Unemployment Insurance and Macro-Financial (In)Stability*

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Abstract

We identify and study two mechanisms that can undermine the stabilizing effects of unemployment insurance policies. First, households in economies with more generous unemployment insurance reduce their precautionary savings and borrow more in the mortgage market. Second, the share of mortgages among bank assets, as well as the proportion of mortgages with higher loan-to-income ratios, increases on bank balance sheets. As a result, both bank and household balance sheets become vulnerable to adverse shocks, which deepens recessions. Furthermore, booms are also amplified, as reduced income risk enables households to increase their mortgage debt, consumption, and housing demand in response to expansionary shocks. We employ a quantitative general equilibrium model that incorporates interactions between household, bank, and firm balance sheets, as well as county- and state-level evidence from the U.S. housing and mortgage markets, to demonstrate the importance of these channels.

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1 Introduction

Automatic stabilizers are government policies that automatically adjust tax rates and transfer payments to stabilize income and consumption without requiring a vote from legislators. Unemployment insurance (UI) is one of the textbook examples of automatic stabilizers. The predominant view is that UI policies stabilize economic downturns by transferring income to households with a high marginal propensity to consume (MPC) and by reducing their income risk.[1]

Contrary to this widely-held view, we argue that there are two mechanisms strong enough to overturn the stabilizing effects of unemployment insurance. First, under more generous UI policies, there is a reduction in the risk of rare disastrous state, namely unemployment. As a result, households hold fewer liquid assets and borrow more in the mortgage market, increasing their leverage.[2] Hence, household balance sheets become more vulnerable to adverse shocks.

Second, bank balance sheets become more vulnerable to adverse shocks as well since banks increase credit supply and offer looser credit terms due to lower idiosyncratic default risk. The share of mortgages, as well as the proportion of mortgages with higher loan-to-income ratios, increases in bank balance sheets. When faced with an adverse shock, an economy with more vulnerable balance sheets experiences a deeper contraction despite more generous UI benefits. Furthermore, booms are also amplified since households with smaller income risk increase their mortgage debt, consumption, and housing demand more in response to expansionary shocks.[3]

We present two sets of evidence for the destabilizing effects of unemployment insurance. Firstly, using a quantitative general equilibrium model that takes into account the interactions between household, bank, and firm balance sheets, we demonstrate that economies with higher unemployment insurance replacement rates actually experience larger booms and busts in response to aggregate shocks. Secondly, we provide micro-level evidence on the effects of unemployment insurance on house prices and mortgages, using a border discontinuity design in the US that supports the quantitative model's predictions.

[1]See for example, Baunsgaard and Symansky (2009), Blanchard, Dell Ariccia and Mauro (2010), Blinder (1975); Blanchard, Dell Ariccia and Mauro (2010), Auerbach (2002), and Feldstein (2009).

[2]Rare disaster risk has been shown to have stronger implications than an equivalent risk measured by standard deviation. It can help understand some puzzling features of data, such as the equity premium, international risk sharing, and others. Additionally, it can generate high welfare costs from aggregate fluctuations. For more information, see references such as Barro (2006), Farhi and Gabaix (2016), Gabaix (2012), and Chatterjee and Corbae (2007).

[3]The arguments we make regarding destabilizing effects of unemployment insurance can be extended to other government tax and transfer programs that reduces the left tail income risk.

Our quantitative general equilibrium model combines three key sectors of the economy: (i) a rich heterogeneous agent overlapping-generations structure of households who face income and unemployment risk, and who make housing tenure decisions and borrow through long-term mortgages, (ii) banks that issue short-term loans to firms and long-term mortgages to households and whose ability to intermediate funds depend on their capital, and (iii) firms that finance part of their capital from banks through short-term loans.

Households can default on their mortgages in any period throughout the life of the mortgage. As mortgage contracts internalize the default probability of households, each mortgage is individual-specific, and borrowing limits endogenously arise due to limited commitment by households.

Banks fund themselves through international investors and household deposits, and can give short-term loans to firms, and issue and invest in long-term mortgages. We assume that bankers can steal a fraction of their assets and default. As a result, to avoid such behavior in equilibrium, lenders limit their funding to banks, creating an endogenous collateral constraint on bank lending where the market value of banks's assets serve as collateral. This constraint limits banks' credit supply.

We calibrate the steady state of the model to match several US data moments, most importantly those regarding household and bank balance sheets. We then analyze the steady state effects of unemployment insurance, which we find to be substantial. A higher level of unemployment insurance mitigates households' left-tail income risk, thereby reducing their default risk. Consequently, households receive better credit terms from banks. The combination of lower income risk and better credit terms allows households to borrow more in the mortgage market, increasing their leverage. Moreover, households reduce precautionary savings, which increases the fraction of hand-to-mouth households. Overall, we find that increasing the unemployment insurance replacement rate from zero to 40 percent reduces precautionary savings by about 30 percent and average down payment ratio by 64 percent, while increasing the mortgage debt-to-income ratio by 26 percent. The size of banking sector, measured by bank assets to GDP ratio, increases by 10 percent. The share of mortgages among bank assets increases by 15 percent.

To analyze the (de)stabilizing effects of unemployment insurance, we study a boom-bust transition generated by two unexpected shocks under different levels of UI generosity. [4] Our results indicate that not only are busts amplified under more generous unemployment

[4] Although we use shocks to the bank funding rate for our benchmark results, we have also generated boom-bust cycles with different shocks, such as bank leverage, housing demand, or productivity shocks. These specifications yield qualitatively similar results.

insurance systems, but so are booms. House prices, household debt, consumption, and output increase more during the boom and decline more in the recession. Foreclosures increase, bank net worth declines, and the credit supply decreases, leading to a larger increase in the bank lending rate during the recession, which further raises the cost of borrowing for households and firms.

The destabilizing effects of unemployment insurance are driven by its impact on the employed during a recession. In fact, unemployment insurance fulfills its intended purpose by helping the unemployed: they experience lower foreclosure rates and smaller declines in consumption, as well as smaller increases in foreclosures during a recession in an economy with higher unemployment insurance. Conversely, the situation is different for the employed during a recession. They enter the recession with higher leverage and do not receive the benefits of unemployment insurance, resulting in larger declines in consumption and greater increases in foreclosures. Since the majority of the population is employed, their behavior largely drives aggregate trends.

That unemployment insurance destabilizes economic fluctuations is not an a priori conclusion in our model. In fact, when the government increases unemployment insurance unexpectedly and temporarily during a recession, such a discretionary increase stabilizes the downturn. However, permanent increases in unemployment insurance affect household and bank balance sheets in a manner that makes them vulnerable to downturns, which dominates its stabilizing effects.

To analyze the drivers of the destabilizing effects of unemployment insurance, we conduct several decomposition exercises and show that general equilibrium effects play an important role in destabilizing effects of unemployment insurance. First, we focus on the general equilibrium feedback from the bank balance sheets to the rest of the economy. As mortgages are long-term assets, their market value declines when credit markets tighten in recessions. This makes bank balance sheets more vulnerable to adverse shocks, especially when banks have more mortgages on their balance sheets. Additionally, an increase in the mortgage debt-to-income ratio makes banks more prone to foreclosures. Consequently, bank net worth declines more under a more generous UI system, causing a larger decline in credit supply and a larger increase in the bank lending rate, which makes borrowing more costly for both households and firms, deepening recession.

To disentangle the role of the bank balance sheet channel, we solve a version of the model where banks do not face any capital constraints, effectively eliminating the sharp increase in the bank lending rate during a recession. In this case, a higher unemployment insurance no longer destabilizes output and actually stabilizes consumption (at least in the short run) during recessions. House prices still decline more and foreclosures increase more under a higher unemployment insurance system, but by smaller amounts. Overall, these results show that the bank balance sheet channel is an important contributor to the destabilizing effects of higher unemployment insurance.

Second, we show that the systemic risk created by increasing unemployment insurance for the entire economy is not captured by studying the stabilizing effects of unemployment insurance using cross-sectional variation. In fact, when we create cross-sectional variation across regions within our model economy, as in the data, we find that regions with higher unemployment insurance actually experience smaller declines in consumption during a recession. The destabilizing effects on other variables are also significantly smaller. These results suggest that empirical findings that rely on cross-state variation in unemployment insurance could be underestimating the destabilizing effects of unemployment insurance since they might not fully capture the systemic risk that it creates on the banking system of the whole economy.

In the second part of the paper, we provide empirical evidence from the US housing and mortgage markets that supports the model's predictions. The UI system in the U.S. provides an ideal setting as each state can set its own UI level, which leads to significant heterogeneity in UI generosity across states. We exploit this heterogeneity by comparing two neighbor counties that are located at state borders, one of them located in one state and the other located in the other state.[5] On the one hand, being located in different states, these counties have different levels of UI benefits. On the other hand, being neighbors to each other, when an economic shock hits one county, the neighboring county is affected by the shock in symmetrically. Therefore, the discontinuous change in UI levels at the state borders allows us to compare the responsiveness of border counties to economic shocks based on their UI levels.

We start our analysis by exploring the relationship between UI generosity and leverage and analyzing whether it is quantitatively strong in the data. For this purpose, we use Home Mortgage Disclosure Act (HMDA) data from the US and show that UI and loan-to-income (LTI) at origination are highly positively correlated across US counties. Quantitatively, as UI benefits increase from the 10th percentile to the 90th percentile, the LTI ratio increases by 20 percentage points (equivalent to around 10 percent). This is economically large and statistically highly significant.

Second, we find that border counties with more generous UI benefits tend to have higher

[5] Dube, Lester and Reich (2010), Hagedorn et al. (2013), Hagedorn, Manovskii and Mitman (2015), and Arslan, Degerli and Kabas (2018) also use state border discontinuity design.

volatility in mortgage loans and house price growth, contradicting the idea that UI benefits act as an automatic stabilizer. Motivated by this finding, we continue our analysis by formally testing how UI benefits interact with an economic shock, long-term interest rates (the shock that we use in the quantitative model). To ensure that our results are not driven by omitted variables, we follow two strategies. First, we perform a matching exercise where we pair the counties on a rich set of observables. Second, we employ a border discontinuity design in which we compare neighboring counties that are located on the two sides of a state border. Both exercises show that, counties with more generous UI benefits experience higher (lower) mortgage and house price growth when long-term interest rates decline (increase). In all of our regression models, we include other important macro-economic variables, their interactions with UI benefits, as well as other state-level social welfare policies and their interactions with long-term rates. These two empirical strategies with the help of mentioned control variables give us a reliable set of estimations.

Related Literature

There is ample evidence that supports the balance sheet channels that we highlight in this paper. On the household side, Mian and Sufi (2010) and Mian, Rao and Sufi (2013) show that U.S. counties with higher household leverage as of 2006 experienced a deeper 2007–09 recession. Kaplan and Violante (2014) highlight the importance of "hand-to-mouth" consumers for the response of aggregate consumption to income/wealth shocks. In our model, a more generous UI increases fraction of hand-to-mouth households, therefore increasing the economy's response to adverse transitory shocks.

On the banking side, the role of mortgages in the Great Recession is well documented (Bernanke (2018) and Gertler and Gilchrist (2018)). In addition, English, Van den Heuvel and Zakrajšek (2018) and Gomez et al. (2021) find that a higher share of mortgages increases the interest rate risk that banks face, and influences banks' equity prices and lending in response to changes in interest rates. All these mechanisms operate in our framework as well.

Our paper contributes to the literature on the automatic stabilization effects of unemployment insurance. McKay and Reis (2016, 2021) merge the standard incomplete-markets model of consumption with the New Keynesian model of nominal rigidities and business cycles and find that tax-and-transfer programs reduce aggregate volatility. Di Maggio and Kermani (2016) use cross-sectional variation in benefit replacement rates to show that higher unemployment insurance attenuates the impact of adverse shocks on employment. We contribute to this literature by identifying new channels that overturn the stabilizing effects of unemployment insurance, which we demonstrate to be important both quantitatively and empirically.

The literature, starting from Gruber (1994), has shown that UI benefits smooth the decline in consumption for the unemployed. Recently, Hsu, Matsa and Melzer (2018) found that UI benefits were beneficial in smoothing the housing market by lowering mortgage defaults of the unemployed. In our model, we confirm the findings of this literature by showing that a higher UI indeed stabilizes downturns for the unemployed. However, it has the opposite effect on the employed, and the aggregates are driven by the employed, who constitute the majority.

Our paper contributes to the existing literature that investigates the costs and benefits of UI benefits. While Coglianese (2015) and Chodorow-Reich, Coglianese and Karabarbounis (2018) report small effects, Hagedorn et al. (2013) and Hagedorn, Manovskii and Mitman (2015) find significant adverse effects on employment. We employ a similar empirical methodology as Hagedorn et al. (2013) and Hagedorn, Manovskii and Mitman (2015). They focus on the negative effects on job search and vacancy creation. On the other hand, we study the negative effects of unemployment insurance on household and bank balance sheets and provide new micro-level evidence from the US housing and mortgage markets that supports that.

Our findings corroborate recent studies by Coglianese (2015), Kekre (2016), and Mitman and Rabinovich (2021). Coglianese (2015) examines the impact of UI extensions during the Great Recession and finds evidence of UI benefits boosting aggregate demand. Kekre (2016)) argues that even a marginal increase in UI generosity can enhance aggregate demand, as the unemployed have a higher marginal propensity to consume. Mitman and Rabinovich (2021) study the optimal (Ramsey) UI policy in response to a shock that imitates the COVID-19 recession and conclude that a substantial and transitory increase in UI is optimal. Like these studies, we demonstrate that unexpected and temporary extensions of UI benefits can mitigate downturns.

A related literature suggests that implementing counter-cyclical UI benefits, which are more generous during recessions, may be beneficial (Kroft and Notowidigdo (2016), Landais, Michaillat and Saez (2018*a*,*b*), and Gorn and Trigari (2021)). Although we do not specifically study effects of counter-cyclical UI benefits, our findings suggests that such policies may weaken household and bank balance sheets, if lower expected income risk during recessions may lead to increased borrowing and reduced saving during good times. Consequently, the stabilization benefits of these policies may be lower than expected. It is important to note, however, that accurately quantifying the stabilization role of counter-cyclical unemployment insurance policies requires proper modeling of aggregate risk.

Our paper shares similarities with Athreya and Simpson (2006), Nakajima (2019), and Bornstein and Indarte (2023) who examine the interaction between credit markets and public insurance. Consistent with our steady-state findings, Athreya and Simpson (2006) and Nakajima (2019) also find that increases in public insurance's generosity might lead to more unsecured household debt. Bornstein and Indarte (2023), leveraging zip code heterogeneity in staggered expansions of Medicaid, find that the expansion led to a significant increase in household debt, which aligns with the channels and empirical findings we highlight in our paper. We complement these studies by focusing on mortgage debt and the destabilizing effects of unemployment insurance.

Our findings are similar to the "volatility paradox" described in Brunnermeier and Sannikov (2014). In their framework, contracts that improve risk-sharing may lead to higher leverage and more frequent crises. Similarly, in our framework, higher UI benefits insure households against risk, and households respond by borrowing more for mortgages, amplifying booms and busts.

Our general equilibrium framework combines key elements from two literatures. First, an active literature has modeled the pricing of household default risk in mortgage and unsecured credit markets without considering their consequences on bank balance sheets.[6] Second, an active literature has studied the importance of bank balance sheet channel without taking into account the effect of household foreclosures on bank balance sheets.[7] In addition to studying a different question from those addressed in these papers, our theoretical contribution is to combine household and bank balance sheets into one framework, as done in Arslan, Guler and Kuruscu (2023), who studied the drivers of the US boom-bust cycle around 2009. We introduce unemployment risk and UI benefits in their framework in order to study the (de)stabilizing effects of UI.[8]

2 Quantitative Analysis

2.1 The Model

The model economy is composed of five sectors: (i) finitely-lived households, (ii) a continuum of all-identical banks, (iii) real estate agents, (iv) production sector, and (v) the

[6] Among others, see Chatterjee et al. (2007), Livshits, MacGee and Tertilt (2007, 2010), Jeske, Krueger and Mitman (2013), Corbae and Quintin (2015), Chatterjee and Eyigungor (2015), Arslan, Guler and Taskin (2015), Guler (2015), Hatchondo, Martinez and Sanchez (2015), Boar, Gorea and Midrigan (2017), Kaplan, Mitman and Violante (2020), Garriga and Hedlund (2020), and Guren, Krishnamurthy and McQuade (2021).

[7] See among other Mendoza and Quadrini (2010), Gertler and Kiyotaki (2010, 2015), Gertler and Karadi (2011), Bianchi and Bigio (2014), and Corbae and D'Erasmo (2013, 2019).

[8] Other papers that study household and bank bank balance sheets together include Elenev (2017), Elenev, Landvoigt and Van Nieuwerburgh (2016), Elenev, Landvoigt and Van Nieuwerburgh (2018) Landvoigt (2017), Ferrante (2019), and Diamond and Landvoigt (2022), which focus on different questions from ours.

government. In this section we provide a description of each sector.[9] A detailed formulation of all the problems are provided in the Appendix A.

2.1.1 Households

Household live until age J and retire at age $J_r < J$ and receive utility from consumption and housing services.

Income and Unemployment Risk: Working-age households can be either employed or unemployed exogenously. When they are employed, they supply labor inelastically. The efficiency unit of a household's labor takes the form $\exp(f(j) + z_j)$, where $f(j)$ is the lifecycle component of the household's productivity and z_j follows an AR(1) process given by $z_j = \rho z_{j-1} + \varepsilon_j$, with ε_j being independently and identically distributed as $N(0, \sigma_\varepsilon^2)$. Here, 'j' represents age, ρ indicates the persistence of the stochastic income shock process, and ε_j represents the innovation.

Along with the income shock, each worker receives an age dependent employment opportunity. The ones who do not get an employment opportunity become unemployed and receive UI benefits. Following McKay and Reis (2016), we assume that UI benefits are are given as a fraction of current period potential income (income that would have been earned if the household were employed).

Combining both shocks, a household's income process $y(j, z_j)$ can be summarized by

$$y(j, z_j) = \begin{cases} w \exp(f(j) + z_j), & \text{if } j \leqslant J_r \textit{ and employed} \\ \min\{\Psi, \theta w \exp(f(j) + z_j)\} & \text{if } j \leqslant J_r \textit{ and unemployed} \\ w y_R(z_{J_r}), & \text{if } j > J_r \end{cases} \tag{1}$$

where w is the wage rate per efficiency units of labor and $y_R(z_{J_r})$ is a function that approximates the US retirement system as in Guvenen and Smith (2014). UI benefits can be described with two parameters: θ and Ψ where θ is the replacement rate and Ψ is the cap, the maximum benefit level.

Household's Housing Decisions: Households can choose between renting and purchasing a house. They can finance their housing purchases through mortgages, and there is no unsecured borrowing in the model. Additionally, households have the option to default on their mortgages, and banks price mortgages based on default risk, which is a function of household characteristics, house value, and mortgage amount. Then, households choose the

[9] We build on the framework developed in Arslan, Guler and Kuruscu (2020). To their framework we add unemployment risk and UI benefits.

loan amount based on this price schedule. As a result, the down payment and mortgage interest rate are endogenously determined. This is one of the mechanisms through which more generous unemployment insurance benefits affect the economy. More generous unemployment insurance benefits lower income risk, and as a result, banks offer better terms for mortgage credit since the default risk is lower. Due to lower income risk and better mortgage terms, households end up borrowing more.

Defaulting on a mortgage is possible but costly. After default, households temporarily lose access to the housing market and become become *inactive* renters. Inactive renters can return to the housing with probability π and become *active* renters. Therefore, households have three statuses regarding their housing market status: homeowner, active renter, or inactive renter. We now describe the decision of each type of household separately.

Active Renters: Households are born as active renters. An active renter has two choices: to continue to rent or to purchase a house. If she continues to rent, she pays the rental price, makes her consumption and saving choices, and remains as an active renter in the next period. If she decides to purchase a house, she chooses a mortgage contract among a possible set of contracts offered by the bank. After purchasing a house, she begins the next period as a homeowner.

Inactive Renters: Inactive renters are households who cannot access the housing market due to their default in previous periods. They become active renters and gain access to the housing market with an exogenous probability π. Since they cannot buy a house, they only make consumption and saving decisions.

Homeowners: A homeowner has four options: stay as a homeowner, refinance, sell the current house and become a renter or buy a new house or default. A homeowner who chooses to stay in her existing house makes the consumption and saving decisions given her income shock, housing, mortgage debt, and assets. The ones who refinance needs to pay the full balance of any existing debt and obtain a new mortgage. The third choice for a homeowner is to sell the current house and either become a renter or buy a new house. Selling a house is subject to a transaction cost, that is a φ_s fraction of the selling price. Moreover, a seller has to pay the outstanding mortgage debt in full to the lender.

The fourth possible choice for a homeowner is to default on the mortgage if she has any. A defaulter has no obligation to the lender. In case of household default, the lender seizes the house, sells it subject to a foreclosed house transaction cost, which is a φ_e fraction of the house value with $\varphi_e > \varphi_s$, and transfers any positive amount from the sale of the house, net of the outstanding mortgage debt and transaction costs, back to the defaulter. Since defaulting is more costly than selling, a homeowner with positive home equity will choose to sell the house instead of defaulting. Hence, negative equity is a necessary condition for default in the model, and a defaulter receives no funds from the lender. The defaulter starts the next period as an active renter with the probability π. With probability $(1-\pi)$, she stays as an inactive renter.

Amortization of mortgages Mortgages can be characterized by the mortgage debt, denoted as d. To maintain tractability, we assume that fraction μ of the mortgage debt amortizes each period. In reality, the amortization schedule of mortgages are computed at their individual-specific mortgage interest rates. However, to save from an additional state variable, we assume that mortgage amortization is computed at bank lending rate r_ℓ, following the approach of Hatchondo, Martinez and Sanchez (2015) and Kaplan, Mitman and Violante (2020). Individual default risk will show up in the pricing of the mortgages at the origination rather than in the mortgage interest rate. Thus, the relation between the mortgage debt d and mortgage payment m in a period, is given as

$$d \;=\; m\left(1+{}^{(1-\mu)}/_{(1+r_\ell)}+\left({}^{(1-\mu)}/_{(1+r_\ell)}\right)^2+\ldots\right)\longleftrightarrow m=d\left(1-{}^{(1-\mu)}/_{(1+r_\ell)}\right). \tag{2}$$

The mortgage debt in the following period will be $d'=(d-m)(1+r_\ell)=d(1-\mu)$.

Firms and Rental Companies: A perfectly competitive firm produces final output by renting from households capital K at rate r_k and labor N at rate w. The firm also chooses the utilization rate (or hours) u per worker. The wage per efficiency units of a worker $w(\overline{w},u)$ (same as w) is assumed to depend on the hours worked. We assume that the firm has to finance a fraction μ of the wage bill in advance from banks and pay interest r_ℓ on that portion. Thus, the firm solves $\max_{K,N,u} \mathbb{Z}K^\alpha (Nu)^{1-\alpha}-(r_k+\delta_k)K-(1+\mu r_\ell)\,w(\overline{w},u)\,N$.

Rental companies are owned by households and own part of the housing stock (subject to depreciation), and rent them to the households at the rental rate p_r. In each period they choose how much new housing units to purchase (or sell). Since both capital and rental company shares are riskless in a deterministic equilibrium, i.e. in the steady-state and along the transition path except for the unanticipated shock periods, both assets have to pay the same rate of return in equilibrium. Given this, the first-order condition of the rental company gives the rental rate as $p_r=\kappa+p_h-\frac{(1-\delta_h)p_h'}{1+r_k}$, where κ is the maintenance cost, δ_h is the depreciation cost of housing , and p_h and p_h' are house prices in the current and next periods.

Banks: We assume a competitive banking industry with a unit of continuum of identical banks that are risk-averse and maximize the discounted lifetime utility $\sum_{t=0}^{\infty}\beta^{t-1}\log\left(c_t^B\right)$ where c_t^B is the banker's consumption. There is no entry to the banking sector. Banks fund their operations from their net worth and by borrowing in the form of deposits in the domestic market and the international markets at a risk-free interest rate r. They lend to firms at rate r_ℓ, and issue mortgages and purchase existing mortgages.

We assume that bankers can walk away at the beginning of a period without paying back their creditors. In that case, they can keep a fraction of their assets but are excluded from banking operations in the future and can only invest those assets at rate r. Knowing this, creditors lend to banks to the point where banks do not walk away, which generates a collateral constraint with a haircut.

We focus on a symmetric equilibrium where all banks hold the market mortgage portfolio. This allows simple aggregation despite the fact that banks hold a rich set of heterogenous mortgages (see Arslan, Guler and Kuruscu (2023) for more details).

2.2 Calibration

We calibrate the model economy to match relevant moments of the US data in 1995.

Timing: We assume that households start the economy at the age of 26 and work until the age of 65. After that age households retire and live until age 85. The model period is 2-years. This relatively long time period makes the computation of the transition faster. We show in Appendix C that when we calibrate the model period to 6 weeks, our results for the steady-state hold.

Preferences: We assume that households receive utility from consumption and housing services captured by the following CES utility specification: $u(c,s) = \left((1-\gamma)c^{1-\epsilon}+\gamma s^{1-\epsilon}\right)^{\frac{1-\sigma}{1-\epsilon}}/(1-\sigma)$. We choose $\epsilon = 1$, which implies a unit elasticity of substitution between housing and consumption, consistent with the estimates in Piazzesi, Schneider and Tuzel (2007). Following the literature, we set $\sigma = 2$, which implies an elasticity of intertemporal substitution of 0.5. We calibrate γ internally and target to match the share of housing services in aggregate income. Households are born either as a capitalist or a depositor. We calibrate the discount factor for the capitalists, to match capital-output ratio of 1 in our biannual model. Lastly, we calibrate the discount factor for the depositors, so that the share of aggregate wealth that belongs to capitalists is 80%. As a result, wealth inequality in the model is close to the data.

Income and unemployment risk: We follow Storesletten, Telmer and Yaron (2004) and we set the annual persistence of income shock to 0.96 and the standard deviation to 0.17. We approximate this income process with a 14-state first order Markov process using the discretization method as in Tauchen (1986). We use Guvenen and Smith (2014) to

Table I – Externally Set Parameters

Parameter	Explanation	Value
σ	risk aversion	2
α	capital share	0.3
ρ_ε	persistence of income	0.936
σ_ε	std of innovation to AR(1)	0.236
φ_s	selling cost for a household	7%
φ_e	selling cost for foreclosures	25%
φ_m	fixed cost of mortgage origination	1
δ_h	housing depreciation rate	3%
τ	variable cost of mortgage origination	0.75
η	rental adjustment cost	3
π	prob. of being an active renter	0.265

approximate retirement income in the US retirement. We adjust the retirement income such that working age-households pay 12% tax.

We set the economy wide unemployment rate to 5.5 percent in the steady-state. Each individual receives an employment shock along with the income shock. Employment shock is independent of income shock. But, to mimic the data, we consider that younger workers are more likely to get unemployed. We use the percent of households that have unemployment spell of more than 2 years to calibrate the probability of transition from unemployment to employment.

Housing and mortgage markets: We follow the estimates in Gruber and Martin (2003) and set house selling cost, φ_s to 7 percent. Banks can sell the foreclosed properties at a 25 percent discount consistent with the estimates of Campbell, Giglio and Pathak (2011). We set the fixed mortgage origination cost to 1 percent of the aggregate output, and variable cost of mortgage origination to 0.75 percent of the mortgage loan. Default flag remains on a defaulted household on average 7 years. To match this, we calibrate the per-period probability of becoming an active renter to 0.265. We set house price to rent ratio to 5.5 to match the annual counterpart 11 in the data. Housing units depreciate 3 percent in every 2 years. We use minimum and maximum house size to match home-ownership rate and housing services to output ratio.

Production sector: We target capital-output ratio of 1 that corresponds to 2 in the annual data. We normalize total labour N and steady-state labour utilization to 1. Following Arslan, Guler and Kuruscu (2023) we target the share of housing services in aggregate income as 0.15.

Table II – Internally Calibrated Parameters

Parameter		Value
β_K	discount factor–capitalist	1.05
β_D	discount factor–depositor	0.76
$\underline{h}$	minimum house size	0.51
r	deposit rate	0.07
γ	weight of housing services in utility	0.25
$\bar{H}$	housing supply	0.86
ϕ_k	share of wage bill financed from banks	0.67
β_L	bank discount factor	0.82
ξ	bank seizure rate	0.23
κ	rental maintenance cost	0.02
δ_k	capital depreciation rate	0.19

Financial Sector: We assume that bankers have log utility. We view banks in our model as broader than a typical deposit taking institution. We follow Arslan, Guler and Kuruscu (2023) and the ratio of mortgages to total bank's financial assets as 45 percent. We calibrate bank funding rate, r, to match debt-output ratio of 40% (corresponding to 80 percent ratio in an annual model), and we target $r_\ell - r = 3$ percent representing average biannual gap between 30-year mortgage interest rate and treasury rate in the data. We also target steady-state bank leverage as 10. With these targets we calibrate bank's discount factor and the hair cut on bank borrowing from the international markets.

After externally calibrating most of the parameters, we internally calibrate the remaining 8 parameters shown in Table IIto jointly match the following 8 data moments reported in Table III: 66% average home-ownership rate, 39% homeownership rate for the population younger than 40 calculated from the Census data, capital rental rate of 4%, house price-to-output ratio of 3, 30% share of maintenance costs for rental units, leverage ratio of 10 for banks, 2% premium for mortgages, and the share of mortgages in bank balance sheet as 50%.

Shocks: We study how the model economy reacts to the changes in interest rates, which corresponds to the bank-funding rate in our framework. For the analysis, we first give an MIT shock that generates a boom. We assume that shocks are expected to be permanent (Figure 4, upper left and middle panels). But after 6 periods (i.e. 12 years), unexpectedly, the shock reverts to its initial steady-state. We choose the size of the interest rate shock to generate a sizable boom-bust cycle in house prices.[10]

We do not have endogenous labor supply decision in our framework. Modeling job search, job creation, and destruction, accepting/rejecting job offers would certainly enrich

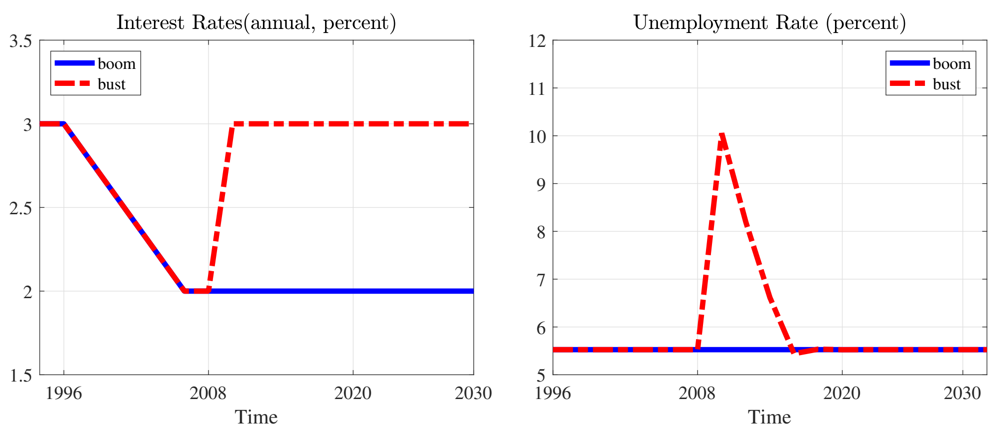
[10] The results hold for other shocks as well. See Appendix D.1.

Table III – Moments

Statistic	Data	Model
Capital-output ratio	1	1
Home ownership rate–aggregate	66 percent	66 percent
Share of wealth that belongs to capitalists	80 percent	80 percent
Debt-output ratio	40 percent	40 percent
House price-output ratio	0.825	0.825
Share of housing services in aggregate output	15 percent	15 percent
Ratio of mortgage loans to total loans in bank assets	0.45	0.45
Mortgage premium	0.03	0.03
Bank leverage ratio	10	10
House price-rental price ratio	5.5	5.5
Non-residential investment-output ratio	16 percent	16 percent

Note: Flow variables (output and rental price) are measured biannually.

Figure 1 – Boom-bust shocks



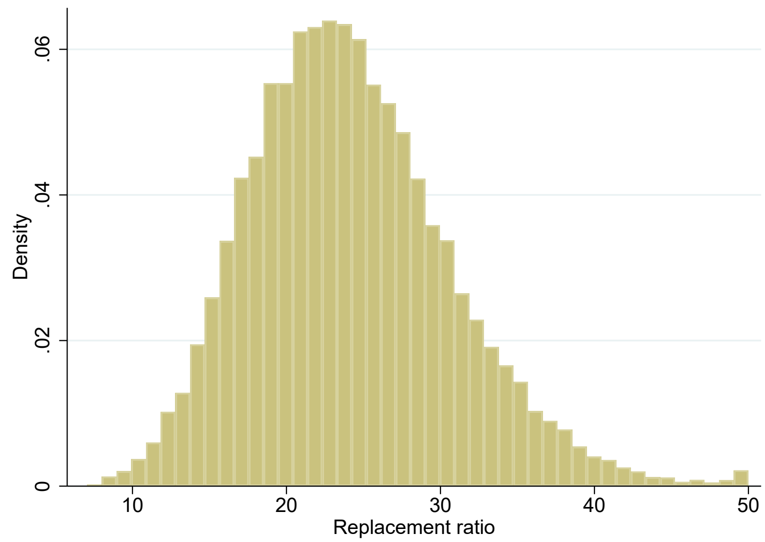
Notes: The graph plots the shocks that generate the boom-bust episode. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight.

the model, but with a large computational burden. As a result, we generate an increase in the unemployment rate exogenously. In particular, we assume that the unemployment rate increases from 5.5 to 10 percent during the bust period. After the bust, it linearly declines to 5.5 percent in 10 years. We do not impose a decline in unemployment rates during the boom period.

2.3 Quantitative Effects of Higher Unemployment Insurance

Figure 2 illustrates the significant variation in UI replacement rates across US counties, measured by the ratio of the maximum unemployment insurance benefit to median county income. As can be observed from the figure, the variation is quite high, ranging from below

Figure 2 – Variation in UI replacement rates ($\frac{\text{maximum UI benefit}}{\text{county median income}}$) in US counties



10 percent to 50 percent. Almost half of this variation is attributable to the variation in the numerator (maximum benefit level), which increases by two and a half fold from the lowest to highest maximum replacement rate. In the simulations that follow, we will solve the model with three different levels of UI generosity.

2.3.1 Steady State Analyses

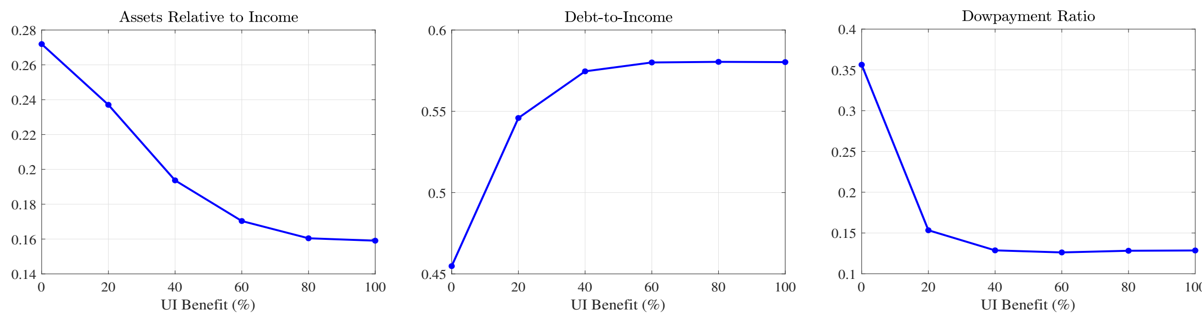
To quantify the effects of UI benefits on balance sheets in the steady-state, we solve the model with different UI benefit levels and report corresponding steady-state values of several balance sheet strength measures. We start with household balance sheets.

Life-Cycle Dynamics in the Steady-state: In this section, we present life-cycle dynamics of important variables briefly (details are in Figure 13 in Appendix B). Consumption, homeownership, and mortgage debt increase in a concave fashion over the lifecycle in our benchmark economy, which is broadly consistent with the data. When comparing across economies, we observe that consumption and homeownership rates start at lower levels and increase more steeply under more generous unemployment insurance systems. As UI generosity declines, the precautionary saving motive becomes more powerful, which keeps consumption and housing low at young ages. As unemployment risk declines with age, consumers start to consume their savings. Additionally, the higher risk of default under less generous systems lowers the demand for mortgages over the life cycle.

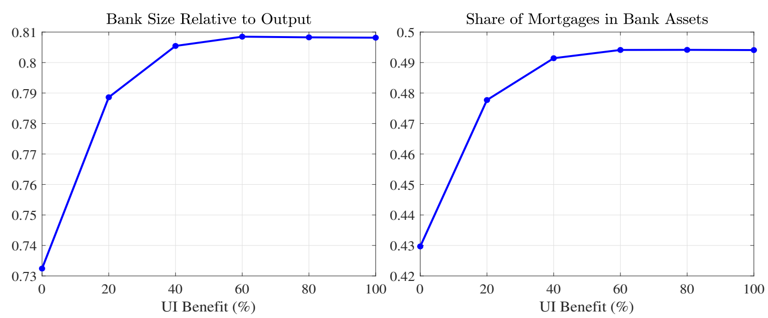
The model generates a decline in consumption upon unemployment, which is consistent with the data. Additionally, the effect of UI on the reduction in consumption aligns with

Figure 3 – Unemployment Insurance and Balance Sheets

Panel A: Household Balance Sheets



Panel B: Bank Balance Sheets



Notes: Panel A plots the steady-state values of several household balance sheet items for a range of UI generosity levels. Panel B plots the steady-state values of several bank balance sheet items for a range of UI generosity levels.

estimates reported in the literature.[11] Finally, substantial refinancing activity is observed among the unemployed, which increases with age and is more prevalent in economies with lower UI benefits, indicating a substitution effect between UI and refinancing.[12]

Unemployment Insurance and Balance Sheet Vulnerabilities: In this section, we show that UI generosity substantially affects households' and banks' balance sheets (Figure 3). As UI becomes more generous, households' income risk declines. As a result, they first reduce their precautionary savings. Moving from no UI benefits to one with a 40 percent replacement rate reduces the average financial asset-to-income ratio from 27 percent to below 20 percent. Second, households' default risk also declines, resulting in better credit terms

[11]For example, Ganong and Noel (2019) documented that household consumption declines by about 10 percent upon unemployment. The corresponding number in the model is around 13 percent (weighted by the unemployment rates of each age) if one considers that the average UI in the US is 50 percent. Regarding the effects of UI generosity, Gruber (1994) (and more recently Kroft and Notowidigdo (2016)) find that a 10 percentage point increase in UI generosity leads to about a 2.8 percent reduction in the fall in consumption upon job loss. The corresponding number in our model is 3.7 percent.

[12]The widespread use of refinancing among the unemployed is consistent with recent findings in Braxton, Herkenhoff and Phillips (2020), which suggest that unemployed individuals have significant access to credit.

from banks. The combination of lower income risk and better credit terms allows households to borrow more in the mortgage market, increasing their leverage.[13] The average mortgage debt-to-income ratio starts at 45 percent when there is no insurance and exceeds 57 percent with a 40 percent replacement rate. The average down payment ratio declines from 36 percent to 13 percent when the economy moves from no unemployment insurance to one with a 40 percent replacement rate.

As households demand more mortgage debt, the share of mortgages in total bank assets increases from 43 percent to almost 50 percent as the UI replacement rate is increased from zero to 40 percent. The size of the banking sector also increases from around 73 percent to above 80 percent. Since mortgages are long-term assets, their market value declines when credit markets tighten in recessions. Even holding constant the effect of higher unemployment insurance on the increase in foreclosures during recessions, these two facts make bank balance sheets more vulnerable to adverse shocks. In addition, mortgages become riskier against adverse shocks since their loan-to-income ratios are higher. Thus, the vulnerability of bank balance sheets to adverse shocks increases even further.

2.3.2 The Boom-bust Analysis

Before we delve into comparing how aggregate fluctuations in economies with different unemployment insurance levels differ, it will be instructive to illustrate how the shock to the bank borrowing rate $\mathfrak{r}$ transmits to the economy.

Transmission of the Shock: The changes in the bank lending rate $\mathfrak{r}_\ell$ is the key mechanism through which the bank borrowing rate shock transmits to the economy. For example, during the boom, banks earn more excess return $\mathfrak{r}_\ell - \mathfrak{r}$ on leveraged funds, allowing them to accumulate net worth and increase credit supply. Thus, the equilibrium $\mathfrak{r}_\ell$ gradually falls during the boom and is expected to stay low permanently. Due to lower borrowing cost, first households increase their housing demand causing house prices to increase. Second, firms hire more labor, leading to increases in labor income and output, which further contributes to the increase in house prices. The combination of the increases in house prices and labor income generates an increase in consumption.

The bank borrowing rate $\mathfrak{r}$ unexpectedly and permanently reverts back to its steady-state level during the bust, leading to a permanent increase in $\mathfrak{r}_\ell$. However, the deterioration of bank balance sheets amplifies this increase. An iterative approach demonstrates how

[13] Consistent with the implications of our model, Hsu, Matsa and Melzer (2018) find that both unemployed and employed households are offered lower mortgage and credit card interest rates and higher credit card limits in US states with higher maximum unemployment insurance benefits.

this mechanism works: the increase in r causes an increase in the equilibrium bank lending rate $r_{\ell,t+1}$, which reduces the bank's net worth by lowering mortgage valuations. This results in a decline in loan supply L_{t+1} and further increases in $r_{\ell,t+1}$. With higher $r_{\ell,t+1}$, mortgage valuations and bank net worth decline further, generating further increases in $r_{\ell,t+1}$. Foreclosures also contribute to the decline in bank net worth and credit supply.

With higher unemployment insurance, banks have more mortgages on their balance sheets making bank balance sheets more vulnerable to adverse shocks. Additionally, an increase in the mortgage debt-to-income ratio makes banks more prone to foreclosures. Consequently, bank net worth declines more under a more generous UI system, causing a larger decline in credit supply and a larger increase in the bank lending rate, which makes borrowing more costly for both households and firms, deepening recession. We now explore these channels in more detail.

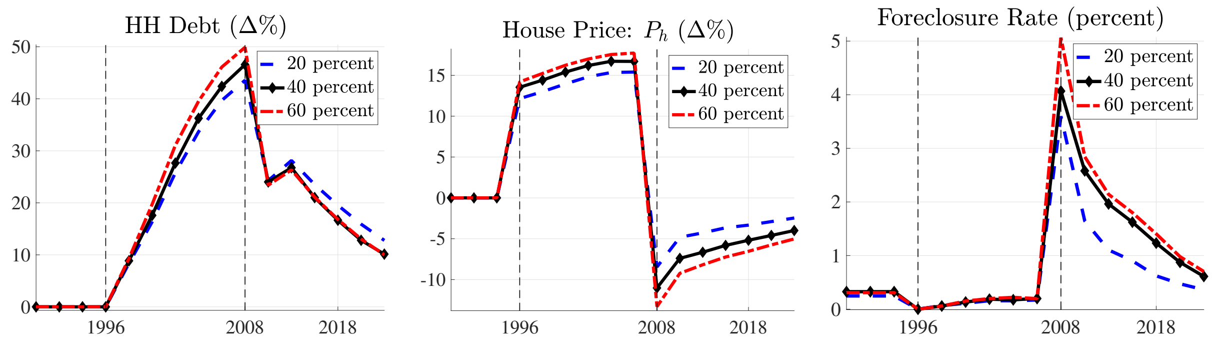
(De)stabilizing Effects of Unemployment on Aggregates: In this section, we study the destabilizing effects of unemployment insurance on the boom-bust cycle. Our results indicate that not only are busts amplified, but booms in the housing and goods market are also amplified under higher unemployment insurance systems. Additionally, the bust in the banking system is more severe under such systems.

Housing Market Dynamics: In the model, a more generous UI amplifies the boom-bust cycle in the housing market (Figure 4). Household debt increases by 44 percent when the replacement ratio is 20 percent and increases by more than 48 percent when the benefits are 60 percent. The increase in debt is partly supported by the decline in down payment ratios. With the bust, households in all economies deleverage, but it happens faster in higher UI economies. House prices have a bigger boom-bust cycle as UI generosity increases. During the boom, house prices increase by 15.5 percent, 16.5 percent, and 17.5 percent, respectively, for 20 percent, 40 percent, and 60 percent replacement rates. During the bust, house prices decline by 21 percent, 24 percent, and 26 percent, respectively, for the same replacement rates.

In the steady state, foreclosures are slightly lower in the low UI economy. The main difference across different UI levels arises during the bust. Foreclosure rates increase more for the 60-percent UI economy and exceed 5 percent, while they stay below 4 percent for the 20-percent UI economy. The larger decline in house prices, higher household debt, lower liquid asset holdings, and lower down payment rates cause larger increases in foreclosure rates for more generous UI economies.[14]

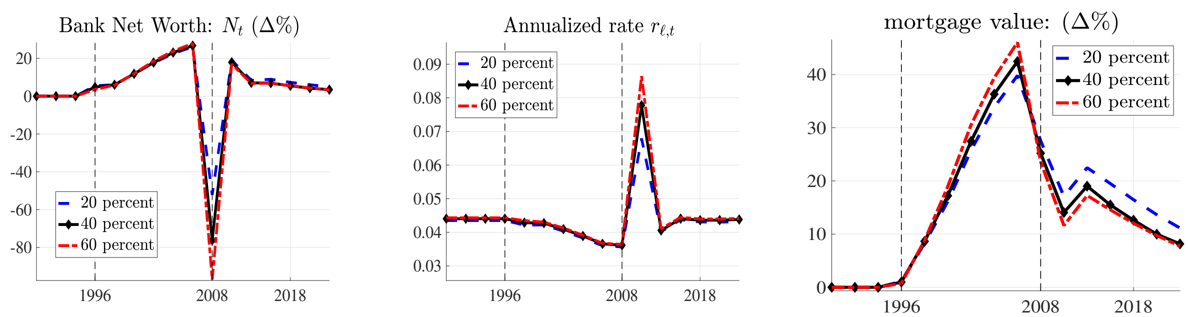
[14] Negative equity is a necessary condition for default in our framework. Otherwise, it would be optimal to

FIGURE 4 – Boom-Bust in the Housing Market



Notes: The graph plots the dynamics of key housing market variables during the boom-bust episode. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight.

FIGURE 5 – Boom-Bust in the Banking Sector



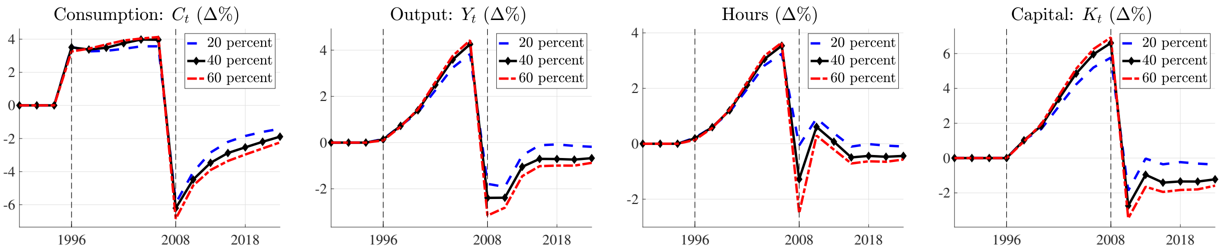
Notes: The graph plots the dynamics of key banking variables during the boom-bust episode. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight.

Banking Sector Dynamics: Figure 5 presents the evolution of bank net worth and lending rates. During the boom, no differences in the evolution of these variables across different UI levels are observed. However, significant differences appear during the bust. Bank net worth declines more in more generous UI economies because mortgages, whose price declines with tightness in bank credit, constitute a larger fraction of banks' assets, and each mortgage is riskier. The larger decline in bank net worth generates a bigger spike in the bank lending rate $r_{\ell,t}$, reaching almost 9 percent in the 60-percent UI economy compared to 7 percent in the 20-percent UI economy. The contraction in mortgage values is also sharper in higher UI economies because of larger increases in foreclosures.

Goods Market Dynamics: Higher UI generosity amplifies the boom and bust cycles in the macroeconomy (Figure 6). Consumption increases more for 60% UI benefit (4%) than

sell the house. However, negative equity is not sufficient because of the cost of default. Additional triggers, such as low liquidity and lower income (both of which worsen as UI becomes more generous), are also important for the foreclosure dynamics.

FIGURE 6 – Boom-Bust in the Macroeconomy



Notes: The graph plots the dynamics of key macro economic variables during the boom-bust episode. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight.

for 20% UI (3.6%), while the decline is deeper for higher UI generosity (10% for 60% UI and 9% for 20% UI). The recovery is relatively faster for lower UI economies. Output and wages also experience larger boom-bust cycles, with the decline in wages during the bust being about twice as large for the 60% UI economy compared to the 20% UI economy. Very similar to output and wages, fluctuations in hours are also larger in more generous UI economies.

One of the main factors behind the more severe bust in higher UI economies is the bigger increase in the bank lending rate, which raises borrowing costs for households and firms. This causes firms to cut back on labor demand, resulting in larger declines in output and wages. The larger drop in wages, coupled with the higher borrowing costs, leads households to reduce consumption. Additionally, the decline in capital becomes more pronounced during the bust and persists for longer as UI generosity increases. This persistent low capital depresses output, wages, and labor utilization in higher UI economies for an extended period.

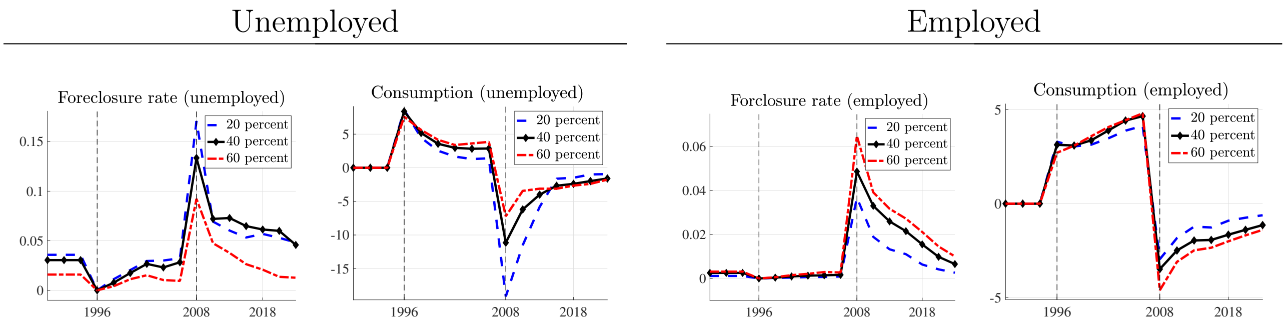
2.3.3 Unemployed versus Employed

Generous unemployment benefits both increase vulnerabilities for both unemployed and employed individuals during adverse shocks but provide insurance for the unemployed, thus affecting the two groups differently.

We find that the insurance channel dominates the balance sheet channel for the unemployed. For example, during the bust, while foreclosures among the unemployed reach 17 percent when UI benefits are 20 percent, they increase to 9 percent when UI is 60 percent (Figure 7). Similarly, the decline in consumption is much smaller, about 10 percentage points, for the unemployed in the 60-percent UI economies compared to the decline in the 20-percent one. Thus, unemployment insurance does indeed do the intended job of helping the unemployed, which is consistent with findings of Hsu, Matsa and Melzer (2018) that more generous benefits help to avoid mortgage default for the unemployed.[15]

[15]For the employed, they find the opposite effect, but the relationship is insignificant. The insignificance

Figure 7 – Unemployed vs. Employed



Notes: The graph plots the dynamics of foreclosures and consumption for the employed and unemployed. Foreclosure rates are normalized by each groups home ownership rate. Consumption for employed and unemployed are normalized by the employment and unemployment rates for the respective groups. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight.

The opposite is true for the employed. Since they enter the recession as more leveraged under a higher unemployment insurance economy and do not receive the benefit of unemployment insurance, they experience larger declines in consumption and larger increases in foreclosures during a recession. Since the majority of the population is employed, aggregates are mainly driven by their behavior.

2.3.4 The Importance of General Equilibrium Effects

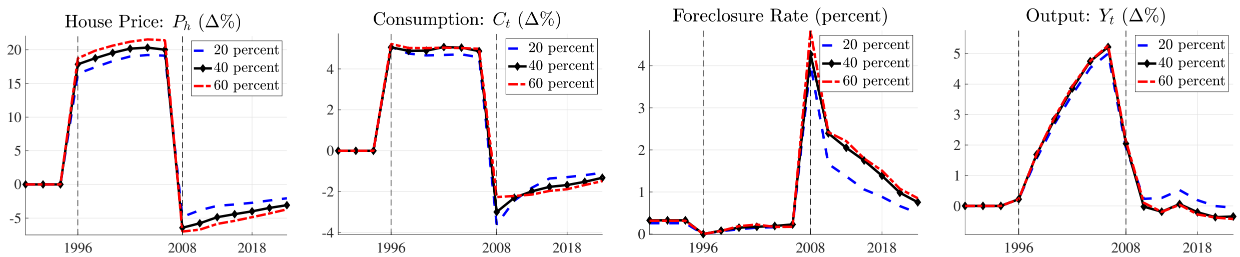
In this section, we show that general equilibrium effects play an important role in destabilizing effects of unemployment insurance. First, we focus on the general equilibrium feedback from the bank balance sheets to the rest of the economy. Second, we show that the systemic risk created by increasing unemployment insurance for the entire economy is not captured by studying the stabilizing effects of unemployment insurance using cross-sectional variation.

The Role of Bank Balance Sheets: Which balance sheets matter more for the results: banks or households? To answer this question, we shut down the general equilibrium feedback from bank balance sheets to the real sector. For this, we solve a version of our model where we assume that banks do not face balance sheet constraints. This would correspond to the same bank lending rate, r_ℓ, in all economies. In this case, all bank balance sheet weaknesses that would arise due to more generous UI benefits would not affect the model dynamics. As a result, the model dynamics would be driven solely by household balance sheets.

The dynamics of house prices and foreclosures remain qualitatively similar even without the bank balance sheet channel (Figure 8), which suggests that household balance sheets and

can be because of the small sample and relatively small effects of UI on employed that we also find here.

FIGURE 8 – The Role of Bank Balance Sheets



Notes: The graph plots the dynamics of some of the key variables during the boom-bust episode where we close the bank balance sheet mechanism. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight. For all three economies bank lending rate corresponds to the bank lending rate that would prevail if banks were not constrained.

household demand are the main driver of the variation in these variables across different UI policies.

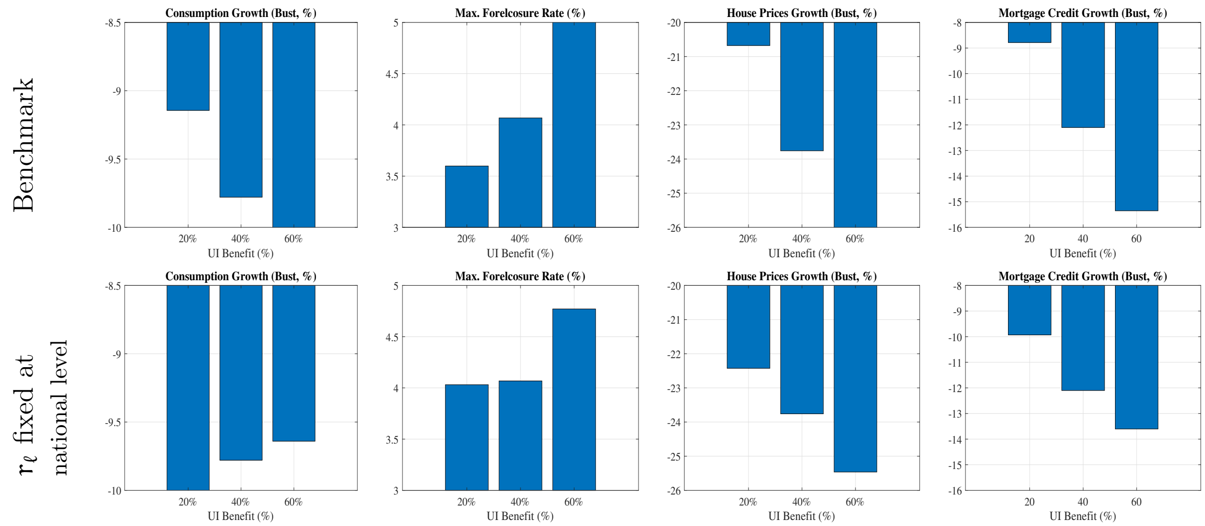
However, remember that in our benchmark, the increase in bank lending rate was larger under higher UI economies, which was the main driver of the larger decline in output and wages during a recession in such economies since firms finance a part of their wage bill from banks. Thus, when we shut down the bank balance sheet channel, the destabilizing role of UI on output and wages almost disappears, which mitigates the drop in consumption. In fact, without the bank balance sheet channel, consumption declines less at the time of the bust in more generous unemployment insurance systems. However, after the bust period, consumption recovers more slowly because of weaker household balance sheets.

Finally, house prices decline by 20 and 23 percent with 20 and 60-percent UI benefits when the bank balance sheet effect is shut down, respectively. On the other hand, the respective numbers were 20 and 27 percent in our benchmark. Thus, half of the amplifying role of UI benefits on house prices during the bust is because of bank balance sheet channel.

Cross-sectional Variation versus Systemic Risk: We have seen so far that bigger deterioration of bank balance sheets under higher UI regimes is critical for the destabilizing effect of UI. This is because increasing the UI for the whole economy creates a systemic risk on the economy's banking system. This general equilibrium mechanism is not captured by empirical papers that rely on cross-sectional analysis.

To illustrate this point, we create a cross-sectional variation in UI across different regions within our economy. For this, we assume that the overall economy is represented by a 40 percent replacement rate. But there are regions with 20 percent and 60 percent replacement rates. We assume that capital is perfectly mobile within the economy and that the sizes of the latter two regions are small so that they do not affect the equilibrium bank lending rate.

Figure 9 – General Equilibrium Effects



Notes: The graph plots the dynamics of some key variables during the bust. The first column shows the dynamics with all the general equilibrium effects. That is, it compares three economies with different UI levels. The bank lending rate r_ℓ is determined locally in each economy. The column "r_ℓ fixed at national level" compares regions with different UI levels within the same economy. Here r_ℓ is determined at the national level (in the 40 percent UI replacement rate economy).

In the analysis below, we assume that these two variational regions take it as given the bank lending rate of the 40 percent economy but, that house prices and wages are still determined locally within each region.[16]

Figure 9 reports the change in variables in the bust period in our benchmark where we compare three economics with different UI levels (first row) and in the counterfactual economy where we compare regions with different UI levels within one economy (second row).

Remember that in our benchmark with all general equilibrium effects, the drop in consumption and house prices, and the rise in foreclosures were larger for higher UI economies. If we compare across regions in the counterfactual economy, we in fact observe that more generous benefits help to stabilize the downturn. Foreclosures still rise more, and house prices and mortgage credit still fall more in higher UI economies, but the difference across different UI benefits becomes smaller. Overall, the comparison of these two columns reveal that studies that compare the stabilization effect of UI across regions within an economy might underestimate (overestimate) its destabilizing (stabilizing) effects.

[16] We have also conducted two more experiments: one where wages are determined at the macro level in addition to bank lending rate and two, in which both wages and house prices are determined at the macro level. In those cases, the variational regions take as given the wages or both wages and house prices of the 40 percent economy. The arguments we make in our main analysis only get stronger in these cases.

2.4 Quantitative Effects of Unexpected Discretionary UI Expansions

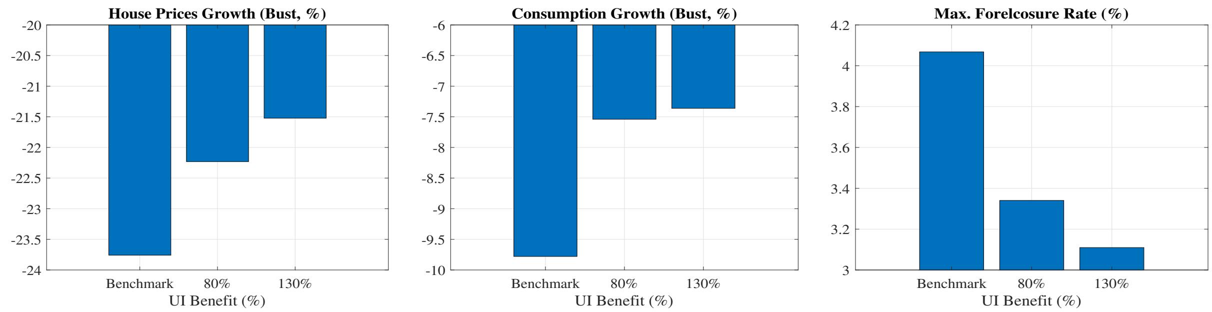
In this section, we analyze whether a surprise rise in UI generosity can smooth the bust. This exercise will help to further quantify the importance of weak balance sheets since a surprise rise in generosity does not ex-ante weaken balance sheets.

Motivated by the CARES act in the US that more than doubled the UI benefits as a response to the Covid-19 slowdown, we study two alternative UI benefit expansion policies. The generosity of UI benefits increases to 80 percent in one economy and increases to 130 percent in the other for two periods. Figure 10 summarizes our results. Our results suggest that these discretionary increases in UI benefits indeed mitigate the downturn despite the increase in labor income tax that finances it. The decline in house prices with UI expansion is at least 1 percentage point smaller than the benchmark. Similarly, consumption declines by about 2.5 percentage points less than its decline in the benchmark. The rises in foreclosures are also around 1 percentage point smaller. These results are in line with many studies that find smoothing effects of UI expansions during the 2008 crisis (see Coglianese (2015) and Hsu, Matsa and Melzer (2018)).

Two mechanisms drive the results. The first one works similarly to the one that operates in Kekre (2016). An unexpected rise in UI benefits shifts resources to those with high MPC. Liquidity constraints and lower housing equity raise the MPC of the unemployed during the bust. The second one works via bank balance sheets. An unexpected rise in UI benefits lowers foreclosure rates. As a result, bank net worth, hence credit supply, worsens less.

Our results highlight the importance of ex-ante risk-taking effects of UI benefits. Absent those, UI benefits smooth cycles. However, policymakers cannot constantly surprise households. If households and banks expect that, in every deep recession, governments will expand the generosity of UI benefits, then that will weaken their balance sheets. And the governments will need to provide even bigger surprises during the next downturn. Consequently, the stabilization benefits of counter-cyclical UI benefits may be lower than argued by Kroft and Notowidigdo (2016), Lalive, Landais and Zweimüller (2015), Landais, Michaillat and Saez (2018*a*,*b*), and Gorn and Trigari (2021). However, accurately quantifying whether counter-cyclical unemployment insurance policies stabilize or destabilize the economy requires proper modeling of aggregate risk.

Figure 10 – Discretionary UI Expansion Smooths the Bust



Notes: The graph plots the decline in several key variables during the bust, where the government expands the UI benefits to 80 and 130 percent for 2 periods unexpectedly. The shock during the boom is a gradual decline in interest rates from 3 to 2 percent. During the bust, interest rates reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized there is perfect foresight.

3 Evidence from disaggregated data

In this section, we provide county- and state-level evidence from the US for the two key implications of the quantitative model. First, mortgage debt is higher in regions with higher unemployment insurance. Second, regions with higher unemployment insurance experience larger fluctuations in aggregates. In the US, states decide on the generosity of the UI system. They impose two main limits on UI benefit payments that an unemployed person can receive: the "benefit duration" and the "dollar cap". The first restriction limits the number of weeks that the unemployed individual can receive benefits, while the other limit sets a maximum dollar amount for the weekly benefits, which each state annually determines. The unemployed individual receives the weekly benefits determined by the dollar cap for the benefit duration. We follow the literature and use the product of the dollar cap and benefit duration as the measure of UI generosity in a state, which represents the maximum UI amount an unemployed individual can receive during their unemployment spell.

3.1 Unemployment Insurance and Mortgage Borrowing

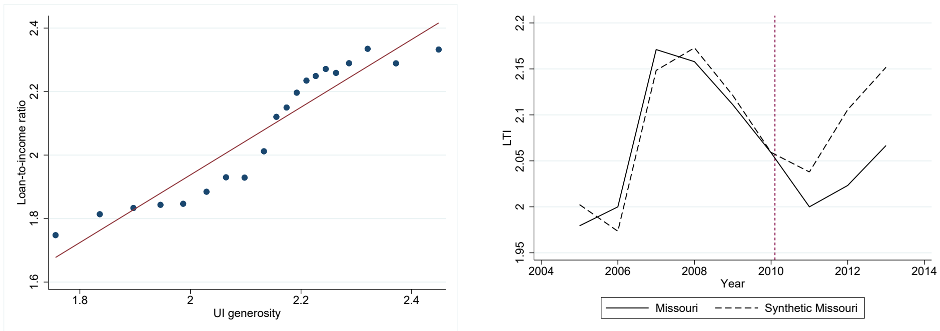
To analyze whether the model's implications about the relationship between UI generosity and leverage are in line with the data, we provide county- and state-level evidence from the US. We also provide an event study evidence from Missouri, which arguably cut back UI benefits unexpectedly in April of 2011.

3.1.1 Evidence from the US counties

We use Home Mortgage Disclosure Act (HMDA) data, which enables us to observe both loan amounts and income at the loan level. We use this information to calculate the LTI ratio

Figure 11 – LTI increases with UI generosity

US counties | Evidence from Missouri



Note: The left panel provides a bin-scatter plot with a linear fit of LTI ratios on the vertical axis and the UI generosity on the horizontal axis. LTI ratio is the ratio of the mortgage amount to the income. UI generosity is the log of the maximum amount of money a person can get from UI. The right panel plots the dynamics of LTI for Missouri and the "synthetic Missouri".

for each mortgage. Then, we aggregate the loan-level observations up to the bank-county-year level by taking a weighted average of LTI ratios where the weights are the mortgage amounts. Figure 11 (left panel) provides a bin-scatter plot of loan-to-income ratios against unemployment insurance generosity and documents a positive and strong relationship between these two variables.

Since this positive correlation can be driven by confounding factors, we use a regression model to investigate the relationship between UI benefits and LTI ratios more rigorously. We estimate the following regression model:

$$\mathsf{LTI}_{bcy} = \beta * \mathsf{UIbenefits} + \gamma * \mathsf{Controls} + \mathsf{YearFE} + \mathsf{CountyFE} + \mathsf{BankFE} + \varepsilon_{bcy}$$

where we use the LTI_{bcy} ratio as the dependent variable, where b stands for bank, c stands for county and y for year. Following the literature we define $\mathsf{UIBenefits}$ is the log of the maximum UI amount. Controls include the log of county-level average income, the share of subprime borrowers, the log of the size of labor force, county-level HHI of industry composition and deposit markets, as well as other state-level policies such as the log of minimum wage, health insurance payments, non-UI transfer payments, and union coverage. In addition, we saturate the model with year-fixed effects to control for economy-wide changes, county-fixed effects to absorb time-invariant county characteristics, and bank-fixed effects to control for bank characteristics. We cluster the standard errors at the state-year level as this is the treatment level.

Table IV shows the results. In Column (1), we estimate the model without any control variables, except county-level income, and find a positive and statistically significant coefficient for the UI benefits. In Column (2), we include county- and state-level control variables. In

Table IV – LTI and UI Benefits

Dependent Variable: Loan-to-income ratio								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
UI Benefits	0.462***	0.261***	0.148***	0.216***	0.220***	0.213***	0.042***	0.056***
	(0.032)	(0.041)	(0.040)	(0.077)	(0.076)	(0.074)	(0.015)	(0.017)
Controls	N	Y	Y	Y	Y	Y	N	Y
Year FE	N	N	Y	Y	Y	Y	N	N
County FE	N	N	N	Y	Y	Y	N	N
Bank FE	N	N	N	N	Y	N	N	N
Bank*Time FE	N	N	N	N	N	Y	N	Y
Pair*Time FE	N	N	N	N	N	N	Y	Y
Obs.	2,950,010	2,021,977	2,021,977	2,021,977	2,021,365	2,008,819	2,220,346	1,510,563
R^2	0.075	0.082	0.100	0.183	0.305	0.370	0.204	0.415

This table documents the positive association between the LTI ratios and UI generosity. The dependent variable is LTI ratio, which is the ratio of the mortgage amount to the income. The main independent variable is UI generosity, which is the log of the maximum amount of money a person can get from UI. Control variables and fixed effects are indicated at the bottom of each column. Control variables are the log of county-level average income, the share of subprime borrowers, the log of the size of labor force, county-level HHI of industry composition and deposit markets, state-level log of minimum wage, health insurance payments, non-UI transfer payments, and union coverage. Columns (1)-(6) use the whole sample. Columns (7)-(8) use county-pairs, in which the counties are neighbors to each other but located in different states. Standard errors are clustered at the state-year level.

the next three columns, we include year, county, and bank fixed effects consecutively. In Column (6), we include bank*year fixed effects, which means that we compare LTI ratios of mortgages that are issued by the same bank in the same year. Even in this tight specification, UI Benefits has a positive and significant coefficient, which suggests that as UI benefits increase from the 10th percentile to the 90th percentile, the LTI ratio increases by more than 20 percentage points (or 10 percent). Being economically large, this number is also in line with the estimates we obtain from our model. We also find that the effects are nonlinear, i.e., effects are larger for lower UIs, as in our model. These results suggest that our model's qualitative and quantitative implications are in line with the data.

In the next two columns, we take a step further and consider the possibility that the positive correlation between LTI ratio and UI benefits could be driven by an omitted variable. For instance, an economic shock could affect both LTI ratios and UI generosity, creating a bias in our estimations even though we include county and $\mathtt{bank} * \mathtt{year}$ fixed effects, and several county- and state-level control variables. To control for such unobservables, we leverage one institutional detail about UI generosity in the US. In the US, each state determines its own

UI generosity, resulting in a large heterogeneity across states. For instance, in 2000, the unemployment insurance replacement rate in California was 13 percent, while it was close to 40 percent in Massachusetts. This state-level discretionary power indicates that UI generosity changes discontinuously at the state borders. To exploit these discontinuous changes, we use the neighboring counties that are located on different states (Dube, Lester and Reich (2010), Hagedorn et al. (2013), Hagedorn, Manovskii and Mitman (2015), and Arslan, Degerli and Kabas (2018)). Being located next to each other, these counties arguably experience similar economic shocks. Yet, being located on different states, these counties enjoy different levels of UI generosity. Thus, comparing these neighboring counties to each other controls for the economic shocks that could introduce a bias into our estimations. To make this comparison, we form county pairs that consist of two neighboring counties located on different states and include $\mathtt{pair} * \mathtt{year}$ fixed effects in Columns (7) and (8).[17] We estimate a positive and significant coefficient for $\mathtt{UIBenefits}$ in these models, with and without county- and state-level control variables and $\mathtt{bank} * \mathtt{year}$ fixed effects. These findings also suggest that UI generosity has a positive effect on household leverage.

3.1.2 Evidence From Missouri: An Unexpected Cut in UI Duration

The unexpected cut in UI generosity in Missouri in 2011 provides an additional opportunity to test whether UI and mortgage borrowing are related. Since it was an unexpected cut we expect to see reduction in LTI ratios.

During the Great Recession (i.e., the recession following the 2008 financial crisis), two programs provided extended unemployment benefits: Extended Benefits (EB) and Emergency Unemployment Compensation (EUC). EB allowed for 13 to 20 extra weeks of benefits for workers who have exhausted their regular benefits. At the beginning of the recession, the federal government paid for half of the program's cost, which included a set of triggers that states could adopt. Initially, many states, including Missouri, adopted high triggers. However, as a result of the American Recovery and Reinvestment Act, which made EB fully federally funded through December 2013, Missouri (and other states) enacted legislation that increased EB's duration from 13 to 20 weeks.

In contrast, EUC was federally funded from the beginning and eventually had four tiers, providing potentially 53 weeks of additional benefits. The availability of each tier depended on state unemployment rates. However, four Missouri state senators filibustered the receipt of additional funds through the EB program. To end the filibuster, the legislature brokered a compromise that would cut regular benefits from 26 to 20 weeks in exchange for the state

[17] Note that we use only state border counties in these columns.

accepting federal funds and maintaining extended benefits for the long-term unemployed. Effectively, Missouri instituted shorter UI durations in the long run while allowing extended benefits for the already long-term unemployed.

The legislation was passed and took effect in mere five days after the media first reported a compromise that included potential cuts to regular benefits, marking it arguably an unexpected cut in UI duration (Johnston and Mas (2018)). Because federal regulations calculate federal benefits administered during times of high unemployment relative to regular state UI benefits, the cut triggered an additional 10-week reduction in emergency benefits. Thus, claimants approved for UI by April 13, 2011, could receive benefits for a maximum of 73 weeks. Those approved after April 13 were only eligible for a maximum of 57 weeks. The shortened potential UI duration did not coincide with any other change in the state's UI system, such as changes in program administration or search requirements (Johnston and Mas (2018)).

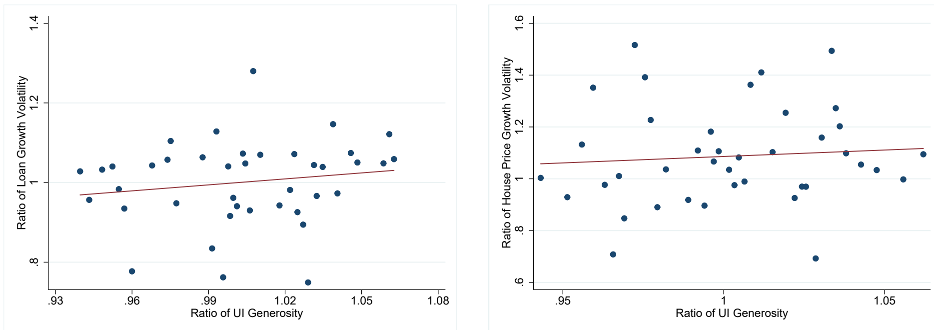
We only have one treated unit, which is Missouri. In such cases, we can apply the synthetic control approach, which uses control units (which are states in our case) to create a synthetic Missouri. This is done by assigning weights to each control state. The weights are assigned to each state to minimize the mean squared prediction error between the treatment and control groups prior to the benefit cut. Our baseline synthetic counterfactual is constructed from state-specific weights selected to match the pre-treatment values of the outcome variable. We consider 2011Q1 as the time of treatment since the policy change affected outcomes in nearly all of 2011Q2. Our beginning time period is 2006Q3. We exclude states that cut UI duration around the time of Missouri's policy change from the donor pool, as the synthetic control must be a weighted average of untreated units. This method allows us to see how Missouri would behave if this unexpected cut did not happen.

Figure 11 (right panel) shows our results: the average LTI ratio in Missouri would have been 10 basis points (approximately 5 percent) higher if the unexpected cut did not happen. The results are very similar in magnitude when we use the state-level aggregate LTI ratio or median LTI ratio.

3.2 Destabilizing Effects of Unemployment Insurance

In this section, we provide our empirical findings on whether UI benefits act as an automatic stabilizer. We use Home Mortgage Disclosure Act (HMDA) data obtained from Neil Bhutta's webpage, which enables us to observe both loan amounts and income at the county level. Our first evidence is from a graphical (non-parametric) cross-sectional analysis

Figure 12 – Economic Volatility and UI Generosity



Note: This figure provides a scatter plot for UI generosity and volatility of different variables. The sample consists of neighboring counties that are located on different states. The volatility measures are standard deviations of the variables over the sample period (1994-2010). UI generosity is the mean value of maximum amount of UI benefits over the sample period. The ratios are calculated by dividing one county's variable by other county's variable in the same county pair. The scatter plots use the variables after controlling for the ratio of volatilities of average income.

where we look into the relationship between economic fluctuations and UI benefits. Then, we analyze how UI benefits interact with long-term interest rates.

3.2.1 Non-parametric analysis

We begin our empirical analysis with a general framework in which we do not impose any model structure on the data. We restrict our county sample to only include neighboring counties located in different states. These counties face similar economic environments but different UI policies. Another advantage of this approach is that counties are generally small relative to the state they are in; therefore, they are unlikely to affect state-level policies.

We report our results in Figure 12. The figure displays the ratio of UI generosity of the counties in the same pair on the x-axis and the ratio of the volatility of different variables on the y-axis. As we move right on the x-axis, the counties become more generous compared to their neighbor counties in the same pair, and as we move up on the y-axis, the counties become more volatile. Figure 12 shows that counties that have higher UI generosity experience larger fluctuations in their mortgage loans and house prices.

3.2.2 Panel data analysis

In this section we investigate how UI benefits interact with the long-term interest rates using panel data from US counties. We focus on interest rates because this is the shock that we use in the data. We estimate the following model:

$$\begin{aligned}\Delta y_c^{q} &= \beta_1 \Delta Int.\ Rate_{10y}^{q} + \beta_2 \Delta Int.\ Rate_{10y}^{q-1} \cdot UIBen._c^{y} + UIBen._c^{y} \\ &+ Macro\ Controls^{q-1} + State\ Controls_c^{y} + County\ Controls_c^{y} + \theta_c + \mu_q + \epsilon_{c,t}\end{aligned} \tag{3}$$

where Δy_c^q is the quarterly outcome variable (house prices and new mortgage loans), $\Delta \text{Int. Rate}_{10y}^{q-1}$ is quarterly change in 10-year U.S. Treasury interest rate, UIBen._c^y is a dummy variable which is 1 if UI generosity is high. We expect to find negative β_1 since an increase in long term rates should decrease mortgage originations and house prices. Our coefficient of interest is β_2. If it is positive, then UI is dampening the impact of long-term rates. However, if β_2 is negative, then UI fails to be an automatic stabilizer and increases the long-term rates' influence on outcome variables.

There might be several problems with Equation 3. For instance, in addition to long-term rates, other important macroeconomic variables can have an effect on the outcome variables. Therefore, β_1 may spuriously pick up the effect of other macro variables. To mitigate this concern, we include log changes in GDP, changes in the unemployment rate and changes in the CPI as other macroeconomic control variables (Ottonello and Winberry (2018)). Moreover, the interaction term β_2, might be picking up the interaction of UI benefits with these macroeconomic variables. Thus, Equation 3 also includes interactions of UIBen._c^y with these four macro variables.

Another concern is related to the fact that UI benefit generosity is not the only welfare policy that is determined at the state level in the U.S. States have the freedom to choose their minimum wage, public health insurance coverage, and the amount of total monetary transfers. If the other state-level welfare policies also interact with $\Delta \text{Int. Rate}_{10y}^{q-1}$, then β_2 would be biased. Due to this reason, we add the interactions of $\Delta \text{Int. Rate}_{10y}^{q-1}$ with other state-level welfare policies into the model. Moreover, we include month fixed effects, μ_m, to control for seasonality in outcome variables, county fixed effects , θ_c, to control for time-invariant county characteristics, and a battery of county control variables in the model.[18] Overall, Equation 3 carefully considers and addresses the endogeneity problems concerning the observables.

While the model in equation 3 includes a rich set of control variables, it cannot fully address unobservable factors. Other macroeconomic variables that are not accounted for, in addition to the four macro level control variables, can impact both β_1 and β_2. Furthermore, uncontrolled or unobserved variables that are correlated with UI benefits can influence how UI benefits interact with long-term rates. To address these concerns, we employ two strategies. Firstly, we use propensity score matching to create county pairs that are as similar as possible, except for UI benefits. By doing so, we can compare how two matched counties react to long-term rates depending on their UI benefits. Secondly, we leverage discontinuous changes

[18]County controls are log of total wage, log change of labor force, log of population, log change of establishments, log change of nominal personal income, change in sectoral employment HHI, change in deposit market HHI.

in UI benefits at state borders by using $\mathtt{pair} * \mathtt{year}$ fixed effects. These two strategies enable us to evaluate whether UI acts as an automatic stabilizer.

Tables V and VI present the results for the regression model in equation 3. We regress the quarterly log change of mortgage lending at the county level, $\Delta\log(\mathsf{HMDA})_c$, on $\Delta\mathsf{Int.\ Rate}_{10y}^{q-1}$, $\mathsf{UIBen.}_c^y$, and its interaction in column (1). As explained above, we include macro, state, and county controls, relevant interaction terms, as well as county and quarter fixed effects in the model. The coefficient of $\Delta\mathsf{Int.\ Rate}_{10y}^{q-1}$ is estimated precisely with a negative sign. The economic magnitude of the coefficient is that one standard deviation increase in $\Delta\mathsf{Int.\ Rate}_{10y}^{q-1}$ decreases the $\Delta\log(\mathsf{HMDA})_c$ by 14 percent.

Given that we are interested in the stabilizing nature of UI benefits, we assess the sign of the coefficient of the interaction term. Consistent with the evidence from Figure 12, the interaction term is negative and significant. This indicates that UI generosity increases the impact of long-term rates in a statistically significant way. To understand the economic magnitude, note that $\mathsf{UIBen.}_c^y$ is a dummy variable and switching from 0 to 1 increases the UI benefits generosity by 2,100 USD. Since this number is slightly lower than 1 standard deviation of UI benefits in our sample, we interpret the coefficient of interaction as a 1 standard deviation increase in UI benefits. Therefore, a 1 standard deviation increase in UI benefits amplifies the impact of interest rates on mortgages by approximately 10 percent.

In column (2), we include time fixed effects to control for unobserved time effects. With time fixed effects, it is not possible to estimate the direct effect of $\Delta\mathsf{Int.\ Rate}_{10y}^{q-1}$, 10y, yet the interaction term has a negative sign with high statistical significance. In the remaining two columns, we apply the matching strategies explained previously. In the third column, we use county pairs created using propensity scores. Instead of time fixed effects, we include $\mathsf{Pair(matching)} * \mathsf{Time}$ fixed effects, so that we compare each high UI county with its matched low UI county pair. The magnitude of the interaction term decreases slightly but is significant at 8 percent. In the last column, we switch to county pairs that are neighbors to each other but located in different states. Again, with $\mathsf{Pair(border)} * \mathsf{Time}$ fixed effects, we find that the interaction term is negative with a magnitude close to the one in the previous column. The evidence from this exercise supports the claim that UI benefits amplify the impact of a change in long-term interest rates for mortgages.

For the impact of long-term interest rates on house prices, we adopt the same regression model as in the mortgage analysis. In Table VI, as the independent variable, we use the quarterly log change of house prices, $\Delta\log(\mathsf{HP})_c$. In the first column, we saturate the model with macro, state and county controls with county and quarter fixed effects. Similar to the previous table, the direct effect of long-term rates, $\Delta\mathsf{Int.\ Rate}_{10y}^{q-1}$, is precisely estimated and it is negative as expected. The interaction of $\Delta\mathtt{Int.\ Rate}^{q-1}_{10y}$ and $\mathtt{UIBen.}^{y}_{c}$ is negative and statistically significant. The magnitude of the coefficient suggests that a 1 standard deviation increase in UI benefits increases the impact of long-term rates on house prices by 12 percent.

Starting from the column (2), we include time fixed effects. Controlling for observed and unobserved time factors, the interaction term of $\Delta\mathtt{Int.\ Rate}^{q-1}_{10y}$ and $\mathtt{UIBen.}^{y}_{c}$ stays remarkably stable with high statistical significance. In the third column, we use the matched sample produced by the propensity score matching method. The magnitude of the coefficient stays the same, indicating a robust relation. In column (4), similar to the previous table, we use contiguous counties that are located in different states. Consistent with the previous columns, the interaction term is significant and negative with a similar magnitude. Overall, the results in Tables V and VI suggest that UI might fail to act as an automatic stabilizer.

Discussion In this section, we provided evidence from micro data that is supporting the predictions of the quantitative model. Since the empirical analysis in this section uses cross-sectional variation as a source of identification, it does not account for general equilibrium effects. Therefore, the results in this section are more comparable to the partial equilibrium analysis that we performed in Section 2.3.4, which suggests that studies that rely on cross-sectional variation might not capture the systemic risk created by higher UI for the whole economy. Thus, the findings of this section can be considered as a lower bound on the destabilizing effects of UI.Discussion and Conclusions

In this paper, we examine whether UI policies stabilize economic cycles. Contrary to the common view, we argued that, in most cases, they do not. We present both empirical and theoretical evidence to support our hypothesis.

Two distinct mechanisms drive our results. First, ex-ante, more generous UI benefits lower savings and increase borrowing. More importantly for the housing market, it lowers down payment ratios and liquid asset holdings (i.e. the fraction of households with high leverage and that are hand-to-mouth increases). As a result, both household and bank balance sheets become more vulnerable to a decline in house prices and more responsive to even transitory shocks. Given price movements (e.g. house prices and wages), more generous UI policies will smooth the downturn and lower foreclosures. However, our findings suggest that there are non-negligible effects of UI benefits on prices: the decline becomes larger as UI becomes more generous. Second, we show that more generous UI benefits amplify the boom episodes. As a result, weak balance sheets get even weaker in higher UI economies during the boom.

To not to blur the mechanisms that we discuss in our paper we abstain from studying several important mechanisms that have been extensively studied in the literature. For example, search effort, accepting/rejecting job offers, job creation, and destruction, are all important channels through which UI benefits influence economic dynamics. We find it important to extend our framework in these directions in our future work, in particular, to analyze how these decisions interact with balance sheets.

We chose not to perform a welfare analysis. The main reason is that we would need to have aggregate uncertainty in our framework for a sound analysis. This is computationally unfeasible in our current setting. However, we show that stricter macroprudential regulations may particular be necessary for high UI economies. With tighter regulations, the ex-ante negative effects of UI benefits on balance sheets can be mitigated.[19]

Our results have broader policy implications than just UI benefits. Any government policies that lower micro and/or macro-economic uncertainties, may induce risk-taking and increase leverage. For example, progressive income taxation may have similar effects. At the macro level, Bean (2011) argues that "the great moderation", partly induced by better policy frameworks, has created strong incentives to take on risk. These are interesting and important areas for future research.

[19]Kabas and Roszbach (2021) document that a loan-to-value ratio restriction can generate UI-like effects by reducing household leverage.

TABLE V – Interest rate shock and UI benefits: Housing Credit

	All		Pair(matching)	Pair(border)
	(1)	(2)	(3)	(4)
$\Delta \mathtt{Int.Rate}^{10y}_{q-1}$ X UI Ben.	-0.039***	-0.036***	-0.016*	-0.017*
	(0.009)	(0.011)	(0.009)	(0.009)
$\Delta \mathtt{Int.Rate}^{10y}_{q-1}$	-0.337***			
	(0.113)			
County Controls	Y	Y	Y	Y
State Controls	Y	Y	Y	Y
Macro Controls	Y	Y	Y	N
County FE	Y	Y	Y	Y
Month FE	Y	N	N	N
Time FE	N	Y	N	N
Pair(matching)*Time FE	N	N	Y	N
Pair(border)*Time FE	N	N	N	Y
Obs.	93,873	93,873	29,214	34,932
R^2	0.490	0.774	0.892	0.933

Standard errors in parentheses
* $p<0.10$,** $p<0.05$, *** $p<0.01$

This table estimates the effect of a long term interest rates on mortgages and how generous UI benefits increase the effect of the rate. In all models, the dependent variable is quarterly log change of mortgages , $\Delta \mathsf{log}(\mathsf{HMDA})_c$. The main independent variable is 10-year interest rate, $\Delta \mathtt{Int.Rate}^{10y}_{t-1}$ and its interaction with UI benefits, $\mathsf{UI Ben}$. $\mathsf{UI Ben}$. is a dummy variable which is 1 if the value is above median of the sample of each year. Control variables and fixed effects are indicated at the bottom of each column. County controls are log of total wage, log change of labor force, log of population, log change of establishments, log change of nominal personal income, change in sectoral employment HHI, change in deposit market HHI. County controls are yearly. Macro controls are log change in GDP, change in unemployment rate, change in VIX, change in CPI, and interaction of these variables with $\mathsf{UI\ Ben}$. All macro controls are quarterly and enter model with 1 quarter lag. State controls include minimum wage, aggregate non-UI transfers, aggregate state health insurance payments and their interactions with $\mathtt{Int.\ Rate}^{10y}_{q-1}$. These variables are dummy variables which is 1 if the value is above median of the sample of each year. Column (1) and (2) use the entire sample. Column (3) uses matched sample. Column (4) uses contiguous counties in different states. In columns (3) and (4), crucial fixed effects are $\mathsf{Pair} * \mathsf{Time}$ fixed effects. Standard errors are clustered at state and date level in columns (1)-(3), at border segment and state level in column (4).

Table VI – Interest rate shock and UI benefits: House Prices

	All		Pair(matching)	Pair(border)
	(1)	(2)	(3)	(4)
$\mathtt{Int.Rate}^{10y}_{q-1}$ X UI Ben.	-0.002***	-0.002***	-0.002**	-0.001*
	(0.000)	(0.000)	(0.001)	(0.001)
$\mathtt{Int.Rate}^{10y}_{q-1}$	-0.017***			
	(0.005)			
County Controls	Y	Y	Y	Y
State Controls	Y	Y	Y	Y
Macro Controls	Y	Y	N	N
County FE	Y	Y	Y	Y
Seasonality FE	Y	N	N	N
Time FE	N	Y	N	N
Pair(matching)*Time FE	N	N	Y	N
Pair(border)*Time FE	N	N	N	Y
Obs.	280,903	280,903	175,826	124,384
R^2	0.180	0.297	0.705	0.722

Standard errors in parentheses

+ p<0.15, * p<0.10,** p<0.05, *** p<0.01

This table estimates the effect of a long term interest rates on house prices and how generous UI benefits increase the effect of the rate. In all models, the dependent variable is quarterly log change of house prices , $\Delta\log(\mathsf{HP})_c$. The main independent variable is 10-year interest rate, $\Delta\mathtt{Int.\ Rate}^{10y}_{q-1}$ and its interaction with UI benefits, $\mathtt{UI\ Ben}$. $\mathtt{UI\ Ben}$. is a dummy variable which is 1 if the value is above median of the sample of each year. Control variables and fixed effects are indicated at the bottom of each column. County controls are log of total wage, log change of labor force, log of population, log change of establishments, log change of nominal personal income, change in sectoral employment HHI, change in deposit market HHI. County controls are yearly. Macro controls are log change in GDP, change in unemployment rate, change in VIX, change in CPI, and interaction of these variables with $\mathtt{UI\ Ben}$. All macro controls are quarterly and enter model with 1 quarter lag. State controls include minimum wage, aggregate non-UI transfers, aggregate state health insurance payments and their interactions with $\Delta\mathtt{Int.\ Rate}^{10y}_{t-1}$. These variables are dummy variables which is 1 if the value is above median of the sample of each year. Column (1) and (2) use the entire sample. Column (3) uses matched sample. Column (4) uses contiguous counties in different states. In columns (3) and (4), crucial fixed effects are $\mathtt{Pair} * \mathtt{Time}$ fixed effects. Standard errors are clustered at state and date level in columns (1)-(3), at border segment and state level in column (4).

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APPENDIX

A Model Details

A.1 Household Decision Problems

A.1.1 Active Renters

An active renter has two choices: to continue to rent or purchase a house, i.e. $V^r = \max\left\{V^{rr}, V^{rh}\right\}$ where V^{rr} is the value function if she decides to continue renting and V^{rh} is the value function if she decides to purchase a house. If an active renter chooses to purchase a house, she can access the mortgage market to finance her purchase. She chooses a mortgage debt level d that determines $q^m(d; a, h, z, j)$, the price of the mortgage at the origination, which will be a function of the current state of the household (current wealth a, income realization z, and age j), house size h, and the amount of debt d.

$$V_{ij}^{rr}(a, z) = \max_{c,s,a' \geqslant 0} \left\{u(c, s) + \beta_i E V_{j+1}^{r}(a', z')\right\} \tag{4}$$

subject to

$$c + \frac{a'}{1 + r_i} + p_r s = w(1 - \tau)\, y(j, z) + a$$

The value function of an active renter who buys a house is given by

$$V_{ij}^{rh}(a, z) = \max_{c,d,h,a' \geqslant 0} \left\{u(c, h) + \beta_i E V_{ij+1}^{h}(a', h, d, z')\right\} \tag{5}$$

subject to

$$\begin{aligned} c + p_h h + \vartheta p_h h + \varphi_f + \frac{a'}{1 + r_i} &= w(1 - \tau)\, y(j, z) + a + d\left(q^m(d; a, h, z, j) - \varphi_m\right) \\ d' &\leqslant p_h h(1 - \phi), \end{aligned}$$

x': the next period value of any variable x,

z: income shock, which includes unemployment and employment shocks,

a: the end-of-period financial wealth,

p_r: the rental payment,

r_i: is the return to savings. For capitalists have rate of return $r_K = \tilde{r}$ and depositors have rate of return $r_D = r$.

w: wage rate per efficiency unit of labour.

E: expectation operator is over the income shock z'.

p_h: housing price,

υ: the maintenance cost proportional to the housing size,

φ_m: the variable cost of mortgage origination,

φ_f: the fixed cost of paid at the origination,

ϕ: is the minimum down payment.

A.1.2 Inactive Renters

Inactive renters are not allowed to purchase a house because of their default in previous periods. However, they can become active renters with probability π. Since they cannot buy a house, they only make rental size, consumption, and saving decisions. The value function of an inactive renter is given by

$$V^i_{ij}(a,z) = \max_{c,s,a'\geqslant 0} \left\{u(c,s) + \beta_i \left[\pi E V^r_{j+1}(a',z') + (1-\pi) E V^i_{ij+1}(a',z')\right]\right\} \tag{6}$$

subject to her budget constraint

$$c + \frac{a'}{1+r_i} + p_r s \quad = \quad w\,(1-\tau)\,y(j,z) + a$$

A.1.3 Homeowners

A homeowner has four options: ie. $V^h = \max\left\{V^{hh}, V^{hf}, V^{hr}, V^{hi}\right\}$, where $V^{hh}$is the value of staying as homeowner, V^{hf} is the value of refinancing,V^{hr} is the value of selling, and V^{hi} is the value of defaulting.

Stayer: A stayer makes a consumption and saving decision given his income shock, housing, mortgage debt, and assets.

$$V^{hh}_{ij}\left(a,h,d,z\right) = \max_{c,a'\geqslant 0} \left\{u\left(c,h\right) + \beta_i E V^h_{ij+1}\left(a',h,d',z'\right)\right\} \tag{7}$$

subject to

$$\begin{aligned}
c + \vartheta p_h h + \frac{a'}{1+r_i} + m &= w(1-\tau)\,y(j,z) + a \\
m &= d\left(1 - \frac{1-\mu}{1+r_\ell}\right) \\
d' &= (1-\mu)\,d.
\end{aligned}$$

Refinancer: Refinancing requires paying the full balance of any existing debt and getting a new mortgage. We assume that refinancing is subject to the same transaction costs as new mortgage originations.

$$V_{ij}^{hf}(a,h,d,z) = \max_{c,d',a'\geqslant 0} \left\{u(c,h) + \beta_i E V_{ij+1}^{h}(a',h,d',z')\right\} \tag{8}$$

subject to

$$c + d + \vartheta p_h h + \varphi_f + \frac{a'}{1+r_i} = w(1-\tau)\,y(j,z) + a + d'\left(q^m(d';a,h,z,j) - \varphi_m\right)$$

$$d' \leqslant p_h h\,(1-\phi)\,.$$

Seller: Selling a house is subject to a transaction cost that equals fraction φ_s of the selling price. Moreover, a seller has to pay the outstanding mortgage debt, d, in full to the lender. A seller, upon selling the house, can either rent a house or a buy a new one. Her problem is identical to a renter's problem.

$$V_{ij}^{hr}(a,h,d,z) = V_{ij}^{r}\left(a + p_h h(1-\varphi_s) - d, z\right)$$

where φ_s of the selling cost and outstanding mortgage debt, d.

Defaulter: A defaulter has no obligation to the bank. The bank seizes the house, sells it on the market, and returns any positive amount from the sale of the house, net of the outstanding mortgage debt and transaction costs, back to the defaulter. For the lender, the sale price of the house is assumed to be $(1-\varphi_e)\,p_h h$. Therefore, the defaulter receives $\max\{(1-\varphi_e)\,p_h h - d, 0\}$ from the lender. The defaulter starts the next period as an active renter with probability . With probability $1-\pi$, she stays as an inactive renter.

$$V_{ij}^{hi}(a,d,z) = \max_{c,s,a'\geqslant 0} \left\{ u(c,s) + \beta_i E\left[\pi V_{ij+1}^{r}(a',z') + (1-\pi) V_{ij+1}^{i}(a',z')\right]\right\} \quad (9)$$

subject to

$$c + \frac{a'}{1+r_i} + p_r s \;=\; a + w(1-\tau) y(j,z) + \max\{(1-\varphi_e) p_h h - d, 0\}$$

A.2 Banks

Bankers maximize

$$\sum_{t=0}^{\infty} \beta_L^{t-1} \log\left(c_t^B\right)$$

subject to

$$c_t^B + L_{t+1}^k + \int_\theta p_t(\theta)\,\ell_{t+1}(\theta) \;=\; N_t + B_{t+1}.$$

$$N_{t+1} \;=\; \int_\theta \int_{\theta'} v_{t+1}^l(\theta')\,\Pi(\theta'|\theta)\,\ell_{t+1}(\theta) + L_{t+1}^k\left(1 + r_{t+1}^*\right) - B_{t+1}(1 + r_{t+1}),$$

where

$$v_{t+1}^l(\theta') \;=\; m_{t+1}(\theta') + p_{t+1}(\theta').$$

Denote its value of defaulting by $\Psi_{t+1}^D\left(\varphi L'_{t+1}\right)$, where

$$L'_{t+1} = \left(\int_\theta \int_{\theta'} v_{t+1}^l(\theta')\,\Pi(\theta'|\theta)\,\ell_{t+1}(\theta) + L_{t+1}^k\left(1 + r_{t+1}^*\right)\right).$$

Note that

$$L_{t+1} = L_{t+1}^k + \int_\theta p_t(\theta)\,\ell_{t+1}(\theta).$$

Enforcement constraint is given as

$$\tilde{\Psi}_{t+1}\left(\varphi_{t+1}, B_{t+1}^I\right) \geqslant \Psi_{t+1}^D\left(\varphi L'_{t+1}\right).$$

c_t^B: the banker's consumption,

B_{t+1}: bank's borrowing amount $B_{t+1}^I + B_{t+1}^D$,

B_{t+1}^I: bank's borrowing from international investors,

B_{t+1}^D: bank's deposits,

r_{t+1}: bank's borrowing rate,

L_{t+1}^k: bank lending to the firm at interest rates r_{t+1}^*,

$\theta = (d; a, h, z, j)$: define type of a mortgage (defined above by the household's problem),

N_t: the bank's net worth,

$\ell_{t+1}(\theta)$: be the amount of investment in mortgage type θ.

A.3 Production Firms

A perfectly competitive firm maximizes

$$\max_{K_t, N_t, u_t} A_t K_t^\alpha (N_t u_t)^{1-\alpha} - (\tilde{r}_t + \delta) K_t - \left(1 + \phi_k r_{t+1}^*\right) w(\bar{w}_t, u_t) N_t.$$

N_t: number of workers,

u: labour utilization rate,

K_t:capital,

w wage rate, $w(\bar{w}_t, u_t) = \bar{w}_t + \varphi \frac{u_t^{1+\psi}}{1+\psi}$.

A.4 Rental Companies

The objective of the company is to maximize its total market value $V_t\left(H_{t-1}^r\right)$:

$$\begin{aligned}
V_t\left(H_{t-1}^r\right) &= \max_{H_t^r} \frac{1}{1+\tilde{r}_t}\left(d_t + V_{t+1}\left(H_t^r\right)\right) \\
&\quad \text{s.t.} \\
d_t &= p_t^h (1-\delta) H_{t-1}^r - p_t^h H_t^r - \frac{\eta}{2} p_t^h \left(H_t^r - H_{t-1}^r\right)^2 + (p_t^r - \phi) H_t^r.
\end{aligned}$$

$(1-\delta_r) H_{t-1}^r$: units of housing stock that rental company owns,

δ_r: depreciation rate of rental housing,

$\frac{\eta}{2} p_t^h \left(H_t^r - H_{t-1}^r\right)^2$: quadratic adjustment cost,

$(p_t^r - \phi) H_t^r$: net rent,

ϕ :per-period maintenance cost,

$d_t = p_t^h (1-\delta) H_{t-1}^r - p_t^h H_t^r - \frac{\eta}{2} p_t^h \left(H_t^r - H_{t-1}^r\right)^2 + (p_t^r - \phi) H_t^r$: dividend to shareholders.

From the no-arbitrage condition:

$$1 + \tilde{r}_t = \frac{d_t + V_{t+1}(H_t^r)}{V_t\left(H_{t-1}^r\right)},$$

where $V_{t+1}(H_t^r)$ is the post-dividend market value of the company at the end of period t.

B Auxiliary Quantitative Results

B.1 Life-Cycle Dynamics in the Steady-state

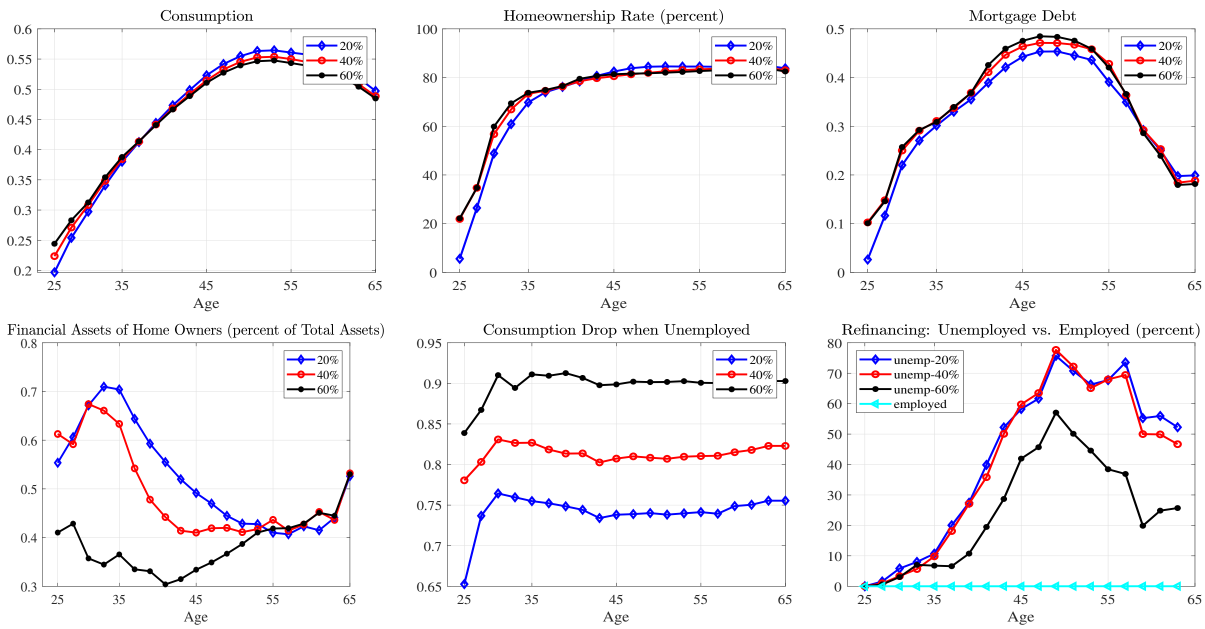
Consistent with the earlier literature, consumption is hump-shaped and more than doubles from age 25 to 55 in all economies (Figure 13, top-left panel). But the rise of consumption is higher in lower UI economies. Home ownership rate and mortgage debt start much lower, close to 0, in the 20-percent UI economy (Figure 13, top-middle and right panels).Consumers shold less liquid assets when UI is more generous, in particular early in life (Figure 13, bottom,-left panel). For all these results, the dynamics of income risk plays a crucial role. When UI generosity declines, the precautionary saving motive becomes more powerful, which keeps consumption and housing low at young ages. As unemployment risk declines with age, consumers start to consume their savings. On top of that, default cost lowers the mortgage demand over the life cycle.

More generous UI benefits help to smooth consumption drops during unemployment (Figure 13, lower-middle panel). Consumers who got unemployed in the 20-percent UI economy, lower their consumption by about 25 percent. The decline is around 10 percent in the 60-percent UI economy. The drops are larger for the younger ages as they have neither financial nor housing wealth.

Both the decline in consumption when unemployed and the effect of benefits on the consumption drop are close to the estimates found in the literature. For example, Ganong and Noel (2019) use detailed bank account data and document that household consumption declines by about 10 percent upon unemployment. The corresponding number in the model is around 13 percent (weighted by the unemployment rates of each age) if one considers that the average UI in the US is 50 percent. Regarding the effects of UI generosity, Gruber (1994) (and more recently Kroft and Notowidigdo (2016)) find that a 10 percentage point increase in UI generosity leads to about a 2.8 percent reduction in the fall in consumption upon job loss. The corresponding number is 3.7 percent in our model. Both results suggest that our model's micro implications are consistent with empirical estimates.

Finally, UI also affects refinancing activity (Figure 13, bottom-right panel). Once unemployed, households tap their home equity and refinance. In all UI economies, the share of unemployed who refinance increases until around age 50 and exceeds 50 percent. However, refinancing is larger for lower UI economies as the UI benefits are not enough to smooth the decline in consumption. This suggests that UI and refinancing act like substitutes. The wide-spread use of refinancing among unemployed is consistent with the recent findings

FIGURE 13 – Unemployment Insurance Policies and Life-Cycle Dynamics



Notes: The graph plots life-cycle dynamics of hey variables in the steady-state for different UI benefit levels. "Consumption drop" is the average of consumption drops of recently unemployed relative to their consumption when employed during the previous period. "Refinancing" is the percent of individuals in either employed or unemployed groups who refinances.

in Braxton, Herkenhoff and Phillips (2020) that suggest unemployed individuals maintain significant access to credit.

C Steady-state results when the model period is 6 weeks

In the dynamic model where we solved model's transition we assumed that a model period is 2 years. Given that this is longer than a typical unemployment spell in the US, in this section we show the results of the steady-state still hold when we assume that the model period is 6 weeks: household balance sheets weaken strongly as UI becomes more generous. In particular, down payment ratios decline from 8.9 to 4.4 percent, debt-to-output ratio increases from 3.19 to 6.56, and the amount of liquid wealth relative to debt declines from 6.19 to 2.63 when UI increases from 10 to 40 percent.

Table VII – Steady-state results when model period is 6 weeks

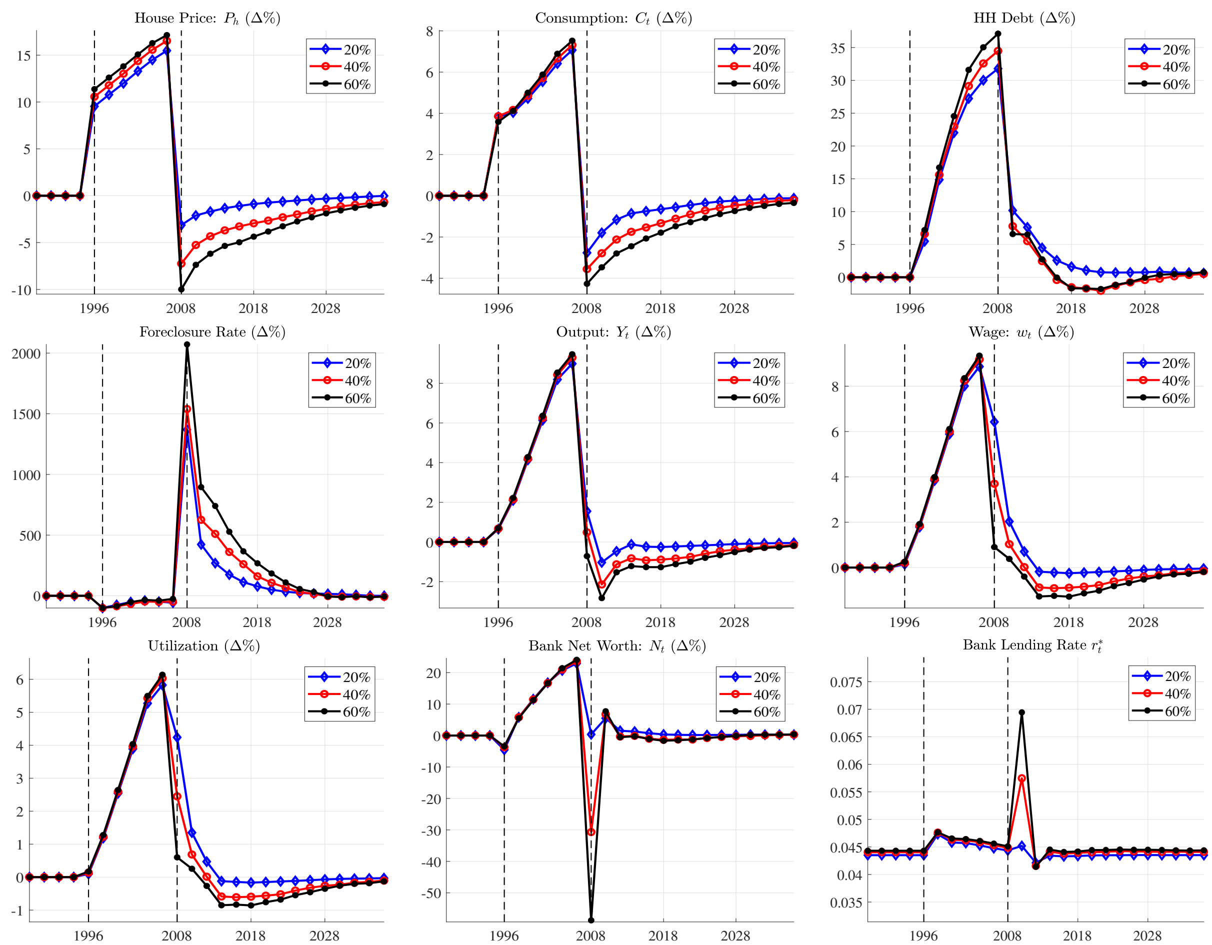
Notes: This table provides the steady-state statistics for the main balance sheet variables where we calibrate the model period to be 6 weeks. Income and output correspond to their 6-week values. 10 percent and 40 percent UI are made bold since we compare them in the text.

	UI Generosity					
	1%	**10%**	20%	**40%**	60%	80%
Down payment (%)	19.5	**8.9**	7.2	**4.4**	2.9	2.5
Loan-to-Income	16.0	**17.54**	18.11	**18.53**	19.41	20.31
Debt/Output Ratio	2.02	**3.19**	4.42	**6.56**	7.95	8.68
Financial wealth-to-income	28.77	**26.98**	26.28	**25.86**	25.42	25.44
Financial wealth-to-debt	10.14	**6.19**	4.36	**2.63**	2.34	2.15
Ownership Rate (%)	58	**62**	64	**64**	65	62

D Boom-bust with other shocks

D.1 Productivity Shocks

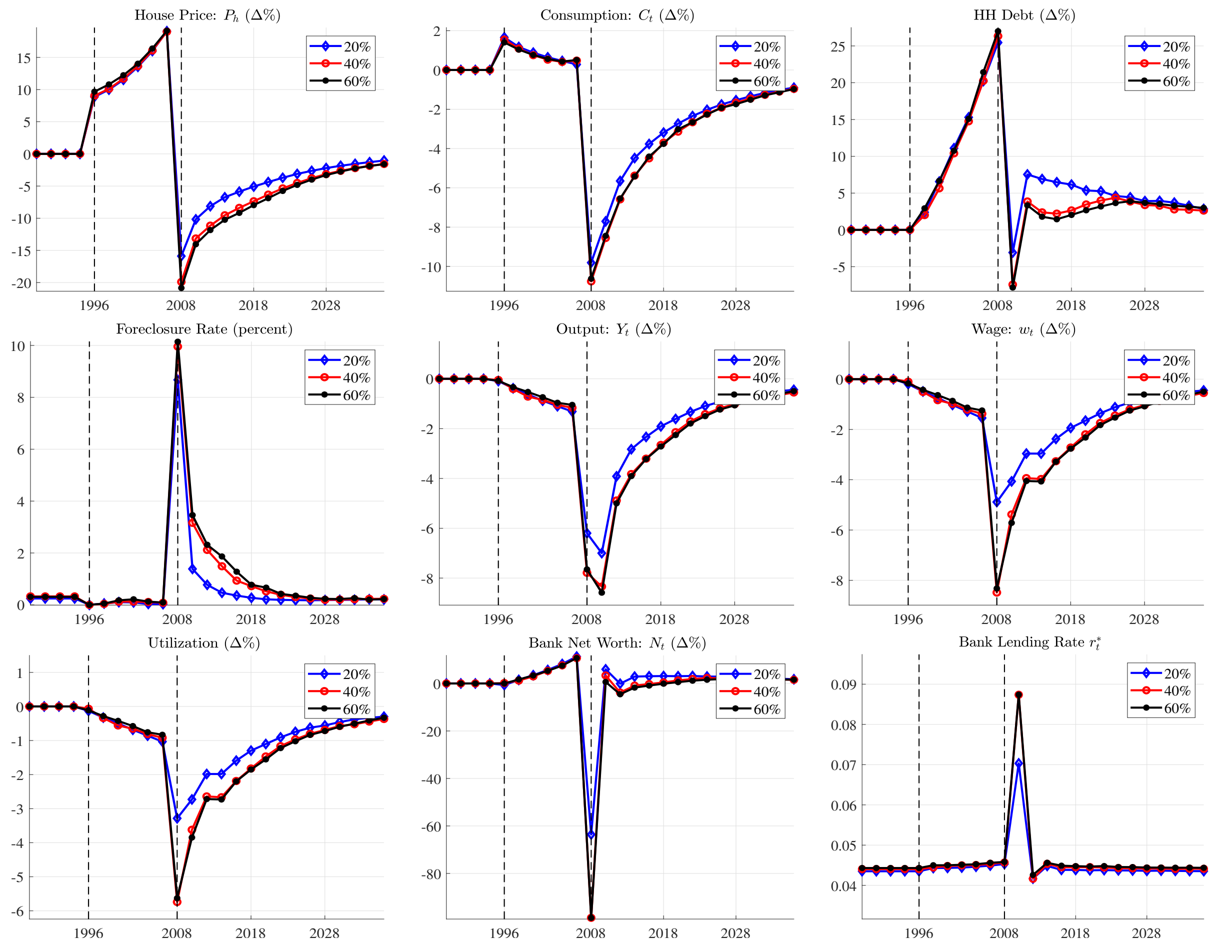
FIGURE 14 – Boom-Bust with Productivity Shocks



Notes: The graph plots the dynamics of key banking variables during the boom-bust episode. The shock during the boom is a gradual increase in productivity. During the bust, productivity reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized it is perfect foresight.

D.2 Expectation Shocks

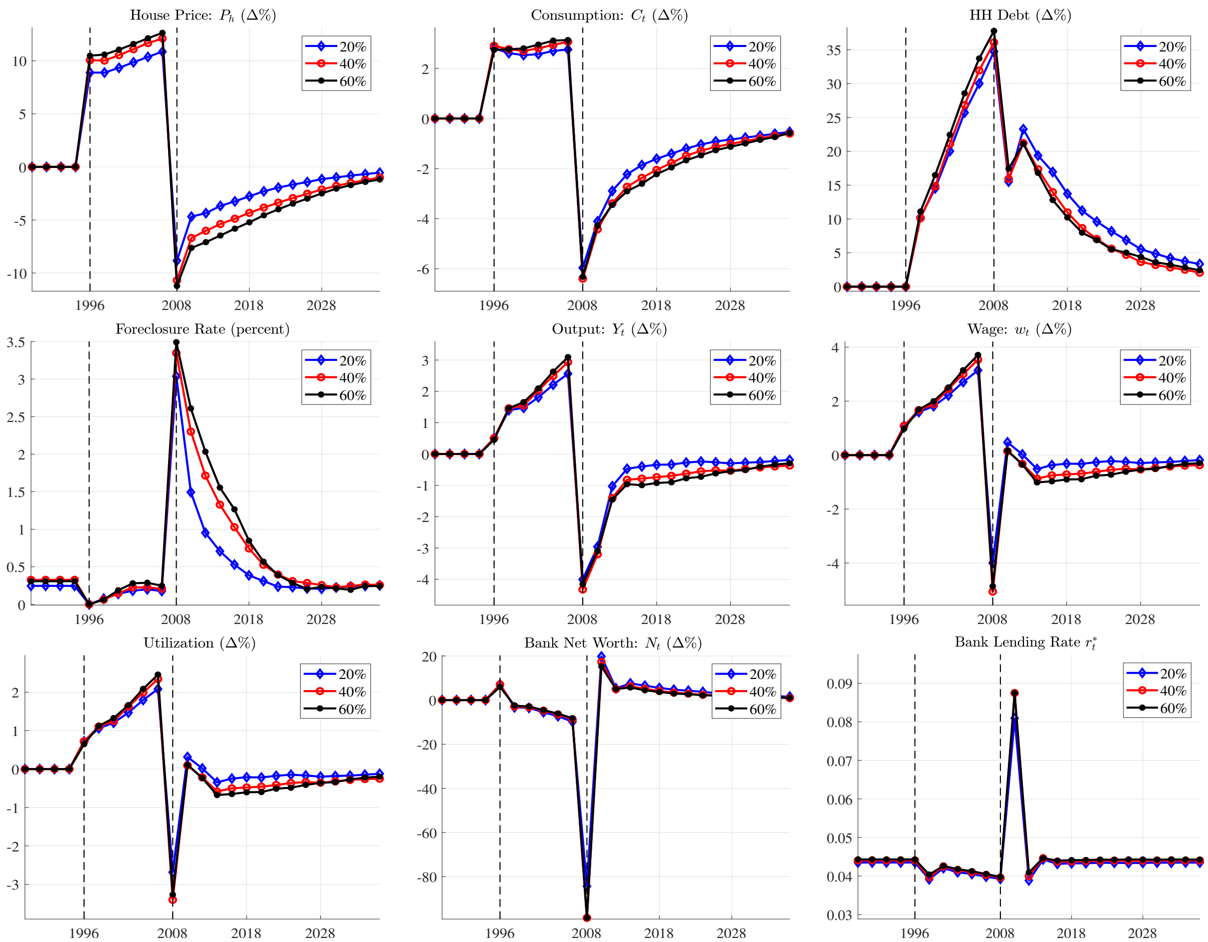
Figure 15 – Boom-Bust with Expectation Shocks



Notes: The graph plots the dynamics of key banking variables during the boom-bust episode. The shock during the boom is an expectation shock: everyone in the economy expects that house prices will increase by about 19 percent. During the bust, expectation reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized it is perfect foresight.

D.3 Credit Supply Shocks

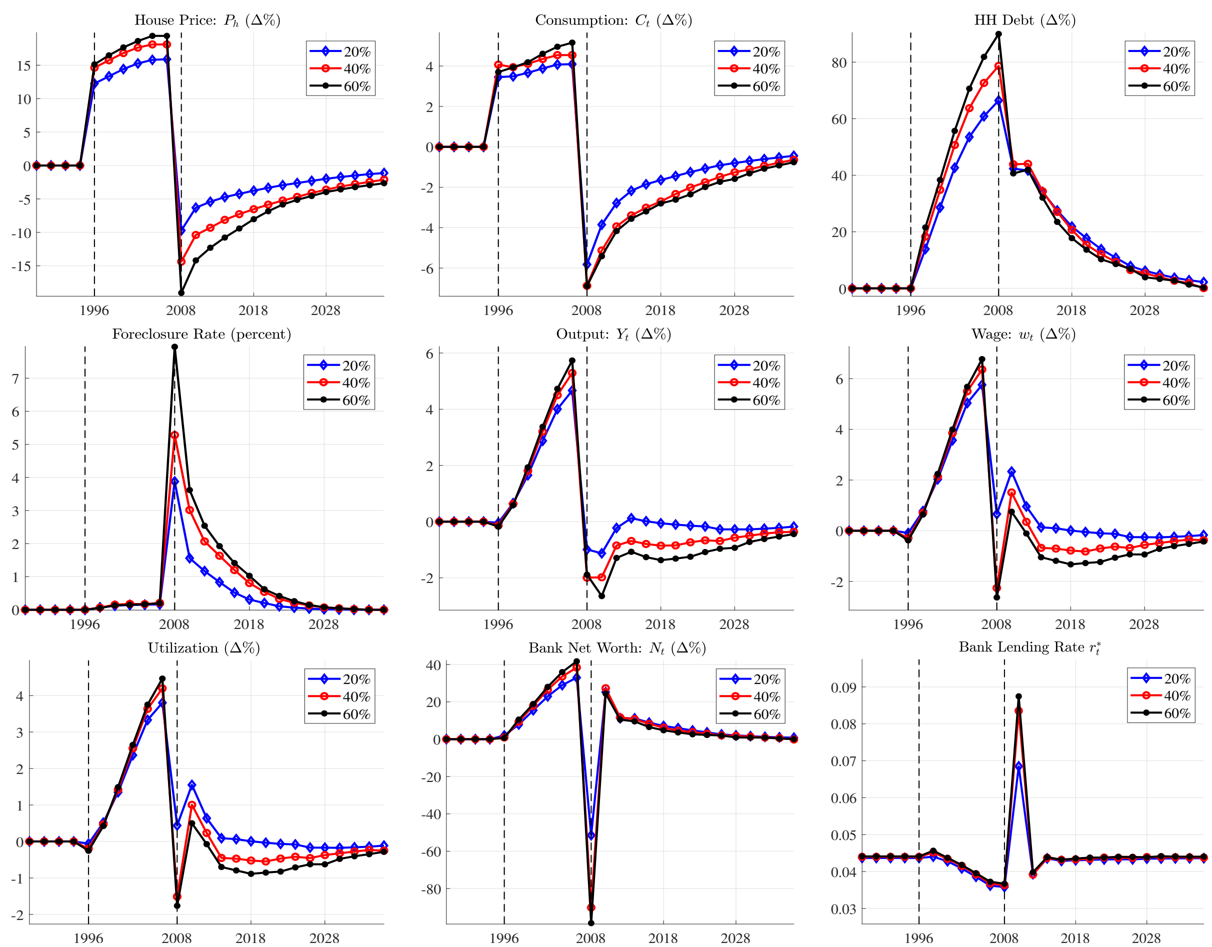
FIGURE 16 – Boom-Bust with Credit Supply Shocks



Notes: The graph plots the dynamics of key banking variables during the boom-bust episode. The shock during the boom is a gradual increase in bank leverage. During the bust, bank leverage reverses to the initial steady-state and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized it is perfect foresight.

D.4 Interest Rate+LTV Shocks

FIGURE 17 – Boom-Bust with Interest Rate and LTV Shocks



Notes: The graph plots the dynamics of key banking variables during the boom-bust episode. The shock during the boom is a gradual increase in bank leverage and a loosening LTV constraint on mortgages. During the bust, bank leverage and LTV reverse to the initial steady-state, and unemployment rate increases to 10 percent and declines back to 5.5 percent linearly in 6 years. Both the boom and bust shocks are unexpected. But, once realized it is perfect foresight.

E Summary Statistics

We give the summary statistics of the variables used in interest rate analysis in Table ??. The data is from the period between 1994 and 2010. Average quarterly increase in mortgages at county level is 2 basis point (bp) and average house price growth rate is 1 bp. Monthly mortgage origination information is available for largest 500 counties, thus the number of observations is different for these credit and house price growth rates. Quarterly changes in

TABLE VIII – Summary Statistics

This table provides the summary statistics for main variables. Time period is between 1994 and 2010. Δ denotes quarterly changes for house prices, mortgages origination and macro variables, whereas it denotes yearly changes for county level variables. $\mathsf{non-UI\,Trans.}_s$, Health_s, and $\mathsf{Tot.\,Wage}_c$ are in million dollars. $\mathsf{Pop.}_c$ is in thousands.

	Mean	SD	25^{th} perc.	Median	75^{th} perc.
LTI_{cb}	2.08	0.89	1.51	2.03	2.56
$\Delta\log(\mathsf{HMDA})_c$	0.02	0.31	-0.18	0.00	0.21
$\Delta\log(\mathsf{HP})_c$	0.01	0.02	-0.00	0.01	0.02
$\Delta Int.\ Rate_{10y}^{q-1}$	-0.05	0.44	-0.39	-0.07	0.27
$UI\ \mathsf{Ben.}_s$	8.82	2.57	7.15	8.42	10.22
$\Delta\log(\mathsf{GDP})$	0.01	0.01	0.00	0.01	0.01
$\Delta\mathsf{CPI}$	-0.02	1.01	-0.40	-0.01	0.37
$\Delta\mathsf{VIX}$	0.19	7.35	-2.90	-0.40	2.60
$\Delta Unemp.$	0.07	0.34	-0.20	0.00	0.20
$non\text{-}UI\ \mathsf{Trans.}_s$	4.48	4.98	1.44	2.73	5.20
Health_s	7.61	8.49	2.58	4.98	8.82
$Min.\ \mathsf{Wage}_s$	5.29	1.29	4.95	5.15	6.15
$Tot.\ \mathsf{Wage}_c$	2032.66	7749.76	121.56	327.05	1075.68
$\Delta\log(\mathsf{Inc.})_c$	4.57	4.52	2.39	4.63	6.84
$\mathsf{Pop.}_c$	140.04	377.12	21.07	42.95	112.95
$\Delta\log(\mathsf{Labor})_c$	0.79	3.68	-0.74	0.79	2.33
$\Delta\mathsf{Unemp.}_c$	0.25	1.29	-0.40	0.00	0.70
$\Delta\log(\mathsf{Estab.})_c$	1.14	3.20	-0.72	0.97	2.88
$\Delta HHI_c^{\mathsf{Emp}}$	13.82	135.48	-10.19	3.40	26.97
$\Delta HHI_c^{\mathsf{Dep}}$	-0.00	0.03	-0.01	-0.00	0.00

10-year U.S. Treasury rates has mean of -5 bp in our sample with a large standard deviation of 44 bp. The mean value of $\mathsf{UI\,Ben}_c^{02}$ is 8,800 USD and its standard deviation is 2,530 USD which indicates that there is a large variation in UI generosity among states. The macroeconomic variables are at quarterly level on a 3-month rolling basis, whereas due to lack of information, state and county level variables are at yearly level.