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Fakultät für Wirtschaftswissenschaften
Facoltà di Economia
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BEMPS –
Bozen Economics & Management
Paper Series

NO 90/ 2022

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January 28, 2022

Abstract

In this article, we integrate a collateral constraint into a model with heterogeneous agents to study the effect of collateral on wealth inequality. We use estimates from US microeconomic data and the simulated time series from our macro model to predict the wealth accumulation response at the top and bottom of the personal income distribution. Debt is modelled as collateral-dependent and its concentration poses a serious concern. Our results indicate that high collateral requirements benefit high-income more than low-income households.

Keywords: Income distribution, household loans, collateral, inequality

JEL Codes: E21, E25, D31, H31

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1 Introduction

One of the oldest and most contentious themes of public debate in the United States is what causes wealth inequality. One theory is that wealth disparity is thought to be linked to a higher level of debt. Indeed, Mian et al. (2020) looked at the rise in wealth inequality in the US and found that those at the extreme bottom of the distribution are heavily leveraged. Still, this literature is lacking empirical investigation of how debt concentration may affect wealth accumulation and worsen wealth inequality. Furthermore, in a society with collateral-constrained agents, households with high default risk and weaker collateral can borrow if collateral requirements become sufficiently loose. As a result, debt concentration among such borrowers can harm household wealth and exacerbate economic disparities. Our contribution is, therefore, to provide a novel transmission channel of debt on wealth accumulation and investigate the effects of changes in collateral requirements on wealth inequality.

Motivated by these observations, we developed a macroeconomic model with heterogeneous agents. The key ingredient is a collateral constraint, which is crucial to uncover the rise in income and wealth inequality. The collateral constraint works as follows: a household takes out a loan and offers collateral to secure the debt. If the borrower fails to repay, the creditor can seize the collateral. Posting funds against a loan can be the most effective way to reduce debt risk for banks, but this is not beneficial for households with limited collateral or high default risk. If banks lend, particularly to low-income individuals with a high level of uncollectible debt, this will hurt household wealth, contribute to rising regional imbalances, and exacerbate societal inequality.

Our model features households that consume, supply labour, accumulate bonds, and have access to loans, but face collateral constraints that limit their borrowing capacity. First, we consider the transmission of a collateral requirement shock to household borrowing. We extend this analysis to study the impact of collateral and personal debt on household wealth. Moreover, we focus on the relationship between household debt and household

wealth using bank microdata, household-level data and aggregate regional data. We also estimate the influence of household loans on wealth accumulation. By aggregating the bank-level data by the year and state, we classify observations into those with a per capita income below (low-income states) or above (wealthiest states) the US national average. The data suggest a significant positive relationship between household debt and wealth accumulation in wealthy regions and a significant positive but modest relationship between household debt and wealth accumulation in low-income regions.

Second, we simulate the model under two alternative environments: a tight and a loose collateral requirement regime. The simulated dynamic effects of a high collateral requirement on wealth accumulation are contrasted with the scenario in which the collateral requirement is low. By comparing these scenarios, we empirically analyse the impact of household borrowing on wealth. We use the estimated coefficients from microdata and the macro model to predict the responses of wealth accumulation in low-income and high-income states. Our results indicate that the level of wealth variation for the top of the income distribution (wealthiest states) is always better off under a high collateral requirement. In contrast, individuals within the low-income states (bottom of the income distribution) have a higher level of wealth accumulation when the collateral requirement is high, but the effect is considered modest. Our analysis supports the claim that higher bank lending to households in low-income regions may exacerbate wealth inequality. Finally, the heterogeneity in the consequences of debt on wealth accumulation implies that the geographic distribution of debt and its concentration across the United States should be subject to consideration in any reformulation of location-based policies that have the potential to reduce inequality.

Literature Review

A number of recent contributions to the literature have extended the standard macroeconomic frameworks to allow for heterogeneity, including contributions by Cloyne et al.

(2016) for heterogeneity in household income and wealth[1] and Iacoviello (2015) for heterogeneity in the household desire to save. The work by Krueger et al. (2016) serves as another example, citing the importance of household heterogeneity for the propagation of macroeconomic shocks. An influential paper by Krusell and Smith (1998) considers a standard macroeconomic model that includes an idiosyncratic income shock. Their model generates an endogenous distribution of wealth across consumers.[2] The present model also features heterogeneity in household income and contributes to this literature by including empirical evidence of increasing wealth inequality[3] and extensively discusses the link between household debt, wealth, and income distribution using microdata.

This paper is related to the literature that focuses on household wealth. Important assessments include those by Mian and Sufi (2014), who addressed the role of housing net worth in generating a high unemployment level. Moreover, Mian et al. (2013) considered the geographical distribution of wealth shocks to understand the sharp decline in consumption, using variations in housing net worth across zip codes to evaluate the responses of consumption to changes in wealth. Iacoviello (2008) showed that rises in income inequality lead to an increase in debt.[4] A great deal of literature concerns the relationship between consumption inequality and income inequality, such as Attanasio and Pistaferri (2016), Aguiar and Bils (2015), Blundell et al. (2008), Krueger and Perri (2005), and Treeck (2014). The main contribution of this paper is that we estimate the transmission channel of debt on wealth accumulation and investigate the implications of variations in collateral requirements on household wealth accumulation. We also document that geographical disparities in debt and income lead to different degrees of

[1] See also Heathcote and Perri (2018), who explored heterogeneity in wealth and its implications for aggregate saving. Gabaix et al. (2016), who studied the dynamics of inequality by allowing for heterogeneity in the standard deviation of income innovations.

[2] For a review of this literature, see Heathcote et al. (2009)

[3] Numerous studies have addressed the relationship between debt and inequality. For example, see Mian et al. (2020) who explored the relationship between saving and debt accumulation, Kuhn et al. (2019) who studied the trends in income and wealth inequality, and Miranda-Pinto et al. (2020) who presented evidence that high inequality and high debt weaken the effects of government spending on consumption.

[4] More recently, Auclert and Rognlie (2020) investigated the output effects of inequality.

impact of collateral conditions in the macroeconomy.

This paper is also related to the recent literature on the propagation of shocks in heterogeneous agent models. For instance, Kaplan et al. (2018) focused on the transmission of monetary policy in a heterogeneous agent model with nominal rigidities. Berger et al. (2019) reviewed how imperfect risk sharing affects the propagation of aggregate shocks. Further, Kaplan and Violante (2014) developed a standard incomplete market life cycle framework where households can hold two assets: liquid and illiquid. Kaplan and Violante (2014) studied the effects of fiscal stimulus on consumption and found that a tax rebate and the presence of wealthy hand-to-mouth households amplify aggregate consumption responses. In contrast, the responses of consumption to the fiscal stimulus are lower in a calibrated one-asset model.[5]

Several papers have investigated the implications for the transmission of a credit-constraint shock on the macroeconomy. Guerrieri and Lorenzoni (2017) interrogated the effect of the credit crunch in the context of incomplete market models. Guerrieri and Iacoviello (2017) evaluated the impact of housing booms and busts with a collateral constraint that binds occasionally. Buera and Moll (2015) used wedges in a representative agent model where heterogeneity is essential and found that a credit crunch leads to efficiency in wedges if the productivity of final goods producers is heterogeneous. Buera and Moll (2015) emphasised that the effect of the credit crunch on aggregate variables depends crucially on the level of heterogeneity. Comparable work has been carried out by Jones et al. (2019), who assessed the responses of consumption and employment to a credit crunch. Jones et al. (2019) developed a monetary union model with a large number of states and combined state-level data with aggregate-level data to estimate the model, and focused on household leverage and the sensitivity of consumption and employment to a tightening of credit constraints. These papers take a more general approach in analysing the impact of the credit crunch. Our study, focuses instead on the implications

[5] For a recent study of an incomplete markets model with aggregate shocks, see Violante et al. (2020).

of collateral conditions on wealth. We assume that a borrower pledges collateral, which is equal to a fraction of their assets, and in the event of default, the bank seizes the collateral. Collateral condition implications are quite similar to credit shocks because a credit shock directly affects lending, whereas collateral has an indirect effect.

The paper is organised as follows. Section 2 provides a brief overview of the data. Section 3 describes the macroeconomic model, characterises the equilibrium, and lays out the data. Section 4 reviews the association between household debt and wealth accumulation using microeconomic data, and discusses the estimates of the debt effect on household wealth. The experiments on wealth accumulation representing a change in collateral conditions are provided in Section 5. Section 6 concludes the work.

2 Household Income and Debt in the United States

Wealth Inequality and Household Debt. Understanding the link between collateral constraint and inequality is not a trivial task. The channel proposed in this study is that debt which is collateral-dependent affects wealth accumulation, and the effect depends crucially on the income distribution–more specifically, the effect differs between high-income and low-income states. To shed light on the interaction between wealth inequality and household debt, we focus on interesting observations from the PSID. Figure 1 shows how wealth inequality has grown significantly in the United States in the last 10 years. The very top of households in the wealth distribution own a large share of wealth whereas the bottom 40% own only 1% of wealth, this is in good accordance with previous studies.[6] The expanding wealth inequality throughout the US coincides with growing household debt. Figure 2 reveals how household debt has been steadily rising from 1999 to 2017. As Figures 1 and 2 illustrate, wealth inequality was associated with a rise in household debt.

[6] See for instance Mian et al. (2020).

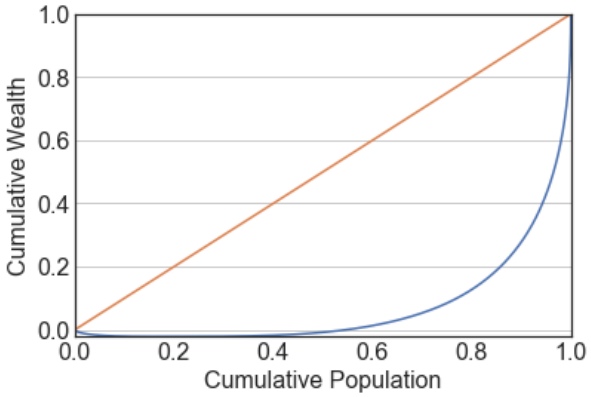

Figure 1: Lorenz Curve

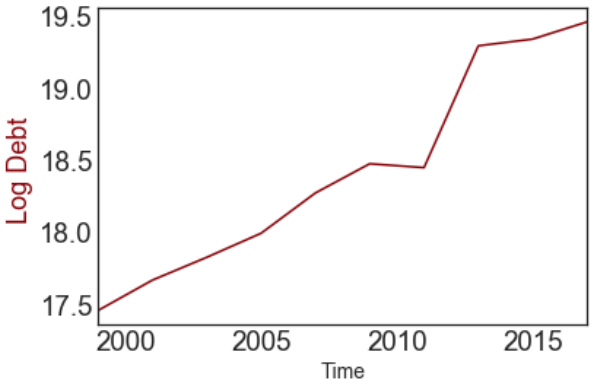

Figure 2: Debt Dynamics

Note: Based on the data from the Panel Study of Income Dynamics.

Income Inequality. While we focus on wealth inequality, it is useful to examine the evolution of personal income distribution in the United States. Figure 3 illustrates how high-income regions gained wealth between 2015 and 2018. In a span of four years, the distribution of aggregate personal income in the United States significantly shifted, particularly for high-income regions (right side of the figure 3), where aggregate personal income has increased considerably. The significant shift in income distribution from 2015 to 2018, reveals the extent to which income inequality is increasing in the United States.

Household Debt, Uncollectible Debt and Personal Income: High vs Low-income States. Recognising the growing wealth and income inequality that coincides with high levels of debt in the United States, Figure 4 illustrates a potential relationship between household loans and regional personal income from 2015 to 2018 (see Appendix E for details about the data). On the right side of the horizontal axis, the greatest values are about $2 trillion, which correspond to the aggregate personal income of California. The left side of the figure demonstrates that many states have personal incomes of less than $1 trillion. Perhaps surprisingly, there are more loans made in states with low-income than in the wealthiest states. The supply of loans to households is significantly higher in low-income regions, whereas the household debt level is relatively low in wealthy regions. One

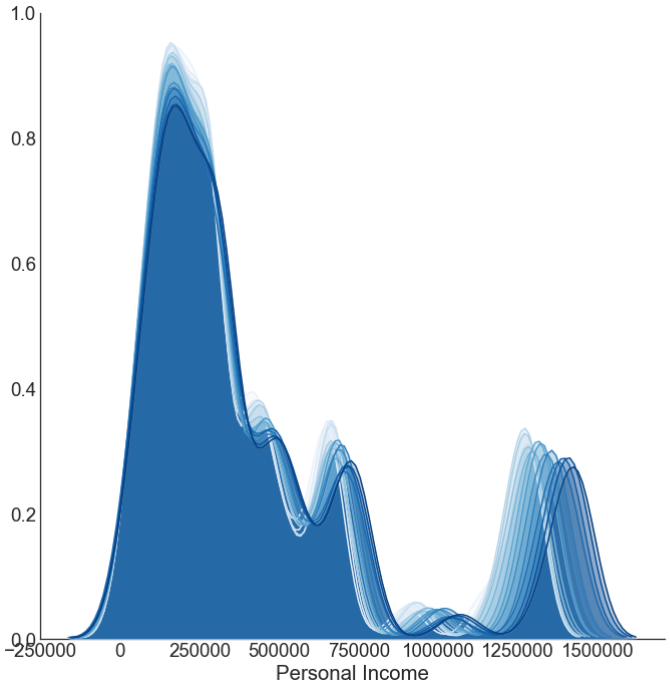

Figure 3: Evolution of Personal Income Distribution 2015 Q1–2018 Q4, State Level

Note: Distribution of aggregate personal income between 2015 Q1 and 2018 Q4. The lighter contour line corresponds to 2015 and the darker contour line corresponds to 2018. Data are reported in thousands of US dollars ($ in 000). Source: Bureau of Economic Analysis (BEA).

could interpret this as a banking sector policy to finance regions with lower revenues and overcome regional inequality. An alternative explanation is that impoverished people may need more external funds to achieve their desired level of consumption.

According to Mian et al. (2020), individuals at the bottom of the distribution are highly levered. The rich at the top 1% of wealth distribution saved more in financial assets and borrowed less whereas the bottom 90% saved substantially less and have a high level of debt. This is consistent with our observation that the supply of loans to households is significantly high in low-income regions whereas the individual debt level is relatively low in wealthy regions.

Figure 5 illustrates that the level of uncollectible debt is much higher in low-income regions than in high-income regions. Thus borrowers in economically depressed regions are more likely to default on their loans, which banks then classify as uncollectible debt.

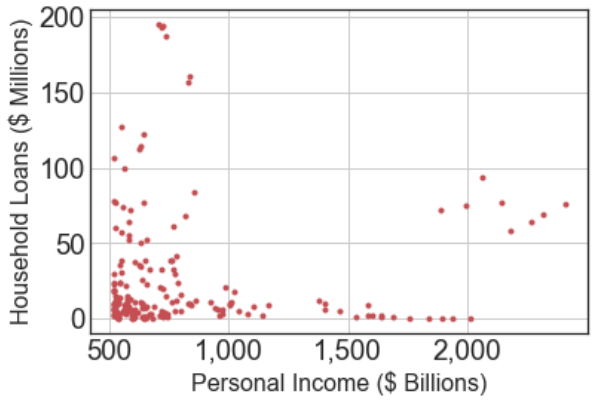

Figure 4: Household Loans and Personal Income, State Level

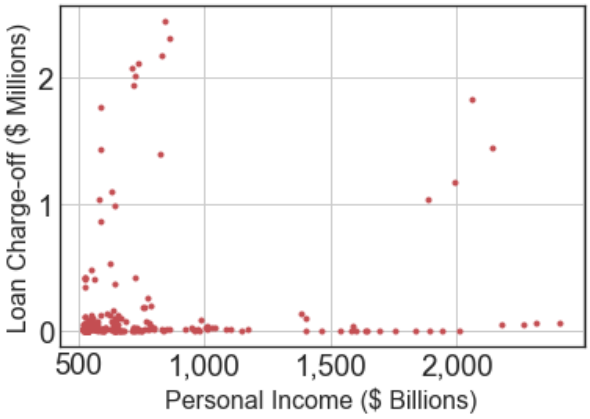

Figure 5: Uncollectible Debt and Personal Income, State Level

Note: Bank data retrieved from the Federal Deposit Insurance Corporation (FDIC) and regional data retrieved from the Bureau of Economic Analysis (BEA). All points on the figures correspond to quarterly US aggregate personal income by state, quarterly uncollectible loans (Loans Charge-off) by state, and quarterly loans (real estate, credit card, and auto loans) approved by depository institutions at the FDIC from Q1 2015 to Q4 2018.

It is reasonable to suppose that banks lend excessively to households in low-income regions, and that households in these regions have weaker collateral. This situation makes those borrowers less able to afford the debt and its associated cost. In what follows, we expect a difference in the correlation between wealth and debt depending on the income distribution, more specifically the correlation differs between high-income and low-income states.

In summary, these observations strongly indicate that wealth and income are unequally distributed and household debt has remarkably increased between 1999 and 2017 in the United States. This added to an uncertain environment characterized by a high concentration of debt and uncollectible debt in low-income states between 2015 and 2018.

Causality Running from Debt to Wealth Accumulation: What is the Mechanism we have in Mind? We now turn our attention to the causality running from debt to wealth accumulation. The concentration of debt among households at the very bottom of the income distribution leads to the deterioration of wealth accumulated by those households.

Our view is that if the debt is issued to low-income households with a high chance of default, those households are more likely to have difficulty repaying the debt and may lose the pledged collateral. This means that low-income households can accumulate less wealth simply because they can spend a substantial portion of their income on consumption and borrowing repayments, or because they may not be able to afford debt servicing and default on their loan, in which case the pledged collateral is lost. To put it another way, when low-income households are over-indebted and their finances are tight, they will accumulate less wealth. Wealthy households, on the other hand, have sufficient means to meet their intended consumption as well as their debt repayments.

One remaining concern is the issue of endogeneity between debt and wealth accumulation and the use of loan charge-offs as a valid instrument for debt. One could object that debt can exert a significant influence on household wealth accumulation, and of course, think that the level of debt can respond to a decrease in household wealth. Our procedure for correcting the causality problem requires an IV2SLS procedure with an instrumental variable that is correlated with household debt but uncorrelated with the error term, which means that it cannot directly determine the wealth accumulation level. We use the loan charge-offs as an instrument because a change in this variable is associated with changes in the credit supply to households but does not lead to a change in household wealth accumulation. In fact, financial institutions are typically concerned about the level of uncollectible debt (loan charge-offs).[7] When banks are raising the amount of loans supplied in low-income locations, they rely on the level of uncollectible debt. In this case, households that have large debt and low-income could face financial difficulties with paying back the debt or default on their loans and this is expected to lower the wealth accumulated by those households. Section 4 provides further details.

[7] In our analysis, uncollectible debt and loan charge-offs are used interchangeably to refer to the same thing.

3 Model

We developed a standard heterogeneous agent model with collateral-constrained households. The purpose of this model is to assess the implications for the transmission of collateral constraint shocks on household wealth. In this paper, we first describe the model, and then outline our use of the data to calibrate the model.

3.1 Model Description

A discrete time economy is indexed by $t = 0, 1, ...$ and populated by a continuum of households who live in low-income and high-income regions. Households engage in a multitude of activities: working, consuming, saving, and borrowing. Households are collateral-constrained, and are willing to use their assets as collateral to obtain new loans.

Households This economy consists of two types of households that differs by geographical location. Within each type there is a continuum of households who have identical preferences. Households are indexed by $\{j \in l, h\}$, l if they live in low-income regions and h if they live in high-income regions, which take the form:

$$\text{maximise} \quad U(C_t(j), H_t(j), V_{m,t}(j), V_{c,t}(j)),$$

The objective of households in low-income regions is to maximise the utility function by choosing sequences of $\{C(l), H(l), V_{m,t}, V_{c,t}\}_{t=0}^{\infty}$:

$$\text{maximise} \quad E_0 \Sigma_{t=0}^{\infty} \beta^t \left\{ \log(C_t(l)) - \chi^l \frac{H_t^{1+\phi^l}(l)}{1+\phi^l} + \frac{{V_{m,t}}^{1-\sigma_m}(l)}{1-\sigma_m} + \frac{{V_{c,t}}^{1-\sigma_c}(l)}{1-\sigma_c} \right\}, \tag{3.1}$$

where $0 < \beta < 1$ is the discount factor, $C_t(l)$ denotes the per capita consumption, and $H_t(l)$ represents the labour supply. The parameter ϕ^l is the curvature on disutility of labour and controls household willingness to intertemporally substitute labour. We use

this parameter to pin down the disutility weight on labour χ^l. $V_{c,t}(l)$ denotes the value of assets that can guarantee the credit line[8], and $V_{m,t}(l)$ denotes the value of property. The key assumption is that $V_{c,t}(l)$ and $V_{m,t}(l)$ enter the utility function and serve as collateral assets for debt. The parameters σ_c and σ_m are the elasticity of assets demand of $V_{c,t}(l)$ and $V_{m,t}(l)$.

Households maximise (3.1) subject to budget constraints and collateral constraints:

$$\begin{aligned}(1-\tau^c)C_t(l) + B_t(l) + M_{t-1}(l)(1+R_{t-1}) &= \omega_t(l)H_t(l) \\ &+(1+R^b_{t-1})B_{t-1}(l) + M_t(l), \qquad (3.2)\\ \kappa^m V_{m,t}(l) &\geq M^m_t \mu_{ml}, \qquad (3.3)\\ \kappa^c V_{c,t}(l) &\geq M^c_t \mu_{cl}, \qquad (3.4)\end{aligned}$$

where $B_t(l)$ denotes household savings, although we can also interpret it as a government bond or safe assets that store value. Moreover, $M_t(l)$ is household debt, R^b_t indicates the rate of return on holding bonds, and R_t denotes the interest rate on loans. The total resources consist of labour income $\omega_t(l)H_t(l)$, where $\omega(l)$ is the wage rate, the earnings generated by holding bonds are $(1+R^b_{t-1})B_{t-1}(l)$, and new loan amount is $M_t(l)$. The flow of expenses includes the after-tax consumption $(1-\tau^c)C_t(l)$ with the tax rate on consumption τ^c, the repayment of debt and interests are $M_{t-1}(l)(1+R_{t-1})$, and the purchase of a new government bond is $B_t(l)$. Given the endowment as labour income, an individual reconciles consumption decisions with available funds. If this is insufficient to support the desired consumption, the household may take a new loan from a bank and offer collateral to secure the debt. Equations (3.3) and (3.4) represent the collateral constraints in this economy, where $V_{m,t}(l)$ is the value of property in an impoverished region. In addition, $V_{c,t}(l)$ denotes the value of assets in low-income regions. The parameters κ^m and κ^c stand for the fraction of assets pledged by a household to

[8] We interpret $V_{c,t}(l)$ as a cash or security deposit that can guarantee the credit line, such as secured credit card, secured student loans, and secured auto loans.

obtain a mortgage loan M_t^m and non-mortgage loan M_t^c, respectively. According to these expressions, a household cannot obtain more than the amount of collateral on hand. The collateral coefficients are restricted to $0 < \kappa^m < 1$, $0 < \kappa^m < 1$, thus the equation can be written as follows:

$$\kappa^m = \frac{1}{1+\eta^m}, \quad \kappa^c = \frac{1}{1+\eta^c},$$

where η^c and η^m are required to be nonnegative and guarantee that the collateral requirement varies between 0 and 1. Households in low-income regions have a share μ_{ml} that measures the weight of mortgage debt M_t^m in the total debt held by households, and μ_{cl} is the share of non-mortgage debt M_t^c in the total debt held by households.

Households who live in high-income regions maximise utility:

$$\text{maximise} \quad E_0 \Sigma_{t=0}^{\infty} \beta^t \left\{ \log(C_t(h)) - \chi^h \frac{H_t^{1+\phi^h}(h)}{1+\phi^h} + \frac{{V_{m,t}}^{1-\sigma_m}(h)}{1-\sigma_m} + \frac{{V_{c,t}}^{1-\sigma_c}(h)}{1-\sigma_c} \right\}, \tag{3.5}$$

where $C_t(h)$ denotes the per capita consumption, and the term $H_t(h)$ represents the labour supply. The curvature on disutility of labour is parametrised by ϕ^h, and χ^h measures the disutility weight on labour. We assume that $V_{c,t}(h)$ and $V_{m,t}(h)$ enter the utility function and serve as collateral assets for debt, where $V_{c,t}(h)$ is the value of assets, and $V_{m,t}(h)$ is the value of property. The parameters σ_c and σ_m are the elasticity of assets demand of $V_{c,t}(h)$ and $V_{m,t}(h)$.

Households in high-income regions are subject to budget constraints, capital accumulation,

and collateral constraints:

$$(1-\tau^c)C_t(h) + I_t + M_{t-1}(h)(1+R_{t-1}) + B_t(h) = \omega_t(h)H_t(h)$$
$$+M_t(h) + (1+R^b_{t-1})B_{t-1}(h) + r^k_t K_{t-1}, \tag{3.6}$$
$$K_t = (1-\delta)K_{t-1} + \Big[1 - \frac{\kappa^i}{2}\Big(\frac{I_t}{I_t}\Big)\Big]I_t, \tag{3.7}$$
$$\kappa^m V_{m,t}(h) \geq M^m_t \mu_{mh}, \tag{3.8}$$
$$\kappa^c V_{c,t}(h) \geq M^c_t \mu_{ch}. \tag{3.9}$$

Note that the household has access to government bonds, denoted as $B_t(h)$, and debt $M_t(h)$. R^b_t denote the rate of return on holding government bonds. Further, τ^c is the tax rate on consumption, and R_t indicates the loan interest rate. The right side of the budget constraint equation represents the total source of funds available to a household at time t, labour income at time t, new loan amount, earnings generated by holding bonds and capital. For example, households in high-income regions rent capital K to firms at rate r^k. These sources of funds are used to consume $C(h)$ and invest I at time t, pay debt $M_{t-1}(h)(1+R_{t-1})$ (e.g. principal and interest) held over from the previous period, and purchase a new bond $B(h)$ at time t. The wage rate in the budget constraint (Eq.(3.6)) is given by $\omega(h)$, and we assume that $\omega(h) > \omega(l)$. The capital law of motion (Eq. (3.7)) states that households accumulate new capital K that depends on the existing capital, which decays at the fixed rate δ and investment good I. Finally, the quantity of investment at period t is proportional to the adjustment cost function $\Big[1 - \frac{\kappa^i}{2}\Big(\frac{I_t}{I_t}\Big)\Big]$. Equations (3.8) and (3.9) represent the collateral constraints in this economy, where $V^m_t(h)$ is the value of property in the wealthiest region, and $V^c_t(h)$ denotes the value of assets purchased in high-income regions. As explained above, the collateral parameters κ^m and κ^c are meant to capture the fraction of assets pledged by a household to obtain a mortgage loan M^m_t and non-mortgage loan M^c_t, respectively. Formally, the collateral parameters are given by $\kappa^m = \frac{1}{1+\eta^m}$ and; $\kappa^c = \frac{1}{1+\eta^c}$; and satisfy the restriction that $0 < \kappa^m < 1$ and

$0 < \kappa^m < 1$. This implies that the coefficient η^c and η^m are strictly nonnegative. Similar to low-income regions, the parameter μ_{mh} corresponds to the share of mortgage debt M_t^m in the total debt held by households in high-income regions, and μ_{ch} is the share of consumptive debt M_t^c in the total debt held by households in high-income regions.
The total debt in this economy M_t comprises of two components, mortgage M_t^m and non-mortgage debt M_t^c:

$$M_t^m = M_t\theta, \tag{3.10}$$

$$M_t^c = M_t(1-\theta), \tag{3.11}$$

where the parameter θ determines the weight of these two components in the total debt. Households in low- and high-income regions hold both mortgage and non-mortgage debt with shares $\{\mu_{mh}, \mu_{ch}, \mu_{ml}, \mu_{cl}\}$, and are given by the following:

$$M_t(h) = M_t^m\mu_{mh} + M_t^c\mu_{ch}, \tag{3.12}$$

$$M_t(l) = M_t^m\mu_{ml} + M_t^c\mu_{cl}. \tag{3.13}$$

For future reference, the values of household personal income in regions l and h are denoted by $\iota_t(l)$ and $\iota_t(h)$, given as follows:

$$\iota_t(l) = \omega_t(l)H_t(l), \tag{3.14}$$

$$\iota_t(h) = \omega_t(h)H_t(h). \tag{3.15}$$

The ratio of total bond supply to personal income is given by the following:

$$\varrho = \frac{B_t}{\iota_t}. \tag{3.16}$$

In the bond market, equilibrium is given by $B_t = B_t(l) + B_t(h)$, where B_t is the total amount of government-issued bonds at time t.

We define the debt-to-income ratio as follows:

$$\zeta = \frac{M_t^m + M_t^c}{\iota_t(l) + \iota_t(h)}, \tag{3.17}$$

with a debt-to-income ratio in impoverished regions that equals:

$$\zeta_t(l) = \frac{M_t(l)}{\iota_t(l)}. \tag{3.18}$$

In addition, the debt-to-income ratio in the wealthiest regions is given by:

$$\zeta_t(h) = \frac{M_t(h)}{\iota_t(h)}. \tag{3.19}$$

The first-order conditions with respect to consumption, labour, value of property, value of assets, and loans in low-income regions take the form:

$$\frac{\partial \mathcal{L}_t}{\partial C_t(l)}: \qquad \lambda_t(l) = \frac{1}{C_t(l)(1-\tau^c)}, \tag{3.20}$$

$$\frac{\partial \mathcal{L}_t}{\partial H_t(l)}: \qquad \lambda_t(l) = \frac{\chi^l {H_t^l}^{\phi^l}(l)}{\omega_t(l)}, \tag{3.21}$$

$$\frac{\partial \mathcal{L}_t}{\partial V_t^c(l)}: \qquad \lambda_t(l) = \frac{{V_{c,t}}^{\sigma_c}(l)}{\kappa^c}, \tag{3.22}$$

$$\frac{\partial \mathcal{L}_t}{\partial V_t^m(l)}: \qquad \lambda_t(l) = \frac{{V_{m,t}}^{\sigma_m}(l)}{\kappa^m}, \tag{3.23}$$

$$\frac{\partial \mathcal{L}_t}{\partial M_t(l)}: \qquad \beta\lambda_{t+1}(l)(1+R_t) = \lambda_t(l). \tag{3.24}$$

Moreover, the first-order conditions with respect to consumption, labour, value of property, value of assets, debt, and capital in high-income regions are given by:

$$\frac{\partial \mathcal{L}_t}{\partial C_t(h)}: \qquad \lambda_t(h) = \frac{1}{C_t(h)(1-\tau^c)}, \tag{3.25}$$

$$\frac{\partial \mathcal{L}_t}{\partial H_t(h)}: \qquad \lambda_t(h) = \frac{\chi^h {H_t}^{\phi^h}(h)}{\omega_t(h)}, \tag{3.26}$$

$$\frac{\partial \mathcal{L}_t}{\partial V_t^m(h)}: \qquad \lambda_t(h) = \frac{{V_{m,t}}^{\sigma_m}(h)}{\kappa^m}, \tag{3.27}$$

$$\frac{\partial \mathcal{L}_t}{\partial V_t^c(h)}: \qquad \lambda_t(h) = \frac{{V_{c,t}}^{\sigma_c}(h)}{\kappa^c}, \tag{3.28}$$

$$\frac{\partial \mathcal{L}_t}{\partial M_t(h)}: \qquad \beta\lambda_{t+1}(h)(1+R_t) = \lambda_t(h), \tag{3.29}$$

$$\frac{\partial \mathcal{L}_t}{\partial K_t}: \qquad r_t^k = \frac{\lambda_t(h) + \beta(1-\delta)\lambda_{t+1}(h)}{\beta\lambda_{t+1}(h)}. \tag{3.30}$$

Technology Intermediate good firms operate a technology that uses capital and labour supplied by households, according to the following technology function:

$$Y_t = (K_t)^{\alpha}(H_t(h)H_t(l))^{1-\alpha}, \tag{3.31}$$

where Y_t is the output, $H_t(l)$ and $H_t(h)$ are the hours worked in high and low-income regions, and K_t is the capital factor. The problem of the producer of intermediate good is to minimise the costs, $\omega_t(l)H_t(l) + \omega_t(h)H_t(h) + r_t^k K_t$, subject to the technology function.

The optimal conditions are given by:

$$\lambda_t^p = \frac{\omega_t(h)H_t(h)}{(1-\alpha)Y_t}, \tag{3.32}$$

$$\lambda_t^p = \frac{\omega_t(l)H_t(l)}{(1-\alpha)Y_t}, \tag{3.33}$$

$$\lambda_t^p = \frac{r_t^k}{\alpha Y_t}, \tag{3.34}$$

$$\frac{K_t}{H_t(l)} = \left(\frac{\alpha}{1-\alpha}\right)\frac{\omega_t(l)}{r_t^k}, \tag{3.35}$$

$$\frac{K_t}{H_t(h)} = \left(\frac{\alpha}{1-\alpha}\right)\frac{\omega_t(h)}{r_t^k}, \tag{3.36}$$

$$\frac{H_t(l)}{H_t(h)} = \frac{\omega_t(h)}{\omega_t(l)}. \tag{3.37}$$

In equilibrium marginal cost equals marginal utility:

$$mc_t = \lambda_t^p = (2-\alpha)(1-\alpha)^{(\alpha-1)}\left(\frac{1}{\alpha}\right)^{\alpha}\frac{(\omega_t(h))^{1-\alpha}(r_t^k)^{\alpha}}{(\omega_t(l))^{\alpha}}. \tag{3.38}$$

Government Our assumption ar that government issues a one period bond $B_{t-1}(j)$ with return rate R_{t-1}^b, collects a consumption tax, and follows a fiscal rule that constrains its behaviour in supplying bonds. The rule states that issuing bonds must be proportional to the total income taxes:

$$B_t - B_{ss} = \rho^b \left(GI_t - GI_{ss}\right), \tag{3.39}$$

where ρ^b is a smoothing parameter that is assumed to be nonnegative and indicates that the adjustment of the government bond supply to government income is gradual. The total amount of tax collected from consumers is given by $GI_t = \tau^c C_t(l) + \tau^c C_t(h)$.

Market Clearing Condition The goods market equilibrium condition is given by:

$$Y_t = C_t + I_t. \tag{3.40}$$

The market clearing condition implies that output is used for consumption and investment, where C_t is the aggregate consumption in low- and high-income regions, with $C_t = C_t(l) + C_t(h)$. Thus, consumption is expressed in the two regions as follows:

$$C_t(l) = C_t S_l, \tag{3.41}$$

$$C_t(h) = C_t S_h, \tag{3.42}$$

where S_h (S_l) measures the share of households consumption in the wealthiest (impoverished) regions.

Monetary Policy Finally, the model is closed by introducing monetary policy, which is defined as follows:

$$R_t = \rho^p R_{t-1} + \epsilon_t. \tag{3.43}$$

The monetary policy follows a first-order autoregressive process with the smoothing parameter ρ^p and ϵ_t, which is a random monetary policy shock.

Definition 1. *The dynamic equilibrium is defined by a set of quantities* $\{C_t(l), C_t(h), H_t(l), H_t(h), B_t(l), B_t(h), K_t, I_t\}$, *debt variables* $\{M_t(l), M_t(h)\}$, *the value of assets* $\{V_{m,t}(l), V_{m,t}(h), V_{c,t}(l), V_{c,t}(h)\}$, *aggregate quantities* $\{C_t, \iota_t(l), \iota_t(h), B_t, M_t, M_t^m, M_t^c, GI_t, Y_t, W_t\}$, *debt-to-income shares* $\{\zeta_t(l),\zeta_t(h)\}$, *exogenous monetary policy shocks* $\{\epsilon_t\}$, *and prices* $\{\omega_t(l), \omega_t(h), R_t^b, R_t, r_t^k\}$ *that evolve according to a system of equations. This definition implies that the following conditions are satisfied at any time t:*

a) Household optimality conditions: (3.30), (3.25), (3.20), (3.21), *and* (3.26); *the collateral*

constraints: (3.8), (3.9), (3.3), *and* (3.4); *and capital accumulation:* (3.7).

b) *The share of the debt to income:* (3.17), (3.18),*and* (3.19) *and aggregate personal income:* (3.14) *and* (3.15).

c) *Aggregate mortgage and nonmortage debt:* (3.10), (3.11), (3.12), *and* (3.13) *and savings-to-income ratio:* (3.16).

d) *Producer optimality conditions:* (3.38), (3.35), (3.36), (3.37) *and the aggregate production function:* (3.31).

e) *The economy is subject to monetary policy shock:* (3.43).

f) *The government fiscal rule:* (3.39).

g) *The market clearing conditions:* (3.40), (3.41), *and* (3.42).

3.2 Data

We use three data set for our analysis: the Panel Study of Income Dynamics (PSID), the Federal Deposit Insurance Corporations (FDIC), and the Bureau of Economic Analysis (BEA).

Panel Study of Income Dynamics (PSID). In this paper, we use the PSID data encompassing a measure of household wealth and debt. The PSID is collected in waves: 1999, 2001, 2003, 2005, 2007,2009, 2011, 2013, 2015, 2017. In each wave of the PSID, we have a representative sample of 17117 households. Our sample is split into two sub-samples that represent households who live in states with high per capita income and low per capita income, and provide information on wealth, debt, and geographic locations of each interviewee.

Federal Deposit Insurance Corporations (FDIC) The Federal Deposit Insurance Corporations (FDIC) has a large sample on US banking industry which enable us to characterise the evolution of individual debt: student loans, credit card, auto loans and real estate loans, uncollectible debt by type (housing and individual loans), and recoveries by type of loan (housing and individual loans). The data were retrieved from the Statistics on Depository Institutions (SDI). It includes: loans to individuals, loans to individuals (charged off), liquidated individual loans, housing loans, housing loans (charged off), liquidated housing loans. The data collected is annual and covers the period between 1997 and 2018. We aggregate data by state and year, we take the sum of total uncollectible loans, outstanding loans, and recoveries for both individual and housing loans reported by year and by banks operating in a given state.

Bureau of Economic Analysis (BEA) Our analysis also exploits data from the Bureau of Economic Analysis. We use personal income and personal consumption expenditures at the state level. The data is annual and covers the period between 1997 and 2018. To estimate the transmission channel of debt on wealth accumulation, we need a measure of wealth variation. We then construct an additional variable which is defined to be the change in wealth (effective personal saving), this new variable is the difference between income and consumption. Our measure is a partial approximation of wealth variation (effective saving) at state and year level. We are not claiming this is the only way to measure wealth. Nevertheless, we think that our methodology for the calculation of change in wealth is fair enough.

Finally, we complete the Bureau of Economic Analysis data with the data from the FDIC. We use this data to characterise trends in wealth variation and also the evolution of debt across time and states between 1997 and 2018.

4 Association Between Aggregate Wealth Accumulation and Debt: Estimation and Results

When we claim that banks offering loans to individuals in impoverished regions are hurting household wealth, we particularly refer in particular to when households need to post costly funds to borrow from banks, which they lose if they default on the loans. Moreover, the data reveal that the level of delinquent debt is higher in regions with lower aggregate personal income, implying a high level of collateral liquidation. Therefore we argue that collateral liquidation is detrimental to household wealth. To support this claim, we limited the analysis to the relationship between household wealth variation and household debt. One restriction of the regional data is that we cannot observe the level of household wealth, which is challenging to measure properly.[9] To address this limitation, we defined the variation in household wealth to be dependent on income and consumption. We assume that variations in household wealth can be measured by the difference between personal income and personal consumption. More specifically, we construct a measure for change in wealth $\Delta W_t(j)$:

$$\Delta W_t(j) = \text{Income}_t(j) - \text{Consumption}_t(j),$$

where $\Delta W_t(j)$ represents the variation in wealth in state j at time t, which is equal to the difference between personal income and personal consumption across states and time.

The analysis of the effect of household debt on wealth accumulation is conducted at the state-year level across the United States. To this end, we merge aggregated bank-level data on individual loans, housing debt, uncollectible debt, and liquidated loans, with regional data on aggregate personal income and individual consumption during the

[9] Both the Federal Deposit Insurance Corporation and the Bureau of Economic Analysis data lack observation on wealth. Conversely, the data from the Panel Study of Income Dynamics (PSID) contain information on wealth.

period from 1997 to 2018.

We assessed the relationship between debt and wealth variation by running the regression:

$$\Delta W_{i,t}(j) = \beta_0^j + \beta_1^j M_{i,t}(j) + \beta_i^j + \beta_t^j + \epsilon_{i,t}^j,$$

let j denote low and high-income regions such as $j \in l, h$ and the dependent variable $W_{i,t}$ is the aggregate wealth variation in state i at time t. In addition, $M_{i,t}$ is the value of loans issued by banks in state i at time $t = 1997, ..., 2018$, and $\epsilon_{i,t}^j$ is the residual. Further, the parameter β_1^j measures the effect of debt on personal wealth variation from 1997 to 2018 and is the point estimate of interest. Moreover, β_i^j and β_t^j are the state and time fixed effects.

To consider the potential relationship between household debt and wealth accumulation, we used the above specification for two data samples, because the heterogeneity among households is at the core of this model. We defined the wealthiest regions as states with a per capita income above the US national average for the first subsample. The second subsample represents states with a per capita income below the US national average. Household heterogeneity leads to substantial differences in the consequence of debt on wealth. The concentration of debt and eventually of uncollectible debt in low-income locations is detrimental and can exacerbate disparities in wealth across the United States. Figures 6, 7, 8, and 9 display the level of debt against wealth variation from 1997 to 2018 for the restricted samples. They depict the growing wealth inequality between the wealthiest and most impoverished regions. For example, wealth accumulation in high-income locations was much higher than its level in low-income states. While wealth variation has followed an upward trend in both locations, it coincides with the path of debt in low-income states. However, the level of debt in high-income regions fluctuates considerably across the same period. Both locations have experienced an increasing trend

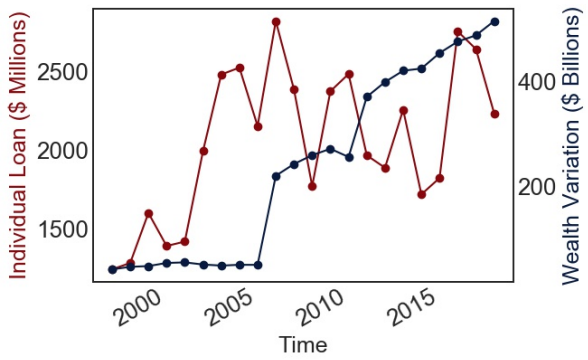

Figure 6: Wealthiest States: Individual Wealth Variation vs Debt

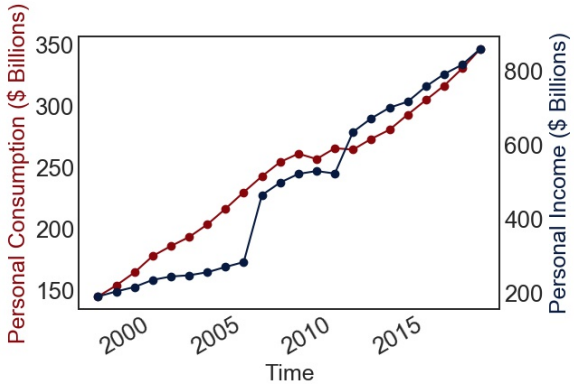

Figure 7: Wealthiest States: Individual Consumption vs Personal Income

Loan is defined as the sum of all total individual loans and housing debt reported by all banks in the sample of the wealthiest states (states with per capita income above the national average). Wealth variation is the difference between personal income and personal consumption in the wealthiest states. Data sources: the Federal Deposit Insurance Corporation and the Bureau of Economic Analysis 1997-2018.

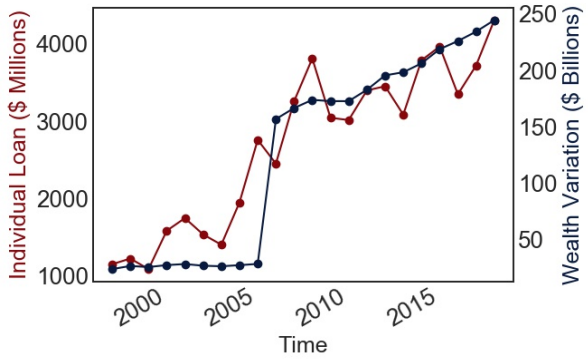

Figure 8: Low-Income States: Individual Wealth Variation vs Debt

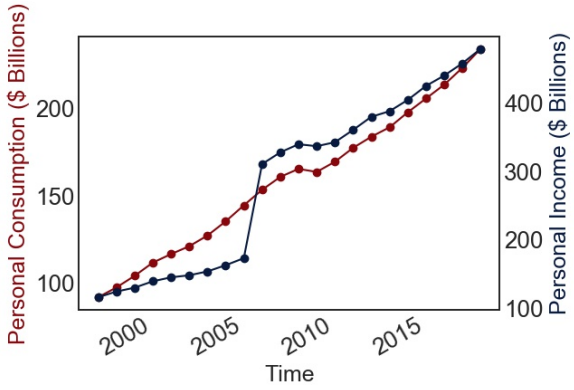

Figure 9: Low-Income States: Individual Consumption vs Personal Income

Individual loan is defined as the sum of all individual loans and housing debt reported by all banks in the sample of the poorest states (states with a per capita income below the national average). Wealth variation is the difference between personal income and personal consumption in the poorest states. Data sources: the Federal Deposit Insurance Corporation and the Bureau of Economic Analysis 1997-2018.

in personal income, with a much lower level of personal income in low-income than in high-income locations. In addition, a positive relationship exists between consumption and personal income. Consumption in high-income locations was much higher than its

level in low-income states at the beginning of the period, but the difference becomes smaller at the end of the period.

Estimates of the Debt Effect on Household Wealth We consider ordinary least squares (OLS) and two-stage least squares using instrumental variable (IV2SLS) to estimate the coefficient β_1. We report the estimates of β_1 for high-income regions (per capita income above the national average) and low-income regions (per capita income below the national average).[10] Appendix D contains the estimated effects of housing debt on wealth accumulation and the estimation of the transmission channel of individual debt (credit card and auto loans) on wealth accumulation. The regression results from the Bureau

Table 1: Results of Ordinary Least Squares Estimation of the Relationship Between Debt and Wealth Variation: States with High Per Capita Income

	Dependent Variable:			
	Δ Wealth in States with the Highest Per Capita Income			
	(1)	(2)	(3)	(4)
Const	155570.07***	133835.16***	145670.96***	131134.07***
	(5.81)	(3.61)	(5.39)	(3.51)
Debt	0.82***	1.03***	0.92***	1.05***
	(4.41)	(5.25)	(4.92)	(5.38)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	19.40	27.51	24.23	28.93
No. Observations:	426	426	426	426

[a] Ordinary least squares regression over the subsample of states with the highest per capita income; (1) with time and state fixed effects, (2) with time fixed effects, (3) with state fixed effects, (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and the Bureau of Economic Analysis (1997-2018).

of Economic Analysis (BEA) and the Federal Deposit Insurance Corporation (FDIC) data are presented in tables 1, 2, and 3. By restricting the sample to regions with high incomes, the results reveal a significant positive relationship between household debt and wealth variation, with an estimated β_1 that equals 1.05. This outcome suggests that

[10] Restricting the analysis to subsamples based on per capita income leads to two samples with different number of observations. For example, observations in states with low incomes equal 660, in contrast to 426 observations in states with high incomes.

lending to households may positively influence the variation of wealth in wealthy states. Furthermore, we included state and time fixed effects to absorb all state- and time-level factors that influence wealth accumulation. This implies a statistically significant β equal to 0.82 (Table 1).

The results of the IV2SLS estimates point to a significant positive relationship between

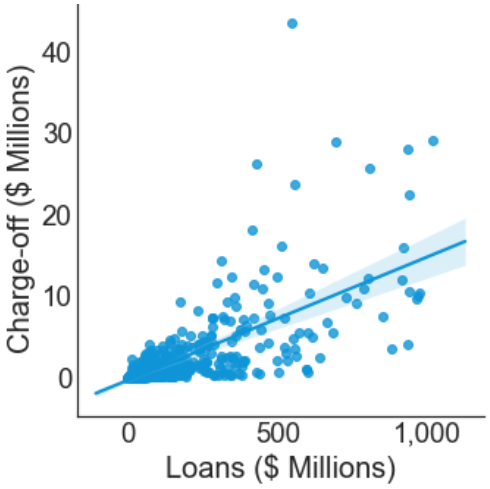

Figure 10: Correlation between Household Loans and Loan Charge-offs

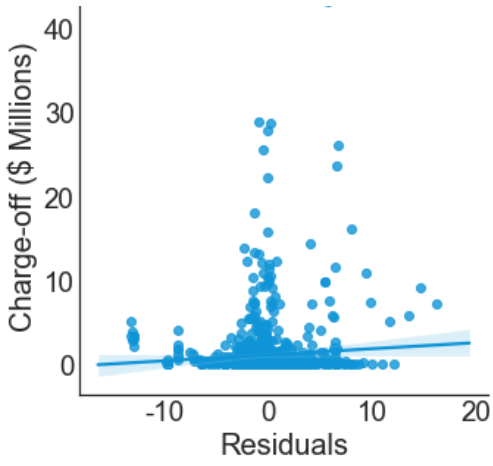

Figure 11: Correlation between Loan Charge-offs and Residuals

Source: Federal Deposit Insurance Corporation and the Bureau of Economic Analysis (1997-2018).

household debt and wealth variation for the wealthiest states, with an estimated β_1 of 1.46 (Table 2). The IV-2SLS is adequate to address the sources of endogeneity. We chose the loan charge-off as an instrument, which is correlated with household debt but not with wealth variation.[11] Figures 10 and 11 demonstrate the relevance of the choice of loan charge-off as an instrument. A strong fit exists between the endogenous regressor (loans) and instrument (loan charge-offs). A bank that experiences a high level of uncollectible debt (debt classified as a loss) attempts to reduce exposure to risk, diminishing the supplied credit particularly to risky borrowers. A higher level of household debt generates substantial variation in US household wealth from 1997 to 2018. Accordingly,

[11] In section 2, we discussed the causality running from debt to wealth accumulation and how the instrumental variable, loan charge-off, is associated with changes in loan supply to households but does not lead to a change in wealth accumulation.

Table 2: Results of Two-stage Least Squares Regression Using Instrumental Variable of the Relationship Between Debt and Wealth Variation for: States with High Per Capita Income

	Dependent Variable: Δ Wealth in States with the Highest Per Capita Income Instrument: Loan Charge-off					
	(1)	(2)	(3)	(4)	(5)	(6)
Const	13423.38	49452.79	88185.67***	85922.29***	9509.81	14826.01
	(0.25)	(0.97)	(2.87)	(2.83)	(0.22)	(0.35)
Liquidated Loan	15.14	143.31				
	(0.13)	(1.25)				
Debt	2.13***	1.53***	1.46***	1.48***	2.19***	2.15***
	(3.49)	(2.68)	(6.15)	(6.44)	(7.51)	(7.49)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	Time		State, Time	State	Time	
F-statistic:	28.16	28.83	37.83	41.47	56.45	56.03
No. Observations:	426	426	426	426	426	426

[a] Two-stage least squares regression using Instrumental Variable over the subsample of states with the highest per capita income, (1) with time fixed effects, controlling for liquidated loans; (2) with no fixed effects, controlling for liquidated loans; (3) with time and state fixed effects; (4) with state fixed effects; (5) with time fixed effects; (6) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and the Bureau of Economic Analysis (1997-2018).

we used the loan charge-offs as an instrument because a change in the charge-off level is associated with changes in the credit supply to households but does not lead to a change in household wealth accumulation.

We also estimated the effect of household debt on wealth variation in regions with low incomes. The results across this subsample indicate that household debt in impoverished states negatively influences wealth accumulation (the value of β_1 is -0.25). When we include the time fixed effects and additional controls, the point estimate rises, has a negative sign, and remains statistically significant (Table 3).

The regression results from the Panel Study of Income Dynamics (PSID) data are presented in Tables 4 and 5. Table 4 records the point estimate of high-income states. Debt has a strongly positive effect on household wealth with a point estimate of 1.5 (which is statistically significant) and is in accordance with the estimates based on FDIC-BEA data. In comparison, Table 5 reports the regression results concerning low-income states. The

Table 3: Results of Ordinary Least Squares Estimation of the Relationship Between Debt and Wealth Variation for States with Low Per Capita Income

	Dependent Variable: Δ Wealth in States with the Lowest Per Capita Income					
	(1)	(2)	(3)	(4)	(5)	(6)
Const	186945.11***	172808.71***	160664.38***	148717.16***	170479.49***	156702.81***
	(9.50)	(8.77)	(8.43)	(7.78)	(8.89)	(8.15)
Liquidated Loan	437.08***	406.08***				
	(4.48)	(4.27)				
Loan Charge-offd					33.79***	28.03***
					(3.21)	(2.89)
Debt	-1.43***	-1.22***	-0.38***	-0.25**	-0.87***	-0.65***
	(-5.53)	(-4.84)	(-3.45)	(-2.27)	(-4.63)	(-3.68)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	Time		Time		Time	
F-statistic:	16.17	11.73	11.90	5.135	11.20	6.765
No. Observations:	660	660	660	660	660	660

[a] Ordinary least squares regression over the subsample of states with the lowest per capita income, (1) with time fixed effects, controlling for liquidated loans; (2) with no fixed effcets and controlling for liquidated loan; (3) with time fixed effects; (4) with no fixed effects; (5) with time fixed effects and controlling for loan charge-offs; (6) with no fixed effects and controlling for loan charge-offs. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and the Bureau of Economic Analysis (1997–2018).

point estimate is now positive and statistically different from zero (the estimate of β_1 equals 0.8), implying that household debt positively affects wealth in impoverished states, differing from the estimates of the FDIC and BEA data. The estimates for low-income states using FDIC and BEA data are -1.43, -1.22, -0.38, -0.25, -0.87, -0.65, compared to estimates from the PSID data 0.8, 0.82, 0.83, 0.84. This result is important and indicates that the rise in debt supply in top income states leads to a rise in accumulated wealth. However, with a rise in household debt, the wealthiest states experience a greater increase in wealth accumulation than impoverished states. The concern is that the wealthiest states benefited from the increase in household debt more than low-income states, which leads to a vicious cycle of economic inequality.

We should use caution when interpreting the results. The negative relationship between debt and wealth in low-income states when we use the FDIC and BEA data, as mentioned, contrast with the positive relationship when we use the PSID data for the estimation.

Table 4: Results of Ordinary Least Squares Estimation of the Relationship Between Household Debt and Wealth: States with the Highest Per Capita Income

	Dependent Variable: Household Wealth in States with the Highest Per Capita Income [a]			
	(1)	(2)	(3)	(4)
Const	416445.61***	417359.66***	415479.88***	416290.86***
	(29.36)	(30.86)	(29.23)	(30.72)
Debt	1.55***	1.49***	1.61***	1.56***
	(10.95)	(13.50)	(11.44)	(14.18)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	120.1	182.4	130.9	201.1
No. Observations:	17560	17560	17560	17560

[a] Ordinary least squares regression over the subsample of states with the highest per capita income, (1) with time and state fixed effects; (2) with state fixed effects; (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Panel Study of Income Dynamics (1999-2017).

Table 5: Results of Ordinary Least Squares Estimation of the Relationship Between Household Debt and Wealth: States with the Lowest Per Capita Income

	Dependent Variable: Household wealth in States with the Lowest Per Capita Income [a]			
	(1)	(2)	(3)	(4)
Const	240529.19***	240334.56***	240200.07***	240025.97***
	(40.79)	(38.13)	(40.66)	(38.02)
Debt	0.80***	0.82***	0.83***	0.84***
	(14.34)	(16.24)	(14.84)	(16.75)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	205.9	263.8	220.2	280.8
No. Observations:	26682	26682	26682	26682

[a] Ordinary least squares regression over the subsample of states with the lowest per capita income, (1) with time and state fixed effects; (2) with time fixed effects; (3) with state fixed effects; (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Panel Study of Income Dynamics (1999-2017).

Because of the lack of data on wealth from the FDIC and BEA, we construct an artificial variable called wealth accumulation (the difference between personal income and individual consumption) at the state level. The loss of precision from the FDIC and BEA estimates indicate that the estimates from the PSID are preferred.

5 Implications of Collateral Conditions and Income Distribution

In this section, we use the model to simulate wealth accumulation at the bottom and top of income distribution to show how alternative collateral requirements (high vs low) can lead to different counterfactual predictions.

Model calibration. Table 6 lists the calibrated parameters taken from the observed data or literature. First, we set the discount factor β to the standard value most commonly found in the literature (0.9711) to target the risk-free interest rate R of 3.09% (annual rate). We fix the value of capital stock depreciation δ at 0.04 to compute the capital rental rate r^k. The wage rate in low-income states is set at (0.14) and the wage rate in the wealthiest states is set to (0.22), which is in line with the living wage calculator estimates.[12] The capital share α is set at 0.4, and the consumption tax is fixed at 0.1, which alignes with the literature. The investment adjustment cost is set at 2.48, as in Christiano et al. (2014). The curvature on the disutility of labour in low-income states ϕ^l and the wealthiest states ϕ^h is fixed at 1.05 and 1.1, respectively.

As a target, we set the ratio of debt securities to personal income ϱ at 0.28 to match data from the balance sheet of households and non-profit organizations in the financial accounts of the United States. The loan-to-value ratio for housing debt κ^m and consumptive debt κ^c are set to the value of 0.97 and 0.94, respectively.[13] The parameter θ is fixed at 0.68 to reflect the share of mortgage debt within the total household debt.[14] The values of the Taylor rule parameters are taken from Christiano et al. (2014). Table 7 indicates

[12]The MIT living wage calculator data were created by Amy Glasmeier and are available online at link. In California, for example, the average hourly rate is $19.9, whereas in Nevada, the average hourly rate is $17.27. We divided the average hourly rates by a base value of 100.

[13]We took the last observation of the loan-to-value ratio (DTCTLVULNM) retrieved from the FRED database.

[14]The Quarterly Report on Household Debt and Credit published by the Federal Reserve Bank of New York indicates that the share of US mortgage loans in terms of total debt represents 68.71%, whereas non-mortgage debt represents 31.29% of the total debt.

Table 6: Exogenous and Endogenous Calibration Parameters

Parameters	Interpretation	Values
β	Discount factor	0.97
ϕ^l	Curvature on disutility of labour in low-income states	1.05
ϕ^h	Curvature on disutility of labour in high-income states	1.10
$\omega(l)$	Average wage rate in low-income states	0.14
$\omega(h)$	Average wage rate in wealthiest states	0.22
τ^c	Consumption tax	0.10
ϱ	Ratio of debt securities to personal income	0.28
δ	Capital depreciation rate	0.04
α	Capital share	0.40
κ^I	Investment adjustment cost	2.48
θ	Mortgage debt to household debt	0.68
κ^m	Loan-to-value ratio for housing debt	0.97
κ^c	Loan-to-value ratio for consumptive debt	0.94
ρ^P	Coefficient on the lagged interest rate	0.87
σ^P	Standard deviation of policy rate	0.52

Table 7: Model vs Data

Ratio	Description	Data	Model
$\frac{K}{Y}$	Capital to output	6.38	6.62
$\frac{M^m}{M}$	Mortgage debt to total debt	0.68	0.68
$\frac{M^c}{M}$	Non-mortgage debt to total debt	0.32	0.32
$\frac{M^m}{Y}$	Mortgage debt to output	0.43	0.65
$\frac{M^c}{Y}$	Non-mortgage to output	0.20	0.30
$\frac{M^m}{\iota}$	Mortgage to income	0.31	0.31
$\frac{M^c}{\iota}$	Non-mortgage to income	0.14	0.14

that the model matches the targeted ratios reasonably well. The target ratio of capital to output $\frac{K}{Y}$ of 6.38 is close to its counterparts in the model. Similarly, the mortgage and non-mortgage debt-to-income ratios implied by the model match the data almost exactly. Besides matching the share of non-mortgage and mortgage debt in the total debt, the model also does a respectable job relative to the ratios of mortgage debt to output (0.43 vs 0.65) and non-mortgage debt to output (0.20 vs 0.30).

The link between debt and wealth accumulation in the model. Given our specification of the budget constraint of households in high and low income regions, Equations (3.6) and (3.2). We can define consumer's change in wealth in high[15] and low-income[16] regions as:

$$\Delta W_t(h) = B_t(h) - B_{t-1}(h) + I_t + (1 + r_{t-1})M_{t-1}(h) - M_t(h) \tag{5.1}$$

$$\Delta W_t(l) = B_t(l) - B_{t-1}(l) + (1 + r_{t-1})M_{t-1}(l) - M_t(l) \tag{5.2}$$

At this point, we can write the transmission coefficient for the debt $M_t(j)$ as $\beta_1^j = \frac{cov(\Delta W_t(j), M_t(j))}{var(M_t(j))}$, the unit measure of households in low and high-income regions is indexed by $j \in l, h$. This coefficient measure the influence of debt on wealth accumulated. We demonstrated above how debt affects the accumulation of wealth by estimating the transmission channel of debt on household wealth accumulation. Regardless of how household debt affects wealth accumulation, households in high- and low-income states must satisfy the individual budget constraints, Equations 3.6 and 3.2. Accordingly, we specified the relationship between debt and wealth as follows:

$$\Delta W_t(h) = \beta_0^h + \beta_1^h M_t(h) + \epsilon_t^h, \tag{5.3}$$

$$\Delta W_t(l) = \beta_0^l + \beta_1^l M_t(l) + \epsilon_t^l, \tag{5.4}$$

where β_1^h (β_1^l) is the coefficient that measures the effect of debt on wealth accumulation in region h (l) and ϵ_t^h (ϵ_t^l) is the residual.

Some remarks on change in wealth. In the terminology of this paper, effective saving refers to the difference between income (including capital gains) and consumption.

[15] Note that wealth accumulation is defined as the difference between income and consumption. Therefore, change in wealth in high-income locations is defined by $\Delta W_t(h) = \omega_t(h)H_t(h) + r_t^k K_t + r_{t-1}^b B_{t-1}(h) - (1 - \tau^c)C_t(h)$.

[16] Change in wealth in low-income locations is defined by $\Delta W_t(l) = \omega_t(l)H_t(l) + r_{t-1}^b B_{t-1}(l) - (1 - \tau^c)C_t(l)$.

Specifically, the effective saving is defined as Saving = Income − Consumption, and the change in wealth is equal to the $\Delta W_t = W_t - W_{t-1} =$ Saving.

A recent paper relevant to our research is Robbins (2019). In landmark result, Robbins (2019) shows that including capital gains in measures of income are important in explaining income inequality.[17] Our objective is to demonstrate in a simple way how debt affects the accumulation of wealth, we, therefore, defined the change in wealth ΔW as income minus consumption, including capital gain as an income. Consistent with our measure of wealth accumulation in the model, the measure we use for household wealth from the PSID data includes equity, and the measure of aggregate personal income from the BEA data also includes income from business ownership and dividends.

Methodolgy for analysing scenarios. Our strategy is to compare the implied results from the macroeconomic model under two scenarios. The macroeconomic model is augmented with the equation that characterizes the effect of debt on wealth. This allows us to predict the wealth accumulation response at the top and bottom of the personal income distribution. Formally, we change the value of collateral requirement and we obtain simulated time series for wealth accumulation under two alternative environments: a high and a low collateral requirement.

Counterfactual wealth accumulation: results. To understand the influence of collateral conditions on household wealth accumulation, we used the estimated regression coefficients β_1 from the micro model to simulate the response of household wealth variation in the macro model. In the following paragraph, we demonstrate the sensitivity of the response of household wealth accumulation to changes in collateral conditions. Table 8 reveals that household wealth accumulation can be more or less responsive to variations in collateral requirements depending on the regional income distribution. The wealth accumulation level in the wealthiest states is always better off under a high value of

[17] See Bricker et al. (2018) and Dynan et al. (2004) for an intuition along this line.

Table 8: Sensitivity of Wealth to Collateral Requirement Change

	Household Wealth Accumulation (ΔW)	
Collateral Requirement	High Income States	Low Income States
Low κ	381294	230119
High κ	416445	240529
Difference	35151	10410

κ. Households within high-income states have an adequate level of collateral, a lower level of uncollectible debt, and can borrow more, which causes wealth accumulation to increase. In contrast, the low κ value means that households with enough resources can take on less debt because of low collateral requirements, which offsets any increase in the accumulated wealth level.

The response of accumulated wealth in low-income states implied by the model suggests that the level of accumulated household wealth is lower under a low κ value; however, the magnitude of variation is much smaller compared with the response of wealth in high-income regions. Households within this group have less collateral to pledge and a higher concentration of uncollectible debt, whereas the low value of κ means that households pledge fewer resources and take on less debt. In contrast, high collateral requirements lead to a higher level of accumulated wealth, although still at a level less sensitive to collateral requirement changes when compared to high-income regions.

The analysis reveals a significant positive relationship between household debt and wealth accumulation at the top of the income distribution, and a positive relationship between household debt and wealth at the bottom of the income distribution. The response of wealth variation in the wealthiest states is always better off under a high collateral requirement. Individuals within this subgroup have an adequate amount of collateral, a lower risk of default, and can borrow more. Thus, the lower collateral requirement represents a higher opportunity cost for borrowers. The response of wealth

variation implied by the model in states with the lowest incomes in the United States suggests that wealth is higher under high collateral requirements. If collateral conditions are tight, individuals within these states take on less debt and face limited losses in case of default. The basic implication is as follows: if banks lend to households in high and low-income regions, the wealthiest locations benefit more from the increase in debt supply than impoverished regions which increases inequality.

6 Conclusion

This paper present the study of the influence of collateral constraints on household borrowing and wealth in the context of a heterogeneous agent model. The objective is to provide theoretical and empirical validation of the following argument. If banks lend to households in low-income regions, where borrowers tend to have weaker collateral and high concentration of uncollectible debt, this can hurt household wealth and exacerbate income inequality. For instance, if a debt is collateral-dependent, the bank seizes the collateral in the event of default. In such a case, when the concentration of debt is high within low-income states, borrowers experience a decline in their asset holdings, which further decreases their wealth and amplifies economic disparities.

First, crucial micro evidence from household-level data indicates a positive relationship between household debt and accumulated wealth among households in states with the lowest incomes and a positive relationship between household debt and wealth variation for households in the wealthiest states. Second, household wealth can be more or less responsive to a variation in collateral requirements depending on whether a household is at the top or bottom of the income spectrum. Third, a high collateral requirement can benefit individuals in wealthiest states more than individuals in low-income states. The increase in loan supply likely leads to amplifying wealth inequality. Consequently, these results offer support for the claim that excessive bank lending to households in low-

income regions may adversely affect household wealth accumulation and worsen income inequality simply because the wealth responses to an increase in debt supply in low and high income locations are not the same. The heterogeneity in the debt consequences on wealth highlights the importance of considering the geographic distribution of debt from a policy perspective. We further maintain that the details of this heterogeneity matter for the reformulation of location-based policies with the potential to reduce inequality. Given that individuals differ according to income and debt, those with low incomes and high debt levels are much more severely affected by collateral liquidation than others.

References

Aguiar, M. and Bils, M. (2015). Has Consumption Inequality Mirrored Income Inequality? *American Economic Review*, 105(9):2725–2756.

Attanasio, O. P. and Pistaferri, L. (2016). Consumption Inequality. *Journal of Economic Perspectives*, 30(2):1–27.

Auclert, A. and Rognlie, M. (2020). Inequality and Aggregate Demand. Working paper.

Berger, D., Bocola, L., and Dovis, A. (2019). Imperfect Risk-Sharing and the Business Cycle. Working paper.

Blundell, R., Pistaferri, L., and Preston, I. (2008). Consumption Inequality and Partial Insurance. *American Economic Review*, 98(5):1887–1921.

Bricker, J., Henriques, A., and Hansen, P. (2018). How much has wealth concen-tration grown in the United States? A re-examination of data from 2001-2013. Finance and Economics Discussion Series 024, Board of Governors of the Federal Reserve System.

Buera, F. J. and Moll, B. (2015). Aggregate Implications of a Credit Crunch: The Importance of Heterogeneity. *American Economic Journal: Macroeconomics*, 7(3):1–42.

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

Cloyne, J., Ferreira, C., and Surico, P. (2016). Monetary Policy when Households Have Debt: New Evidence on the Transmission Mechanism. Discussion paper.

Dynan, K. E., Skinner, J., and Zeldes, S. P. (2004). Do the Rich Save More? *Journal of Political Economy*, 112(2):397–444.

Gabaix, X., Lasry, J.-M., Lions, P.-L., and Moll, B. (2016). The Dynamics of Inequality. *Econometrica*, 84(6):2071–2111.

Guerrieri, L. and Iacoviello, M. (2017). Collateral Constraints and Macroeconomic Asymmetries. *Journal of Monetary Economics*, 90:28–49.

Guerrieri, V. and Lorenzoni, G. (2017). Credit Crises, Precautionary Savings and the Liquidity Trap. *The Quarterly Journal of Economics*, 132(3):1427–1467.

Heathcote, J. and Perri, F. (2018). Wealth and Volatility. *The Review of Economic Studies*, 85(4):2173–2213.

Heathcote, J., Storesletten, K., and Violante, G. L. (2009). Quantitative Macroeconomics with Heterogeneous Households. *Annual Review of Economics*, 1:319–354.

Iacoviello, M. (2008). Household Debt and Income Inequality, 1963–2003. *Journal of Money, Credit and Banking*, 40(5):929–965.

Iacoviello, M. (2015). Financial Business Cycles. *Review of Economic Dynamics*, 18(1):140–163.

Jones, C., Midrigan, V., and Philippon, T. (2019). Household Leverage and the Recession. NBER Working paper 16965.

Kaplan, G., Moll, B., and Violante, G. (2018). Monetary Policy According to HANK. *American Economic Review*, 108(3):697–743.

Kaplan, G. and Violante, G. L. (2014). Model of the Consumption Response to Fiscal Stimulus Payments. *Econometrica*, 82(4):1199–1239.

Krueger, D., Mitman, K., and Perri, F. (2016). Macroeconomics and Household Heterogeneity. NBER Working Paper 22319.

Krueger, D. and Perri, F. (2005). Does Income Inequality Lead to Consumption Inequality? Evidence and Theory. *The Review of Economic Studies*, 73(1):163–193.

Krusell, P. and Smith, A. (1998). Income and Wealth Heterogeneity in the Macroeconomy. *Journal of Political Economy*, 106(5):867–896.

Kuhn, M., Schularick, M., and Steins, U. (2019). Income and Wealth Inequality in America, 1949-2016. Working paper.

Mian, A., Rao, K., and Sufi, A. (2013). Household Balance Sheets, Consumption, and the Economic Slump. *The Quarterly Journal of Economics*, 128(4):1687–1726.

Mian, A., Straub, L., and Sufi, A. (2020). The Saving Glut of the Rich and the Rise in Household Debt. NBER Working Paper 26941.

Mian, A. and Sufi, A. (2014). What Explains the 2007-2009 Drop in Employment? *Econometrica*, 82(6):2197–2223.

Miranda-Pinto, J., Murphy, D., Walsh, K. J., and Young, E. (2020). Saving Constraints, Debt, and the Credit Market Response to Fiscal Stimulus. Federal Reserve Bank of Cleveland, Working Paper 20-07.

Robbins, J. (2019). Capital Gains and the Distribution of Income in the United States. In 2019 meeting papers.

Treeck, T. (2014). Did Inequality Cause the US Financial Crisis? *Journal of Economic Surveys*, 28(3):421–448.

Violante, G. L., Kaplan, G., and Mitman, K. (2020). The Housing Boom and Bust: Model Meets Evidence. *Journal of Political Economy*, 128(9).

Online Appendix

Appendix A Model Appendix

This appendix lists the equilibrium equations.

Monetary policy shock $\log(R_t) - \log(R_{ss}) = \rho^p \ (\log(R_{t-1}) - \log(R_{ss})) + \frac{1}{R_{ss}} \epsilon_t$

First-order condition with respect to capital $r^k_{t+1} = \frac{\lambda_t(h) - \beta \ (1-\delta) \ \lambda_{t+1}(h)}{\beta \, \lambda_{t+1}(h)}$

Producer marginal cost $\lambda^p_t = (2-\alpha) \ (1-\alpha)^{\alpha-1} \left(\frac{1}{\alpha}\right)^{\alpha} \frac{\omega_t(l)^{1-\alpha} \, {r^k_t}^{\alpha}}{\omega_t(h)^{\alpha}}$

Euler equation $(-K_t) + \frac{\alpha}{1-\alpha} \frac{\omega_t(l)}{r^k_t} H_t(l) = 0$

Euler equation $(-K_t) + \frac{\alpha}{1-\alpha} \frac{\omega_t(h)}{r^k_t} H_t(h) = 0$

Euler equation $(-H_t(l)) + H_t(h) \frac{\omega_{t-1}(h)}{\omega_t(l)} = 0$

Production function $Y_t = {K_t}^{\alpha} \ (H_t(l) \, H_t(h))^{1-\alpha}$

Capital accumulation $K_t = (1-\delta) \ K_{t-1} + I_t \left(1 - \frac{\kappa^I}{2} \left(\frac{I_t}{I_{t-1}} - 1\right)^2\right)$

First-order condition with respect to consumption in low-income regions $C_t(l) = \frac{1}{\lambda_t(l) \, (1-\tau^c)}$

First-order condition with respect to consumption in high-income regions $C_t(h) = \frac{1}{(1-\tau^c) \ \lambda_t(h)}$

First-order condition with respect to labour in low-income regions $\left(-\chi^l\right) + \frac{\omega_t(l) \, \lambda_t(l)}{H_t^{\phi^l}(l)} = 0$

First-order condition with respect to labour in high-income regions $\left(-\chi^h\right) + \frac{\lambda_t(h) \, \omega_t(h)}{H_t^{\phi^h}(h)} = 0$

Market clearing condition $C_t = Y_t - I_t$

Consumption in low-income regions $C_t(l) = C_t\, S_l$

Consumption in high-income regions $C_t(h) = C_t\, S_h$

Mortgage debt $M_t^m = M_t\, \theta$

Consumptive (non-mortgage) debt $M_t^c = M_t\ (1-\theta)$

Total debt in high-income regions $M_t(h) = M_t^m\, \mu^{mh} + M_t^c\, \mu^{ch}$

Total debt in low-income regions $M_t(l) = M_t^m\, \mu^{ml} + M_t^c\, \mu^{cl}$

Debt-to-income ratio $\zeta = \dfrac{M_t^m + M_t^c}{\iota_t(l) + \iota_t(h)}$

Debt-to-income ratio in high-income regions $\zeta_t(h) = \dfrac{M_t(h)}{\iota_t(h)}$

Debt-to-income ratio in low-income regions $\zeta_t(l) = \dfrac{M_t(l)}{\iota_t(l)}$

Collateral constraints on mortgage loans in high-income regions $\dfrac{1}{1+\eta^m} V_t^m(h) = M_t^m \mu^{mh}$

Collateral constraints on mortgage loans in low-income regions $\dfrac{1}{1+\eta^m}\, V_t^m(l) = M_t^m\, \mu^{ml}$

Collateral constraints on consumptive loans in high-income regions $\dfrac{1}{1+\eta^c}\, V_t^c(h) = M_t^c\, \mu^{ch}$

Collateral constraints on consumptive loans in low-income regions $\dfrac{1}{1+\eta^c} V_t^c(l) = M_t^c\, \mu^{cl}$

Household personal income in the wealthiest regions $\iota_t(l) = \omega_t(l)\, H_t(l)$

Household personal income in impoverished regions $\iota_t(h) = \omega_t(h)\, H_t(h)$

Treasury securities $B_t = \iota_t(h)\iota_t(l)\varrho$

Fiscal rule $B_t - B_{ss} = \rho^b\, (GI_t - GI_{ss})$

Wealth variation in low-income regions $\Delta W_t(l) = \beta_0^l + \beta_1^l M_t(l) + \epsilon_t^l$

Wealth variation in high-income regions $\Delta W_t(h) = \beta_0^h + \beta_1^h M_t(h) + \epsilon_t^h$

Appendix B Data Appendix

Table 9: Data Sources

Variables	Data Sources Description
Panel A: *Federal Deposit Insurance Corporation (FDIC)*	
Loans to individuals (lncon)	Loans to individuals for household, family, and other personal expenditures, including outstanding credit card balances and other secured and unsecured consumer loans (FDIC, SDI 1997-2018).
Loans to individuals (charged off) (drcon)	Total loans to individuals for household, family, and other personal expenditures that have been charged off and debited to the allowance for loan and lease losses established by the institution (FDIC, SDI 1997-2018).
Liquidated individual loan (crcon)	Total recoveries of loans to individuals for household, family, and other personal expenditures that have been credited to the allowance for loan and lease losses established by the institution (FDIC, SDI 1997-2018).
Housing loans (lnre)	Total real estate loans , Loans secured primarily by real estate (FDIC, SDI 1997-2018).
Housing loan (charged off) (drre)	Total amount of charged-off loans secured by real estate debited to the allowance for loan and lease losses established by the institution (FDIC, SDI 1997-2018).
Liquidated housing loan (crre)	The total amount of recoveries of loans secured by real estate credited to the allowance for loan and lease losses established by the institution (FDIC, SDI 1997-2018).
Panel B: *Bureau of Economic Analysis (BEA)*	
Personal income (SQINC1)	Personal income (in millions of US dollars) represents income from wages and salaries, business ownership, dividends, social security, and other sources. The data are quarterly and seasonally adjusted. All dollar estimates are in current dollars (not adjusted for inflation) (BEA, 1997-2018).
Personal consumption expenditures (PCE)	Consumer spending is the value of goods and services purchased at the state level. Annual data are transformed into quarterly data (BEA, 1997-2018).
Panel C: *Panel Study of Income Dynamics (PSID)*	
Wealth variable including equity (IMP WEALTH W/ EQUITY (WEALTH2))	Households report their wealth level including equity over the period 1999 to 2017. The data is collected in waves and the series includes: IMPWEALTH W EQUITY WEALTH2 99, IMPWEALTH W EQUITY WEALTH2 2001, IMPWEALTH W EQUITY WEALTH2 2003, IMPWEALTH W EQUITY WEALTH2 2005, IMPWEALTH W EQUITY WEALTH2 2007, IMPWEALTH W EQUITY WEALTH2 2009, IMPWEALTH W EQUITY WEALTH2 2011, IMPWEALTH W EQUITY WEALTH2 2013, IMPWEALTH W EQUITY WEALTH2 2015, IMPWEALTH W EQUITY WEALTH2 2017.
All family debt (IMP VALUE OTH DEBT (W39)):	Housholds report their debt level over the period 1999 to 2017. The series includes: IMPVALUEOTHDEBT W39 99, IMPVALUEOTHDEBT W39 01, IMPVALUEOTHDEBT W39 03, IMPVALUEOTHDEBT W39 05, IMPVALUEOTHDEBT W39 07, IMPVALUEOTHDEBT W39 09, IMPVALUEOTHDEBT W39 2011, IMPVALUEOTHDEBT W39 2013, IMPVALUEOTHDEBT W39 2015, IMPVALUEOTHDEBT W39 2017

Appendix C Debt and Personal Income across US Regions.

In this section, we study the geographical distribution of household loans and personal income in the United States and compare the growth rate of personal income in 2017 at the county level. Moreover, we repeat the exercise for household loan growth rates across counties. We obtain a concrete example of heterogeneity in terms of household debt and personal income.

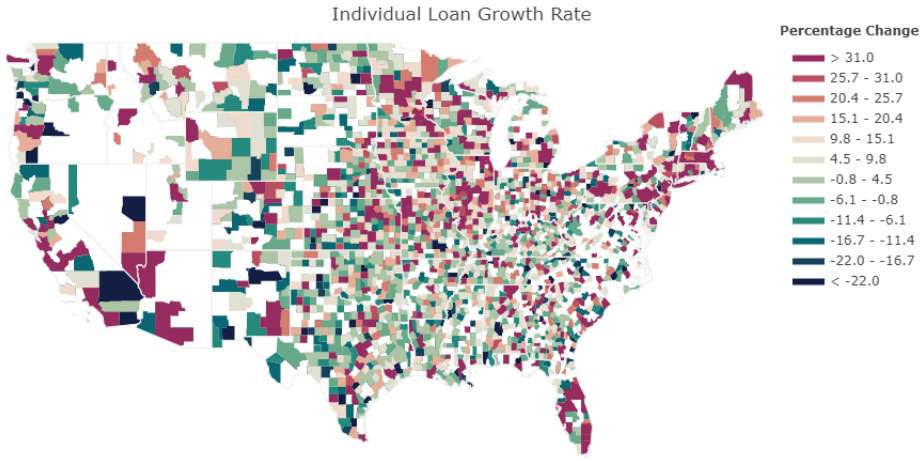

Figure 12: Percent Change in Individual Loans across US Counties, 2016–2017 (Annual)

Note: This map presents US counties coloured based on the per cent change rate of individual loans, which illustrates the growth and decline in individual loans supplied by each banking sector in US counties in 2017. The data were retrieved from the Federal Deposit Insurance Corporation.

Figure 12 displays the percentage change in individual loans in 2017 across counties. It appears that the lower growth rate of household loans is concentrated in the Southeast and Northwest United States. For instance, states with negative or low household debt growth rates include California, Mississippi, North Dakota, South Dakota, Texas, and New Mexico. Individual loans have reached the highest growth rates in states such as Illinois, Iowa, Missouri, Minnesota, Kansas, New Jersey, Pennsylvania, Florida, New York, and Ohio. The growth rate of individual loans in banks differs from one county to another (Figure 12). A high growth rate of household loans is concentrated in the Northeast, generally in large cities and metropolitan areas. This result clearly illustrates

an economy with an unequal distribution of debt growth rates that can increase income inequality and the gap between wealthy and poor regions.

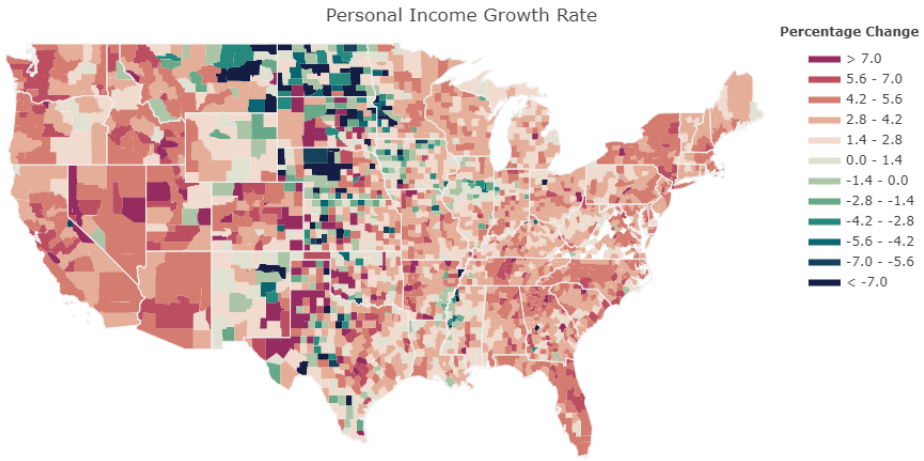

Figure 13: Percent Change in Personal Income across US Counties, 2016-2017 (Annual)

Note: This map presents US counties coloured based on the percent change rate of personal incomes, illustrating the growth and decline in aggregate personal income by county in 2017. The data were retrieved from the Bureau of Economic Analysis.

In the figure, we illustrate the personal income growth rate across US counties in 2017. A closer examination of Figure 13 indicates the presence of regional disparities in personal income that reflect the differences within and between states. Specifically, a high growth rate of personal income is concentrated in Texas, Florida, California, Oklahoma, Utah, Nevada, New York, North Carolina, and South Carolina. A low or negative growth rate of personal income is concentrated in Nebraska, South Dakota, North Dakota, Kansas, Iowa, Illinois, and Montana. This measure is vital to any attempt to understand the current US consumer income across the country.

Appendix D Additional Regressions Results

D.1 Housing Debt and Wealth

Table 10: Results of Two-stage Least Squares Using Instrumental Variable Estimation of the Relationship Between Mortgage Loan and Wealth Variation

	Dependent Variable: Δ Wealth in States with the Lowest Per Capita Income Instrument: Loan Charge-off
Constant	128596.79***
	(5.56)
Mortgage loan	0.10
	(0.38)
Liquidated Loan (mortgage loan)	-177.49
	(-1.27)
Covariance Type:	Unadjusted
F-statistic:	0.9442
No. Observations:	660

[a] Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 11: Results of Ordinary Least Squares Estimation of the Relationship Between Mortgage Loan and Wealth Variation

	Dependent Variable: Δ Wealth in States with the Lowest Per Capita Income			
	(1)	(2)	(3)	(4)
Const	168909.06***	158783.13***	165795.82***	153066.11***
	(8.57)	(8.05)	(8.62)	(7.93)
Liquidated Loan	147.04	261.50		
	(0.73)	(1.39)		
Mortgage Loan	-0.71***	-0.65***	-0.55***	-0.37***
	(-2.76)	(-2.65)	(-3.83)	(-2.62)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	Time		Time	
F-statistic:	7.598	4.414	14.67	6.870
No. Observations:	660	660	660	660

[a] Ordinary least squares regression over the subsample of states with the lowest per capita income, (1) with time fixed effects and controlling for liquidated loan; (2) controlling for liquidated loan; (3) with time fixed effects; (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 12: Results of Two-stage Least Squares Using Instrumental Variable Estimation of the Relationship Between Mortgage Debt and Wealth Variation

	Dependent Variable: Δ Wealth in States with the Highest Per Capita Income Instrument: Loan Charge-off					
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	225546.70***	218137.57***	206703.79***	189504.42***	168666.71***	162556.59***
	(3.97)	(4.08)	(5.88)	(5.59)	(2.96)	(2.98)
Liquidated Loan	1963.41***	2234.66***				
	(4.64)	(5.69)				
Mortgage loan	-0.88	-0.94	0.45	0.66*	0.92	0.99*
	(-1.26)	(-1.49)	(1.21)	(1.89)	(1.57)	(1.82)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	Time		State, Time	State	Time	
F-statistic:	12.03	17.96	1.457	3.60	2.45	3.30
No. Observations:	426	426	426	426	426	426

[a] Two-stage least squares regression using instrumental variable over the subsample of states with the highest per capita income, (1) with time fixed effects and controlling for liquidated loan; (2) with no fixed effects and controlling for liquidated loan; (3) with time and state fixed effects; (4) with state fixed effects; (5) with time fixed effects;(6) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 13: Results of Ordinary Least Squares Estimation of the Relationship Between Mortgage Debt and Wealth Variation

	Dependent Variable: Δ Wealth in States with the Highest Per Capita Income			
	(1)	(2)	(3)	(4)
Constant	181936.56***	181021.67***	182268.29***	182295.41***
	(4.78)	(4.72)	(4.77)	(4.74)
Loan Charge-off			3.50	13.48
			(0.11)	(0.48)
Mortgage Loan	0.76***	0.77***	0.74**	0.69**
	(2.82)	(2.87)	(2.34)	(2.26)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	Time		Time	
F-statistic:	7.951	8.224	3.972	4.221
No. Observations:	426	426	426	426

[a] Ordinary least squares regression over the subsample of states with the highest per capita income, (1) with time fixed effects and controlling for loan charge-offs; (2) with no fixed effects; (3) with time fixed effects and controlling for loan charge-off; (4) with no fixed effects and controlling for loan charge-offs. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

D.2 Individual Loan (credit card and auto loan) and Wealth

Table 14: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable: Δ Wealth in States with the Highest Per Capita Income			
	(1)	(2)	(3)	(4)
Constant	155283.84***	152295.51***	118368.52***	118163.01***
	(7.28)	(6.98)	(3.61)	(3.57)
Individual Loan	3.43***	3.55***	4.87***	4.88***
	(7.05)	(7.25)	(8.42)	(8.42)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	State	Time	
F-statistic:	49.64	52.49	70.94	70.93
No. Observations:	426	426	426	426

[a] Ordinary least squares regression over the subsample of states with the highest per capita income, (1) with time and state fixed effects; (2) with state fixed effects; (3) with time fixed effects; (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 15: Results of Two-stage Least Squares Using Instrumental Variable Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable: Δ Wealth in States with the Highest Per Capita Income Instrument: Loan Charge-off		
	(1)	(2)	(3)
Constant	154363.15***	113718.12***	115967.16***
	(7.29)	(3.45)	(3.48)
Individual Loan	1.73**	6.11***	5.49***
	(2.13)	(5.22)	(4.70595)
Liquidated Loan	261.26***	-158.45	-78.69
	(2.61)	(-1.21)	(-0.60)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	
F-statistic:	28.59	36.25	35.59
No. Observations:	426	426	426

[a] Two-stage least squares regression using instrumental variable over the subsample of states with the highest per capita income, (1) with time and state fixed effects and controlling for liquidated loan; (2) with time fixed effects and controlling for liquidated loan; (3) controlling for liquidated loan. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 16: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable:			
	Δ Wealth in States with the Lowest Per Capita Income			
	(1)	(2)	(3)	(4)
Constant	138797.01***	141199.26***	125302.46***	134185.42***
	(10.48)	(7.84)	(9.26)	(7.42)
Individual Loan	-0.61*	-0.73*	0.08	-0.38
	(-1.68)	(-1.95)	(0.21)	(-1.01)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	2.835	3.806	0.04517	1.023
No. Observations:	660	660	660	660

[a] Ordinary least squares regression over the subsample of states with the lowest per capita income, (1) with time and state fixed effects; (2) with time fixed effects; (3) with state fixed effects; (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 17: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable:		
	Δ Wealth in States with the Lowest Per Capita Income		
	(1)	(2)	(3)
Constant	142993.56***	157224.58***	147299.24***
	(10.75)	(8.72)	(8.12)
Individual Loan	-2.86***	-6.16***	-5.00***
	(-2.88)	(-5.15)	(-4.24)
Liquidated Loan	386.48**	878.14***	754.57***
	(2.43)	(4.77)	(4.12)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	
F-statistic:	4.38	13.33	9.02
No. Observations:	660	660	660

[a] Ordinary least squares regression over the subsample of states with the lowest per capita income, (1) with time and state fixed effects and controlling for liquidated loan; (2) with time fixed effects and controlling for liquidated loan; (3) with no fixed effects and controlling for liquidated loan. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 18: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable:	
	Δ Wealth in States with the Lowest Per Capita Income	
	(1)	(2)
Constant	149123.31***	140124.17***
	(8.28)	(7.74)
Individual Loan	-3.46***	-2.55***
	(-3.95)	(-3.01)
Loan Charge-off	79.90***	64.53***
	(3.44)	(2.85)
Covariance Type:	Unadjusted	Unadjusted
Fixed Effects:	Time	
F-statistic:	7.85	4.58
No. Observations:	660	660

[a] Ordinary least squares regression over the subsample of states with the lowest per capita income, (1) with time fixed effects and controlling for loan charge-off; (2) with no fixed effects and controlling for loan charge-off. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 19: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable:			
	Δ Wealth in States with the Highest Per Capita Income			
	(1)	(2)	(3)	(4)
Constant	116371.45***	131470.50***	108500.97***	127018.38***
	(5.86)	(4.15)	(5.36)	(3.97)
Individual Loan	4.95***	4.36***	5.26***	4.54***
	(10.87)	(8.75)	(11.49)	(9.08)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	118.1	76.61	132.1	82.44
No. Observations:	426	426	426	426

[a] Ordinary least squares regression over the subsample of states with the highest per capita income, (1) with time and state fixed effects; (2) with time fixed effects; (3) with state fixed effects; (4) with no fixed effects. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 20: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable:			
	Δ Wealth in States with the Highest Per Capita Income			
	(1)	(2)	(3)	(4)
Constant	99371.08***	113776.16***	93416.68***	110399.46***
	(5.15204)	(3.66739)	(4.73)	(3.519)
Individual Loan	10.85***	11.48***	10.64***	11.28***
	(9.86)	(7.56)	(9.72)	(7.50)
Liquidated Loan	-788.59***	-968.44***	-720.88***	-917.89***
	(-5.84)	(-4.95)	(-5.37)	(-4.74)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	81.21	52.77	84.99	54.56
No. Observations:	426	426	426	426

[a] Ordinary least squares regression over the subsample of states with the highest per capita income, (1) with time and state fixed effects and controlling for liquidated loan; (2) with time fixed effects and controlling for liquidated loan; (3) with state fixed effects and controlling for liquidated loan; (4) with no fixed effects and controlling for liquidated loan. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Table 21: Results of Ordinary Least Squares Estimation of the Relationship Between Individual Loan and Wealth Variation

	Dependent Variable:			
	Δ Wealth in States with the Highest Per Capita Income			
	(1)	(2)	(3)	(4)
Constant	113617.09***	138584.55***	105616.83***	132173.83***
	(5.67)	(4.34)	(5.19)	(4.10)
Individual Loan	5.52***	2.86***	5.88***	3.44***
	(7.86)	(2.75)	(8.48)	(3.38)
Loan Charge-off	-12.00	32.15	-13.09	23.53
	(-1.06)	(1.64)	(-1.18)	(1.24)
Covariance Type:	Unadjusted	Unadjusted	Unadjusted	Unadjusted
Fixed Effects:	State, Time	Time	State	
F-statistic:	59.64	39.81	66.79	42.04
No. Observations:	426	426	426	426

[a] Ordinary least squares regression over the subsample of states with the highest per capita income, (1) with time and state fixed effects and controlling for loan charge-off; (2) with time fixed effects and controlling for loan charge-off; (3) with state fixed effects and controlling for loan charge-off; (4) with no fixed effects and controlling for loan charge-off. Statistical significance (t statistics in parentheses): 0.1*, 0.05**, 0.01***. Data sources: Federal Deposit Insurance Corporation and Bureau of Economic Analysis (1997-2018).

Appendix E Debt and Income: What Do the Data Reveal?

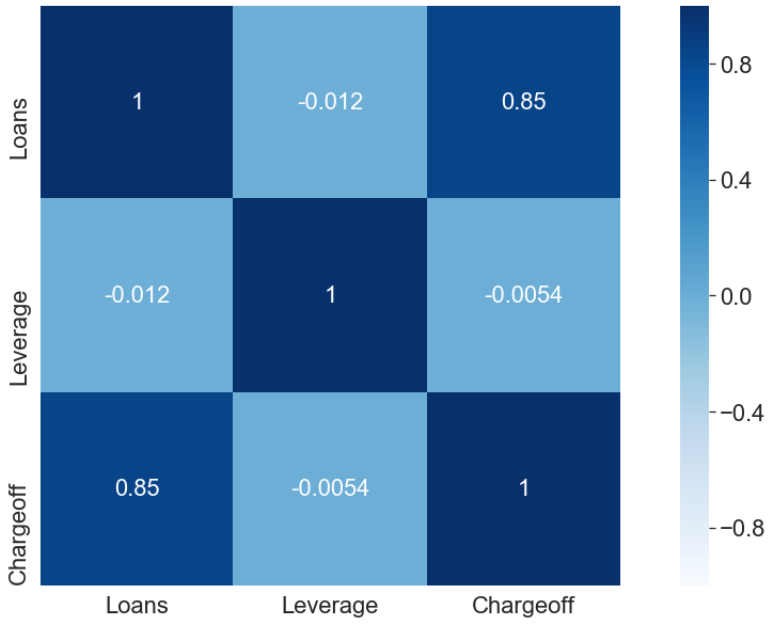

Figure 14: Correlation among Loans, Charge-offs, and Leverage Q1 2015-Q4 2018

Note: This figure reports the Pearson correlation coefficient between individual loans, total loans to individuals that have been charged off by the bank, and bank leverage ratios. The bank data were retrieved from the Federal Deposit Insurance Corporation from Q1 2015 to Q4 2018.

Correlation Between Individual Debt, Uncollectible Loans, Bank Leverage Ratios. We investigated the association between loan charge-offs, household lending, and bank leverage. Figure 14 displays a strong positive correlation between individual loans and uncollectible debt. One possible interpretation is that banks increase their supply of loans and may face a risk of non-payment of debt proportional to the individual loans. We document a weak negative correlation between bank leverage and individual loans and between bank leverage and loan charge-offs (-0.012 and -0.0054, respectively). The relatively low empirical correlation between the leverage level and individual loans shows that bank leverage plays a minimal role.

Household Loans and Charge-off by Type of Banks and Over Time. Tis section aims to investigate the association between household loans and the uncollectible debt in different

bank classes.

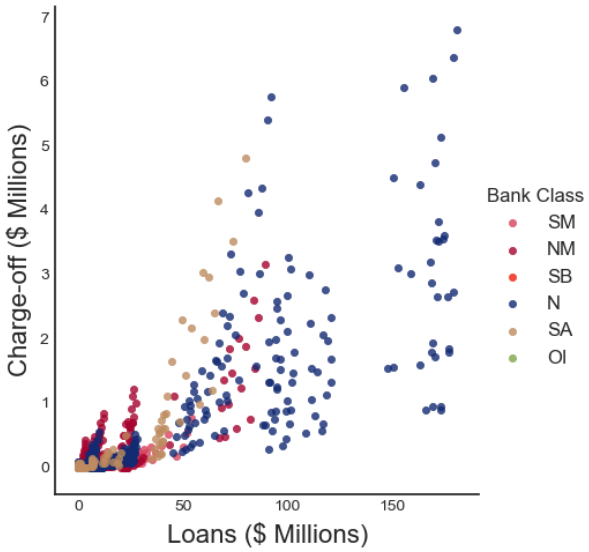

Figure 15: Household Loans and Charge-offs Q1 2015–Q4 2018

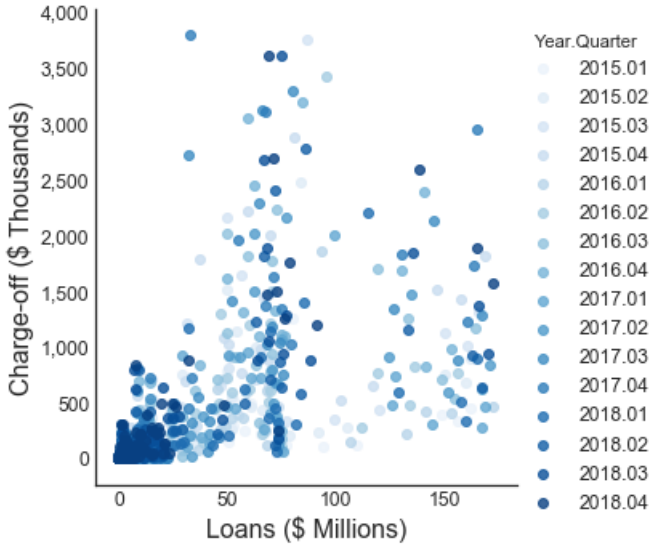

Figure 16: Trends in Household Loans and Charge-offs Q1 2015–Q4 2018

Note: These figures display the relationship between individual loans and total loans to individuals who have been charged off by the bank. The data were retrieved from the Federal Deposit Insurance Corporation from Q1 2015 to Q4 2018.

Figure 15 highlights the positive relationship between lending to individuals and the level of loan charge-offs, conditioned on the class of banks. We documented that national commercial banks (N) supervised by the Office of the Comptroller of the Currency (OCC) tend to supply more loans to individuals than state savings associations (SA). National commercial banks (N) face a higher level of uncollectible debt than savings associations. Intuitively, high levels of uncollectible debt can be a potential source of financial stress for the banking sector. The figure illustrates some of the heterogeneity that exists among banks by showing the difference in the charge-off levels and household debt across different financial institutions types, which can lead to different outcomes. The bottom of the graph indicates that banks succeeded in maintaining a low level of uncollectible debt when the level of individual loans is low, and it appears that non-member commercial banks poorly manage the level of loan charge-offs. At the top of the graph, national commercial banks and savings associations dominate household loan supply. As long

as these banks raise household loans, their uncollectible debt level grows faster. The implication is that household debt can be a real problem if not managed carefully, and banks should control household debt, given the level of uncollectible debt.

There is a growing concern among policy-makers regarding the surge in household over-indebtedness. An interesting observation from bank-level data throughout 2015 to 2018 is that the supply of loans increased in high-income regions and remained stagnant in low-income regions. Figure 16 reveals that an uncertain environment prompts banks to lower their household loans from previous years in an attempt to reduce the risks that may be derived from some segment of individual loans, leaving banks less resilient to economic shocks.

In summary, these observations strongly indicate that an uncertain environment prompts financial institutions to lower the supply of household loans they offer and reduce the risk that may come from uncollectible debt.

Household Loans and Personal Income by Type of Banks. Figure 17 illustrates the level of individual loans and personal income conditioned on bank classification. It is useful to examine the distribution of state personal income as a function of bank classes to understand how different bank types are located in high- or low-income regions. The most dominant banks in low-income regions are non-members and savings banks, whereas national commercial banks dominate high-income regions. The top of the figure indicates that the supply of individual loans by member commercial banks (SM) is greatest in states with high incomes, whereas non-member banks (NM), national commercial banks (N), and savings associations (SA) lend more to individuals in poor regions.

Charge-offs and Personal Income by Bank Type. Figure 18 demonstrates that banks located in low-income regions suffer the most from a high level of delinquent debt. For instance, the uncollectible debt level is the highest for non-member banks (NM), national commercial banks (N), and savings association (SA). In the previous section, these same

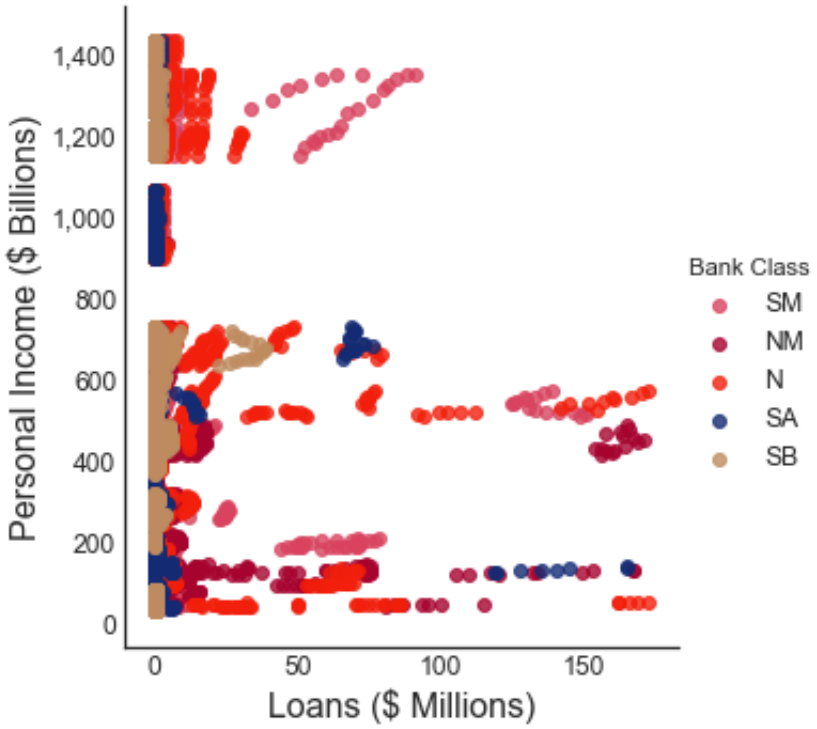

Figure 17: Household Loans and Personal Income Q1 2015–Q4 2018

Note: This figure presents the relationship between individual loans and personal income, distribution of individual loans, and distribution of personal income by bank type. The data were retrieved from the Federal Deposit Insurance Corporation and the Bureau of Economic Analysis from Q1 2015 to Q4 2018.

classes of banks were shown to lend excessively to individuals in low-income regions.

As depicted in Figure 18, the loan charge-offs vary across bank types and regions. In high-income states, loan charge-offs are the highest for member commercial banks (SM). Banks that operate in high-income regions maintain a reasonable uncollectible debt level compared to banks in low-income states.

Personal Income and Uncollectible Debt over Time. Figure 19 depicts the relationship and dynamics between regional personal income and the uncollectible debt level from 2015 to 2018. Examining at the distribution of personal income from 2015 to 2018, the bottom of the figure presents an increase in the gap in regions given the aggregate personal income level. Some banks experienced a shift in high personal income brackets.

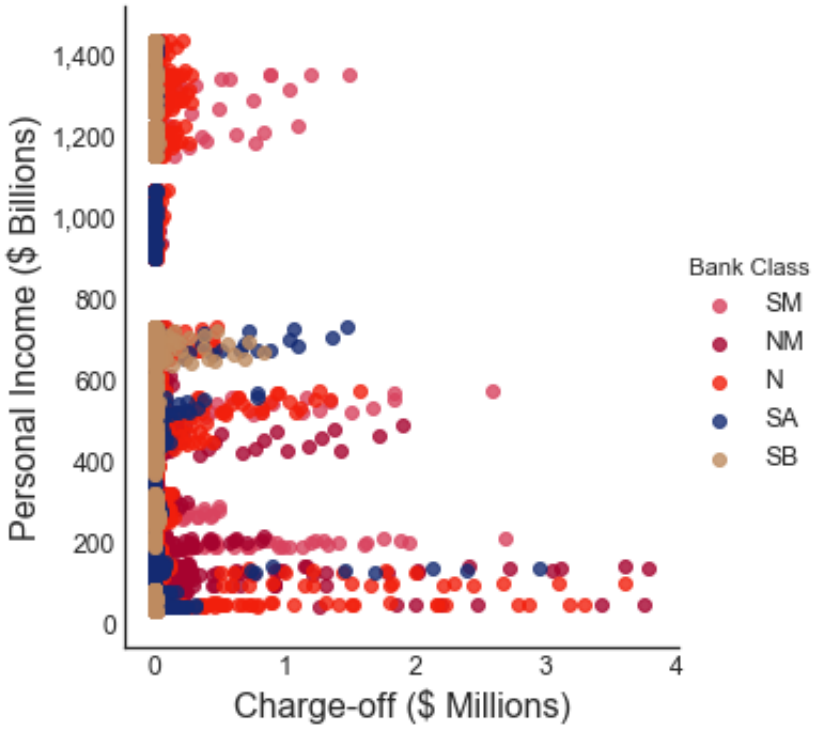

Figure 18: Personal Income and Charge-off Q1 2015–Q4 2018

Note: This figure illustrates the relationship between individual loans charged off and personal income, distribution of uncollectible loans, and distribution of personal income by bank type. The data were retrieved from the Federal Deposit Insurance Corporation and the Bureau of Economic Analysis from Q1 2015 to Q4 2018.

The top of Figure 19 illustrates the increase in aggregate personal income, especially in high-income states. The loan charge-offs level were pushed slightly by the increasing individual loan supply in high-income regions. From 2015 to 2018, the uncollectible debt drops significantly in low-income regions, whereas the aggregate personal income in this region remains stagnant.

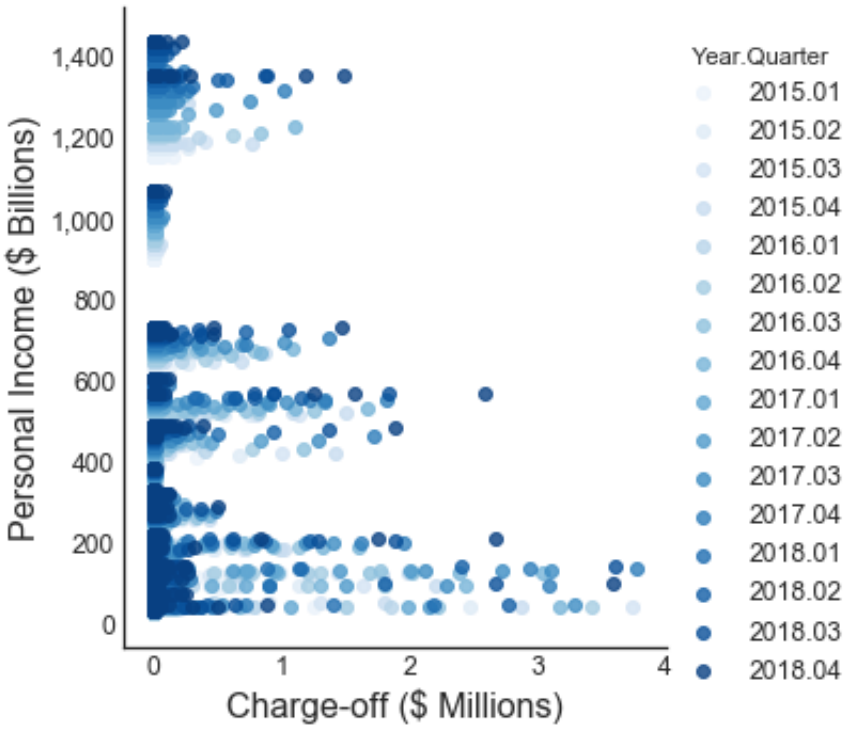

Figure 19: Trends in Personal Income and Charge-offs Q1 2015–Q4 2018

Note: This figure presents the relationship between uncollectible loans and personal income over time, the distribution of uncollectible loans over time, and the distribution of personal income over time. The data were retrieved from the Federal Deposit Insurance Corporation and the Bureau of Economic Analysis from Q1 2015 to Q4 2018.

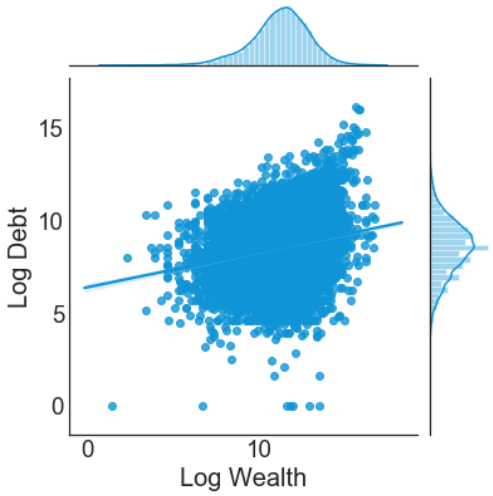

Figure 20: Log Wealth vs Log Debt at the Bottom of Income Distribution

Figure 21: Log Wealth vs Log Debt at the Top of Income Distribution

Note: Based on the data from the Panel Study of Income Dynamics.