set the bargaining shares in the labor market in accordance with the Hosios condition, i.e., $\lambda^\chi = \epsilon^\chi$.[24] The matching elasticity and bargaining share in the general sector are equal to $\epsilon^g = \lambda^g = 0.5$ based on the estimates reported in Petrongolo and Pissarides (2001). The matching elasticity and bargaining share in the housing sector, $\epsilon^h = \lambda^h$, will be chosen to target a ratio of the housing stock to GDP. The level parameters of the matching function are backed out as $\bar{m}^\chi = f^\chi (\theta^\chi)^{\epsilon^\chi}$.

The remaining parameters of the labor market are w_0^χ, $\bar{z}^\chi$, and k^χ. We normalize $\bar{z}^g$ and $\bar{z}^h$ to 1. We assume that the income of an unemployed, w_0^χ, has both a fixed and variable component. The fixed

[23] The series we use are: All Employees - Total nonfarm (Fred II series I.D. PAYEMS); All Employees - Construction (Fred II series I.D. USCONS); Unemployed (Fred II series I.D. UNEMPLOY).

[24] The Hosios conditions in the labor and goods market guarantee constrained efficiency provided that borrowing constraints do not bind. See, e.g., Petrosky-Nadeau and Wasmer (2011).

component, l, corresponds to the utility of leisure or home production. (It will remain fixed in our experiments in the next section.) The variable component is interpreted as benefits that are proportional to wages. Mulligan (2012) estimates a median replacement rate in the U.S. of 63%, covering the variety of income support programs available to workers. Therefore, $w_0^\chi = 0.63 \times w_1^\chi + l$.[25] We pin down l by requiring that $w_0^\chi = 0.85z^\chi$ following Rudanko (2011). The next section details the strategy for pinning down k^g, which in turn will determine k^h from (33), as part of the calibration of the goods and housing markets.

5.2 Calibrating the Goods and Housing Markets

The matching function in the goods market is Cobb-Douglas, $\bar{m}^d(n^g)^{1-\epsilon^d}$, where $\bar{m}^d > 0$ and $\epsilon^d \in (0,1)$. We assume that sellers and buyers have symmetric contributions to the matching process, setting the elasticity $\epsilon^d = 0.5$, and we impose an egalitarian bargaining solution by setting $\eta = 1/2$. The level parameter of the matching function, $\bar{m}^d$, is calibrated to a low frequency of spending shocks, α, such that on average equity financed consumption events occur every 4 to 5 years, i.e., $\alpha = m^d(n^g)^{1-\epsilon^d} = 0.02$. This low frequency is motivated by an average maturity of home lines of credit of 5 years.

The eligibility probability of homes as collateral, $0 < \nu < 1$, is calibrated so that the amount of household equity financed expenditure matches the evidence in Greenspan and Kennedy (2007), who provide quarterly estimates from 1991:I to 2008:4. That is, define aggregate consumption expenditure in the DM as $C_{DM} \equiv \mu\alpha\nu\left[(1-\eta)\upsilon(y) + \eta y\right]$, and disposable income as $Y^D \equiv n^g z^g + n^h z^h - k^g o^g - k^h o^h$. We target $C_{DM}/Y^D = 0.05$, at the lower end of its value observed for the period of interest. The homeownership rate is set to $\mu = 0.67$ as reported for the year 2007 in the Survey of Consumer Finance (2012).

We express the parameter ρ as the product of two components, $\bar{\rho}$ and ρ_a. We think of $\bar{\rho}$ as a standard loan-to-value (LTV) ratio. Adelino et al. (2012) find that during the period 1998-2001, on average 60 percent of transactions where at a LTV of exactly 0.8. We choose a more conservative value of $\bar{\rho} = 0.6$ and we will consider experiments relaxing lending standards. The second component, ρ_a, is interpreted as the equity share of a home that can be pledged. The survey of consumer finance (2012) indicates a median household holding of debt secured by a primary residential property of 112.1 thousands 2010 U.S. dollars. The same

[25] For a discussion on how to formalize unemployment income in the long run and the distinction between transfer payments and utility of leisure, see Pissarides (2000, Section 3.2).

household holdings of non-financial wealth, amounts to 209.5 thousand dollars in a primary residence.[26] Based on this we assume $\rho_a = 0.5$, resulting in $\rho = \bar{\rho} \times \rho_a = 0.6 \times 0.5 = 0.3$.

We choose the bargaining share in the construction sector, λ^h, to target the ratio of the value of the aggregate housing stock to GDP in 2001, before the large run up in housing prices, $qA/\left(n^g z^g + n^h z^h\right) = 1.88$, based on the Flow of Fund.[27] To see why the bargaining share, λ^h, will allow us to reach this target, notice that the target implies a relative productivities in the two sectors,

$$\frac{z^g}{z^h} = \frac{n^h}{n^g}\left(\frac{GDP}{\delta qA} - 1\right),$$

where we have used (23) and (46), i.e., $q = \bar{z}^h/z^h$ and $A = n^h \bar{z}_h/\delta$, to express the value of the housing stock as $qA = z^h n^h/\delta$. The depreciation rate of the housing stock over 1996-2001 is taken from Harding et al.'s (2007) estimate of 0.0275 per year, i.e., $\delta = 0.002\,3$.[28]

The functional form for the utility of housing services is $\vartheta(A) = \varsigma \ln A$, in accordance with Rosen (1979) and Mankiw and Weil (1989), and the level parameter is $\varsigma = RA$. We compute the rental rate as $R = (R/q)_{data} \times q$ where the rent to price ratio is given by the Lincoln Institute of Land Policy, available quarterly over the period 2000:IV to 2011:I and averaging to 4.06%.[29]

The utility function in the DM takes the form $\upsilon(y) = y^{1-\omega_1}/(1-\omega_1)$ with $\omega_1 \in (0,1)$. We choose ω_1 so that the model's liquidity premium is consistent with the one in the data. From (36) we compute the liquidity premium in the data as $\mathcal{L}/q = r + \delta - R/q$. In the model it is given by (37). Therefore,

$$r + \delta - \frac{R}{q} = \left(1 - \delta + \frac{R}{q}\right)\alpha\nu\rho\eta\left[\frac{y^{-\omega_1} - 1}{(1-\eta)y^{-\omega_1} + \eta}\right],$$

where, from (43), y solves $(1-\eta)y^{1-\omega_1}/(1-\omega_1) + \eta y = [q(1-\delta) + R]\,\rho A/\mu$. From (22) this implies a value

[26] See Survey of Consumer Finance (2012), Table 13 page 59 and Table 9 page 45.

[27] This ratio is equal to 2 on average over the period 2000 to 2012. The data for the U.S. stock of housing: Real Estate - Assets - Balance Sheet of Households and Nonprofit Organizations (FRED series I.D. REABSHNO), billions of dollars. This data comes from the Z.1 Flow of Funds release of the Board of Governors in Table B.100. Model consistent GDP is constructed as personal consumption expenditure (FRED series I.D. PCE) plus residential investment (FRED series I.D. PRFI). By comparison, Midrigan and Philippon (2001) target a housing stock to consumption expenditure ratio of 2.11.

[28] This is lower than the rate of 3.6% used in Midrigan and Philippon (2011), and greater than the value of 1.6% in Gomme and Rupert (2007).

[29] The Lincoln Institute of Land Policy provides reliable time series of the Rent-Price ratio, the average ratio of estimated annual rents to house prices for the aggregate stock of housing in the US (the rental data are gross and do not account for income taxes or depreciation).

for the productivity in the goods sector,

$$z^g = \bar{z}^g + \frac{\alpha(n^g)}{n^g}\nu(1-\eta)\mu\left(\frac{y^{1-\omega_1}}{1-\omega_1} - y\right).$$

We make this value consistent with θ^g obtained above and the free-entry condition, (34), by adjusting the vacancy cost parameter, k^g. Table 2 presents the baseline parameter values.

Table 2: Baseline Calibration

Parameter	Definition	Value	Source/Target
Panel A: Labor Market Parameters			
σ^g	Job destruction rate - general	0.032	JOLTS
σ^h	Job destruction rate - housing	0.061	JOLTS
w_0^g	Value of non-employment - general	$0.85z^g$	Rudanko (2011)
w_0^h	Value of non-employment - housing	$0.85z^h$	Rudanko (2011)
k^g	Vacancy cost - general goods	0.22	Job filling rate
k^h	Vacancy cost - housing	1.22	Job filling rate
ϵ^g	Elasticity, labor matching - general	0.50	Petrongolo and Pissarides (2001)
ϵ^h	Elasticity, labor matching - housing	0.11	Hosios condition / Competitive search
$\overline{m}^g$	Level, labor matching - general	0.53	Job finding rate
$\overline{m}^h$	Level, labor matching - housing	0.60	Job finding rate
λ^g	Worker's wage bargaining weight	0.50	Hosios condition / Competitive search
λ^h	Worker's wage bargaining weight	0.11	Housing stock to GDP
Panel B: Housing Market Parameters			
$\overline{z}^h$	Technology in housing sector	1	
μ	Home ownership rate	0.67	Survey of Consumer Finance
ς	Level, housing services utility	0.08	Rent to price ratio
δ	Housing stock depreciation rate	0.002	Harding et al. (2006)
Panel C: Goods and Credit Market Parameters			
$\overline{z}^g$	Technology in general sector	1	
ω_1	Curvature, DM good utility	0.96	Housing liquidity premium
η	DM bargaining weight, consumer	0.50	Hosios condition / Egalitarian bargaining
$\overline{m}^d$	Level, DM matching function	0.02	Frequency of spending opportunities
ϵ^d	Curvature, DM matching function	0.50	Balanced matching function
ν	Acceptability of collateral	0.71	Equity financed consumption
ρ	Loan to value of net equity $\overline{\rho} \times \rho_a$	0.30	Adelino et al (2012) and net equity for collateral

5.3 Quantitative Results

Our next objective is to assess quantitatively the long-run effects of regulations or financial innovations that affect home equity-based borrowing. We will vary three parameters: (i) The loan-to-value ratio (LTV), $\bar{\rho}$; (ii) The eligibility of homes as collateral, ν; (iii) The rate of homeownership, μ. Our first experiment will consist in changing the first two parameters, that are both measures of lending standards, separately in order to generate a reduction in the ratio of equity finance expenditure to disposable income from 5% to 2.5%. This experiment answers our first question: What is the change in the natural rate of unemployment that could be attributed to the increase in home equity-based borrowing that took place during the 90's? To answer our second question—If financial innovations keep making housing assets more liquid, how will equilibrium unemployment and housing prices be affected?—we alternately raise $\bar{\rho}$ and μ to their maximum value, one. Finally, to consider how policies favoring homeownership affect the labor market we will reduce and raise the rate of homeownership around our benchmark calibration value (67%).

Changes in lending standards We first engineer a decrease in the share of consumption financed with home equity-based borrowing from 5% (approximately, its level in 2001) to 2.5% (its level at the beginning of the 90's) by reducing the LTV ratio, $\bar{\rho}$, from 60% to 30%. The results are presented in the second and third columns of Table 3. A change in the LTV ratio has a direct effect on the size of home equity loans, $b(y)$, which is cut by a little more than half. The tightening of lending standards reduces firms' marginal revenue in the general sector, z^g, by about 5%, a sizeable number. The frequency of spending opportunities is almost unchanged at 2%.

Housing prices decrease by 4.8%—the same magnitude as the increase in productivity in the general sector—while the annualized liquidity premium decreases by 0.1 percentage point. These price movements are low relative to recent changes in housing prices, but our theory does not aim to explain short-run price fluctuations.[30] Both the aggregate stock of housing and employment in the construction sector are almost

[30] We also studied the model in Section 4.2 where the stock of housing is kept fixed by shutting down the construction sector. We calibrate the model using similar targets as in our benchmark calibration (see the Appendix for details). A reduction of the LTV ratio from 60% to 30% generates a more modest impact on z^g, which declines by 2.2%. The aggregate unemployment rate increases from 6.8% to 7%. Keeping the stock of housing fixed makes the impact on housing prices significantly larger. The price of housing, q, declines by 17% and the annualized liquidity premium decreases from 2.6% to 1.8%.

unchanged—they increase by 1.8%. In theory a change in the LTV ratio can have non-monotonic effects on housing prices and the housing stock. We find such non-monotonicities in our calibrated example as illustrated in Figure 7. A decrease in $\bar{\rho}$ from 0.6 to 0.4 leads to a 20% increase in the stock of housing and the liquidity premium can increase from 2.6% to 3.4%.

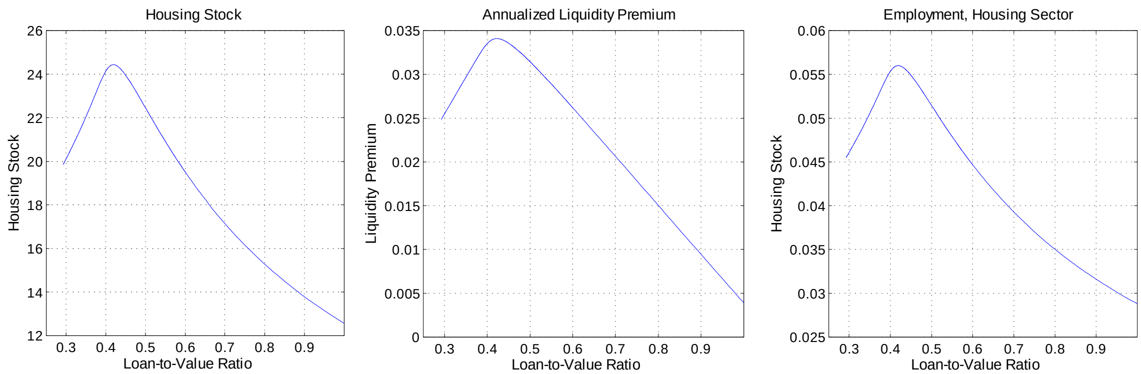

Figure 7: Steady State Effect of Changes in LTV on the Housing Sector

We now turn to the labor market and unemployment. As previously indicated, a tightening of lending standards back to their level at the beginning of the 90's generates a fall in productivities in both sectors of about 5%. As a result the aggregate unemployment rate increases from 6.8% to 7.4%. See Figure 8. So a change in lending standards of a similar magnitude as what happened during the 90's explains a half percentage point change in the unemployment rate. Employment in the general goods sector decreases by less than 1%. The unemployment rate in the housing sector, defined as $s^h/(s^h + n^h)$, increases from 13.7% to 16.6% as the construction sector job finding rate declines by 20%. This finding suggests that shocks to household finance are quantitatively important for labor market outcomes and unemployment.

We should emphasize that the size of the effect on the labor market will depend on the choice of the value of non-market activities, as suggested by Shimer (2005) and Hagedorn and Manovskii (2008). In the Appendix we recalibrate the model to a smaller difference between w_0^χ and z^χ, namely, $w_0^\chi = 0.9z^\chi$, and report the results of the same experiments in Table A7. A reduction of $\bar{\rho}$ from 60% to 30% has similar effects on the housing and goods markets, yet a significantly larger effect on the unemployment rate, which increases from 6.8% to 7.9%. For such a calibration strategy the expansion of home equity-based borrowing in the 90's would account for about one percentage point change in the unemployment rate.

Figure 8: Steady State Effect of LTV on Unemployment Rates

Table 3: Innovations to Loan-to-Value Ratio $\bar{\rho}$

		Decline to 30%		Increase to 100%	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.025	-50.078	0.053	6.488
Frequency of Spending shocks α	0.020	0.020	-0.367	0.020	0.972
DM good sales $b(y)$	7.177	3.391	-52.746	7.733	7.748
General sector productivity z_g	1.112	1.055	-5.146	1.113	0.120
Housing Market					
House price q	1.226	1.166	-4.849	1.227	0.113
Annual rent to price ration R/q	0.041	0.042	3.212	0.063	54.969
Annualized Liquidity premium $\mathcal{L}$	0.026	0.025	-4.983	0.004	-85.123
Housing stock A	19.498	19.854	1.825	12.568	-35.544
Labor Market					
Aggregate unemployment rate	0.068	0.074	8.301	0.067	-2.098
Employed - general n_g	0.887	0.880	-0.733	0.904	1.953
Employed - housing n_h	0.045	0.045	1.825	0.029	-35.544
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.069	6.405	0.065	-0.136
Unemployment rate - housing $s_h/(s_h+n_h)$	0.137	0.166	20.933	0.137	-0.399
Job finding rate - general p_g	0.462	0.432	-6.436	0.463	0.146
Job finding rate - housing p_h	0.384	0.307	-20.060	0.386	0.464

The fourth and fifth columns of Table 3 describe a relaxing of lending standards from $\bar{\rho} = 0.6$ to $\bar{\rho} = 1$.

The size of home equity loans, $b(y)$, increases only by 7.7% because the lax lending standards are compensated by a 35% drop in the stock of housing due to a reallocation of labor from the construction sector to the general sector—employment in the general sector increases by 2% while employment in construction declines by 35%. Despite the large increase in the LTV ratio, the positive productivity effect is small, about 0.1%. It follows that the effect on the aggregate unemployment rate is also small: it decreases from 6.8% to 6.7%. These findings suggest that permanent changes of lending standards have nonlinear and asymmetric effects on housing and labor market outcomes: negative shocks have larger effects on unemployment rates than positive ones.

From Proposition 3 the effects of financial innovations on labor market outcomes depend qualitatively on the structure of the retail goods market and the division of market powers between the firm and the household. In order to check whether our choice for the bargaining power in the goods market matters quantitatively, we raise the household bargaining power from 1/2 to 2/3 and we recalibrate the model (see Appendix). We show, in Tables A4 to A6, that the quantitative effects of a change in lending standards are broadly consistent with the ones described above.

Changes in the eligibility of collateral Our next experiment, the results of which are reported in the second and third columns of Table 4, consists in reducing the eligibility of homes as collateral, ν, from 71% to 36%. Since both ν and ρ represent measures of lending standards, our objective here is to assess whether a tightening of eligibility standards has quantitatively similar effects as a tightening of LTV ratios.

Even though a reduction in ν does not have a direct effect on the borrowing capacity of homeowners, conditional on being eligible for a loan, it decreases the incentives to accumulate housing assets—as seen from the 3% decline in the stock of homes—which leads to a decrease in the size of home equity loans, $b(y)$, of 7.8%. The productivity in the general sector decreases by 5.17%, which is of a similar magnitude as the one observed from a change in $\bar{\rho}$. This suggests that by targeting a given change in the fraction of consumption financed with home equity borrowing we obtain a similar productivity effect as the one obtained from a change in $\bar{\rho}$.

A decrease in ν affects the housing market in a quantitatively similar way as a decrease in $\bar{\rho}$. Housing prices fall by 4.87%, which is comparable to the decrease in productivity in the general sector. This finding is consistent with productivity growth being (almost) equalized across sectors. The quantitative effects on the labor market are also broadly consistent with the ones obtained from a change in $\bar{\rho}$, e.g., the aggregate unemployment rate increases from 6.8% to 7.4%.

Table 4: Innovations to Acceptability Rate ν

		Decline to 0.36		Increase to 1	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.025	-49.983	0.068	37.716
Frequency of Spending shocks α	0.020	0.020	-0.229	0.020	0.249
DM good sales $b(y)$	7.177	6.615	-7.825	7.335	2.203
General sector productivity z_g	1.112	1.054	-5.169	1.158	4.184
Housing Market					
House price q	1.226	1.166	-4.871	1.273	3.906
Annual rent to price ration R/q	0.041	0.044	8.521	0.040	-2.163
Annualized Liquidity premium $\mathcal{L}$	0.026	0.023	-13.216	0.027	3.356
Housing stock A	19.498	18.887	-3.134	19.180	-1.632
Labor Market					
Aggregate unemployment rate	0.068	0.074	7.967	0.065	-5.383
Employed - general n_g	0.887	0.883	-0.457	0.891	0.498
Employed - housing n_h	0.045	0.043	-3.134	0.044	-1.632
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.069	6.437	0.062	-4.430
Unemployment rate - housing $s_h/(s_h+n_h)$	0.137	0.166	21.048	0.120	-12.132
Job finding rate - general p_g	0.462	0.432	-6.466	0.485	4.956
Job finding rate - housing p_h	0.384	0.307	-20.151	0.445	16.000

In the fourth and fifth columns of Table 4 we consider a positive innovation that makes all homes eligible as collateral, $\nu = 1$. The effect on the fraction of home equity financed consumption and the productivity effect is much stronger than the one obtained by raising the LTV ratio to its maximum value. The fraction of home equity financed consumption increases by 38% compared to 6.5% when relaxing the LTV ratio. Productivity in the general goods sector increases by a little more than 4% and housing prices increase by a little less than 4%. The aggregate unemployment rate decreases from 6.8% to 6.5%, which is also a larger effect than the one obtained earlier. Moreover, the stock of housing decreases by 1.6% relative to a 35% fall when $\bar{\rho}$ is raised to one. This finding is in accordance with our analytical results according to which financial frictions on the intensive (LTV ratio) and extensive (eligibility for a loan) margins can affect labor and housing markets outcomes in a markedly different way. It also suggests that there is more scope for relaxing borrowing constraints through eligibility requirements rather than LTV ratios.

Finally, we did some robustness checks by raising the household's bargaining power in the DM to $\eta = 2/3$ (Table A5) and reducing the value of leisure so that $w_1^{\chi}/z^{\chi} = 0.9$ (Table A7). In both cases we found slightly stronger productivity effects and larger effects on the unemployment rate.

Changes in access to homeownership Homeownership is often considered by policy makers as a tool for social and economic mobility—See Grinstein-Weiss and Key (2013) for a broad overview. We consider the effect of policies designed to increase homeownership, or shocks reducing homeownership, on long-term labor market outcomes and housing prices by varying the model parameter, μ. In Table 5 we describe the effects of a decrease in the rate of homeownership, μ, from 67% to 50%. In the long run the supply of homes decreases by 20% to match the lower demand from the reduced number of homeowners. Firms in the general sector have fewer opportunities to sell their output in the DM and as a result their productivity decreases by 2.5%. This effect is smaller than the one obtained from our previous experiments, but it is due to the fact that the share of equity financed consumption to disposable income decreases from 5% to 3.9% instead of 2.5% earlier.

The change in housing prices is of the same magnitude as the change in productivity in the general sector, about -2.3%. In the long run the supply of homes has absorbed most of the decrease in the demand due to the change in μ. The effect on the aggregate unemployment rate is rather small—it increases from 6.8% to 7%.

An increase in the rate of homeownership from 67% to 75% has symmetric but smaller effects on the labor and housing markets. Productivities in both sectors increase by a little more than 1%, the housing stock and employment in the construction sector increase by about 10%. However, employment in the general sector decreases slightly so that the aggregate unemployment rate is almost unchanged.

Table 5: Innovations to Homeownership Rate μ

	Benchmark	Decline to 0.50 Level	Decline to 0.50 % change	Increase to 0.75 Level	Increase to 0.75 % change
Goods Market					
Equity financed to Disp. Income	0.050	0.039	-21.060	0.054	9.512
Frequency of Spending shocks α	0.020	0.020	0.434	0.020	-0.195
DM good sales $b(y)$	7.177	5.557	-22.571	7.928	10.475
General sector productivity z_g	1.112	1.084	-2.470	1.124	1.139
Housing Market					
House price q	1.226	1.197	-2.320	1.239	1.066
Annual rent to price ration R/q	0.041	0.052	29.278	0.037	-9.511
Annualized Liquidity premium $\mathcal{L}$	0.026	0.014	-45.378	0.030	14.760
Housing stock A	19.498	15.440	-20.810	21.320	9.345
Labor Market					
Aggregate unemployment rate	0.068	0.070	2.324	0.068	-1.064
Employed - general n_g	0.887	0.895	0.869	0.883	-0.389
Employed - housing n_h	0.045	0.035	-20.810	0.049	9.345
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.067	2.925	0.064	-1.267
Unemployment rate - housing $s_h/(s_h+n_h)$	0.137	0.149	9.001	0.132	-3.643
Job finding rate - general p_g	0.462	0.448	-3.038	0.469	1.372
Job finding rate - housing p_h	0.384	0.347	-9.570	0.401	4.381

6 Conclusion

We have studied the long-run effects of changes in household finance on the labor and housing markets. We have constructed a tractable general equilibrium model that generalizes the Mortensen-Pissarides framework along several dimensions: (i) The labor market has two sectors, including a construction sector; (ii) There is a frictional goods market, formalized as in the monetary search literature, where household consumption is financed with collateralized loans; (iii) There is a housing market where households can rent housing services and buy and sell homes. The model has generated a variety of new insights—e.g., how financial frictions and the structure of the goods market are intertwined to determine labor market outcomes—and it has been used to study analytically how changes in lending standards could affect the whole economy. We calibrated the model to the U.S. economy and showed that the effects of financial innovations on unemployment could be significant, nonlinear, and asymmetric across positive and negative shocks.

The next step is to investigate the short-run (transitional) dynamics of our model to see if innovations affecting household finance generate trajectories for housing prices and unemployment consistent with those of the Great recession. We will generalize our model along two dimensions that are missing for realistic short-run dynamics: workers' decision to reallocate to a different sector will be costly; households will use a learning scheme to form expectations about future housing prices rather than having perfect foresight.

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Appendix: Proofs of propositions

Proof of Proposition 1. As it has been shown in the text Condition (48) guarantees the existence of an equilibrium with two active markets. Market tightness, θ, is the unique solution to (47). The left side of (47) is increasing in θ and the right side is increasing in $\bar{z}^g$. Therefore, $\partial\theta/\partial\bar{z}^g > 0$. By a similar reasoning one obtains the comparative statics for θ in the second row of the table. The unemployment rate is $u = \sigma/\left[m(1,\theta)+\sigma\right]$. The comparative statics for u are obtained from the comparative statics for θ. For instance, since u is decreasing in θ, $\partial u/\partial\bar{z}^g < 0$. Employment in the housing sector is $n^h = \delta\vartheta'^{-1}\left[(r+\delta)\bar{z}^g/\bar{z}^h\right]/\bar{z}^h$. Since ϑ' is decreasing it follows that $\partial n^h/\partial\bar{z}^g < 0$. Moreover, differentiating $\vartheta'\left(n^h\bar{z}^h/\delta\right) = (r+\delta)\bar{z}^g/\bar{z}^h$ and using that $\bar{z}^h n^h/\delta = A$ we obtain the following elasticity:

$$\frac{\partial n^h/n^h}{\partial\bar{z}^h/\bar{z}^h} = \frac{-\vartheta'(A)}{A\vartheta''(A)} - 1.$$

So $\partial n^h/\partial\bar{z}^h > 0$ if $\left|\vartheta'(A)/A\vartheta''(A)\right| > 1$. An increase in the marginal utility of housing services, ϑ', leads to an increase in n^h. Employment in the consumption goods sector is determined by $n^g = 1 - u - n^h$. Therefore, $\partial n^g/\partial\bar{z}^g = -\partial u/\partial\bar{z}^g - \partial n^h/\partial\bar{z}^g > 0$. The rest of the comparative statics are for n^g follow a same logic. The stock of housing is given by $A = \vartheta'^{-1}\left[(r+\delta)\bar{z}^g/\bar{z}^h\right]$. Since ϑ' is decreasing, $\partial A/\partial\bar{z}^g < 0$ and $\partial A/\partial\bar{z}^h > 0$. An increase in the marginal utility for housing services increases the supply of homes. Finally, housing prices are $q = \bar{z}^g/\bar{z}^h$ so that $\partial q/\partial\bar{z}^g > 0$ and $\partial q/\partial\bar{z}^h < 0$. ■

Proof of Proposition 2. The statements in the proposition are proved in the text. In the following we explain how we obtained the comparative statics for the case where liquidity is scarce, $\vartheta'(A)A < r\mu b(y^*)/(1+r)\rho$. The pair of endogenous variables, (q,θ), is jointly determined by (49) and (51). Both equations give a positive relationship between θ and q. Since the equilibrium might not be unique, we focus on equilibria where the HP curve representing (51) intersects the JC curve representing (49) by below in the space (q,θ). From (49) given q an increase in $\bar{z}$ or ν raises θ. Graphically JC moves upward. From (51) given θ an increase in $\bar{z}$ or ν does not affect q. Graphically HP does not shift. It follows that the equilibrium values of θ and q increase. By a similar reasoning an increase in λ, w_0, σ, or k moves JC downward without affecting HP. Therefore, θ and q decrease. We show in the text that an increase in μ shifts JC upward.

From (51) an increase in μ reduces the stock of housing of homeowners, A/μ, which reduces y and increases the liquidity premium on housing for a given θ. Therefore, HP moves to the right. The overall effect is an increase in both θ and q. An increase in ρ raises market tightness given by (49) for a given q. So HP moves upward. The effect on housing prices given by (51) is ambiguous. Finally, given θ the unemployment rate is determined by $u = \sigma / [m(1, \theta) + \sigma]$. ■

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A Data Appendix

The data used in calibrating the model are the following:

Job destruction rates: Total Separation - Non-Farm; FRED II I.D. JTSTSR. Total Separation - Construction; FRED II I.D. JTU2300TSR

Employment: All Employees - Total Non-Farml; FRED II I.D. PAYEMS. All Employees - Constructions; FRED II I.D. USCONS

Unemployment: Aggregate Unemployment: UNEMPLOY. Construction Unemployment; FRED II I.D. LNU03032231.

Housing Stock and GPD: Real Estate Assets, Balance Sheet of Households and Non-Profit Organizations; FRED II I.D. REABSHNO. Gross Domestic Product; FRED II I.D. GDP.

Rent to Price Ratio: Lincoln Institute of Land Policy.

Equity Financed Consumption: Greenspan and Kennedy (2007).

B Additional Quantitative Results

Tables A1 to A3 present the results from the baseline quantitative experiments of section 5.3. After calibrating the model to the U.S. economy in a first step, we then engineer 50% declines in the steady state ratio of equity financed consumption expenditure to disposable income. This is done by reducing the loan-to-value ratio (Table A1) and reducing the acceptability of housing a collateral (Table A2). We then fully relax these financial parameters and compute there effect on the long run equilibrium. Our experiments with respect to the homeownership rate μ, in Table A3, presents the long run equilibrium to both a decline of the rate to 50% and then an increase to 75%.

B.1 Comparative Static 1 - Changes in ρ, ν and μ

Table A1: Innovations to Loan-to-Value Ratio $\overline{\rho}$

		Decline to 30%		Increase to 100%	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.025	-50.078	0.053	6.488
Frequency of Spending shocks α	0.020	0.020	-0.367	0.020	0.972
DM good sales $b(y)$	7.177	3.391	-52.746	7.733	7.748
General sector productivity z_g	1.112	1.055	-5.146	1.113	0.120
Housing Market					
House price q	1.226	1.166	-4.849	1.227	0.113
Annual rent to price ration R/q	0.041	0.042	3.212	0.063	54.969
Annualized Liquidity premium $\mathcal{L}$	0.026	0.025	-4.983	0.004	-85.123
Housing stock A	19.498	19.854	1.825	12.568	-35.544
Labor Market					
Aggregate unempployment rate	0.068	0.074	8.301	0.067	-2.098
Employed - general n_g	0.887	0.880	-0.733	0.904	1.953
Employed - housing n_h	0.045	0.045	1.825	0.029	-35.544
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.069	6.405	0.065	-0.136
Unemployment reate - housing $s_h/(s_h+n_h)$	0.137	0.166	20.933	0.137	-0.399
Job finding rate - general p_g	0.462	0.432	-6.436	0.463	0.146
Job finding rate - housing p_h	0.384	0.307	-20.060	0.386	0.464

Table A2: Innovations to Acceptability Rate ν

	Benchmark	Decline to 0.36 Level	Decline to 0.36 % change	Increase to 1 Level	Increase to 1 % change
Goods Market					
Equity financed to Disp. Income	0.052	0.027	-46.648	0.071	38.043
Frequency of Spending shocks α	0.020	0.020	-0.473	0.020	0.342
DM good sales $b(y)$	7.427	7.197	-3.088	7.520	1.257
General sector productivity z_g	1.113	1.058	-4.877	1.160	4.298
Housing Market					
House price q	1.184	1.128	-4.758	1.233	4.133
Annual rent to price ration R/q	0.041	0.042	3.198	0.040	-1.246
Annualized Liquidity premium $\mathcal{L}$	0.026	0.025	-4.998	0.027	1.948
Housing stock A	20.883	21.247	1.742	20.308	-2.757
Labor Market					
Aggregate unemployment rate	0.068	0.076	10.948	0.064	-6.905
Employed - general n_g	0.884	0.875	-0.943	0.890	0.685
Employed - housing n_h	0.048	0.049	1.742	0.047	-2.757
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.070	7.344	0.061	-5.355
Unemployment reate - housing $s_h/(s_h+n_h)$	0.129	0.176	35.982	0.105	-18.496
Job finding rate - general p_g	0.461	0.427	-7.317	0.488	6.051
Job finding rate - housing p_h	0.411	0.286	-30.387	0.518	26.061

Table A3: Innovations to Homeownership Rate μ

		Decline to 0.50		Increase to 0.75	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.039	-21.060	0.054	9.512
Frequency of Spending shocks α	0.020	0.020	0.434	0.020	-0.195
DM good sales $b(y)$	7.177	5.557	-22.571	7.928	10.475
General sector productivity z_g	1.112	1.084	-2.470	1.124	1.139
Housing Market					
House price q	1.226	1.197	-2.320	1.239	1.066
Annual rent to price ration R/q	0.041	0.052	29.278	0.037	-9.511
Annualized Liquidity premium $\mathcal{L}$	0.026	0.014	-45.378	0.030	14.760
Housing stock A	19.498	15.440	-20.810	21.320	9.345
Labor Market					
Aggregate unempployment rate	0.068	0.070	2.324	0.068	-1.064
Employed - general n_g	0.887	0.895	0.869	0.883	-0.389
Employed - housing n_h	0.045	0.035	-20.810	0.049	9.345
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.067	2.925	0.064	-1.267
Unemployment reate - housing $s_h/(s_h+n_h)$	0.137	0.149	9.001	0.132	-3.643
Job finding rate - general p_g	0.462	0.448	-3.038	0.469	1.372
Job finding rate - housing p_h	0.384	0.347	-9.570	0.401	4.381

B.2 Comparative Static 2 - Higher DM Bargaining weight η

We recalibrate the model following the exact same strategy described in section 5.2 with one exception: we set the household's bargaining weight in the DM market η to 2/3. Once the model is calibrated the the U.S. economy, we compute the long run effects of financial innovations to the loan-to-value ration $\bar{\rho}$, the acceptability of housing as collateral ν, of the same magnitude as in section 5.3, as feel as the same changes in the rate of homeownership. The results are reported in Tables A4 to A6.

Table A4: Greater DM bargaining weight $\eta = 2/3$ - Innovations to Loan-to-Value Ratio $\bar{\rho}$

		Decline to 30%		Increase to 100%	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.052	0.047	-7.958	0.054	3.861
Frequency of Spending shocks α	0.020	0.019	-2.455	0.020	1.070
DM good sales $b(y)$	7.427	6.626	-10.787	7.798	5.005
General sector productivity z_g	1.113	1.107	-0.474	1.112	-0.042
Housing Market					
House price q	1.184	1.179	-0.458	1.184	-0.040
Annual rent to price ration R/q	0.041	0.022	-44.785	0.065	59.040
Annualized Liquidity premium $\mathcal{L}$	0.026	0.044	70.106	0.002	-92.096
Housing stock A	20.883	37.996	81.945	13.136	-37.097
Labor Market					
Aggregate unempployment rate	0.068	0.072	5.304	0.067	-1.844
Employed - general n_g	0.884	0.841	-4.849	0.903	2.152
Employed - housing n_h	0.048	0.087	81.945	0.030	-37.097
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.065	0.648	0.065	0.057
Unemployment reate - housing $s_h/(s_h+n_h)$	0.129	0.133	2.601	0.129	0.224
Job finding rate - general p_g	0.461	0.457	-0.689	0.460	-0.061
Job finding rate - housing p_h	0.411	0.399	-2.911	0.410	-0.257

Table A5: Greater DM bargaining weight $\eta = 2/3$ - Innovations to Acceptability Rate ν

		Decline to 0.36		Increase to 1	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.025	-49.983	0.068	37.716
Frequency of Spending shocks α	0.020	0.020	-0.229	0.020	0.249
DM good sales $b(y)$	7.177	6.615	-7.825	7.335	2.203
General sector productivity z_g	1.112	1.054	-5.169	1.158	4.184
Housing Market					
House price q	1.226	1.166	-4.871	1.273	3.906
Annual rent to price ration R/q	0.041	0.044	8.521	0.040	-2.163
Annualized Liquidity premium $\mathcal{L}$	0.026	0.023	-13.216	0.027	3.356
Housing stock A	19.498	18.887	-3.134	19.180	-1.632
Labor Market					
Aggregate unempployment rate	0.068	0.074	7.967	0.065	-5.383
Employed - general n_g	0.887	0.883	-0.457	0.891	0.498
Employed - housing n_h	0.045	0.043	-3.134	0.044	-1.632
Unemployment rate - general $s_g/(s_g + n_g)$	0.065	0.069	6.437	0.062	-4.430
Unemployment reate - housing $s_h/(s_h + n_h)$	0.137	0.166	21.048	0.120	-12.132
Job finding rate - general p_g	0.462	0.432	-6.466	0.485	4.956
Job finding rate - housing p_h	0.384	0.307	-20.151	0.445	16.000

Table A6: Greater DM bargaining weight $\eta = 2/3$ - Innovations to Homeownership Rate μ

		Decline to 0.5		Increase to 0.75	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.052	0.040	-22.106	0.057	10.161
Frequency of Spending shocks α	0.020	0.020	0.449	0.020	-0.206
DM good sales $b(y)$	7.427	5.667	-23.698	8.260	11.217
General sector productivity z_g	1.113	1.084	-2.567	1.126	1.210
Housing Market					
House price q	1.184	1.155	-2.491	1.198	1.168
Annual rent to price ration R/q	0.041	0.053	31.197	0.037	-10.116
Annualized Liquidity premium $\mathcal{L}$	0.026	0.013	-48.709	0.030	15.817
Housing stock A	20.883	16.324	-21.831	22.966	9.971
Labor Market					
Aggregate unempployment rate	0.068	0.071	3.630	0.067	-1.646
Employed - general n_g	0.884	0.892	0.901	0.880	-0.412
Employed - housing n_h	0.048	0.037	-21.831	0.053	9.971
Unemployment rate - general $s_g/(s_g + n_g)$	0.065	0.067	3.669	0.064	-1.599
Unemployment reate - housing $s_h/(s_h + n_h)$	0.129	0.150	16.029	0.121	-6.050
Job finding rate - general p_g	0.461	0.443	-3.785	0.469	1.738
Job finding rate - housing p_h	0.411	0.346	-15.864	0.442	7.395

B.3 Comparative Static 3 - Higher Replacement Rate

We recalibrate the model following the exact same strategy described in section 5.2 with one exception: we target a steady ratio of non-employment to employment flow values of 90%, up from 85%. Once the model is calibrated the the U.S. economy, we compute the long run effects of financial innovations to the loan-to-value ration $\bar{\rho}$, the acceptability of housing as collateral ν, of the same magnitude as in section 5.3, as feel as the same changes in the rate of homeownership. The results are reported in Tables A7 to A9.

Table A7: Greater Replacement Rate - Innovations to Loan-to-Value Ratio $\bar{\rho}$

		Decline to 30%		Increase to 100%	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.051	0.025	-49.969	0.054	6.570
Frequency of Spending shocks α	0.020	0.020	-0.632	0.020	1.021
DM good sales $b(y)$	7.068	3.335	-52.821	7.621	7.817
General sector productivity z_g	1.111	1.054	-5.103	1.112	0.116
Housing Market					
House price q	1.146	1.087	-5.133	1.147	0.115
Annual rent to price ration R/q	0.041	0.042	3.165	0.063	54.869
Annualized Liquidity premium $\mathcal{L}$	0.026	0.025	-4.908	0.004	-84.948
Housing stock A	20.545	20.993	2.177	13.251	-35.504
Labor Market					
Aggregate unemppployment rate	0.068	0.079	14.764	0.067	-2.104
Employed - general n_g	0.884	0.873	-1.259	0.903	2.053
Employed - housing n_h	0.047	0.048	2.177	0.030	-35.504
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.073	11.941	0.065	-0.228
Unemployment reate - housing $s_h/(s_h+n_h)$	0.131	0.175	33.281	0.130	-0.545
Job finding rate - general p_g	0.461	0.408	-11.408	0.462	0.244
Job finding rate - housing p_h	0.405	0.288	-28.736	0.407	0.630

Table A8: Greater Replacement Rate - Innovations to Acceptability Rate ν

		Decline to 0.36		Increase to 1	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.051	0.025	-50.221	0.069	36.615
Frequency of Spending shocks α	0.020	0.020	-0.485	0.020	0.363
DM good sales $b(y)$	7.068	6.503	-8.001	7.223	2.189
General sector productivity z_g	1.111	1.054	-5.162	1.156	4.040
Housing Market					
House price q	1.146	1.086	-5.194	1.192	4.016
Annual rent to price ration R/q	0.041	0.044	8.729	0.040	-2.149
Annualized Liquidity premium $\mathcal{L}$	0.026	0.023	-13.535	0.027	3.334
Housing stock A	20.545	19.931	-2.990	20.186	-1.749
Labor Market					
Aggregate unemployment rate	0.068	0.078	14.537	0.063	-8.194
Employed - general n_g	0.884	0.876	-0.967	0.891	0.728
Employed - housing n_h	0.047	0.046	-2.990	0.046	-1.749
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.073	12.106	0.060	-7.138
Unemployment reate - housing $s_h/(s_h+n_h)$	0.131	0.175	33.818	0.110	-15.781
Job finding rate - general p_g	0.461	0.408	-11.548	0.499	8.220
Job finding rate - housing p_h	0.405	0.287	-29.083	0.492	21.564

Table A9: Greater Replacement Rate - Innovations to Homeownership Rate μ

		Decline to 0.36		Increase to 1	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.051	0.040	-20.914	0.056	9.435
Frequency of Spending shocks α	0.020	0.020	0.362	0.020	-0.168
DM good sales $b(y)$	7.068	5.474	-22.550	7.808	10.469
General sector productivity z_g	1.111	1.084	-2.447	1.123	1.128
Housing Market					
House price q	1.146	1.117	-2.451	1.158	1.125
Annual rent to price ration R/q	0.041	0.052	29.244	0.037	-9.506
Annualized Liquidity premium $\mathcal{L}$	0.026	0.014	-45.314	0.030	14.749
Housing stock A	20.545	16.296	-20.683	22.451	9.275
Labor Market					
Aggregate unempployment rate	0.068	0.072	4.855	0.067	-2.051
Employed - general n_g	0.884	0.891	0.725	0.881	-0.335
Employed - housing n_h	0.047	0.037	-20.683	0.051	9.275
Unemployment rate - general $s_g/(s_g+n_g)$	0.065	0.068	5.223	0.064	-2.159
Unemployment reate - housing $s_h/(s_h+n_h)$	0.131	0.149	13.331	0.124	-5.044
Job finding rate - general p_g	0.461	0.436	-5.308	0.472	2.359
Job finding rate - housing p_h	0.405	0.350	-13.537	0.429	6.113

B.4 Comparative Static 3 - Fixed Stock of Housing

In this section we shut down the construction sector, treating the stock of housing as an exogenous variable. We calibrate the modified model to the U.S. economy as in section 5.2, employing the same targets in the labor, consumption, and housing markets. The parameter values from this calibration are presented in Table A10. We then engineer 50% declines in the steady state ratio of equity financed consumption expenditure to disposable income. This is done by reducing the loan-to-value ratio (Table A111) and reducing the acceptability of housing a collateral (Table A12). We then fully relax these financial parameters and compute there effect on the long run equilibrium. Our experiments with respect to the homeownership rate μ, in Table A13, presents the long run equilibrium to both a decline of the rate to 50% and then an increase to 75%.

Table A10: Fixed Housing Stock - Parameter Values

Parameter	Definition	Value	Source/Target
Panel A: Labor Market Parameters			
σ^g	Job destruction rate - general	0.032	JOLTS
w_0^g	Value of non-employment - general	$0.85z^g$	Rudanko (2011)
k^g	Vacancy cost - general goods	0.22	Job filling rate
ϵ^g	Elasticity, labor matching - general	0.50	Petrongolo and Pissarides (2001)
$\overline{m}^g$	Level, labor matching - general	0.55	Job finding rate
λ^g	Worker's wage bargaining weight	0.50	Hosios condition / Competitive search
Panel B: Housing Market Parameters			
μ	Home ownership rate	0.67	Survey of Consumer Finance
ς	Level, housing services utility	0.07	Rent to price ratio
ψ	Curvature, housing services utility	1	Rosen (1979), Mankiw and Weil (1989)
Panel C: Goods and Credit Market Parameters			
$\overline{z}^g$	Technology in general sector	1	
ω_1	Curvature, DM good utility	0.96	Housing liquidity premium
η	DM bargaining weight, consumer	0.50	Hosios condition / Egalitarian bargaining
$\overline{m}^d$	Level, DM matching function	0.02	Frequency of spending opportunities
ϵ^d	Curvature, DM matching function	0.50	Balanced matching function
ν	Acceptability of collateral	0.37	Equity financed consumption
ρ	Loan to value of net equity $\overline{\rho} \times \rho_a$	0.30	Adelino et al (2012) and net equity for collateral

Table A11: Fixed Stock of Housing - Innovations to Loan-to-Value Ratio

		Decline to 30%		Increase to 100%	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.025	-50.051	0.061	21.520
Frequency of Spending shocks α	0.020	0.020	-0.107	0.020	0.038
DM good sales $b(y)$	6.607	3.212	-51.378	8.099	22.580
General sector productivity z_g	1.052	1.029	-2.197	1.061	0.837
Housing Market					
House price q	1.000	0.831	-16.942	0.735	-26.541
Annual rent to price ration R/q	0.041	0.049	20.398	0.055	36.131
Annualized Liquidity premium $\mathcal{L}$	0.026	0.018	-31.675	0.011	-56.076
Labor Market					
Aggregate unempployment rate	0.068	0.070	2.901	0.068	-1.041
Employed - general n_g	0.931	0.930	-0.213	0.932	0.077
Job finding rate - general p_g	0.435	0.422	-3.026	0.440	1.130

Table A12: Fixed Stock of Housing - Innovations to Acceptability Rate ν

		Decline to 0.22		Increase to 1	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.025	-50.382	0.146	190.114
Frequency of Spending shocks α	0.020	0.020	-0.126	0.020	0.408
DM good sales $b(y)$	6.607	5.293	-19.885	7.875	19.198
General sector productivity z_g	1.052	1.025	-2.572	1.163	10.511
Housing Market					
House price q	1.000	0.800	-19.952	1.193	19.263
Annual rent to price ration R/q	0.041	0.051	24.926	0.034	-16.152
Annualized Liquidity premium $\mathcal{L}$	0.026	0.016	-38.699	0.033	25.112
Labor Market					
Aggregate unempployment rate	0.068	0.071	3.422	0.061	-11.111
Employed - general n_g	0.931	0.929	-0.252	0.939	0.817
Job finding rate - general p_g	0.435	0.420	-3.552	0.494	13.419

Table A13: Fixed Stock of Housing- Innovations to Homeownership Rate μ

		Decline to 0.36		Increase to 1	
	Benchmark	Level	% change	Level	% change
Goods Market					
Equity financed to Disp. Income	0.050	0.043	-14.155	0.051	1.025
Frequency of Spending shocks α	0.020	0.020	-0.038	0.020	0.003
DM good sales $b(y)$	6.607	5.625	-14.866	6.679	1.086
General sector productivity z_g	1.052	1.044	-0.794	1.053	0.057
Housing Market					
House price q	1.000	0.851	-14.916	1.011	1.089
Annual rent to price ration R/q	0.041	0.048	17.531	0.040	-1.078
Annualized Liquidity premium $\mathcal{L}$	0.026	0.019	-27.226	0.027	1.675
Labor Market					
Aggregate unempployment rate	0.068	0.069	1.020	0.068	-0.073
Employed - general n_g	0.931	0.931	-0.075	0.932	0.005
Job finding rate - general p_g	0.435	0.430	-1.084	0.435	0.078