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TIGHTER CREDIT AND CONSUMER BANKRUPTCY INSURANCE

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JEL Classification: E44, E52, E58, G21, G32

Keywords: Deleveraging, Chapter 7, BAPCPA

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Tighter Credit and Consumer Bankruptcy Insurance*

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January 15, 2020

Abstract

How does bankruptcy protection affect household balance sheet adjustments and aggregate consumption when credit tightens? Using a tractable model of unsecured consumer credit we quantify the trade-off between the insurance and the creditworthiness effects of bankruptcy in response to tighter credit. We show that bankruptcy dampens the effect of tighter credit on aggregate consumption on impact. This is because it allows borrowers to sustain consumption against severe financial distress. However, by leading to consumers' exclusion from the credit market for a certain period, bankruptcy also reduces their ability to smooth consumption over time, implying a slower recovery. The bankruptcy code establishes how costly it is to default, and, thus, plays a crucial role in determining consumers' bankruptcy decisions and in shaping consumption dynamics. We quantify that the 2005 BAPCPA reform, by making filing for bankruptcy more costly, worsened the negative welfare effects of the subsequent credit tightening.

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1. Introduction

Household deleveraging has been a prominent feature of the U.S. economy in the decade following the Global Financial Crisis. The reduction in the volume of household debt was not only driven by a decline in new borrowing, but also by default on existing credit. The number of filings for Chapter 7 of the U.S. Bankruptcy Code increased dramatically between 2008 and 2013, and Figure 1 (top panel) shows that the total amount of debt discharged (solid line) reached a remarkable share of GDP by the end of 2010.

[PLEASE INSERT FIGURE 1 ABOUT HERE]

The link between the contraction in households' borrowing capacity and the macroeconomy has attracted a great deal of attention (e.g. Mian and Sufi (2011); Hall (2011); Eggertsson and Krugman (2012); Guerrieri and Lorenzoni (2017); Jones, Midrigan and Philippon (2018); Justiniano, Primiceri and Tambalotti (2015), Justiniano, Primiceri and Tambalotti (2019)). Consumption accounts for about 71 percent of GDP in the U.S.. Thus, it is important to understand how tighter credit affects aggregate spending by impending households' ability to use credit to smooth consumption. Yet, there is little analysis of how bankruptcy protection impacts households' deleveraging and consumption in response to financial shocks. This paper makes progress along this dimension by focusing on unsecured consumer debt.

The primary purpose of bankruptcy is to discharge certain types of debt to enable a "fresh start". This is an insurance mechanism against severe financial distress. Although unsecured consumer credit represents a modest fraction of total household debt, bankruptcy on unsecured consumer credit as a share of GDP is comparable to federal expenditures on unemployment insurance, and exceeds other federal insurance programs. Thus, as shown in Figure 1 (top panel) it is one of the largest social insurance programs in the U.S..

Our contribution is to show that consumer bankruptcy decisions have important implications for the magnitude and persistence of the slowdown in aggregate consumption in response to tighter credit. Bankruptcy introduces a trade-off between consumption smoothing *across states* versus *over time*. Consumers can resort to bankruptcy to support consumption in response to adverse shocks, hence helping to smooth consumption *across states*. But bankruptcy also has negative consequences for their creditworthiness: upon default consumers typically get excluded from credit markets for a certain period.

This reduces their ability to smooth consumption *over time*.

In response to a worsening of financing conditions, consumers optimally adjust towards lower levels of debt. The aggregate effects depend on which side of the trade-off prevails. If borrowers value more the insurance provided by bankruptcy, the deleveraging is more pronounced and their consumption could experience a drop that is less sizable on impact but more persistent over time. If instead they value more the possibility of keeping access to the credit market over time, default is less likely. This, coupled with reduced access to new borrowing, may imply a larger, but possibly less persistent, drop in consumption. Thus, the assessment of how bankruptcy protection affects individual and aggregate responses to tighter credit is ultimately a quantitative question.

We explore the aggregate and redistributive implications of bankruptcy protection during a credit tightening through the lens of a quantitative general equilibrium model in which consumers borrow and default optimally. In our framework tighter credit, by restricting the access to new borrowing, results in aggregate deleveraging and a drop in consumption. Bankruptcy exacerbates the severity of deleveraging. However, it also dampens the impact effect of the credit tightening on aggregate consumption at the cost of a slower recovery. The bankruptcy code, by establishing how costly it is to declare bankruptcy, is crucial to determine the willingness of consumers to default and to shape aggregate consumption dynamics.

Our analysis is based on a heterogeneous agent model with incomplete markets (e.g. Bewley (1977), Huggett (1993) and Aiyagari (1994)) augmented with defaultable debt (e.g. Livshits, MacGee and Tertilt (2007); Chatterjee, Corbae, Nakajima and Ríos-Rull (2007)). Consumers are subject to default risk in the form of both income and expense (divorce, children, medical expenses) shocks and can default on unsecured debt in accordance with the U.S. Chapter 7 Bankruptcy Code. The pricing of loans is endogenous and depends on the riskiness of each individual consumer in the model. Perfectly competitive banks offer a menu of contracts that take into account the default risk of each borrower, giving rise to an endogenous *risky spread*.

We calibrate the model to match key micro and macro features of consumer bankruptcy in the U.S. data. Then, we use it as a laboratory to study the effects of a tightening in credit. We depart from the standard way of modelling a credit tightening through exogenous changes in borrowing limits. Instead, we consider a tightening in bank lending standards, i.e. more restrictive conditions in the bank's lending terms, that result in

higher borrowing costs and endogenous changes in borrowing limits.

This paper provides several results. First, in response to tighter credit, consumers decrease new borrowing and, in many cases, default on existing credit. This results in deleveraging and in a drop in aggregate consumption. A key prediction of our model is that the effect is larger on credit quantities than on the average lending spread. This is due to a *selection effect* in the composition of borrowers. In our model, the default probability is endogenous and is priced by the intermediation sector. More restricted access to credit implies that lower quality borrowers face greater difficulty to obtain new loans. Thus, over time credit shifts towards less risky borrowers and the risky spread declines. As a result, the effects of the credit tightening on the average lending spread is mitigated.

Second, the effects of a credit tightening are not evenly distributed across heterogeneous households: the adverse consumption and welfare effects are especially harsh for households at the bottom of the wealth distribution. Low income individuals borrow and default to smooth the effect of negative shocks. Upon default, they lose access to the credit market, possibly for several years. This reduces their ability to smooth consumption over time. Their consumption declines sharply and recovers only slowly. In contrast, higher income households tend to be savers. Thus, they can draw down deposits to offset bad shocks and are less prone to default. As a consequence, they do not experience the same adverse effect of a tightening in credit. The essential difference is that bankruptcy is the main way in which borrowers insure against severe expenditure shocks, while savers can often self-insure.

Finally, the bankruptcy code has an important role in shaping the response of aggregate consumption. In particular, higher bankruptcy costs reduce the willingness of consumers that cannot self-insure to use default as an insurance mechanism to smooth consumption. This leads to a larger drop in consumption on impact. In the extreme case in which at the time of a credit tightening default is so costly that consumers decide to not default, the drop in aggregate consumption on impact is two times larger than the baseline. In addition, a longer exclusion from the credit market reduces consumers' ability to smooth consumption over time and, thus, implies a more persistent effect on aggregate consumption. In the extreme case in which upon bankruptcy consumers do not lose access to the credit market, aggregate consumption recovers in half of the time compared to the baseline simulations.

To our knowledge the question of how the bankruptcy code affects the response of the economy to tighter credit is novel. This is important because the U.S. Bankruptcy Code affects households' ability to default and thus contributes to shaping the dynamics of consumption during economic downturns. Importantly, in 2005, i.e. two years before the financial crisis, the U.S. Bankruptcy Code was modified. The purpose of the Bankruptcy Abuse Prevention and Consumer Protection Act (BAPCPA) was to make filing for bankruptcy more difficult to prevent abuse of the system. We document that the reform had two important effects. First, the default rate on consumer credit spiked right before the implementation of the reform. This is because the reform was long discussed before its implementation. Second, by making filing for bankruptcy more difficult, BAPCPA reduced the ability of households to default in response to the negative shocks and mitigated the increase in the average default rate. At the same time the economy experienced a sharper drop in aggregate consumption. An assessment of the change in the bankruptcy code in terms of welfare, suggests that overall BAPCPA exacerbated the negative effects of the subsequent credit tightening.

1.1 Related Literature

Our paper connects to the growing literature assessing the effects of changes in borrowing conditions. Several authors have investigated the aggregate effects of financial shocks in quantitative general equilibrium models (e.g. Jermann and Quadrini (2012); Christiano, Motto and Rostagno (2014); Justiniano et al. (2019), Chen and Zha (2015)). An increasing number of papers also quantifies the redistributive effects of credit supply shocks on production (e.g. Khan and Thomas (2013); Bassetto, Cagetti and De Nardi (2015); Buera, Fattal-Jaef and Shin (2015)) and consumer spending (e.g. Guerrieri and Lorenzoni (2017)). Differently from these studies we focus on consumer bankruptcy and its implications for aggregate consumption.[1]

Our model is also related to the literature on consumer bankruptcy in general equilibrium. Chatterjee et al. (2007) construct a model of consumer bankruptcy that replicates key empirical characteristics of unsecured consumer borrowing in the U.S. Athreya (2006); Livshits et al. (2007); Chatterjee and Gordon (2012); and Athreya, Tam and Young (2012) study the effects of alternative bankruptcy arrangements and Pavan (2008)

[1]Recent papers study the effects of tighter credit in general equilibrium models of firms default (e.g. Senga, Thomas, Khan et al. (2017), Zetlin-Jones and Shourideh (2017)) and firm and bank default (e.g. Mendicino, Nikolov, Suarez and Supera (2019))

explores the effects of bankruptcy exemptions. Livshits, MacGee and Tertilt (2010) accounts for changes in consumer bankruptcy over time. Nakajima and Rios-Rull (2014) and Gordon (2015) introduce aggregate uncertainty into consumer default models. From a methodological point of view our paper shares with these previous works the explicit modeling of consumer credit and default risk. In addition, we combine these elements with bank-intermediation supply factors in order to explore the effects of tighter credit on consumers' bankruptcy and aggregate consumption.

Work by MacGee, Livshits and Fieldhouse (2016) and, more recently, Dempsey and Ionescu (2019) introduces credit supply factors in models of consumer bankruptcy to study how lenders' credit granting decisions interact with cyclical fluctuations in bankruptcies. Our paper is complementary to theirs in that we explore the aggregate and redistributional effects of an exogenous tightening in bank-intermediated credit. Thus, we focus on the economy's transitional dynamics after an unexpected increase in borrowing costs due to changes in the aggregate supply of credit. This approach is particularly useful for the purpose of our paper as it also allows us to study the interaction with the BAPCPA bankruptcy reform.

Our findings are also complementary to existing work on the effects of the BAPCPA reform (e.g. Arthreya, Sanchez, Tam and Young (2015), Mitman (2016)). Relative to previous papers, we assess the aggregate and redistributive effects of the interaction between the reform and a tightening in bank lending standards, in a general equilibrium framework. Our results on the role played by the leniency of the bankruptcy system for individual bankruptcy decisions and aggregate demand are also in line with empirical evidence in Albanesi and Nosal (2018) and Auclert, Dobbie and Goldsmith-Pinkham (2019).

The paper proceeds as follows. Section 2 reports key facts about consumer credit and bankruptcy during the global financial crisis. Section 3 outlines the model and Section 4 maps the model to U.S. data. Section 5 reports the results of a quantitative exercise to assess the impact of credit tightening, including the transitional dynamics; and computes the welfare effects on heterogeneous agents. Section 6 examines the role of bankruptcy protection on aggregate consumption and Section 7 investigates how the BAPCPA affected the response to tighter credit. Section 8 concludes.

2. Consumer Credit and Bankruptcy: Key Facts

The evolution of consumer credit and bankruptcy during the recent financial crisis is characterized by a number of interesting facts. As shown in Figure 1 (bottom panel) unsecured consumer debt to GDP decreased by about 30 percent between 2008 and 2013. The drop in unsecured consumer debt over the 2008-2013 period is remarkable and comparable to the drop in other types of debt, such as mortgages and home equities that declined by 24 and 29 percent, respectively, over the same period.[2]

The amount of debt discharged at the end of Chapter 7 as a fraction of GDP also increased remarkably during the recent financial crisis. Figure 1 (top panel) depicts that the debt discharged after Chapter 7 increased by a factor of 3 both in terms of total debt (dotted-dashed line) and unsecured debt (dashed line). The latter is the focus of this paper. The unsecured debt discharged reached levels as high as about 1% of GDP. This is comparable to federal expenditures on unemployment insurance, and exceeds the earned income tax credit (EITC), SNAP benefits and Supplemental Security Income.

Between 2007 and 2009 the supply of bank-intermediated consumer credit experienced an unprecedented tightening. We measure credit tightening by using the changes in lending standards for consumer credit as reported on the Federal Reserve Board's Senior Loan Officer Opinion Survey on Bank Lending Practices (SLOOS). Figure 2 (top panel) depicts the net percentage of respondent banks tightening lending standard on credit cards (solid line) and consumer loans other than credit cards and auto loans (dashed line).[3] This fraction increased from about 0% between 2003 and the beginning of 2007 to about 70% at its peak in 2008. This indicates a substantial tightening in the supply of bank-intermediated consumer credit during the financial crisis.[4] Figure 2 (bottom panel) depicts a sizable increase in the spread on different types of unsecured credit over the same period. This is consistent with a tightening in lending standards depicted in the top panel of the same figure.

[2]See Appendix Figure C1.

[3]Participating banks are asked to report about their lending standards during the survey period in the following way: "Over the past three months, how have your bank's credit standards for approving applications for credit cards/consumer loans other than credit card and auto loans from individuals or households changed?" (1) tightened considerably, (2) tightened somewhat, (3) remained basically unchanged, (4) eased somewhat, and (5) eased considerably. The net percentage of banks tightening credit standards corresponds to the share of banks whose response is either (1) or (2) minus the share of banks whose response is either (4) or (5).

[4]See also Bassett, Chosak, Driscoll and Zakrajšek (2014) for a new indicator of changes in the supply of bank-intermediated credit that combines changes in overall bank lending standards (to business and households) with other bank-specific and macroeconomic variables.

[PLEASE INSERT FIGURE 2 ABOUT HERE]

Periods of severe financial distress are generally characterized by a significant rise in the default of borrowers. Figure 3 illustrates the pattern of the number of filings for Chapter 7 of the U.S. Bankruptcy Code (top panel) and the amount of debt discharged (bottom panel) during the Great Recession. The number of yearly filings for Chapter 7 of the U.S. Bankruptcy Code increased dramatically from about 50,000 to 300,000 at its peak in 2010.

Finally, Figure 3 (bottom panel) also reports the charge-off rate on consumer loans (black line) over the same period.[5] In line with the increase in bankruptcy discharges reported in 1 (top panel), the value of loans removed from the books of commercial banks also increased by about the same factor, thus, suggesting that a large fraction of discharged debt was bank-intermediated.

[PLEASE INSERT FIGURE 3 ABOUT HERE]

3. The model

Time is discrete and indexed by $t = \{1, 2, ...\}$. The economy is inhabited by a continuum of infinitely-lived households of measure one who are *ex-ante* identical. Households face two types of idiosyncratic shocks: (i) a labor productivity shock; and (ii) an expense shock. There is no aggregate uncertainty.

Households can borrow from a financial intermediary that channels resources from saving to borrowing households and to producers. Consumer credit financing takes the form of unsecured one period debt. Borrowers can default on their obligations. Upon default, households debt is discharged and defaulting households are excluded from the credit markets for a certain number of periods. The production sector is characterized by a technology with constant returns to scale, and the produced good can be used for consumption or investment.

In each time period, the sequence of events in the economy is the following: (i) The exogenous idiosyncratic shocks are revealed; (ii) capital and labor are rented, production takes place, and factors are remunerated; (iii) households decide whether to default: if they default, all debts are discharged (including the expense shock, if any), and no saving

[5] Charge-offs are the value of loans removed from the books of all commercial banks measured net of recoveries.

is possible; if they do not default, then they pay the expense shock (if any) and decide how much to lend or borrow; finally, (iv) consumption takes place.

The economic environment is described in detail below.

3.1 The production sector

A representative firm in any time period t converts capital, K_t, and labor, N_t, into output Y_t, according to the following constant returns to scale production technology:

$$Y_t = AK_t^{\alpha} N_t^{1-\alpha},\ \alpha \in (0,1),\ A > 0.$$

Competition in the production sector implies that inputs are paid according to their marginal productivity. Let w_t and r_t^K be the wage rate and the rental price of capital at period t, respectively. We have that:

$$w_t = (1-\alpha) A K_t^{\alpha} N_t^{-\alpha},$$
$$r_t^K = \alpha A K_t^{\alpha-1} N_t^{1-\alpha}.$$

Capital is rented from financial intermediaries and depreciates at rate $\delta \in (0,1)$ in each period.

3.2 The household sector

Each household has preferences defined over consumption, c_t, given by the following utility function:

$$\mathbf{E}_0 \left[\sum_{t=0}^{\infty} \beta^t u(c_t) \right],\ \beta \in (0,1), \tag{1}$$

with

$$u(c) = \frac{c^{1-\sigma} - 1}{1-\sigma},\ \sigma > 0.$$

Households are endowed with one unit of time in each period and supply it inelastically to the representative firm. A household hit by productivity shock z_t receives labor income $w_t z_t$. We assume that z_t follows a finite state Markov process with support $\mathcal{Z}$ and transition probability $\mathcal{P}(z, z') = \Pr(z_{t+1} = z' | z_t = z)$. Expense shocks e_t also follow a finite state Markov process with support $\mathcal{E}$ and have a transition probability given by $\mathcal{P}(e) = \Pr(e_{t+1} = e)$. We assume that these shocks are uncorrelated over time.

3.2.1 The household's problem

Households can save and borrow by means of one-period pure discount bonds intermediated by banks. Loans and deposits are defined as follows:

- A loan is a promise made by the borrower in period t to pay back $-a_{t+1} > 0$ to the bank in period $t+1$, against the immediate delivery by the bank to the household of $q_{a_{t+1},z_t} \cdot (-a_{t+1})$ units of the final good.
- A deposit is a promise made by the bank to deliver $a_{t+1} > 0$ units of the final good in period $t+1$ against a deposit by the household of $q_{a_{t+1},z_t} a_{t+1} > 0$ units of the final good during period t.

We have that $a_{t+1} \in \mathcal{A} \equiv [-\underline{b}, \overline{a}]$ and assume that $-\underline{b}$ is a large negative number. We also assume a large upper bound on assets, $\overline{a}$.[6] The implicit discount rate $q_{a_{t+1},z_t} > 0$ is a function of the loan/deposit amount, household's credit score and current household productivity. The exogenous shocks affecting the household are observable by all agents. Let $x_t = (a_t, z_t, e_t)$ denote the vector of these three state variables for a particular household.

Intuitively, the asset decisions a_{t+1} are made as follows: At the beginning of period t a household with access to credit and real asset holdings a_t, observes its productivity shock z_t and expense shock e_t, rents labor and receives labor income $w_t z_t$. If $a_t - e_t < 0$, the household decides whether to default or not. By defaulting, she will be banned from borrowing during the bankruptcy period (i.e., $a_{t+1} \geq 0$), but all her debts are discharged (that is, $a_t - e_t = 0$); otherwise, the household either asks for a loan to roll over its debt, in which case $a_{t+1} < 0$, or repays its debt and makes a deposit, which corresponds to $a_{t+1} \geq 0$. If $a_t - e_t \geq 0$, there is no default decision; the household either asks for a loan ($a_{t+1} < 0$) or maintains a positive asset position ($a_{t+1} \geq 0$). The problem of each household is formally described below.

The set of possible individual states is $\mathcal{U} = \mathcal{X} \times \{0, 1\}$, where $\mathcal{X} = \mathcal{A} \times \mathcal{Z} \times \mathcal{E}$. The last set of the product in the definition of $\mathcal{U}$ characterizes each household in terms of credit record status, where 0 corresponds to households with a good credit record and 1 corresponds to households with a bad credit record. Let Υ be the associated Borel σ-algebra. For each $B \in \Upsilon$, $\lambda(B)$ corresponds to the mass of households whose individual state vectors lie in B. The household's value function depends not only on the current

[6] In the quantitative experiments these numbers are large enough to not constrain the solutions.

idiosyncratic state, but also on aggregate measures such as the wage, the deposit interest rate, and the state contingent loan rates.

Households enter the period with either assets ($a_t \geq 0$) or debt ($a_t < 0$) and either a clean credit record ($s_t = 0$) or an impaired one ($s_t = 1$). Let $W_t(x_t, s_t, \lambda_t)$ be the current value of the problem with the option to default. Households with debt ($a_t < 0$) and a good credit score ($s_t = 0$) choose whether to default on the debt ($d_t = 1$) or not ($d_t = 0$). The bankruptcy decision of a household with a credit score $s_t = 0$ is made by choosing $d_t \in \{0, 1\}$ to maximize:

$$W_t(x_t, 0, \lambda_t) = \max_{d_t \in \{0,1\}} \{(1 - d_t)V_t(x_t, \lambda_t) + d_t V_t^D(x_t, 0, \lambda_t)\}. \tag{2}$$

where $V_t(x_t, \lambda_t)$ and $V_t^D(x_t, 0, \lambda_t)$ correspond to the value of repaying the debt or declaring bankruptcy with state vector $x_t \in \mathcal{X}$ and credit record $s_t = 0$. When $V_t(x_t, \lambda_t) \geq V_t^D(x_t, 0, \lambda_t)$ then $d_t = 0$; otherwise $d_t = 1$. Therefore, this problem defines optimal policy function $h_{d,t}(x_t, 0, \lambda_t)$. Households who enter the period without debt ($a_t \geq 0$) do not have a default decision to make ($d_t = 0$).

The value of repaying the debt with a good credit record ($s_t = 0$) is summarized by the following value function:

$$V_t(x_t, \lambda_t) = \max_{c_t \geq 0, a_{t+1} \in \mathcal{A}} \{u(c_t) + \beta E_t[W_{t+1}(x_{t+1}, s_{t+1}, \lambda_{t+1})]\}, \tag{3}$$

subject to the aggregate law of motion $\lambda_{t+1} = \Lambda_t(\lambda_t)$ and

$$c_t + q_{a_{t+1}, z_t} a_{t+1} \leq a_t - e_t + w_t z_t. \tag{4}$$

Equation (3) states that the household with a good credit record chooses consumption and next period asset value in order to maximize current utility and the continuation value of utility which depends on whether or not the household declares bankruptcy in the future. Equation (4) implies that consumption plus the present value of future asset holdings and the expense shock must be less than or equal to the sum of current net wealth and labor income. This problem defines policy functions $h_{c,t}(x_t, 0, \lambda_t)$ and $h_{a,t}(x_t, 0, \lambda_t)$.

The value of declaring bankruptcy ($d_t = 1$), which requires $s_t = 0$, is given by:

$$V_t^D(x_t, 0, \lambda_t) = u(c_t) + \beta E_t[\eta V_{t+1}^D(x_t, 1, \lambda_{t+1}) + (1 - \eta)W_{t+1}(x_{t+1}, 0, \lambda_{t+1})],$$

subject to the aggregate law of motion $\lambda_{t+1} = \Lambda_t(\lambda_t)$ and

$$c_t \leq (1 - \gamma)\, w_t z_t - \phi\,. \tag{5}$$

Equation (5) reflects the fact that all household debts are fully discharged under bankruptcy, and that the defaulting household cannot save ($a_{t+1} = 0$). The latter implies that any remaining assets would be seized in the bankruptcy process. We assume that default follows the rules laid down in Chapter 7 of the U.S. Bankruptcy Code. In the model, the Bankruptcy Code is summarized by three institutional parameters (η, γ, ϕ), which the household takes as given. The parameter η regulates the duration of bad credit score spells following a bankruptcy case, γ represents a pecuniary wage loss associated with bankruptcy, and ϕ is the one-time lump-sum fixed cost of filing for bankruptcy. Upon paying the filing fee ϕ and discharging her debts, the household retain a bad credit record spell for a certain number of periods during which she cannot borrow and is subject to pecuniary losses equal to a fraction γ of her labor income. In every period, the bad credit score can revert back to normal with probability η. As a result, the household's access to the credit market is restored and she is not subject to pecuniary losses any longer (e.g. Chatterjee et al. (2007), Athreya et al. (2012)). The parameter η is calibrated so that the average duration of the credit market exclusion matches the one in the data (more details are in the calibration section).

Households with a bad credit record ($s_t = 1$) face the following problem:

$$V_t^D(x_t, 1, \lambda_t) = \max_{c_t \geq 0, a_{t+1} \geq 0} \{u(c_t) + \beta E_t[\eta V_{t+1}^D(x_t, 1, \lambda_{t+1}) + (1-\eta) W_{t+1}(x_t, 0, \lambda_{t+1})]\},$$

subject to the aggregate law of motion $\lambda_{t+1} = \Lambda_t(\lambda_t)$ and

$$c_t + q_{a_{t+1}, z_t} a_{t+1} \leq \max\{a_t - e_t, 0\} + (1-\gamma)\, w_t z_t. \tag{6}$$

During a bad credit score period, consumers can save but not borrow ($a_{t+1} \geq 0$), they are still subject to the pecuniary cost $\gamma w_t z_t$, and still face an exogenous probability $(1-\eta)$ to start next period with a good credit score. Associated with this problem are policy functions for consumption $h_{c,t}(x_t, s_t, \lambda_t)$ and asset holdings $h_{a,t}(x_t, s_t, \lambda_t)$. Notice that that $h_{d,t}(x_t, 1, \lambda_t) = 1$ whenever $a_t - e_t < 0$.

3.3 The Banking Sector

Banks intermediate funds between saving and borrowing households. We assume free entry in the banking sector. Therefore, any bank has zero profits in loans to agents of the same type. This implies that there is no cross-subsidization in loans to households.[7]

[7] See Chatterjee et al. (2007) for a discussion.

Given that the banks' payoffs are affine in the decision variables and there is free entry, we assume without loss of generality that there is only one bank which holds all capital. Let $A_{a_0,z_{-1}}$ denote the amount of type (a_0, z_{-1}) contracts maturing at $t = 0$. Given the initial portfolio of previous contracts, $\{A_{a_0,z_{-1}}\}_{(a_0,z_{-1})\in\mathcal{A}\times\mathcal{Z}}$, the initial amount of capital K_0, and the deposit and loan discount rates q_{a_{t+1},z_t}, the financial intermediary chooses the amount A_{a_{t+1},z_t} of type (a_{t+1}, z_t) contracts and the amount of capital K_{t+1} to hold, in order to maximize the present value of current and future cash flows, discounted at the risk free interest rate $\{r_t\}_{t=0}^{\infty}$,

$$\sum_{t=0}^{\infty} \frac{1}{\prod_{j=1}^{t}(1+r_j)}\ \pi_t, \tag{7}$$

with

$$\pi_t = (1 + r_t^K - \delta)K_t + D_{t+1} - (1+\tau)L_{t+1} - K_{t+1} - D_t + L_t. \tag{8}$$

The parameter τ represents a cost of intermediating funds and introduces an exogenous spread between borrowing and lending rates. As we see in equation (10) below, in addition to τ there is also an endogenous component of the spread, which is loan specific.

Deposits and newly extended loans are defined, respectively, as

$$\begin{aligned} D_{t+1} &= \sum_{(a_{t+1},z_t)\in\mathcal{A}\times\mathcal{Z},\ a_{t+1}\geq 0} q_{a_{t+1},z_t} a_{t+1} A_{a_{t+1},z_t}, \\ L_{t+1} &= \sum_{(a_{t+1},z_t)\in\mathcal{A}\times\mathcal{Z},\ a_{t+1}<0} q_{a_{t+1},z_t}\,(-a_{t+1})\,A_{a_{t+1},z_t}, \end{aligned}$$

while existing deposits and loans are given by

$$\begin{aligned} D_t &= \sum_{(a_t,z_{t-1})\in\mathcal{A}\times\mathcal{Z},\ a_t\geq 0} a_t A_{a_t,z_{t-1}}, \\ L_t &= \sum_{(a_t,z_{t-1})\in\mathcal{A}\times\mathcal{Z},\ a_t<0} \left(1 - p_{a_t,z_{t-1}}\right)(-a_t)\,A_{a_t,z_{t-1}}\,. \end{aligned}$$

The variable $p_{a_t,z_{t-1}}$ is the probability that a type (a_t, z_{t-1}) contract maturing in period t is defaulted upon. This is given by the fraction of households that, in the current period, suffer idiosyncratic shocks such that they choose to default. As discussed previously, $p_{a_t,z_{t-1}} = 0$ whenever $a_t - e_t \geq 0$. Any sequence of deposits/loans and capital $\{A_{a_{t+1},z_t}, K_{t+1}\}_{z_t\in\mathcal{Z},t=0,\ldots,\infty}$ implies a sequence of risk-free bond holdings $\{B_t\}_{t=0,\ldots,\infty}$ by the bank which satisfies $B_0 = 0$ and[8]

$$B_{t+1} = (1 + r_t)B_t + \pi_t\,. \tag{9}$$

[8]In equilibrium the interest rate on risk-free bonds and deposits will be similar and therefore to save in notation we use r_t also for risk-free bonds.

Providing loans to households is a risky activity, and intermediaries demand compensation for such risks. In addition to a proportional intermediation cost τ, the pricing of loans also depend on the (endogenous) default probabilities. We assume that intermediaries are able to perfectly observe each households' current state, and thus they offer a household-specific loan price menu. Depending on the size of the desired loan, banks perfectly foresee the future default probabilities (which are based on the transition matrix $\mathcal{P}(z|z')$ and on $\mathcal{P}(e')$) and take into account the losses associated with default. This assumption, along with the fact that there is a continuum of households, implies that banks earn zero profits for *each* agent type (there is no cross-subsidization):

$$q_{a_{t+1},z_t} \cdot a_{t+1} = \left[\frac{1}{(1+\tau)(1+r_{t+1})}\right] \sum_{x_{t+1}\in\mathcal{X}} \mathcal{P}(z,z_{t+1})\mathcal{P}(e_{t+1})[1-h_d^{t+1}(x_{t+1},0)] \cdot a_{t+1}, \quad (10)$$

Thus, for $a_{t+1} \geq 0$, investors are indifferent between holding capital, making deposits or holding risk free bonds issued by the bank. For $a_{t+1} < 0$, the loan interest rate increases with the probability of default, given the risk free discount rate. Thus, a risk premium emerges endogenously as a response to default.[9]

3.4 The service providers

The expense shocks, e, go to a service provider sector, such as courts, which provide legal services, or hospitals that provide health services. If a household does not default, then service providers receive the expense shock e_t. If a household defaults, then service providers receive nothing if the household's net wealth is negative, but receive a_t when this is positive. In order to ensure zero profits in this sector we assume that service providers charge a markup m_t such that

$$\int_{\mathcal{U}} [(1-h_{d,t}(x_t,s_t,\lambda_t))e_t + h_{d,t}(x_t,s_t,\lambda_t)\max\{0,a_t\}]d\lambda_t = \int_{\mathcal{U}} \frac{e_t}{m_t} d\lambda_t. \quad (11)$$

3.5 Equilibrium

The endogenous transition probability of the households' state vector, the competitive equilibrium, and the aggregate law of motion implied by the individual decision rules are defined in Appendix A. A stationary equilibrium is an equilibrium where prices and aggregate objects are stationary over time.

[9] An equivalent formulation with ex-post payment of interest rate on loans, $1 + r_{a_{t+1},z_t}$, would imply $1 + r_{a_{t+1},z_t} = \frac{1}{q_{a_{t+1},z_t}} = \frac{(1+r_{t+1})(1+\tau)}{1-p_{a_{t+1},z_t}}$.

4. Mapping the Model to the Data

The calibration proceeds in two steps. A first set of parameters assumes values commonly used in the literature. A second set of parameters is calibrated so that the model stationary equilibrium matches key empirical observations in the United State for the pre-financial crisis period (i.e. 1990-2004). A model period represents one year. Table 1 reports all the parameter values resulting from our calibration.

[PLEASE INSERT TABLE 1 ABOUT HERE]

4.1 Pre-set parameters

Six parameters are set to take values commonly used in the literature. Below we describe how we choose each of them.

Production. The production function is Cobb-Douglas with the share of capital α equal to 30 percent, a value consistent with estimates in Gollin (2002). In line with other studies, the depreciation rate δ is set to 0.06, which, along with our choices for α and the targeted risk free interest rate, implies a capital to output ratio of 3.

Preferences and idiosyncratic shocks. The inverse of the intertemporal elasticity of substitution, σ equals 2, (see, for instance, Mehra and Prescott (1985)).

The idiosyncratic labor productivity shock follows the estimates in Krueger and Perri (2005). Using data from the Consumer Expenditure Survey and controlling for several idiosyncratic characteristics, they report a cross-sectional variance of the log of wages σ_ε^2 of 0.719. The shock is modelled as an AR(1) process with an autocorrelation parameter of $\rho = 0.98$. We use a Rouwenhorst discretization of the AR(1) process with 9 grid points; see Kopecky and Suen (2010) for details.[10]

Bankruptcy filing. We set η equal to 0.1 so that defaulting households have a bad credit record for, on average, ten years (see Chatterjee et al. (2007)).

[PLEASE INSERT TABLE 2 ABOUT HERE]

[10] The Markov transition matrix $\mathcal{P}(z, z')$ and the vector with values of $\mathcal{Z}$ are in Appendix Table C1.

4.2 Internally calibrated parameters

We calibrate the magnitude of the expense shock, its probability, the bankruptcy penalty parameter γ, intermediation cost parameter τ, the fixed cost parameter ϕ and the discount factor β to match key data moments. We focus on unsecured consumer debt and target the debt-to-output ratio, the fraction of people in debt, the default rate, the bankruptcy filing fee. In addition, we also target the risk-free interest rate and the spread on consumer credit. Table 2 reports the calibration targets based both on micro and macro data, as well as the corresponding model values. All data moments are calculated as averages over the pre-financial crisis period 1990-2014.[11]

[PLEASE INSERT TABLE 3 ABOUT HERE]

We target the proportion of consumers in debt in the stationary equilibrium to be 8.63%, computed by using the (1990-2014) Survey of Consumer Finances. Following Chatterjee et al. (2007), we compute this fraction by considering households with negative net worth, excluding debts that are likely to be due to entrepreneurial activity, i.e. negative net worth larger than 120% of average income. As in Livshits et al. (2007) we compute the percentage of filers for bankruptcy as the number of Chapter 7 non-business bankruptcy filings relative to the number of households in the U.S. that over our sample period is of 0.80%. The debt-to-output target of 0.63% is computed as the average amount of debt among all households relative to GDP per household over the same period. We target a fixed cost of filing for bankruptcy of $600; this is in line with the pre-2005 cost of bankruptcy for a debtor under Chapter 7 reported in White (2007). The risk-free interest rate targets a 4 percent per annum. The average spread is computed as the difference between the average interest rates charged for non-secured credit and the average risk-free rate over the same period.

The bottom panel of Table 1 summarizes the values for the model's parameters. The resulting value for the intermediation cost parameter τ is 2%. This is in line with the values reported in Mehra, Piguillem and Prescott (2011) and Philippon (2013) over the same period. The parameter γ is 0.19, where γ corresponds to wage loss and $(1-\gamma)w_t z_t$ is the fraction of work income that a defaulted household can utilize. In equilibrium the amount lost by the household is very small in aggregate terms, corresponding to 0.54% of output. We treat it as a deadweight loss.

[11] Appendix B describes the data series and sources.

Regarding the expense shock, we assume a simple structure of only two serially uncorrelated realizations: $e = 0$ (no expense shock) and a positive value.[12] Finally, the scale parameter A is such that equilibrium aggregate production is normalized to one.

In addition to the data targets, Table 2 also presents a summary of the model implied moments. The calibrated model matches quite closely the data targets. Finally, Table 3 presents a summary of the model implied stationary wealth distribution of the calibrated economy and the data counterpart. The performance of the model in terms of reproducing the un-targeted wealth distribution is satisfactory. In particular, the model matches very well the wealth of the lowest two quintiles.

[PLEASE INSERT TABLE 3 ABOUT HERE]

4.3 Model's Properties

Figure 4 displays an important feature of the asset policy in the model: over time a borrower may become a saver and vice versa. The figure shows that if an agent suffers a negative productivity shock, for example $\log(z) = -2$, then if current holdings are low enough, the agent can default, which is represented by the flat region in the right panel. In contrast, a borrower with a good productivity shock, say $\log(z) = 2$, can switch from borrowing to saving.

Figure 5 illustrates the probability that a borrower defaults on a loan in equilibrium in the baseline case of no expense shock ($e_t = 0$). The figure shows that default can occur abruptly. Conditional on the realization of labor productivity, at lower levels of debt, default probabilities are small. However, for sufficiently high levels of debt the probability of default is high, and the rise is abrupt. As default probabilities are closely linked to loan pricing (Equation (10)), this leads to very sharp rises in the spread due to small increments in the loan size, a pattern resembling credit card limits.

[PLEASE INSERT FIGURE 4 and 5 ABOUT HERE]

Figure 6 depicts the endogenous credit limits in the stationary equilibrium of the calibrated model (black line), as a function of the realized productivity shock, along with the share of borrowers at each z (black bars). The black line depicts the endogenous

[12] Appendix Table C2 presents the implied expense shock levels $\mathcal{E}$ and the Markov matrix. Livshits et al. (2007) measure directly medical bills, divorces and unplanned pregnancies and then calibrate positive levels of expenditure shocks and their respective probabilities for a three-year period. Health shocks are difficult to convert from a three year to an annual frequency.

credit limits - i.e. maximum cash that households of a given productivity level (right axis, measured as a percentage of total savings) can obtain - whereas the bars represent the share of borrowers. The model predicts that most borrowers are concentrated among low income earners. Low wage-earners face stringent credit limits. However, the share of borrowers in Figure 6 indicates that even though high wage-earners could obtain relatively large loans, they prefer not to do so.[13]

[PLEASE INSERT FIGURE 6 ABOUT HERE]

5. Quantitative Exercise: Tighter Credit

We use our quantitative model as a laboratory to explore the distributional and welfare effects of changes from the calibrated economy (baseline) to an economy with tighter credit. We model the tightening in the supply of bank-intermediated credit as an exogenous increase in τ, i.e. the parameter that controls the tightness of bank lending standards. Higher τ increases the cost of borrowing for consumers for any given level of borrower riskness.

The experiment is conducted as follows:

- In period $t = 0$, the economy starts at the stationary equilibrium associated with the calibrated τ.
- For periods $t = 1, 2, 3, 4, ...$ we compute the transition to an unexpected and immediate increase in τ up to the new higher time-invariant long-run level.
- During the transition, the economy is not subject to aggregate shocks.

Our baseline experiment assumes an immediate increase in τ that occurs unexpectedly.[14] The increases in τ from 2 to 4.46 percent is chosen so that the increases in the average spread on consumer credit matches the post-2007 average increase of 2 percentage points (p.p.) in the interest rate spreads on credit cards.

Figure 6 reports the endogenous credit limit for the new stationary equilibrium of the model with higher τ (red line), in addition to the baseline model (black line). The

[13] Taking into account the positive correlation between productivity and default risk (figure 5), the patterns portrayed in 6 are consistent with evidence provided by Agarwal, Chomsisengphet, Mahoney and Stroebel (2017), who find that despite the availability of credit (high credit limits), high credit-score individuals' willingness to borrow is low.

[14] For a similar exercise, without default, see Guerrieri and Lorenzoni (2017).

endogenous credit limit shifts downwards when τ increases, which indicates tighter credit. Compared to other papers that study the effects of exogenous changes in credit limits (e.g. Guerrieri and Lorenzoni (2017), Eggertsson and Krugman (2012)), our model is able to generate endogenous movements in the borrowing constraints as well as in the average credit spread.

[PLEASE INSERT FIGURE 6 ABOUT HERE]

5.1 Long-run Effects

We start by exploring the long-run (stationary equilibrium) effects of changes in τ on key model variables. Table 4 reports the long run effects of an increase to high τ from its calibrated value to 4.46%.[15]

[PLEASE INSERT TABLE 4 ABOUT HERE]

A higher τ, by increasing the average cost of credit for borrowers, reduces households borrowing capacity. Thus, the fraction of households that borrow declines, as well as, the debt to output ratio. The decline in the fraction of borrowers and in total (unsecured) credit is remarkable, whereas the effect is less sizable in terms of the change in the average spread. Crucially, the model displays incomplete pass-through (around 80%) of the increase in τ to the average total spread. This happens because the default rate of borrowers declines along with the average risk spread, i.e. the part of the spread that prices in the riskiness of the borrower. Thus, the total increase in the average credit spread is lower than the increase in τ.[16]

In response to tighter credit, the model display a *selection effect* in the composition of borrowers as lending is channeled to "better quality borrowers". The fraction of households with a probability of defaulting below 5 % increases remarkably whereas the fraction of borrowers with a higher probability of default declines. Interestingly, deleveraging is *not* concentrated among the lowest productivity households. This is due to households' *bunching* behavior (Saez (2010)), implied by a kink in the cost of marginal debt (or, equivalently, in the benefit of marginal savings) at $a = 0$. This, however, does not necessarily mean that in the new stationary equilibrium with tighter credit, the *pool* of borrowers is riskier. In fact, the new equilibrium features a *safer* pool of borrowers, which leads to a decrease in the average default rate.

[15] See also Figure C2, Appendix B, for the full set of comparative statics.

[16] This explains why in this exercise, τ needs to increase by 2.26 p.p. to match an increase in the total credit spread of 2 p.p.

5.2 Transitional effects on allocations

In this section we examine the transition to tighter bank-intermediated credit. Figure 7 illustrates the economy's response to an increase in τ.

[PLEASE INSERT FIGURE 7, 8 and 9 ABOUT HERE]

The fraction of borrowers gradually declines as well as the ratio of debt over GDP. In the periods after the tightening in lending standards, only consumers with lower default risk, that did not default upon the occurrence of the shock, can access the credit market. The cost of borrowing becomes too high for risky consumers. The share of less risky borrowers increases. See Figure 8. Due to this *selection effect* in the composition of borrowers, the effect of a credit tightening is larger on credit quantities than on the lending spreads. Indeed, the initially large increase in the average total spread is substantially reduced in the subsequent periods due to the decline in the risky part of the spread.

Figure 9 reports the response of aggregate consumption as well as of average consumption by wealth quantiles. The drop in aggregate consumption is driven by the sizable and negative effect of the shock on consumers at the bottom of the distribution. The negative effect on aggregate consumption is very persistent. Crucially, default affects the creditworthiness of consumers for a certain numbers of years. This reduces their ability to smooth consumption over time and increases the persistence in the effects the shock.[17]

5.3 Effect on welfare

Table 7 reports the average welfare effects measured by the average of the percentage change in consumption that each consumer would be willing to pay so that the expected utility in the initial stationary equilibrium equals that of the equilibrium with a higher credit spread. It also displays the average effects on the savers and borrowers and on the group of consumers belonging to different quantiles of the income distribution.[18] In assessing the welfare effects of tighter credit we take into account the transition path to the new stationary equilibrium.

[PLEASE INSERT TABLE 5 ABOUT HERE]

Long run aggregate consumption is largely unaffected by the different levels of τ. However, the welfare effects of tighter credit are heterogeneous. The long run welfare

[17] While τ reaches the higher level immediately, the endogenous spread, as well as consumption and all other aggregate variables take much longer to reach the new stationary equilibrium.

[18] We consider consumers belonging to each quantile before the occurrence of the shock.

effects are positive for the left tail of the income distribution, because the long-run rise in wages more than compensates for the increased debt burden. Despite the positive, although small, long-run effects of tighter credit on aggregate consumption and welfare, the effects including the transition are negative for all agents. In particular, the largest losses accrue to borrowers.

6. Understanding the Role of Bankruptcy Protection

In order to understand how bankruptcy protection interacts with lending standards and the response of the economy to tighter credit, we explore the role of the two key parameters that characterize the bankruptcy code in our model: the cost of filing for bankruptcy (ϕ) and the length of exclusion from the credit market after bankruptcy (η). It is important to recall that bankruptcy involves a trade-off. On the one hand, bankruptcy increases households' ability to smooth consumption *across states*, in response to negative shocks. At a given point in time, consumers can discharge their financial obligations and be free of their current debt. On the other hand, upon default, households lose access to the credit market for a certain period. This reduces households' ability to smooth consumption *over time*. Thus, the option to default provides borrowers with insurance against bad luck today, but at the cost of exclusion from the credit market and/or a higher borrowing rates for a period of time. In what follows we show that both the cost of filing for bankruptcy and the length of the exclusion from the credit market affect this trade-off and thus have an impact on the response of the aggregate economy. In addition they also have important implications for the ex-ante credit limits, i.e. in the initial stationary distribution before the change in τ.

[PLEASE INSERT FIGURE 10 ABOUT HERE]

Bankruptcy cost. Figure 10 (top left panel) displays the response of aggregate consumption to tighter credit for low and high values of the cost of filing for bankruptcy. Easier bankruptcy (ϕ=0) makes borrowers more willing to default as it allows them to consume more when bankrupt. Thus, compared to the baseline (ϕ=1.2) the drop in aggregate consumption is less sizable on impact. In contrast, when bankruptcy is harsher (ϕ=3) consumers are less willing to default and the drop in aggregate consumption is more sizable. These results seem to suggest that easier bankruptcy is beneficial for an economy facing a credit supply shock. However, the cost of filing for bankruptcy introduces impor-

tant ex-ante effects. While easier bankruptcy reduces the cost of a credit tightening for borrowers, harsher bankruptcy procedures facilitate access to credit ex-ante. Figure 11 shows how the ex-ante endogenous credit limits move with respect to different bankruptcy costs. A higher ϕ (red solid line) is associated with higher credit limits (looser lending standards) for low income borrowers compared to the baseline model (black solid line). Thus, depending on which of two effects the consumers value more, it could be more or less beneficial to change the bankruptcy filing cost.

[PLEASE INSERT FIGURE 11 ABOUT HERE]

Credit market exclusion. The baseline model delivers very persistent effects of a credit tightening. While the increase in τ is immediate, most of the endogenous variables take several periods to reach the new equilibrium. The endogenous decision of consumers to declare bankruptcy in response to a tightening in credit supply, can, indeed, cause the slowdown to be persistent. Figure 10 (bottom left panel) compares the baseline response of aggregate consumption to tighter credit with an alternative setting that features no exclusion from the credit market (η=1) as well as with an extremely long exclusion of on average 50 years (η=0.02). The longer the average exclusion from the credit market, the more persistent the negative aggregate effects of a credit tightening. However, a longer ex-post exclusion from the market is also associated with ex-ante easier access to the credit market. See Figure 11 (solid blue line).

Additional Elements. We now explore the role of other two elements of the model that help us understand the importance of the insurance provided by bankruptcy. First, Figure 10 (top right panel) quantifies the aggregate implications of default by assuming that at the time in which the economy is hit by the unanticipated increase in τ bankruptcy is too costly and consumers cannot default.[19] The drop in consumption on impact is twice as large compared to the baseline simulations. Second, we explore the role of the most importance source of (idiosyncratic) default risk in the model: the expense shock. Figure 10 (bottom right panel) shows the model response in the absence of expense shocks during the transition to the new credit market equilibrium (red dashed line). When consumers do not face expense shocks, the drop in consumption is remarkably larger on impact. This is explained by the fact that consumers are much less risky and ex-ante access to credit is easier, as depicted in Figure 11 (dotted line). Thus, the fraction of borrowers

[19] We assume that filing cost ϕ takes an extreme value only for one period, i.e the first period of increase in τ. Both changes are unexpected.

is significantly larger compared to the baseline specification. The more dramatic drop in consumption reflects the fact that a much larger fraction of agents is affected by the negative shock, and thus the deleveraging process is more severe.[20]

7. 2005 Reform of Personal Bankruptcy

To assess the effects of a concrete change in the cost of bankruptcy, we now quantify how the Bankruptcy Abuse Prevention and Consumer Protection Act of 2005 (BAPCPA) affected the response of bankruptcy and consumption to tighter credit during the financial crisis. The law made several significant changes to the U.S. Bankruptcy Code intended to make filing for bankruptcy more difficult to prevent abuse of the system. Figure 12 shows how the filing for bankruptcy evolved from the mid-1990 to 2018. The vertical line in the figure marks the year of BAPCPA implementation. The reform was passed in Congress in April 2005 and applied to cases filed on or after October 17, 2005. In anticipation of costlier bankruptcy, there is a sharp spike in the number of bankruptcy filings immediately prior to the enactment of BAPCPA.

[PLEASE INSERT FIGURE 12 ABOUT HERE]

In order to understand how the BAPCPA interacted with the financial shock, we explore its effects in an economy subject to the BAPCPA reform two periods before the tightening in credit. The BAPCPA experiment is conducted as follows:

- In period $t = -1$, we start the economy at the stationary equilibrium associated with the calibrated $\tau = 2$ percent and bankruptcy filing cost $\phi = 1.2$.
- In period $t = 0$, a 50% increase in the cost of filing for bankruptcy ϕ (BAPCPA) is announced to take place in $t = 1$.
- In period $t = 1$, ϕ increases permanently to the new level ($\phi = 1.8$).
- In period $t = 3$, the unexpected increase in τ takes place.

We compare the results of the BAPCPA simulations with the baseline economy that in $t = -1, 0, 1, 2$ is at the initial stationary equilibrium (τ=2 and $\phi = 1.2$) and is subject

[20]The credit shock produces an even harsher consumption drop (in the case with no expense shocks) when the option to default is not available. See the blue line in Figure 10 (bottom right panel). This happens because ex-ante credit limits are even higher in this case, and thus even more households are negatively affected by the credit tightening.

to the increase in τ only in period $t = 3$. While in the baseline case the shock hits the economy in a regime of low bankruptcy filing costs, (pre-BAPCPA $\phi = 1.2$), in the BACPCA case the same shock hits the economy when the bankruptcy filing cost is higher (post-BAPCPA $\phi = 1.8$).[21] The assumption that the two economies are identical in period $t = -1$, i.e. at the initial equilibrium characterized by the same calibrated values of ϕ and τ, ensures that the comparison of the effects of tighter credit with high and low bankruptcy costs is not affected by ex-ante differences in the two economies.

Figure 13 displays the simulations that account for the BAPCPA (black solid line) and baseline simulations (red dashed line). The black solid line reproduces the fact that bankruptcy increased sharply after the announcement of BAPCPA. In addition, it also suggests that BAPCPA alleviated the increase in bankruptcy triggered by the tightening in the credit supply. With BAPCPA the fraction of less risky borrowers increases and this is reflected in the reduction in the average lending spread. Thus, when credit becomes tighter the economy features a lower fraction of borrowers but of better quality. This explains the smaller increase in defaults at time $t = 3$. Nevertheless, the economy suffers a larger and more persistent reduction in aggregate consumption. This is due to the fact that default is more costly compared to the baseline economy. Overall, the welfare effects of the credit tightening are amplified by BACPCA and are particularly worse for poor consumers and borrowers. See Table 5.

8. Conclusion

We study the effects of a credit tightening in a quantitative model with heterogeneous households, unsecured credit and default. A sudden tightening in credit leads to a decline in the fraction of borrowers, but to a higher fraction of the less risky ones. While in the long run aggregate consumption remains roughly constant, the transition and welfare effects show large changes at the individual and aggregate consumption level. The lowest two quantiles in the income distribution experience relatively large declines in consumption during the transition and non-negligible welfare effects. In addition, the adjustment is very slow.

Our results also elucidate new policy considerations, which are often challenging in environments with heterogeneous agents. We evaluate how the bankruptcy code affects

[21] As in the baseline, the increase in τ is not anticipated and the economy is not subject to aggregate shocks.

the transmission of a credit crunch. Our results indicate that a more lenient bankruptcy system (e.g. involving a less costly bankruptcy procedure or a shorter period of exclusion from the credit market upon bankruptcy) could help to mitigate the negative and persistent effects of a credit tightening on aggregate consumption. In contrast, the 2005 BAPCPA, by making filing for bankruptcy more difficult, increased the welfare costs of the subsequent credit tightening.

References

Agarwal, S., Chomsisengphet, S., Mahoney, N. and Stroebel, J. (2017), 'Do banks pass through credit expansions to consumers who want to borrow?', *The Quarterly Journal of Economics* **133**(1), 129–190.

Aiyagari, S. R. (1994), 'Uninsured idiosyncratic risk and aggregate saving', *Quarterly Journal of Economics* **109**(3), 659–684.

Albanesi, S. and Nosal, J. (2018), Insolvency after the 2005 bankruptcy reform, Technical report, National Bureau of Economic Research.

Arthreya, K., Sanchez, J., Tam, X. and Young, E. (2015), 'Labor Market Upheaval, Default Regulation, and Consumer Debt', *Review of Economic Dynamics* **18**(1), 32–52.

Athreya, K. (2006), 'Fresh start or head start? uniform bankruptcy exemptions and welfare', *Journal of Economic Dynamics and Control* **30**(11), 2051–2079.

Athreya, K., Tam, X. S. and Young, E. R. (2012), 'A quantitative theory of information and unsecured credit', *American Economic Journal: Macroeconomics* **4**(3), 153–183.

Auclert, A., Dobbie, W. S. and Goldsmith-Pinkham, P. (2019), Macroeconomic effects of debt relief: Consumer bankruptcy protections in the great recession, Technical report, National Bureau of Economic Research.

Bassett, W. F., Chosak, M. B., Driscoll, J. C. and Zakrajšek, E. (2014), 'Changes in bank lending standards and the macroeconomy', *Journal of Monetary Economics* **62**, 23 – 40.

Bassetto, M., Cagetti, M. and De Nardi, M. (2015), 'Credit crunches and credit allocation in a model of entrepreneurship', *Review of Economic Dynamics* **18**(1), 53–76.

Bewley, T. (1977), 'The permanent income hypothesis: A theoretical formulation', *Journal of Economic Theory* **16**(2), 252–292.

Buera, F., Fattal-Jaef, R. and Shin, Y. (2015), 'Anatomy of a credit crunch: From capital to labor markets', *Review of Economic Dynamics* **18**(1), 101–117.

Chatterjee, S., Corbae, D., Nakajima, M. and Ríos-Rull, J.-V. (2007), 'A quantitative theory of unsecured consumer credit with risk of default', *Econometrica* **75**(6), 1525–1589.

Chatterjee, S. and Gordon, G. (2012), 'Dealing with consumer default: Bankruptcy vs garnishment', *Journal of Monetary Economics* **59**, S1–S16.

Chen, k. and Zha, T. (2015), Assessing the macroeconomic impact of bank intermediation shocks: a structural approach, FRB Atlanta Working Paper 2015-8, Federal Reserve Bank of Atlanta.

Christiano, L. J., Motto, R. and Rostagno, M. (2014), 'Risk shocks', *American Economic Review* **104**(1), 27–65.

Dempsey, K. and Ionescu, F. (2019), Lending standards and consumption insurance over the business cycle, *in* '2019 Meeting Papers', Society for Economic Dynamics.

Eggertsson, G. B. and Krugman, P. (2012), 'Debt, deleveraging, and the liquidity trap: A Fisher-Minsky-Koo approach', *The Quarterly Journal of Economics* **127**(3), 1469–1513.

Gollin, D. (2002), 'Getting income shares right', *Journal of Political Economy* **110**(2), 458–474.

Gordon, G. (2015), 'Evaluating default policy: The business cycle matters', *Quantitative Economics, 6(3):* **6**(3), 1795–823.

Guerrieri, V. and Lorenzoni, L. (2017), 'Credit crises, precautionary savings, and the liquidity trap', *The Quarterly Journal of Economics* **132**(3), 1427–1467.

Hall, R. E. (2011), 'The long slump', *American Economic Review* **101**(2), 431–69.

Huggett, M. (1993), 'The risk-free rate in heterogenous-agent incomplete-insurance economies', *Journal of Economic Dynamics and Control* **17**, 953–969.

Jermann, U. and Quadrini, V. (2012), 'Macroeconomic effects of financial shocks', *American Economic Review* **102**(1), 238–71.

Jones, C., Midrigan, V. and Philippon, T. (2018), Household leverage and the recession, IMF Working Papers 18/194, International Monetary Fund.

Justiniano, A., Primiceri, G. E. and Tambalotti, A. (2015), 'Household leveraging and deleveraging', *Review of Economic Dynamics* **18**(1), 3–20.

Justiniano, A., Primiceri, G. E. and Tambalotti, A. (2019), 'Credit supply and the housing boom', *Journal of Political Economy* **127**(3), 1317–1350.

Khan, A. and Thomas, J. (2013), 'Credit shocks and aggregate fluctuations in an economy with production heterogeneity', *Journal of Political Economy* **121**(6), 1055 – 1107.

Kopecky, K. A. and Suen, R. (2010), 'Finite state markov-chain approximations to highly persistent processes', *Review of Economic Dynamics* **13**(3), 701–714.

Krueger, D. and Perri, F. (2005), 'Understanding consumption smoothing: Evidence from the US Consumer Expenditure Data', *Journal of the European Economic Association* **3**(2-3), 340–350.

Livshits, I., MacGee, J. and Tertilt, M. (2007), 'Consumer bankruptcy: A fresh start', *American Economic Review* **97**(1), 402–418.

Livshits, I., MacGee, J. and Tertilt, M. (2010), 'Macroeconomic effects of financial shocks', *American Economic Journal: Macroeconomics* **2**(2), 165–193.

MacGee, J., Livshits, I. and Fieldhouse, D. (2016), Aggregate fluctuations, consumer credit and bankruptcy, Mimeo, University of Western Ontario.

Mehra, R., Piguillem, F. and Prescott, E. C. (2011), 'Costly financial intermediation in neoclassical growth theory', *Quantitative Economics* **2**(1), 1–36.

Mehra, R. and Prescott, E. C. (1985), 'The equity premium: A puzzle', *Journal of Monetary Economics* **15**, 145–162.

Mendicino, C., Nikolov, K., Suarez, J. and Supera, D. (2019), 'Bank capital in the short and in the long run', *Journal of Monetary Economics* .

Mian, A. and Sufi, A. (2011), 'House prices, home equity-based borrowing, and the us household leverage crisis', *The American Economic Review* **101**(5), 2132–2156.

Mitman, K. (2016), 'Macroeconomic effects of bankruptcy and foreclosure policies', *American Economic Review* **106**(8), 2219–55.

Nakajima, M. and Rios-Rull, J.-V. (2014), Credit, bankruptcy, and aggregate fluctuations, Technical report, Federal Reserve Bank of Minnepolis.

Pavan, M. (2008), 'Consumer durables and risky borrowing: The effects of bankruptcy protection', *Journal of Monetary Economics* **55**(8), 1441 – 1456.

Philippon, T. (2013), Has the US finance industry become less efficient? on the theory and measurement of financial intermediation, Technical report, National Bureau of Economic Research.

Saez, E. (2010), 'Do taxpayers bunch at kink points?', *American Economic Journal: Economic Policy* **2**(3), 180–212.

Senga, T., Thomas, J., Khan, A. et al. (2017), Default risk and aggregate fluctuations in an economy with production heterogeneity, *in* '2017 Meeting Papers', Society for Economic Dynamics.

White, M. (2007), 'Bankruptcy reform and credit cards', *Journal of Economic Perspectives* **21**(4), 179–199.

Zetlin-Jones, A. and Shourideh, A. (2017), 'External financing and the role of financial frictions over the business cycle: Measurement and theory', *Journal of Monetary Economics* **92**(1), 1–15.

Table 1: Parameter Values

Parameters	Values	Source
α	0.30	Capital income share, estimates by Gollin (2002)
δ	0.06	Capital to output ratio, $\frac{K}{Y} = 3$
σ	2	Risk aversion coefficient based on micro evidence reported by Mehra and Prescott (1985)
ρ	0.98	Persistence parameter Krueger and Perri (2005)
σ_ϵ^2	0.0285	Cross-sectional variance of shocks based on Krueger and Perri (2005)
η	0.9	Average bad credit score spell - 10 years; see Chatterjee et al. (2007)
A	0.5613	Equilibrium aggregate production is equal to 1
β	0.9273	Real interest rate on risk free asset of 4%
ϕ	0.012	Cost of filing for bankruptcy of about $600
γ	0.19	Pecuniary penalty for bad credit
τ	0.02	Intermediation cost

This table describes the baseline parameterization of the model. The parameters in the bottom panel are set to match some of the moments reported in Table 2.

Table 2: Calibration Targets

Moment	**Source**	**Data (%)**	**Model (%)**
Unsecured debt to output	SCF	0.62	0.63
Default Rate (Chapter 7)	ABI	0.80	0.62
% HH with negative netwealth	SCF	8.63	9.83
Risk-Free interest rate	3m Tbill	4	4
Average Spread	FED	9.44	9.11
Bankruptcy fee ($)	White (2007)	600	600

This table reports the data targets used to calibrate the model (sample period: 1990-2004) as well as the corresponding model values and the sources for the data moments. SCF refers to the Survey of Consumer Finances, and ABI refers to the American Bankruptcy Institute. Details on the calculations of the moments are provided in the Data Appendix.

Table 3: Stationary Wealth Distribution

	Q1	Q2	Q3	Q4	Q5	Top 10%	Top 5%	Top 1%
Model (%)	-0.21	1.14	7.04	19.81	72.22	51.12	34.12	11.22
Data (%)	-0.20	1.37	4.99	12.35	81.50	68.49	56.47	32.79

The first five columns represents the model-generated moment and the data counterpart to the average wealth in each quintile of the wealth distribution. Similarly, the last three columns represent the average wealth of the households in the top quantiles of distribution. Details on the construction of the wealth quintiles, based on the Survey of Consumer Finances, can be found in the Data Appendix.

Table 4: Permanent Credit Tightening: Long-run Effects

	$\tau = 2\%$	$\tau = 4.46\%$
Unsecured debt to output	0.63	0.17
Default Rate	0.62	0.22
Perc. HH with negative netwealth	9.83	3.77
Average Spread	9.11	11.11
Aggregate Consumption	1	1.0003
% of HH with Default Probability $< 5\%$	8.8	15.7
% of HH with $5\% \leq$ Default Probability $\leq 10\%$	90.8	84.0
% of HH with Default Probability $\geq 5\%$	0.3	0.3

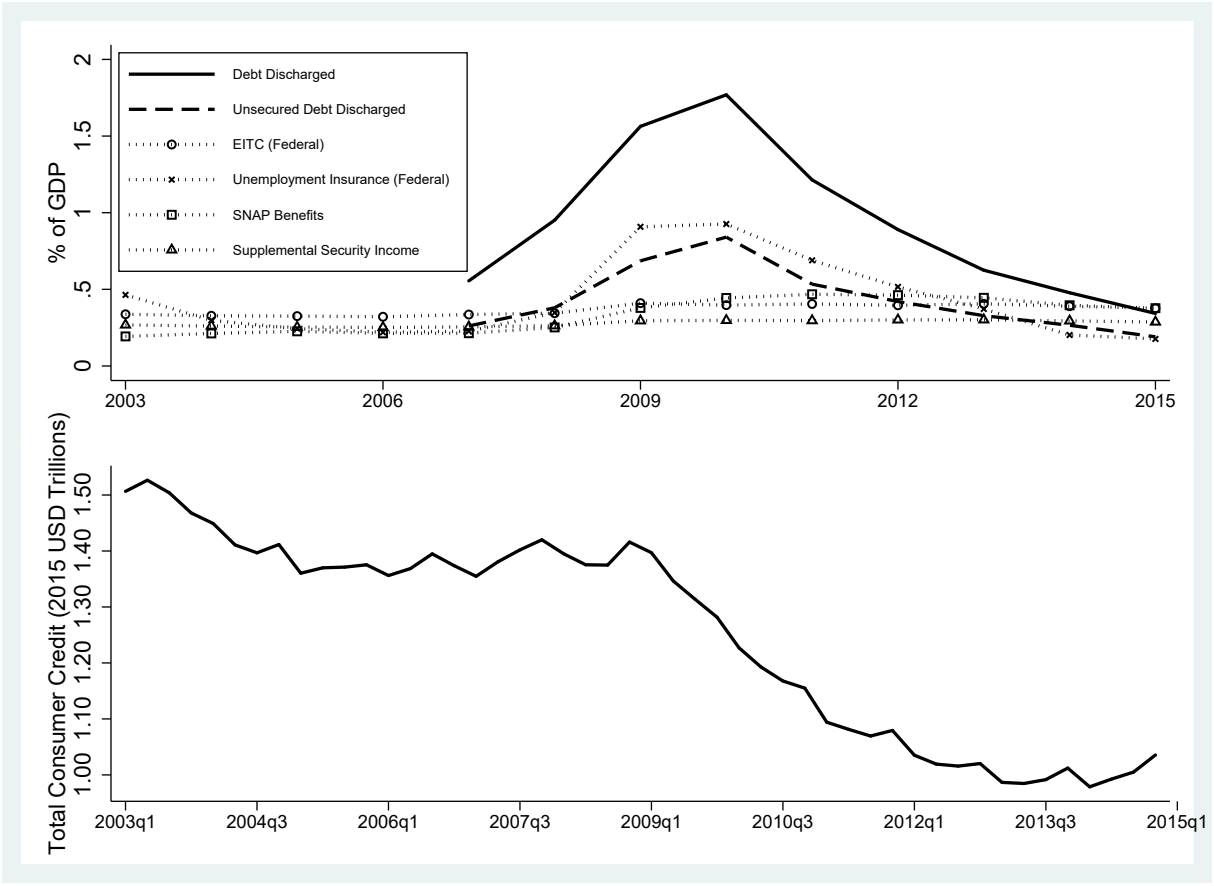
This table compares outcomes in the initial steady-state and in the final steady-state. The default rate represents the share of the entire population of households that default on their debt in a given period. The spread represents the average difference between the loan and the risk-free rates, weighted by the number of loan contracts. Aggregate consumption is normalized to one in the first equilibrium ($\tau = 2\%$).

Table 5: Welfare Effects of Tighter Credit

Income Pctile	Q1	Q2	Q3	Q4	Q5
Long Run	0.38	0.18	0.06	-0.01	-0.05
Tighter Credit	-0.28	-0.07	-0.03	-0.01	-0.02
No Default in t=1	-2.83	-0.23	-0.03	-0.01	-0.02
BAPCPA	-0.33	-0.08	-0.03	-0.01	-0.02
Group	Avg. Gain	Savers	Borrowers	Def. Switchers	
Tighter Credit	-0.08	-0.04	-0.45	-0.47	
No Default in t=1	-0.62	-0.11	-5.31	-	
BAPCPA	-0.09	-0.05	-0.55	-1.00	

Welfare gains for each group are computed as the percentage point equivalent increase in steady-state consumption. The columns Q1-Q5 represent each quintile of the labor income distribution. The first row represents the total welfare in the final stationary equilibrium relative to the first steady-state (in consumption equivalent terms). The rows label "Tighter Credit" represent the baseline credit shock scenario, where τ suddenly rises from 2% to 4.46%. The rows titled "No Default in t = 1" represent welfare changes in response to the baseline credit shock, but default is prohibited in the first transition period. The columns titled "BAPCPA" also represent welfare changes in response to the same credit shock, but two periods after a bankruptcy reform increases the parameter ϕ by 50%. Def. Switchers refers to the households who default in the period when the credit shock materializes, but would not have filed for bankruptcy in its absence.

Figure 1: Bankruptcy as an Insurance Mechanism and Consumer Credit

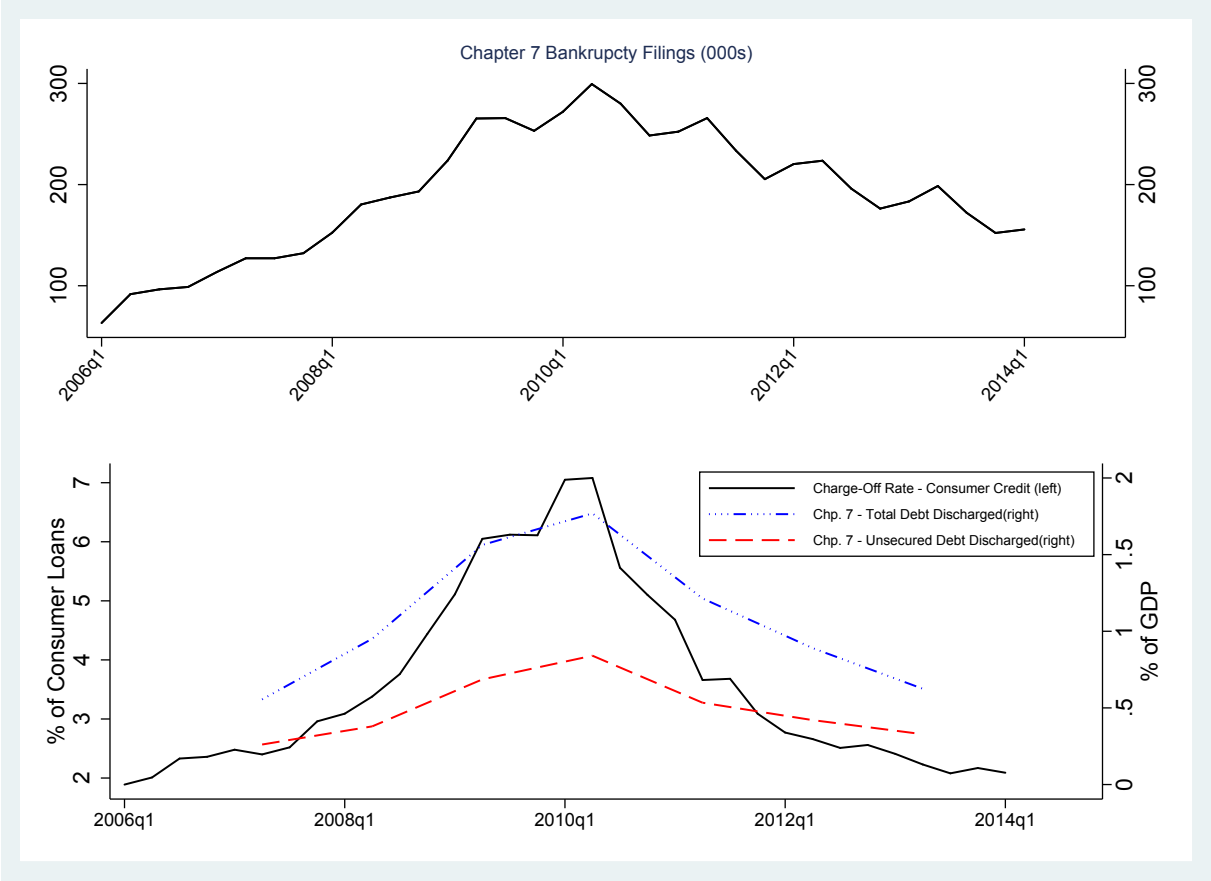


Top Panel: Total (solid line) and unsecured (dashed line) debt discharged and the following total Federal expenditures in each category of insurance mechanism: Earned Income Tax Credit (dotted-circle line), Supplemental Nutrition Assistance Program (dotted-square line), Unemployment Insurance (dotted-cross line), and Supplemental Security Income (dotted-triangle line). All series are reported as a share of GDP.
Bottom Panel: Consumer credit, measure in trillions of 2015 US dollars, CPI deflated. See Data Appendix for data sources and construction.

Figure 2: Lending Standards and Credit Spreads

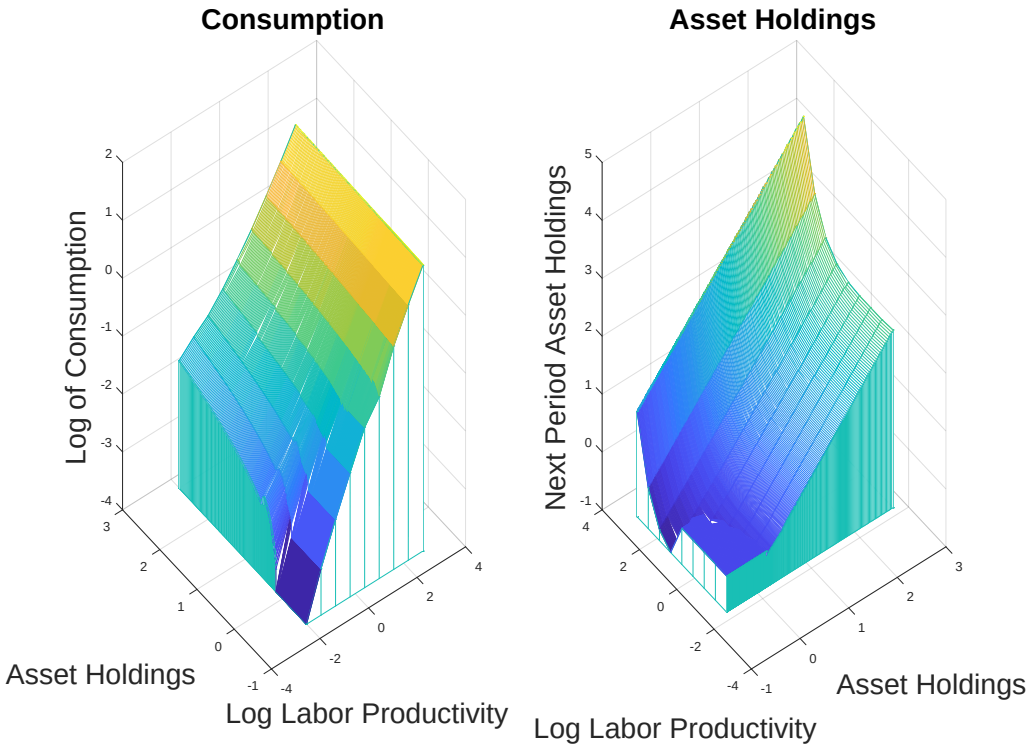
Top Panel: The Senior Loan Opinion Survey on Bank Lending; The credit tightening index is constructed as following: let $x \in \{-1, 0, 1\}$ be the variable that represents the change in bank lending standards. It equals minus unity if a bank report either having "tightened considerably" or "tightened somewhat" in that period. Similarly, it equals zero if standards have not change, and one otherwise. In every period, the plotted lines of the top panel represent the average of x across the surveyed banks.
Bottom Panel: Interest rates spreads on personal loans (red dashed line), all credit cards (black solid line), and credit cards with assessed interest (blue dot-and-dashed line). The spread is calculated by subtracting the 3-month Treasury bill rate from the respective consumer credit rate. See Data Appendix for data sources and construction.

Figure 3: Bankruptcy and Charge-Offs



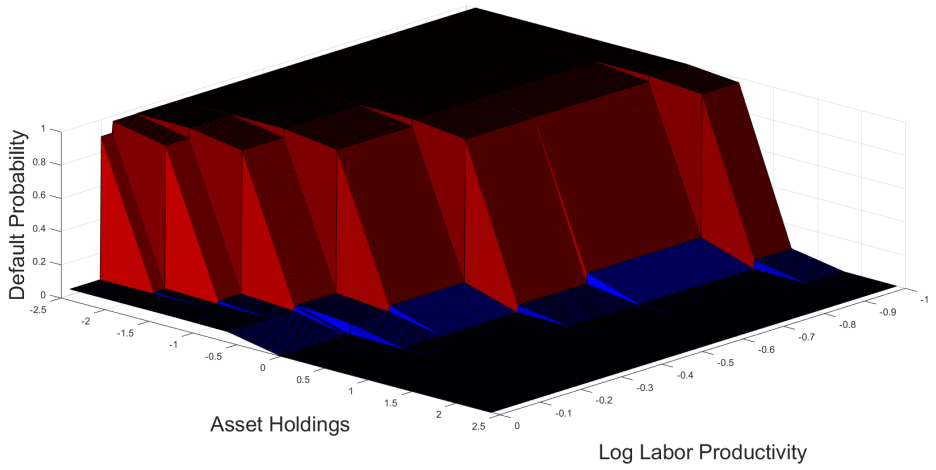
Top panel: number of Chapter 7 non-business bankruptcy fillings relative to the number of households in the US; Source in data Appendix.
Bottom panel: Charge-off rates correspond to the percentage of outstanding consumer credit balances which the largest 100 banks (by assets) write off as noncollectable. Total Debt Discharged, following the US Bankruptcy Code (28 U.S.C. 159(c)(3)(C)), corresponds to the "the aggregate amount of debt discharged in cases filed during the reporting period, determined as the difference between the total amount of debt and obligations of a debtor reported on the schedules and the amount of such debt reported in categories which are predominantly nondischargeable". Unsecured debt comprises the subset of total debt that is not backed by collateral - typical examples of dischargeable unsecured debt are credit card debts and medical bills. Sources in data Appendix.

Figure 4: Asset Policy Functions



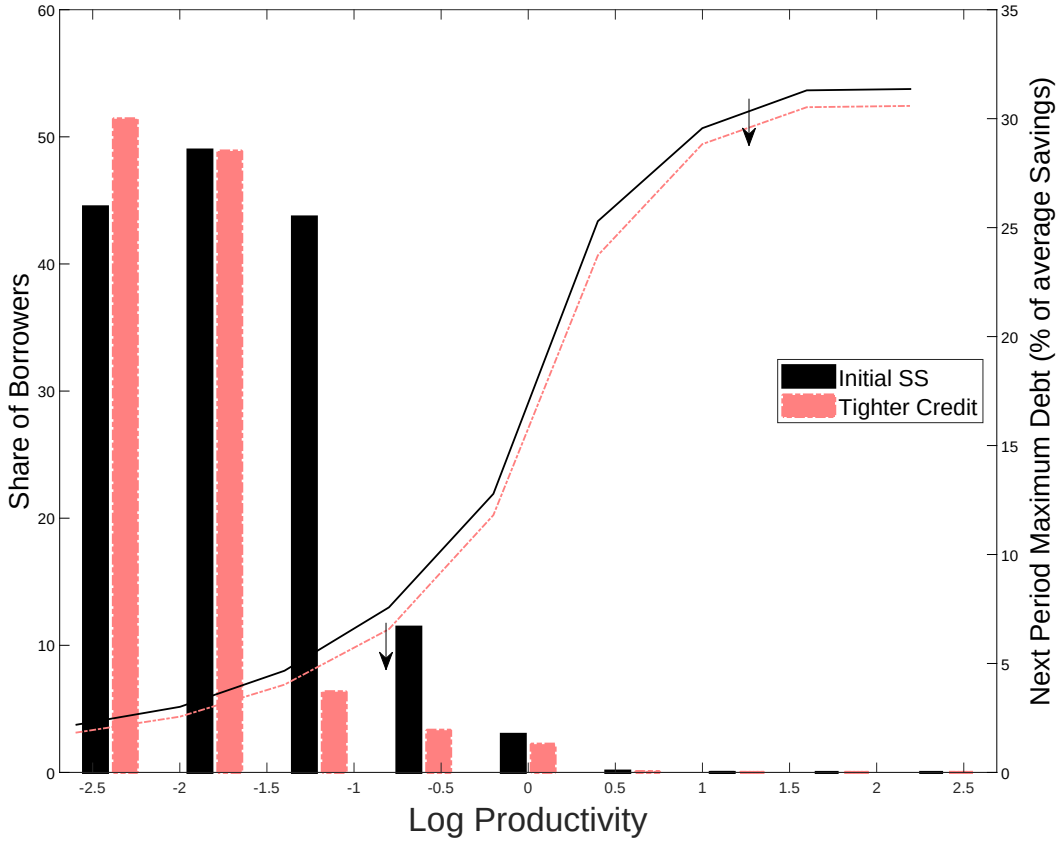
This figure plots the stationary equilibrium policy for consumption (left) and savings/loans (right), as a function of asset holdings and (the log of) labor productivity. The flat line on the right figure represents the consumers who default on their debt, and thus implicitly choose $a' = 0$.

Figure 5: Equilibrium Default Probabilities



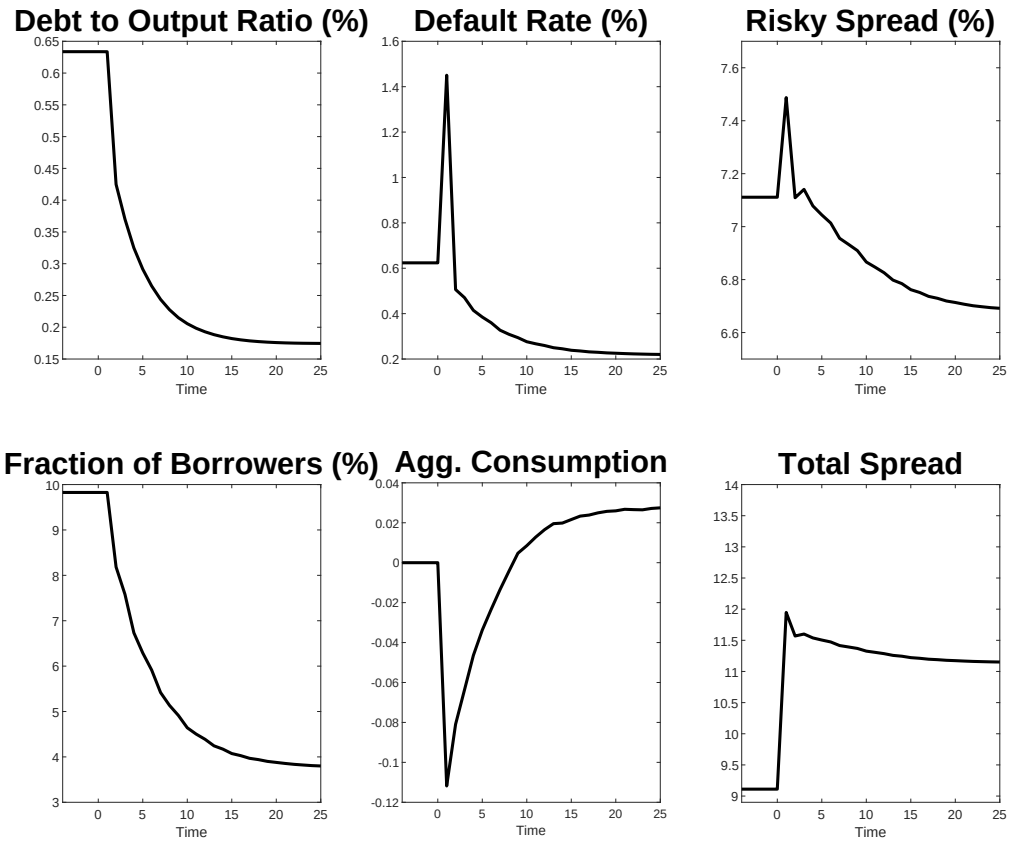
This figure plots the next period default probabilities as a function of current assets and (the log of) labor productivity.

Figure 6: Credit Limits and Share of Borrowers by Productivity



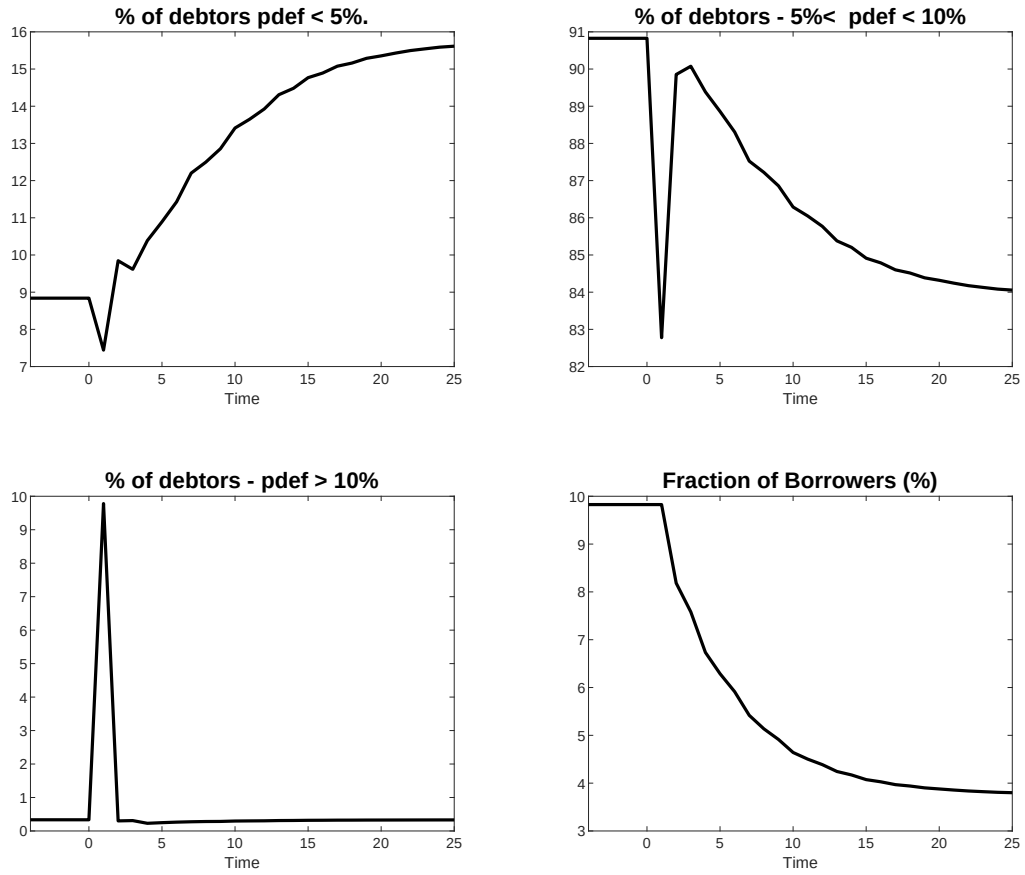
The lines depict the maximum cash that can be obtained through a loan for each household productivity level (right axis) for each stationary equilibrium. The bars represent the share of borrowers for each productivity level across equilibria.

Figure 7: Benchmark Shock - Credit Indicators



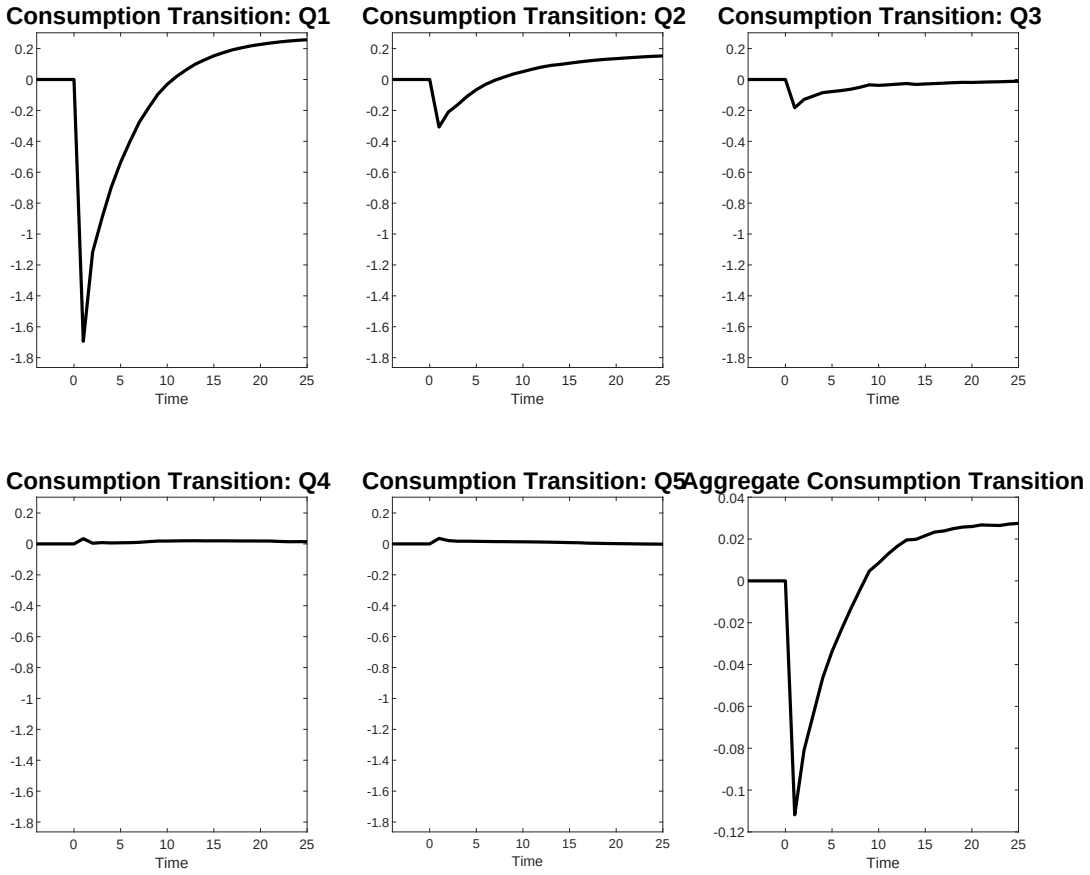
This figure depicts the transitional dynamics in response to the baseline credit shock. The default rate represents the share of the entire population of households that default on their debt in a given period. The total spread represents the average difference between the loan and the risk-free rates, weighted by the number of loan contracts, while the risky spread subtracts τ from the total spread.

Figure 8: Benchmark Shock - Default Probabilities



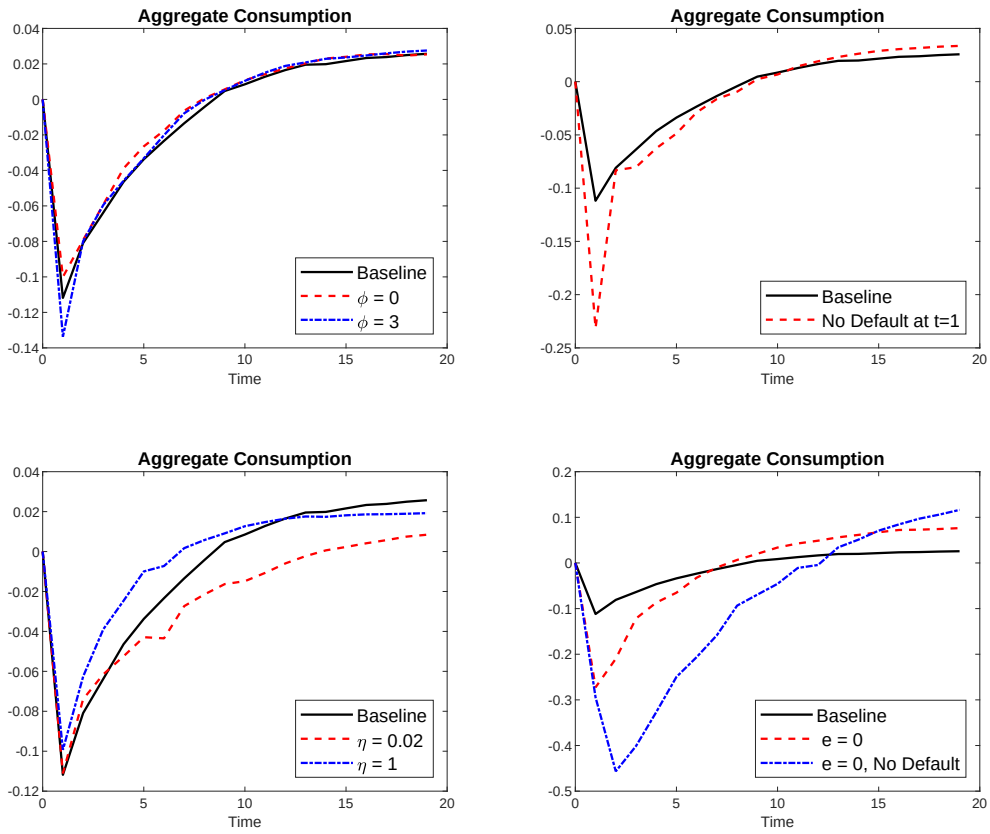
This figure depicts the transitional dynamics in response to the baseline credit shock. The "% of debtors pdef $< 5\%$" represents the percentage debtors whose probability of default (in the next period) is below 5%. '% of debtors $5\% <$ pdef $< 10\%$" represents the share of debtors whose next period default probabilities lie between 5% and 10%, whereas "% of debtors - pdef $> 10\%$" represents the share of debtors with default probability larger than 10%.

Figure 9: Benchmark Shock - Consumption Transition



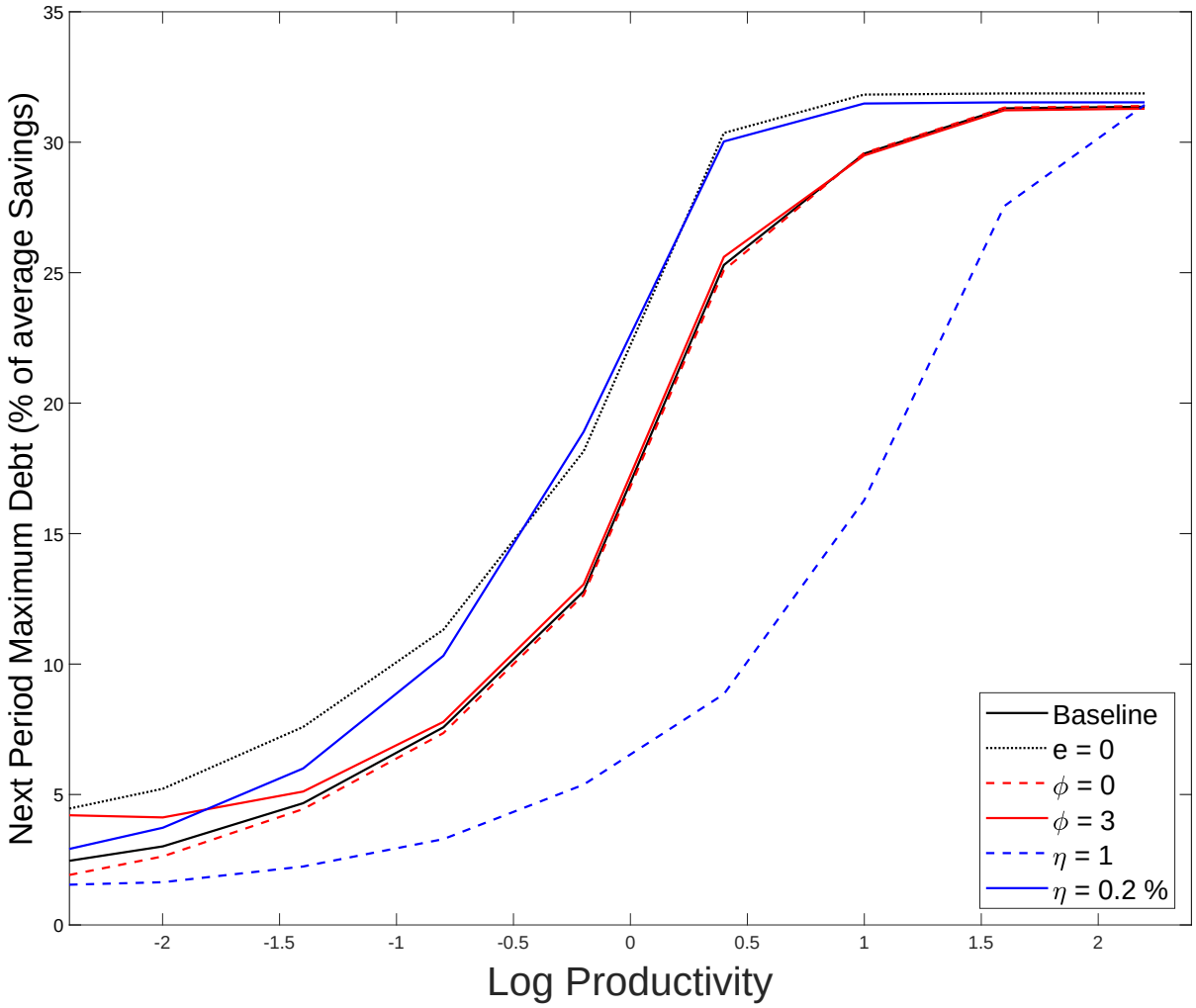
This figure depicts the transitional dynamics of consumption in response to the baseline credit shock. The panels labeled Q1-Q5 depict the evolution of the average consumption of the respective labor income quintile.

Figure 10: Aggregate Consumption and Bankruptcy Settings



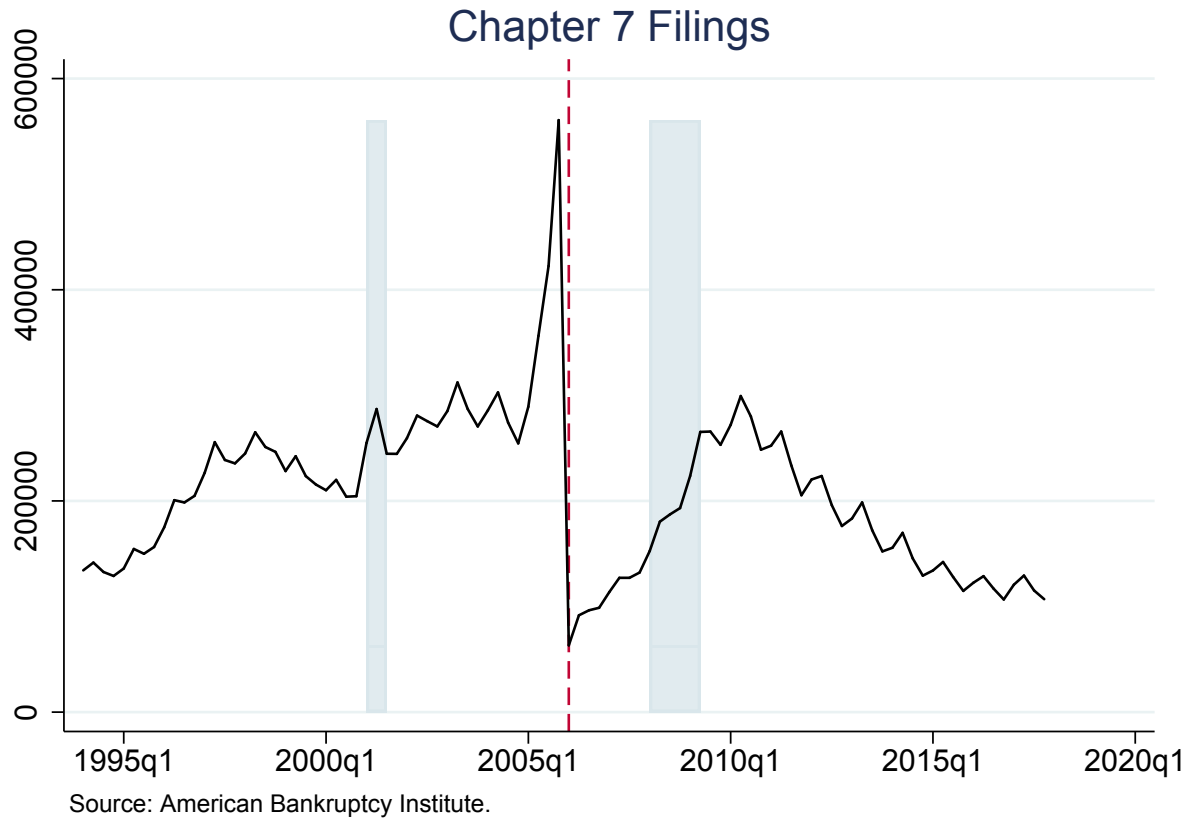
This figure depicts the transitional dynamics of consumption in response to the *same* baseline credit shock under several different initial steady-states. The bottom-left panel represents initial differences in ϕ. The top-right panel compares the baseline case with one in which default in the first period of the transition is prohibited. The bottom-left panel represents different scenarios in terms of bad credit score duration. Finally, the bottom-right panel compares the baseline transition with an economy without expense shocks, along with an economy without expense shocks and where default is not available.

Figure 11: Credit Limits and Cost of Filing for Bankruptcy



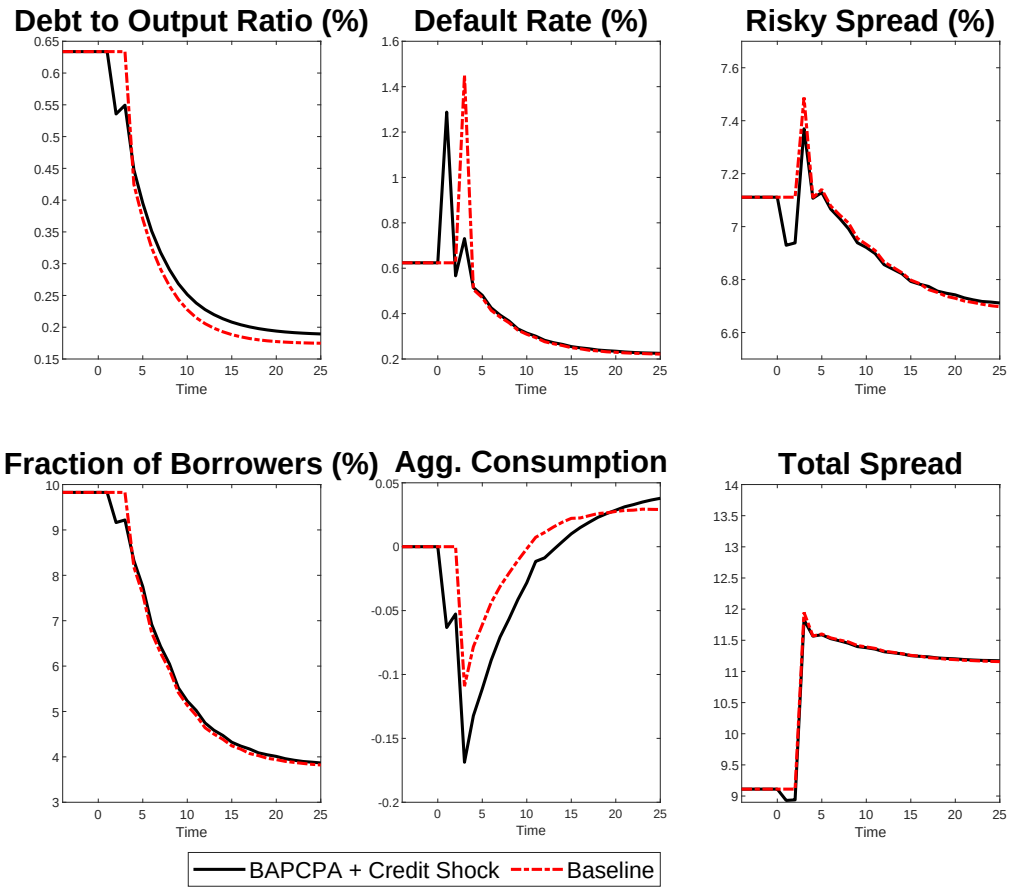
The lines depict the maximum cash that can be obtained through a loan for each household (log) productivity level for each corresponding stationary equilibrium.

Figure 12: BAPCPA Reform and Bankruptcy



This figure represents the evolution of the quarterly number of Chapter 7 bankruptcy filings. The red-dashed line marks the quarter when the reform took effect (the precise date is October 17, 2005).

Figure 13: BAPCPA Reform and the Credit Supply Shock - Credit Indicators



The black line depicts the transitional dynamics in response to two shocks. In period zero, it is revealed that BAPCPA will come into effect in the next period (ϕ increases by 50%). In addition, in period three the intermediation cost τ unexpectedly rises from 2% to 4.46%. The red-dashed line depicts the transitional dynamics in response to the baseline credit shock, which in this case is revealed (and realized) in period three. The default rate represents the share of the entire population of households that default on their debt in a given period. The total spread represents the average difference between the loan and the risk-free rates, weighted by the number of loan contracts, while the risky spread subtracts τ from the total spread.

Appendix A: Equilibrium Conditions

Observe first that, given $h_{d,t} = h_{d,t}(x_t, s_t, \lambda_t)$, there is an endogenous transition probability from the current credit score to the future credit score that can be defined by

$$\mathcal{P}(s_t, s_{t+1}; h_{d,t}) = \begin{cases} 1 & \text{if } s_t = 0 \text{ and } s_{t+1} = 0 \text{ and } h_{d,t} = 0 \\ 0 & \text{if } s_t = 0 \text{ and } s_{t+1} = 1 \text{ and } h_{d,t} = 0 \\ 0 & \text{if } s_t = 0 \text{ and } s_{t+1} = 0 \text{ and } h_{d,t} = 1 \\ 1 & \text{if } s_t = 0 \text{ and } s_{t+1} = 1 \text{ and } h_{d,t} = 1 \\ \eta & \text{if } s_t = 1 \text{ and } s_{t+1} = 1 \\ 1-\eta & \text{if } s_t = 1 \text{ and } s_{t+1} = 0 \ . \end{cases}$$

Let $Q_t(x_t, s_t, \lambda_t, C; h_{a,t}, h_{d,t})$ be the endogenous transition probability of the households' state vector. It describes the probability that a household with state (x_t, s_t) will have a state vector lying in $C \in \Upsilon$ next period, given the current asset distribution λ_t and policy functions $h_{a,t}$ and $h_{d,t}$. Therefore,

$$Q_t(x_t, s_t, \lambda_t, C; h_{a,t}, h_{d,t}) = \sum_{(x_{t+1}, s_{t+1}) \in \mathcal{U}: (h_{a,t}, s_{t+1}) \in C} \mathcal{P}(z_t, z_{t+1}) \mathcal{P}(, e_{t+1}) \mathcal{P}(s_t, s_{t+1}; h_{d,t}) \, .$$

The aggregate law of motion implied by transition function Q_t is an object $\Lambda_t(\lambda_t, Q_t)$ that assigns a measure to each Borel set C. It can be computed as

$$\Lambda_t(\lambda_t, Q_t)(C) = \int_{\mathcal{U}} Q_t(x_t, s_t, \lambda_t, C; h_{a,t}, h_{d,t}) d\lambda_t \, . \tag{12}$$

We are now in a position to define the competitive equilibrium for this economy.

Definition Given initial aggregate capital, K_0, measure of asset holdings, λ_0, bank bond holdings, $B_0 = 0$, and an exogenous spread τ, a *competitive equilibrium* consists of:

A set of strictly positive paths for prices, $\{w_t, r_t^K, r_t\}_{t=0,\ldots,\infty}$;

a set of non-negative paths for loan and deposit rates, and default probabilities,

$$\left\{q_{a_{t+1}, z_t}, p_{a_{t+1}, z_t}\right\}_{(a_{t+1}, z_t) \in \mathcal{A} \times \mathcal{Z},\, t=0,\ldots,\infty} ;$$

a non-negative path for the service providers markup, $\{m_t\}_{t=0,\ldots,\infty}$;

a set of strictly positive paths for aggregate capital and labor, $\{K_t, N_t\}_{t=0,\ldots,\infty}$;

a non-negative path for contract quantities, $\{A_{a_{t+1}, z_t}\}_{(a_{t+1}, z_t) \in \mathcal{A} \times \mathcal{Z},\, t=0,\ldots,\infty}$;

a path for bank bond holdings, $\{B_t\}_{t=1,\ldots,\infty}$;

a set of decision rules, $\{h_{a,t}, h_{c,t}, h_{d,t}\}_{t=0,\ldots,\infty}$; and

a path for the probability measure, $\{\lambda_t\}_{t=1,\ldots,\infty}$,

such that, in every period t:

1. The decision rules $h_{a,t}$, $h_{c,t}$ and $h_{d,t}$ solve the households' optimization problem;
2. The aggregate capital K_t and labor N_t inputs solve the optimization problem of the firm;
3. Aggregate capital K_{t+1} and number of contracts A_{a_{t+1},z_t} solve the bank's optimization problem;
4. The rates of default p_{a_{t+1},z_t} are consistent with the household's default decision rule $h_{d,t}$;
5. The service providers markup m_t ensures zero profits, such that (11) is satisfied;
6. The labor market clears, $N_t = \int_X z_t d\lambda_t$;
7. The credit market clears, $\int_{\mathcal{U}} \mathcal{I}_{\{h_{a,t}(x_t,s_t,\lambda_t)=a_{t+1}\}} d\lambda_t = A_{a_{t+1},z_t}$ for all a_{t+1} and z_t;
8. The bond market clears, $B_{t+1} = 0$;
9. The goods market clears,

$$AK_t^{\alpha} N_t^{1-\alpha} + (1-\delta)K_t = \int_{\mathcal{U}} h_{c,t}(x_t, s_t, \lambda_t) d\lambda_t + \int_{\mathcal{U}} h_{a,t}(x, s_t, \lambda_t) d\lambda_t + \gamma w_t \int_{s_t=1} z_t d\lambda_t + \int_{\mathcal{U}} \frac{e_t}{m_t} d\lambda_t \,.$$

10. The aggregate law of motion implied by the individual decision rules, $T_t(\lambda_t, Q_t)$, is consistent with the household's aggregate forecasting rule, Λ_t. That is, for every Borel set C, the measure generated by the aggregate motion equation, $\lambda^*_{t+1}(C) = T_t(\lambda_t, Q_t)(C)$, is equal to the measure associated with the aggregate forecasting rule, $\lambda_{t+1}(C)$, where $\lambda_{t+1} = \Lambda_t(\lambda_t)$.

Appendix B: Data series and sources

Data Used in the Calibration

- Proportion of consumers in debt: percent of households with negative net wealth (excluding those with net worth below $120,000). Source: Survey of Consumer Finance, average over years 1990-2004.

- Unsecured debt, as a fraction of average income: average amount of debt a relative to the gross domestic output per household (Figure 3, bottom panel, red line). Sources: Survey of Consumer Finances (net worth), Bureau of Economic Analysis (Table 1.1.5, per capita income), US Census (household count)

- Percentage of bankruptcy filers: number of Chapter 7 non-business bankruptcy fillings relative to the number of households in the US (Figure 3, top panel). Souces: US Courts for the bankruptcy fillings and US Census via HAVER (ticker: POPH@USECON). Average over years 1990-2004.

- Consumer credit spread: Difference between the *Finance Rater on Personal Loans at Commercial Banks, 24 Month Loan* (FED Board of Governors, G19) and the *3-Month Treasury Bill: Secondary Market Rate* (H.15, FED Board of Governors), both averaged within years. Average over years 1990-2004.

- Wealth Distribution Shares - calculated using the Survey of Consumer Finances. Average over years 1990-2004.

Other

- Lending Standards (Figure 2): The Senior Loan Opinion Survey on Bank Lending - tickers: SUBLPDCLCS_N.Q (Net percentage of domestic banks tightening standards for credit card loans) and SUBLPDCLXS_N.Q (Net percentage of domestic banks tightening standards for consumer loans excluding credit card and auto loans).

- Charge-off Rates (Figure 3): Board of Governors of the Federal Reserve System (US), Charge-Off Rate on Consumer Loans, Top 100 Banks Ranked by Assets (ticker: CORCT100N), retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/CORCT100N.

- Total Cases and Total Debt Discharged by Means of Chapter 7 (Figure 3, bottom panel) - BAPCPA Tables 1A. Total Debt Discharged corresponds to *Net Scheduled Debt*, ad Unsecured Debt Discharged corresponds to *Total Unsecured Debt Discharged*. Source: US Federal Courts.

- Insurance Mechanisms (Figure 1)

  - Earned Income Tax Credit Series (Annual): U.S. Department of the Treasury. Internal Revenue Service, Individual Income Tax Filing: Earned Income Credit [ENINCCTA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/ENINCCTA.

  - Supplemental Nutrition Assistance Program (SNAP) Series (Annual): U.S. Bureau of Economic Analysis, Government social benefits: To persons: Federal: Supplemental Nutrition Assistance Program (SNAP) [TRP6001A027NBEA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TRP6001A027NBEA.

  - Supplemental Security Income Series (Annual): U.S. Bureau of Economic Analysis, Government social benefits: To persons: Federal: Supplemental security income [TRP7001A027NBEA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/TRP7001A027NBEA.

  - Unemployment Insurance Series (Annual): U.S. Bureau of Economic Analysis, Personal current transfer receipts: Government social benefits to persons: Unemployment insurance [W825RC1A027NBEA], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/W825RC1A027NBEA.

- Gross Domestic Product Series (U.S. Bureau of Economic Analysis, Real Gross Domestic Product [GDPC1], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/GDPC1.)

- Credit Volumes: New York Fed Consumer Credit Panel. The series consists of credit card debt and "other" credit categories, which includes consumer finance (sales financing, personal loans) and retail (clothing, grocery, department stores, home furnishings, gas etc) loans. The series is deflated by the CPI.

- Consumer Price Index: Organization for Economic Co-operation and Development, Consumer Price Index: Total All Items for the United States.

Appendix C: Additional Figures and Tables

Table C1: Idiosyncratic Labor Productivity Shock

z	$\mathcal{P}(z, z')$								
0.0909	0.9227	0.0746	0.0026	0.0001	0.0000	0.0000	0.0000	0.0000	0.0000
0.1655	0.0093	0.9234	0.0653	0.0020	0.0000	0.0000	0.0000	0.0000	0.0000
0.3014	0.0001	0.0186	0.9239	0.0560	0.0014	0.0000	0.0000	0.0000	0.0000
0.5490	0.0000	0.0003	0.0280	0.9242	0.0466	0.0009	0.0000	0.0000	0.0000
1.0000	0.0000	0.0000	0.0006	0.0373	0.9243	0.0373	0.0006	0.0000	0.0000
1.8214	0.0000	0.0000	0.0000	0.0009	0.0466	0.9242	0.0280	0.0003	0.0000
3.3174	0.0000	0.0000	0.0000	0.0000	0.0014	0.0560	0.9239	0.0186	0.0001
6.0421	0.0000	0.0000	0.0000	0.0000	0.0000	0.0020	0.0653	0.9234	0.0093
11.0048	0.0000	0.0000	0.0000	0.0000	0.0000	0.0001	0.0026	0.0746	0.9227

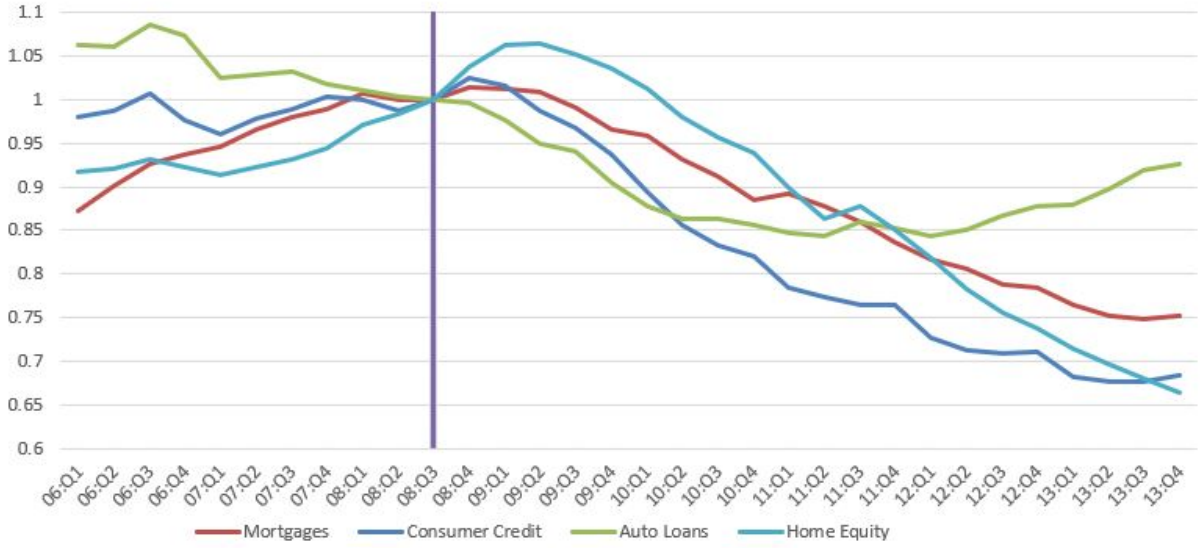
Vector with discrete values for idiosyncratic productivity and Markov matrix using Rouwenhorst's method of discretization, arranged so that the current state varies across rows and the next state varies across columns.

Table C2: Expense Shock

e	$\mathcal{P}(e, e')$	
0.0000	0.9244	0.0756
0.2830	0.9244	0.0756

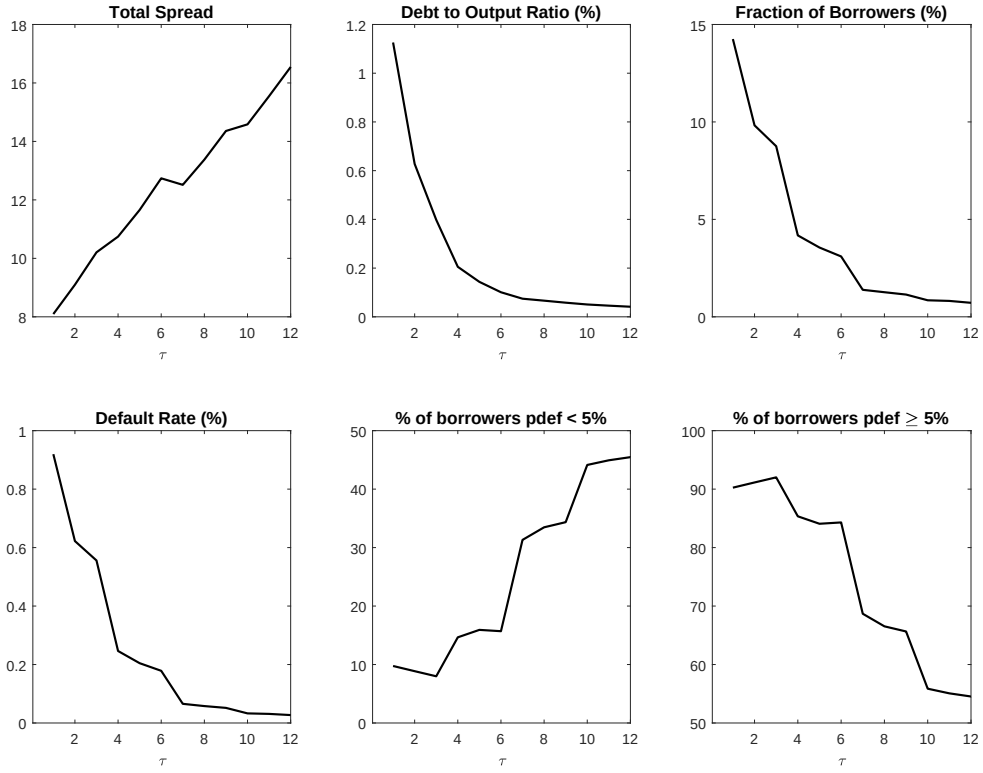
Vector with discrete values for expense shocks and Markov matrix arranged so that the current state varies across rows and the next state varies across columns.

Figure C1: Household debt



Each line depicts the evolution of the aggregate amount of the corresponding indicator in the US economy as a percentage of Gross Domestic Output, normalized to one in the outset of the financial crisis (purple-vertical line). Source: The New York FED Consumer Credit Panel.

Figure C2: Comparative Statics - Baseline Model



This figure plots outcomes of several steady-states in model-economies who differ only in their intermediation cost τ. The default rate represents the share of the entire population of households that default on their debt in a given period. The total spread represents the average difference between the loan and the risk-free rates, weighted by the number of loan contracts. The "% of borrowers pdef $<$ ($\geq$)5%" represents the percentage of debtors whose next-period default probability is below (more or equal to) 5%.