Labor Market Slack, Refinancing Eligibility, and the Distribution of Monetary Transmission

Han Zhang, University of California, Riverside

Working draft, November 2026. Comments welcome.

Abstract

Refinancing typically requires documented employment. I ask who gains from a cut in mortgage rates, and when, in a calibrated model with illiquid housing. Where housing is at least half as illiquid as in 2011, the rule delays most of the gain rather than removing it, household by household. In the baseline 5 percent of unemployed homeowners raise consumption in the quarter of the cut against 27 percent of the employed; their refinancing lags one to two quarters and has nearly caught up after two years. The unemployed cohort's average response depends on how many sell. A slack labor market delays the aggregate response more than it reduces it: about two fifths weaker in the quarter of the cut, 8 percent over three years. In two household panels, mortgagors with an unemployment spell refinanced half as often in 2009, consistent with the mechanism; the larger regional shortfall mostly follows house prices.

1 Introduction

Refinancing a mortgage in the United States typically requires documented employment and income, and DeFusco and Mondragon (2020) document the requirement and its bite in 2009. Homeowners who lose their jobs therefore largely cannot refinance into a lower rate, or borrow against their home equity, until they are back at work, and re-employment takes longer when the labor market is slack. I ask who receives the gains from a cut in mortgage rates, and when, once refinancing is conditional on employment. In a calibrated model with illiquid housing, unemployment benefits that run out and an employment requirement on new loans, the rule delays most of the gain rather than removing it. In the quarter of the cut, 5 percent of unemployed homeowners raise their consumption against 27 percent of the employed; their refinancing runs one to two quarters behind and has nearly caught up after two years. A slack labor market lengthens the wait, so it delays the aggregate response to a cut more than it reduces it.

The counterfactual at the center of the question, what unemployed homeowners would do if they could refinance or could sell without delay, is not observed, and regional data do not separate the labor market from home equity, so I answer with a model. It is the economy of Garriga and Hedlund (2020), in which heterogeneous households hold long-term fixed-rate mortgages, may refinance, extract equity, default or sell, and houses sell through search with a price-dependent probability of sale. To it I add a tight-or-slack

labor market that sets separation and job-finding rates measured from flows in the Current Population Survey; eligibility rules on new loans (employment, a payment-to-income cap and a loan-to-value cap); unemployment benefits that run out, as they did after 99 weeks in 2009 to 2012; and a Calvo-type friction on refinancing opportunities. The origination rate follows a Markov chain measured from Freddie Mac's Primary Mortgage Market Survey. The mortgage rate is the only price that moves, and one calibration, anchored to published series, not estimated, serves the whole paper. I follow fixed cohorts defined by their state in the quarter of the cut, so that re-employment does not change who is in a group, and I compare the model with two household panels and with loan data from the easing of 2008. Three results follow: a household-level result on who responds and when, a cohort average that depends on how many of the unemployed sell, and an aggregate result that a slack labor market delays the consumption response to a cut more than it reduces it.

The first result is about households. Unemployed homeowners are the wealthy hand-to-mouth of Kaplan and Violante (2014): they have home equity and little liquid wealth, the rule stops them from borrowing against the equity, and at the calibrated frictions a sale is slower and costlier than waiting, so they wait for a job. In the baseline none of them refinances in the quarter of the cut; 11 percent of the cohort have refinanced after two quarters against 19 percent of the employed cohort, and 33 against 36 percent after two years. Across seventeen other economies, wherever housing is at least half as illiquid as in the calibration, unemployed homeowners are a tenth to six tenths as likely as employed ones to raise consumption in the quarter of the cut, and those who do not sell rarely respond. A large part of the gap is the rule: with the employment requirement removed, 13 percent of the same unemployed cohort respond in that quarter, and the ratio of the two shares rises from 0.19 to 0.42. Over three years the cohort's gain in goods is 88 percent of the employed cohort's. The requirement changes the path of the gains far more than their total.

The second result is that housing liquidity governs whether the employment requirement shows up as a lower average consumption response of the unemployed cohort or as gains concentrated among the few who sell. On impact the unemployed cohort gains 4 percent against 8 for the employed, then 9 and 13 percent in the next two quarters, when re-employment makes its members eligible and they refinance from a low level of consumption. Lower the housing frictions to nearly nothing and the same cohort's impact response is 39 percent instead of 4: they sell, consume part of the equity and buy again once re-employed. Eligibility rules and housing illiquidity are complements; the rule bites because the other route to liquidity, a sale, is slow. Where the average is high it is the response of the few who sell; in the baseline sellers account for 38 percent of it and households that run down liquid assets ahead of re-employment for most of the rest. It moves with whatever makes a sale more attractive: lower entry costs of the housing market, shorter benefits and a slack labor market, and it reaches the employed response or exceeds it when these combine. With benefits that never run out the ratio is 13 percent; with the entry costs at two thirds of their calibrated value it is 81 percent; in a slack labor market at those entry costs it exceeds one, while 90 percent of the cohort still do not respond. The delay in the averages therefore requires an illiquid housing market, as in 2008 to 2011. Exits from homeownership in two household panels bound the entry costs of 2007 to 2009 from below, because a more liquid market implies more sales than the panels show: at about two thirds of the calibrated value if prices fall, at the calibrated value if they do not. Over that range the

unemployed cohort's impact response is 44 to 81 percent of the employed cohort's in a tight labor market.

The third result places the labor market in the aggregate. A slack labor market delays the consumption response to a cut more than it reduces it: the response is about two fifths weaker in the quarter of the cut, 15 percent weaker over the first year and 8 percent weaker over three years, a share that moves across calibrations while the ordering holds in every calibration whose aggregate response is not near zero. Most of the difference is behavioral, employed households saving more of their refinancing gains when job loss is more likely; the rest is composition, which is bounded by the share of mortgagors who are unemployed, 6 to 9 percent. Within the model the starting rate, the source of state dependence in Eichenbaum, Rebelo and Wong (2022), moves the impact response more than the labor-market state does. The labor market matters less for how much a cut delivers to consumption than for whom it reaches and when.

Two household panels from the 2008 easing are consistent with the mechanism. In the 2007-09 panel of the Survey of Consumer Finances, among in-the-money fixed-rate mortgagors still holding their 2007 loan when rates fell, families in which the head or spouse had an unemployment spell refinanced 52 percent less in 2009 than families with no spell (standard error 12). They had considered refinancing as often. The Panel Study of Income Dynamics gives the same gap for 2009, 52 percent (13), and follows the families further: the gap is in the year of the cut, and families whose spell is over do not refinance less than families with no spell. The model's gap in the level of refinancing over the first year after a cut is 39 to 52 percent. Hurst and Stafford (2004) find in the same panel for the early 1990s that homeowners with an unemployment spell and few liquid assets refinanced and extracted equity more often; that is the liquidity motive of this paper, and it agrees with the higher refinancing of families whose spell is over. The comparisons are descriptive: a spell also lowers income and credit standing, and the order of job loss and refinancing within a year is not observed. The same data give the aggregate effect by arithmetic: the share of mortgagor families with a spell rose from 11 to 20 percent between 2007 and 2009, which at this gap lowers aggregate refinancing by about 5 percent, the order of the model's aggregate effect.

Regional data show a shortfall several times larger, and most of it has another cause. In Freddie Mac loan-level data, prepayment of in-the-money loans fell 17 percent more in high-unemployment than in low-unemployment metropolitan areas in the year after the cut, and refinance originations were 32 percent lower. But the gap opens with the house-price bust, a year before the cut; it closes in 2012, when the second version of the Home Affordable Refinance Program removed the loan-to-value ceiling on refinancing; for refinancing that does not extract equity it is absent where prices did not fall; and Home Mortgage Disclosure Act records place it in applications, not denials. The regional shortfall mostly follows house prices, the equity channel of Beraja, Fuster, Hurst and Vavra (2019). To put the two channels on one scale I add an exogenous house-price state to the model and change no other parameter (Appendix C). For a cohort with the leverage of the loans of 2009, a 20 percent fall in prices lowers first-year refinancing by between a fifth and a quarter and a slack labor market by less than a tenth.

The results have a policy counterpart. Removing the employment requirement raises the response of unemployed homeowners from 4 to 9 percent in the quarter of the cut and from 9 to 15 percent in the next, and is worth about 0.17 percent of lifetime consumption to them. The form of access matters more than its existence. Access that lets the unemployed refinance into the current rate without extracting equity, the rule of streamline programs, is worth almost nothing to the unemployed, because few of them are

in the money at an ordinary cut and the payment relief is small next to the proceeds of a cash-out loan. DeFusco and Mondragon (2020) find that unemployed borrowers did use streamline refinancing in 2009, which the model does not contradict: use does not imply a large gain. A waiver of the loan-to-value cap confined to the rate, as in the 2012 program, restores refinancing, about half of the consumption shortfall of the households it reaches, and little of the consumption response of homeowners as a whole. These consumption magnitudes rest on equity extraction: most refinancing in 2009 did not raise the balance, so they are not statements about 2009, while who is eligible to refinance, and when, does not depend on them.

The paper draws on three sets of work. The first studies the refinancing channel of monetary policy and its state dependence: the regional distribution of home equity in Beraja et al. (2019), the distribution of rate gaps in Eichenbaum et al. (2022), prepayment and path dependence in Berger, Milbradt, Tourre and Vavra (2021), refinancing and consumption in Wong (2021) and Di Maggio et al. (2017), equity extraction in Bhutta and Keys (2016), payment-to-income and loan-to-value constraints in Greenwald (2018), and the Home Affordable Refinance Program in Agarwal et al. (2023) and Abel and Fuster (2021). Relative to this work I add the labor-market state and the employment condition on eligibility as a distinct dimension of state dependence, and I ask about the distribution and timing of the gains rather than the size of the aggregate response; the cut to a new low that I use for 2008 is a case of the path dependence of Berger et al. (2021), obtained by conditioning on a history of rates rather than by modeling one. The second set builds quantitative models of housing illiquidity, mortgage default and credit, in Garriga and Hedlund (2020), Hedlund (2016), Kaplan, Mitman and Violante (2020) and Gete and Zecchetto (2024); from it I take the illiquid housing block, which here is what makes the eligibility rule matter for the timing of the gains. The third studies credit as insurance for the unemployed: unsecured borrowing in Herkenhoff, Phillips and Cohen-Cole (2024) and Braxton, Herkenhoff and Phillips (2024), foreclosure delay in Herkenhoff and Ohanian (2019), and refinancing under macroeconomic uncertainty in Chen, Michaux and Roussanov (2020). The complementarity of the rule and housing illiquidity separates mortgage credit from the unsecured credit those papers study, and the behavioral effect in my aggregate decomposition is of the same family as the precautionary motive in Chen et al. (2020) and is not new here. What the paper adds is to put the labor-market state, eligibility rules and housing illiquidity in one quantitative framework, in which their interaction rather than any one alone determines who receives the gains from a cut in mortgage rates and when.

Section 2 sets out the model, Section 3 the calibration and the moments that check it, Section 4 the results, household by household, in cohort averages and in the aggregate, Section 5 the evidence from the 2008 easing, and Section 6 concludes; Appendix C puts house prices and employment together.

2 Model

The model is a Garriga–Hedlund economy with one addition: a household's employment status decides whether a lender will write it a new mortgage. Households earn labor income that depends on employment and a persistent productivity draw, hold liquid savings, and either rent or own a house financed by a long-term fixed-rate mortgage. An owner can keep paying, refinance at the current origination rate if eligible and if an opportunity arrives, default, or list the house for sale in a search market where sales take time and

distressed sales carry a discount. Two aggregate states move over time: the origination rate and the labor market. House prices, rents and wages are fixed, which shuts the equity channel of Beraja et al. (2019) and isolates the labor-market and eligibility channels; Appendix C adds house prices as an exogenous aggregate state. The independence of the two aggregate chains, non-recourse default and uniform loan pricing are simplifications.

Time is discrete and quarterly. All quantities are in units of the consumption good, and the quarterly wage w is normalized to one.

2.1 Aggregate state, labor market and income

The aggregate state is $\Omega = (S, \bar{r})$. The labor-market state $S \in \{\text{tight}, \text{slack}\}$ follows a Markov chain Π_S and determines the separation rate $\delta(S)$ of the employed and the job-finding rate $\phi(S)$ of the unemployed. The origination rate $\bar{r}$ on new fixed-rate mortgages follows a Markov chain $\Pi_{\bar{r}}$ on a finite grid $\{r_1 < \cdots < r_{N_r}\}$. The two chains are independent in the baseline, so that the same rate cut can be compared across labor-market states; the joint transition is $\Pi_\Omega = \Pi_S \otimes \Pi_{\bar{r}}$. The house price per unit p_H, the rent per unit ρ, the wage w and the return on liquid savings i are constant.

Employment $e \in \{E, U\}$ evolves between periods at the rates of the current labor-market state,

$$\Pr(e' = E \mid e = E, S) = 1 - \delta(S), \qquad \Pr(e' = E \mid e = U, S) = \phi(S).$$

Labor income is

$$y(E,z) = (1-\tau)\,wz, \qquad y(U,z) = \rho_b\, wz \text{ while benefits last}, \qquad y(U,z) = \underline{\rho}_b\, wz \text{ afterwards},$$

where τ is a proportional tax, ρ_b and $\underline{\rho}_b < \rho_b$ are the replacement rates of unemployment insurance while benefits last and afterwards, and z is residual productivity, which follows a finite Markov chain Π_z independent of employment and of Ω. In each quarter of continued unemployment a household that still receives benefits loses them with probability p_x; a new job restores the entitlement, and whether benefits have run out is part of the household's state. Section 4.3 reports other benefit rules, among them benefits that last as long as the spell. The tax does not balance the benefit outlays within the model.

Households die with probability π_d at the end of each period and are replaced by newborn renters, employed, with zero assets, clean credit and productivity drawn from the stationary distribution of Π_z. A dying owner's house goes to the specialist of Section 2.4 at the value $Q(h)$; the lender recovers $\min\{M, Q(h)\}$ on the balance M and the remainder is lost. Death and replacement are the main source of turnover from owning to renting in the baseline, in which few owners sell (Section 4.1), and supply the inflow of renters, as in Hedlund (2016).

2.2 Households

Households differ permanently in their taste for owning. A household's type k is drawn at birth from a finite set with shares π_k and never changes; it enters preferences only through an owner premium $\omega_O(k) \geq 0$.

The premium breaks a knife-edge in the tenure margin: with fixed prices and a rental menu that includes the owner-occupied house sizes, every household of a given productivity would otherwise make the same tenure choice.

Preferences over consumption c, housing services h^{serv} and tenure are

$$E_0 \sum_{t\geq 0} \tilde{\beta}^t \Big[\log c_t + \omega_h \log h_t^{serv} + \omega_O(k)\, \mathbf{1}\{\text{owner}_t\} \Big], \qquad \tilde{\beta} \equiv \beta(1-\pi_d),$$

where h^{serv} is the house size h for an owner and the rented unit h_R for a renter, and ω_h weights housing. I write $u(c,h_R) = \log c + \omega_h \log h_R$ for a renter and $u_O(c,h,k) = \log c + \omega_h \log h + \omega_O(k)$ for an owner. Consumption below a small floor $\underline{c}$ is infeasible; liquid assets satisfy $a' \geq 0$ and face no other borrowing constraint.

A homeowner is described by the state $x^O = (a,h,M,r,z,e,f,k)$: liquid savings a, house size $h \in \mathscr{H}$, mortgage payoff M, contract rate r on the outstanding mortgage, productivity z, employment e, credit status $f \in \{0,1\}$ ($f=1$ after a default, until the flag is removed with probability ρ_f per period) and type k. A renter is described by $x^R = (a,z,e,f,k)$. Every value and policy function also depends on the aggregate state Ω.

2.3 Mortgage contract, refinancing and eligibility

A mortgage is a long-term fixed-rate contract characterized by its payoff M, the amount that extinguishes the loan today, and its contract rate r. An owner who keeps the mortgage chooses a payment ℓ, and the balance evolves as

$$M' = (M-\ell)(1+r), \qquad \ell_{\min}(M,r) \equiv M - \frac{(1-\alpha)M}{1+r} \;\leq\; \ell \;\leq\; M.$$

The lower bound is the scheduled payment under geometric amortization: the balance falls by at least the fraction α each quarter. The upper bound is full prepayment; a payment in between is a partial prepayment. Refinancing replaces the contract: the owner repays M, pays a fixed closing cost κ_F, and originates a new loan M' at the current origination rate $\bar{r}$, receiving the proceeds $q(\bar{r})M'$, where

$$q(\bar{r}) = \frac{1}{(1+\bar{r})(1+\zeta)}$$

and ζ is a proportional origination cost. The price q is uniform across borrowers, as for a loan carrying a government guarantee: it does not depend on the borrower's assets, income, employment or loan-to-value, the pricing that Hurst et al. (2016) document for conforming loans, whose rates do not vary with regional default risk. A default therefore imposes a loss on a guarantor rather than a price on the borrower; Section 2.5 defines that loss. A refinancing with proceeds $q(\bar{r})M' \leq M + \kappa_F$ is rate-and-term; one with larger proceeds is cash-out, and $q(\bar{r})M' - M - \kappa_F$ is the cash extracted. A cash-out refinancing costs an additional $\kappa_C \geq 0$, which stands in for the price adjustments and the rate premium that the agencies apply to loans that extract equity. An owner may also repay the loan in full without originating a new one, at no closing cost.

A new loan $M' > 0$, whether originated by a refinancing owner or by a buyer, is feasible only if four conditions hold:

(i) Employment verification: $e = E$. Under the streamline variant of Section 4.4, an unemployed owner may instead originate a rate-and-term loan, $q(\bar{r})M' \leq M + \kappa_F$.

(ii) Payment-to-income: the scheduled payment on the new loan does not exceed a fraction θ_{PTI} of current income, $\ell_{\min}(M', \bar{r}) \leq \theta_{PTI}\, y(e,z)$. When the employment requirement is removed in Section 4.4, this condition is evaluated at benefit income; under the streamline variant it is not applied.

(iii) Loan-to-value: the proceeds do not exceed a fraction of the house value, $q(\bar{r})M' \leq \overline{LTV}_R\, p_H h$ for a refinancing and $q(\bar{r})M' \leq \overline{LTV}_P\, p_H h$ for a purchase.

(iv) Credit: $f = 0$.

Condition (i) is the employment-verification rule documented by DeFusco and Mondragon (2020) and is the object of the paper. Conditions (ii) and (iv) are institutional detail; the payment-to-income cap seldom binds and changing it changes no result (Section 4.7). Condition (iii) produces the equity gradient of Section 4.2. I write $\mathscr{E}(M', h, z, e, f; \Omega) \in \{0,1\}$ for the indicator that a new loan M' satisfies (i) to (iv), with the purchase cap in place of the refinancing cap for a buyer.

Each period an owner receives the opportunity to originate a new loan with probability λ, independently across households and over time; without it she can only keep paying, default or sell. A buyer needs no draw, pays no cash-out cost and may borrow up to the purchase cap. The Calvo-type friction stands in for the inattention and the fixed hassle costs that spread refinancing over several quarters after a rate cut (Andersen et al. 2020; Zhang 2024).

2.4 Housing market and the specialist

Houses are traded through directed search with free entry of intermediaries, as in Garriga and Hedlund (2020) and Hedlund (2016). A seller of a house of size h posts a discount $d \geq 0$ below the reference price, a posted price of $p_H h(1-d)$, and enters that submarket. Intermediaries enter each submarket at a cost κ_s per unit of housing until the expected spread equals the entry cost. With market tightness Θ (intermediaries per seller), the seller meets an intermediary with probability $\eta(\Theta) = \Theta/(1+\Theta)$ and an intermediary meets a seller with probability $1/(1+\Theta)$. Free entry requires

$$\kappa_s h = \frac{p_H h d}{1+\Theta_s(d)} \quad \Longrightarrow \quad \Theta_s(d) = \max\left\{\frac{p_H d}{\kappa_s} - 1, 0\right\}, \qquad \eta_s(d) = \frac{\Theta_s(d)}{1+\Theta_s(d)} = \max\left\{1 - \frac{\kappa_s}{p_H d}, 0\right\}.$$

A discount smaller than κ_s/p_H finds no intermediary; a larger discount sells faster. At the calibrated entry cost discounts of five, ten and thirty percent sell within the quarter with probabilities 0.14, 0.57 and 0.86. Buyers face the mirror-image problem: a buyer posts a premium d above the reference price, pays $p_H h(1+d)$ if matched, and is matched with probability $\eta_b(d) = \max\{1 - \kappa_b/(p_H d), 0\}$, where κ_b is the entry cost on the buying side. Intermediaries hold no inventory; their spreads are a resource cost. A seller who lists and fails to sell pays a utility cost ξ for the period.

Houses that enter the market through a default or a death are bought by a competitive specialist, who resells them through the same search market from the following period on. The specialist's value of a house at the start of the market, $A(h)$, and its willingness to pay for a house arriving after today's market, $Q(h)$, solve

$$A(h) = \max_{d} \left\{ \eta_s(d)\,(1-\chi_R)\,p_H h(1-d) + \big(1-\eta_s(d)\big)\,Q(h) \right\}, \qquad Q(h) = d_L A(h),$$

where χ_R is a proportional disposal cost on the specialist's sales and $d_L = 1/(1+i_L)$ is the discount factor of the financial sector. In the calibration the specialist posts a 7.5 percent discount, sells with probability 0.43 per quarter, and pays $Q(h) = 0.82\,p_H h$: the liquidation discount on a distressed house is 18 percent of the reference price. On a default the lender recovers $\min\{M, Q(h)\}$ and the household receives the surplus $\max\{Q(h) - M, 0\}$.

2.5 Lender and guarantor

Lenders are competitive and discount at d_L. The value to the lender of an existing loan on an owner in state x^O with $f = 0$, before the current period's housing market, is

$$\begin{aligned} J(x^O, \Omega) = \eta_s^* M + \big(1-\eta_s^*\big) \Big[& \mathbf{1}_{\mathscr{F}} M + \mathbf{1}_{\mathscr{D}} \min\{M, Q(h)\} \\ & + \mathbf{1}_{\mathscr{K}} \Big(\ell + d_L \big[(1-\pi_d)\, E\, J(x^{O\prime}, \Omega') + \pi_d \min\{M', Q(h)\} \big] \Big) \Big], \end{aligned}$$

where η_s^* is the probability that the owner's chosen listing sells, $\mathbf{1}_{\mathscr{F}}$, $\mathbf{1}_{\mathscr{D}}$ and $\mathbf{1}_{\mathscr{K}}$ indicate the owner's choice among refinancing (which repays M), default and keeping, ℓ and M' are the chosen payment and next balance, and the expectation is over the owner's next state under her policies and the transition of Ω.

With uniform pricing the originator receives $(1+\zeta) q(\bar{r}) M'$ for a new loan, so the guarantor's expected loss on a loan of M' to a household entering next period in post-decision state $x^{O\prime}$ is

$$L(M', x^{O\prime}, \Omega) = (1+\zeta)\, q(\bar{r}) M' - d_L \Big[(1-\pi_d)\, E\, J(x^{O\prime}, \Omega') + \pi_d \min\{M', Q(h)\} \Big].$$

I report the expected loss summed over the period's originations as the guarantor's cost of a policy. With competitive pricing, which I do not use, q would instead be the borrower-specific price that sets $L = 0$, as in Garriga and Hedlund (2020).

2.6 Timing and recursive problems

A period has four stages. First, the aggregate state Ω, productivity z, employment e and the credit flag f are realized from the previous period's transitions, income $y(e,z)$ is received, and each owner learns whether she has a refinancing opportunity. Second, the housing market opens: owners decide whether to list and at what discount, renters whether to attempt a purchase and at what premium, and matches are realized. Third, financing and consumption: a successful seller repays the mortgage and rents for the period; an owner who did not list or did not sell keeps, refinances or defaults; a successful buyer originates

a mortgage; a renter chooses a rental unit; everyone chooses consumption and savings. Fourth, households die with probability π_d and are replaced, survivors draw z', e' and f', and the aggregate state moves to Ω'. A successful seller may buy again from the next period on; a successful buyer cannot sell or default in the period of purchase; a defaulted house reaches the specialist after the period's market.

Renting stage. A household with cash on hand Y that rents for the period solves

$$\mathscr{R}(Y,z,e,f,k;\Omega) = \max_{a'\geq 0,\, h_R\in\mathscr{H}_R} u(c,h_R) + \mathscr{C}^R(a',z,e,f,k;\Omega), \qquad c = Y - \rho\, h_R - \frac{a'}{1+i},$$

where $\mathscr{C}^R$ is the renter's continuation value, defined below.

New-loan stage. A household with cash on hand Y that will own a house of size h, as a buyer or a refinancer, solves

$$\mathscr{N}(Y,h,z,e,f,k;\Omega) = \max_{a'\geq 0,\, M'\geq 0} u_O(c,h,k) + \mathscr{C}^O(a',h,M',\bar{r},z,e,f,k;\Omega),$$

$$c = Y - \kappa_m p_H h + q(\bar{r})M' - \frac{a'}{1+i},$$

subject to $\mathscr{E}(M',h,z,e,f;\Omega) = 1$ whenever $M' > 0$, where $\kappa_m p_H h$ is maintenance.

Owner's choices without a sale. An owner who has not sold chooses among keeping, refinancing and defaulting. Keeping is

$$\mathscr{K}(x^O;\Omega) = \max_{a'\geq 0,\, \ell_{\min}(M,r)\leq \ell\leq M} u_O(c,h,k) + \mathscr{C}^O(a',h,M',r,z,e,f,k;\Omega),$$

$$c = a + y(e,z) - \kappa_m p_H h - \ell - \frac{a'}{1+i},$$

with $M' = (M-\ell)(1+r)$. Refinancing repays the old loan and enters the new-loan stage,

$$\mathscr{F}(x^O;\Omega) = \mathscr{N}\big(a + y(e,z) - M - \kappa_F\, \mathbf{1}\{M'>0\} - \kappa_C\, \mathbf{1}\{q(\bar{r})M' > M + \kappa_F\},\, h,z,e,f,k;\Omega\big),$$

and equals $-\infty$ when the household has no refinancing opportunity; within $\mathscr{N}$ the eligibility indicator removes the ineligible. Default is available to an owner with $M>0$ and $f=0$: the house goes to the specialist, the household receives the surplus, rents for the period and enters credit exclusion,

$$\mathscr{D}(x^O;\Omega) = \mathscr{R}\big(a + y(e,z) + \max\{Q(h) - M, 0\},\, z,e,1,k;\Omega\big).$$

The value of an owner who has not sold is $\mathscr{W}(x^O;\Omega) = \max\{\mathscr{K},\mathscr{F},\mathscr{D}\}$.

Owner's listing decision. A sale at discount d yields $p_H h(1-d)$, repays M, and leaves the household renting for the period; a failed listing costs ξ and leaves the owner with $\mathscr{W}$:

$$V^O(x^O;\Omega) = \max\Big\{\mathscr{W}(x^O;\Omega),\ \max_{d\geq 0}\Big[\eta_s(d)\,\mathscr{R}\big(a+y(e,z)+p_H h(1-d)-M,\,z,e,f,k;\Omega\big) + \big(1-\eta_s(d)\big)\big(\mathscr{W}(x^O;\Omega)-\xi\big)\Big]\Big\}.$$

A seller must cover the balance out of the proceeds and cash on hand; an underwater owner who cannot does not list. V^O is the value with a refinancing opportunity and V_0^O the value without one, the same problem with $\mathscr{F}=-\infty$; the value before the draw, $\bar{V}^O=\lambda V^O+(1-\lambda)V_0^O$, is what enters continuation values.

Renter's purchase decision. A renter who attempts a purchase of size h at premium d pays $p_H h(1+d)$ and enters the new-loan stage if matched, and rents if not:

$$V^R(x^R;\Omega) = \max\Big\{\mathscr{R}\big(Y,z,e,f,k;\Omega\big),\ \max_{h\in\mathscr{H},\,d\geq 0}\Big[\eta_b(d)\,\mathscr{N}\big(Y-p_H h(1+d),\,h,z,e,f,k;\Omega\big) + \big(1-\eta_b(d)\big)\,\mathscr{R}\big(Y,z,e,f,k;\Omega\big)\Big]\Big\},\qquad Y=a+y(e,z).$$

A purchase requires the down payment out of cash on hand and, if there is a loan, eligibility with the purchase cap.

Continuation values. The continuation value of entering next period as an owner with post-decision state (a',h,M',r) is

$$\mathscr{C}^O(a',h,M',r,z,e,f,k;\Omega) = \tilde{\beta}\sum_{\Omega'}\Pi_\Omega(\Omega'\mid\Omega)\sum_{z'}\Pi_z(z'\mid z)\sum_{e'}\Pr(e'\mid e,S)\sum_{f'}\Pr(f'\mid f) \times \bar{V}^O(a',h,M',r,z',e',f',k;\Omega'),$$

with $\Pr(f'=0\mid f=1)=\rho_f$ and $\Pr(f'=0\mid f=0)=1$; $\mathscr{C}^R$ is the same object with V^R in place of $\bar{V}^O$. The employment transition uses the rates of the current state S, so a worse labor market bites in the period in which it is realized. Dying households are removed, hence the discount $\tilde{\beta}$.

2.7 Equilibrium, impulse responses and cohorts

Equilibrium. Given the fixed prices (p_H,ρ,w,i), the contract parameters, the matching technology and the aggregate chain Π_Ω, a recursive partial equilibrium consists of (i) value functions V^O, V_0^O, V^R and the associated policy functions for every aggregate state Ω; (ii) the specialist's values $A(h)$ and $Q(h)$; (iii) the lender's value J; and (iv) a law of motion for the distribution μ_t of households over individual states, such that households optimize given Q, J and Π_Ω, the specialist's values satisfy its Bellman equation, the lender's value is consistent with household policies, and the distribution evolves according to the policies, the exogenous transitions, death and replacement. Because every price is fixed, the aggregate state is

an exogenous Markov chain: households forecast it with Π_Ω and no forecasting rule for endogenous aggregates is needed.

Let T_Ω denote the transition operator on individual states induced by the policies at Ω together with the exogenous transitions of (z, e, f) and survival, and let N denote the inflow of newborns, which places mass π_d on the newborn state in proportion to the type shares. The distribution evolves as $\mu_{t+1}(\cdot \mid \Omega_t) = (T_{\Omega_t} + N)^\top \mu_t$. The ergodic joint distribution $\mu(x, \Omega)$ of households and aggregate states satisfies

$$\mu(\cdot, \Omega') = \sum_{\Omega} \Pi_\Omega(\Omega' \mid \Omega)\,(T_\Omega + N)^\top \mu(\cdot, \Omega),$$

and the steady-state moments of Section 4.1 are computed under it. The conditional distributions $\mu(\cdot \mid \Omega)$ differ across aggregate states because households have lived through different histories.

Generalized impulse responses. The response to a rate cut is a generalized impulse response conditional on the labor-market state. Fix a starting rate $\bar{r}_{hi}$, the next lower grid point $\bar{r}_{lo}$ and a labor-market state S. Start from the ergodic distribution of households conditional on $\Omega_{t-1} = (S, \bar{r}_{hi})$, advance it one period under the policies of Ω_{t-1} to obtain the beginning-of-t distribution μ_t, and compare two paths: at t the aggregate state is $(S, \bar{r}_{lo})$ on the shocked path and $(S, \bar{r}_{hi})$ on the baseline path. From t on both paths evolve under the chain, propagated by $(T_\Omega + N)^\top$ and averaged over the future aggregate states Ω_{t+j}. The response of a variable X at horizon j is

$$\mathrm{IRF}_j^X(S) = E\left[X_{t+j} \mid \Omega_t = (S, \bar{r}_{lo}),\, \mu_t\right] - E\left[X_{t+j} \mid \Omega_t = (S, \bar{r}_{hi}),\, \mu_t\right].$$

The cut is a realization of the chain, not a surprise permanent change, so expectations are consistent with the model; the distributions are propagated exactly, so the responses contain no simulation noise. Consumption responses are in percent of consumption in the quarter before the cut in the tight state, the same denominator for both labor-market states, so that *slack weaker by ten percent* means that the twelve-quarter sum of the slack response is 90 percent of the tight sum.

Decomposition. I decompose the difference between the slack and tight responses by crossing the two ingredients that differ: the conditioning distribution μ_t, which reflects the labor-market state before the cut, and the policies and transitions from t on, which reflect the state during and after it. The composition effect is the response with the slack-state distribution and tight-state policies, minus the tight response; it measures how many households are in a position to respond. The behavioral effect is the response with the tight-state distribution and slack-state policies, minus the tight response; it measures how the same households respond differently. The interaction is the remainder. The decomposition is in levels; the ordering is not unique, and when the interaction is large relative to either term I report the three terms rather than attribute shares.

Fixed cohorts. A fixed cohort is the set of households in a given state in the quarter of the cut, for example the unemployed homeowners at t. A mortgagor is in the money at a cut if the contract rate on

the loan is above the new origination rate. I follow the same households afterward, whatever their later state, under the survival-only operator $T_{\Omega}^{\top}$ without newborns, and compute per-capita consumption of the survivors on the shocked and baseline paths. When a member is re-employed and refinances, the gain is credited to the cohort she belonged to at the time of the cut. This distinguishes *the unemployed gain later* from *the unemployed become employed*: a group defined by its current state each period would show the latter, a cohort the former. I report cohort responses in percent of the cohort's own pre-cut consumption.

Appendix A describes the discretization and the solution method.

3 Calibration

One calibration serves the whole paper. It is data-anchored rather than estimated: the labor-market, mortgage-rate, income, refinancing-cost, contract and demographic parameters each come from a published series or study, and the two taste-type parameters are set to match homeownership and the rate at which renters buy. There are no standard errors. Table 1 lists the parameters. The housing-transaction frictions and the house-size menu are not pinned down by a single series; the end of this section compares what they imply with outside evidence, and Section 4.7 varies them.

The slack state is the labor market of 2009 to 2012, the episode the evidence of Section 5 comes from: an unemployed worker finds a job with probability 0.44 per quarter, against 0.62 in the tight state. The unemployment rate is 5.6 percent in the tight state and 9.0 in the slack state. The frequency and persistence of the slack state are those of all quarters with unemployment at or above 6 percent (Table 1), so the model spends a third of the time in a labor market as weak as that of 2009 to 2012; Section 4.7 reports an alternative that also takes the flows from all such quarters. Homeownership is 66 percent against a target of 65, and renters buy at 1.7 percent per quarter against about 1 percent in the data, with a gradient of ownership by income (36, 75, 79 percent across the three productivity states); 42 percent of owners hold the large house, and the average house is worth 3.4 years of average earnings, against a ratio of median price to median income of about 4.4 in the data.

No parameter was fitted to refinancing rates, but the level of cash-out refinancing is not an independent check: the additional cost of a cash-out refinance, set from the agencies' price adjustments, was introduced after a version without it refinanced at 2.1 percent per quarter (Section 4.7). Mortgagors refinance at 1.3 percent per quarter, of which 1.2 points extract equity. In the Freddie Mac sample of Section 5 the quarterly refinancing rate is 2.5 to 3.7 percent and 41 percent of refinances extract equity, 1.0 to 1.5 percent per quarter. Cash-out refinancing is inside the range of the loan data, and rate-and-term refinancing is too rare, 0.15 percent per quarter: on a three-state rate grid most loans already carry the lowest rate soon after rates fall, so few are in the money. Refinancing is concentrated in the low-rate state (3.7 percent per quarter) and nearly absent in the high-rate state (0.0 percent). Section 4.6 uses a finer rate grid.

The return on liquid savings is the rate on 3-month Treasury bills over the sample of the rate grid less the same 2.5 percent of inflation, -0.14 percent per quarter; it is below every origination rate, as the return on deposits is. Liquid wealth is not a target, and the survey of Section 5 gives a check on it. In the model 78 percent of mortgagors, and 85 percent of unemployed ones, hold liquid assets worth less than a quarter

Table 1: Parameters (quarterly).

Block	Parameter	Value	Source / target
Labor market	Job-finding ϕ(S), S = tight, slack (quarterly)	0.62, 0.44	CPS gross flows; tight: quarters with unemployment below 6%, 1990–2026; slack: 2009–2012
	Separation δ(S)	0.035, 0.048	CPS gross flows, same periods
	Π_S: persistence of tight, slack	0.96, 0.92	Quarters with unemployment at or above 6%: share 32%, mean spell 12 quarters
Mortgage rate	Real origination-rate grid, quarterly	0.29%, 0.70%, 1.08%	Freddie Mac PMMS 2000–2026 terciles, less 2.5% inflation
	$\Pi_{\bar{r}}$: persistence of low, middle, high	0.92, 0.78, 0.86	PMMS quarterly transitions
Refinancing	Opportunity probability λ	0.164	Zhang (2024): mean probability of being able to refinance
	Closing cost κ_F (quarterly wages)	0.12	$\approx$ \$2,400; LodeStar 2024, CoreLogic 2021
	Additional cost of a cash-out refinance κ_C (quarterly wages)	0.30	Agency price adjustments of 1.5 to 2.5 points on cash-out loans plus a rate premium of 0.125 to 0.25 points
	Origination cost ζ	0.01	Not disciplined by data
	Payment-to-income cap θ_{PTI}	0.36	Conventional limit of 36 percent on debt payments relative to income, applied here to the mortgage payment
	LTV caps, refinancing LTV_R / purchase LTV_P	0.80 / 0.95	Conventional limit; low-down-payment purchase loans
	Amortization α (quarterly)	0.0085	30-year schedule: balance halves after 20 years
	Credit recovery ρ_f	0.05	Five years of exclusion after a default
	Return on liquid savings i (quarterly)	-0.14%	3-month Treasury bill 2000–2026, less 2.5% inflation
	Lender's discount rate i_L (quarterly)	0.7%	Not disciplined by data
Income	UI replacement ρ_b; tax τ	0.40; 0.10	DOL 1997–2018 average; not disciplined by data
	Probability per quarter that benefits run out; replacement rate afterwards	0.13; 0.27	99 weeks of benefits, 2009–2012; Rothstein and Valletta (2017)
	Residual productivity z; quarterly persistence; innovation s.d.	{0.44, 0.89, 1.78}; 0.992; 0.061	Rouwenhorst discretization of a persistent PSID-type earnings process
Housing	Reference price p_H per unit; rent per unit	3.5; 0.044 per quarter	Rent-price ratio 5% per year
	House sizes (owner); rental units	{3, 5}; {1.5, 3, 5}	See text
	Entry costs κ_s, κ_b; maintenance κ_m; listing cost ξ; disposal cost χ_R	0.15, 0.15; 0.005; 0.02; 0.10	See text; liquidation discount 18%
Preferences	β, ω_h	0.99, 0.30	Standard; for β see text
	Taste types: share never owning; premium ω_O of the others	15%; 0.15	Homeownership 65%; renters' purchase rate $\approx$ 1% per quarter
Demographics	Death / replacement π_d	0.00625	40-year horizon

of their annual earnings. In the 2007 wave of the survey the shares are 80 percent of the mortgagor families that had no unemployment spell in the following two years and 87 percent of those that had one, counting transaction accounts against normal income. With a return of 0.4 percent per quarter the first share is 64 percent.

The discount factor, 0.99 per quarter, is a conventional value and was not fitted. One moment bears on it. With a discount factor of 0.985, 90 percent of mortgagors hold liquid assets below a quarter of their earnings, and with 0.995, 73 percent, against 78 in the baseline and 80 in the survey. This is three points and no standard error, and the same moment moves as much with the return on liquid savings (64 percent at the earlier return), so it disciplines the two parameters together and not the discount factor alone.

Homeownership does not arbitrate: it is 59 and 71 percent at the other two values, but the taste parameters were set to match it at 0.99 and would be set again at another value. With 0.995 mortgagors refinance at 0.9 percent per quarter, further below the loan data. The parameter matters for levels: the aggregate impact response is 2.9, 4.8 and -0.2 percent at the three values, a pattern that is not monotone, while the unemployed cohort responds less on impact than the employed cohort at each of them.

Three parameter blocks have no single source. The first is the housing market. With entry costs of 0.15, a seller who gives up 7.5 percent of the price sells within the quarter with probability 0.43, and one who gives up 10 percent with probability 0.57. Brokerage commissions of 5 to 6 percent (Hsieh and Moretti, 2003) plus closing costs and a modest concession put the usual cost of a sale in that range, so a seller who pays the usual cost waits a median of 11 to 16 weeks. Measures of time on the market put the calibrated market at about the illiquidity of 2011 for all listings and of 2009 for traditional sellers (Appendix E). Maintenance costs 2 percent of the house's value a year (Sections 4.3 and 4.7). A house that passes to the liquidation specialist is worth 18 percent less than its reference price, against the foreclosure discount of 27 percent in Campbell, Giglio and Pathak (2011).

Whether the housing market of 2007 to 2012 was this illiquid matters for the main result (Section 4.3); Section 5.3 bounds the entry costs with the exits from homeownership in two household panels.

The second block is the house-size menu, two sizes for owners and three rental units, chosen so that the small house costs 2.6 years of the average wage and the large one 4.4. The third is the benefit rule. Benefits run out. Rothstein and Valletta (2017) find that a household loses about a third of its income when unemployment benefits run out, which a replacement rate of 0.27 afterwards reproduces for a single earner with a replacement rate of 0.40 before. In 2009 to 2012, the years of the slack state and of the evidence in Section 5, benefits lasted up to 99 weeks, a probability of 0.13 per quarter of continued unemployment that they run out, and I use that rule in both labor-market states. Regular benefits last 26 weeks, 0.5 per quarter; Section 4.3 reports that rule and benefits that last as long as the spell, which earlier versions of this paper took as the baseline, and why the choice matters.

4 Results

4.1 Who the unemployed homeowners are

The households that eligibility rules exclude are the ones with the most to gain from a rate cut. Unemployed homeowners are 4.4 percent of households; 91 percent of them hold less than a quarter's average wage in liquid assets and 87 percent have at least 20 percent equity in the house, yet none of them can refinance (Table 2).

Unemployed homeowners are the wealthy hand-to-mouth of the model: they have home equity but little liquid wealth, the eligibility rules prevent them from borrowing against the equity, and few of them sell, 1.0 percent per quarter, at the calibrated frictions. Two further features of the steady state matter below. Default is rare (0.013 percent of mortgagors per quarter), even though benefits run out. And most refinancing extracts equity (1.2 of the 1.3 percent quarterly rate).

Table 2: Steady state of the baseline economy (ergodic distribution). Liquid assets of unemployed homeowners are measured here against one quarter of the average wage; the comparison with the survey in Section 3 measures them against the household's own earnings.

Statistic	Value
Unemployment rate (all / tight / slack)	6.7% / 5.6% / 9.0%
Homeownership (within the owning type)	66% (78%)
Unemployed homeowners, share of households	4.4%
... of whom with liquid assets below one quarter of the average wage / zero	91% / 18%
... of whom with a mortgage / with loan-to-value ≥ 0.6 / ≥ 0.8	100% / 63% / 13%
Consumption per capita: employed owners / unemployed owners / unemployed renters	0.83 / 0.48 / 0.35
Refinancing rate of unemployed mortgagors	0 (employment verification)
Refinancing rate of mortgagors, total / cash-out	1.3% / 1.2% per quarter
Default rate of mortgagors per quarter; credit-excluded share	0.013%; 0.15%
Owners' quarterly listing rate / sale rate (highest across aggregate states)	1.64% / 0.49%
Unemployed owners' quarterly listing rate / sale rate	3.53% / 1.04%

4.2 Who responds to a cut, and when

A rate cut reaches the consumption of employed homeowners in the quarter it happens and that of unemployed homeowners one to two quarters later, after re-employment makes them eligible. This section first looks household by household, in the baseline and in other housing markets, labor markets and benefit rules, and then at the cohort averages, which the rest of the paper uses and which hide most of what households do. The cut is a one-step fall of the origination rate from the middle to the low state (0.70 to 0.29 percent per quarter, about 1.6 percentage points at annual rates; Section 4.6 considers smaller cuts and a cut to a new low). Cohorts are fixed by their state in the quarter of the cut; cumulative responses sum that quarter and the twelve that follow.

Few households move in the quarter of the cut, and the delay shows in the schedule of refinancing. In the baseline 5 percent of unemployed homeowners raise consumption by more than 1 percent in that quarter, against 27 percent of employed homeowners. No unemployed owner refinances in the quarter of the cut; 5, 11, 21 and 33 percent of the cohort have refinanced at least once by the end of quarters 1, 2, 4 and 8, against 8 percent of the employed cohort in the quarter of the cut and 14, 19, 27 and 36 percent afterwards. The delay is in this schedule: the unemployed cohort is one to two quarters behind in the first year and has nearly caught up after two, when about two thirds of either cohort have not refinanced.

Table 3 looks inside the cohorts, household by household, in the baseline and in 17 other economies. These vary the entry costs from 0.05 to 0.15, the labor market at the cut, tight or slack, and the benefit rule: 99 weeks as in the baseline, 26 weeks, or without end. A household responds if its consumption in the quarter of the cut is more than 1 percent above its consumption on the path without the cut. Consumption and assets are on grids, so nearly all other households do not change consumption at all, and about 1 percent lower it. Most households of either cohort do not respond in the quarter of the cut, and the unemployed

are much less likely to. With entry costs of 0.075 or more the ratio of the two shares is between 0.09 and 0.61; with entry costs of 0.05 it is 0.79 to 0.83, so where houses sell fast the two cohorts are almost equally likely to respond.

The threshold matters little, because nearly every household that responds does so by far more than 1 percent. At thresholds of 5 and 10 percent in place of 1, the ratio of the two shares across the economies with entry costs of 0.075 or more is 0.09 to 0.62 and 0.05 to 0.67. A large part of the gap is the rule: with the employment requirement removed, 13.0 percent of the same unemployed cohort respond in the quarter of the cut and 8.4 percent refinance, against 5.1 percent and none with it, and 30.9 percent of the employed cohort; the ratio of the two shares rises from 0.19 to 0.42. The rest of the gap reflects who the unemployed are.

The unemployed who respond are mostly those who sell: leaving sellers aside, between 0.6 and 8.5 percent of unemployed owners respond when entry costs are 0.075 or more, against 16 to 29 percent of employed owners. An unemployed owner who does not sell rarely responds. The delay also shows without any threshold, in the schedule of refinancing. By the end of the second quarter 7 to 12 percent of the unemployed cohort have refinanced, against 18 to 20 percent of the employed cohort; by the end of the eighth the shares are 22 to 35 against 34 to 37 percent. The unemployed cohort's schedule is slower where more of it sells first.

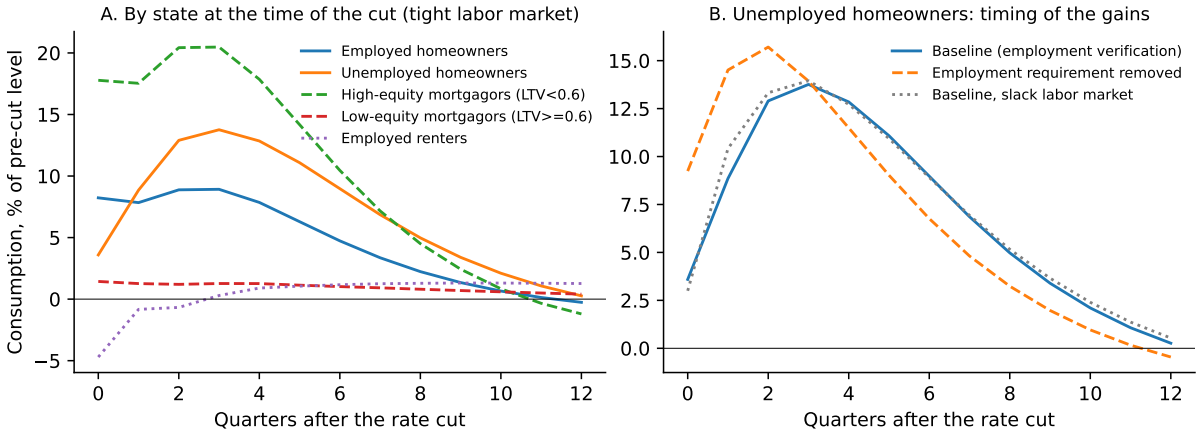


Figure 1: Consumption responses of fixed cohorts to a one-step cut in the origination rate, in percent of each cohort's pre-cut consumption. Panel A: cohorts defined by their state in the quarter of the cut, tight labor market. Panel B: the cohort of unemployed homeowners in the baseline, with the employment requirement removed, and in a slack labor market.

Employed homeowners respond on impact (+8.2 percent) and their response stays near that level for a year (+8.9 percent two quarters later). Unemployed homeowners respond by +3.6 percent on impact, 44 percent of the employed response, then by +8.9 and +12.9 percent in the following two quarters, when re-employment makes them eligible and they refinance from a low consumption level. Their cumulative gain over twelve quarters is +91 percentage points of their own pre-cut consumption, against +60 for the employed cohort. The unemployed cohort consumes about 60 percent of what the employed cohort does before the cut, so in goods its gain is 88 percent of the employed cohort's: most of the gain arrives,

Table 3: Who responds in the quarter of the cut. One-step cut at unchanged prices. Respond: the household's consumption is more than 1 percent above its consumption on the path without the cut. Sellers' share: the part of the unemployed cohort's mean response that comes from households that sell in the quarter. Refinanced: share of the unemployed cohort that has refinanced at least once by the end of the quarter; for the employed cohort the shares are 17 to 20 and 30 to 37 percent across all rows. Benefits of 99 weeks (the baseline) and of 26 weeks are followed by a replacement rate of 0.27.

Entry costs	Benefits	Labor market at the cut	Impact, unemployed / employed (%)	Ratio	Respond, unemployed / employed (%)	Unemployed who sell, with / without the cut (%)	Sellers' share of the mean (%)	Unemployed refinanced by q2 / q8 (%)
0.15	99 weeks	tight	+3.6 / +8.2	0.44	5.1 / 27.4	1.6 / 0.6	38	11 / 33
0.15	99 weeks	slack	+3.0 / +5.9	0.51	2.5 / 16.9	3.2 / 1.3	98	8 / 29
0.125	99 weeks	tight	+4.7 / +8.6	0.55	6.6 / 28.2	2.5 / 0.8	50	11 / 32
0.125	99 weeks	slack	+4.8 / +6.1	0.78	4.8 / 17.3	4.9 / 1.7	96	8 / 28
0.1	99 weeks	tight	+7.1 / +8.7	0.81	9.6 / 28.0	4.5 / 1.0	70	11 / 30
0.1	99 weeks	slack	+9.6 / +6.2	1.53	10.1 / 19.9	8.9 / 2.0	96	7 / 24
0.075	99 weeks	tight	+11.4 / +8.5	1.35	15.4 / 28.4	8.2 / 1.4	79	9 / 27
0.075	99 weeks	slack	+12.9 / +6.7	1.93	13.9 / 22.7	11.7 / 2.7	94	7 / 22
0.05	99 weeks	tight	+19.1 / +9.4	2.03	26.9 / 32.6	15.3 / 2.5	80	8 / 21
0.05	99 weeks	slack	+18.8 / +7.8	2.40	22.0 / 28.0	18.9 / 5.2	91	5 / 16
0.15	without end	tight	+1.1 / +8.0	0.13	3.9 / 27.5	0.6 / 0.3	23	12 / 35
0.15	without end	slack	+0.7 / +5.7	0.13	1.6 / 17.0	0.9 / 0.4	74	9 / 32
0.125	without end	tight	+1.6 / +8.4	0.19	4.9 / 28.1	0.9 / 0.4	34	12 / 35
0.125	without end	slack	+3.3 / +6.3	0.53	3.6 / 17.5	2.9 / 0.5	95	9 / 30
0.1	without end	tight	+4.0 / +8.7	0.46	7.9 / 29.0	2.9 / 0.4	74	11 / 33
0.1	without end	slack	+7.3 / +6.4	1.13	7.0 / 19.0	5.5 / 0.5	96	8 / 28
0.15	26 weeks	tight	+4.0 / +8.1	0.49	4.9 / 26.3	3.1 / 0.9	80	11 / 31
0.15	26 weeks	slack	+5.9 / +5.7	1.03	5.8 / 16.0	6.0 / 2.3	96	8 / 26

Table 4: Per-capita consumption response of fixed cohorts, percent of the cohort's pre-cut level; tight labor market unless noted; one-step cut.

Cohort (state at the time of the cut)	impact (%)	+1q	+2q	+3q	+4q	12q cum. (% pts)	peak
Employed homeowners	+8.2	+7.8	+8.9	+8.9	+7.9	+60	q3
Unemployed homeowners	+3.6	+8.9	+12.9	+13.8	+12.8	+91	q3
Mortgagors with low liquid assets	+7.7	+9.0	+10.2	+10.2	+8.9	+66	q2
Mortgagors with high liquid assets	+10.1	+1.3	+1.8	+2.4	+2.7	+29	q0
Low-equity mortgagors (LTV ≥ 0.6)	+1.4	+1.3	+1.2	+1.3	+1.3	+12	q0
High-equity mortgagors (LTV < 0.6)	+17.8	+17.5	+20.4	+20.5	+17.9	+132	q3
Employed renters	−4.7	−0.8	−0.7	+0.3	+0.9	+4.9	q9
Employed homeowners, slack labor market	+5.9	+7.4	+8.3	+8.2	+7.2	+56	q2
Unemployed homeowners, slack labor market	+3.0	+10.4	+13.3	+14.0	+12.7	+93	q3
Unemployed homeowners, employment requirement removed	+9.2	+14.5	+15.7	+13.9	+11.5	+91	q2

late. The cohort cannot refinance in the quarter of the cut, and its refinancing rate does not move in that quarter; its impact response comes from the few who sell and from lower saving ahead of the credit that re-employment will open. The exclusion mostly shifts the gains in time: removing it leaves the cohort's twelve-quarter gain at +91 points and raises its impact response from +3.6 to +9.2 percent. In a slack labor market the same cohort's impact response is smaller (+3.0 against +3.6 percent) and its path over the next four quarters is close to the tight-market path (+10.4 and +13.3 percent in the first two quarters against +8.9 and +12.9). The peak is in the same quarter. A spell lasts 2.3 quarters on average in a slack market against 1.6 in a tight one, too small a difference to move the peak on a quarterly grid.

Equity determines the size of the gain. High-equity mortgagors gain 11 times as much as low-equity mortgagors over twelve quarters (+132 against +12 points), because cash-out refinancing is capped at 80 percent loan-to-value; this is the equity mechanism of Beraja et al. (2019) operating within a region, and Appendix C lets house prices move it. Liquid assets change the shape of the response: mortgagors with high liquid assets respond on impact (+10.1 percent, against +7.7 for those with low liquid assets) and little afterwards, +29 points over twelve quarters against +66, consistent with households that hold liquid assets having less use for the proceeds of a new loan. Renters reduce consumption on impact (−4.7 percent), consistent with cheaper mortgages raising the return to saving for a down payment.

The timing result has two parts of unequal strength: the first, about households, is that wherever entry costs are 0.075 or more unemployed homeowners are 0.1 to 0.6 times as likely as employed homeowners to respond in the quarter of the cut and refinance one to two quarters behind; the second is the cohort's mean response on impact: where it is high it is the response of the few who sell, while in the baseline sellers account for 38 percent of it and households that run down liquid assets ahead of re-employment for most of the rest (Table 3). The mean rises when entry costs fall, when the cut arrives in a slack labor market (a longer wait for re-employment makes a sale more attractive: the ratio of the means is 0.44 in a tight and 0.51 in a slack market at the baseline entry costs, 1.53 in a slack market at entry costs of 0.10), and when benefits run out sooner. Section 4.3 shows which of these economies the home sales of 2007 to 2009 allow; for a cut like that of 2008, in a slack market, the ratio of the means is about a half at the baseline entry costs and 1.5 at entry costs of 0.10, which the home sales allow only if prices fall, while the

unemployed remain 0.15 to 0.51 times as likely as the employed to respond.

4.3 The delay requires illiquid housing

The unemployed wait for re-employment rather than sell the house because, at the calibrated search frictions and liquidation discount, selling is slower and costlier than waiting. Lower the intermediary entry costs on both sides of the housing market from 0.15 to 0.01, holding everything else fixed, and the same cohort's impact response rises from +3.6 to +39.4 percent and its next-quarter response to +40.2 percent: with liquid housing the unemployed sell, consume part of the equity, and buy again once re-employed and eligible. The employed cohort moves from +8.2 to +11.1 percent on impact and from +60 to +54 points cumulatively.

How illiquid must housing be? With entry costs of 0.10, at which a 7.5 percent concession sells within the quarter with probability 0.62, the unemployed cohort's impact response is +7.1 percent against +8.7 for the employed, with the peak in quarter 2. With entry costs of 0.05, at which the same concession sells with probability 0.81, it is +19.1 against +9.4 percent, with the peak in quarter 1. Unemployed owners then list at 12 percent and sell at 5 percent per quarter in the long run, against 1.0 percent in the baseline. The delay is a property of housing markets about as illiquid as that of 2011, when the median listing took 14 weeks to sell; in a market where houses sell within a month or two the unemployed would sell. If a seller concedes 7.5 percent of the price, entry costs of 0.05 mean a median of about 5 weeks on the market, close to the 4 weeks of traditional sellers in 2004 and 2005. At entry costs of 0.089, 59 percent of the calibrated value, the unemployed cohort's mean response reaches that of the employed cohort. At half the calibrated value, which on the same reckoning is the 6 to 7 weeks typical of traditional sellers before the bust, it exceeds it: +11.4 percent for the unemployed against +8.5 for the employed (Figure 2). The timing result is about rate cuts that arrive in a depressed housing market, as the cut of 2008 did, and should not be expected to hold in a normal one. Section 5.3 uses the exits from homeownership in two household panels to say which market it was.

Lowering one side of the housing market at a time shows what a liquid market does. With the seller's entry costs alone at 0.05 the unemployed cohort's impact response is 77 percent of the employed cohort's; with the buyer's alone, 89 percent; with both, 203 percent; the baseline has 44. Each side moves the cohort mean, the buyer's side at least as much as the seller's, and the pair moves it far more than either alone: what a liquid market offers is a fast sale together with a cheap return to ownership. At low entry costs a sale followed by a purchase replaces a refinance. A cohort mean that reaches the employed response does not mean that the unemployed stop waiting: where the mean is high it is the response of the few who sell, as Table 3 shows.

Benefit rules. In the baseline benefits run out with probability 0.13 per quarter of continued unemployment, the 99 weeks available in 2009 to 2012, and the replacement rate then falls from 0.40 to 0.27 (Section 3). Table 5 reports the baseline by benefit status. Homeowners whose benefits have run out are 9 percent of unemployed homeowners. They list their houses at 22.0 percent per quarter, sell at 7.2 percent and default at 1.56 percent, against 1.6, 0.4 and 0.06 percent for those still receiving benefits. Two other rules bracket the baseline. With benefits that last as long as the spell, the cohort of homeowners unemployed at the cut

responds by +1.1 percent on impact against +8.0 for the employed, 13 percent of it, where the baseline has +3.6 against +8.2, 44 percent. With the 26 weeks of regular benefits it responds by +4.0 against +8.1 percent, 49 percent of it, with the peak in quarter 3. On the check of Section 5.3, families with a spell sell 3.8 points more often than others at unchanged prices in the baseline and 0.7 points more often when prices fall; with 26 weeks of benefits the two numbers are 7.9 and 1.2, against 0.4 (1.0) in the survey. Benefits that run out work through sales, the more so the sooner they run out, and the survey's additional exits are not sales. At unchanged prices the baseline's difference is already above the survey's and the difference with 26 weeks is twice as large; when prices fall both are within its sampling error. In levels, the baseline's sale rates stay below the survey's upper bounds on both paths of prices (6.9 and 3.3 percent of the families with a spell sell within two years, against a bound of 7.2), while with 26 weeks of benefits they do not when prices are unchanged (11.4 percent). The benefit rule and the entry costs compound: with benefits without end the ratios along the entry-cost grid are 13, 19 and 46 percent and with 26 weeks 49, 71 and 113, against 44, 55 and 81 in the baseline (Table 3).

Table 5: Selling and default margins by benefit status in the baseline.

Homeowner group (baseline: benefits run out after 99 weeks, replacement 0.27 afterwards)	**Share of households**	**Listing rate / quarter**	**Sale rate**	**Default rate**	**Consumption per capita**
Employed	61.66%	0.74%	0.18%	0.00%	0.83
Unemployed, receiving benefits	3.99%	1.61%	0.40%	0.06%	0.50
Unemployed, benefits run out	0.41%	22.02%	7.16%	1.56%	0.29
… and liquid assets below one quarter of the average wage	0.40%	22.82%	7.42%	1.61%	0.27

Figure 2 puts these moments on a grid of entry costs. The survey's exits are upper bounds for the model's sales, so the comparison is one-sided: an economy is at odds with the survey when it sells more than the survey's rate plus two standard errors. The sale rate of families without a spell is below that bound from entry costs of 0.06 on when prices are unchanged and from 0.10 on when they are 20 percent lower; the sale rate of families with a spell is below its bound from 0.15 on and from 0.10 on. On either path of prices one of the two groups therefore requires entry costs of about 0.10 or more. At entry costs of 0.10 the impact response of unemployed owners is 81 percent of the employed response; it is 70 percent at 0.1125, 55 at 0.125 and 44 at the baseline's 0.15 (Panel C). The ratio is steep in this parameter. Within what the sales of 2007 to 2009 allow, the timing result holds, and its size is anywhere between 44 and 81 percent of the employed response; in goods, the twelve-quarter gain of the unemployed cohort is 88 to 95 percent of the employed cohort's. Where the result stops, and what time on the market says about the entry costs, is in Appendix E.

These are bounds from single moments, not estimates with standard errors, and they are joint: a buyer in the model needs no refinancing opportunity and can borrow up to 95 percent of the price, so a sale followed by a purchase is a way around the frictions on refinancing, and the absence of a wave of sales in the survey rejects liquid housing jointly with that feature. I have separated the two sides of the housing market but not this. The survey may also under-count movers; Section 5.3 takes this up with the second

panel. The maintenance cost acts on the same margin and is bounded by the same sale rates (Section 4.7).

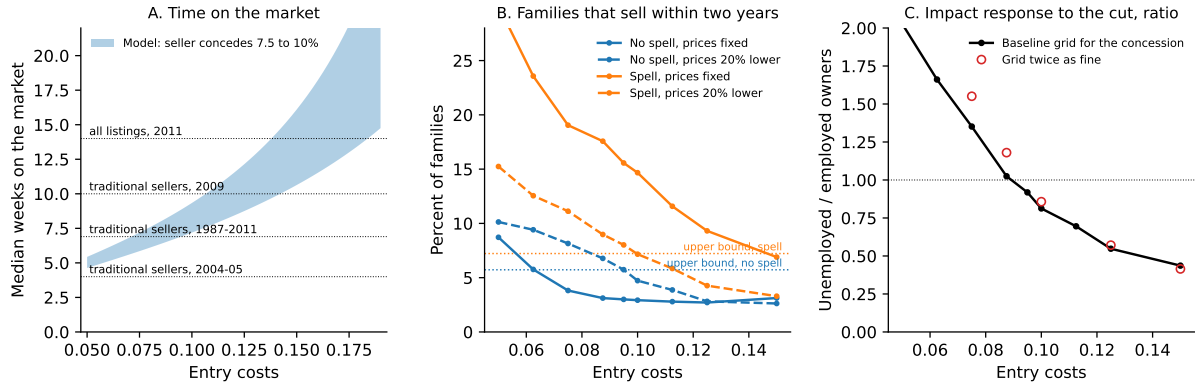


Figure 2: Housing entry costs: what the model implies and what the data of 2007 to 2012 show. Panel A: median time on the market of a seller who concedes 7.5 to 10 percent of the price, and the National Association of Realtors' medians (two measures that are not comparable). Panel B: share of mortgagor families that sell within two years on the path of 2007 to 2009 (labor market slack from the first quarter, rate cut in the fifth), with and without an unemployment spell, at unchanged prices and at prices 20 percent lower; the horizontal lines are upper bounds, the survey's exits other than distress plus two standard errors, for the two groups. Panel C: consumption response in the quarter of the cut, unemployed relative to employed homeowners, tight labor market, unchanged prices; hollow markers use a grid for the seller's concession twice as fine; the baseline is 0.15.

Eligibility rules and housing illiquidity are complements. Remove the illiquidity and the unemployed respond more than the employed on impact (+39.4 against +11.1 percent); remove the employment requirement and their impact response rises from +3.6 to +9.2 percent, 112 percent of the employed response in the baseline (Table 4). It takes both frictions to hold the mean impact response of the unemployed to 44 percent of the employed one. This is why results from unsecured-credit models, in which borrowing does not depend on documented employment, do not carry over to mortgage credit.

4.4 Access policy and welfare

Table 6 compares the baseline with the employment requirement removed and with access restricted to refinancing into the current rate without equity extraction (the rule of streamline programs): the first brings the gains of the unemployed forward, the second is worth almost nothing to them.

Removing the employment requirement raises the steady-state consumption of unemployed homeowners by 3.7 percent, moves their response to a rate cut forward (the impact response rises from +3.6 to +9.2 percent), and is worth 0.17 percent of lifetime consumption to them and 0.09 percent to all households. The guarantor's expected loss on new loans moves from 0.01079 to 0.01073 per quarter. This number says little about the cost of access: most of the measured loss is the gap between the lender's discount rate, which is not disciplined by data, and the origination rate.

The gain is modest because unemployment spells are short: 1.6 to 2.3 quarters (the reciprocals of the job-finding rates of Table 1), so most of the unemployed are eligible again within two or three quarters anyway. The payment-to-income cap, applied to benefit income once the employment requirement is gone,

Table 6: Access counterfactuals. Welfare is the consumption-equivalent change evaluated at the baseline distribution.

	Baseline	**Employment requirement removed**	**Rate-and-term access only**
Consumption of unemployed homeowners	0.482	0.500 (+3.7%)	0.482
Refinancing flow of the unemployed per quarter (share of households)	0.0000	0.0012	0.00009
Aggregate consumption	0.7188	0.7188	0.7189
Guarantor expected loss on new loans, per quarter (quarterly wages per household)	0.01079	0.01073	0.01083
Unemployed cohort impact response to the cut (tight)	+3.6%	+9.2%	+3.1%
Welfare, unemployed homeowners (consumption equivalent)	—	+0.17%	+0.004%
Welfare, all homeowners	—	+0.12%	+0.003%
Welfare, all households	—	+0.09%	+0.002%
Welfare, unemployed homeowners, five-rate grid	—	+0.20%	+0.005%
Welfare, all households, five-rate grid	—	+0.10%	+0.003%

still excludes part of them at a replacement rate of 0.40. And the closing cost, 0.12 of a quarterly wage, is 28 percent of the average quarterly benefit of an unemployed mortgagor.

The form of access matters more than its existence. Allowing the unemployed only to refinance into the current rate without extracting equity (column 3) is worth 0.004 percent of lifetime consumption to them, 0.005 percent on the five-rate grid of Section 4.6. Few unemployed mortgagors are in the money in the ergodic distribution, 6 percent on the five-rate grid, because employed owners refinance within a few quarters of a cut. And the relief is small when it is available: a one-step cut lowers the scheduled payment on the mean balance by 4 to 6 percent of benefit income, a reduction the household obtains on re-employment anyway. The unemployed do use the access when a cut makes it valuable, their refinancing rate rising by 1.4 percentage points on impact against 0.0 without it, but their consumption response on impact is +3.1 percent with the access and +3.6 without. This is consistent with DeFusco and Mondragon (2020), who find that unemployed borrowers used streamline refinancing in 2009: use does not imply a large value. What the unemployed need is liquidity, and only access that allows equity extraction provides it. The experiment starts from the ergodic distribution; a cut to a new low, as in 2009, leaves a larger stock of above-market loans and raises the value of rate-and-term access, so the low value found here is a statement about ordinary cuts.

4.5 Aggregate state dependence

A slack labor market delays the aggregate consumption response to a rate cut more than it reduces it. The response is 38 percent weaker in the quarter of the cut, 15 percent weaker over the first year, 11 percent over two years and 8 percent over three. Figure 3 compares the response to the same one-step cut in tight

and slack labor markets and decomposes the impact difference.

Across the baseline and the 38 one-at-a-time variants of Table 7 whose aggregate response is not close to zero, the impact weakening runs from 16 to 89 percent and the three-year weakening from 6 to 14 percent, and in every one the quarter of the cut is weakened more than the three years. (The 0.995 variant is left out because its aggregate response is near zero; Section 4.7.) The 38 percent is the baseline's value of a number that moves; the ordering is what holds.



Figure 3: Panel A: aggregate consumption response to the same one-step cut, by labor-market state at the time of the cut, in percent of the tight-state pre-cut level. Panel B: the slack-minus-tight impact difference decomposed into composition (slack distribution with tight policies), behavior (tight distribution with slack policies) and interaction.

The impact response is 4.8 percent in a tight and 2.9 percent in a slack labor market. The slack path lies above the tight path from quarter 7 on (Figure 3, Panel A), so the cumulative response over three years is 8 percent weaker, far less than the impact difference. Panel B decomposes the impact difference of -1.82 percent of consumption. Applying tight-market policies to the slack-market distribution (composition: fewer eligible households) accounts for -0.30; applying slack-market policies to the tight-market distribution (behavior: employed households save more of their refinancing gains when job loss is more likely) accounts for -1.63; the interaction is +0.10. The behavioral term is 5.5 times the composition term. The composition term is bounded by the share of mortgagors who are unemployed, six to nine percent, and the behavioral term is the precautionary motive; neither makes the labor market a first-order determinant of the size of the aggregate channel. Section 4.6 compares it with the rate-gap source of state dependence inside the model, and Appendix C with house prices.

4.6 The size and starting point of the cut, and a cut to a new low

The labor-market weakening is stable across cuts of different size and starting point, while the level of the response is not: a cut of similar size does far more when it starts from a low rate, because that is when mortgagors are in the money. The one-step cut on the three-state rate grid is large. On a five-state grid built from PMMS quintiles (annual rates of 3.4, 4.2, 5.3, 6.3 and 7.1 percent, less inflation), the one-step cuts reported here are 0.8 to 1.2 percentage points. Figure 4 reports the aggregate response to the three

one-step cuts that start at or above the middle state; the text adds the two-step cut from the middle state, whose size (1.9 points) is close to the three-state cut of Section 4.2 and so bridges the two grids.

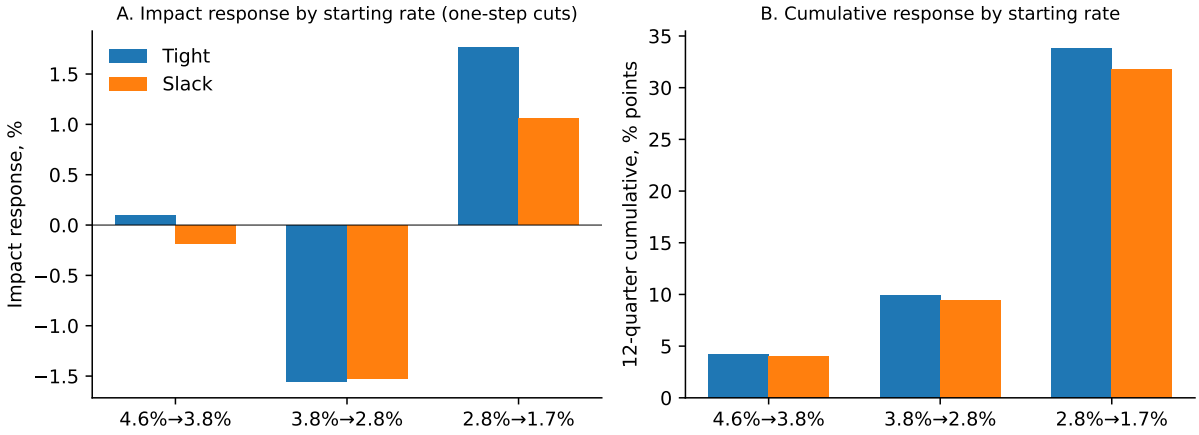


Figure 4: Aggregate consumption response to one-step cuts on the five-state rate grid, by starting rate and labor-market state, in percent of the tight-state pre-cut level.

A cut of similar size does much less when it starts from a high rate. The impact response is +0.1 and −1.6 percent for the two cuts that start at 3.8 percent or above and +1.8 percent for the cut that starts at 2.8, and the refinancing rate on impact rises by 0.1, 0.4 and 2.3 percentage points: few mortgagors are in the money until the rate is low. A negative impact response is consistent with renters saving toward a purchase when mortgages become cheaper, the same force that lowers renters' consumption in Table 4, though the experiment does not isolate it. This is the rate-gap state dependence of Eichenbaum et al. (2022) inside the model, and it is the larger of the two sources: moving the starting rate changes the impact response by about 2 points, moving the labor-market state changes it by 0.0 to 0.7 points for the one-step cuts and 2.0 for the two-step cut. The weakening in slack labor markets, 5 to 9 percent of the cumulative response, is stable across the four cuts.

A cut to a new low. The experiments above draw households from the long-run distribution, in which most mortgagors already hold the lowest coupon when the rate falls to its lowest state: 19 percent of mortgagors are in the money at the one-step cut. The easing of 2008 was not of that kind. The lowest third of mortgage rates between 2000 and 2026 was first reached in 2011, so in 2008 no outstanding loan carried a coupon from a time of lower rates. I put such a history into the model: the economy runs thirty years on which the origination rate never enters its lowest state, which is one realization of the same rate process, and the one-step cut then reaches the households of that history. 72 percent of mortgagors are then in the money, against 71 percent of the loans in the Freddie Mac sample of Section 5 in February 2009. More households are moved by the cut and every response is larger. Employed homeowners gain +13.3 percent on impact and the unemployed cohort +4.2 percent, followed by +14.8 and +20.3 percent in the next two quarters. The unemployed cohort's impact response is 0.32 of the employed one, against 0.44 in the baseline experiment, and the slack labor market weakens the cumulative aggregate response by 8 percent, the same as in the baseline experiment (8 percent). A history of ten years gives 0.30 and 7 percent. The timing result and the size of the state dependence do not depend on which loans are in the

money at the cut. Appendix C uses the same history to give the cohort the leverage of the loans of 2009.

The history is rare because the rate process is estimated on 2000 to 2026, where the lowest third of rates holds a third of the quarters. A chain estimated on 1990 to 2026 with three equal-width bins of the rate (annual rates of 4.0, 6.5 and 8.6 percent, less inflation) has a lowest state that is entered once in the sample and lasts 54 quarters on average, so that thirty years without it has probability 15 percent instead of 1, and 24 percent of mortgagors are in the money even at a cut from the long-run distribution. It is not a better baseline. Its states are more persistent and its real rates higher, so the stock sinks to the current coupon between cuts and rate-and-term refinancing falls to 0.05 percent per quarter, homeownership to 56 percent, and the one-step cut is 2.5 percentage points. No stationary chain reproduces the decline of mortgage rates from 1982 to 2021; that would take a process with a trend, which I leave for future work. The results under this chain are those of the baseline with a larger cut. The unemployed cohort's impact response is 42 percent of the employed cohort's in a tight labor market (+5.4 against +12.7) and 70 percent in a slack one, its refinancing rate does not move in the quarter of the cut, the slack labor market weakens the cumulative aggregate response by 10 percent over three years and 52 percent on impact, or 5 and 20 percent once the ownership premium is re-set to bring homeownership back to 67 percent, and after the thirty-year history the unemployed cohort responds by +4.7 percent on impact against +16.6 for the employed, a ratio of 0.28 against 0.42 from the long-run distribution.

4.7 Robustness, sensitivity and boundaries

Calibration. Two alternative calibrations differ from the baseline in ways that matter for levels. The first has no additional cost of cash-out refinancing and a slack state measured over all quarters with unemployment at or above 6 percent (job-finding rate 0.51). Its refinancing rate is 2.1 percent per quarter; employed homeowners gain +9.4 percent on impact and the unemployed cohort +2.2 percent, with the peak in quarter 3, and the slack labor market weakens the cumulative aggregate response by 6 percent. The second also replaces the income process with a three-state process of low dispersion (0.75, 1, 1.25) and caps purchase loans at 80 percent. There employed homeowners gain +7.4 percent on impact and the unemployed cohort +1.3 percent, with the peak in quarter 3, and the weakening is 6 percent. Figure 5 overlays the three. The delay is common to all of them; the size of the unemployed cohort's impact response, 17 to 44 percent of the employed response, and the aggregate weakening, 6 to 8 percent, depend on income dispersion and on the depth of the slack state.

Table 7 changes one parameter at a time. The cohort unemployed at the cut responds less on impact than the employed cohort in every variant except the one with housing entry costs of 0.05, the complementarity of Section 4.3 seen from the other side. Across the variants that leave the housing market alone it responds by +1.1 to +5.6 percent on impact against +2.5 to +11.1 percent for the employed cohort, its peak arrives between quarters 2 and 4, and its cumulative gain in percent of its own consumption exceeds the employed cohort's in every one. The weakening of the three-year aggregate response in slack lies between 6 and 14 percent across the baseline and the 38 variants of Section 4.5, including the rows that change the return on liquid savings, and between 6 and 13 percent without them and without the discount-factor rows. Those two parameters move the level of the aggregate response rather than the comparison: the

Table 7: Sensitivity of the main results to one-at-a-time parameter changes around the baseline (baseline values: β = 0.99, ω_h = 0.30, κ_F = 0.12, cash-out cost 0.30, λ = 0.164, $\kappa_s = \kappa_b$ = 0.15, ξ = 0.02, χ_R = 0.10, purchase cap 0.95, ρ_b = 0.40, θ_{PTI} = 0.36, i = −0.14%, τ = 0.10, ζ = 0.01, lender's discount rate 0.7%, house sizes {3, 5}, κ_m = 0.005 with an ownership premium of 0.15). Cohort responses for a one-step cut in a tight labor market.

Parameter	Value	Owner share	Refi rate per quarter	Impact, employed (%)	Impact, unemployed (%)	Peak, unemployed	12q cum., unemployed / employed	Slack weaker by, impact	Slack weaker by, 3 years
Baseline		66%	1.3%	+8.2	+3.6	q3	+91 / +60	38%	8%
Discount factor β	0.985	59%	1.5%	+7.9	+3.5	q3	+83 / +50	49%	6%
	0.995	71%	0.9%	+2.5	+1.7	q2	+48 / +19	—	−25%
Housing weight ω_h	0.20	66%	1.2%	+7.3	+4.8	q2	+61 / +42	48%	8%
	0.40	58%	1.3%	+8.8	+5.0	q3	+91 / +65	57%	8%
Closing cost κ_F	0.06	66%	1.4%	+9.3	+3.5	q3	+91 / +63	54%	10%
	0.24	66%	1.2%	+7.3	+3.3	q3	+90 / +57	48%	8%
Cash-out cost	0.15	66%	1.6%	+8.8	+3.3	q3	+92 / +64	49%	10%
	0.50	66%	1.1%	+6.3	+3.3	q3	+91 / +55	43%	6%
Opportunity probability λ	0.10	66%	1.1%	+5.3	+4.1	q3	+82 / +52	56%	8%
	0.30	66%	1.5%	+11.1	+2.5	q3	+96 / +64	19%	9%
Housing entry costs $\kappa_s = \kappa_b$	0.05	67%	1.1%	+9.4	+19.1	q1	+120 / +60	16%	7%
	0.10	68%	1.3%	+8.7	+7.1	q2	+100 / +62	28%	7%
	0.30	59%	1.3%	+7.6	+2.4	q3	+81 / +55	89%	13%
Listing cost ξ	0.05	66%	1.3%	+8.2	+3.7	q3	+90 / +59	43%	9%
Disposal cost χ_R	0.20	66%	1.3%	+8.3	+3.6	q3	+91 / +60	45%	9%
Purchase LTV cap	0.90	62%	1.4%	+8.6	+3.3	q3	+92 / +63	57%	12%
Replacement rate ρ_b	0.30	65%	1.3%	+7.8	+3.9	q2	+83 / +49	45%	11%
	0.50	66%	1.3%	+8.9	+2.7	q4	+93 / +66	28%	8%
Payment-to-income cap θ_{PTI}	0.28	66%	1.3%	+8.3	+3.6	q3	+91 / +60	46%	9%
	0.45	66%	1.3%	+8.2	+3.6	q3	+91 / +60	38%	8%
Return on liquid savings i	0	66%	1.3%	+7.9	+4.4	q3	+84 / +57	34%	10%
	0.2%	66%	1.3%	+8.3	+4.1	q2	+68 / +50	31%	12%
	0.4%	66%	1.3%	+10.9	+3.1	q2	+52 / +43	51%	14%
Tax rate τ	0.05	66%	1.3%	+7.9	+2.6	q3	+87 / +57	36%	12%
	0.15	66%	1.3%	+8.7	+3.3	q3	+87 / +58	45%	8%
Origination cost ζ	0	66%	1.5%	+9.6	+3.6	q3	+93 / +64	48%	11%
	0.02	66%	1.2%	+7.1	+2.6	q3	+87 / +55	48%	9%
Lender's discount rate	0.5%	66%	1.3%	+8.2	+3.6	q3	+91 / +60	38%	8%
	1.0%	66%	1.3%	+8.2	+3.6	q3	+91 / +60	38%	8%
House sizes (owner)	{2.5, 5}	67%	1.4%	+8.8	+3.6	q3	+92 / +64	42%	9%
	{3.5, 5}	64%	1.3%	+9.0	+3.7	q3	+90 / +61	39%	8%
	{3, 4}	67%	1.2%	+7.7	+3.1	q3	+75 / +51	33%	7%
Maintenance κ_m	0.0025	72%	1.4%	+9.1	+2.6	q3	+91 / +67	42%	8%
Benefits	without end	67%	1.4%	+8.0	+1.1	q3	+90 / +63	40%	8%
	26 weeks	65%	1.3%	+8.1	+4.0	q3	+84 / +53	38%	11%
Replacement rate after benefits run out	0.20	65%	1.3%	+8.3	+5.6	q3	+83 / +57	46%	13%
	0.33	67%	1.3%	+8.3	+1.2	q3	+91 / +62	40%	7%
Benefits without end and maintenance κ_m	0.0075, ownership premium 0.21	65%	1.2%	+7.7	+3.1	q3	+82 / +49	48%	10%
	0.010, ownership premium 0.32	65%	1.1%	+6.7	+3.2	q3	+60 / +40	40%	12%

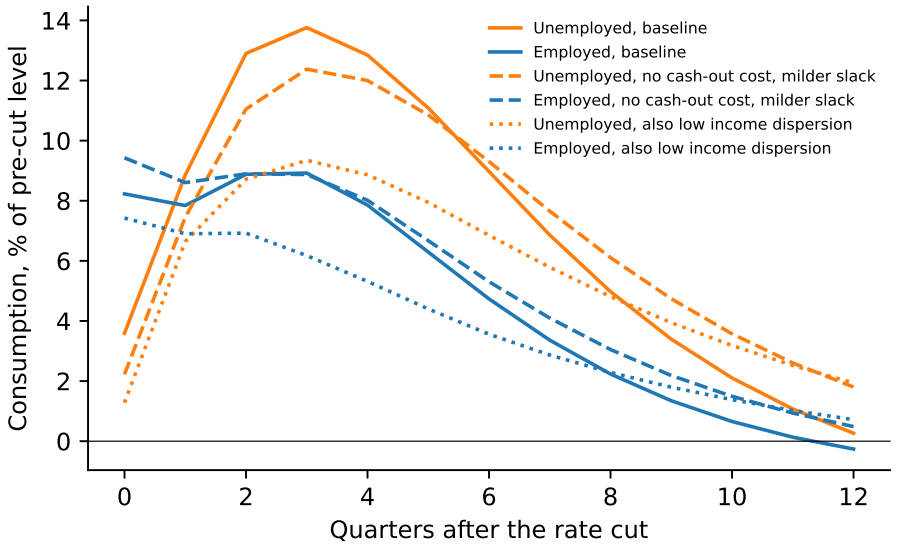


Figure 5: The timing result under the baseline and two alternative calibrations; tight labor market; one-step cut.

impact response is 2.9, 4.8 and −0.2 percent at discount factors of 0.985, 0.99 and 0.995, and with the higher factor, where the response is close to zero, the three-year weakening is −25 percent; a return on liquid savings of zero changes little (+7.9 and +4.4 percent on impact for the two cohorts), and a return of 0.4 percent per quarter, above the lowest origination rate, raises the employed cohort's impact response to +10.9 percent and should not be read as a plausible case. The opportunity probability moves the employed cohort's impact response (+5.3 percent at 0.10, +11.1 at 0.30) and, in the other direction, the unemployed cohort's (+4.1 and +2.5 percent), which waits either way; the replacement rate, the housing weight, the closing and cash-out costs, the listing and disposal costs and the loan-to-value and payment-to-income caps leave the comparison where it is.

Four rows vary the benefit rule (Section 4.3 discusses the first two). What households live on after benefits run out matters as much as when they run out: a replacement rate of 0.20 afterwards gives 68 percent and one of 0.33 gives 14 percent, where the baseline's 0.27 is the third of income that Rothstein and Valletta (2017) find is lost. The weakening of the three-year aggregate response in slack is 8, 11, 13 and 7 percent in the four rows.

Twelve rows vary the parameters that have no data source and that the rows above do not cover; nine of them, the tax rate, the origination cost, the lender's discount rate and the house-size menu, leave the timing result and the weakening in slack as they are: across these 9 variants the unemployed cohort's impact response is +2.6 to +3.7 percent against +7.1 to +9.6 for the employed cohort, and the weakening in slack is 7 to 12 percent. The maintenance cost, in the other three, is the exception. I compute the two rows with higher maintenance under benefits without end, because a household whose benefits have run out cannot pay a higher maintenance cost on the large house; the comparison row is the one for that benefit rule. Doubling it with nothing else changed lowers homeownership to 26 percent, so these two rows also re-set the ownership premium to bring homeownership back to 65 percent, unlike the rest of the table. At 3 percent a year the unemployed cohort's impact response is 40 percent of the employed cohort's and at 4

percent 48 percent, against 13 at the baseline maintenance cost under the same benefit rule: a house that costs more to hold is sold sooner, unemployed owners selling at 1.3 percent per quarter in both economies against 0.4 at the baseline cost. The timing result depends on the margin between holding and selling, on which the entry costs and the maintenance cost both act, and the sale rates of Section 5.3 bound the second as they bound the first: with maintenance of 4 percent a year the model sells more than the survey allows on both paths of prices (7.6 percent of the families without a spell when prices fall, against a bound of 5.7), with 3 percent only when prices are unchanged (8.8 percent of the families with a spell against 7.2), as with entry costs of 0.10. Within what the survey allows, the unemployed cohort's impact response is between 13 and 40 percent of the employed cohort's under that benefit rule.

The consumption responses are spending out of extracted equity. Per dollar of additional cash-out proceeds, the consumption of the in-the-money cohort rises by 0.20 in the quarter of the cut, 0.45 over a year and 0.78 over three years. Surveys of what households do with cash-out proceeds give 16 to 17 cents of consumer spending per dollar, 42 to 44 with the repayment of other debt and 77 with home improvements (Canner, Dynan and Passmore, 2002; Greenspan and Kennedy, 2008). The model's spending per dollar at one year is thus just above the measure that includes the repayment of other debt and well below the broadest one, and nothing disciplines it at three years. The model also extracts more per cash-out refinance than one survey reports, 19 percent of the house's value against 12, and 26 percent in the cohort of the cut to a new low. And too much of its refinancing extracts: in the cohort of the cut to a new low of Section 4.6, 78 percent of the first year's refinances are cash-out; in the economy with a price state the share is 80 percent, and 68 to 72 percent when prices fall with the cut, against 15 percent of the families that refinanced in 2009 in the survey panel of Section 5 and 36 to 39 percent, depending on the comparison group, in the second panel. Members of the cohort who are above the loan-to-value cap and can refinance only the rate add nothing to its consumption response: their own response is negative in the first year, -14 percent of the cohort's, and about zero over three years, whereas Agarwal et al. (2023) find that spending on cars rose after refinances that only lowered the rate. The consumption magnitudes of this paper are those of a cut after which households can and do extract equity. For 2009 they overstate the part that comes from extraction and leave out the part that comes from lower payments. Who is eligible to refinance, and when eligibility returns, does not depend on this.

5 Evidence from the 2008 easing

The model makes a household-level prediction and an aggregate one. A homeowner who is unemployed when rates fall refinances far less than an employed one over the following year, although the wish to refinance is the same; and because unemployed homeowners are a small share of mortgagors, a slack labor market lowers aggregate refinancing only a little. This section checks both against the easing that began in December 2008, when the average 30-year mortgage rate fell from about 6 to about 5 percent while unemployment rose toward 10 percent. Two household panels are consistent with the first prediction at the model's magnitude, and in the second, families whose spell is over do not refinance less than others. Neither panel identifies the eligibility rule: a spell also lowers income, cash on hand and credit standing, and the comparisons below are descriptive. The regional data are in Section 5.4; Appendix C puts a

house-price state in the model beside them.

5.1 Families with an unemployment spell refinanced half as often

The Federal Reserve's 2007–09 panel of the Survey of Consumer Finances re-interviewed the 2007 respondents between July and December 2009 (Bricker et al., 2011). Families still in their 2007 home were asked whether they had refinanced, borrowed more or modified the mortgage since the first interview, whether they had considered it, and whether they had applied. Head and spouse report whether they were unemployed and looking for work at any time in the previous twelve months, roughly the first year after the cut.

I keep families with a mortgage on their principal residence in 2007, the same home in 2009, and the head or spouse in the labor force in 2007: 1,616 families. The 822 closest to the model's in-the-money cohort at the cut still hold their 2007 fixed-rate loan at the start of 2009 at a contract rate at least half a percentage point above the 2009 average of 5.04 percent. In 141 of them the head or spouse had an unemployment spell.

Table 8 gives the result. Of families without a spell 13.9 percent refinanced in 2009, of families with one 6.1 percent, a difference of 7.8 percentage points with no controls and 7.3 with controls for the loan (rate gap, age, balance, FHA insurance, second lien), the household (age, education, normal income, marital status, children), home equity (loan-to-value categories from the 2007 balance and the owner's 2009 valuation) and credit history (late payments and credit denial in 2007). Families with a spell refinanced 52 percent less (standard error 12). The controls move the coefficient by half a point: the measured differences in equity and credit history do not account for the gap.

Table 8: Refinancing after the 2008 cut by unemployment experience (SCF 2007–09 panel)

Share of families, percent	**No spell**	**Spell**	**Difference, all controls**	**Relative gap**
Refinanced in 2009	13.9	6.1	−7.3 (1.9)	−52% (12)
of which without borrowing more	11.8	5.1	−6.6 (1.8)	−55% (13)
Considered refinancing or modification	44.3	41.4	−2.7 (3.8)	−6% (9)
Applied	18.6	12.8	−5.3 (2.3)	−28% (12)
Considered, but obtained neither	29.3	35.3	+5.6 (3.2)	+19% (11)
Families	681	141		

Notes: Families with a fixed-rate mortgage on their principal residence in 2007 at a contract rate of at least 5.54 percent, in the same home in 2009, head or spouse in the labor force in 2007, and no refinancing, additional borrowing or modification dated 2007 or 2008. "Spell": head or spouse unemployed and looking for work at some time in the twelve months before the 2009 interview. Weighted linear probability models with the panel weight. Standard errors in parentheses combine the sampling variance from 999 replicate weights with the variance across the five implicates.

The other rows say where the gap opens (Figure 6). Families with a spell considered refinancing as often as the others, 41 against 44 percent, but applied less often, obtained a new loan half as often, and more often considered without obtaining, as an eligibility rule known to applicants would produce. Fewer than 20 of them applied without success, too few to tabulate the reasons the survey records, but "unemployed"

and "unable to prove income" appear only in that group.

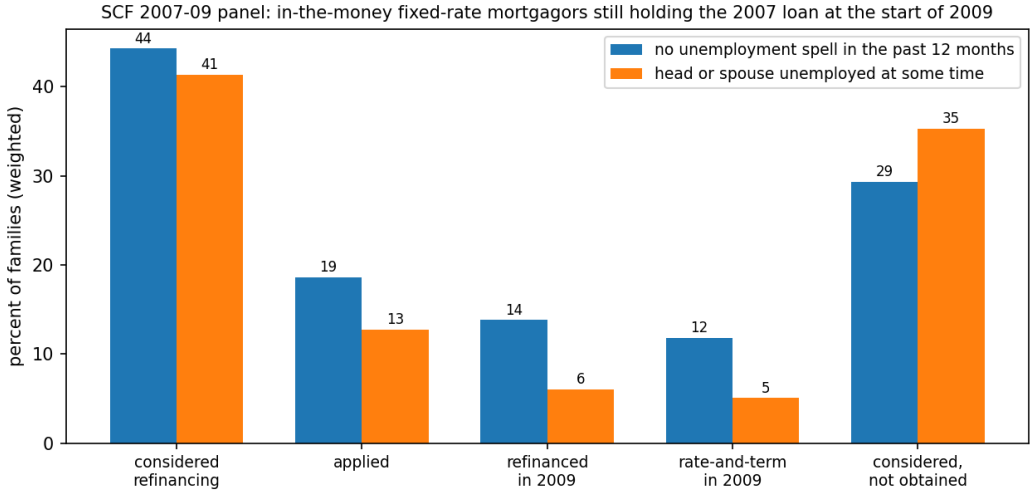


Figure 6: Considering, applying for and obtaining a refinance in 2009, by unemployment experience. In-the-money fixed-rate mortgagors still holding their 2007 loan at the start of 2009; weighted shares.

The gap does not depend on the sample definition: 43 percent (standard error 12) without the in-the-money and fixed-rate restrictions (1,422 families), the same with families that refinanced in 2007 or 2008 added back, 38 percent (24) with unemployment measured at the interview date (56 families), 56 percent (15) for spells shorter than 26 weeks and 44 percent (19) for longer spells.

The sample conditions on still owning the 2007 home, which families with a spell left more often; Section 5.3 reports the exits and uses them.

The model does not target this moment. The employment requirement stops refinancing during the spell by construction; what the model determines is how fast re-employment and the arrival of opportunities close the gap and how many households sell instead, and the range it gives is wide. In the model, in-the-money mortgagors unemployed in the quarter of the cut raise their refinancing rate over the first year by 45 percent less than the employed in a tight labor market and 58 percent less in a slack one, and by 55 and 67 percent less over three quarters. With the milder slack state of the first alternative calibration in Section 4.7 the first-year gaps are 53 and 59 percent. These are responses to the cut. The survey measures a level, and in levels on the path with the cut the model's gaps are 39 and 52 percent over the first year and 50 and 63 over three quarters. The estimate of 52 percent is at the upper end of the first-year gaps in levels, inside the three-quarter gaps in levels, inside the baseline's first-year range of responses and below the others. The comparison is not exact: a spell at any time in the year includes families that lost a job after the cut and families already back at work, both pulling the measured gap toward zero, so a cleaner measure would lie above the model's first-year gaps in levels.

The same data give the aggregate effect by arithmetic. Families with a spell were 11 percent of the sample in 2007 and 20 percent in 2009, and nine more points of families refinancing half as often lower the aggregate refinancing rate by about 5 percent. The model's counterpart, the difference between a slack and a tight labor market in the in-the-money cohort's first-year refinancing response, is 5 percent in the

baseline experiment (5 percent with a house-price state), 7 percent for a cut to a new low (Table 12) and 6 to 7 percent with the data's loan-to-value distribution (Table 15). The labor market's effect on who refinances is large, its effect on how much refinancing takes place small.

5.2 A second panel: the gap is in the year of the cut and does not outlast the spell

The survey panel has one re-interview. The Panel Study of Income Dynamics (PSID) interviewed the same families in 2007, 2009, 2011 and 2013, records the year the first mortgage was obtained or last refinanced, its rate and whether the rate is fixed, and reconstructs from an employment calendar the months in which the head and the wife were unemployed in each calendar year. The comparison can thus be made for each year from 2009 to 2012, and so can one a single re-interview does not allow: whether families refinance once the spell is over.

The unit is a family in a calendar year. The loan is the first mortgage held at the start of the year, refinanced if the loan reported at the next interview was obtained in that year. I keep fixed-rate loans at least half a point above the year's average 30-year rate, families in the same owned home, and the head or wife in the labor force: 5,563 family-years from 2,214 families. A family has a spell if the head or wife was unemployed and looking for work in some month of the year, 640 family-years.

Table 9 gives the results. In 2009, 18.0 percent of families without a spell refinanced and 8.0 percent of families with one, a gap of 52 percent (standard error 13) with controls for the loan and the household and 49 percent (13) with home equity, arrears and loan modification added. Two panels with different questionnaires and measures of unemployment give the same number for the year after the cut. Without the in-the-money and fixed-rate restrictions the gap is 32 percent (13), with unemployment from the calendar alone 52 percent (14).

After 2009 the gap is smaller: 13 percent (13) for 2010 to 2012 together. The model has this property in part. On its path with a cut, in-the-money mortgagors unemployed in the quarter of the cut refinance 39 to 52 percent less than the employed over the following year, on the path without a cut from -16 to -29 percent: refinancing is then mostly equity extraction, much of which the unemployed take up after re-employment, while a cut adds refinancing worth doing at once, which they miss. Rates fell again in 2012, and the gap of that year, 16 percent (20), is too imprecise to say whether it reopened.

Panel B asks whether the unemployed refinance late or not at all, comparing families with a spell in the year, and families whose spell is over, with families that had no spell in three years. A family whose spell was over in 2009 had it before the cut and was at work when rates fell, so its refinancing, 79 percent above the reference group (44), shows that a past spell leaves no lasting mark on access, not that a missed cut is made up. The year that bears on the delay is 2010: families with a spell in 2008 or 2009 and none in 2010 refinanced 45 percent more than the reference group (30), the sign the model predicts and not distinguishable from zero on 116 family-years. In the model the cohort unemployed at the cut refinances 13 to 18 percent more than the employed cohort in the second year, 0 to 9 percent less often among those not yet refinanced. In 2011 and 2012 the difference is zero, and over the four years families whose spell is over refinanced 23 percent more (14). The data reject a lasting exclusion more clearly than they establish catching up. The group whose spell is over may include families that left the labor force.

Table 9: Refinancing by unemployment experience, 2009 to 2012 (PSID)

A. Share of families refinancing in the year, percent	**No spell**	**Spell**	**Difference, controls**	**Relative gap**
2009	18.0	8.0	−9.2 (2.7)	−52% (13)
2010 to 2012	14.0	11.1	−1.9 (1.8)	−13% (13)
2009 to 2012	14.9	9.9	−3.9 (1.6)	−26% (10)
B. Relative to families with no spell in the year or the two years before	**Reference rate**	**Spell in the year**	**Spell over**	**Family-years, spell over**
2009	16.7	−48% (14)	+79% (44)	74
2010	12.1	−12% (23)	+45% (30)	116
2011 and 2012	15.0	−11% (17)	−3% (15)	304
2009 to 2012	14.6	−24% (11)	+23% (14)	494
C. By the change in the balance, 2009 to 2012				
Balance higher by more than 5 percent	4.0	−57% (17)	+10% (31)	494
Balance not higher	10.6	−12% (15)	+28% (20)	494

Notes: Family-years of fixed-rate first mortgages held at the start of the year at a rate at least 0.5 percentage points above the year's average 30-year rate; family in the same owned home; head or wife in the labor force. "Spell": head or wife unemployed and looking for work in some month of the year. "Spell over": no spell in the year, a spell in one of the two years before. Weighted linear probability models with controls for the loan (rate gap, age, balance, second lien) and the household (age, education, family income, marital status, children), and year effects. Panel C splits refinancing by whether the balance at the next interview exceeds the earlier balance by more than 5 percent. Standard errors in parentheses: rescaled bootstrap on the sampling-error strata and clusters of the PSID, 999 replicates.

Panel C splits refinancing by whether the balance rose, a coarse marker of equity extraction since balances are observed two years apart. Families with a spell in the year were 57 percent less likely (17) to refinance into a higher balance and 12 percent less likely (15) to refinance without one. In 2011 and 2012 the first gap is still 71 percent (20) and the second is gone. In 2009 alone the gaps are 73 percent (16) and 31 percent (23): in the year of the cut refinancing without a higher balance was lower too, as in the survey panel (55 percent, standard error 13, for refinancing without borrowing more), and only in the later years is equity extraction alone lower. Over the four years the gap in a spell year is mostly in equity extraction, the form of access that matters for consumption in Section 4. The model also predicts a rebound of equity extraction after the spell, which Panel C does not show: families whose spell is over refinanced into a higher balance 10 percent more often (31), too imprecise to count for or against.

Section 5.3 reports the exits from homeownership in this panel.

Expenditure. The PSID also records spending. I take mortgagor families that stay in the same home between two interviews, 6,425 two-year windows ending in 2009, 2011 and 2013 (6,250 with the household controls of the estimates below), and the two-year change in log expenditure on food, utilities, telephone, transportation, education, childcare, health, clothing, furnishings, repairs, trips and recreation, leaving out

mortgage payments and other housing costs, which a refinance changes mechanically. The comparisons were fixed before the outcomes were seen. Families in a spell at the second interview, looking for work then or unemployed during the previous calendar year, spent 5.6 log points less than families with no spell (standard error 1.8), and 17.8 points less on items that can be postponed (3.1), while families whose spell had ended were back at the growth of the others (+0.8, standard error 2.4). The difference between the two groups is 6.4 points (2.8), and 6.0 (2.9) with the change in family income held fixed. These are two groups compared in two-year changes, not the same families followed through a spell. Lower spending in a spell and no shortfall after it is what the model's delay implies, and also what the recovery of income alone would give. A refinance between the interviews, in turn, is not associated with higher spending growth (+1.6 points, standard error 2.1), and refinances into a higher balance give +1.9 points (3.1). A cash-out refinance in the model releases about 62 percent of a year's earnings, about half of it spent within a year, several times what this estimate allows unless the spending falls between the two interviews: like the comparisons of Section 4.7, the panel speaks against the size of the model's spending out of extracted equity. Whether a refinance matters more for families coming out of a spell, and through equity extraction, cannot be read: 85 family-windows have a spell that ended and a refinance (+2.0 points, 7.6), 23 of them with a higher balance. And the 2009 wave alone has too few refinancing families in a spell to be read. Two interviews two years apart are a blunt instrument: a fall and a recovery inside a window cancel, and a late refinance has no time to show. The panel is consistent with a temporary loss of spending during a spell, finds no association on the step from refinancing to consumption, and cannot test the interaction.

5.3 Who left their homes: evidence on housing liquidity

The timing result of Section 4 requires that unemployed owners wait instead of selling (Section 4.3). The two panels show how often owners gave up the house, and why. In the Survey of Consumer Finances, of the families with a mortgage in 2007, 6.3 percent of those without an unemployment spell and 11.9 percent of those with one no longer owned the same home in 2009, a difference of 5.6 points (standard error 1.4). The survey asks why the family left. Nearly all of the difference is distress: 6.6 percent of the families with a spell and 1.4 percent of the others left through foreclosure, a short sale or abandonment, which the public file reports as one category, a difference of 5.2 points (1.2). Exits for every other reason, ordinary sales among them, are as frequent in the two groups, 5.3 against 4.9 percent, a difference of 0.4 points (1.0). The families with a spell that left in distress had a median loan-to-value ratio of 0.88 in 2007, against 0.64 for the families with a spell that stayed.

In the model an ordinary exit is a sale and a distress exit is a default. I follow the mortgagors of a tight labor market for eight quarters, the time between the two interviews. The labor market turns slack in the first quarter and the mortgage rate falls by one step in the fifth, as it did at the end of 2008; a family has a spell if it is unemployed in any of the last four quarters. House prices either stay unchanged or are 20 percent lower from the first quarter on, as in the economy of Appendix C; the experience of 2007 to 2009 lies between the two. In the baseline 3.1 percent of the families without a spell and 6.9 percent of those with one sell when prices are unchanged, and 2.6 and 3.3 percent when prices fall. In the survey 4.9 percent (standard error 0.4) and 5.3 percent (standard error 1.0) left for a reason other than distress. These rates include moves that the model does not have, such as moves for a new job, so they are upper

bounds for it. The baseline is below them or inside their sampling error on both paths; its highest rate, that of families with a spell at unchanged prices, is 6.9 percent against 5.3 percent (standard error 1.0) in the survey.

More liquid housing markets are not. With entry costs of 0.05, 8.7 percent of the families without a spell sell within the two years when prices are unchanged and 10.1 percent when prices fall, 1.8 to 2.1 times the survey's rate and outside its sampling error; families with a spell sell at 30.0 and 15.2 percent. With entry costs of 0.10 the families with a spell sell at 14.7 percent when prices are unchanged, above the survey's rate, but when prices fall the two groups sell at 4.7 and 7.2 percent, which the survey does not reject. The reason is that in a liquid housing market a sale substitutes for a refinance, so a rate cut sets off a wave of sales. In a tight labor market at normal prices, the sale rate of unemployed owners in the quarter of the cut is 16.9 percent with entry costs of 0.05, against 3.4 percent had the rate not fallen; in the baseline the two numbers are 1.9 and 0.7 percent (in the economy with a price state, at normal prices; Table 3 gives the economy without one). The survey shows no such wave. It is inconsistent with entry costs of 0.05, the economy in which the cohort means are reversed, on either path of prices. It does not separate the baseline from entry costs of 0.10.

The Panel Study of Income Dynamics follows families that move and finds more exits. Over the two-year windows that start in 2009 and 2011, 9.4 percent of the mortgagor families without a spell (standard error 0.6) left their home other than through a foreclosure or with the mortgage in arrears, about twice the survey's rate. But the panel also records why the family moved, and the sale of the model, a sale to release equity, is neither a move for a job nor a move for more or better housing. Without those two, 4.2 percent (0.5) of the families without a spell left, close to the survey's rate and about half of what entry costs of 0.05 imply, and families with a spell left 1.1 points more often (1.1). The case against entry costs of 0.05 rests on this narrower count. On the total the two panels agree: families with a spell left 5.6 points more often (1.5), and all of that difference is in families that rent afterwards (6.0 points, standard error 1.3), not in families that move to another owned home.

Default is where the model falls short. The two groups differ in default by 0.4 point in the baseline at unchanged prices, by 0.4 when prices fall and by 0.6 with 26 weeks of benefits and falling prices, against 5.2 points of distress in the survey; Gerardi et al. (2018) find in the Panel Study of Income Dynamics for 2009 to 2013 that an unemployed head raises the probability of being 60 days late by about 5 points. Default is rare in the model, 1.3 per 10,000 mortgagors per quarter, and I do not add a channel to match it. The omission has a direction. A family that loses its home to foreclosure releases no equity and cannot refinance, so for that family the gain from a rate cut is lost, not delayed. Families that left in distress are about 7 in 100 of those with a spell, 5 more than among other families; the timing result describes the families that keep the home.

A bound shows how much the omission can matter. Suppose that the families that lose the home in distress receive none of the gain from the cut and would otherwise have received their cohort's average. At the survey's two-year rates, 6.6 percent of the families with a spell and 1.4 percent of the others, the twelve-quarter gain of the unemployed cohort falls from 88 to 84 percent of the employed cohort's in goods; at twice those rates, which allows for a third year, to 79 percent. The survey's rates cover spells at any time between the two interviews, and the families that left in distress had little equity, a median

loan-to-value ratio of 0.88, so the gain they would have had is overstated and the bound is conservative.

5.4 The regional shortfall is larger, and follows house prices

Regional data show a shortfall several times larger than the household evidence implies, and its timing shows that most of it has another cause. I merge the Freddie Mac loan-level sample (12,500 fixed-rate loans per origination quarter since 1999, 1.3 million loans and 73 million loan-months) with metropolitan unemployment rates from the BLS Local Area Unemployment Statistics and the FHFA house price index, and sort 403 metropolitan areas into terciles by the unemployment rate in October 2008, below 5.1 percent and above 6.4 percent. In a loan-level event study with area and month fixed effects, a spline in the rate gap, current loan-to-value and loan characteristics, prepayment of in-the-money loans in the high-unemployment tercile fell 17 percent relative to the low tercile in the twelve months after the cut. New refinance loans per outstanding loan give a shortfall of 32 percent in the first year and 17 percent in the second, two to six times the 5 to 7 percent that the household evidence and the model attribute to unemployment.

Timing explains the difference. In Figure 7 the log ratio of high- to low-unemployment areas in the prepayment of in-the-money loans is 3 log points above zero in 2007 and 30 below in 2008, before the December cut, reaches −40 in 2009 and is back to −6 in 2012. The gap opens with the fall in house prices and closes when the second version of the Home Affordable Refinance Program, announced in late 2011 and in effect from 2012, removed the loan-to-value ceiling on refinancing (Agarwal et al., 2023). The event study, which measures changes from the six months before the cut, could not see that the gap was already open.

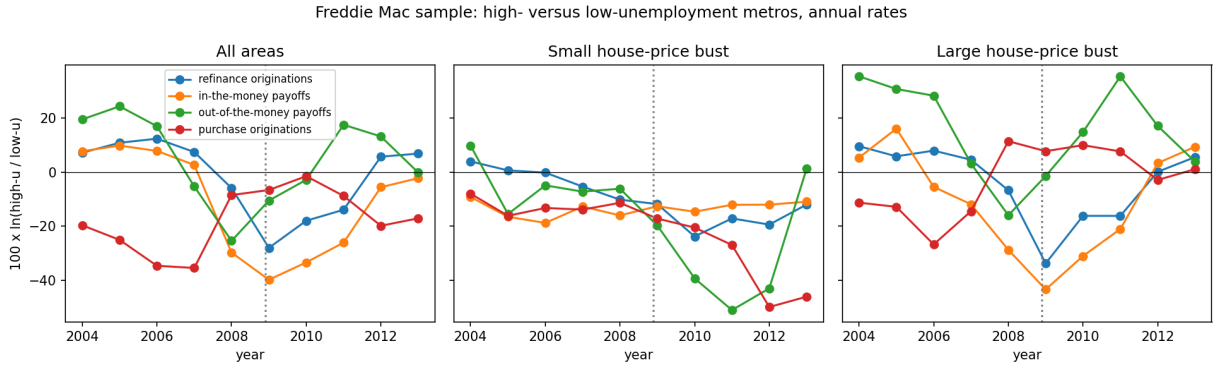


Figure 7: High- relative to low-unemployment metropolitan areas, Freddie Mac sample, annual rates. Areas sorted by the unemployment rate in October 2008; "small" and "large" house-price bust split areas at the median change in the FHFA index from 2006Q4 to 2008Q4. The dotted line marks the December 2008 cut.

Geography says the same. The median change in house prices from the end of 2006 to the end of 2008 is close to zero, so splitting areas at it separates areas where prices fell from areas where they did not. Table 10 reports the change in the log ratio of high- to low-unemployment areas from 2005–2007 to 2009–2011 in each half. Where prices fell, prepayment of in-the-money loans in high-unemployment areas dropped 31 log points relative to low-unemployment areas. Where prices did not fall it did not move:

+3 with a standard error of 10, an interval that includes zero and the 5 to 7 percent the model and the household data imply, and excludes the 30 to 40 log points of the pooled comparison. Rate-and-term refinancing shows the same contrast. Cash-out refinancing is the exception: it fell in high-unemployment areas in both halves, by 27 log points where prices did not fall, though gradually over 2009–2012 and not in the year of the cut.

Table 10: Change in the high- minus low-unemployment gap, 2009–2011 against 2005–2007, by house-price bust (Freddie Mac sample)

$100 \times \Delta \ln($**high-**$u/$**low-**$u)$	**All areas**	**Small bust**	**Large bust**
Prepayment rate, in-the-money loans	−39.9 (8.1)	+2.9 (10.4)	−31.4 (10.6)
Rate-and-term refinance originations	−12.3 (8.9)	−1.3 (17.6)	−21.8 (12.6)
Cash-out refinance originations	−45.3 (10.4)	−26.9 (8.5)	−41.6 (11.1)
All refinance originations	−30.2 (8.1)	−16.0 (7.1)	−28.2 (10.7)
Areas, high / low unemployment	131 / 133	33 / 98	92 / 30

Notes: Pooled annual rates by unemployment tercile; originations are per outstanding loan. The entry is the mean log ratio of the high- to the low-unemployment tercile in 2009–2011 minus its mean in 2005–2007, times 100. Standard errors from 500 bootstrap draws of areas within tercile. Areas without the house-price index are in neither half.

5.5 The shortfall is in applications, not denials

The Freddie Mac data contain only loans that closed. The Home Mortgage Disclosure Act register records every application and its outcome, so originations factor exactly into applications, the share reaching a decision, the share approved, and the share of approvals accepted. I regress the log of each term for conventional refinance applications of up to $417,000 in 386 metropolitan areas on unemployment-tercile-by-year indicators with area and year fixed effects, 2008 as the reference year, and the area's 2008 application count as weight. The four coefficients sum to the coefficient on originations.

Table 11: Where the regional shortfall in refinance originations opens (HMDA, 2007–2012)

High- minus low-unemployment tercile, log points × 100, 2008 = 0	**Originations**	**Applications**	**Approval rate**	**Completion rate**
2007	+32.3 (6.2)	+25.1 (4.8)	+5.5 (1.7)	+0.7 (0.6)
2009	−18.4 (4.7)	−20.6 (5.3)	+0.6 (1.5)	−1.5 (0.4)
2010	−11.0 (5.5)	−16.3 (6.3)	+3.0 (1.8)	−1.3 (0.5)
2011	−4.4 (5.6)	−12.4 (6.3)	+4.4 (1.9)	−0.6 (0.5)
2012	+13.7 (5.6)	+3.9 (5.9)	+5.9 (2.1)	−0.9 (0.5)

Notes: First-lien, owner-occupied, one-to-four-family conventional refinance applications of at most $417,000. Areas grouped by the October 2008 unemployment rate. The acceptance rate, the fourth term of the decomposition, is omitted; it rises by 3 to 5 log points. Standard errors clustered by area.

The shortfall is entirely in applications (Table 11). In 2009, originations in the high-unemployment tercile are 18 log points lower than in the low tercile relative to 2008, applications 21 lower, and the approval rate unchanged. Denials for "employment history" are 0.2 to 0.3 percent of decided applications

in every tercile and every year. The 2007 row repeats the lesson of Figure 7: originations in these areas had already fallen 32 log points between 2007 and 2008. An application never filed has no recorded reason, so the register cannot tell a homeowner who does not want to refinance from one who knows the loan-to-value ratio or the income documents will not pass. With the unemployment rate and the house-price bust entered together as continuous variables, a standard deviation of either lowers 2009 applications by about 8 log points (standard errors 3 and 4). The two are correlated 0.6 across areas, and regional data alone cannot apportion the shortfall between them.

5.6 House prices and employment together, in brief

Appendix C adds an exogenous house-price state to the model, a fall of 20 percent as in the half of metropolitan areas where prices fell most. For the cohort of a cut to a new low, which has the leverage of the loans of 2009, slack lowers the first-year refinancing response by 7 percent, lower prices by 23 percent and both by 26 percent; low prices neither amplify the labor channel nor remove it. Within the cohort, employed households above the loan-to-value cap refinance 80 percent less in the first year than employed households below it, unemployed households below the cap 56 percent less, and households excluded on both counts 92 percent less; the household panels give the same ordering (Appendix C). With each area's leverage, the model's level of refinancing after the cut has the sign of the regional data and a third to four fifths of their size where prices fell, and the part of the regional gap that goes with the bust is a gap in levels that the bust opened before the cut. A waiver of the loan-to-value cap confined to the rate, as in the 2012 program, restores the cohort's refinancing, 49 percent of the consumption shortfall of the households it reaches, and little of the consumption response of homeowners as a whole. The appendix gives the tables and figures, the comparison with the regional cells, the leverage of the cohorts, and the extension's limits.

6 Conclusion

Homeowners who lose their jobs as mortgage rates fall have loans above the new rate and equity in their houses, but not the job a lender typically asks for. They wait because, at the calibrated housing frictions, selling is slower and costlier than the wait for a job, which for most ends within two or three quarters. In the quarter of the cut 5 percent of unemployed homeowners raise their consumption against 27 percent of the employed, those who do not sell rarely respond, and none refinances. Re-employed a quarter or two later, they refinance, nearly catch up within two years, and receive in goods 88 percent of the employed cohort's twelve-quarter gain. The employment rule delays most of the gain rather than removing it.

The cohort average depends on how many of the unemployed sell: under half the employed response in the baseline, smaller when benefits never run out, larger with cheaper housing transactions, shorter benefits or a slack labor market, and where it is high it is the response of the few who sell. Illiquid housing and the rule are complements: removing either undoes the delay in the average on impact. Slack delays the aggregate response more than it reduces it, about two fifths weaker in the quarter of the cut, 8 percent over three years.

The excluded lack liquidity: rate-only access is worth almost nothing to the unemployed, while access

that permits equity extraction brings their gains forward, worth 0.17 percent of lifetime consumption; a loan-to-value waiver as in 2012 restores refinancing for homeowners above the cap and little of the consumption response of homeowners as a whole. Two household panels are consistent with the mechanism: families with an unemployment spell refinanced half as often in 2009 and not less once it was over. The larger regional shortfall mostly follows house prices: it opened with the bust, before the cut, and in the model, with the leverage of the 2009 loans, a 20 percent price fall costs between a fifth and a quarter of first-year refinancing, slack less than a tenth.

The timing result requires an illiquid housing market; in a typical market the delay in the averages is weak or absent, although the households that do not sell still wait. And the consumption magnitudes rest on equity extraction, so they are not statements about 2009; who can refinance, and when, is what the evidence speaks to.

I bound the housing frictions from single moments. Estimating them would mean adding a commission separate from the seller's concession, so that time on the market becomes a moment, and fitting both sides' entry costs to it and to the two-year sale rates, turning the 44 to 81 percent range into an estimate with a standard error. Since no stationary chain gives the fall in rates from 1982 to 2021, the 2008 cut rests on a history with probability below 1 percent; a process with a trend would make such a cut a regular event rather than a rare history and would let the access experiments be run for the 2009 cohort.

References

Abel, J. and A. Fuster (2021). How do mortgage refinances affect debt, default, and spending? Evidence from HARP. American Economic Journal: Macroeconomics 13(2), 254–291.

Agarwal, S., G. Amromin, S. Chomsisengphet, T. Landvoigt, T. Piskorski, A. Seru and V. Yao (2023). Mortgage refinancing, consumer spending, and competition: Evidence from the Home Affordable Refinance Program. Review of Economic Studies 90(2), 499–537.

Andersen, S., J. Y. Campbell, K. M. Nielsen and T. Ramadorai (2020). Sources of inaction in household finance: Evidence from the Danish mortgage market. American Economic Review 110(10), 3184–3230.

Beraja, M., A. Fuster, E. Hurst and J. Vavra (2019). Regional heterogeneity and the refinancing channel of monetary policy. Quarterly Journal of Economics 134(1), 109–183.

Berger, D., K. Milbradt, F. Tourre and J. Vavra (2021). Mortgage prepayment and path-dependent effects of monetary policy. American Economic Review 111(9), 2829–2878.

Bhutta, N. and B. J. Keys (2016). Interest rates and equity extraction during the housing boom. American Economic Review 106(7), 1742–1774.

Braxton, J. C., K. Herkenhoff and G. Phillips (2024). Can the unemployed borrow? Implications for public insurance. Journal of Political Economy.

Bricker, J., B. Bucks, A. Kennickell, T. Mach and K. Moore (2011). Surveying the aftermath of the storm: Changes in family finances from 2007 to 2009. Finance and Economics Discussion Series 2011-17, Federal Reserve Board.

Campbell, J. Y., S. Giglio and P. Pathak (2011). Forced sales and house prices. American Economic Review 101(5),

2108–2131.

Canner, G., K. Dynan and W. Passmore (2002). Mortgage refinancing in 2001 and early 2002. Federal Reserve Bulletin 88(12), 469–481.

Chen, H., M. Michaux and N. Roussanov (2020). Houses as ATMs: Mortgage refinancing and macroeconomic uncertainty. Journal of Finance 75(1), 323–375.

DeFusco, A. and J. Mondragon (2020). No job, no money, no refi: Frictions to refinancing in a recession. Journal of Finance 75(5), 2327–2376.

Di Maggio, M., A. Kermani, B. J. Keys, T. Piskorski, R. Ramcharan, A. Seru and V. Yao (2017). Interest rate pass-through: Mortgage rates, household consumption, and voluntary deleveraging. American Economic Review 107(11), 3550–3588.

Eichenbaum, M., S. Rebelo and A. Wong (2022). State-dependent effects of monetary policy: The refinancing channel. American Economic Review 112(3), 721–761.

Garriga, C. and A. Hedlund (2020). Mortgage debt, consumption, and illiquid housing markets in the Great Recession. American Economic Review 110(6), 1603–1634.

Gerardi, K., K. F. Herkenhoff, L. E. Ohanian and P. S. Willen (2018). Can't pay or won't pay? Unemployment, negative equity, and strategic default. Review of Financial Studies 31(3), 1098–1131.

Gete, P. and F. Zecchetto (2024). Mortgage design and slow recoveries: The role of recourse and default. Review of Economic Studies 91(2), 1039–1084.

Greenspan, A. and J. Kennedy (2008). Sources and uses of equity extracted from homes. Oxford Review of Economic Policy 24(1), 120–144.

Greenwald, D. (2018). The mortgage credit channel of macroeconomic transmission. Working paper, MIT Sloan.

Hedlund, A. (2016). Illiquidity and its discontents: Trading delays and foreclosures in the housing market. Journal of Monetary Economics 83, 1–13.

Herkenhoff, K. and L. Ohanian (2019). The impact of foreclosure delay on U.S. employment. Review of Economic Dynamics 31, 63–83.

Herkenhoff, K., G. Phillips and E. Cohen-Cole (2024). How credit constraints impact job finding rates, sorting, and aggregate output. Review of Economic Studies 91(5), 2832–2877.

Hsieh, C.-T. and E. Moretti (2003). Can free entry be inefficient? Fixed commissions and social waste in the real estate industry. Journal of Political Economy 111(5), 1076–1122.

Hurst, E. and F. Stafford (2004). Home is where the equity is: Mortgage refinancing and household consumption. Journal of Money, Credit and Banking 36(6), 985–1014.

Hurst, E., B. J. Keys, A. Seru and J. Vavra (2016). Regional redistribution through the US mortgage market. American Economic Review 106(10), 2982–3028.

Kaplan, G. and G. L. Violante (2014). A model of the consumption response to fiscal stimulus payments. Econometrica 82(4), 1199–1239.

Kaplan, G., K. Mitman and G. Violante (2020). The housing boom and bust: Model meets evidence. Journal of Political Economy 128(9), 3285–3345.

Rothstein, J. and R. G. Valletta (2017). Scraping by: Income and program participation after the loss of extended unemployment benefits. Journal of Policy Analysis and Management 36(4), 880–908.

Wong, A. (2021). Refinancing and the transmission of monetary policy to consumption. Working paper, Princeton University.

Zhang, D. (2024). Closing costs, refinancing, and inefficiencies in the mortgage market. Working paper.

A Discretization and solution method

State space. Liquid assets lie on a grid of 20 points from zero to 21 quarterly wages, denser near zero (a quadratic spacing); the mortgage payoff on 16 equally spaced points from zero to 14.7, 84 percent of the value of the large house, so that purchase loans on the large house are limited by the grid and not by the 95 percent cap; house sizes in $\mathscr{H} = \{3,5\}$ and rental units in $\mathscr{H}_R = \{1.5,3,5\}$ in units of housing, with the reference price $p_H = 3.5$ per unit; the contract rate on the same three-point grid as the origination rate; productivity on three points; employment, credit status and four types, two taste types by whether benefits have run out. With the extended productivity index (type $\times$ productivity, twelve points) an owner has $20 \times 2 \times 16 \times 3 \times 12 \times 2 \times 2 = 92{,}160$ states and a renter 960, so each aggregate state carries 93,120 individual states and the joint state space of the baseline, with two labor-market states and three rates, has 558,720 points. The five-rate economy of Section 4.6 has 5×5 rate and contract-rate combinations and about 1.5 million joint states, and the house-price economy of Section C has four labor-and-price states and 1,117,440. Listing discounts and purchase premia lie on 13 points from zero to 30 percent.

Scheduled payment off the grid. The scheduled balance $(1-\alpha)M$ after a minimum payment generally falls between two grid points. The keep decision therefore includes, besides every on-grid balance at or below $(1-\alpha)M$ (prepayment), a lottery between the two grid points that bracket the scheduled balance, with weights that preserve its expectation; the continuation value is the weighted average over the two nodes and the transition operator places the corresponding mass on each. This keeps amortization exact in expectation without refining the balance grid.

Specialist and matching. Given the fixed price, the specialist's values $A(h)$ and $Q(h)$ are solved once by value iteration on the discount grid; they do not depend on Ω. The matching probabilities $\eta_s(d)$ and $\eta_b(d)$ follow from the free-entry conditions in closed form.

Household problem. For each aggregate state the household problem is solved by policy iteration with exact policy evaluation. Given expected continuation values, a sweep computes the optimal policy at every individual state by enumeration over the choice grids; this is the only step that is approximate, and only through the grids. Given a policy, the value function solves a linear system in which the coefficient matrix is the identity minus the discounted transition, and the system is block-structured over the aggregate state: block (Ω,Ω') is $\Pi_\Omega(\Omega' \mid \Omega)$ times the policy transition at Ω. For the baseline the system is solved directly with a sparse LU factorization; for the five-rate economy it is solved by GMRES preconditioned with the LU factors of the diagonal blocks. The iteration stops when the Bellman residual is below 10^{-8}; the reported solutions have residuals at machine precision. A solution of the baseline takes about a quarter of an hour on four cores, and those of the house-price and five-rate economies twenty to twenty-five minutes.

Refinancing opportunities and other blocks. Because the opportunity to refinance is drawn independently each period, the start-of-period value is the λ-weighted mixture of the value with the refinancing branch and the

value without it, and the policy transition operator is the same mixture of the two policy-induced operators.

Lender. Given household policies, the lender's value J of every existing loan solves a linear system of the same block structure; the guarantor's expected loss on each origination follows from J. Under the competitive-pricing variant, J and the price menu q would be iterated to a fixed point with damping; the uniform-pricing baseline needs no such iteration.

Distribution. The ergodic joint distribution is computed by iterating the distribution operator, which is the transpose of the joint transition including the newborn inflow, until the L^1 change falls below 10^{-9}. Conditional impulse responses propagate the conditional distribution under the shocked and baseline aggregate paths with expectations over future aggregate states, so they contain no simulation noise. Fixed cohorts are propagated under the survival-only operator, which removes households at the death rate and admits no newborns; the cohort's mass declines geometrically and per-capita responses divide by the surviving mass.

Checks. Four gates are verified for every reported solution: the Bellman residual, a budget identity at every state (consumption plus saving plus housing and mortgage payments equals cash on hand), conservation of mass under the transition operator, and the stationarity residual of the distribution. The code reproduces every nested special case exactly, including each extension with its switch turned off (44 tests).

B Data sources

Calibration. Job-finding and separation rates are computed from the labor force status flows of the Current Population Survey published by the Bureau of Labor Statistics. The origination-rate grid and its transitions come from Freddie Mac's Primary Mortgage Market Survey (PMMS), 30-year fixed rate, 2000 to 2026. The time on the market is the median reported by the National Association of Realtors, and closing costs are the averages reported by LodeStar for 2024 and CoreLogic for 2021. The replacement rate is the average ratio of benefits to wages reported by the Department of Labor for 1997 to 2018.

Household panel. The 2007–09 panel of the Survey of Consumer Finances is the public release of the Board of Governors of the Federal Reserve System: the full data set, the summary extract and the replicate weights. Estimates use the panel weight; standard errors combine the 999 replicate weights with the variance across the five implicates.

Second household panel. The Panel Study of Income Dynamics, public use dataset, is produced and distributed by the Survey Research Center, Institute for Social Research, University of Michigan, Ann Arbor, MI. I use the family files of 2007, 2009, 2011 and 2013 and the cross-year individual file, which links the families through their heads and gives the sampling-error strata and clusters. Estimates use the family longitudinal weight; standard errors come from a rescaled bootstrap that draws clusters within strata (63 strata, 126 clusters, 999 replicates). The year a loan was obtained is reported by the respondent, and of several refinancings between two interviews only the last is seen. The collection of these data was partly supported by the National Institutes of Health and the National Science Foundation.

Loan and regional data. Loan-level outcomes are from the Freddie Mac Single-Family Loan-Level Dataset, a sample of 12,500 fixed-rate loans per origination quarter. Metropolitan unemployment rates are from the Local

Area Unemployment Statistics of the Bureau of Labor Statistics, and house prices from the all-transactions House Price Index of the Federal Housing Finance Agency. Applications and their outcomes are from the Home Mortgage Disclosure Act loan and application registers for 2007 to 2013 distributed by the Consumer Financial Protection Bureau. Loan-to-value ratios at a given date (Appendix D) divide the balance in February 2009 by the value at origination carried to that date with the index of the loan's metropolitan area, or of its state for the 46 percent of loans, by weight, without a metropolitan index. The merged loan sample has 403 metropolitan areas, the house-price index 410 and the application regressions 386, which is why the number of areas differs across tables.

C House prices and employment together

This appendix adds an aggregate house-price state, sized from the metropolitan areas where prices fell, with no other parameter changed, and puts the collateral channel next to the labor channel. Section 5.6 summarizes the results; the tables and figures follow.

C.1 A house-price state

The aggregate state becomes a triple: labor market, house price and origination rate. A unit of housing costs p_H in the normal state and $0.80\,p_H$ in the bust. The price enters the loan-to-value caps on new loans, sale proceeds, the cost of a purchase and maintenance. Balances do not change, so a fall in prices raises the loan-to-value ratio of every existing loan; a borrower who keeps the loan faces no margin call. Entry costs are fixed in goods, so housing is less liquid in the bust. Rents do not change.

The FHFA all-transactions index for 410 metropolitan areas sets the size and duration of the bust. In the half of areas where prices fell more between the end of 2006 and the end of 2008, the index was 16 log points below its 2006 level at the end of 2008 and 23 to 31 points below in 2009 to 2011; in the other half it was flat. The bust price is 0.80 of the normal price; I report 0.90 and 0.70. Nominal prices in the large-bust half regained their 2006 level in 2018, so the bust ends with probability 0.02 per quarter. It begins with probability 0.005, one bust in the 48 years of the index; that rests on a single episode and matters only through expectations in normal times, since every experiment conditions on the state. Those expectations are not negligible: the in-the-money cohort is less leveraged here than in the baseline (Appendix D). The price state is independent of the labor-market state.

The experiment is the one-step cut of Section 4 with cohorts fixed at the cut. Prices fall in the quarter of the cut, before any household can pay down its balance: an upper bound on the exclusion in December 2008, when prices had been falling for two years. Appendix D reports the other extreme, households drawn from the long-run distribution of the bust state. "Above the cap" means that a new loan equal to the balance plus the closing cost would exceed 80 percent of the house's value at the bust price.

The size of the price effect depends on how many in-the-money mortgagors a given fall pushes above the cap, so the aggregates below use the cohort of a cut to a new low (Section 4.6), whose leverage is close to that of the loans of 2009, with the long-run cohort beside it; Appendix D compares the leverage of the two cohorts with the data's.

C.2 The two channels side by side

Table 12 puts the two channels on one scale. Relative to a cut in a tight labor market at normal prices, slack lowers the first-year refinancing response of the new-low cohort by 7 percent, lower prices by 23 percent, and both by 26 percent. The effects nearly add; the joint effect is 4 points less than their sum because a household both unemployed and above the cap is excluded only once. Slack lowers the response by 4 percent when prices are low and by 7

percent when they are not: low prices neither amplify the labor channel nor remove it. The price effect grows with the fall, 9 percent for a fall of 10 percent and 31 percent for 30. In the long-run cohort the same 20 percent fall lowers the response by 46 percent and slack by 5 percent, because about twice as large a share of it starts close to the cap (Figure 8, Panel A, shows the new-low cohort's paths). For the easing of 2008 the first set of numbers is the relevant one: a price fall of the size seen in the bust areas cost between a fifth and a quarter of the refinancing response, the slack labor market less than a tenth.

Table 12: A rate cut in a slack labor market, after a fall in house prices, and both: change in the response relative to a tight labor market at normal prices, percent

	Slack only	**Prices 20% lower only**	**Both**
A. Cut to a new low: the cohort has the leverage of the loans of 2009			
Refinancing, in-the-money mortgagors, year 1	−7	−23	−26
with equity extraction, year 1	−8	−34	−38
Consumption, in-the-money mortgagors, 12 quarters	−7	−50	−55
Consumption, homeowners at the cut, 12 quarters	−7	−37	−42
B. Cohort of the long-run distribution			
Refinancing, in-the-money mortgagors, year 1	−5	−46	−48
with equity extraction, year 1	−2	−56	−56
Consumption, in-the-money mortgagors, 12 quarters	−5	−65	−69
Consumption, homeowners at the cut, 12 quarters	−8	−62	−66

Notes: One-step cut. Entries are the percent difference in the cumulative response (path with the cut minus path without it) from the response in a tight labor market at normal prices. Prices fall in the quarter of the cut. Panel A: the cut follows thirty years on which the origination rate never enters its lowest state (Section 4.6). Panel B: households drawn from the long-run distribution of the normal-price state. Cohorts are fixed at the cut and exclude entrants. Appendix D gives further rows and timings for the long-run cohort.

Consumption falls by more than refinancing. In the new-low cohort, homeowners' cumulative twelve-quarter consumption response is 37 percent smaller after the price fall and 42 percent smaller with both, against 7 percent for slack alone. The cap binds on the amount borrowed, so refinancing that extracts equity falls by 34 percent against 23 percent for all refinancing. In the long-run cohort the consumption response is 62 percent smaller after the price fall.

C.3 Excluded by unemployment, by equity, or by both

Table 13 splits the in-the-money cohort by employment and equity at the cut, in a slack labor market with lower prices. In the new-low cohort, employed households above the cap, 39 percent of the cohort, refinance 80 percent less in the first year than employed households below it; unemployed households below the cap 56 percent less, unemployed households above it 92 percent less. The long-run cohort has more households above the cap and gaps of 87, 55 and 94 percent. The employment gap does not depend on the price state: across the four aggregate states, whether the bust arrives with the cut or long before it, it lies between 41 and 58 percent in the long-run cohort.

The equity exclusion is the tighter of the two for the household it hits, and it lasts longer. An unemployed homeowner regains eligibility with a job, after about two quarters on average, and after three years has refinanced 64 percent as often as an employed one. A homeowner above the cap must wait for prices to recover or pay down the balance, and after three years has refinanced 30 percent as often as one below it (Figure 8, Panel B).

The two household panels of Section 5 allow the same split (Panel B). In the Survey of Consumer Finances,

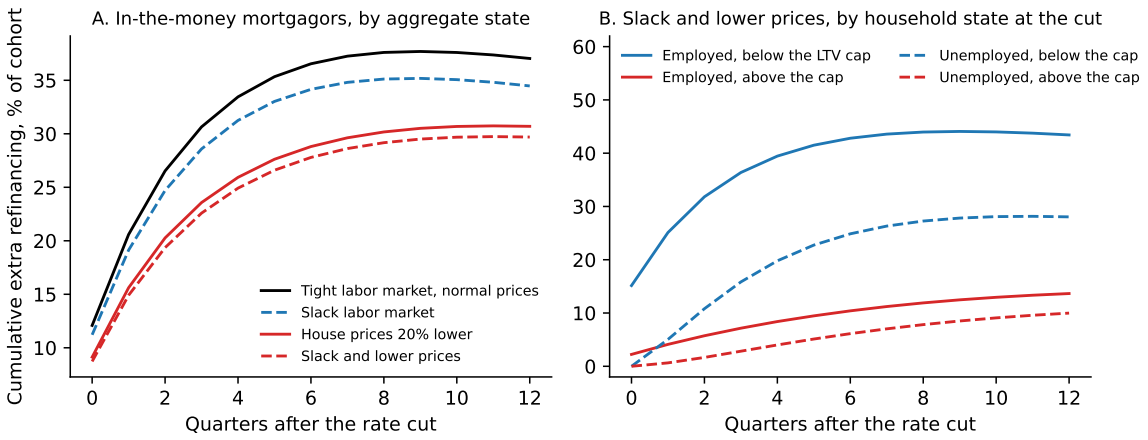


Figure 8: Cumulative refinancing in response to a one-step cut, in percent of the cohort (path with the cut minus path without it); cohort of a cut to a new low. Panel A: in-the-money mortgagors by aggregate state; prices fall in the quarter of the cut. Panel B: slack labor market and lower prices, by employment and equity at the cut.

Table 13: In-the-money mortgagors by employment and equity: first-year refinancing relative to employed households below the cap, model and the two household panels

A. Model: slack labor market, house prices 20 percent lower

	Cut to a new low		Long-run distribution	
State at the cut	**Share, %**	**Gap, %**	**Share, %**	**Gap, %**
Employed, below the cap	52	–	28	–
Employed, above the cap	39	−80	63	−87
Unemployed, below the cap	5	−56	3	−55
Unemployed, above the cap	4	−92	6	−94

B. Household panels, refinancing in 2009: gap in percent (standard error)

	Survey of Consumer Finances		Panel Study of Income Dynamics	
State in 2009	**Raw**	**Controls**	**Raw**	**Controls**
No spell, above 80 percent	−60 (10)	−86 (12)	−36 (13)	−50 (13)
Spell, below 80 percent	−52 (14)	−50 (13)	−61 (14)	−58 (16)
Spell, above 80 percent	−92 (8)	−105 (12)	−52 (16)	−72 (18)

Notes: Panel A: one-step cut; prices fall in the quarter of the cut; gap in cumulative additional refinancing over the first four quarters relative to employed households below the cap, a gap in the response to the cut; shares are those of the slack-state distribution. Panel B: in-the-money fixed-rate families of Tables 8 and 9, split by an unemployment spell and by whether the mortgage balance is at least 80 percent of the owner's valuation of the home; gap in the share that refinanced, a level, relative to families with neither, from a linear probability model, so that a gap can exceed 100 percent. For the unemployed the model's level gap is five to nine points smaller than its response gap (Section 5). Controls: household characteristics. Standard errors as in Section 5.

families above 80 percent without a spell refinanced 60 percent less in 2009 than families with neither, families with a spell below 80 percent 52 percent less, and the 40 families with both 92 percent less. In the Panel Study of Income Dynamics the raw gaps are 36, 61 and 52 percent, and 50, 58 and 72 with household controls. Each exclusion alone shows up in both panels. The employment gap is stable, 50 to 61 percent across panels and specifications, against 56 in the model; the equity gap is not, 36 to 86 percent, around the model's 80. The joint cell has the largest gap in the first panel, as in the model, but in the second only with household characteristics held fixed. Families above 80 percent without a spell were not less interested: in the first panel 52 percent considered refinancing, against 41 percent of the reference group. Valuations are self-reported and the joint cells are small.

Consumption follows access to equity (Figure 9). The cut raises the consumption of homeowners below the cap, employed or not; the unemployed among them receive it one to two quarters later, as in Section 4. It does nothing for homeowners above the cap for about a year, employed or not: those who refinance at all bring cash to do so.

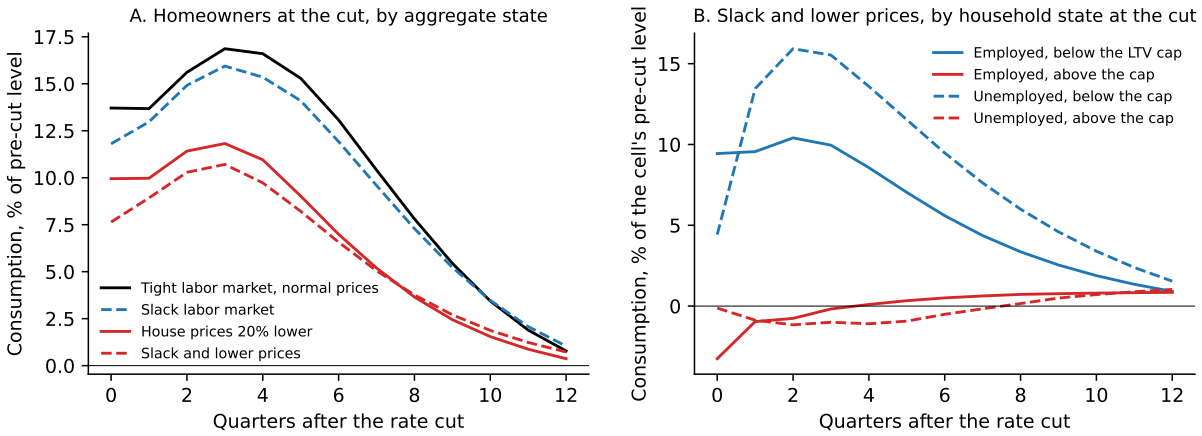


Figure 9: Consumption response to a one-step cut; cohort of a cut to a new low. Panel A: homeowners at the cut, by aggregate state, in percent of their pre-cut consumption in a tight labor market at normal prices; prices fall in the quarter of the cut. Panel B: in-the-money mortgagors in a slack labor market with lower prices, by employment and equity at the cut, in percent of each cell's pre-cut consumption.

C.4 The regional contrasts in the data

No parameter was chosen to match regional refinancing, so the regional data of Section 5 are a check on it. I sort the metropolitan areas into four cells by the house-price split and the unemployment terciles used there, with small bust and low unemployment as the reference. The upper panel of Table 14 reports, for the other three cells, the change in the prepayment rate of in-the-money loans relative to the reference cell between 2005–2007 and 2009–2011, and the change in all lenders' refinance originations in the Home Mortgage Disclosure Act registers between 2007 and 2009–2011.

These are levels, refinancing after the cut relative to refinancing before the bust, so the model counterpart is the level on the path with the cut, not the response. I take the new-low cohort class by class, classes formed on loan-to-value after the fall, weight the classes by the distribution of each cell's in-the-money loans at end-2008 or end-2010 prices, and compute refinancing on the path with the cut relative to the reference cell, before and after, as in the data (lower panel). Where only prices fell, refinancing in the year after the cut is 9 to 14 percent lower; prepayment in the data fell by 26 percent, two-standard-error band 10 to 39, and refinance originations by 17 percent (-33 to $+4$). Where prices fell and unemployment was high the model gives 27 to 36 percent, against 46 percent (34 to 56) and

44 percent (-54 to -32). Where only unemployment was high it gives 6 to 8 percent lower refinancing, against $+3$ percent for prepayment, with a wide band around zero, and 18 percent lower originations (-30 to -3). Where prices fell the model has the sign of the data and the larger shortfall in the cell where both hit, but falls short of the size: 34 to 53 percent of the fall in prepayment where only prices fell and 58 to 79 percent where both hit. With end-2010 leverage its numbers are inside the two-standard-error bands of both measures in every cell; with end-2008 leverage they are at or beyond the edge of the prepayment band where prices fell. The bands are wide: agreement in sign and rough size, not a tight test.

The timing shows what kind of gap this is. Most of the regional gap in prepayment was open in 2008, before the cut: relative to 2008, prepayment in 2009–2011 changed by -8 and -11 percent in the two bust cells, and all lenders' refinance originations by $+3$ and $+1$ percent, none different from zero. The model has the same property: with each cell's leverage, the level of refinancing after the cut relative to the same path without the cut differs from the reference cell by $+1$ and $+6$ percent. A fall in prices lowers the level of refinancing, mostly by removing equity extraction, and the cut then raised refinancing in the bust areas in about the same proportion as in the reference areas: the part of the regional gap that goes with the bust is a gap in levels the bust opened, not a proportionally weaker response to the cut. What remains after 2008 is in the areas with high unemployment and a small bust, where all lenders' refinance originations were 18 percent lower against 2007 and the model gives 6 to 8 percent.

The cells differ in more than prices and unemployment, and the comparison period, 2005–2007, was a boom in the areas that later fell. The price fall in the cell with high unemployment and a large bust was three times as deep as in the cell with low unemployment and a large bust, so the difference between them reflects the depth of the bust, not unemployment biting harder where prices fall; the model has no such interaction. The gap left open in Section 5 narrows but does not close: cash-out originations fell by 24 percent in high-unemployment areas where prices held (two-standard-error band 9 to 36), and with that cell's leverage the model's equity extraction in the year after the cut is 8 to 12 percent lower. In the bust cells it gives 21 to 28 percent against 27 in the data, and 50 to 58 percent against 52.

C.5 Lifting the loan-to-value ceiling

From 2012 the second version of the Home Affordable Refinance Program let borrowers with agency loans refinance the outstanding balance at any loan-to-value ratio. I remove the cap on new loans up to the balance plus the closing cost and keep the cap on equity extraction and the employment requirement. The numbers are for the long-run cohort, which has more households above the cap, so they are an upper bound on what the waiver restores. In a slack labor market with lower prices, the first-year refinancing response of the in-the-money cohort rises from 14 to 35 percent of the cohort, within 3 percent of its value at normal prices under the same rule. Employed households above the cap refinance as often as those below it. Unemployed households above the cap go from 2 to 18 percent, still half the employed rate, because they must first find a job. The regional gap in prepayment closes in 2012 (Figure 7).

Consumption recovers less. The cohort's twelve-quarter consumption response rises from 16 to 32 percent of quarterly consumption, against 48 percent at normal prices, 49 percent of the shortfall, and the response of all homeowners at the cut stays 63 percent below its normal-price value, against 66 percent without the waiver. A lower payment on an unchanged balance is small next to the proceeds of a cash-out loan; most of homeowners' consumption response to a cut comes from borrowing more, which the waiver does not allow. The program's timing is not clean evidence for the model, since rates fell again and prices began to recover in 2012.

Table 14: Regional contrasts in loan data and the model's level of refinancing after the cut, with each cell's leverage

	High unemployment, small bust	**Low unemployment, large bust**	**High unemployment, large bust**
Data: cell relative to low unemployment, small bust			
House prices, log points, end of 2008 / 2010	−2 / −3	−9 / −15	−30 / −39
Unemployment rate, October 2008, points	+2.8	+0.3	+3.8
Prepayment, in-the-money loans, log points	+3 (11)	−30 (10)	−62 (10)
in percent	+3	−26	−46
Cash-out originations, log points	−27 (9)	−32 (8)	−73 (11)
in percent	−24	−27	−52
Refinance originations, all lenders, percent (against 2007)	−18	−17	−44
Areas	33	30	92
Model, cut to a new low, leverage of the cell's loans at end-2008 / end-2010 prices, percent			
Refinancing after the cut, year 1	−6 / −8	−9 / −14	−27 / −36
Refinancing after the cut, years 1–3	−6 / −7	−7 / −11	−22 / −30
With equity extraction, after the cut, year 1	−8 / −12	−21 / −28	−50 / −58
Refinancing response to the cut, year 1	−8 / −9	−9 / −14	−25 / −35

Notes: Data: pooled annual rates by cell; the entry is the mean log ratio of the cell to the reference cell in 2009–2011 minus its mean in 2005–2007, times 100, with standard errors from 500 bootstrap draws of areas within cells (Table 10 draws within terciles, which gives slightly different standard errors); cell characteristics are weighted by the 2008 loan stock. Cells use the unemployment terciles and the median split of the 2006Q4–2008Q4 change in the FHFA index of Section 5; the middle tercile is omitted. All lenders: refinance originations in the Home Mortgage Disclosure Act registers, pooled by cell, 2009–2011 against 2007, relative to the reference cell. Model: one-step cut after thirty years without the lowest rate; prices fall in the quarter of the cut; class outcomes of the experiment that matches the cell (slack; prices 10 percent lower; slack and prices 30 percent lower), classes formed on loan-to-value at the lower price, weighted by the distribution of the cell's in-the-money loans (February 2009 balance over the origination value carried to the stated date with the FHFA index). "After the cut": the level on the path with the cut, relative to the reference cell, over the same ratio for the path without the cut at normal prices and end-2006 leverage. "Response": the path with the cut minus the path without it.

C.6 What this extension does not do

House prices are an exogenous state: the model does not explain the bust, and the fall in refinancing and consumption does not feed back on prices. On the purchase side the model is at odds with the bust: with rents fixed and prices expected to recover, renters buy more when prices are low, and the homeownership rate in the long-run distribution of the bust state is 73 percent against 67 percent in normal times in this economy. The results above use cohorts fixed at the cut and drawn from the normal-price distribution, which this does not touch, and report homeowners' rather than aggregate consumption for the same reason. The history of a cut to a new low is rare (Section 4.6); it describes the easing of 2008, not a typical cut. Sales are rare in the model, 2 to 4 percent of the cohort a year depending on the state, so it has nothing to say on the part of prepayment that is home sales.

D The house-price extension: leverage of the cohort and the long-run cohort

This appendix supports two choices of Appendix C: the use of the cohort of a cut to a new low for the aggregates, and the timing of the price fall. It also gives the full set of results for the cohort of the long-run distribution.

D.1 How leveraged the cohort is

The size of the price effect depends on how many in-the-money mortgagors a given fall pushes above the cap, and no parameter targets that number. Table 15 compares the cohort with two data sources. In the model's long-run distribution, 34 percent of the cohort has a loan-to-value ratio above 79 percent at normal prices, the highest ratio at which the balance can be refinanced under the cap, and the median ratio is 75. In the Freddie Mac sample I take the loans outstanding in February 2009 with a coupon at least half a point above the market rate and value each house at the prices of the end of 2006, carrying the value at origination forward with the FHFA index of its area. The median ratio is 60 and 13 percent of the loans are above 79. In the survey of Section 5, counting all debt secured by the home against the owner's 2007 valuation, the median is 60 and 26 percent are above 79 (19 percent for the first mortgage alone).

The same holds after the fall. A 20 percent fall puts 69 percent of that cohort above the cap. In metropolitan areas where the index fell by 15 to 25 log points between the end of 2006 and the end of 2008, 39 percent of in-the-money loans were above 79 percent at the prices of the end of 2008 and 53 percent at those of the end of 2010, when the index in those areas was 27 percent below its 2006 level. In the cell of areas with a large bust and high unemployment the shares are 40 and 53 percent. In the survey, 32 percent of families were above 79 percent in 2009 on the first mortgage and 37 percent on all debt, across all regions. The long-run cohort is far more exposed to a given fall than the loans in the data.

The source is the rate process (Section 4.6): the long-run cohort is the 19 percent of mortgagors who borrowed while rates were not at their lowest, recent and large loans, while 71 percent of the 2009 loans, seasoned ones included, were in the money. The model's stock of all mortgages is close to the data in the upper part of the distribution: 12 percent are above 79 percent.

A cut to a new low gives the model the cohort of 2009. Section 4.6 describes the experiment: the economy runs thirty years on which the origination rate never enters its lowest state, as was true of every year before 2011, and the one-step cut follows. 72 percent of mortgagors are then in the money, the median loan-to-value ratio of the cohort is 56, and 17 percent are above 79 percent (Table 15, Panel A). A 20 percent fall puts 42 percent of this cohort above the cap in a tight labor market; Panel B gives the cohort's responses. The household-level gaps move less; Table 13 gives them for this cohort beside the long-run cohort's and the survey's.

A second route to the same correction keeps the long-run cohort and changes its weights. Refinancing in the model depends on leverage class by class, so the data's distribution can be applied to the model's responses. I split the cohort by loan-to-value at normal prices, compute the response of each class in every experiment, and weight the classes by the data's shares (Panel B). With the Freddie Mac distribution a 20 percent fall lowers the first-year response by 30 percent, not 46; slack lowers it by 6 percent, not 5; and the two together by 32 percent, not 48. With the survey's distributions the price effect is 22 to 24 percent and the labor effect 7 percent. The price effect is smaller because more of the data's loans are far from the cap: 54 percent of the Freddie Mac loans and 54 percent of the survey families are at or below 63 percent, where a 20 percent fall does not bind, against 31 percent of the long-run cohort. The labor effect is larger for the same reason: borrowers with low ratios refinance to extract equity, and equity extraction is what slack holds back. The two routes agree: a 20 percent fall lowers first-year refinancing

Table 15: Leverage of in-the-money mortgagors in the model and in the data, and the experiments of Appendix C under the data's distribution

A. Loan-to-value ratio before the fall, percent of the cohort

	55 or less	55–63	63–71	71–79	Above 79	Median
Model, long-run distribution	18	13	13	22	34	75
Model, cut to a new low	42	16	11	14	17	56
Model, all mortgagors	29	20	18	21	12	65
Freddie Mac, in-the-money loans, end-2006 prices	42	13	14	18	13	60
Survey, in-the-money families, first mortgage	48	11	11	11	19	57
Survey, in-the-money families, all debt on the home	45	9	11	9	26	60

B. First-year refinancing response of the cohort, percent change from a tight labor market at normal prices

Distribution of the cohort	Slack	Prices −10%	Prices −20%	Prices −30%	Slack, prices −20%	Consumption, prices −20%
Model, long-run distribution	−5	−21	−46	−52	−48	−65
Model, cut to a new low	−7	−9	−23	−31	−26	−50
Long-run cohort re-weighted: Freddie Mac loans	−6	−11	−30	−38	−32	−56
survey, first mortgage	−7	−8	−22	−30	−25	−51
survey, all debt on the home	−7	−9	−24	−32	−27	−52

Notes: Panel A: loan-to-value classes in percent of the house value, upper bounds included; the balance can be refinanced under the 80 percent cap up to 79 percent, allowing one point for closing costs. Model: households at the cut in a tight labor market at normal prices, drawn from the long-run distribution or from the distribution after thirty years without the lowest origination rate ("cut to a new low"). Freddie Mac: loans outstanding in February 2009 with a coupon at least 0.5 percentage points above the January 2009 market rate, weighted; balance in February 2009 over the origination value carried to 2006Q4 with the FHFA all-transactions index of the loan's metropolitan area or state. Survey: the in-the-money families of Table 8, 2007 balances over the owner's 2007 valuation. Panel B: first and second rows, the cohort's own response, as in Table 12. Other rows: the long-run cohort's response in each experiment, class by class, weighted by the distribution of the data source. Last column: the cohort's consumption response over twelve quarters. Loans above 100 percent before the fall, 2 percent or less of each data source, take the response of the model's highest class.

by 22 to 30 percent and slack by 6 to 7 percent, so the two channels differ by a factor of about 3 to 5, not 10. The consumption response is less sensitive to the distribution. The cohort's twelve-quarter response falls by 56 percent after a 20 percent fall under the Freddie Mac distribution, against 65 percent, and that of all mortgagors at the cut, a slightly different group from the homeowners of Table 12, by 53 percent against 62; the effect of slack on it is 5 percent either way.

Two limits apply. The Freddie Mac file holds conforming first mortgages, and the index that values the houses draws on appraisals as well as sales, so the loan data are likely to understate leverage after the fall; the survey counts all debt on the home, at the owner's valuation, and gives a smaller price effect because fewer of its families sit just below the cap. The re-weighting keeps the composition of each class as in the long-run cohort, and a class holds one or two points of the balance grid; the new-low cohort, which needs no weights, is the check on it.

D.2 The cohort of the long-run distribution

For the long-run cohort of Table 12 the cap binds on the amount borrowed, so refinancing that extracts equity falls by 56 percent and refinancing that does not by 31 percent. In the long-run distribution of the bust state the rate-and-term refinancing rate is 0.23 percent per quarter, against 0.15 percent at normal prices: households that cannot extract equity refinance the balance instead. In the normal-price states the quarterly refinancing rate is 1.4 percent and 12 percent of mortgagors could not refinance their balance without bringing cash; in the bust states the rate is 0.9 percent and the share 32 percent, 3 percent of mortgagors owe more than the house is worth, and the default rate does not rise.

The size of the price effect depends on how far prices fall and on when. A fall of 10 percent lowers first-year refinancing of in-the-money mortgagors by 21 percent and a fall of 30 percent by 52 percent; the labor effect is 5 percent in each case. When households are drawn from the long-run distribution of the bust state, after those who can have paid down their balances, the price effect of a 20 percent fall is 33 percent and the joint effect 35 percent. A bust half as persistent gives 47 percent for the joint effect, and holding matching probabilities at their normal-price values gives 48 percent.

D.3 Sales and prepayment

Prepayment is not refinancing: a loan is also paid off when the house is sold, and the Freddie Mac sample is not the market. Sales do not account for the difference where only prices fell: in the model the cohort sells 2 to 3 percent of its homes in the year after the cut, about as many when prices are low, and in the registers purchase originations in the two cells with a bust changed by 0 and +15 percent relative to the reference cell after 2007. The collapse of home sales came before 2007, outside the registers used here, and its part in the fall of prepayment since 2005–2007 stays unmeasured.

D.4 The length of the history

The length of the history is the one choice in the new-low experiment. Table 16 shows what it does. The share of mortgagors in the money rises with the length and reaches the 71 percent of the loan data near thirty years, the length used in the paper; the leverage of the cohort falls with it toward the loan data without having been chosen for it: 20 percent of the cohort are above 79 percent at thirty years, against 13 percent of the loans. In the economy with a price state the cohort is less leveraged, 17 percent above 79 percent and a median of 56 against 62 here (Table 15); the two economies differ only in the possibility of a bust, and the difference is not decomposed here. A history of ten years leaves the cohort about halfway between the long-run one and that of thirty years.

Table 16: The in-the-money cohort after a history without the lowest origination rate, by length of the history

Quarters without the lowest rate	**0**	**40**	**80**	**120**	**160**	**200**
Mortgagors in the money, percent	19	41	58	72	82	89
Cohort above 79 percent loan-to-value, percent	38	30	24	20	18	16
Median loan-to-value of the cohort, percent	75	73	65	62	56	56
Probability of the history, percent	66.4	14.9	3.4	0.8	0.2	0.0

Notes: Baseline economy without a price state, tight labor market. Zero quarters is the long-run distribution; its probability is that of not being in the lowest state. Loan data: 71 percent of Freddie Mac loans in the money in February 2009, 13 percent of them above 79 percent at end-2006 prices, median 60.

E Housing frictions: a finer grid, time on the market, and one side of the market at a time

Time on the market and the calibrated entry costs. The National Association of Realtors has two measures of time on the market, which are not comparable. For all listings, short sales included, the median was 14 weeks in mid-2011 and 10 weeks in mid-2012. For traditional sellers it peaked at 10 weeks in 2009, against a typical 7 weeks over 1987 to 2011 and 4 weeks in 2004 and 2005. For a seller who pays the usual cost the calibrated market is about as illiquid as the market of 2011 on the first measure, somewhat less liquid than the market of 2009 on the second, and less liquid than a normal market on either. Owners who list in the model concede less, 6 percent on average, and sell with probability 0.26 per quarter, a median of about 30 weeks. The comparison with the Realtors' medians is therefore for a seller who gives up the usual cost, and it reads the concession as the whole cost of a sale: the model has no separate commission. If the commission is a cost paid in any market and only the remainder buys speed, a remainder of 2 to 4 percent sells nothing at these entry costs. Time on the market does not pin the entry costs down as sales do, because it depends on what a seller concedes. If sellers concede the usual 7.5 to 10 percent, the 10 weeks of traditional sellers in 2009 correspond to entry costs of 0.11 to 0.14 and the 14 weeks of all listings in 2011 to 0.14 to 0.18, the region of the bound from sales and of the baseline. With concessions of 5 to 7.5 percent the same 10 weeks correspond to 0.07 to 0.11. Across the grid the model's sellers concede 3 to 6 percent on average and take a median of 13 to 30 weeks to sell, longer than either measure at every entry cost and not monotone in it, because they choose the concession. Time on the market is therefore used here to say what the entry costs mean under a stated concession, not as a second bound.

Part of the steepness comes from a grid. A seller chooses the concession in steps of 2.5 percent of the price, and at entry costs below 0.0875 the smallest step already sells. On a grid twice as fine the ratio is 0.41 at entry costs of 0.15, 0.57 at 0.125, 0.86 at 0.10, 1.18 at 0.0875 and 1.55 at 0.075, against 0.44, 0.55, 0.81, 1.02 and 1.35 on the baseline grid. The bound from sales is then 0.11, where the ratio is about 79 percent. The baseline moves little (0.41 against 0.44); the liquid end of the range is somewhat higher on the finer grid, and the shape is the same.

The same grid says where the result stops. The impact response of the unemployed reaches that of the employed at entry costs of 0.089, 59 percent of the calibrated value (0.094 on the finer grid). If sellers concede the usual cost, the typical 7 weeks of traditional sellers over 1987 to 2011 correspond to entry costs of 0.071 to 0.095, at which the ratio is between 0.9 and 1.4: in a typical housing market the cohort means show a weak delay or none, and in a fast one, as with entry costs of 0.05, none. That reading inherits the assumption about concessions, and its upper end meets the lower end of what the sales of 2007 to 2009 allow.

Lowering one side of the housing market at a time gives the same reading. With the seller's entry costs alone at 0.10 the sale rates stay below the survey's bounds only when prices fall, and with the buyer's alone at 0.10 only when prices fall; at 0.075 the seller's side stays below them only when prices fall and the buyer's side on neither path. The cohort mean is 53 and 59 percent of the employed response at 0.10 (seller's side, buyer's side) and 61 and 68 percent at 0.075. The survey bounds the buyer's side at least as tightly as the seller's: what it rules out is above all a cheap return to ownership.