Mortgage Defaults, Bank Runs, and Regulation in a Housing Economy*

Marcus Mølbak Ingholt† Johannes Poeschl† Xue Zhang§

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Preliminary and incomplete draft. Please find updated versions of the paper here.

Abstract

We develop a macroeconomic model capturing the linkages between house price fluctuations, mortgage defaults, and bank runs. In the model, endogenous house price drops can lead to bank runs if the liquidation value of the banking sector falls below the value of its outstanding deposits. Once a technology shock is calibrated for the model to match GDP, the model predicts the historical movements in consumption, house prices, mortgage debt, and bank equity. We use the model to evaluate different macroprudential policies. Both stricter loan-to-value standards and bank capital requirements effectively reduce default rates. However, this comes at the cost of impeding financial intermediation over the business cycle. By contrast, a dynamic loan loss provisioning is able to reduce default rates without impeding intermediation, since this tightening only binds in times of financial distress. The dynamic provisioning is also more effective at preventing bank runs, as compared to the two other policies.


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†University of Copenhagen. E-mail address: mi@econ.ku.dk.

‡Danmarks Nationalbank. E-mail address: jpo@nationalbanken.dk.

§KBC Bank. E-mail address: xue.zhang@kbc.be.


1 Introduction

Between 2007 and 2010, the U.S. economy witnessed a financial crisis unprecedented in modern history. Falling house prices initially caused mortgage delinquency and default rates to spike and banks to incur losses on mortgage lending. The associated depletion of capital forced banks to contract lending and raise lending rates. This amplified the fall in house prices, further weakening the banks’ financial positions to the point that triggered runs on a variety of institutions, such as Bear Stearns in March 2008 and Lehman Brothers in September 2008. The ensuing fire sales of bank assets amplified the overall distress in financial markets, as well as the contraction in economic activity.

Despite these events, macroeconomic models remain silent about the linkages between house price fluctuations, mortgage defaults, and bank runs. This gap largely stems from the literature diverging on how to model the effects of the housing boom-bust cycle on real activity. One strand of the literature relies on financial accelerator effects. In these models, weak balance sheet conditions of firms or households undermine their access to credit, creating a negative feedback loop that impairs their balance sheets further (Bernanke and Gertler, 1989; Kiyotaki and Moore, 1997).\(^1\) Another strand of the literature studies bank runs on corporate finance markets, where banks intermediate funds from households to nonfinancial firms. This literature emphasizes either how liquidity mismatch in banking opens up the possibility of bank runs (Diamond and Dybvig, 1983) or how the depletion of bank capital in economic downturns hinders banks’ abilities to intermediate funds (Gertler and Kiyotaki, 2010).\(^2\) Since mortgage credit is paramount to the workings of the modern macroeconomy, linkages between housing markets and bank runs raises some fundamental questions. How do house price busts lead to bank runs? Through which channels do house prices affect financial intermediation outside bank runs? To what extent does liquidity mismatch in mortgage banking, i.e., the combination of short-term liabilities and long-term assets, open up the possibility of bank runs? What, if any, role does the state of the economy play in the probability of bank runs occurring? Can macroprudential regulation eliminate the risk of bank runs?

In order to understand these issues better, we develop a tractable dynamic stochas-
tic general equilibrium (DSGE) model with patient and impatient households, a housing market, and a banking sector. We solve the model globally, by approximating the non-linear policy and transition functions on an adaptive sparse state grid and computing the resulting equilibrium via backward iteration (Brumm and Scheidegger, 2017). Our model exhibits four key features: financially constrained borrowers and lenders, liquidity mismatch in mortgage banking, endogenous defaults on mortgage loans, and endogenous bank runs. With this framework, house price drops lead to bank runs for the following reasons. House price drops lower the liquidation value of indebted households’ houses, inducing an increasing share of the homeowners to default of their mortgage loan obligations. As mortgage default rates spike and the repossession values of houses fall, banks increasingly incur losses on lending, which reduces the banks’ net worth. If their net worth falls sufficiently, so that the liquidation value of the banking sector is smaller than the value of its outstanding deposits, bank runs from the depositors start occurring with a nonzero probability. While bank runs may occur also in the absence of liquidity mismatch, the liquidity mismatch makes the bank runs more likely, by preventing banks from contracting their credit exposure in the face of elevated default rates.

The mortgage market is disciplined by two regulatory constraints. On the banks’ side, mortgage lending is restricted by a leverage constraint, restricting the lending ability of banks to a multiple of their net worth. On the households’ side, mortgage borrowing is restricted by a collateral constraint, reflecting that houses collateralize loans. Importantly, in the absence of bank runs, there is a financial accelerator channel leading from house prices to credit, via the always-binding collateral constraint. In addition to this, if the leverage constraint also binds, house price drops reduce banks’ lending ability, by eroding their net worth, thus forcing households to increasingly rely on inefficient short-term lending.

We calibrate a series of technology shocks such that the model matches the path of GDP in the U.S. between 1985 and 2017. In the implied simulation, the model predicts the historical movements in untargeted variables, such as consumption, house prices, mortgage debt, and bank equity. An implication of this match is that both the consumption cycle and the housing-financial cycle can, within our framework, largely be accounted for by technology shocks. Starting from 2003, positive technology shocks initially pushed up consumption and house prices. These movements were then propagated into the banking sector, via a reduction in the household credit spread and a relaxation of the collateral constraint, which led homeowners to borrow more. From around year 2009, however, a series of negative technology shocks overturned this expansion in output and credit,
consequently causing a recession.

We lastly use the model to examine the effectiveness of three macroprudential policies in reducing the frequency and severity of financial crises. The policies are (i) a lower loan-to-value limit, (ii) a higher minimum bank capital requirement, (iii) a dynamic loan loss provisioning that requires banks to provision against expected credit losses by setting funds aside. Higher loan-to-value limits and static capital requirements effectively reduce mortgage default rates and raise the recovery rates of defaulted loans, by forcing households to increasingly relying on equity financing. However, this comes at the cost of impeding financial intermediation over the business cycle. As such, the economy under these tightened policies is less Pareto efficient. Furthermore, the policies do not effectively prevent bank runs from occurring. Lowering the loan-to-value limit actually makes bank runs more probable, by making household leverage more countercyclical, increasing the probability of bank runs in deep recessions. Provisioning against expected credit losses is, by contrast, able to substantially reduce default rates, raise recovery rates, and prevent bank runs from occurring. The dynamic provisioning importantly does so without impeding intermediation over the business cycle. Similarly to the two other policies, this policy also distributes wealth from savers to borrowers, by lowering the credit spreads faced by households.

The rest of the paper is structured as follows. Section 2 presents the theoretical model. Section 3 lays out the calibration of the model. Section 4 demonstrates model dynamics historically and around the steady state. Section 5 conducts the macroprudential experiments. Section 6 contains the concluding remarks.

2 Model

The model has an infinite time horizon. Time is discrete, and indexed by $t$. The economy is populated by two representative groups of households: a patient group and an impatient group. Households consume goods and housing services, and supply labor inelastically. The time preference heterogeneity implies that the patient households lend funds directly to the impatient households. In addition to this, the patient households make deposits in banks, which then issue mortgage loans to the impatient households. The banks specialize in intermediating funds between the two groups of households, enabling them to do this more effectively than with the direct inter-household lending. The impatient households may default on their mortgage payments, in which case their houses are repossessed by the banks. If such defaults cause the liquidation value of the banking sector to fall below
the value of its outstanding deposits, banks may incur runs by depositors, in which case they default on some of their deposits. Goods are produced by a representative firm, by combining employment and nonresidential capital. The patient households own and operate the banks and the firm. We denote variables and parameters related to the patient households with "P", the impatient households with "I", and the banks with "B". Figure 1 provides an overview of the economy. The equilibrium conditions are derived in the Online Appendix.

2.1 Patient and Impatient Households

The economic size of each group of households is measured by their wage shares: \( \mu \in (0, 1) \) for the patient households and \( 1 - \mu \) for the impatient households. Each group is comprised of a unit continuum of individual households. The aggregate households maximize their respective utility functions,

\[
E_{0} \left\{ \sum_{t=0}^{\infty} (\beta^{J})^{t} \left[ \chi^{J} \left( \frac{(C_{t}^{J})^{1-\sigma}}{1-\sigma} - 1 \right) + (1 - \chi^{J}) \left( \frac{(H_{t}^{J})^{1-\sigma}}{1-\sigma} - 1 \right) \right] \right\},
\]

where \( J \in \{P, I\} \). Moreover, \( C_{t}^{J} \) denotes goods consumption, and \( H_{t}^{J} \) denotes a portfolio of houses held in the beginning of period \( t \). Finally, \( \beta^{J} \in (0, 1) \) measures the pure time discount factor, \( \chi^{J} \in (0, 1) \) measures the consumption weight in the utility function, and \( \sigma \in \mathbb{R}_{+} \) is the coefficient of relative risk aversion of the households. The household types differ along two dimensions. First, \( \beta^{P} > \beta^{I} \), so that the impatient households discount future utility more than the patient households do. Second, \( \chi^{P} > \chi^{I} \), so that impatient households have a higher preference for housing than patient households have. This lat-
Heterogeneity ensures that the share of houses which are owned by the impatient households is equal to the share of households which are net-borrowers.

**Houses** The housing portfolio of each household consists of the houses that are owned by the individual household members:

\[ H_i^J = \int_i H_{i,t}^J di, \]  

(2)

where \( J \in \{P, I\} \) and \( H_{i,t}^J \) denotes the house that is owned by household member \( i \) in the beginning of period \( t \). The idiosyncratic real price of house \( i \), \( P_{i,t}^H \), is the product of an idiosyncratic house price shock and the aggregate house price:

\[ P_{i,t}^H = \varepsilon_{i,t} P_t^H, \]  

(3)

where \( \varepsilon_{i,t} \sim \text{Lognormal}(\frac{1}{2}(\sigma^2), \sigma^2) \) is the idiosyncratic house price shock, and \( P_t^H \) denotes the aggregate real house price. The idiosyncratic house price distribution implies that \( \mathbb{E} \{ P_{i,t}^H \} = P_t^H \).

The aggregate stock of housing is fixed. The housing demand of the patient households is also fixed at its steady-state level, so that the impatient households are always the marginal buyers of housing, as in Greenwald (2018). This assumption is motivated by Landvoigt, Piazzesi, and Schneider (2015), who show that cyclical movements in the aggregate house price primarily stem from the lower end of the price distribution, where homeowners tend to be credit constrained. Housing transactions between the impatient households occur in the following way. By the end of period \( t \), the individual household sells its remaining housing stock, \((1 - \delta)H_{i,t}^I\), off at price \( P_{i,t}^H \), and purchases a new stock, \( H_{i,t+1}^I \), also at price \( P_{i,t}^H \). The net change in the individual household’s housing wealth from period \( t \) to period \( t + 1 \) is consequently

\[ (H_{i,t+1}^I - (1 - \delta)H_{i,t}^I) P_{i,t}^H, \]  

(4)

where \( \delta \in [0,1] \) measures the depreciation of residential capital. By contrast, the net changes in the value of the housing portfolios of the aggregate households are

\[ \delta P_t^H H^P \quad \text{and} \quad \delta P_t^H H^I, \]  

(5)

since no trade of houses takes place between the households. These net changes must be
financed on the period $t$ budget of the households.

**Bank Deposits** Aggregated deposits, $D^p_t$, made by the patient households are held from period $t$ to period $t + 1$ as single-period bonds within the banking system. The bonds promise to pay a non-contingent gross interest rate, $R^D_{t+1}$, in period $t + 1$. If there is no bank run in period $t + 1$, the patient households will receive the full promised return on their deposits. If there is a bank run, by contrast, the patient households will only receive a gross return, $X^D_t R^D_{t}$, on their deposits, where $X^D_t$ denotes the average share of deposits that can be recovered from the liquidation of the banking sector.

**Direct Lending** The patient households issue an aggregate portfolio of single-period loans directly to the impatient households,

$$O^d_t = \int_i O^d_{i,t} di,$$

where $J \in \{P, I\}$ and $O^d_{i,t}$ denotes the single-period loan that is issued by/to household member $i$. Being single-period debt contracts, the loans mature every period. The gross interest rate on the loans is $R^O_t$. It is not possible for impatient households to default on their loan payments.

**Mortgage Loans** The banks issue an aggregate portfolio of mortgage loans to the impatient households,

$$M^d_t = \int_i M^d_{i,t} di,$$

where $J \in \{I, B\}$ and $M^d_{i,t}$ denotes the mortgage loan that is issued to household member $i$. Mortgage loans are long-term debt contracts that mature probabilistically, as in Chatterjee and Eyigungor (2012). Both originated and continuing loans are priced at the endogenous bond price $P^M_t$. Without a loss of generality, the gross coupon rate on the mortgage loans is unity.

The individual impatient household may choose to default on its mortgage payments. However, the individual impatient households’ loans are secured by the households’ corresponding houses. If an individual household does not default, the household has to pay a debt service, $\rho M^d_{i,t}$, to the bank. If the household reversely does default, the bank repossesses the household’s house, and sells it off, in order to make up for the losses on the loan. Loans are nonrecourse, so the bank cannot seek the deficiency balance from
the borrower elsewhere if the proceeds from selling the house are insufficient to cover the losses. Taken together, these assumptions imply that the aggregate impatient household has the following mortgage-related net expenses in every period:

$$\rho \left[ 1 - \Phi_t^M (1 - X_t^M) \right] M_t^I - P_t^M (M_{t+1}^I - (1 - \rho) \left[ 1 - \Phi_t^M (1 - X_t^M) \right] M_t^I),$$

(8)

where $\Phi_t^M$ denotes the mortgage default rate in the impatient household, $X_t^M$ denotes the recovery rate across all household members, and $\rho \in [0, 1]$ measures the amortization rate. This net-expense stream can be rewritten as

$$R_t^M \left[ 1 - \Phi_t^M (1 - X_t^M) \right] M_t^I - P_t^M M_{t+1}^I,$$

(9)

where $R_t^M \equiv [\rho + P_t^M (1 - \rho)]$ denotes the effective gross interest rate on mortgage loans. This rate captures that the effective mortgage rate differs from the coupon rate on mortgage loans, due to the mortgage price deviating from par. The realized gross return rate on mortgage loans is

$$\tilde{R}_t^M \equiv R_t^M \left[ 1 - \Phi_t^M (1 - X_t^M) \right] = (P_t^M (1 - \rho) + \rho) \left[ 1 - \Phi_t^M (1 - X_t^M) \right].$$

(10)

This rate additionally captures that the realized return on mortgage loans differs from the effective mortgage rate, because of defaults that are not fully recovered.

Direct lending contracts are first-tranche securities, while mortgage loans are second-tranche securities. Hence, when the banks repossess the houses upon delinquency, they are not allowed to cover their losses on mortgage lending with the part of the collateral that covers the first tranche. The repossession value to the bank of house $i$ consequently becomes $(1 - \delta)P_{i,t} H_{i,t} - \zeta R_t^O O_{i,t}^I$. Furthermore, the recovery rate of defaulted mortgage loan $i$ is

$$X_{i,t}^M \equiv A_t \frac{(1 - \delta)P_{i,t} H_{i,t} - \zeta R_t^O O_{i,t}^I}{R_t^M M_{i,t}^I},$$

(11)

where $A_t$ is a collateral quality shock. The shock provides an exogenous source of variation in the mortgage recovery rate, similarly to the capital quality shock in Gertler and Kiyotaki.
The collateral quality shock follows a bounded AR(1) process,

\[ A_t = \min \left( \hat{A}_t, 1 \right), \]
\[ \log \hat{A}_t = \rho^A \log \hat{A}_{t-1} + \varepsilon_t^A, \]

where \( \varepsilon_t^A \sim N(0, \nu^A) \). The expected recovery rate across all impatient individuals consequently becomes

\[ X_t^M = \int_{X_{i,t}^M < 1} X_{i,t}^M f(X_{i,t}^M) dX_{i,t}^M, \] (12)

where \( f(X_{i,t}^M) \) denotes the probability density function of \( X_{i,t}^M \).

**Collateral Constraint** Because each loan is secured by a corresponding house, utility maximization of the aggregate impatient household is consequently subject to an aggregate collateral constraint,

\[ \zeta O_{t+1}^I + P_t^M M_{t+1}^I \leq (1 - \rho)(1 - \Phi_t^M) P_t^M M_t^I + \rho \kappa P_t^H H_{t+1}^I, \] (13)

where \( \zeta \geq 1 \) measures the excess risk weight on direct lending, and \( \kappa \in [0, 1] \) measures the loan-to-value limit. For \( \zeta > 1 \), the impatient households will always prefer mortgage loans over direct loans. The assumption \( \beta > \beta' \) implies that (13) always holds with equality around the steady state, making the impatient households perpetually credit constrained. The collateral constraint importantly ties the borrowing ability of the impatient households to the expected value of their housing wealth.

**Optimal Default Decision** The individual impatient household is forced to give up the current value of its housing stock except the part reserved for the first-tranche direct loan contract, \( (1 - \delta) P_{i,t} H_{i,t}^I - \zeta R_t^Q O_{i,t}^I \), to the bank if the household defaults on its mortgage loan.\(^3\) The individual household will consequently choose to default if and only if the value that it foregoes is less than the outstanding liability which the household owes to the bank,

\[ (1 - \delta) P_{i,t} H_{i,t}^I - \zeta R_t^Q O_{i,t}^I < R_t^M M_{i,t}^I. \] (14)

\(^3\)(1 - \( \delta \))\( P_{i,t} H_{i,t}^I > \zeta R_t^Q O_{i,t}^I \) always applies under our calibration of \( \zeta \).
The impatient households thus default on their mortgage loans whenever the idiosyncratic recovery rate of the defaulted loan falls below unity (i.e., $X^M_{i,t} < 1$).

The aggregate mortgage default rate can be characterized by a cutoff rule for the idiosyncratic house price shock, which is determined by

$$(1 - \delta) \varepsilon^*_i P_t H^I_t - \zeta R^O_t O^I_t = R^M_t M^I_t,$$  \tag{15}

where $\varepsilon^*_i$ denotes the cutoff value of the idiosyncratic house price shock. If the realized idiosyncratic house price shock falls below the cutoff value (i.e., $\varepsilon_{i,t} < \varepsilon^*_i$), it is optimal for the individual household $i$ to default on its mortgage loan. The aggregate default rate is now determined by

$$\Phi^M_t = \Pr(\varepsilon_{i,t} \leq \varepsilon^*_i).$$ \tag{16}

Defaults and foreclosures occur in the beginning of each period, while repossessions first occur at the end of the period. This timing captures that foreclosures usually are a time-consuming processes that allow the affected homeowners to remain in their houses until the repossession.\footnote{The average length of a foreclosure is 625 days, according to the National Association of Realtors.}

In our model, foreclosed households buy new houses from the banks at the end of each period, financed by loans and incomes obtained during the period. As such, the households never become homeless.

**Budget Constraints** Utility maximization of the patient households is subject to a budget constraint,

$$C^P_t + \delta P^H_t H^P_t + D^P_{t+1} + O^P_{t+1} + n^P = W_t L^P_t + \left[1 - \Phi^D_t (1 - X^D_t)\right] R^D_t D^P_t + R^O_t O^P_t + (1 - \tau) \left(\Pi^B_{t} + \Pi^F_{t}\right).$$ \tag{17}

where $n^P$ denotes equity invested into new banks, $W_t$ denotes the real wage of both households, $L^P_t$ denotes employment of patient workers measured in hours, $\Phi^D_t$ denotes the aggregate default rate of deposits, $X^D_t$ denotes the aggregate recovery rate of deposits, $\Pi^B_{t}$ denotes dividends from the banking sector, and $\Pi^F_{t}$ denotes dividends from the firm. The aggregate default rate of deposits is zero outside bank runs (i.e., $\Phi^D_t = 0$). Finally, $\tau \in [0, 1]$ measures capital income taxation.
Utility maximization of the impatient households is subject to a budget constraint,

\[
C_t^I + \delta P_t^H H_t^I + \rho \left[ 1 - \Phi_t^M (1 - X_t^M) \right] M_t^I + R_t^O O_t^I
= W_t L_t^I + P_t^M \left( M_{t+1}^I - (1 - \rho) \left[ 1 - \Phi_t^M (1 - X_t^M) \right] M_t^I \right) + O_{t+1}^I + T_t^I, \tag{18}
\]

where \( L_t^I \) denotes employment of impatient workers measured in hours, and \( T_t^I \) denotes transfers from the government. The government runs a balanced budget in every period, and redistributes capital income taxes to the impatient households:

\[
T_t^I = \tau \left( \Pi_t^{B,P} + \Pi_t^{F,P} \right). \tag{19}
\]

### 2.2 Banks

The banking sector is comprised of a unit continuum of individual banks. The sector maximizes the aggregate discounted value of current and expected future dividend payouts from the banks,

\[
\mathbb{E}_0 \left\{ \sum_{t=0}^{\infty} (\beta^P)^t (1 - \eta)^{t-1} \frac{U_P^C(C_t^P, H_t^P)}{U_P^C(C_0^P, H_0^P)} \Pi_t^{B,P} \right\}, \tag{20}
\]

where \( \frac{U_P^C(C_t^P, H_t^P)}{U_P^C(C_0^P, H_0^P)} \) denotes the stochastic discount factor of the patient households, and \( \eta \in [0, 1] \) measures the bank exit rate. The banks discount future dividends at the stochastic discount factor of the patient households, since these households own the banking system. We assume that a fixed share of the banks exit the economy in every period, following, e.g., Gertler and Kiyotaki (2010, 2015). Dividend payouts are constituted by the net worth of these banks being paid out:

\[
\Pi_t^{B,P} = \eta n_t^B, \tag{21}
\]

where \( n_t^B \) denotes the net worth of the incumbent banks. This assumption ensures that banks do not accumulate equity infinitely, which would otherwise lead to an overaccumulation of equity, implying that they would no longer need to take deposits in order to issue loans. New banks enter at the same rate as the old banks exit, keeping the aggregate number of banks constant.

The banking sector is comprised of newly entering banks and incumbent banks. The
net worth of the banking sector is

\[ N_t^B = \eta n_P^t + (1 - \eta) n_t^B, \tag{22} \]

where \( N_t^B \) denotes the net worth of the banking sector, and \( n_P^t \) denotes the net worth of new banks. In the beginning of each period, the patient households invest equity into the banking sector, by financing the entry of new banks. New banks thus have the following net worth:

\[ n_P^t = \mu E, \tag{23} \]

where \( E \in \mathbb{R}_+ \) measures the amount of equity invested into the banking sector. The net worth of the incumbent banks is

\[ n_t^B = \tilde{R}_t^M M_t^B - R_t^D D_t^B. \tag{24} \]

It follows from (24) that the banks face a liquidity mismatch. Bank assets are long-term mortgage loans, generating a flow of income that is secured several periods in advance (the average maturity of a loan is \( \frac{1}{p} \)). By contrast, bank liabilities are short-term deposits, which savers may contract on a period-by-period basis. The liquidity mismatch prevents banks from contracting their asset exposure if the patient households unexpectedly contract their deposits. In such a situation, the net worth of the banks may become negative.

**Balance Sheet Constraint**  Mortgage loans are the only assets of the banks, while deposits and equity are the only liabilities of the banks. The balance sheet constraint of the banks consequently requires that

\[ P_t^M M_{t+1}^B = D_{t+1}^B + N_t^B. \tag{25} \]

**Capital Requirement Constraint**  Banks are subject to runs from depositors if their net equity falls sufficiently. In order to prevent this from happening, regulators impose an occasionally binding capital requirement lending constraint on the banks,

\[ \frac{P_t^M M_{t+1}^B}{N_t^B} \leq \psi, \tag{26} \]
where $\psi \geq 0$ denotes the leverage limit. The lending constraint ties the lending ability of the banks to the size of their net worth. The banks maximize dividends subject to this constraint.

### 2.2.1 Bank Runs

We model bank runs as coordination failures of the depositors that lead to runs on the entire banking sector, as in Gertler and Kiyotaki (2015). Once a bank run happens, the assets of the banks get liquidated, and banks can no longer take deposits or grant mortgage loans. The patient households receive the liquidation value of the banking sector. The recovery rate of deposits for patient households is

$$X_t^{D*} \equiv \frac{\tilde{R}^M_* M^t_B}{R^D_t D_t}, \quad (27)$$

where $\tilde{R}^M_*$ denotes the realized gross return rate on mortgage loans in bank runs.

In the bank run, all impatient households stop paying their mortgage loans, causing the default rate to reach unity (i.e., $\Phi^M_t = 1$). The impatient households’ housing stock is hence foreclosed and repossessed by the banks. From (10), the realized gross return rate on mortgage loans in bank runs consequently becomes

$$\tilde{R}^M_* = R^M_t [1 - 1 \cdot (1 - X^M_t)] = X^M_t R^M_t. \quad (28)$$

The impatient households buy new houses from the banks at the end of the bank-run period, just like defaulters do in the absence of bank runs.

**Intermediation during Bank Runs** While the economy is in a bank-run state, banks do not exist to intermediate mortgage loans between savers and borrowers. Households may still save and borrow in single-period loans. However, as these contracts are less efficient than mortgage loans, reflected in $\zeta > 1$, the total exchange of funds between the households falls. The economy is consequently brought further away from its Pareto efficient allocation. The households are not able to default on their single-period loans in the bank-run states of the economy, just like in no-run states.

**Bank-Run Condition** The conditions for the existence and materialization of bank runs follow the conditions in Gertler and Kiyotaki (2015). A bank-run equilibrium exists if the liquidation value of the banking sector falls below the value of the outstanding
deposits if a run happens. In that case, the patient households cannot fully recover their deposits from liquidating the assets of the bank if a run happens. Given the definition of the recovery rate of deposits in (27), a bank run can occur whenever

\[ X_{t}^{D*} < 1. \]  

(29)

If a bank-run equilibrium exists, the probability that it will actually occur is

\[ \pi_{t}^{NR \rightarrow R} = 1 - \min(X_{t}^{D}, 1). \]  

(30)

In this way, the less the patient households recover from their deposits in the case of a bank run, the more likely it is that the run will actually occur.

**Transition Matrix** The economy will transition back to the no-run state probabilistically after a bank run, once the banks reenter the economy. The transition matrix between the run state and the no-run state is

\[
\begin{pmatrix}
1 - \pi_{t}^{NR \rightarrow R} & \pi_{t}^{NR \rightarrow R} \\
\pi_{t}^{R \rightarrow NR} & 1 - \pi_{t}^{R \rightarrow NR}
\end{pmatrix},
\]

where \( \pi^{R \rightarrow NR} \in (0, 1) \) measures the transition probability back to the no-run state.

**2.3 Production**

The representative firm produces consumption goods and housing investments, by hiring labor from both households. The profits to be maximized are

\[
\Pi_{t}^{F,P} = Y_{t} - W_{t} (L_{t}^{P} + L_{t}^{I}),
\]

(31)

subject to the available goods production technology,

\[
Y_{t} = Z_{t} \mathcal{K}^{1-\alpha} (L_{t}^{P} + L_{t}^{I})^{\alpha},
\]

(32)

where \( Y_{t} \) denotes goods production, \( Z_{t} \) is a technology shock, and \( \mathcal{K} \in \mathbb{R}_{+} \) measures a fixed aggregate stock of nonresidential capital. The firm owns and operates the nonresidential capital stock. Moreover, \( \alpha \in (0, 1) \) measures the goods production elasticity with respect
to labor. The technology shock follows an AR(1) process,

$$\log Z_t = \rho \log Z_{t-1} + \epsilon_t^Z,$$

where $\epsilon_t^Z \sim N(0, \nu^Z)$.

### 2.4 Equilibrium

#### 2.4.1 Market Clearing

The model contains a goods market, a housing market, a deposit market, a mortgage loan market, a single-period loan market, and two labor markets.

**Market Clearing in No-Run States** All six markets are active in the no-run states of the economy. The market clearing conditions are

$$Y_t = \mu C_t^p + (1 - \mu) C_t^l + \delta P_t^H \mathcal{H},$$

$$\mathcal{H} = \mu H_t^P + (1 - \mu) H_t^I,$$

$$D_{t+1}^B = \mu D_{t+1}^P,$$

$$M_{t+1}^B = (1 - \mu) M_{t+1}^I,$$

$$\mu O_{t+1}^P = (1 - \mu) O_{t+1}^I,$$

$$L_t^P = \mu \mathcal{L}^P,$$

$$L_t^I = (1 - \mu) \mathcal{L}^I,$$

where $\mathcal{H} \in \mathbb{R}_+$ measures the fixed aggregate stock of housing, and $\mathcal{L}^P \in \mathbb{R}_+$ and $\mathcal{L}^I \in \mathbb{R}_+$ measure the inelastic labor supplies from the patient and impatient households.

**Market Clearing in Bank-Run States** All banks get liquidated in the bank-run states of the economy, and there is therefore no deposit or mortgage loan markets in this economy. The goods, housing, and single-period loan markets clear just as in the no-run states, while the labor market clearing conditions change. The market clearing conditions
are

\[ Y_t = \mu C_t^P + (1 - \mu)C_t^I + \delta P^H \mathcal{H}, \]  
\[ \mathcal{H} = \mu H^P + (1 - \mu)H^I, \]  
\[ \mu O_{t+1}^P = (1 - \mu)O_{t+1}^I, \]  
\[ L_t^P = (1 - \xi)\mu L^P, \]  
\[ L_t^I = (1 - \xi)(1 - \mu)L^I, \]

where \( \xi \in [0, 1] \) measures the employment loss during bank runs. This employment loss captures that firms are forced to reduce employment when financial markets break down, due to a working capital requirement.

3 Solution and Calibration of the Model

We solve the model with a global solution method. More precisely, we approximate the nonlinear policy and transition functions on an adaptive sparse state grid, and compute the resulting equilibrium via backward iteration, as in Brumm and Scheidegger (2017). The expectations are computed over Gauss-Hermite quadrature nodes for normally distributed variables and Gauss-Legendre quadrature nodes for bounded variables. The model is calibrated to match the U.S. economy during the 1985-2017 period, at a quarterly frequency. Table 1 reports the chosen parameter values, along with information on their calibration.

We begin with the parameters related to the household sector. We set the discount factor of the patient households (\( \beta^P = 0.9949 \)), for the model to match the average net real deposit rate (2.1 pct. per annum). The consumption utility weight for patient households (\( \chi^P = 0.925 \)) is set to match the value added of residential investments as a share of GDP (6.1 pct.). The share of patient households (\( \mu = 0.60 \)) ensures that 40 pct. of the households hold mortgages, while the consumption utility weight for impatient households (\( \chi^I = 0.76 \)) ensures that 40 pct. of the houses are owned and used as collateral by the impatient households. These values are in keeping with Iacoviello (2005) and Iacoviello and Neri (2010), and furthermore approximately match the share of households with loan-to-value ratios above 80 pct. (33 pct.), according to the U.S. Federal Housing Finance Agency.\(^5\)

\(^5\)See the Monthly Interest Rate Survey of the U.S. Federal Housing Finance Agency.
### Table 1: Parameters of Baseline Model

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
<th>Source or Steady-State Target</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Households</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Share of patient households</td>
<td>$\mu$ 0.60</td>
<td>See text</td>
</tr>
<tr>
<td>Discount factor, pt. hh.</td>
<td>$\beta^P$ 0.9949</td>
<td>See text</td>
</tr>
<tr>
<td>Discount factor, impt. hh.</td>
<td>$\beta^I$ 0.9900</td>
<td>Gertler and Kiyotaki (2015)</td>
</tr>
<tr>
<td>Consumption weight, pt. hh.</td>
<td>$\chi^P$ 0.925</td>
<td>See text</td>
</tr>
<tr>
<td>Consumption weight, impt. hh.</td>
<td>$\chi^I$ 0.76</td>
<td>See text</td>
</tr>
<tr>
<td>Relative risk aversion</td>
<td>$\sigma$ 2.00</td>
<td>Kaplan et al. (2017)</td>
</tr>
<tr>
<td>Std. dev., idio. house price shock</td>
<td>$\nu^\varepsilon$ 0.10</td>
<td>See text</td>
</tr>
<tr>
<td>Depreciation of housing stock</td>
<td>$\delta$ 0.00625</td>
<td>Favilukis et al. (2017)</td>
</tr>
<tr>
<td>Amortization rate</td>
<td>$\rho$ 0.05</td>
<td>Five-year maturity, as in Chatterjee and Eyigungor (2012)</td>
</tr>
<tr>
<td>Loan-to-value limit</td>
<td>$\kappa$ 0.80</td>
<td>Standard value</td>
</tr>
<tr>
<td>Risk weight on direct lending</td>
<td>$\zeta$ 3.00</td>
<td>See text</td>
</tr>
<tr>
<td><strong>Banks</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Endowment of new banks</td>
<td>$\mathcal{E}^P$ 0.09</td>
<td>See text</td>
</tr>
<tr>
<td>Bank exit rate</td>
<td>$\eta$ 0.10</td>
<td>See text</td>
</tr>
<tr>
<td>Leverage limit</td>
<td>$\psi$ 12.5</td>
<td>Basel Capital Accord / Basel II</td>
</tr>
<tr>
<td>Bank-run persistence</td>
<td>$\pi^{R \rightarrow R}$ 12/13</td>
<td>See text</td>
</tr>
<tr>
<td><strong>Production and Government</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Non-residential capital stock</td>
<td>$\mathcal{K}$ 1.00</td>
<td>Normalization</td>
</tr>
<tr>
<td>Employment, pt. and impt. hh.</td>
<td>$\mathcal{L}^P, \mathcal{L}^I$ 1.00</td>
<td>Normalization</td>
</tr>
<tr>
<td>Labor share of output</td>
<td>$\alpha$ 0.60</td>
<td>Standard value</td>
</tr>
<tr>
<td>Capital income tax rate</td>
<td>$\tau$ 0.20</td>
<td>Leeper et al. (2010)</td>
</tr>
<tr>
<td>Employment loss in bank run</td>
<td>$\xi$ 0.10</td>
<td>See text</td>
</tr>
<tr>
<td>Stock of housing</td>
<td>$\mathcal{H}$ 1.00</td>
<td>Normalization</td>
</tr>
<tr>
<td><strong>Aggregate Shock Processes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Persistence, technology shock</td>
<td>$\rho^Z$ 0.9655</td>
<td>Autocorr. of detrended productivity</td>
</tr>
<tr>
<td>Persistence, collateral quality shock</td>
<td>$\rho^A$ 0.95</td>
<td>Standard value</td>
</tr>
<tr>
<td>Std. dev., technology shock</td>
<td>$\nu^Z$ 0.01</td>
<td>Normalization</td>
</tr>
<tr>
<td>Std. dev., collateral quality shock</td>
<td>$\nu^A$ 0.025</td>
<td>Normalization</td>
</tr>
</tbody>
</table>

The volatility of the idiosyncratic house price shock ($\nu^\varepsilon = 0.10$) implies that the quarterly mortgage default rate in the model is equal to the average ratio of nonperforming loans that are past due 90+ days to total loans in the data (2.3 pct.).

We next describe the parameter values relating to the banks. We set the endowment of newly entering banks ($\mathcal{E}^P = 0.09$), so that the ratio of bank net profits to mortgage loans outstanding ($\frac{\eta(n^P_t - \mathcal{E}^P)}{M_{t+1}^P}$) in the model matches the ratio of net dividends from commercial banks to the stock of mortgage loans in the data (1 pct.). The bank exit rate ($\eta = 0.10$) is set for the ratio of mortgage loans outstanding to the sum of consumption and residential investments in the model ($\frac{M_{t+1}^P}{\mu C_t^P + (1-\mu) C_t^I + \delta P_t R_t}$) to be equal to the corresponding ratio in the
data (2.9). The bank-run persistence rate \(\pi^{R\rightarrow R} = 12/13\) implies an average duration of bank runs of 3.25 years in the model, consistent with what Poeschl and Zhang (2018) find for OECD countries. The employment loss during bank runs (\(\xi = 0.10\)) matches the drop in aggregate weekly hours per capita that occurred from 2007 to 2009.

4 Model Dynamics

We now use the model to assess the linkages between business cycle fluctuations, mortgage defaults, and bank runs. We first illustrate the effects of a collateral quality shock and a technology shock to the economy. We then examine the historical contributes of technology shocks to the housing-financial cycle.

4.1 Impulse Responses

Due to the nonlinearity of the model, the impulse response to a given shock depends on the initial state of the economy. We therefore report the generalized impulse responses, simulated over one million economies. These responses can be interpreted as the average responses across the state space of the model.

Collateral Quality Shock  Figure 2 plots the effects of a five standard deviations negative collateral quality shock. We choose this size in order to ensure that bank runs will occur in at least some of the simulated economies. The shock reduces the liquidation value of housing collateral by 12 pct., which causes banks to incur larger losses on mortgage lending. In all simulated economies, the associated drop in the net worth of banks tightens the bank lending constraint, causing banks to issue fewer loans to impatient households. In addition to this, in some of the economies in which the net worth of the banks becomes negative, bank runs start occurring, which completely shuts down intermediation. Because these financial break downs generate employment losses, output persistently falls. The house price also falls, increasing the default rate. Higher default rates and lower repossession values further deteriorate bank balance sheets, thus amplifying the financial crisis. The plummeting house prices cause the leverage ratio of the impatient households to rise considerably. Banks, by contrast, are less levered. This is an average effect of economies with bank runs, in which the leverage falls to unity, and economies without bank runs, in which bank leverage increases due to their dwindled net worth. The household credit spread rises, as the households’ default rates rise.
Figure 2: Impulse Responses to a Collateral Quality Shock

(a) Shock Variable ($A_t$)  
(b) Output  
(c) Real House Price  
(d) Leverage, Impatient Households  
(e) Leverage, Banks  
(f) Household Credit Spread ($R_t^{M} - R_t^{D}$)  
(g) Mortgage Default Rate  
(h) Recovery Rate of Mort. Defaults

Note: We simulate one million economies for 1,100 periods, then shock each economy with an additional five standard deviation negative collateral quality shock in period 1,010, and finally compute the average deviation that is caused this additional shock.

Technology Shock  Figure 3 plots the results of a two standard deviation negative technology shock. This shock is insufficient to generate bank runs in any economies, unlike with the previous collateral quality shock. Output falls by the same magnitude as technology, since employment is unchanged. If any bank runs were to happen, the associated employment loss would lead output to fall by more than the decline in technology. The shock reduces the labor incomes of both households, which induces them to cut spending on consumption and housing services. As a result, house prices fall by roughly twice as
Figure 3: Impulse Responses to a Negative Technology Shock

(a) Shock Variable ($Z_t$)

(b) Output

(c) Real House Price

(d) Leverage, Impatient Households

(e) Leverage, Banks

(f) Household Credit Spread ($R_t^M - R_t^D$)

(g) Mortgage Default Rate

(h) Recovery Rate of Mort. Defaults

Note: We simulate one million economies for 1,100 periods, then shock each economy with an additional two standard deviation negative technology shock in period 1,010, and finally compute the average deviation that is caused this additional shock.

much as output. This devaluation of the only asset owned by impatient households causes their leverage ratio to rise considerably. The shock is propagated into the financial sector, via higher default rates and lower liquidation values of repossessed houses. This increases the spread between the mortgage rate and the deposit rate, as the default premium on mortgages rises.

In conclusion, while the signs of the responses of output, house prices, and bank leverage are identical for collateral quality and technology shocks, the causes of these
responses differ across the types of shocks. Moreover, in econometric models, collateral quality and technology shocks shock can be identified separately from the signs of the responses of household leverage and the spread between mortgage and deposit rates, which differ across the two shock types.

4.2 Matching Aggregate Dynamics

We now calibrate a series of technology shocks such that the model matches the historical path of detrended GDP, during the 1985-2017 period. The exercise allows us to evaluate the ability of the model to predict the historical movements in key economic and financial variables, and to shed light on the contribution of technology shocks to the consumption and housing-financial cycles.

Figure 4 plots the endogenous and actual movements in GDP, consumption, house prices, mortgage credit, the household credit spread, and bank equity, conditional on the technology shocks. The model, by construction, perfectly matches the historical path of GDP. An important success of the model is that it, at least partially, predicts the empirical paths of consumption and house prices. The implication of this is that technology shocks have been the principal source of variation not only in GDP, but also in house prices and consumption.

The model qualitatively matches the lion’s share of fluctuations in mortgage credit and bank equity. In both the model and the data, mortgage credit and bank equity rise until around 2008, after which they remain roughly constant for four years, and then fall. The model captures this financial expansion through two channels. Firstly, the initially high labor incomes induced the patient homeowners to save more, consequently forcing banks to narrow the household credit spread, so as to invest the savings. This is evident from Figure 4e, which shows that the household credit spread fell in the boom years, and rose in the bust years, consistent with the data. At the same time, the house price appreciation relaxed the collateral constraint, concurrently allowing impatient homeowners to take on additional debt. The financial expansion was eventually undone, as a series of negative technology shocks capped labor incomes, and caused house prices to plummet, from around 2009.
Figure 4: Empirical and Theoretical Paths of Aggregate Variables

(a) Real GDP
(b) Real Consumption
(c) Real House Price
(d) Real Mortgage Credit
(e) Household Credit Spread
(f) Bank Equity

Note: GDP, consumption, house prices, mortgage credit, and bank equity have been detrended by series-specific linear trends.

5 Macroprudential Regulation

In this section, we compare the effects of three macroprudential interventions:

1. Lowering the loan-to-value limit on mortgage borrowing.
2. Increasing the minimum capital requirement on mortgage lending.
3. Imposing a dynamic loan loss provisioning on mortgage lending.

We simulate the model under each policy, and compare the short- and long-run effects of the policies. The results of these simulations are reported in Table 2.
5.1 Lower Loan-to-Value Limit

Column 3 of Table 2 reports the effects of a drastic tightening in the collateral constraint, namely quartering the loan-to-value limit from 80\% to 60\%. Credit and household leverage levels are naturally reduced, since the loan-to-value limit is lower. Furthermore, house prices are higher, as the collateral value of houses increases with the tighter collateral constraint. The financial system is, on average, more stable in the sense that mortgage default rates and credit spreads are lower and in the sense that recovery rates on delinquent loans are higher. These changes stem from the impatient households being less levered, which makes the default option less attractive to them. However, because household leverage is also made more countercyclical, the risk of bank runs occurring in deep recessions actually increases. On average, this causes bank runs to be more probable. Wealth is redistributed from the patient to the impatient households, because the latter households borrow less, and because credit spreads are lower. This leaves the impatient households’ consumption higher and the patient households’ consumption lower.

5.2 Higher Bank Capital Requirement

Column 4 of Table 2 explores the scope of a drastic tightening in the lending requirement, namely quartering the maximum leverage ratio from 12.5 to 9.375. Under this policy, credit and bank leverage levels are reduced, since the banks are less able to intermediate funds. Household leverage is also lower, like with loan-to-value policy. These decreased leverage levels lead to lower default rates, higher recovery rates, and almost eliminates the existence of bank runs. Thus, unlike with the loan-to-value policy, there is no trade-off between lowering the default rate and reducing the risk of bank runs. Wealth is again redistributed from the patient to the impatient households, because the latter households borrow less, and because credit spreads are lower. As a result, their consumption levels are again more equal.

5.3 Imposing a Dynamic Loan Loss Provisioning

We finally introduce a dynamic bank capital requirement, where banks are required to provision against expected future credit losses by setting funds aside. More specifically, we let the leverage limit in (26) respond negatively to expected future credit losses:

$$
\psi_t = \bar{\psi} - \gamma(\mathbb{E}_t[\Phi_{t+1}(1 - X_{t+1}^M)]),
$$

(46)
Table 2: Level and Dispersion of Variables under Macropudential Regimes

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th>$\kappa = 0.6$</th>
<th>$\psi = 9.375$</th>
<th>$\gamma = 1$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consumption and House Prices</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg. house price (level)</td>
<td>9.12</td>
<td>9.20</td>
<td>9.09</td>
<td>9.16</td>
</tr>
<tr>
<td>Avg. consumption, pt. hh. (level)</td>
<td>1.32</td>
<td>1.25</td>
<td>1.10</td>
<td>1.12</td>
</tr>
<tr>
<td>Avg. consumption, impt. hh. (level)</td>
<td>0.38</td>
<td>0.48</td>
<td>0.70</td>
<td>0.68</td>
</tr>
<tr>
<td>Std. dev. of house price (pct.)</td>
<td>6.82</td>
<td>7.19</td>
<td>7.40</td>
<td>6.91</td>
</tr>
<tr>
<td>Std. dev. of consumption, pt. hh. (pct.)</td>
<td>19.52</td>
<td>16.00</td>
<td>3.96</td>
<td>9.73</td>
</tr>
<tr>
<td>Std. dev. of consumption, impt. hh. (pct.)</td>
<td>98.15</td>
<td>47.92</td>
<td>6.31</td>
<td>17.31</td>
</tr>
<tr>
<td><strong>Credit Quantities</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Leverage, impt. hh. (level)</td>
<td>2.90</td>
<td>2.05</td>
<td>1.82</td>
<td>2.84</td>
</tr>
<tr>
<td>Leverage, banks (level)</td>
<td>12.09</td>
<td>12.15</td>
<td>9.32</td>
<td>12.28</td>
</tr>
<tr>
<td>Mortgages (level)</td>
<td>2.30</td>
<td>1.92</td>
<td>1.64</td>
<td>2.33</td>
</tr>
<tr>
<td>Deposits (level)</td>
<td>2.11</td>
<td>1.76</td>
<td>1.46</td>
<td>2.14</td>
</tr>
<tr>
<td>Bank net worth (level)</td>
<td>0.19</td>
<td>0.16</td>
<td>0.18</td>
<td>0.19</td>
</tr>
<tr>
<td><strong>Correlations</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corr., impt. hh. leverage and GDP</td>
<td>-0.63</td>
<td>-0.79</td>
<td>-0.83</td>
<td>-0.85</td>
</tr>
<tr>
<td>Corr., bank leverage and GDP</td>
<td>0.38</td>
<td>0.44</td>
<td>-0.02</td>
<td>0.50</td>
</tr>
<tr>
<td>Corr., mortgages and GDP</td>
<td>0.18</td>
<td>0.03</td>
<td>-0.33</td>
<td>-0.16</td>
</tr>
<tr>
<td>Corr., deposits and GDP</td>
<td>0.22</td>
<td>0.07</td>
<td>-0.34</td>
<td>-0.09</td>
</tr>
<tr>
<td>Corr., bank net worth and GDP</td>
<td>-0.22</td>
<td>-0.35</td>
<td>-0.28</td>
<td>-0.48</td>
</tr>
<tr>
<td><strong>Credit Spreads, Default, Recovery, and Bank Runs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$R^M_t - R^D_t$ spread (pt. per year)</td>
<td>3.44</td>
<td>1.44</td>
<td>2.27</td>
<td>1.70</td>
</tr>
<tr>
<td>Mortgage default rate (pt. per year)</td>
<td>2.72</td>
<td>0.24</td>
<td>0.08</td>
<td>0.98</td>
</tr>
<tr>
<td>Mortgage recovery rate (pct.)</td>
<td>96.31</td>
<td>97.32</td>
<td>97.93</td>
<td>98.90</td>
</tr>
<tr>
<td>Bank runs (per 100 years)</td>
<td>0.19</td>
<td>0.24</td>
<td>0.04</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Note: The baseline model is calibrated to the following values: $\kappa = 0.80$, $\psi = 12.5$, and $\gamma = 0$. We simulate 1,000 economies for 2,000 periods under each policy regime, then discard the first 1,000 periods, and finally compute averages over the 1,000 economies.

where $\bar{\psi} \geq 0$ measures the static leverage limit, and $\gamma \geq 0$ measures the degree of loan loss provisioning. The marginal effect of an increase in the house price on mortgage credit under a binding lending constraint with the dynamic capital requirement is from (26)

$$\frac{\partial M_{t+1}}{\partial P_t} = \frac{\partial \psi_t}{\partial P_t} N^B_t + \psi_t \frac{\partial N^B_t}{\partial P_t},$$

where $\frac{\partial N^B_t}{\partial P_t} = (X^M_t - 1) \frac{\partial \phi_t}{\partial P_t} + \phi_t \frac{\partial X^M_t}{\partial P_t}$. The regulator can now completely offset any financial acceleration by imposing that $\frac{\partial \psi_t}{\partial P_t} = -\frac{\psi_t}{N^B_t} \frac{\partial N^B_t}{\partial P_t}$, importantly without shutting down financial intermediation. This contrasts the two previous cases, where it was only possible to prevent financial acceleration by completely shutting down intermediation (i.e., setting $\kappa = 0$ or $\psi = 0$).

Column 5 of Table 2 reports the effects of keeping the static leverage limit at 12.5 but,
at the same time, imposing a dynamic loan loss provisioning, with $\gamma = 1$. Unlike under the two former policies, the dynamic capital requirement increases financial intermediation, while also completely eliminating the risk of bank runs. The policy does so by requiring the banks to set funds aside only when they expect to incur losses on mortgage lending. This dynamic provisioning substantially reduces household leverage in these episodes, by preventing the households from borrowing. Banks are, on average, more levered. This reflects that they may take on higher leverage ratios in periods where their expected losses are low, as compared to the baseline calibration. Credit spreads are substantially lower, as the risk premium dwindles. Like before, this redistributes wealth from the patient to the impatient households, making their consumption levels more equal.

6 Concluding Remarks

We develop a macroeconomic model capturing the linkages between house price fluctuations, mortgage defaults, and bank runs. In the model, endogenous house price drops can lead to bank runs if the liquidation value of the banking sector falls below the value of its outstanding deposits. We find that both stricter loan-to-value limits and bank leverage requirements effectively reduce mortgage default rates and raise the recovery rates of defaulted loans. However, this comes at the cost of reducing financial intermediation over the business cycle. Furthermore, these policies cannot effectively prevent bank runs from occurring. By contrast, a dynamic loan loss provisioning is able to reduce mortgage default rates, raise recovery rates, and prevent bank runs from occurring. The provisioning importantly does so without reducing intermediation over the business cycle.

References


