Distributive Effects of Banking Sector Losses*

Caterina Mendicino
European Central Bank

Lukas Nord
University of Pennsylvania

Marcel Peruffo
University of Sydney

November 6, 2024

Abstract

This paper examines the impact of banking sector losses on inequality in a quantitative model with income and portfolio heterogeneity among households and financial intermediation frictions. Consistent with U.S. data, the model predicts that low-income households are disproportionately affected. Their consumption declines significantly due to higher borrowing costs and labor income losses. High-income households are better insured through liquid assets. About 20% of them *benefit* from temporary asset price declines and higher future returns by adjusting their illiquid savings. These portfolio adjustments shape aggregate dynamics in the presence of financial frictions, by affecting the relative response of consumption and investment to aggregate shocks.

Keywords: Banking Crises, Financial Frictions, Household Heterogeneity, Portfolio Choice.
JEL: D31, E21, G01, G21.

*We are grateful to Árpád Ábrahám, Christian Bayer, Edouard Challe, Russell Cooper, Gauti Eggertsson, Axelle Ferriere, Amy Handlan, Urban Jermann, Nobu Kiyotaki, Yann Koby, Dirk Krueger, Alessandro Lin, Pascal Michaillat, Ben Moll, Josef Platzer, Vincenzo Quadrini, Luca Riva, Aditi Singh, as well as conference and seminar participants at Brown University, European Central Bank, European University Institute, Boston Fed, Bank of England, Oxford University, Bank of Canada, University of Delaware, PUC Rio, Singapore University, University of Sydney, 24th CBMM Workshop, 2021 CEF, 2021 EEA, 3rd WMMF Conference, SAET, VfS, WIEM meeting and 2021 BSE Summer Forum, 2022 Oslo Macro Conference, 2023 Konstanz Seminar for useful comments and discussion. The views expressed are those of the authors and do not reflect the views of the ECB or the Eurosystem.

1 Introduction

Are the costs of bank distress distributed equally among households? In the aftermath of the global financial crisis, policymakers have turned their attention to the consequences of financial distress on the real economy and its implications for inequality (e.g. Mersch, 2014; Bernanke, 2018; Draghi, 2016). Inequality is now at the forefront of the policy debate (e.g. BIS, 2021).[1] Although we have gained important insights into how monetary policy and business cycle fluctuations affect inequality (e.g. Krueger *et al.*, 2016; Kaplan *et al.*, 2018; Auclert *et al.*, 2018), little is still known about how different groups of households are impacted by banking sector distress. A clear assessment of the heterogeneous effects of banking crisis is crucial for understanding which households ultimately benefit from government support to distressed financial institutions.

Addressing this question is challenging for at least two reasons. First, general equilibrium considerations are critical since only some households are directly exposed to losses in the banking sector, while all households are affected indirectly by their impact on the broader economy. Distress in the banking sector leads to reduced credit supply, rising borrowing costs, falling asset prices and widespread economic downturns (e.g. Reinhart and Rogoff, 2009; Laeven and Valencia, 2013; Baron *et al.*, 2021). Capturing these general equilibrium effects of bank distress requires an explicit model of the banking sector (e.g. Gertler and Kiyotaki, 2010). Second, households are heterogeneously exposed to the general equilibrium channels of bank distress, depending on the composition of their income between labor earnings and financial returns, whether they are savers or borrowers, and the composition of their savings portfolios. Capturing how these different channels impact households requires a framework that incorporates rich heterogeneity (e.g. Kaplan and Violante, 2014; Kaplan *et al.*, 2018).

This paper provides a quantitative general equilibrium framework suitable for studying the distributive effects of bank losses.[2] The model captures heterogeneity in households' exposure to a wide range of general equilibrium channels. Our findings indicate that, on average, households lose from distress in the banking sector. A more disaggregated analysis reveals significant heterogeneity in effects across households. As a result, inequality increases following an exogenous reduction in bank equity. Consumption of low-income households declines twice as much as that of high-income households over three years, in line with empirical evidence from local projection estimates on U.S. data. We use the model to construct counterfactuals and isolate individual transmission channels. Higher borrowing costs and labor income losses shape the consumption response of low-income households. High-income households are better able to self-insure through their holdings

[1] The issue of inequality was also a prominent topic of discussion in the 2020 monetary policy strategy reviews of the Federal Reserve and the ECB (see e.g. Powell, 2020; Lagarde, 2020).

[2] In line with Baron *et al.* (2021), we examine the implications of banking distress through the lens of bank equity declines.

of liquid assets. In addition, part of the initial decline in consumption of high-income households is due to portfolio adjustments and increased savings to take advantage of temporary asset price declines and higher future returns. Using a model enables us to compute the welfare effects of banking sector distress. We show that welfare losses are more unevenly distributed than initial consumption responses. The top 1% of the income distribution are directly affected by a reduction in bank dividends. Still, approximately 20% of households with disproportionately high income and wealth benefit overall, driven by adjustments to their savings portfolios. We show that these portfolio adjustments shape aggregate dynamics in the presence of financial frictions, making aggregate consumption more responsive and aggregate investment less responsive to aggregate shocks.

We build a two-asset heterogeneous agent model with an explicit banking sector. Households are heterogeneous in labor income, wealth, and portfolio composition. They face uninsurable income risk and choose how much to save and in which type of asset. They can save or borrow through a one-period liquid asset, intermediated by banks. In addition, they can also invest directly in productive capital, which is illiquid due to portfolio adjustment cost and is therefore adjusted infrequently (e.g., Kaplan and Violante, 2014; Bayer *et al.*, 2019). All households receive labor earnings, and the top 1% of the income distribution receive additional income from dividends. Banks use equity and deposits to invest in productive capital and to grant short-term consumer loans. Because of limited enforcement problems in the deposit market (see e.g. Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Maggiori, 2017), banks face an endogenous leverage constraint. Competitive intermediate goods firms produce using labor and productive capital as inputs. Monopolistic final goods firms differentiate intermediate goods into final goods. Capital producers transform the final good into capital goods.

The model captures rich interactions between households' financial decisions and banks' balance sheets. Banks' leverage constraint generates an endogenous spread between the expected return on bank assets and deposits. Portfolio adjustment costs and the resulting illiquidity of capital holdings for households allow the model to sustain this spread in equilibrium without further assumptions on households' ability to evaluate and monitor capital projects.[3] They are willing to accept a liquidity premium on deposits, which they use to insure against idiosyncratic income risk. In addition, the model generates general equilibrium effects of bank distress on labor income, asset prices, and interest rates. This allows us to isolate and quantify the contribution of both direct (bank dividends) and indirect (asset prices, borrowing costs, income) transmission channels of bank distress to household consumption and welfare. The model also features substantial heterogeneity in how households are exposed to these transmission channels, depending

[3]Papers in the financial intermediation literature commonly either exclude direct capital holdings by households exogenously (e.g. Gertler and Karadi, 2011; Gertler and Kiyotaki, 2010) or assume households to be less efficient in managing capital projects than banks (e.g. Gertler *et al.*, 2019).

on whether they are savers or borrowers, their income composition (labor vs. financial), and the composition of their savings portfolio (liquid vs. illiquid). This enables us to examine the distributional effects of banking sector losses.

The model matches targeted moments from macro, banking and financial data for the U.S.. It also closely replicates additional untargeted moments of the joint distribution of income and wealth, as well as differences in portfolio composition along the income distribution. The model's ability to accurately capture the heterogeneity across households observed in the data is an important validation for this paper, as it ensures that the framework captures well households' exposure to banking sector losses.

Bank distress in the model is triggered by an exogenous loss of bank equity.[4] We model this shock as an unanticipated MIT-shock, motivated by the observation that substantial losses in the banking sector are rare events. A sudden decline in bank equity reduces banks' ability to intermediate funds from savers to firms and households. The overall reduction in banks' net worth depends not only on the initial exogenous shock, but also on an endogenous financial amplification mechanism. Due to the leverage constraint, the initial loss in bank equity leads to a reduction in banks' balance sheets, which in turn results in a decline in asset prices. This triggers additional losses to bank equity and further weakens banks' balance sheets. As a result, borrowing costs rise and aggregate productive capital falls, leading the economy into an economic contraction.

While these implications of bank distress for aggregate economic outcomes are widely studied (see e.g. Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Brunnermeier and Sannikov, 2014; Iacoviello, 2015; He and Krishnamurthy, 2019; Mendicino *et al.*, 2024), their distributive effects on household consumption and welfare are largely unexplored. We make progress in this direction and assess the unequal incidence of bank distress by focusing on differences in households' consumption response along the income distribution. While the consumption of all income groups declines on impact before it gradually recovers, households in the bottom quintile of the income distribution experience the largest decline. Their consumption falls by a cumulative 6.2 percent over twelve quarters, about twice that of the households in the top income quintile.

We validate these model predictions against empirical evidence, using consumption data from the Consumer Expenditure Survey as in Coibion *et al.* (2017) and bank equity returns provided by Baron *et al.* (2021). We estimate local projections of consumption by income quintile in response to changes in bank equity returns, controlling for the return on non-financial equities. Our results capture the response to banking distress over and above the effects of overall economic conditions. The estimates confirm significant inequality in how banking sector distress impacts households. The model predictions are

[4] Baron *et al.* (2021) use historical data to show that large bank equity declines are associated with substantial contractions in credit and economic activity. They further show that while panics amplify the effects of bank equity declines, they are not a prerequisite for severe economic consequences. For tractability, our analysis focuses on bank equity losses that are not accompanied by panics.

both qualitatively and quantitatively in line with the estimated distributive impact of banking sector distress.

The model allows us to isolate the transmission channels behind households' consumption responses. We decompose changes in consumption into the contributions of general equilibrium movements in asset prices, interest rates and labor income by simulating the behavior of households under counterfactual price paths as in Kaplan *et al.* (2018). Low-income households are particularly exposed to fluctuations in borrowing costs and labor income. They are often borrowers, poorly insured against income shocks through liquid savings, and highly dependent on labor income to finance their consumption. High-income households are less exposed to the fall in labor income and better able to self-insure through their holdings of liquid assets. A substantial part of the initial decline in their consumption is driven by an increase in their direct investment in capital in response to temporarily low asset prices and high future returns.

Our model allows us to translate consumption responses of households into welfare changes. On average, households would be willing to permanently forgo 0.20 percent of their consumption to avoid the consequences of a 10 percent decline in bank equity. While those in the lowest income quintile would give up 0.64 percent of consumption to avoid the shock, households in the highest quintile experience no welfare loss on average. A small fraction of the wealthiest households hold claims to bank dividends and see their welfare reduced substantially due to their direct exposure to the banking sector. Still, we find that 18% of households experience welfare gains in response to bank losses. These are typically high-income, high-wealth households, with a high proportion of their income from financial sources. These results emphasize that the welfare effects of bank distress are more unevenly distributed than the initial responses of consumption.

Households' portfolio adjustments are the main factor explaining why the welfare effects are distributed more unevenly. Despite substantial capital holdings, high-income households are not necessarily affected by a temporary decline in asset prices. Losses would only materialize if they were to dis-save during a period of low asset prices. Instead, they leverage their ability to increase their capital holdings at low prices and earn high returns going forward. While the increase in savings reduces their consumption initially in response to the shock, it sustains higher consumption in the future. This mechanism is consistent with the role of net savings position for the distributive impact of asset price movements emphasized in Del Canto *et al.* (2023) and Fagereng *et al.* (2024). It explains why the heterogeneity in welfare changes – which includes the gains in future consumption – is more pronounced than what initial consumption responses would suggest.

In summary, we show significant inequality in the impact of bank distress on households. Losses in the banking sector exacerbate inequality, with low-income households experiencing a more substantial reduction in their consumption and welfare relative to high-income households. Our results underscore the central role of household portfolio adjustments between liquid and illiquid assets in determining their responses to bank distress and shaping its distributional implications.

Building on the prominent role of portfolio adjustments for households' response to bank losses, the final part of the paper documents that households' ability to substitute (liquid) deposits for (illiquid) capital is also an important determinant of the economy's aggregate response to productivity shocks. We compare our baseline model to two counterfactual economies: One without banks, where all capital is held directly by households, and one where all savings are intermediated by banks (with no direct capital holdings). We show that, relative to the baseline model, investment is more responsive when all savings are intermediated by banks. In contrast, aggregate investment responds less when, in the absence of banks, all savings are invested directly by households. The opposite is true for consumption. These results are driven by the ability of households to shift savings from deposits to capital, which provides a backstop to the financial accelerator mechanism and stabilizes the response of investment. Our findings emphasize the importance of considering explicit micro-foundations for the demand of intermediated savings when studying the role of financial frictions for aggregate fluctuations.

1.1 Related Literature

This paper bridges two areas of macroeconomic research, studying the implications of financial intermediation frictions and the redistributive effects of shocks and policies in heterogeneous-agent models. The first line of research has provided important insights into the aggregate implications of shocks and policies affecting banks (e.g., Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Brunnermeier and Sannikov, 2014; He and Krishnamurthy, 2019; Iacoviello, 2015; Mendicino *et al.*, 2024).[5] The second has advanced our understanding of the heterogeneous effects of business cycle fluctuations and monetary policy (see e.g. Krusell and Smith, 1998; Krueger *et al.*, 2016; Gornemann *et al.*, 2016; McKay *et al.*, 2016; Guerrieri and Lorenzoni, 2017; Glover *et al.*, 2020; Kaplan *et al.*, 2018; Auclert *et al.*, 2018), abstracting from banks and associated financial amplification effects. Our framework encompassed both an explicit banking sector with financial intermediation frictions and household heterogeneity with endogenous portfolio choices. As a result, the model features endogenous movements in borrowing costs and asset prices as well as heterogeneity in household exposure to the (direct and indirect) transmission channels of bank losses. This enables us to examine the distributional implications of banking sector losses and to show how they exacerbate inequality.

The focus on banks connects us to contemporaneous work combining heterogeneous

[5]This strand of the literature builds on the seminal work of Kiyotaki and Moore (1997) and Bernanke *et al.* (1999), and subsequent studies on the aggregate consequences of financial shocks, such as shocks to collateral constraints or credit spreads that hit borrowers directly (e.g., Eggertsson and Krugman, 2012; Jermann and Quadrini, 2012; Christiano *et al.*, 2014; Justiniano *et al.*, 2019).

households and a banking sector: Arslan *et al.* (2024) study a house price boom and bust in a small open economy framework. Ferrante and Gornemann (2024) analyze the heterogeneous pass-through of exchange rate shocks. Fernández-Villaverde *et al.* (2023) show how interacting financial frictions and household heterogeneity can generate endogenous aggregate volatility. Lee *et al.* (2024) study how countercyclical borrowing wedges amplify business cycles. We share with these papers the joint consideration of financial intermediaries and household heterogeneity, but our focus is on understanding the distributive effects of losses originating in the banking sector. Methodologically, a distinguishing feature of our work is the adoption of a two-asset framework and households' decision to hold capital either directly or indirectly through banks. This feature allows us to consider a portfolio rebalancing mechanism in response to asset price movements. Our results highlight an important role for households' portfolio adjustments both in shaping the distributional implications of bank losses and in affecting aggregate fluctuations in the presence of financial frictions.

Our calibration approach aligns with the empirical literature studying consumption dynamics across the income distribution in response to macroeconomic fluctuations. Meyer and Sullivan (2013) examine the evolution of US consumption inequality during the Great Recession. Using a factor model, De Giorgi and Gambetti (2017) find consumption inequality to be procyclical. Few papers study consumption responses to monetary policy shocks across the income distribution (Coibion *et al.*, 2017) and the homeownership status (Cloyne *et al.*, 2020).[6] Our paper provides complementary evidence on the consumption response to banking sector distress, building on the approach of Baron *et al.* (2021) who provide valuable insights into the response of macroeconomic aggregates to bank equity losses.

The remainder of the paper is structured as follows: Section 2 presents the model; Section 3 discusses the model's quantitative implementation and compares its performance when compared to untargeted moments of the data; Section 4 examines the unequal impacts of banking sector losses in detail; and Section 5 studies the implications of a key feature of our model – the fact that households can hold capital alongside banks – for the response of the economy to aggregate shocks.

2 Model

To analyze the distributive effects of banking sector losses, we build a model economy with rich household heterogeneity and an explicit banking sector featuring frictions to financial intermediation. The economy is populated by five types of agents: Households save or

[6] Recent studies using micro-level data Andersen *et al.* (2021); Holm *et al.* (forthcoming); Jasova *et al.* (2024) provide empirical evidence that low income individuals are generally disproportionately more exposed to policy rate changes.

borrow through a bank-intermediated liquid asset and invest directly in illiquid capital. Banks collect deposits from saving households and lend to borrowing households, invest in productive capital, and are subject to an endogenous leverage constraint. Competitive production firms produce intermediate consumption goods, which are differentiated into final goods by monopolistically competitive retailers. Competitive capital producers transform consumption goods into capital goods. We outline the problem solved by each agent below.

2.1 Households

The demand side of the economy consists of a continuum of heterogeneous households, following Bayer *et al.* (2019). Households are ex-ante identical but ex-post heterogeneous due to idiosyncratic shocks to their labor productivity.

Earnings. Households decide how much labor n to supply in each period and receive compensation wz per unit of labor, depending on the market wage w and their idiosyncratic productivity z. Labor productivity evolves stochastically over time according to a first-order Markov process. We assume that households in productivity state $z = z^*$, which we refer to as *capitalists*, receive additional income in the form of dividends div. Throughout the paper, we refer to non-capitalist households as *workers*.[7]

Savings. In each period, households can freely adjust their position in a liquid asset a, which is intermediated by the banking sector. We will refer to positive a as *deposits* and negative a as *consumer loans*. In addition, households can invest directly in productive capital k, which is subject to stochastic illiquidity: At the beginning of each period, an idiosyncratic utility cost θ of adjusting capital holdings is drawn from a distribution F_θ.

Timing. At the beginning of period t, households can access their liquid assets and receive the return on their illiquid capital holdings, labor earnings, and potential dividend income conditional on the realization of their idiosyncratic productivity state z_t. They also learn about their current cost of adjusting the illiquid portfolio θ_t. They first decide on whether to adjust their capital holdings in this period (extensive margin), and in a second stage jointly decide on borrowing/saving in the liquid asset a_t, investing in capital k_t (intensive margin, if they chose to adjust), labor supply n_t, and consumption c_t.

Non-adjusting. A non-adjusting household incurs no utility cost but must keep capital holdings constant at $k_t = k_{t-1}$. Non-adjusting households solve the dynamic optimization

[7] As in Bayer *et al.* (2019), households transition stochastically into and out of the capitalist state. We detail this process in Section 3, where we describe the model's quantitative implementation.

problem

$$V_t^n(a_{t-1}, k_{t-1}, z_t) = \max_{c_t \geq 0, a_t \geq \underline{a}, n_t \geq 0} \left\{ u(c_t, n_t) + \beta \mathbb{E}_t V_{t+1}(a_t, k_{t-1}, z_{t+1}) \right\} \tag{1}$$

$$\text{s.t. } c_t + (1 - \tau(z_t, a_t))a_t \leq R_t^{HH}(a_{t-1})a_{t-1} + (R_t^K - q_t)k_{t-1} + w_t z_t n_t + \mathbb{I}_{z_t = z^*} div_t,$$

where $\underline{a}$ denotes the (exogenous) borrowing limit and β is households' discount factor. The gross return on capital holdings $R_t^K \equiv r_t^K + q_t - \delta$ includes the rental rate of capital (r_t^K), the price of capital (q_t), and the depreciation rate(δ). The gross return on the liquid asset $R_t^{HH}(a_{t-1})$ depends on the asset position and reflects either the gross market return on deposits R_t^D or loans R_t^L, such that

$$R_t^{HH}(a_{t-1}) = \begin{cases} R_t^D & \text{if } a_{t-1} \geq 0 \\ R_t^L & \text{if } a_{t-1} < 0. \end{cases} \tag{2}$$

Further, we assume that there is a transaction cost of issuing loans $\tau(z_t, a_t)$, which assumes positive values when the household is a borrower ($a_t < 0$) but equals 0 whenever $a_t > 0$. The transaction cost is considered a deadweight loss to the economy. We allow $\tau(\cdot)$ to depend on labor productivity to reflect higher cost of monitoring low income borrowers, resulting in higher credit spreads.[8]

Adjusting. If households chose to incur the utility costs of adjusting, they can select any non-negative value of k_t. Adjusting households solve

$$V_t^a(a_{t-1}, k_{t-1}, z_t) = \max_{c_t \geq 0, a_t \geq \underline{a}, k_t \geq 0, n_t \geq 0} \left\{ u(c_t, n_t) + \beta \mathbb{E}_t V_{t+1}(a_t, k_t, z_{t+1}) \right\} \tag{3}$$

$$\text{s.t. } c_t + (1 - \tau(z_t, a_t))a_t + q_t k_t \leq R_t^{HH}(a_{t-1})a_{t-1} + R_t^K k_{t-1} + w_t z_t n_t + \mathbb{I}_{z_t = z^*} div_t.$$

Adjustment decision. The value function of a household after the realization of its current labor productivity z_t and portfolio adjustment cost θ_t is given by

$$V_t(a_{t-1}, k_{t-1}, z_t, \theta_t) = \max\{V_t^a(a_{t-1}, k_{t-1}, z_t) - \theta_t, V_t^n(a_{t-1}, k_{t-1}, z_t)\}. \tag{4}$$

[8]In section 3, we explain how we calibrate the dependence of τ on labor productivity z to match the share of liquid asset holdings by households at the bottom of the income distribution.

The maximization summarizes a household's decision of whether or not to adjust their portfolios. Households choose to adjust their portfolios whenever

$$\theta_t \leq V_t^a(a_{t-1}, k_{t-1}, z_t) - V_t^n(a_{t-1}, k_{t-1}, z_t).$$

Before the current adjustment cost is revealed, the probability of adjusting conditional on state (a, k, z) is hence given by

$$F_\theta\left(V_t^a(a, k, z) - V_t^n(a, k, z)\right).$$

In the model, as in the data, households hold both deposits and capital simultaneously. The portfolio adjustment cost and the resulting illiquidity of capital holdings at the household level provide an explicit micro-foundation for the willingness of households to hold assets indirectly through banks. Idiosyncratic income risk makes the liquidity provided by holding deposits valuable to households, allowing for a wedge between the market return on holding capital and deposits. This wedge reflects the (endogenously determined) liquidity premium on deposits. The setup provides a micro-foundation of households limited capacity to manage capital (e.g. Gertler *et al.*, 2019). Contrary to models with a representative household, in our framework it is not necessary to assume that direct financing of capital by households entails e.g. an ad-hoc management cost for reduced bank intermediation capacity to be costly.[9]

2.2 Banking Sector

The banking sector consists of a continuum of ex-ante identical banks, which operate under an endogenous leverage constraint as in e.g. Gertler and Kiyotaki (2010) and Gertler and Karadi (2011). Banks are run by risk-neutral bankers, which are assumed to have zero mass and the same discount factor as households. Banks finance their investments using deposits d and equity e. They invest in two types of assets: claims on productive capital k^B, and consumer loans l. The banks' balance sheet satisfies

$$q_t k_t^B + l_t = d_t + e_t. \tag{5}$$

Further, bank equity evolves according to

$$e_t = R_t^K k_{t-1}^B + R_t^L l_{t-1} - R_t^D d_{t-1}, \tag{6}$$

[9] Representative household models with a banking sector assume that households hold capital directly, but are less efficient than banks at evaluating and monitoring capital projects (see e.g. Gertler *et al.*, 2020). A management cost function (increasing and convex in the amount of capital) is assumed so that households have limited capacity to manage capital. This creates a wedge between the return to capital accrued to households and to banks. In our model, households and banks earn identical returns on their capital holdings, but households value the additional liquidity provided by deposits.

where, as before, R^D is the gross return on deposits, R^L is the gross return on (consumer) loans, and R^K is the gross return on banks' investment in capital. Note that R^D and R^L are pre-determined, while R^K is determined ex-post and responds to shocks contemporaneously.

Banks' are liquidated exogenously with probability $1 - p$, in which case their banker exits. The objective of existing bankers is to maximize their bank's expected terminal net worth, given by

$$v_t^B = \max_{\{e_{t+j}, k_{t+j}^B, l_{t+j}, d_{t+j}\}_{j=0}^{\infty}} (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} e_{t+j+1}. \tag{7}$$

Leverage constraint. Lending activity is constrained by limited commitment. In each period, bankers can choose to liquidate their bank and divert a fraction χ of their funds before investing them. To prevent this, depositors ensure that the value of continuing banking activity is at least as large as that of diverted funds, i.e.

$$v_t^B \geq \chi(q_t k_t^B + l_t). \tag{8}$$

Optimal allocation. Given the maximization problem (7), subject to constraints (5), (6), and (8), the bank must be indifferent between lending to households or investing in capital, implying a no-arbitrage condition between returns:

$$R_{t+1}^L = \mathbb{E}_t \frac{R_{t+1}^K}{q_t}$$

We can express an individual banker's objective function as

$$v_t^B = \nu_t(q_t k_t^b + l_t) + \eta_t e_t, \tag{9}$$

where ν_t and η_t represent respectively the marginal values of bank assets and bank net worth.[10] Combining equations (9) and (8) yields

$$l_t + q_t k_t^B \leq \phi_t e_t, \tag{10}$$

where $\phi_t = \frac{\eta_t}{\chi - \nu_t}$ determines banks' maximum leverage ratio.

Aggregation. The linearity in banks' problem allows us to aggregate the banking sector into a single representative bank, with aggregate leverage constraint

$$q_t K_t^B + L_t \leq \phi_t E_t, \tag{11}$$

[10]See Appendix A.4 for a detailed derivation of this result.

where K_t^B, L_t, and E_t are banking *sector* holdings of productive capital, consumer loans, and equity, respectively. This leverage constraint is binding in equilibrium and the banking sector is constrained by its equity in expanding lending as long as $R_{t+1}^L > R_{t+1}^D$, i.e. as long as expanding leverage yields positive expected profits.[11]

We assume that exiting bankers are replaced by new ones. Each new banker receives identical startup funds provided by households.[12] Aggregate equity is given by the sum of continuing bankers' equity E_{ct} and new bankers' equity E_{nt} such that

$$E_t = E_{ct} + E_{nt}$$

The first term is obtained by integrating individual banks' equity law of motion (6) for the share of continuing banks p

$$E_{ct} = p(R_t^K K_{t-1}^B + R_t^L L_{t-1} - R_t^D D_{t-1}). \tag{12}$$

Each new banker's equity is proportional to a fraction $\frac{\omega}{1-p}$ of the value of the assets of exiting banks, i.e.

$$E_{nt} = \omega(q_t K_{t-1}^B + L_{t-1}) \tag{13}$$

Combining (12) and (13) yields the law of motion for aggregate bank equity as

$$E_t = p(R_t^K K_{t-1}^B + R_t^L L_{t-1} - R_t^D D_{t-1}) + \omega(q_t K_{t-1}^B + L_{t-1}) \tag{14}$$

Finally, we assume that capitalist households receive all dividends from banking activity.[13] Bank dividends are given by the equity of exiting bankers net of new equity provided to new bankers

$$div_t^B = \frac{(1-p)}{p} E_{ct} - E_{nt} \tag{15}$$

2.3 Production

Intermediate Goods Producers. A continuum of identical production firms combine K efficiency units of capital and labor input N to produce intermediate goods using

[11] We ensure that this condition holds throughout all simulations of the model.

[12] Banks raise additional equity in the model only through accumulating retained earnings. For tractability we abstract from (outside) equity issuance. While outside equity could enhance banks' ability to mitigate the impact of fluctuations in their net worth, it is costly for a bank to issue outside equity, especially when the banking sector is in distress (see e.g. Gertler *et al.*, 2020). The pivotal factor for banks' lending ability is therefore their inside equity (e.g. Gertler *et al.*, 2019).

[13] An interpretation of our approach is that capitalist households own the banks and delegate their management to bankers, which are paid upon exit of a bank proportionately to net worth upon exit. As bankers are assumed to be of zero mass, their income does not affect aggregate quantities.

production technology

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha}, \tag{16}$$

where A_t represents total factor productivity, r_t^K denotes the rental rate per efficiency unit of capital and w_t the wage per unit of labor.

Production firms sell the intermediate consumption good at price p_t^I to retailers. Assuming competitive markets for capital and labor input, as well as the output of intermediate goods, profit maximization yields factor prices as

$$w_t = p_t^I (1-\alpha) A_t K_t^{\alpha} N_t^{-\alpha} \tag{17}$$

$$r_t^K = p_t^I \alpha A_t K_t^{\alpha-1} N_t^{1-\alpha}. \tag{18}$$

Retailers. Monopolistically competitive retailers differentiate the intermediate consumption good into varieties of final goods. Final goods are combined into households' consumption baskets with a standard CES aggregator such that $c_t = \left[\int_j c_{jt}^{R\,\frac{1}{\mu}} dj\right]^{\mu}$, where $\mu > 1$. The demand for each variety is given as

$$c_{j,t}^R = \left(\frac{p_{j,t}}{P_t}\right)^{\frac{\mu}{1-\mu}} c_t. \tag{19}$$

Normalizing the price of a unit of the consumption bundle c_t to $P_t = 1$ and imposing a symmetric equilibrium, the profit maximization problem of retailers yields the price for the intermediate good as

$$p_t^I = \frac{1}{\mu}. \tag{20}$$

Retailers' profits are distributed to capitalist households as dividends given by

$$div_t^Y = \frac{\mu - 1}{\mu} Y_t. \tag{21}$$

Capital Producers. A continuum of identical, competitive capital producers transform the final consumption good into capital, which they sell to households and banks at price q. As in Gertler and Karadi (2011), capital producers face adjustment costs on to the net-of-depreciation investment. Capital producers are risk neutral and discount the future with households discount factor β. At each period, they select net investment to maximize the present discounted value of profits

$$\max_{I_{nt}} \mathbb{E}_0 \sum_{t=0} \beta^t \left\{ (q_t - 1) I_{nt} - \frac{\phi_K}{2} \left(\frac{I_{nt} + I_{ss}}{I_{n,t-1} + I_{ss}} \right)^2 (I_{nt} + I_{ss}) \right\}, \tag{22}$$

where $I_{nt} \equiv I_t - \delta K_t$ denotes net investment and investment is defined as $I_t = K_{t+1} - (1-\delta)K_t$. Net investment is zero in the steady state of the economy, while gross steady-state investment I^{ss} exactly refurbishes existing capital ($I_{ss} = \delta K_{ss}$). Assuming a competitive market for capital, the resulting optimality condition yields the price of capital as

$$q_t = 1 + \phi^k \left(\frac{I_{nt} + I_{ss}}{I_{n,t-1} + I_{ss}} - 1 \right)^2 + \frac{\phi^k}{2} \cdot \left(\frac{I_{nt} + I_{ss}}{I_{n,t-1} + I_{ss}} - 1 \right)^2 - \beta \phi^k \left(\frac{(I_{n,t+1} + I_{ss})}{(I_{n,t} + I_{ss})} - 1 \right) \left(\frac{I_{n,t+1} + I_{ss}}{I_{n,t} + I_{ss}} \right)^2 \tag{23}$$

This pricing equation highlights how adjustment costs to the aggregate capital stock are important to generate fluctuations in the price of capital. It implies a steady-state value of $q = 1$. In addition, temporary increases in net investment ($I_{nt} > I_{n,t-1}$ and $I_{nt} > I_{n,t+1}$) lead to an increase in the price of capital ($q_t > 1$). The profits from capital production given by equation (22) are distributed to households as dividends

$$div_t^I = (q_t - 1) I_{nt} - \frac{\phi_K}{2} \left(\frac{I_{nt} + I_{ss}}{I_{n,t-1} + I_{ss}} \right)^2 (I_{nt} + I_{ss})$$

2.4 Aggregate Shocks

To study the distributive effects of banking sector losses, we consider an exogenous reduction in bank equity ϵ_t such that

$$e_t = R_t^K k_{t-1}^B + R_t^L l_{t-1} - R_t^D d_{t-1} - \epsilon_t, \tag{24}$$

where ϵ_{SS} is assumed to be zero. ϵ_t is considered a deadweight loss to aggregate resource. One interpretation of this shock is that banks make losses on foreign investments.[14] Crucially, this shock has a direct impact *only* on banks' ability to intermediate funds and affects all other actors in the economy only indirectly, through the response of equilibrium variables such as factor prices and interest rates. It is therefore uniquely suited to study how losses in the banking sector transmit to households along the income distribution.[15]

2.5 Market Clearing

Define $\lambda_t(a, k, z, \theta)$ as the beginning of period distribution of households over the state space, and $a_t(a, k, z, \theta)$, $k_t(a, k, z, \theta)$, and $n_t(a, k, z, \theta)$ to be the household policy functions

[14] Baron *et al.* (2021) provide a discussion of the origins of a large set of historic banking crises. Common causes are exposure to (ex post) troubled sectors, either domestically or internationally. In line with their findings, our shock can be interpreted as banks international investments producing lower returns than expected.

[15] In Appendix B, we show that our results are robust to an alternative shock that hit the productivity of bank intermediated capital, rather than bank equity.

for liquid assets, capital, and labor hours respectively. Market clearing requires that the quantities chosen by bankers align with households' choices of the liquid asset such that

$$L_t = \int_{(a,k,z,\theta)} \lambda_t(a,k,z,\theta)\ \mathbb{I}_{a_t(a,k,z,\theta)<0}\ \left(-a_t(a,k,z,\theta)\right) \tag{25}$$

$$D_t = \int_{(a,k,z,\theta)} \lambda_t(a,k,z,\theta)\ \mathbb{I}_{a_t(a,k,z,\theta)\geq 0}\ a_t(a,k,z,\theta), \tag{26}$$

where $\mathbb{I}$ is an indicator function. In addition, aggregate capital holdings of households are given by

$$K_t^{HH} = \int_{(a,k,z,\theta)} \lambda_t(a,k,z,\theta)\ k_t(a,k,z,\theta). \tag{27}$$

The law of motion for total capital in the economy has to be consistent with the investment choices of capital-producing firms,

$$K_{t+1} = I_t + (1-\delta)K_t \tag{28}$$

and capital market clearing requires that

$$K_t = K_{t-1}^{HH} + K_{t-1}^{B}. \tag{29}$$

Dividends to capitalist households are the sum of dividends from banks, retailers and capital producers, distributed evenly among all households in the capitalist income state, such that

$$div_t = \frac{div_t^Y + div_t^I + div_t^B}{\int_{(a,k,\theta)} \lambda_t(a,k,z^*,\theta)} \tag{30}$$

Market clearing in the goods market requires

$$C_t + I_t + \Xi_t = Y_t, \tag{31}$$

where Ξ_t consists of deadweight losses from the cost of capital adjustment, loan issuance and the bank equity shock[16], given by:

$$\begin{aligned}\Xi_t = {} & \frac{\phi_K}{2}\left(\frac{I_{nt}+I^{ss}}{I_{n,t-1}+I^{ss}}\right)^2 (I_{nt}+I^{ss}) + \\ & + \int_{(a,k,z,\theta)} \tau(a,z)\ \lambda_t(a,k,z,\theta)\ \mathbb{I}_{a_t(a,k,z,\theta)<0}\ \left(-a_t(a,k,z,\theta)\right) + \epsilon_t. \end{aligned} \tag{32}$$

[16]Deadweight losses from bank equity shocks resembles the bankruptcy costs emerging in the the financial accelerator literature (e.g. Bernanke *et al.*, 1999).

Labor market clearing is given by

$$N_t = \int_{(a,k,z,\theta)} \lambda_t(a,k,z,\theta)\ z_t n_t(a,k,z,\theta).$$

A brief definition of an equilibrium in our model economy consists of household value and policy functions, a measure over idiosyncratic states $\lambda_t(a,k,z,\theta)$, a path of exogenous shocks $\{\epsilon_t\}$, and initial conditions $\lambda_1(a,k,z,\theta)$, K_0^B, K_0^{HH}, and R_1^D, R_1^L such that given prices and shocks, households and banks solve their problems in (1), (3), and (7), the measure over states is induced by policy functions, and all markets clear as outlined above. We define an equilibrium in the economy formally in Appendix A.

3 Quantitative Implementation

We calibrate the model to the U.S. economy. We proceed in two steps: First, we calibrate a stationary version of the economy and show that the model performs well in matching untargeted moments of the joint distribution of income, wealth and portfolio composition. Second, we estimate local projections of consumption responses to banking sector conditions, which we use as targets to calibrate the dynamic response of the economy. We outline the calibration strategy and model fit in detail below and describe the algorithm to solve the model in Appendix A.2.

3.1 Calibration: Steady State

We calibrate the steady state of the model economy to match U.S. data prior to the 2007 Global Financial Crisis. A model period corresponds to one quarter. We first set a range of parameters to values commonly used in the literature, and calibrate all remaining parameters jointly to match targets on aggregate outcomes.

Preferences. We assume GHH preferences, such that

$$u(c,n) \equiv u(c,n|z) = \frac{\left(c - \Psi z \frac{n^{1+\psi}}{1+\psi}\right)^{1-\sigma}}{1-\sigma}$$

and set the coefficient of relative risk aversion σ to 2. Following Bayer *et al.* (2019), we scale the disutility of labor by idiosyncratic productivity z to ensure that hours are constant in the cross section of households, while still allowing them to fluctuate in response to aggregate shocks. We set the inverse Frisch-elasticity ψ equal to 2.

Further, we assume the distribution of adjustment cost F_θ to be the logistic distribution with mean μ_θ and variance σ_θ^2, and the cost to be i.i.d. across periods. Given the i.i.d. assumption, μ_θ determines the demand for illiquid capital and we calibrate it jointly with other parameters below. σ_θ is closely related to the dispersion in households' portfolio adjustments. Since there is little empirical evidence on this moment, we set $\sigma_\theta = 10$ in the baseline and repeat our main counterfactual for different values to ensure that this choice does not drive our main conclusions.[17]

Production and Banking. We set the capital share α to 0.33, and the markup parameter μ to 1.1, as in McKay and Reis (2016).[18] We set households' borrowing limit $\underline{a}$ to one time the average quarterly earnings as in Kaplan *et al.* (2018), which we normalize to 1 by scaling households' labor productivity process. Finally, we follow Gertler and Karadi (2011) and set $p = 0.972$, implying bankers' average time of operating is a decade.

Labor Earnings. Capturing a realistic process for labor earnings is crucial for determining households' motive to self-insure against risk, which in turn determines the demand for liquid deposits. Households with high earnings risk tend to hold a relatively larger portion of liquid assets in their portfolio to insure against negative income realizations, thereby increasing the demand for deposits at any given interest rate. To match the rich earnings dynamics in the data as precisely as possible, we construct the process for labor productivity z from two components, such that

$$z = \gamma(\hat{z}, Y)\hat{z}. \tag{33}$$

The first is a stationary process for idiosyncratic shocks $\hat{z}$, which we assume to follow an AR(1) process with innovations drawn from a mixture of normal distributions to capture higher moments of the distribution of earnings changes. The process for $\hat{z}$ is given by

$$\log(\hat{z}_t) = \rho \log(\hat{z}_{t-1}) + \varepsilon_t,$$

with

$$\varepsilon_t \sim \begin{cases} \mathcal{N}(\mu_1, \sigma_1^2) \text{ with probability } \hat{p} \\ \mathcal{N}(\mu_2, \sigma_2^2) \text{ with probability } 1 - \hat{p}. \end{cases}$$

The process is characterized by six parameters, $\{\rho, \mu_1, \mu_2, \sigma_1^2, \sigma_2^2, \hat{p}\}$. We calibrate these via simulated method of moments. We target (i) the cross-sectional variance of log annual earnings, (ii) the standard deviation, (iii) skewness, (iv) kurtosis, and (v) the ratio of the 90th to the 10th percentile of log annual earnings *changes*. Furthermore, we normalize $\mu_2 = -\frac{\hat{p}}{1-\hat{p}}\mu_1$.

[17] See Appendix B for details. In an alternative approach, Bayer *et al.* (2019) target the second quintile of portfolio liquidity, obtaining a value of $\sigma_\theta = 22,500$. In practice, we find that σ_θ has little influence over this moment in our model, which motivates our decision to set it exogenously.

[18] Allowing for positive profits from production and distributing them as dividends to high-income households helps the model in matching moments related to wealth inequality.

We target moments of the distribution of labor earnings, consistent with the assumption of constant hours worked across households that is implied by our choice for preferences. Our model economy does not feature a system of tax and transfers, and thus we target after-tax, household-level earnings. We obtain the values for our five targets from De Nardi *et al.* (2019).[19] The model-implied moments are obtained by simulating the evolution of quarterly earnings for a panel of workers and aggregating them to annual frequency. Table 1 summarizes the results. The model matches all five targets, with implied parameter values $\rho = 0.963$, $\sigma_1 = 0.50$, $\sigma_2 = 0.01$, $\hat{p} = 0.156$, $\mu_1 = -0.105$, and $\mu_2 = 0.019$. We discretize the workers' labor productivity on a grid with eleven earnings states, using the method of Farmer and Toda (2017).

The second part of the earnings process is the function $\gamma(\hat{z}, Y)$, which captures the differential effect of aggregate fluctuations on individual earnings along the income distribution. We calibrate it to match the elasticity of earnings to GDP at different percentiles of the earnings distribution as reported in Guvenen *et al.* (2017). The function is given by

$$\gamma(\hat{z}_t, Y_t) = 1 + \Gamma(\hat{z}_t)\left(\frac{Y_t - Y^{ss}}{Y^{ss}}\right), \tag{34}$$

where $\Gamma(\hat{z}_t)$ is based on the elasticities reported in Guvenen *et al.* (2017) at different percentiles of the earnings distribution of the model. In Appendix A.3, we explain how we map to their estimates while keeping average labor productivity constant over time.

Table 1: Calibration—Earnings Process

Target	**Model**	**Data**
Cross-Sectional Variance	0.57	0.57
Standard Deviation of Changes	0.33	0.33
Skewness of Changes	-0.99	-0.98
Kurtosis of Changes	10.5	10.3
P90-P10 of Changes	0.65	0.64

Notes: Data moments computed for annual log earnings using the PSID waves from 1962 to 1992, based on De Nardi *et al.* (2019). Corresponding parameter values: $\rho = 0.963$, $\sigma_1 = 0.50$, $\sigma_2 = 0.01$, $p = 0.156$, $\mu_1 = -0.105$, and $\mu_2 = 0.019$.

Capitalists. In addition to income from labor earnings, we assume the existence of a *capitalist* state at the top of the discretized labor productivity process and allocate all

[19] Moments are computed from the PSID waves for 1962 to 1992, the years for which annual observations are available. The sample is restricted to households with heads aged twenty-five to sixty. Household-level earnings are adjusted by year fixed effects and family size. See De Nardi *et al.* (2019), Section 2, for full details. We thank Gonzalo Paz-Pardo for kindly making the specific target values available to us.

dividend income in the economy to households in this state.[20] In every period, there is a probability ν^i that a worker in the highest-productivity state will become a capitalist, which we assume to account for 1 percent of the population. With probability $\nu^o = 0.0625$ they transition back into the highest-productivity worker state, corresponding to the probability of falling out of the top 1 percent of the income distribution found in Guvenen *et al.* (2021). The discretized Markov process for idiosyncratic labor productivity together with parameter ν^o and the assumption that capitalists correspond to 1 percent of households implies $\nu^i = 0.025$. Finally, we set labor productivity in the capitalist state to the median labor productivity in the economy.

Internally Calibrated Parameters. All remaining parameters (δ, β, ω, χ, μ_θ, Ψ) and the function $\tau(z, a)$ are calibrated internally. We target an annual capital-output ratio $\frac{K}{Y}$ of 3 based on data from Penn World Tables. The steady-state interest rate on deposits R^D is calibrated to an annualized three-month Treasury bill rate of 2%, and the wedge between deposits and lending rates is set to $R^L - R^D = 2\%$ annually, in line with the results of Philippon (2015) on the returns to intermediation. We target a deposit-to-output ratio $\frac{D}{Y}$ of 0.4 and a ratio of bankers' capital to output $\frac{K^B}{Y}$ of 0.6 to match data on deposit-taking institutions' balance sheets from the Federal Reserve Board's data table H.8 for 2004. We set the parameter Ψ to normalize output to unity in the steady state.

While all parameters are calibrated jointly, each of them is more closely related to specific targets. The depreciation rate is pinned down from the intermediate producer's capital demand in combination with bankers' arbitrage conditions, given our targets for capital-to-output ratio and R^L. The household discount factor β determines the overall desire to save and thus ensures market clearing for savings, given calibrated returns and capital-to-output ratio. The parameter μ_θ regulates the cost of adjusting capital holdings, determining households' share in total capital $\frac{K^{HH}}{K} = 1 - \frac{K^B}{K}$. In addition, given banks' leverage, this share implies the calibrated deposit-to-output ratio. The parameter χ is selected to ensure that the banker's leverage constraint (10) holds with equality, given our targets for deposits, banker's capital, and interest rates, as well as the model-implied demand of consumer loans. Bankers' startup funds, determined by ω, ensure that aggregate bank equity is constant.

Finally, we posit that $\tau(z, a)$ assumes functional form

$$\tau(z,a) = \begin{cases} e^{\left(\log(\bar{\tau}) - \tau^{slope}\left[\frac{z - z^{med}}{z^{med}}\right]\right)} \text{ if } a < 0 \\ 0 \text{ otherwise} \end{cases},$$

where z^{med} refers to the median value of z. We calibrate the parameters $\bar{\tau}$ and τ^{slope}

[20] The concept of a top earner state was first introduced by Castaneda *et al.* (2003) to account for US income and wealth inequality. Distributing dividends at the top of the income distribution is in line with the calibration strategy outlined inBayer *et al.* (2019), which we have adopted.

Table 2: Summary of Calibration Procedure

Target	Model	Data	Closest Parameter	Source
$\frac{K}{Y}$ Ratio	3	3	$\delta = 0.016$	Penn World Tables
Deposit-to-Output $\frac{D}{Y}$	0.40	0.40	χ =0.26	Fed Table H.8 2004
Bank Investment-to-Output $\frac{K^B}{Y}$	0.60	0.60	$\mu_\theta = 16.4$	Fed Table H.8 2004
Annual $R^D - 1$	2%	2%	$\beta = 0.971$	Annualized 3M Tbill rate, net of CPI
Annual Spread $(R^L - R^D)$	2%	2%	$\omega = 0.0036$	Philippon (2015)
Share of Borrowers	18.8%	19.3%	$\bar{\tau} = 0.005$	SCF 2004
Share of Liquid Assets, Q1 of Income	2.2%	2.2%	$\tau^{slope} = 2.45$	SCF 2004
Output Y	1	1	$\Psi = 2.07$	Normalization
Risk Aversion			$\sigma = 2$	standard
Inverse Frisch Elasticity			$\psi = 2$	standard
Capital Share			$\alpha = 0.33$	standard
Bankers' Survival Probability			$p = 0.972$	Gertler and Karadi (2011)
Borrowing Limit			$\underline{a} = -1$	Kaplan *et al.* (2018)
P(Entering Capitalist)			$\nu^i = 0.025$	1% of households are capitalists
P(Exiting Capitalist)			$\nu^o = 0.0625$	Guvenen *et al.* (2021), Bayer *et al.* (2019)
Dispersion of Adjustment Cost			$\sigma_\theta = 10$	see text

Notes: The top panel reports the parameters calibrated internally by matching the corresponding data targets. The bottom panel reports the list of parameters set externally.

to match the share of households with non-positive liquid assets, as well as the share of liquid assets held by households at the bottom quintile of the income distribution.[21] The amount of debt held by the lowest income quintile regulates the exposure of low-income households to changes in the cost of borrowing, which is important for our quantitative results.

All data moments and their model counterparts, as well as the complete set of parameter values, are reported in Table 2. The model matches all targeted moments.

3.2 Model Validation: Income and Wealth Distribution

Table 3 compares the model performance in terms of untargeted distributional statistics in the data. We examine the marginal and joint distributions of income, net worth, and liquid wealth. All wealth data are from the 2004 wave of the Survey of Consumer Finances, while income data are obtained from the Congressional Budget Office. In the data, we define liquid wealth as the sum of checking, savings, and money market accounts net of interest-bearing credit card debt.[22] Income is defined as the total after-tax household income, including labor earnings, as well as income derived from business and financial activities. Consistent with this definition, labor earnings, dividends and returns on deposits and capital are included in the computation of income in the model. Liquid wealth in the model is defined as households position (savings or debt) in the liquid asset a. Net worth is defined as the liquid asset plus (illiquid) capital. For each variable, we report shares by quintile of the respective distribution. Additionally, we report the

[21] The lowest resulting $\tau(z, a)$ is assigned to the capitalist.

[22] Consistent with our definition of deposits, we exclude bonds and stocks from liquid assets. The data moments are calculated including only households whose head is aged 25-65.

distribution of net worth and liquid wealth by quintile of the income distribution.[23]

Table 3: Distribution of Income and Wealth – Model vs. Data

		Quintiles				
		Q1	**Q2**	**Q3**	**Q4**	**Q5**
Net Worth	Model	-0.1	1.9	5.3	10.6	82.3
	Data	-0.2	1.2	4.2	11.5	83.3
Liquid Wealth	Model	-3.6	1.2	4.8	10.7	86.9
	Data	-4.2	0.2	1.7	8.1	94.2
Income	Model	4.3	9.1	13.7	21.5	51.4
	Data	7.0	10.5	14.9	20.8	47.7
Net Worth	Model	2.2	4.6	6.6	13.1	73.6
(by Income)	Data	2.9	4.5	8.1	14.7	69.8
Liquid Wealth	Model	**2.2**	6.0	7.0	12.7	72.1
(by Income)	Data	**2.2**	3.5	8.7	16.8	68.7

Notes: Data for rows 1, 2, 4, and 5 are from the 2004 Survey of Consumer Finances. Data for row 3 are from the Congressional Budget Office, (The Distribution of Household Income, publication no. 56575), quintile shares are for 2004. *By Income* in rows 4 and 5 refers to quintiles of pre-tax household income in the Survey of Consumer Finances. Sample includes households aged 25 to 65.

Table 3 shows that the calibrated model does not only generate realistic distributions of total net worth, liquid assets, and total income, but also reproduces the joint distribution of income and wealth. The marginal distributions of income, net worth and liquid wealth are not used as targets in the calibration. The only distributional moments we target are the share of liquid wealth held by the bottom income quintile and the cross-sectional standard deviation of log-labor-earnings. In line with the close fit of the overall distribution of wealth, the model-implied Gini coefficient of wealth is 0.81, close to its value of 0.79 in the 2004 SCF. In addition, the model generates an average (loan-weighted) interest rate on consumer credit of 12.8%, close to the 11.1% observed in the data.[24]

Figure 1 displays the average portfolio composition by quintile of the net-worth distribution. We report the share of illiquid wealth, defined residually as net worth minus

[23]To compute net worth and liquid wealth by income, we sort households into quintiles based on their pre-tax income in the Survey of Consumer Finances. This yields a mapping into quintiles consistent with our income measure from the Congressional Budget office, as long as post-tax income is monotonic in pre-tax income.

[24]In the data, we consider the assessed interest on credit cards as reported in Fed Release G.19, adjusted by year-to-year inflation and averaged over the period 2000-2008.

liquid wealth. The model captures the general pattern of portfolio composition in the data, especially for the bottom quintile: Low net-worth individuals hold more liquid portfolios. The model underestimates the average share of illiquid assets. This is because our calibration target for aggregate deposits – the liquid asset in our economy – is obtained from banks' balance sheets, rather than household balance sheets.[25]

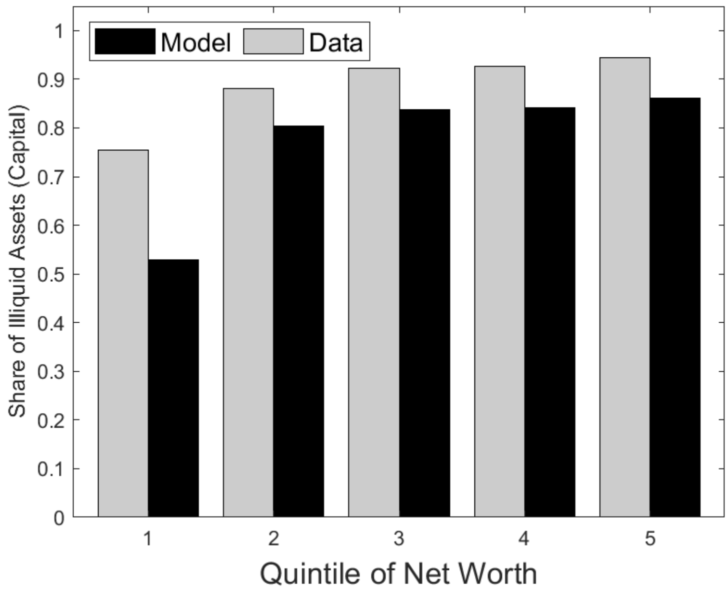


Figure 1: Portfolio Composition by Quintile of Net Worth

Notes: Data from the 2004 Survey of Consumer Finances and authors' own calculations. Model and data samples are restricted to households with strictly positive net worth and non-negative liquid assets. Net liquid assets in the data correspond to the sum of checking, savings, and money market accounts net of credit card debt. Illiquid assets are obtained by subtracting liquid assets from net worth.

The distributive effects of banking sector losses depends on how different groups of households are exposed to fluctuations in market prices. Matching the marginal distributions of income, net worth, and liquid wealth, as well as their correlation validates that the model captures households' exposure to changes in interest rates, asset prices, and labor earnings. The success of the model in generating distributions close to the data suggests that the model is an appropriate environment in which to examine the impact of banking sector distress.

3.3 Calibration: Banking Sector Shock

The primary objective of our analysis is to assess heterogeneity in how banking sector losses affect households across the income distribution. We focus on the response of

[25]Our choice is conservative for the analysis we conduct, as further restricting the supply of liquid assets further would mean that households in general would be less able to insure against shocks, which would increase the (welfare) consequences of bank losses, especially at the bottom of the income distribution.

consumption and proceed in two steps. First, we calibrate the banking sector shock to match the impact of banking sector distress on *aggregate* consumption, estimated from U.S. data. This ensures that our analysis relies on realistic aggregate effects on the household sector as a whole.

Second, we validate the model results by comparing consumption responses across income groups to their data equivalent, which are not targeted in the model's calibration. In this section, we describe the estimation of consumption responses in the data and the calibration of the shock.

Data. To measure banking sector losses in the data we follow Baron *et al.* (2021), who document that bank equity returns are a reliable measure of banking sector conditions. In particular, large bank equity declines align well with crises episodes identified based on narrative approaches (Reinhart and Rogoff, 2009; Laeven and Valencia, 2013), and predict large and persistent contractions in output and credit.[26] Crucially, the equity return indices of Baron *et al.* (2021) are continuous measures available at quarterly frequency, which allows us to focus our analysis on a single country, the U.S. In our analysis, we use their indices of bank and non-financial equity returns.

The series for U.S. aggregate consumption is obtained from national accounts. In addition, we construct quarterly series of consumption by income quintile, based on micro-data from the Survey of Consumer Expenditures (CEX). We follow Coibion *et al.* (2017) in processing the micro-data and construct consumption series by quintiles of post-tax household income.To correct for the well known mismatch between the CEX and national accounts (Aguiar and Bils, 2015), we follow Cloyne *et al.* (2020) and rescale the CEX-series for each income quintile by the quarterly ratio of aggregate consumption in the CEX vs. national accounts. With this transformation, the source of variation in aggregate consumption for all estimation results is the national accounts, whereas the relative variation in consumption across income quintiles originates from the CEX micro-data. Further details on the construction of all variables is provided in Appendix D. To align with our CEX sample, we consider the years 1980-2010 for all specifications.

Estimation. To examine the relation between bank equity returns and household consumption, we follow the approach inBaron *et al.* (2021) and use local projections as in Jordà (2005). Our baseline specification estimates

$$c_{t+h} = \alpha^h + \gamma^h(t+h) + \sum_{j=0}^{J} \beta^{h,j} r^B_{t-j} + \sum_{s=0}^{S} \delta^{h,s} r^{NF}_{t-s} + \sum_{k=0}^{K} \lambda^{h,k} c_{t-k} + \epsilon^h_t, \tag{35}$$

[26] Baron *et al.* (2021) also document that large bank equity declines tend to precede credit spread spikes across one hundred banking crises and uncover a number of episodes of banking distress that do not appear in previous data sets.

wherec_{t+h} is the log of real aggregate household consumption, $h \in \{0, 1, 2, ..., H\}$ denotes horizons ahead of t, r^B and r^{NF} are returns to bank and non-financial corporation indices respectively, and J, S, and K are the number of lags included for each series. Coefficients α and γ estimate a constant and time trend. Our baseline specification includes one lag on each variable ($J = S = K = 1$) and considers c_t as the log of total household consumption, taking the centered four-quarter-moving-average to adjust for seasonality (Cloyne *et al.*, 2020).

The coefficients of interest are $\{\beta^{h,0}\}_h$, which characterize the sequence of local projection impulse responses of consumption to bank equity returns at time t. In line with the specification of Baron *et al.* (2021), we control for non-financial returns r_t^{NF} to adjust for general economic conditions (see e.g. Stock and Watson, 2003). Hence, coefficients $\{\beta_i^{h,0}\}_{i,h}$ capture the change in household consumption associated with variations in bank equity returns, conditional on conditions in the non-financial sector. We apply the same specification for consumption by income quintile, estimating $\{\beta_i^{h,0}\}_h$ in separate regressions for each quintile i.

Consumption Responses. Figure 2 reports the cumulative change in consumption associated with a 10% decline in bank equity returns. We report separately the cumulative impulse response function

$$IRF_m = \sum_{h=0}^{m} \beta^{h,0}$$

for aggregate consumption and five quintiles of the distribution of post-tax household income. The underlying sequence of coefficients $\beta^{h,0}$ as well as confidence intervals around the point estimates are reported in Figure D.19 in Appendix D.

The cumulative decline in aggregate consumption associated with a 10% decline in bank equity returns is 5 percentage points after 12 quarter. In addition, Figure 2 reports substantial variation in consumption responses across income quintiles. The cumulative decline in consumption of the first income quintile is approximately twice as strong as the decline in aggregate consumption, while the estimates for quintiles two to five are close to each other and slightly smaller than the aggregate response. We only target the response of aggregate consumption in the calibration of the shock and use the relative response across quintiles to validate the model's ability to generate realistic distributional implications.

Robustness. Appendix D shows robustness of the general patterns and magnitude of our results for alternative specifications, where we consider a different number of lags, report durable and non-durable consumption separately, sort households by homeownership status, and estimate positive and negative shocks separately. Our conclusion that consumption of the bottom income quintile is more responsive to declines in bank

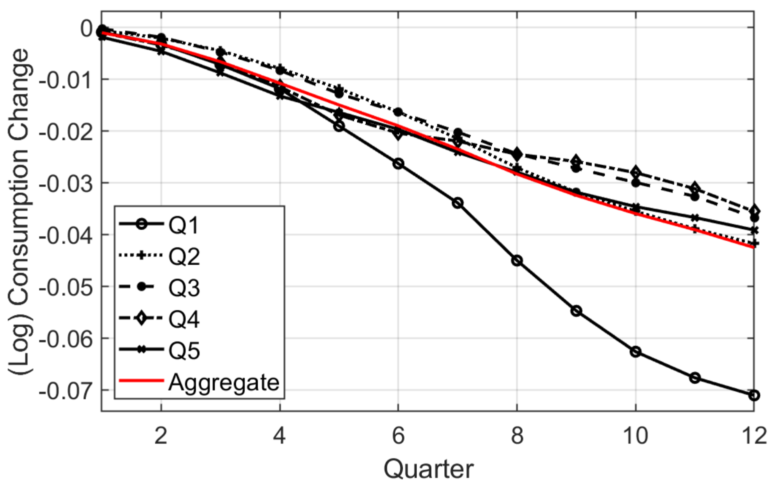


Figure 2: Cumulative Consumption Response

Notes: The figure plots the cumulative IRF of aggregate consumption and consumption by income quintile to a 10% decline in bank equity returns, estimated from (35).

equity returns is robust to all alternative specifications we consider.

Model Parameters. To study the distributive consequences of losses in the banking sector, we simulate the response of the economy to a one-time, unexpected ("MIT") shock to bankers' net worth ϵ_t, which is assumed to revert back to its steady-state value of 0 at rate ρ. Specifically, we assume

$$\epsilon_t = \begin{cases} \bar{\epsilon} & \text{if } t = 1 \\ \rho \epsilon_{t-1} & \text{if } t > 1. \end{cases}$$

We calibrate $\bar{\epsilon}$, ρ, and the adjustment cost of capital ϕ_K to jointly generate (i) an initial 10% decline in bank equity, (ii) the twelve-quarter cumulative consumption response to an initial decline in the bank equity of this magnitude, and (iii) an inverse elasticity of investment with respect to asset prices of 1.72, as in Gertler and Karadi (2011). The capital adjustment cost parameter ϕ_K does not affect allocations in the deterministic steady state and therefor has to be calibrated jointly with the shock. The implied parameter values are $\epsilon = 0.017$, $\rho = 0.75$, and $\phi_K = 2.48$. Note that the initial shock $\bar{\epsilon}$ accounts for only 1.85% of banks equity, i.e. is smaller than the calibrated decline of 10%. This is due to contemporaneous amplification through a financial accelerator mechanism.

4 Distributive Effects of Banking Sector Losses

Our analysis focuses on an exogenous destruction of bankers' net worth, which has the advantage to allow us to isolate the distributive effects of banking sector distress. Since the shock does not affect households directly, but only through the equilibrium response of prices such as interest rates, wages, and the price of capital, we study its effect in two steps: First, we consider how the economy responds to the shock on aggregate. Second, we examine how different households are affected by the changes in aggregate prices. All results reported in this section are obtained by simulating the dynamic response of the calibrated model to a destruction of bank net worth that leads to a 10% decline of net worth on impact.

4.1 Aggregate Responses

Figure 3 reports the responses of aggregate quantities, while Figure 4 reports the responses of prices, wages, and interest rates. On impact, the shock causes a surprise loss in banks' net worth. This leads to a reduction in the size of their balance sheet, tightening the supply of credit to consumers and reducing their investment in capital. In equilibrium, it requires an increase in the interest rate charged on consumer loans R^L and the return on capital R^K. Households partly compensate for the decline in banks' investment. While banks reduce their investment in productive capital, households take advantage of the higher return on capital holdings by increasing their investment in capital. Their incentive to substitute deposits for illiquid capital requires an increase in the interest rate paid on deposits R^D in equilibrium.

Despite increased capital holdings of households, aggregate investment falls in response to the shock and so does the total capital stock in the economy. This is accompanied by a sharp fall in the price of capital. Since the value of banks' assets depends on the price of capital, the decline in asset prices further constrains banks' intermediation capacity, amplifying the decline in investment and the increase in spreads. This effect explains why the decline in bank equity on impact is larger than what would be expected from the direct effect of the shock alone. It is consistent with the financial accelerator amplification mechanism of (Gertler and Kiyotaki, 2010). Finally, aggregate output declines gradually, following the decline in available capital.

After the shock subsides, the economy takes a long time to return to steady state due to a slow recovery of banks' net worth. Households only gradually deplete their additional capital holdings in favor of bank deposits, contributing to the slow recovery of banks' investment in productive capital. As a result, the capital stock remains below its steady-state level for an extended period after the shock dissipates.

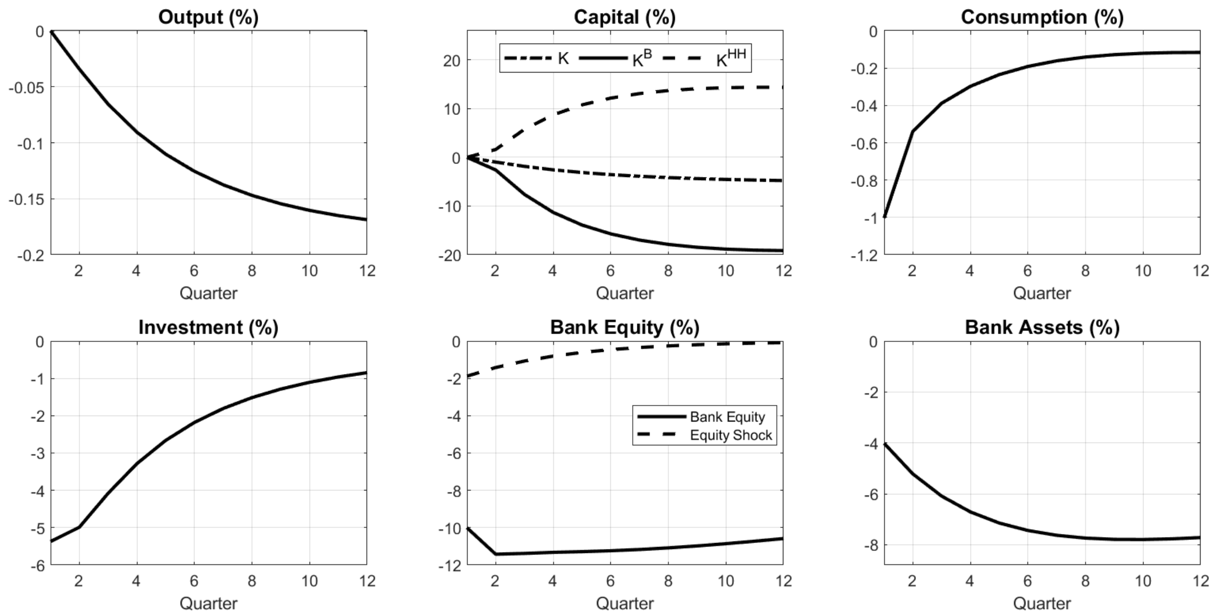


Figure 3: Dynamics of Aggregate Quantities

Note: Responses of aggregate quantities to a 10% decline in bank equity. Responses are reported in percentage deviation from their respective steady-state levels. The shock is reported in percent of steady state equity.

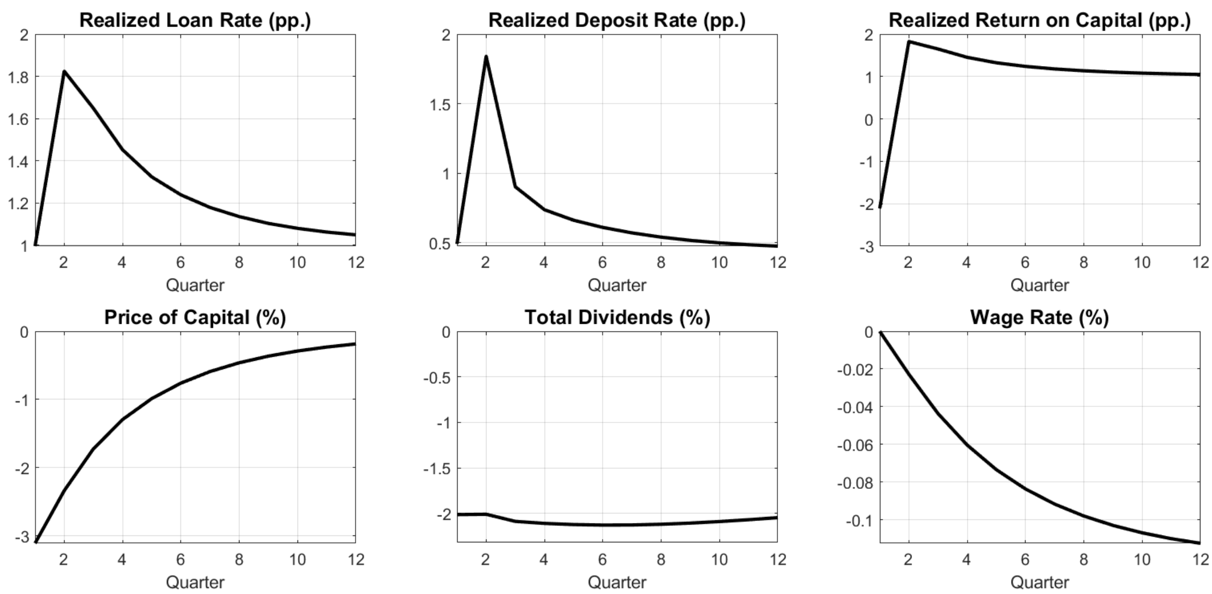


Figure 4: Dynamics of Equilibrium Prices

Note: Responses of prices to a 10% decline in bank equity. Top panels reports responses in percentage points. Bottom panels reports responses in percent deviations from their respective steady-state values. The realized net return to holding capital is defined as $\frac{R_t^K}{q_{t-1}} - 1$

Households are confronted with an unanticipated decline in the return on their capital holdings at the time of the shock, and by its subsequent increase over time. The latter is driven by two factors: An increase in the marginal product of capital, as capital effectively becomes scarcer, and capital gains from the increasing price of capital, as it recovers from its initial sharp drop in response to the shock. The wage rate, in turn, follows the dynamics of the aggregate stock of capital. Finally, dividends also experience a gradual recovery, driven by a reduction in payouts from banking activity that aligns with the gradual recovery of banks' net worth.[27]

4.2 Consumption Heterogeneity

We begin our analysis of the distributive effects of banking sector losses with an examination of the response of consumption across households. Figure 5 reports the model-implied consumption responses by quintile of total (labor and financial) income, in addition to aggregate consumption in the bottom right. The figure shows a substantial decline in consumption for all income groups, with more pronounced losses for households in the lowest income quintile.

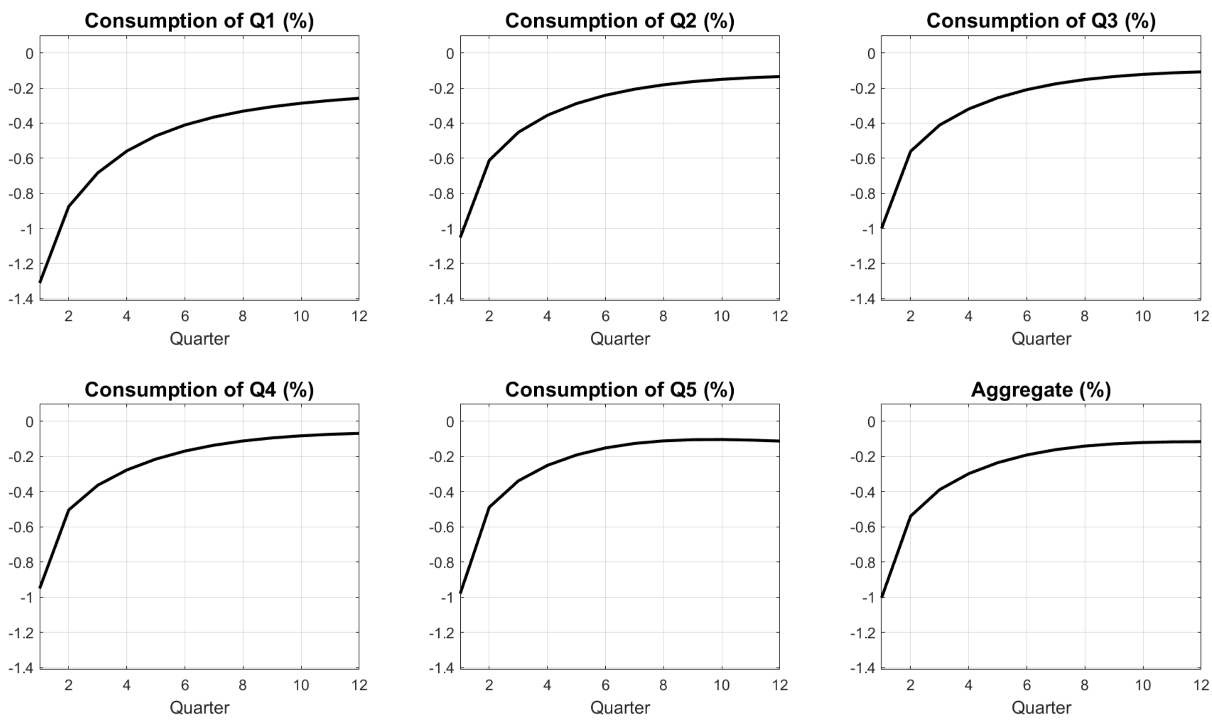


Figure 5: Consumption Responses by Income Quintile

Note: Response of consumption to a 10% decline in bank equity. Households sorted to income-quintiles (earnings, interest received, dividends) in steady state based on their idiosyncratic state (a, k, z). Impulse responses computed for each (a, k, z) as the expected path of consumption after the shock relative to the expected path without a shock. Responses aggregated within each group using the steady-state distribution over idiosyncratic states.

Figure 6 compares the model-implied cumulative IRFs twelve quarters after the shock

[27] Figure D.28 in Appendix D shows that the response of earnings, the return on capital, investment, and credit spreads are qualitatively consistent with their empirical counterparts.

with their empirical counterparts from Figure 2. The pattern of relative responses across income quintiles aligns very well with the data, both qualitatively and quantitatively. While the response of aggregate consumption is a target in the calibration of the shock, the relative response across income quintiles is not a calibration target.

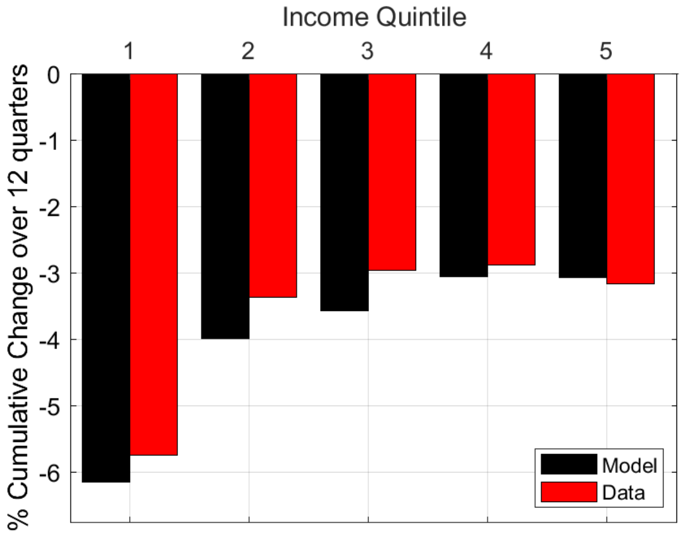


Figure 6: Consumption Responses by Income Quintile—Model vs. Data
Note: 12-quarter cumulative response of consumption to a 10% decline in bank equity. The model- and data-implied responses are represented as log deviations from steady state.

4.3 Welfare Implications

The model's ability to generate consumption responses consistent with those estimated in the data suggests that the model accurately captures a the exposure of households across the income distribution to banking sector disruptions. The model enables us to go beyond empirical consumption responses in two dimensions: First, it allows us to evaluate how changes in consumption translate into changes in welfare. Second, it enables us to examine the underlying transmission channels that contribute to the heterogeneity observed in Figure 6. This section explores the first aspect.

Measuring Welfare Changes. To measure the welfare impact of banking sector losses, we compute households' expected value functions immediately after the shock is realized and compare them to their respective values in steady state. To express welfare changes in terms of consumption equivalence units, we follow Bayer *et al.* (2019) and normalize the difference in value functions by the expected value of the discounted stream of utility from consumption and labor for each household.[28] Thus, we interpret changes in welfare as the fraction of (labor-augmented) consumption a household would

[28]Due to the utility cost of portfolio adjustment, households' value functions differ from the expected discounted stream of utility from consumption and labor.

be willing to permanently forego in order to avoid the consequences of the shock and have the economy remain in steady state. In percentage points, the consumption equivalent (CE) measure is calculated as

$$CE(a,k,z) = 100 \times \left[\left(\frac{V_1(a,k,z) - V^{ss}(a,k,z)}{\mathbb{E}U(a,k,z)} + 1 \right)^{\frac{1}{1-\sigma}} - 1 \right], \tag{36}$$

where

$$\mathbb{E}U(a,k,z) = \mathbb{E} \sum_{t=0}^{\infty} \beta^t u \left(c^{ss}(a,k,z,\theta) - \Psi z_t \frac{n_t^{ss}(a,k,z,\theta)^{1+\psi}}{1+\psi} \right).$$

V_1 and V^{ss} refer to households' value functions upon impact of the shock and in steady state respectively. In addition, $\mathbb{E}U(a,k,z)$ is the expected discounted utility from labor-augmented consumption in the steady state.

Distribution of Welfare Changes. Figure 7 presents the distribution of welfare changes as computed by equation (36). Two patterns are striking: First, although the distribution is centered around a negative value – the average CE change is -0.204% – 18.0 percent of households exhibit a positive change in welfare and are better off in the presence of the bank shock. Second, there is considerable heterogeneity in welfare changes. The top 5% losers experience and average loss of 1.56%, while the top 5% winners experience an average gain of 0.27%.

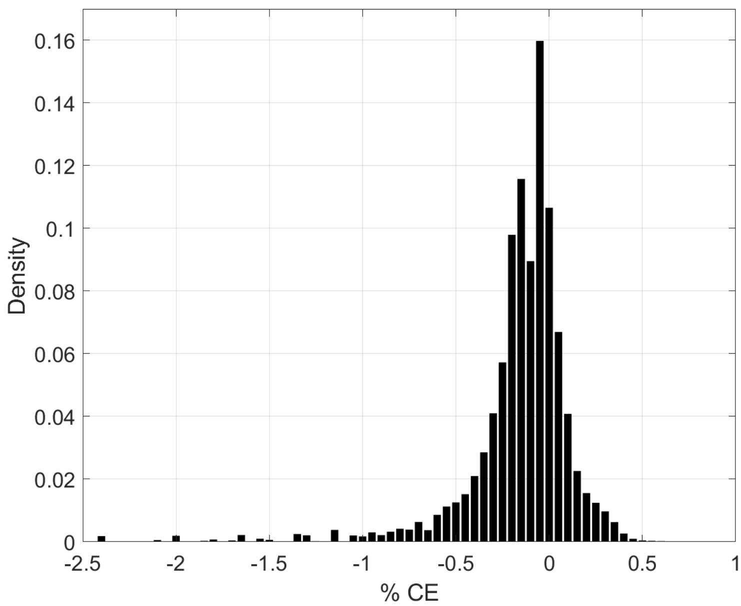


Figure 7: Distribution of Welfare Changes

Note: Distribution of welfare changes, measured in consumption equivalent units as defined in 36.

Table 4 compares households that are worse off after the shock with those that benefit from it. Households that experience a positive welfare change are relatively wealthier, have higher income and receive a larger share of their income from financial sources. In addition, conditional on wealth, better-off agents have a portfolio whose share of liquid assets is 9 percentage points higher than those who are worse off.[29]

Table 4: Characteristics of Gainers and Losers from Bank Losses

Characteristic	Worse Off	Better Off
Avg. Liquid Assets	0.30	4.18
Avg. Capital Holdings	0.49	3.30
Avg. Net Worth	0.47	3.42
Avg. Total Income	0.84	1.73
Avg. Desired Capital Change (%)	-1.1	4.9
Avg. Dependence on Earnings	93.1	74.8

Note: "Dependence on labor income" refers to the average share of earnings in households' total income. Avg. Desired Capital Change refers to the average adjustment in capital holdings absent the shock, relative to the economy wide average capital holding. With the exception of two last rows, numbers are displayed as a multiple of economy-wide averages.

Table B.1 in the Appendix shows a further breakdown of household characteristics for quintiles of the distribution of welfare changes. Overall, the conclusions are the same as those from Table 4.

Welfare Changes along the Income Distribution. Figure 8 illustrates that the impact of the shock on welfare is distributed in a more uneven manner than what is observed for consumption. For welfare (black bars), a clear monotonic pattern emerges with households at the lower end of the income distribution suffering the largest welfare losses. While the welfare of households in the first quintile is reduced by 0.63%, households at the top of the income distribution instead experience an increase in welfare by 0.04% on average. In contrast, the inequality in initial consumption responses is not nearly as pronounced: while the total decline for the first quintile is 6%, for the fifth quintile it is 3%.

[29]This number is obtained by regressing portfolio liquidity $\frac{a}{a+k}$ on a cubic polynomial of net worth $a+k$ and a dummy variable for "better-off". The average portfolio liquidity in the economy is 29%.

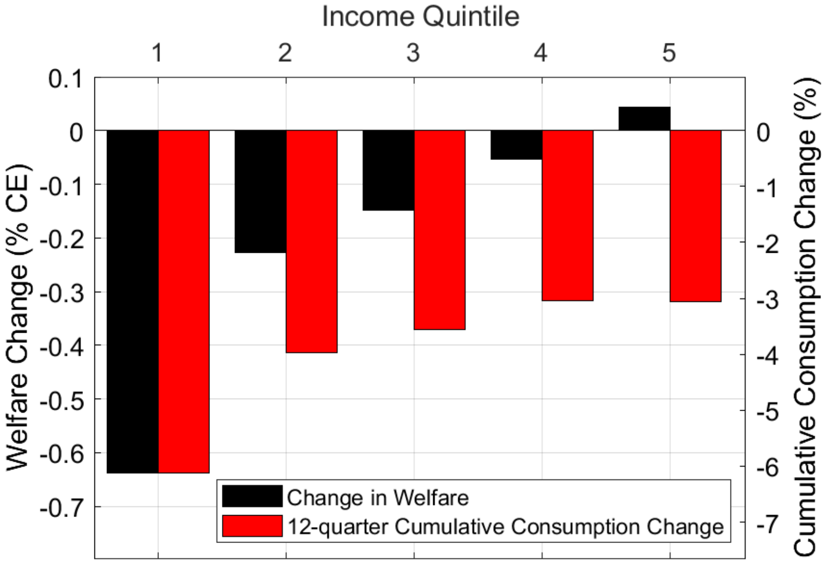


Figure 8: Welfare and Consumption Changes by Income Quintile

Note: Welfare changes (left y-axis) computed as in (36) and aggregated within each income quintile with steady-state distribution. Consumption changes cumulated over 12 quarters following the shock from the series in Figure 5 (right y-axis).

Heterogeneity along the Distribution of Net Worth. Table 5 compares changes in welfare across quintiles of income and net worth. Net worth is defined as the sum of capital and liquid assets.[30] The heterogeneity across quintiles of the net-worth distribution closely resembles that of the income distribution. This is because income and wealth in the model economy are highly correlated, as in the data (see Table 3).

Table 5: Welfare Changes—Heterogeneity

Quintile	Q1	Q2	Q3	Q4	Q5
by Income	-0.639	-0.227	-0.148	-0.053	0.043
by Net Worth	-0.638	-0.217	-0.130	-0.072	0.049

Notes: Changes in welfare measured in consumption equivalent units, as in equation 36.

4.4 Transmission Channels

What mechanisms explain the patterns shown in Figure 8? Why do the rich suffer much less than what their initial consumption response would suggest? How can a considerable fraction of households benefit from an adverse shock? To examine these questions, we decompose the general-equilibrium responses of consumption and welfare into the contribution of movements in different prices and interest rates, following Kaplan *et al.* (2018). We compute counterfactuals in which we allow only one market price at a time to follow

[30] Figure B.3 in the appendix displays the responses of consumption by quintile of net worth.

its realized general-equilibrium path, while keeping all other prices, rates, and dividends at their steady-state levels. In particular, we focus on the respective contribution of (i) labor earnings (z_t, w_t), (ii) the cost of borrowing (R_t^L), (iii) returns to savings (R_t^D, r_t^K, q_t), or (iv) dividends (div_t). For each counterfactual, we allow households to make their consumption, labor supply, savings, and portfolio choices based on the counterfactual price paths.

Figure 9 decomposes the welfare changes by income quintile due to these four components. The figure reveals substantial heterogeneity in transmission channels affecting different households. First, low-income households are exposed to changes in borrowing rates, which account for approximately one-third of their welfare losses. These households use short-term debt to insure against temporary income losses, which becomes more expensive in response to banking sector distress. Second, while households in all income quintiles are substantially affected by changes in earnings, those at the bottom of the distribution are more exposed to this channel. This is due to their inability to insure against income shocks and because they are most severely impacted by the decline in labor income. The larger decline in their income is driven both by earnings accounting for a larger proportion of low-income individuals' income and by their relatively high earnings exposure to the business cycle (via the function $\gamma(\hat{z}_t, Y_t)$).[31] Returns to saving, on the other hand, display a positive contribution for all the quintiles, with welfare gains increasing in household income. Finally, the impact of dividends is concentrated among capitalist households, who are in the top quintile of the income distribution.[32]

[31] Figure B.2 in Appendix B decomposes the effects of labor income further, into changes in average wages and the contribution of differential exposure to the business cycle.

[32] Figure B.1 in Appendix B presents capitalists, which represent 1 percent of the population, as a separate category.

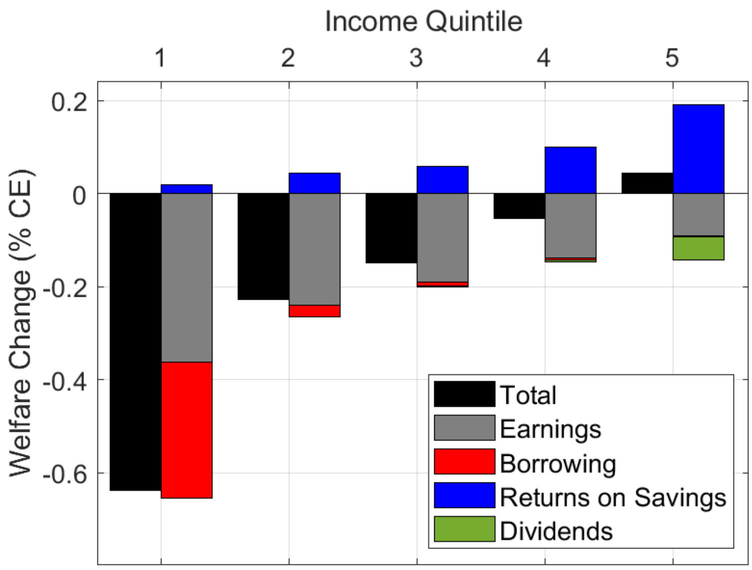


Figure 9: Decomposition of Welfare Changes by Income Quintile

Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, returns to saving $(\{R_t^D, r^K, q_t\}_{t=0}^T)$, and dividends $(\{div_t\}_{t=0}^T)$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values.

Figure 10 shows the consumption counterpart of the decomposition described above. Changes in earnings have a gradual but persistent effect on consumption, reflecting the dynamics of wages. In line with welfare changes, the decline in consumption in response to changes in labor earnings is most pronounce for the lowest income quintile. Changes in borrowing costs lead to large declines in consumption for the lowest income households. Moving up the income distribution, R^L quickly becomes irrelevant, because the amount borrowed by the rich is small. Returns to saving, on the other hand, become more important as we move up the income distribution. In response to movements in returns, households initially reduce their consumption but after six quarters, consumption overshoots its steady-state level for all quintiles. This overshooting is behind the positive welfare changes induced by movements in financial variables. Finally, the effect of dividends is concentrated in the top quintile and its impact is persistent, consistent with the slow recovery in the banking sector.

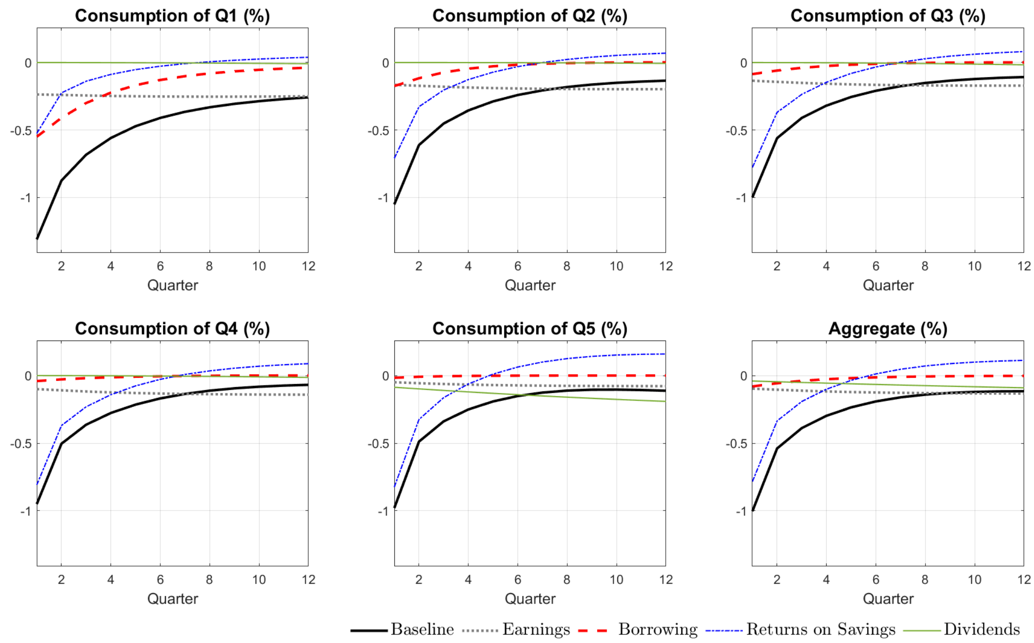


Figure 10: Consumption Decomposition by Income Quintile

Note: Decomposition of consumption responses due to earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, returns to saving $(\{R_t^D, r^K, q_t\}_{t=0}^T)$, and dividends $(\{div_t\}_{t=0}^T)$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values.

The Role of Financial Variables. Figure 11 breaks down the financial component of welfare changes into those due to deposit rates R^D, the rental rate on capital r^K and its price q, and dividends. The latter only affect capitalist households at the very top of the income distribution, who see their income fall in response to the decline in banks' net worth and lower economic activity. The welfare impact of changes in deposit rates is positive as R^D increases and similar across quintiles. This is explained by the fact that households at the bottom are more dependent on those for savings, while those at the top are simply wealthier and their income is thus relatively more exposed to changes in returns on the assets they hold.

Changes in the price of capital reduce welfare for households at the bottom of the income distribution but increase welfare for households at the top. This is due to the fact the decline in capital prices is temporary and only affect households that choose to adjust their capital holdings upon the realization of the shock. Low-income households adjusting their portfolio are more likely to liquidate their capital holdings, such that a reduction in the price of capital lowers their liquidation value. The opposite is true for high-income households: Adjusting households are more likely increase their capital holdings and benefit from buying capital at a temporarily lower price.

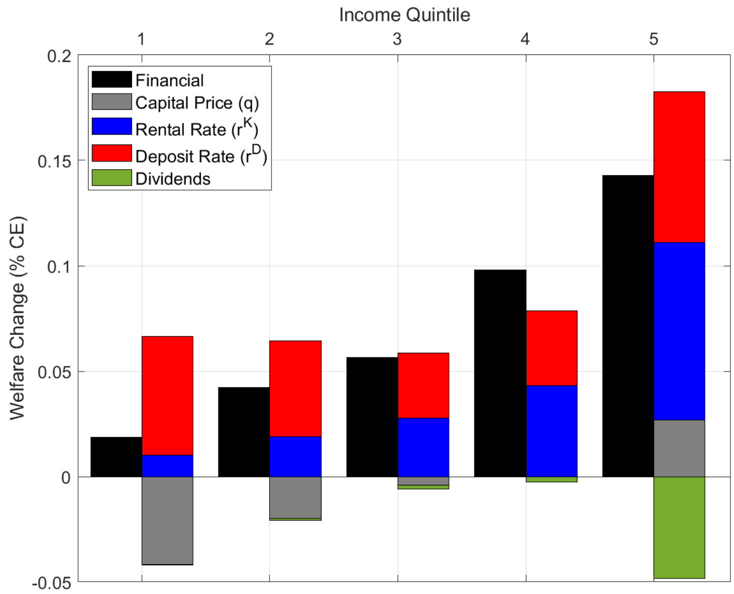


Figure 11: Decomposition of Welfare Changes—Financial Variables

Note: Decomposition of welfare changes due to financial variables (jointly $\{R_t^D, R_t^K, div_t\}_{t=0}^T$, in the black bar) and each of its separate components (gray and colored bars). Each of the gray and colored bars is obtained by simulating the economy in response to the partial-equilibrium path of one variable (or all four, in the case of the black bar).

The increase in the return on capital benefits households across the board, but particularly those at the top of the income distribution who hold most of the capital in the economy. As bank intermediation capacity is reduced by the shock, capital becomes scarcer, and households holding this scarcer resource can benefits from the increased returns.

Margins of Adjustment. Overall, high-income households take advantage of movements in savings markets to finance higher future consumption. This is clearly seen in Figure 12, where general-equilibrium consumption responses are decomposed into adjustments at other margins. For this decomposition, we rely on the budget constraint and treat consumption as the residual, adjusting it to changes in other components. From the budget constraint, we decompose consumption as

$$
\begin{aligned}
c_t = & \underbrace{-\Delta a_t}_{\substack{\text{Changes in}\\ \text{Deposits}}} - \underbrace{q_t \Delta k_t}_{\substack{\text{Changes in}\\ \text{Capital}}} + \underbrace{(R_t^D - 1)a_{t-1}\mathbb{I}_{(a_{t-1})>0} + (R_t^K - q_t)k_{t-1}}_{\substack{\text{Income from}\\ \text{Savings}}} \\
& + \underbrace{w_t z_t n_t + \mathbb{I}_{z_t=z^*} div_t}_{\substack{\text{Earnings and}\\ \text{Dividends}}} - \underbrace{(R_t^L - 1)(-a_{t-1})\mathbb{I}_{a_{t-1}<0} - \tau(z_t, a_t)(-a_t)\mathbb{I}_{a_t<0}}_{\substack{\text{Cost of Loans}\\ \text{(Interest and Cost of Issuance)}}}
\end{aligned}
\tag{37}
$$

where $\Delta a_t = a_t - a_{t-1}$ and $\Delta k_t = k_t - k_{t-1}$ respectively.

The contribution of the temporary increase in capital holdings due to the shock increases monotonically with income and is partially offset by a reduction in deposits and higher income from savings for high-income individuals. Higher capital holdings contribute to sustain a higher consumption over the medium term. Specifically, the impact of changes in capital holdings on consumption becomes positive after 10 quarters as households begin to reduce their holdings, ultimately mitigating welfare losses. This mechanism is most pronounced for individuals at the top of the income distribution.

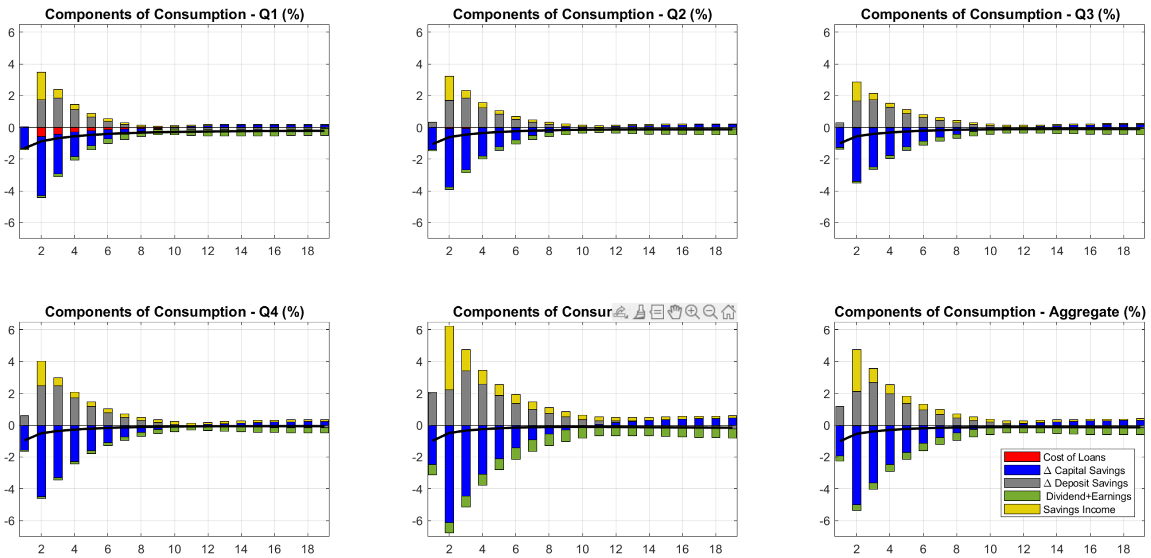


Figure 12: Consumption Decomposition—Components of the Budget

Note: Model-implied consumption responses in general equilibrium (black line), decomposed into margins of adjustments based on the budget constraint as in equation (37). Impulse responses are displayed relative to the counterfactual evolution of consumption (and other margins of adjustment) for each group in the absence of any price variation. "Cost of Loans" refers to the last term of Equation (37), including intermediation costs.

4.5 Robustness

In Appendix B, we show that the results presented in this section are qualitatively robust and quantitatively similar to those obtained when considering a shock that reduces the productivity of bank-held assets, to a specification with inelastic labor supply, and to different values of the parameters σ_θ.

Overall, the results in this section show that disruptions in the banking sector have substantial distributive consequences. In addition to those with a direct claim to bank dividends, losses from banking sector disruptions are concentrated among low-income households, who are particularly exposed to changes in earnings and in the lending rate. In contrast, high-income households are able to benefit from fluctuations in returns to savings. Their notable initial reduction in consumption is compensated by relatively higher future consumption. Thus, the impact of the shock on the welfare of high-income households is more limited, with some of them potentially benefiting from disruptions to the banking sector.

5 Portfolio Choices and Aggregate Dynamics

A salient feature of our model is the role of household portfolio adjustments in shaping the distributional consequences of banking sector losses. In this section, we show that allowing households to invest directly in productive capital has additional implications for aggregate dynamics in response to productivity shocks. To assess the role of direct capital holdings, we compare our benchmark model to two counterfactual economies: An economy with no banks, where all capital is held directly by households, and an economy in which banks intermediate the entire capital stock, where households are unable to invest capital directly.

No-Banks Economy. In the model without banks liquid assets are supplied by the government using debt B_t. This enables us to keep the total supply of liquidity available to households unchanged, relative to our calibration in Section 3. The government imposes lump-sum taxes proportional to labor productivity to finance any interest payment on its debt.[33] We allow the supply of liquid assets to fluctuate with economic activity, but assume a constant debt-to-GDP ratio such that $\frac{B_t}{Y_t} = \bar{B}$. The households' problem in 1 and 3 remains unchanged except for the budget constraint, which now includes the tax necessary to balance the government budget, such that

$$c_t + (1 - \tau(z_t, a_t))a_t + q_t k_t \leq \quad R_t^{HH}(a_{t-1})a_{t-1} + R_t^K k_{t-1} + w_t z_t n_t + \mathbb{I}_{z_t = z^*} div_t - z_t \bar{T}_t,$$

where $\bar{T}_t$ denotes the lump sum tax. The expression above refers to the budget of *adjusting* households. The budget of *non-adjusting* households changes accordingly. Government budget clearing requires

$$R_t^D B_{t-1} - B_t = \int_{(a,k,z,\theta)} \lambda_t(a, k, z, \theta) z_t \bar{T}_t,$$

and asset market clearing requires that

$$B_t = \int_{(a,k,z,\theta)} \lambda_t(a, k, z, \theta) a_t(a, k, z, \theta).$$

Further, as usual in the literature, we assume that the interest rate on consumer loans equals the return on liquid assets, i.e. $R_t^L = R_t^D$.

The calibration of the no-bank economy is as close as possible to the benchmark model. All exogenously set parameters are kept at the same value as before. Compared

[33]The lump-sum tax assumption is made to avoid introducing distortions to the labor supply relative to the benchmark economy.

to the calibration of the benchmark model, for the non-bank economy we neglect the target on banks' share in total capital as well as the parameters which only enter banks' problem (ω and χ) and are obsolete in this version. We set the parameter $\bar{B}$ to keep the ratio of deposits to output in steady state unchanged. In addition, we re-calibrate the parameters μ_θ, β, δ, Ψ, and τ^{slope} to match the same targets on the capital-output ratio, R^D, R^K, the share of liquid assets held by the bottom quintile, and to normalize steady state output to 1.[34]

Only-Banks Economy. In the *only-banks* economy, the banking sector is the same as described in section 2. On the household side, we solve a one-asset version of the model, in which households can only save in liquid bank deposits or borrow in consumer loans, but cannot hold productive capital directly. Households solve the following problem

$$V_t(a_{t-1}, z_t) = \max_{c_t \geq 0, a_t \geq \underline{a}, n_t \geq 0} \left\{ u(c_t, n_t) + \beta \mathbb{E}_t V_{t+1}(a_t, z_{t+1}) \right\}$$
$$\text{s.t. } c_t + (1 - \tau(z_t, a_t))a_t \leq R_t^{HH}(a_{t-1})a_{t-1} + w_t z_t n_t + \mathbb{I}_{z_t = z^*} div_t.$$

For the calibration, we keep again all exogenously set parameters unchanged. Compared to the benchmark model calibration, we neglect the target related to the share of banks' capital in total capital as well as the parameters μ_θ and σ_θ related to the households' capital adjustment decision. In addition, we re-calibrate the parameters ω, χ, β, δ, Ψ, and τ^{slope} to match the same targets on the capital-output ratio, deposits-to-output ratio, R^D, R^K, the share of liquid assets held by the bottom quintile, and to normalize steady state output to 1.[35]

Aggregate Dynamics. We simulate each version of the model in response to an unanticipated total factor productivity shock that reverts to its steady state value at a constant rate. We set the magnitude of the shock to one percent and its persistence equal to 0.9. Importantly, we calibrate the capital adjustment cost parameter to ensure that the inverse elasticity of investment with respect to the price of capital is the same across all economies. The calibration yields ϕ_K equal to 2.49 and 3.18 for the *no-banks* and the *only-banks* version of the model respectively, compared to a value of 2.47 in the benchmark model. Figures 13 and 14 depict the responses of macroeconomic aggregates and prices in the benchmark model, together with the no-bank and only-bank version of the model.

[34]For complete results, see Table C.2 in Appendix C.
[35]For complete results, see Table C.2 in Appendix C.

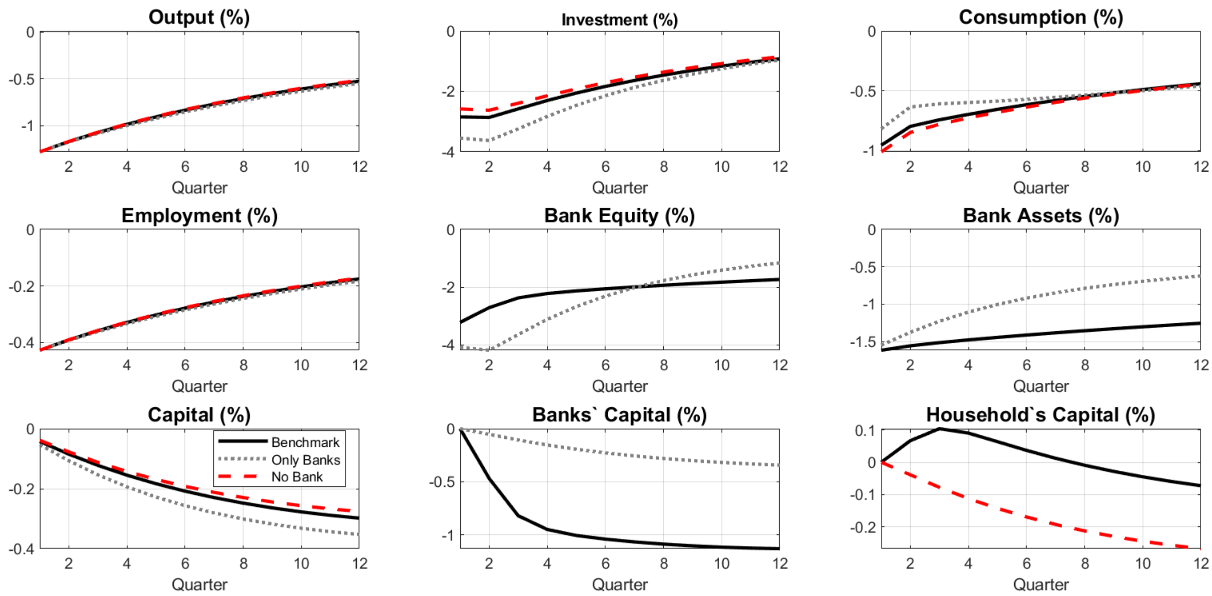


Figure 13: Comparison Across Models - Selected Macroeconomic Variables
Note: Impulse-response functions of selected aggregate variables to a 1% TFP shock with 0.9 persistence. Changes are relative to the steady-state values.

While output responds similarly across models, the response of aggregate consumption and investment varies considerably. Investment declines more strongly when all intermediation occurs through banks compared to the benchmark with partial intermediation. It version of the model in which, absent banks, households finance the entire stock of productive capital. The different response of investment is compensated by the response of aggregate consumption. Consumption responds the least in the economy in which households do not invest in productive capital and declines by most in the economy without a banking sector. Despite the stronger impact on investment, the response of bank-intermediated capital is smaller in the *only banks* economy, relative to the benchmark. In the benchmark economy, households adjust their portfolios and increase their capital holdings, making up for part of the decline in banks' capital holdings.

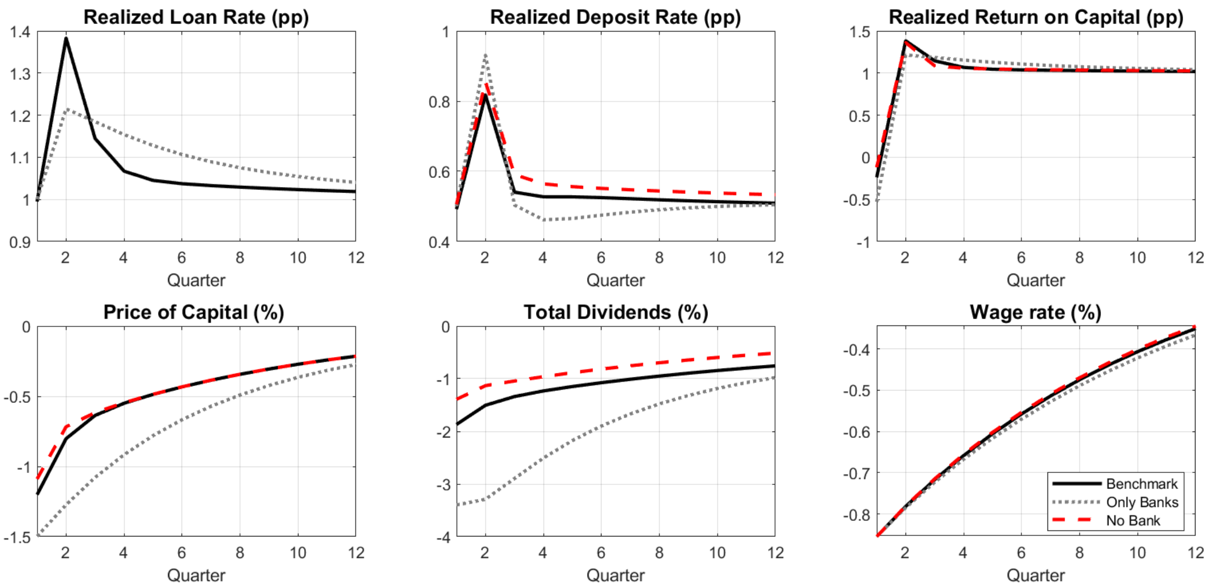


Figure 14: Comparison Across Models - Prices and Rates

Note: Impulse-response functions of selected variables to a 1% TFP shock with 0.9 persistence. Rates on the top panels are displayed in percentage points, while the bottom panels display percent changes relative to steady-state values. The loan rate in the "no bank" economy equals the deposit rate, and is thus not plotted.

The larger reduction of investment in the *only banks* economy is associated with a stronger decline of asset prices and in the return on holding capital. The return on capital recovers more slowly when all capital is held by banks, causing a smaller increase in the loan rate through banks' no-arbitrage condition. The response of deposit rates is strongest in the *only banks* economy, where deposits are the only means of savings for households. Upon a recession, households seek to liquidate them to smooth consumption, leading to a higher equilibrium deposit rate. Finally, the large decline in dividends in the *only-banks* economy is driven by the decline in banking activity, as banks' profits account for a relative larger share of dividends than in the other two economies due to larger bank balance sheets.

New Keynesian Frictions. In Appendix A.2, we check if our results are robust to introducing wage rigidities in a HANK version of our economy. Our conclusions from this section on the relative dynamics of consumption and investment across model economies are unchanged when introducing nominal rigidities, the response of investment remains largest in the *only banks* version and smallest in the *no banks* specification while the reverse is true for consumption.

Our findings show the importance of considering explicit micro-foundations for the demand for intermediated savings when studying the role of financial frictions for aggregate fluctuations. When households can hold capital directly, the supply of funding for banks is determined in an optimal choice between illiquid capital and liquid deposits.

As returns adjust in response to aggregate shocks, an adjusted return-liquidity profile changes households' tradeoff between different assets. The change induces households to adjust their portfolios and absorb some of the reduction in banks' capital holdings, dampening the aggregate fall in investment and capital. An explicit micro-foundation for the supply of deposits, built around households' need for liquidity to insure against idiosyncratic shocks, dampens the aggregate implications of intermediation frictions on the dynamics of investment. In our calibrated benchmark economy, about one-third of capital holdings are intermediated through banks. Quantitatively, however, the overall response of the benchmark economy is still very close to the *no banks* counterfactual.

6 Conclusion

We build a two-asset model featuring rich household heterogeneity and an explicit banking sector. The model replicates several empirical features of the wealth and income distributions of the United States. We employ it to study the distributive effects of losses in the banking sector. In line with empirical estimates, the model predicts consumption to decline more strongly at the bottom of the income distribution. Decomposing the mechanisms behind the observed consumption dynamics, we show that low-income households respond predominantly to fluctuations in borrowing costs and labor income. In contrast, high-income individuals respond to changes in asset returns, increase their savings, and shift their portfolios to illiquid capital holdings to take advantage of temporarily suppressed asset prices. These patterns make the response of welfare substantially more uneven than that of consumption, with 18% of households at the top of the income distribution benefiting from shocks to the financial sector. Finally, comparing the baseline model to counterfactual economies with different degrees of financial intermediation, we find that households' ability to adjust their portfolio composition reduces the sensitivity of investment to aggregate shocks.

References

AGUIAR, M. and M. BILS (2015): "Has consumption inequality mirrored income inequality?" *American Economic Review* **105(9)**: pp. 2725–56.

AKAIKE, H. (1974): "A new look at the statistical model identification." *IEEE Transactions on Automatic Control* **19(6)**: pp. 716–723.

ANDERSEN, A. L., N. JOHANNESEN, M. JØRGENSEN, and J.-L. PEYDRÓ (2021): "Monetary policy and inequality." .

ARSLAN, Y., B. GULER, and B. KURUSCU (2024): "Credit supply, housing demand, and bank balance sheets in the great recession." .

AUCLERT, A., B. BARDÓCZY, and M. ROGNLIE (2023): "Mpcs, mpes, and multipliers: A trilemma for new keynesian models." *Review of Economics and Statistics* **105(3)**: pp. 700–712.

AUCLERT, A., B. BARDÓCZY, M. ROGNLIE, and L. STRAUB (2021): "Using the sequence-space jacobian to solve and estimate heterogeneous-agent models." *Econometrica* **89(5)**: pp. 2375–2408.

AUCLERT, A., M. ROGNLIE, and L. STRAUB (2018): "The intertemporal keynesian cross." *Technical report*, National Bureau of Economic Research.

BARON, M., E. VERNER, and W. XIONG (2021): "Banking Crises Without Panics." *Quarterly Journal of Economics* **136**: pp. 51–113.

BAYER, C., R. LÜTTICKE, L. PHAM-DAO, and V. TJADEN (2019): "Precautionary savings, illiquid assets, and the aggregate consequences of shocks to household income risk." *Econometrica* **87(1)**: pp. 255–290.

BERNANKE, B. (2018): "he real effects of the financial crisis." *Technical report*, Brookings Papers on Economic Activity.

BERNANKE, B. S., M. GERTLER, and S. GILCHRIST (1999): "Chapter 21 the financial accelerator in a quantitative business cycle framework." volume 1 of *Handbook of Macroeconomics*, pp. 1341–1393. Elsevier.

BIS (2021): "BIS annual economic report." Bank for International Settlements.

BRUNNERMEIER, M. K. and Y. SANNIKOV (2014): "A macroeconomic model with a financial sector." *American Economic Review* **104**: pp. 379–421.

CARROLL, C. (2006): "The method of endogenous gridpoints for solving dynamic stochastic optimization problems." *Economics Letters* **91(3)**: pp. 312–320.

CASTANEDA, A., J. DIAZ-GIMENEZ, and J.-V. RIOS-RULL (2003): "Accounting for the us earnings and wealth inequality." *Journal of political economy* **111(4)**: pp. 818–857.

CHRISTIANO, L. J., R. MOTTO, and M. ROSTAGNO (2014): "Risk shocks." *American Economic Review* **104(1)**: pp. 27–65.

CLOYNE, J., C. FERREIRA, and P. SURICO (2020): "Monetary policy when households have debt: new evidence on the transmission mechanism." *Review of Economic Studies* **87(1)**: pp. 102–129.

Coibion, O., Y. Gorodnichenko, L. Kueng, and J. Silvia (2017): "Innocent bystanders? monetary policy and inequality." *Journal of Monetary Economics* **88**: pp. 70–89.

De Giorgi, G. and L. Gambetti (2017): "Business cycle fluctuations and the distribution of consumption." *Review of Economic Dynamics* **23**: pp. 19–41.

De Nardi, M., G. Fella, and G. Paz-Pardo (2019): "Nonlinear Household Earnings Dynamics, Self-Insurance, and Welfare." *Journal of the European Economic Association* **18(2)**: pp. 890–926.

Del Canto, F. N., J. R. Grigsby, E. Qian, and C. Walsh (2023): "Are inflationary shocks regressive? a feasible set approach." *Technical report*, National Bureau of Economic Research.

Draghi, M. (2016): "Stability, equity and monetary policy." 2nd DIW Europe Lecture.

Eggertsson, G. B. and P. Krugman (2012): "Debt, deleveraging, and the liquidity trap: A fisher-minsky-koo approach." *Quarterly Journal of Economics* **127(3)**: pp. 1469–1513.

Fagereng, A., M. Gomez, E. Gouin-Bonenfant, M. Holm, B. Moll, and G. Natvik (2024): "Asset-price redistribution." *Technical report*.

Farmer, L. E. and A. A. Toda (2017): "Discretizing nonlinear, non-gaussian markov processes with exact conditional moments." *Quantitative Economics* **8(2)**: pp. 651–683.

Fernández-Villaverde, J., S. Hurtado, and G. Nuno (2023): "Financial frictions and the wealth distribution." *Econometrica* **91(3)**: pp. 869–901.

Ferrante, F. and N. Gornemann (2024): "Devaluations, deposit dollarization and household heterogeneity." .

Gertler, M. and P. Karadi (2011): "A model of unconventional monetary policy." *Journal of monetary Economics* **58(1)**: pp. 17–34.

Gertler, M. and N. Kiyotaki (2010): "Financial intermediation and credit policy in business cycle analysis." In "Handbook of monetary economics," volume 3, pp. 547–599. Elsevier.

Gertler, M., N. Kiyotaki, and A. Prestipino (2019): "A macroeconomic model with financial panics." *Review of Economic Studies* **87**: pp. 240–288.

Gertler, M., N. Kiyotaki, and A. Prestipino (2020): "Credit booms, financial crises, and macroprudential policy." *Review of Economic Dynamics* .

Glover, A., J. Heathcote, D. Krueger, and J.-V. Ríos-Rull (2020): "Intergenerational redistribution in the great recession." *Journal of Political Economy* **128(10)**: pp. 3730–3778.

Gornemann, N., K. Kuester, and M. Nakajima (2016): "Doves for the rich, hawks for the poor? distributional consequences of monetary policy." .

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

Guvenen, F., G. Kaplan, and J. Song (2021): "The glass ceiling and the paper floor: Changing gender composition of top earners since the 1980s." *NBER Macroeconomics Annual* **35**: pp. 309–373.

Guvenen, F., S. Schulhofer-Wohl, J. Song, and M. Yogo (2017): "Worker betas: Five facts about systematic earnings risk." *American Economic Review* **107(5)**: pp. 398–403.

He, Z. and A. Krishnamurthy (2019): "A macroeconomic framework for quantifying systemic risk." *American Economic Journal: Macroeconomics* **11(4)**: pp. 1–37.

Hintermaier, T. and W. Koeniger (2010): "The method of endogenous gridpoints with occasionally binding constraints among endogenous variables." *Journal of Economic Dynamics and Control* **34(10)**: pp. 2074–2088.

Holm, M. B., P. Paul, and A. Tischbirek (forthcoming): "The transmission of monetary policy under the microscope." *Journal of Political Economy* .

Iacoviello, M. (2015): "Financial business cycles." *Review of Economic Dynamics* **18(1)**: pp. 140–163.

Jasova, M., C. Mendicino, E. Panetti, J.-L. Peydró, and D. Supera (2024): "Monetary policy, labor income inequality and credit: evidence from matched employee-employer and credit registers." .

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

Jordà, Ò. (2005): "Estimation and inference of impulse responses by local projections." *American economic review* **95(1)**: pp. 161–182.

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

Kaplan, G., B. Moll, and G. L. Violante (2018): "Monetary policy according to HANK." *American Economic Review* **108(3)**: pp. 697–743.

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

Kiyotaki, N. and J. Moore (1997): "Credit cycles." *Journal of political economy* **105(2)**: pp. 211–248.

Krueger, D., K. Mitman, and F. Perri (2016): "Macroeconomics and household heterogeneity." volume 2, chapter 11, pp. 843–921. Elsevier.

Krusell, P. and A. A. Smith, Jr (1998): "Income and wealth heterogeneity in the macroeconomy." *Journal of political Economy* **106(5)**: pp. 867–896.

Laeven, L. and F. Valencia (2013): "Systemic banking crises database." *IMF Economic Review* **61(2)**: pp. 225–270.

Lagarde, C. (2020): "The monetary policy strategy review: some preliminary considerations." Speech delivered at the "ECB and Its Watchers XXI" conference.

Lee, S., R. Luetticke, and M. O. Ravn (2024): "Financial frictions: Macro vs micro volatility." .

Maggiori, M. (2017): "Financial intermediation, international risk sharing, and reserve currencies." *American Economic Review* **107(10)**: pp. 3038–3071.

McKay, A., E. Nakamura, and J. Steinsson (2016): "The power of forward guidance revisited." *American Economic Review* **106(10)**: pp. 3133–58.

McKay, A. and R. Reis (2016): “The role of automatic stabilizers in the u.s. business cycle.” *Econometrica* **84(1)**: pp. 141–194.

Mendicino, C., K. Nikolov, D. Supera, and J.-R. Ramirez (2024): “Twin defaults and bank capital requirements.” *Journal of Finance, Forthcoming* .

Mersch, Y. (2014): “Monetary policy and economic inequality.” Keynote speech, Corporate Credit Conference, Zurich.

Meyer, B. D. and J. X. Sullivan (2013): “Consumption and income inequality and the great recession.” *American Economic Review* **103(3)**: pp. 178–83.

Philippon, T. (2015): “Has the us finance industry become less efficient? on the theory and measurement of financial intermediation.” *American Economic Review* **105(4)**: pp. 1408–38.

Powell, J. H. (2020): “New economic challenges and the fed’s monetary policy review.” At ”Navigating the Decade Ahead: Implications for Monetary Policy,” an economic policy symposium sponsored by the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming.

Pulkkinen, T. E. and E. S. Rosengren (1993): “Lessons from the rhode island banking crisis.” *New England Economic Review* .

Reinhart, C. M. and K. S. Rogoff (2009): *This time is different: Eight centuries of financial folly.* Princeton University Press.

Stock, J. H. and M. W. Watson (2003): “Forecasting output and inflation: The role of asset prices.” *Journal of Economic Literature* **41(3)**: pp. 788–829.

Young, E. R. (2010): “Solving the incomplete markets model with aggregate uncertainty using the krusell–smith algorithm and non-stochastic simulations.” *Journal of Economic Dynamics and Control* **34(1)**: pp. 36 – 41.

Appendix

A Further Model Details

A.1 Equilibrium Definition

An equilibrium in our model economy described in Section 2 consists of a sequence of household value $\{V_t^n(a,k,z), V_t^a(a,k,z), V_t(a,k,z)\}$ and policy functions $\{a_t(a,k,z,\theta), k_t(a,k,z,\theta), n_t(a,$ a measure over idiosyncratic states $\{\lambda_t(a,k,z,\theta)\}$, a path of exogenous shocks $\{\epsilon_t\}$, and initial conditions $\lambda_1(a,k,z)$, K_0^B, K_0^{HH}, and R_1^D, R_1^L such that:

1. Given prices and shocks, households and banks solve their problems in (1), (3), and (7)
2. The measure over states is induced by households' policy functions.
3. The following system of equations hold at all times:

$$Y_t = A_t N_t^{1-\alpha} K_t^{\alpha} \qquad \text{(Production Function)}$$

$$K_t = K_{t-1}^{B} + K_{t-1}^{HH} \qquad \text{(Effective Capital Accumulation)}$$

$$N_t = \int_{(a,k,z,\theta)} \gamma(z_t, Y_t) z_t n_t(a,k,z,\theta) \lambda_t(a,k,z,\theta) \qquad \text{(Labor Supply)}$$

$$r_t^K + \delta = \frac{1}{\mu} \alpha \frac{Y_t}{K_t} \qquad \text{(Rental Rate of Capital)}$$

$$w_t = \frac{1}{\mu}(1-\alpha)\frac{Y_t}{N_t} \qquad \text{(Labor Demand)}$$

$$q_t = 1 + \phi^k \left(\frac{I_{nt} + I_{ss}}{I_{n,t-1} + I^{ss}} - 1 \right)^2 + \frac{\phi^k}{2} \cdot \left(\frac{I_{nt} + I^{ss}}{I_{n,t-1} + I^{ss}} - 1 \right)^2$$

$$- \beta \phi^k \left(\frac{(I_{n,t+1} + I_{ss})}{(I_{n,t} + I_{ss})} - 1 \right) \left(\frac{I_{n,t+1} + I^{ss}}{I_{n,t} + I^{ss}} \right)^2 \qquad \text{(K Producer Optimality)}$$

$$div_t^k = (q_t - 1) I_{nt} - \frac{\phi_K}{2} \left(\frac{I_{nt} + I^{ss}}{I_{n,t-1} + I^{ss}} \right)^2 (I_{nt} + I^{ss}) \qquad \text{(K Producer Dividends)}$$

$$K_t^{HH} = \int_{(a,k,z,\theta)} k_t(a,k,z,\theta) \lambda_t(a,k,z,\theta) \qquad \text{(Capital Held by Households)}$$

$$D_t = \int_{(a,k,z,\theta)} \mathbb{I}_{a_t(a,k,z,\theta) \geq 0} \; a_t(a,k,z,\theta) \lambda_t(a,k,z,\theta) \qquad \text{(Deposits)}$$

$$L_t = \int_{(a,k,z,\theta)} \mathbb{I}_{a_t(a,k,z,\theta) < 0} \left(-a_t(a,k,z,\theta) \right) \lambda_t(a,k,z,\theta) \qquad \text{(Consumer Loans)}$$

$$div_t^B = \frac{(1-p)}{p} E_{ct} - E_{nt} \qquad \text{(Dividends from Banks)}$$

$$\phi_t = \frac{\eta_t}{\lambda - \nu_t} \qquad \text{(Optimal Leverage)}$$

$$z_{t,t+1} \equiv \mathbb{E}_t \frac{e_{t+1}}{e_t} \qquad \text{(Growth Rate of Bank Equity)}$$

$$x_{t,t+1} \equiv \frac{q_{t+1} k_{t+1} + l_{t+1}}{q_t k_t + l_t} \qquad \text{(Growth Rate of Bank Assets)}$$

$$\nu_t = \mathbb{E}_t (1-p) \beta (R_{t+1}^K - R_{t+1}^D) + \beta \mathbb{E}_t p x_{t,t+1} \nu_{t+1} \qquad \text{(Marginal Bank Assets Value)}$$

$$\eta_t = (1-p) \beta R_{t+1}^D + \beta p \mathbb{E}_t z_{t,t+1} \eta_{t+1} \qquad \text{(Marginal Bank Equity Value)}$$

$$div_t^Y = \left(1 - \frac{1}{\mu} \right) Y_t \qquad \text{(Dividends from Retailers)}$$

$$R_t^K = r_t^K + q_t - \delta \qquad \text{(Return on Capital)}$$

$$E_t = p(R_t^K q_{t-1} K_{t-1}^B + R_t^L L_{t-1} - R_t^D D_{t-1}) + \omega(q_t K_{t-1}^B + L_{t-1}) - \epsilon_t$$

$$\text{(Law of Motion - Bank Equity)}$$

$$E_t = q_t K_t^B + L_t - D_t \qquad \text{(Bank Balance Sheet)}$$

$$R_{t+1}^L = \mathbb{E}_t \frac{R_{t+1}^K}{q_t} \qquad \text{(Bank Portfolio Optimality)}$$

$$div_t = \frac{div_t^Y + div_t^I + div_t^B}{\int_{(a,k,\theta)} \lambda_t(a,k,z^*,\theta)} \qquad \text{(Dividends per HH)}$$

In the equations above, we used the following definitions:

$$
\begin{aligned}
E_{ct} &= p(R_t^K q_{t-1} K_{t-1}^B + R_t^L L_{t-1} - R_t^D D_{t-1}) \\
E_{nt} &= \omega(q_t K_{t-1}^B + L_{t-1}) \\
I_t &= K_t - (1-\delta)K_{t-1} \\
I_{nt} &= I_t - \delta K_{t-1}
\end{aligned}
$$

A.2 Computational Details

The main exercise in this paper simulates a one-time unexpected ("MIT") shock, followed by a transition back to steady state. Thus, our equilibrium consists of a perfect-foresight transition path for all aggregate variables, households' policies, and the distribution of households across the state space. The solution method requires first solving for a steady-state equilibrium and then computing the transitional dynamics following the shock.

Finding the stationary equilibrium entails (i) solving the households' problem and (ii) satisfying equilibrium conditions under the assumption of stationarity. We solve the households' problem by implementing a version of the algorithm described in Hintermaier and Koeniger (2010). This methodology involves combining the endogenous grid method of Carroll (2006) with a no-arbitrage condition between the marginal values of holding deposits and capital.[36] The latter determines households' portfolio choice. We use the implied policy functions to compute aggregates. To compute the distribution across households we proceed as in Young (2010) and use linear interpolation whenever the policy values do not coincide with grid points—which happens almost surely, with the exception of boundaries and the kink in the return of liquid assets at $a = 0$. To find the steady-state equilibrium, we use a quasi-Newton method iterating on the return on deposits R^d and on bank dividends div^B and impose stationarity on the system of equations given by Production Function (as well as household value functions).

We solve for transitional dynamics of the economy exactly to account for nonlinearities in response to aggregate shocks. We begin by selecting a horizon $T = 500$, after which we assume the economy has returned to its steady state. We then guess a path of endogenous variables, compute the deviations from the equilibrium conditions at each $t = \{1, 2, ..., T\}$, and iterate on the endogenous variables until all equilibrium conditions are satisfied. We obtain an update for the path of endogenous variables through a quasi-Newton method, where we compute the required Jacobian of equilibrium conditions—including non-analytical aggregates from heterogeneous households—following the methodology of Auclert *et al.* (2021).

[36]The endogeous grid method requires concavity of the value function, which is not generally guaranteed in a model with an extensive margin of portfolio adjustment, especially for low values of σ_θ. We ensure ex-post that the converged solution is concave, validating our approach.

A.3 Details - Cyclicality of Earnings Risk

Let $\beta(z)$ be the elasticity of earnings with respect to output. These are obtained by interpolating the results from Guvenen *et al.* (2017) to map elasticities at different percentiles of the income distribution the points of our discretized earnings grid. In the data (as in the model), earnings co-move with output, but this co-movement is different for different individuals across the income distribution. To construct the function $\gamma(z, Y)$, our goal is to capture how individual elasticities differ from the *average*. The income-weighted average elasticity is:

$$\mathbb{E}(z\beta(z)) = \sum_z P(z) z\beta(z)$$

Also, let $\bar{z} = \sum_z zP(z)$. We use the following adjustment factor:

$$adj = \frac{\bar{\beta}}{\bar{z}}$$

Using it, we compute:

$$\tilde{\beta}(z) = \frac{\beta(z)}{adj}$$

We then simply set $\Gamma(z) = \tilde{\beta}(z) - 1$. Note that this ensures that:

$$\begin{aligned}
\mathbb{E}z\Gamma(z) &= \mathbb{E}z(\tilde{\beta}(z) - 1) \\
&= \mathbb{E}z\frac{\beta(z)}{adj} - \bar{z} \\
&= \mathbb{E}z\frac{\beta(z)}{\frac{\bar{\beta}}{\bar{z}}} - \bar{z} \\
&= \bar{z} - \bar{z} = 0
\end{aligned}$$

To see that the economy-wide labor productivity is constant at all times, note that

$$\begin{aligned}
\mathbb{E}\left(z_t\left[1 + \Gamma(z_t)\left(\frac{Y_t - Y^{ss}}{Y^{ss}}\right)\right]\right) &= \mathbb{E}(z_t) + \mathbb{E}z_t\Gamma(z_t)\left(\frac{Y_t - Y^{ss}}{Y^{ss}}\right) \\
&= \bar{z}
\end{aligned}$$

This ensures that aggregate earnings only respond to shocks due to movements in the wage and in hours worked, while $\gamma(z, Y)$ determines the re-distributive effects of fluctuations in output through labor earnings.

A.4 Banker's Problem - Additional Details

In this section we provide further details o how to express bankers' equity as:

$$v_t^B = \nu_t(q_t k_t^b + l_t) + \eta_t e_t, \tag{38}$$

where:

$$\eta_t = (1-p)\beta R_{t+1}^D + \beta p \mathbb{E}_t z_{t,t+1}\eta_{t+1} \tag{39}$$

$$z_{t,t+j} \equiv \mathbb{E}_t \frac{e_{t+j}}{e_t}$$

$$\nu_t = \mathbb{E}_t\left[(1-p)\beta(R_{t+1}^L - R_{t+1}^D) + \beta p x_{t,t+1}\nu_{t+1}\right] \tag{40}$$

$$x_{t,t+j} \equiv \mathbb{E}_t \frac{q_{t+j}k_{t+j} + l_{t+j}}{q_t k_t + l_t}$$

The bankers' value function in (7), evaluated at optimal choices, is given by

$$\begin{aligned} v_t^B &= (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} e_{t+j+1} \\ &= (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} \left\{(R_{t+1+j}^K k_{t+j}^B + R_{t+1+j}^L l_{t+j} - R_{t+1+j}^D d_{t+j})\right\} \\ &= (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} \left\{(R_{t+1+j}^L (q_{t+j}k_{t+j}^B + l_{t+j}) - R_{t+1+j}^D d_{t+j})\right\} \end{aligned}$$

where the second and third steps introduce the law of motion for individual bankers' equity and the non-arbitrage condition. We rearrange and define total bank assets as $S_t \equiv q_t k_t^B + l_t = d_t + e_t$ which, using expression (5), yields

$$\begin{aligned} v_t^B &= (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} \left\{(R_{t+1+j}^L - R_{t+1+j}^D)S_{t+j} + R_{t+1+j}^D e_{t+j}\right\} \\ &= (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} \left\{(R_{t+1+j}^L - R_{t+1+j}^D)S_{t+j}\right\} + (1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} R_{t+1+j}^D e_{t+j} \end{aligned} \tag{41}$$

Take the first summation term above and re-write it as

$$\begin{aligned} &(1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} \left\{(R_{t+1+j}^L - R_{t+1+j}^D)S_{t+j}\right\} \\ &= S_t \mathbb{E}_t \left\{ [(1-p)\beta\left[(R_{t+1}^L - R_{t+1}^D)\right] + [(1-p)\sum_{j=1}^{\infty} p^j \beta^{j+1}\left[(R_{t+1+j}^L - R_{t+1+j}^D)x_{t,t+j}\right] \right\} \end{aligned} \tag{42}$$

Thus, we define:

$$\nu_t \equiv \mathbb{E}_t \left\{ [(1-p)\beta \left[(R^L_{t+1} - R^D_{t+1})\right] + [(1-p) \sum_{j=1}^{\infty} p^j \beta^{j+1} \left[(R^L_{t+1+j} - R^D_{t+1+j}) x_{t,t+j}\right] \right\},$$

which can also be characterized by the recursion (40).

Next, consider the latter term of (41):

$$\begin{aligned}
&(1-p)\mathbb{E}_t \sum_{j=0}^{\infty} p^j \beta^{j+1} R^D_{t+1+j} e_{t+j} \\
&= e_t \mathbb{E}_t \left\{ (1-p)\beta R^D_{t+1} + (1-p) \sum_{j=1}^{\infty} p^j \beta^{j+1} R^D_{t+1+j} z_{t,t+j} \right\}
\end{aligned}$$

Defining the term within the braces as η_t, one can show that it respects the recursion (39).

B Additional Results and Robustness - Unequal Effects of Bank Losses

B.1 Additional Results

Table B.1 provides a breakdown of household characteristics for quintiles of the distribution of welfare changes.

	Q1	Q2	Q3	Q4	Q5
Total Income	0.515	0.674	0.887	1.207	1.697
Capital	0.235	0.334	0.502	0.836	3.035
Net Worth	0.308	0.360	0.508	0.774	2.993
Desired Capital Change (%)	-0.286	-0.198	-0.166	-0.130	0.770

Table B.1: Characteristics of Households by Quintile of Welfare Changes
Note: The table displays average household characteristics for each quintile of the distribution of welfare changes following the bank equity shock, with Q1 representing the largest *losses*. "Desired Capital Change" denotes the percentage change in capital holdings that households would have made in the absence of the shock.

Figure B.1 replicates figure 9, but includes capitalists as a separate category.

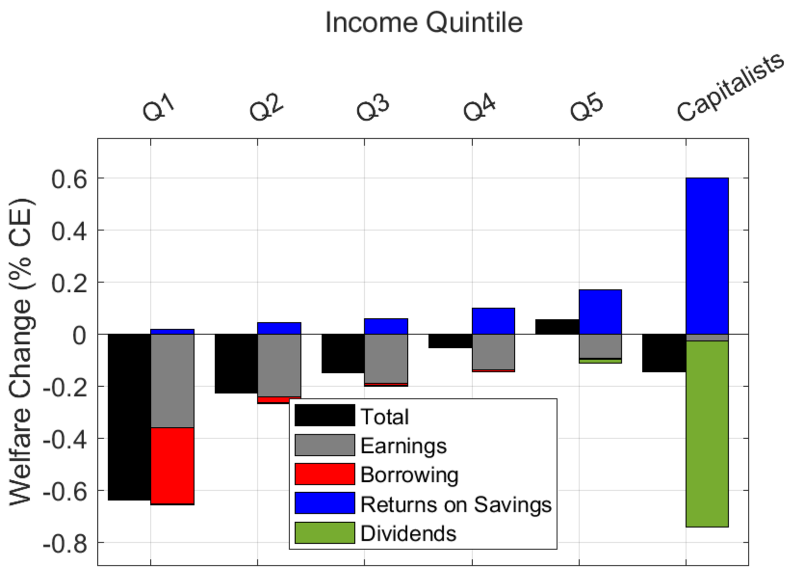


Figure B.1: Decomposition of Welfare Changes by Income Quintile - Capitalists Separately
Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, savings market rates $(\{R_t^D, r_t^K, q_t\}_{t=0}^T)$, and dividends $(\{div_t\}_{t=0}^T)$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values.

Figure B.2 below displays the decomposition of welfare changes only due to changes in labor income.

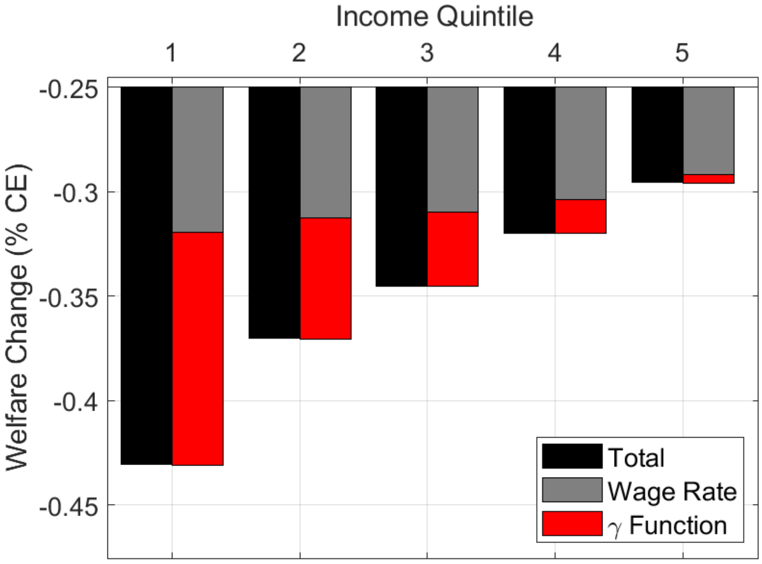


Figure B.2: Decomposition of Welfare Changes due to Labor Income

Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^{T}$, and each of its components. "γ function" refers to the impact of changes in earnings risk (see Equations (33) and (34)). Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values.

Figure B.3 is analogue to figure 5, dividing households by net worth instead of income.

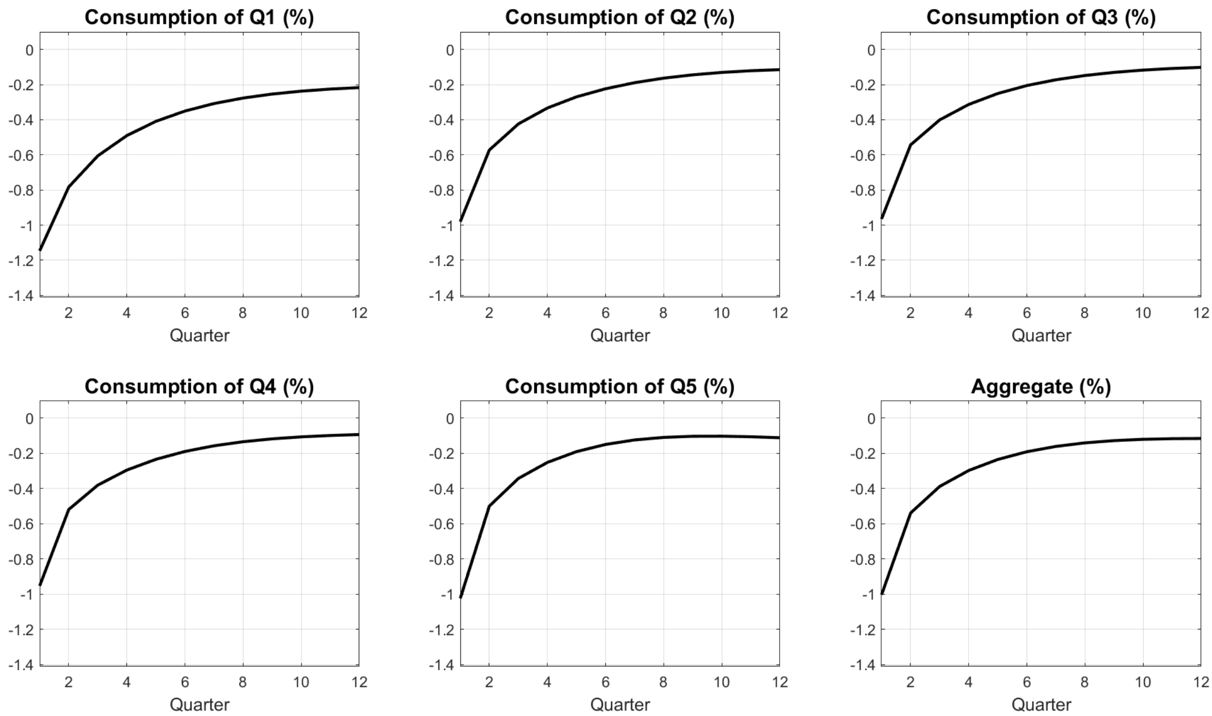


Figure B.3: Consumption Responses by Net Worth Quintile

Note: Households sorted to net worth quintiles in steady state based on their idiosyncratic state (a, k, z). Impulse responses computed for each (a, k, z) as the expected path of consumption after the shock relative to the expected path in its absence. Responses aggregated within each group using the steady-state distribution over idiosyncratic states.

B.2 Robustness - Dispersion of Adjustment Cost σ_θ

In this section, we repeat the results from section 4 for different values of the parameter σ_θ. Given an alternative value for σ_θ, we re-calibrate all other parameters (including the size and persistence of the shock and the capital adjustment cost ϕ_K) to match the same targets as before. We choose alternative values of $\sigma_\theta = 7$ and $\sigma_\theta = 20$ and report the main figures for each alternative calibration below. Further results are available upon request. The graphs presented below are remarkably similar to those in Section 4, suggesting that our main conclusions are robust to different values of the parameter σ_θ.

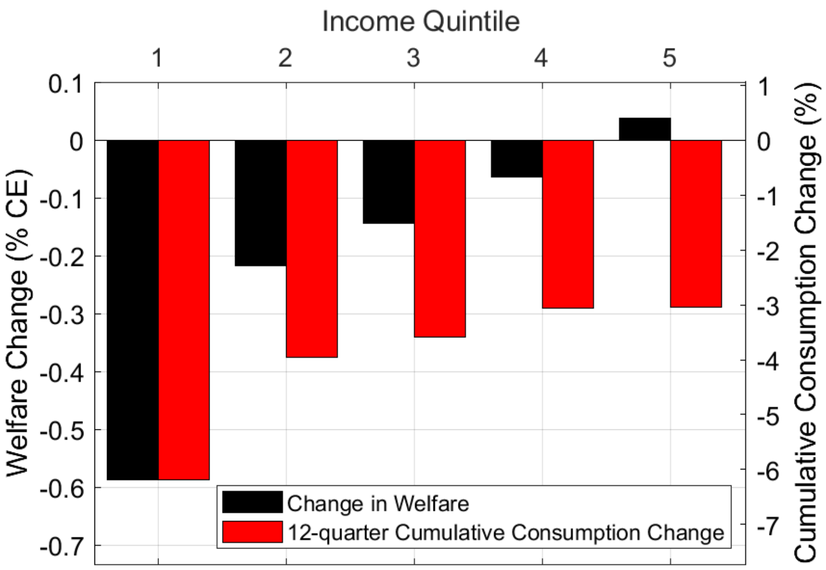


Figure B.4: Welfare and Consumption by Income Quintile ($\sigma_\theta = 7$)

Note: Welfare changes (left y-axis) computed as in (36) and aggregated within each income quintile with steady-state distribution. Consumption changes cumulated over 12 quarters following the shock from the series in Figure 5 (right y-axis). In this simulation, $\sigma_\theta = 7$

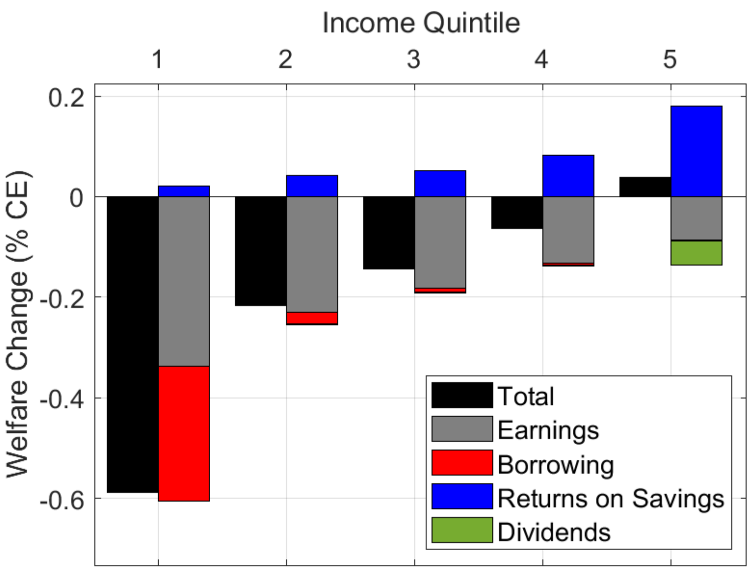


Figure B.5: Decomposition of Welfare by Income Quintile ($\sigma_\theta = 7$)

Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^{T}$, the lending rate $\{R_t^L\}_{t=0}^{T}$, savings market rates $(\{R_t^D, r_t^K, q_t\}_{t=0}^{T})$, and dividends $(\{div_t\}_{t=0}^{T})$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values. In this simulation, $\sigma_\theta = 7$.

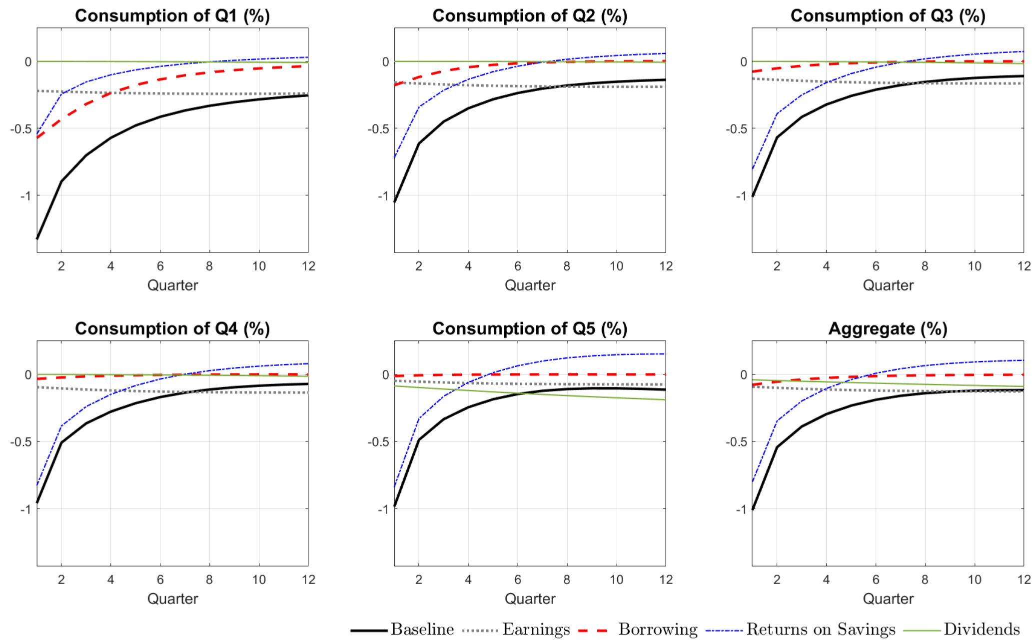


Figure B.6: Consumption Decomposition by Income Quintile ($\sigma_\theta = 7$)

Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. Consumption responses are decomposed into partial-equilibrium effects of earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, returns to savings $\{R_t^D, r_t^K, q_t\}_{t=0}^T$, and dividends $\{div_t\}_{t=0}^T$. In this simulation, $\sigma_\theta = 7$.

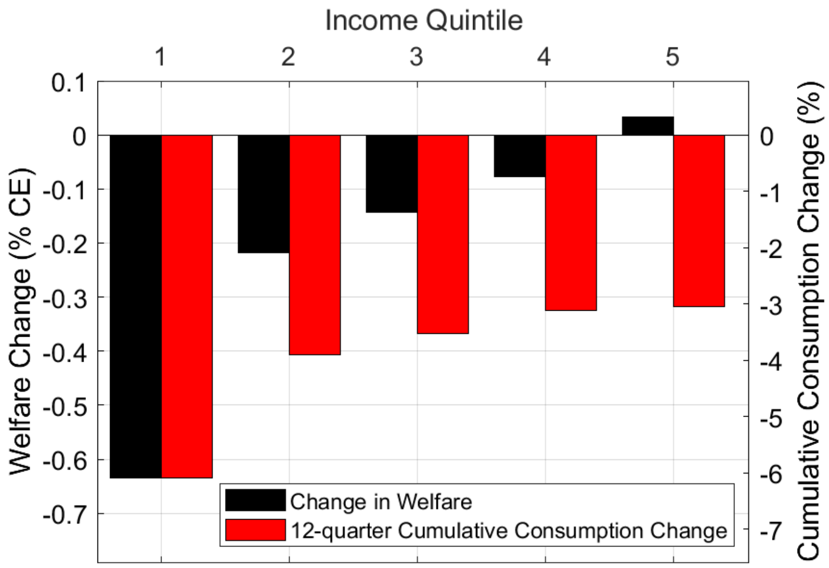


Figure B.7: Welfare and Consumption by Income Quintile ($\sigma_\theta = 20$)

Note: Welfare changes (left y-axis) computed as in (36) and aggregated within each income quintile with steady-state distribution. Consumption changes cumulated over 12 quarters following the shock from the series in Figure 5 (right y-axis). In this simulation, $\sigma_\theta = 20$

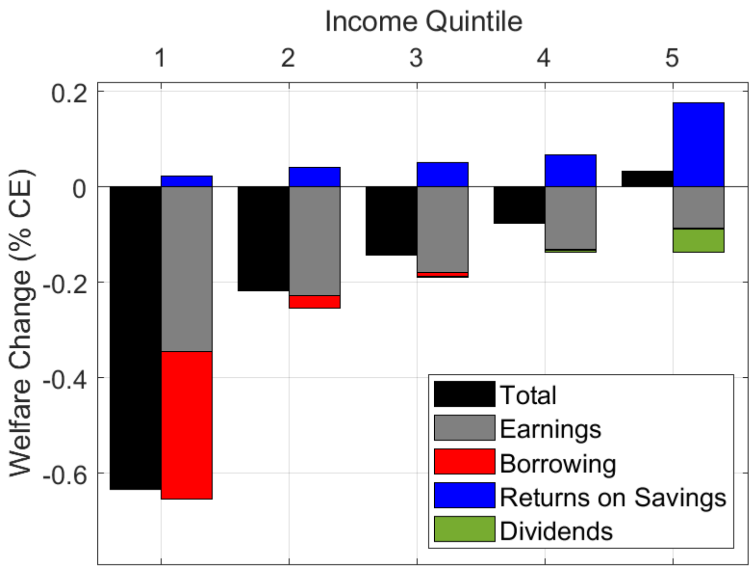


Figure B.8: Decomposition of Welfare by Income Quintile ($\sigma_\theta = 20$)

Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, savings market rates $(\{R_t^D, r_t^K, q_t\}_{t=0}^T)$, and dividends $(\{div_t\}_{t=0}^T)$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values. In this simulation, $\sigma_\theta = 20$.

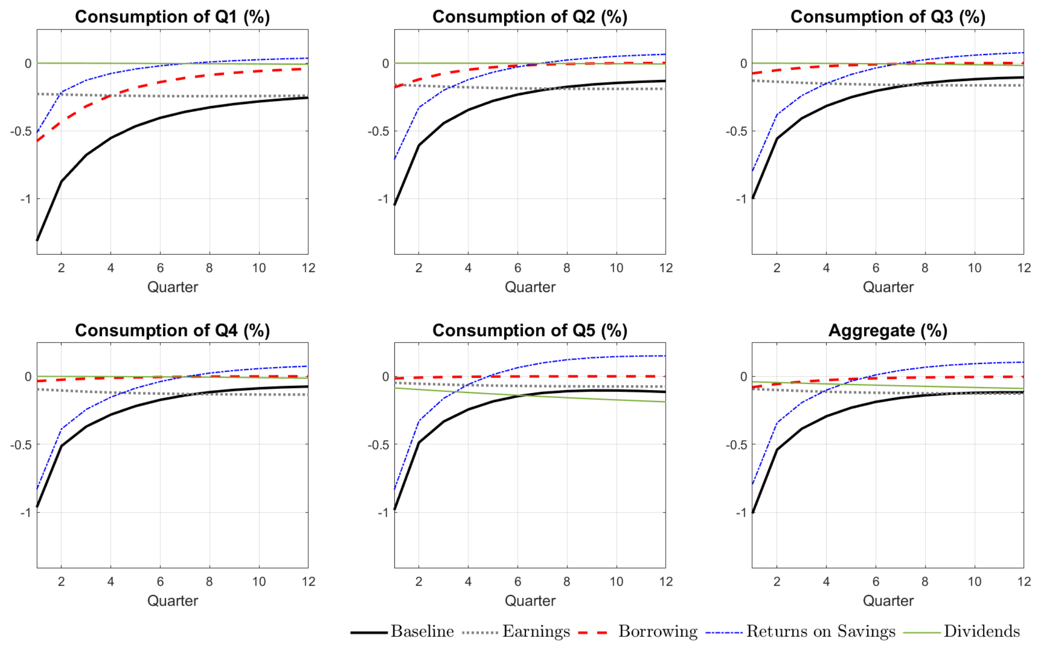


Figure B.9: Consumption Decomposition by Income Quintile ($\sigma_\theta = 20$)

Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. Consumption responses are decomposed into partial-equilibrium effects of earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, returns to savings $\{R_t^D, r_t^K, q_t\}_{t=0}^T$, and dividends $\{div_t\}_{t=0}^T$. In this simulation, $\sigma_\theta = 20$.

B.3 Robustness - Capital Intermediate by Banks: Productivity Shock

In this section, we show that the results in section 4 are robust when instead of eliminating part of banks' equity directly, we hit banks indirectly with a shock to the productivity of their capital holdings. In addition to its effect on aggregate outcomes through the banking sector, this shock also has a direct impact on market prices by reducing the productive capacity of the economy.

We assume that aggregate *efficiency units* of capital are given by

$$K_{t-1} = \xi_t^B K_{t-1}^B + K_{t-1}^{HH}, \tag{43}$$

where K_{t-1}^{HH} is again the total capital held by households, and the shock ξ_t^B is a disturbance to the productive capacity of banks' capital holdings. Note that equation (43) supersedes equation (29) in the main text. This specification provides an indirect way of generating losses in the banking sector, as declines in ξ_t^B lead to lower returns on banks' investment activity and a reduction in equity.

The return on capital held by banks and households may now differ, returns for banks are given by

$$R_t^{K,B} = \frac{\xi_t^B r_t^k + q_t - \delta}{q_{t-1}}$$

All equations including the return that banks earn on investments in capital adjust accordingly.

We assume $\xi_{SS}^B = 1$, such that our calibration for the steady state economy remains unchanged. The shock is calibrated similarly to our main bank equity shock: We set its size and persistence, along with the parameter ϕ^K, to jointly match an initial 10% decline in bank equity, the twelve-quarter cumulative consumption response to a decline in the bank equity index of that magnitude, and an inverse elasticity of investment with respect to asset prices of 1.72, as in Gertler and Karadi (2011).

Results. Below we reproduce figures 8, 9, and 10 for a bank capital productivity shock. Qualitatively and quantitatively, the results are similar to those shown in 4. Again, households at the bottom of the income distribution remain as the biggest losers, with loan rates playing a slightly smaller role in the case of the shock to the productivity of bank assets. Still, welfare changes remain much more unevenly distributed than those of consumption, with the top quintile benefiting from the shock on average.

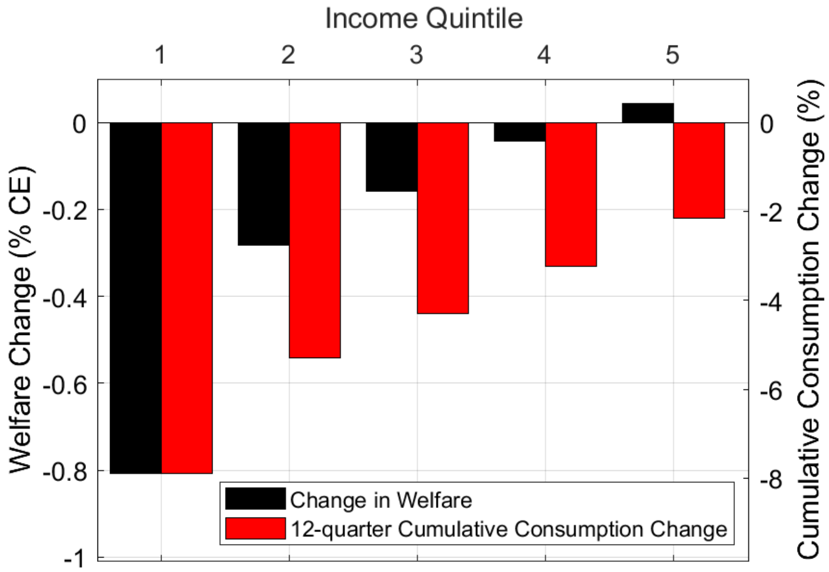


Figure B.10: Welfare and Consumption by Income Quintile (ξ^B shock)

Note: Welfare changes (left y-axis) computed as in (36) and aggregated within each income quintile with steady-state distribution. All results in response to a shock to the productivity of bank-held capital (ξ^B).

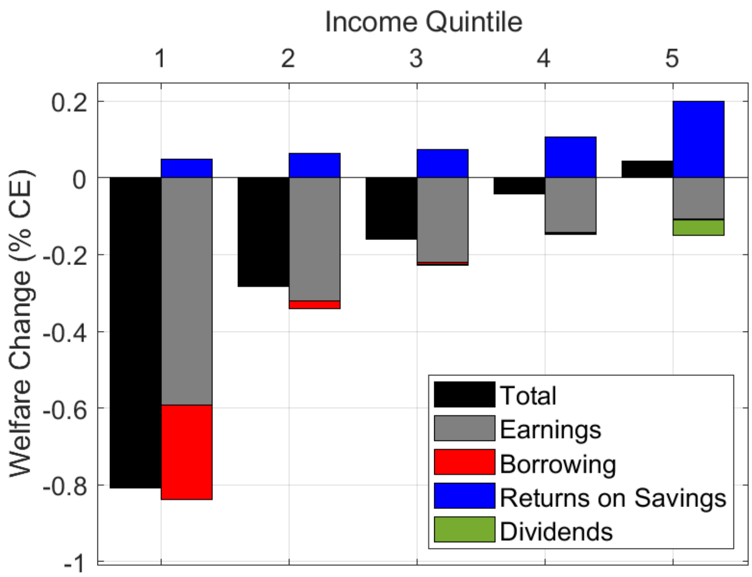


Figure B.11: Decomposition of Welfare by Income Quintile (ξ^B shock)

Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, savings market rates $(\{R_t^D, r_t^K, q_t\}_{t=0}^T)$, and dividends $(\{div_t\}_{t=0}^T)$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values. All results in response to a shock to the productivity of bank-held capital (ξ^B).

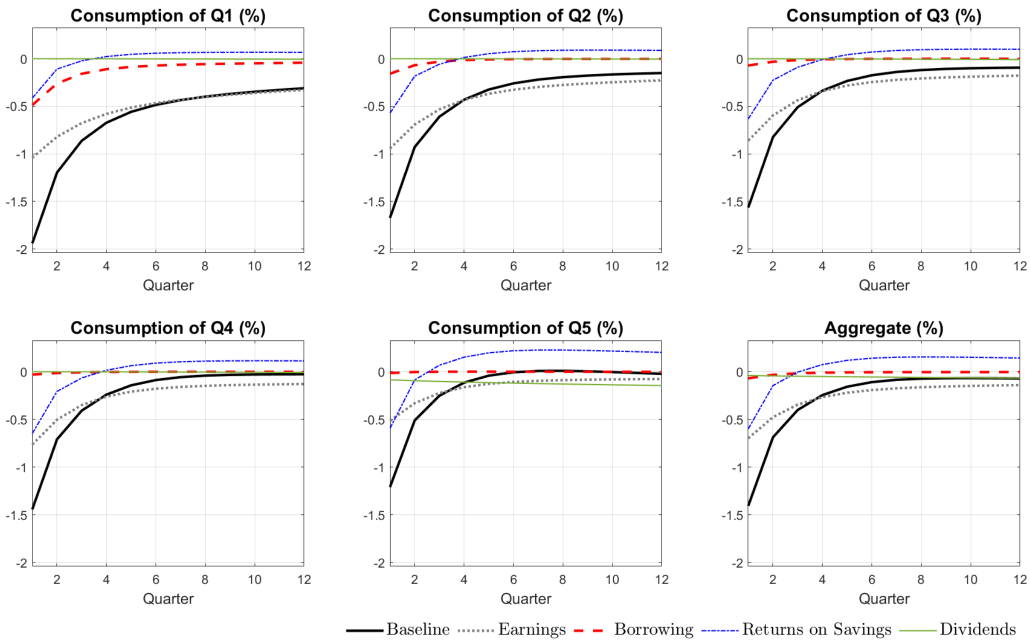


Figure B.12: Consumption Decomposition by Income Quintile (ξ^B shock)
Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. Consumption responses are decomposed into partial-equilibrium effects of earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, returns to saving $\{R_t^D, r_t^K, q_t\}_{t=0}^T$, and dividends $\{div_t\}_{t=0}^T$. All results in response to a shock to the productivity of bank-held capital (ξ^B).

B.4 Robustness - Inelastic Labor Supply

Below we reproduce the main results for an alternative specification of the model where labor supply is inelastic. We impose $n = 1$ for all households exogneously and set $\Psi = 0$. We re-calibrate the remaining parameters of the economy, including the dynamic ones, to match the same targets as before, and re-scale labor productivity z for all households to normalize output to unity again. Figures B.13, B.14, and B.15 show that our takeaways are qualitatively unchanged. Note, however, that inequality in welfare is more evenly distributed in the case of the inelastic labor supply than in the case of section 4. The reason is that the impact of earnings on welfare is larger for the inelastic case, offsetting the gains from savings rate. In all, though, the impact of the shock on welfare remains much more unequal than that of consumption.

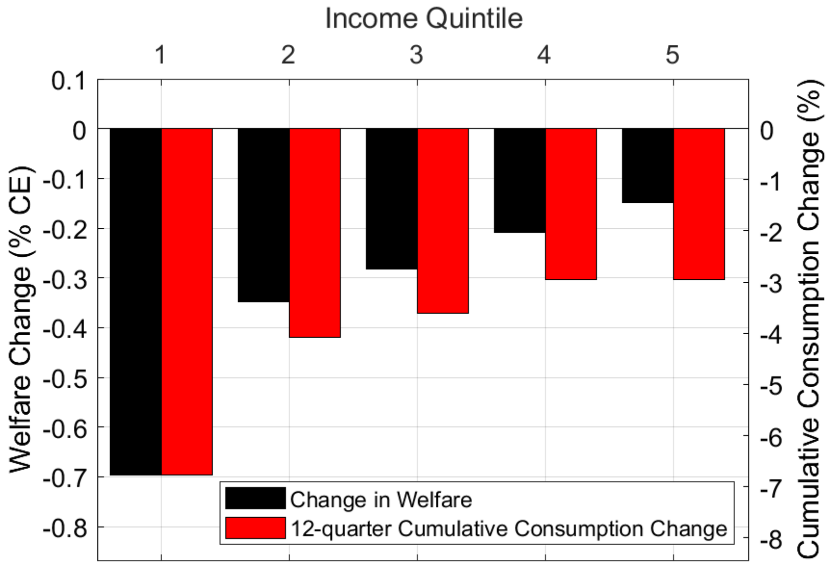


Figure B.13: Welfare and Consumption by Income Quintile (Fixed Labor)
Note: Welfare changes (left y-axis) computed as in (36) and aggregated within each income quintile with steady-state distribution. In this simulation labor supply is inelastic.

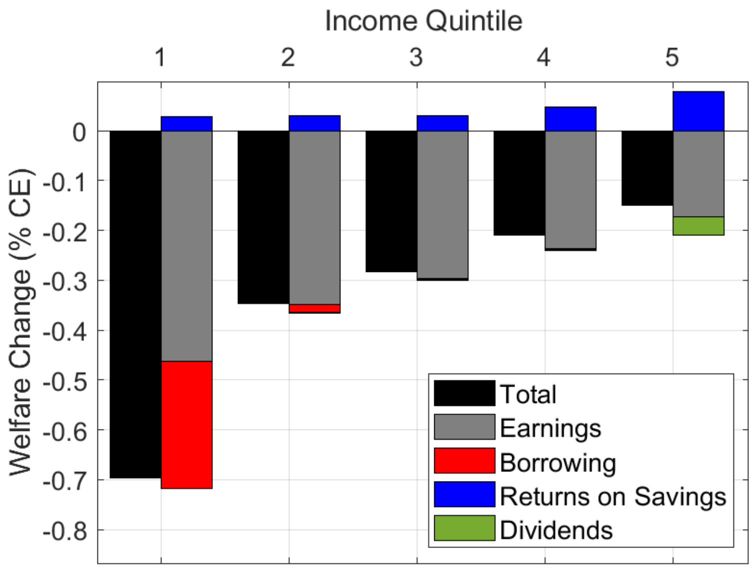


Figure B.14: Decomposition of Welfare by Income Quintile (Fixed Labor)
Note: Decomposition of welfare changes due to earnings $\{z_t, w_t\}_{t=0}^{T}$, the lending rate $\{R_t^L\}_{t=0}^{T}$, savings market rates $(\{R_t^D, r^K, q_t\}_{t=0}^{T})$, and dividends $(\{div_t\}_{t=0}^{T})$. Each counterfactual obtained by simulating the economy under a subset of equilibrium price paths, fixing all other prices at steady-state values. In this simulation labor supply is inelastic.

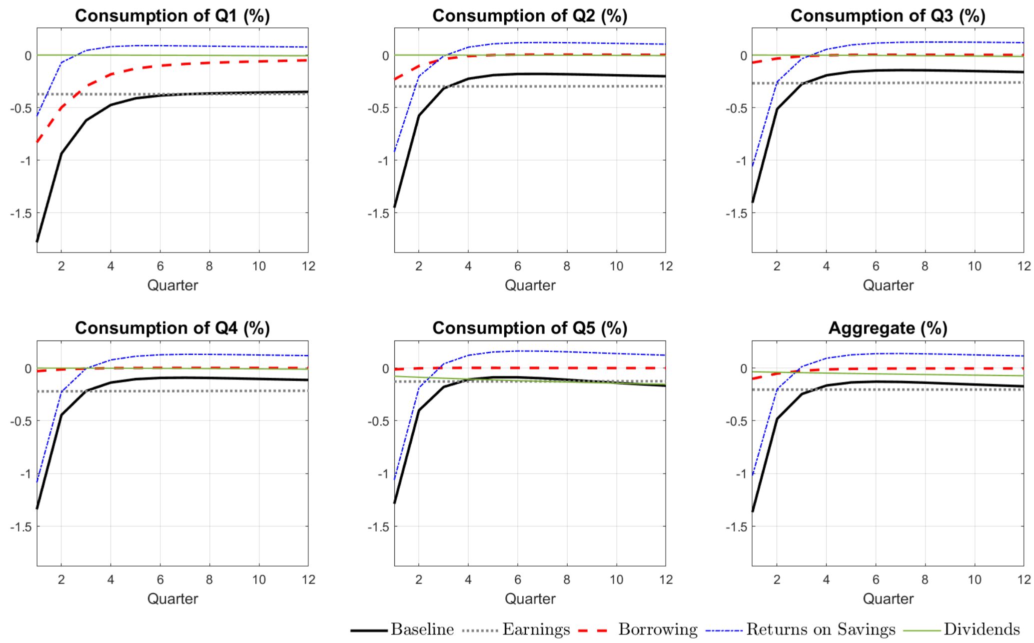


Figure B.15: Consumption Decomposition by Income Quintile (Fixed Labor)

Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. Consumption responses are decomposed into partial-equilibrium effects of earnings $\{z_t, w_t\}_{t=0}^T$, the lending rate $\{R_t^L\}_{t=0}^T$, returns to saving $\{R_t^D, r^K, q_t\}_{t=0}^T$, and dividends $\{div_t\}_{t=0}^T$. In this simulation labor supply is inelastic.

C Aggregate Implication – Results and Robustness

C.1 Calibration Output

Table C.2 displays the results of the internal calibration procedure for the alternative models as outlined in 5. Parameters that are not shown are either unchanged or are obsolete in the model in question.

Table C.2: Summary of Calibration -Alternative Models

			Economy without Banks	
Target	**Model**	**Data**	**Closest Parameter**	**Source**
$\frac{K}{Y}$ Ratio	3	3	$\delta = 0.016$	Penn World Tables
Government Debt-to-Output $\frac{B}{Y}$	0.40	0.40	B =1.6 (quarterly)	Same Liquid Assets Supply as Benchmark
Annual $R^D - 1$	2%	2%	$\beta = 0.976$	Annualized 3M Tbill rate
Annual Spread $(R^L - R^D)$	2%	2%	$\mu_\theta = 19.1$	Philippon (2015)
Share of Liquid Assets, Q1 of Income	2.2%	2.2%	$\tau^{slope} = 1.99$	SCF2004
Output Y	1	1	$\Psi = 2.07$	Normalization
			"All Banks" Economy	
Target	**Model**	**Data**	**Closest Parameter**	**Source**
$\frac{K}{Y}$ Ratio	3	3	$\delta = 0.016$	Penn World Tables
Total Deposits $\frac{D}{Y}$	0.40	0.40	χ =0.197	Implies Same Leverage as Benchmark
Annual $R^D - 1$	2%	2%	$\beta = 0.959$	Annualized 3M Tbill rate
Annual Spread $(R^L - R^D)$	2%	2%	$\omega = 0.0036$	Philippon (2015)
Share of Liquid Assets, Q1 of Income	2.2%	2.2%	$\tau^{slope} = 3.67$	SCF2004
Output Y	1	1	$\Psi = 2.40$	Normalization

C.2 Robustness - Model with Nominal Rigidities

In this section, we show that our results in Section 5, are qualitatively unchanged when we consider a model with New-Keynesian frictions. We begin by describing the extentions we implement in the model.

Nominal Wage Rigidities. We follow Auclert *et al.* (2023) and assume rigidities to nominal wage setting. A union sets wages and allocates labor hours equally across households. Households are assumed to supply a continuum of differentiated labor services, indexed by k, aggregated with a CES function and supplied to the intermediate producer. The union for labor type k solves

$$\max_{W_t} \mathbb{E}_0 \sum_{t=0}^{\infty} \int \left(\mathcal{U}_c(c_{it}, n_{it}) w_{kt} N_{kt} z_{it} + \mathcal{U}_n(c_{it}, n_{it}) N_{kt}\right) di - \frac{\varepsilon_w}{2\kappa_w} \log\left(\frac{W_t}{W_{t-1}}\right)^2$$

In the expression above,($\mathcal{U}_c$ and ($\mathcal{U}_n$ represent respectively the marginal utilities of consumption and labor, and W_{kt} and w_{kt} are respectively the nominal and real wages for type k. The demand curve is:

$$N_{kt} = \left(\frac{w_{kt}}{w_t}\right)^{-\varepsilon_w} N_t,$$

where w_t is the aggregate wage index consistent with CES demand, which is the real wage paid to households.Auclert *et al.* (2023) show that the solution and aggregation to the problem above yields the wage Phillips curve as

$$\log(1+\pi_t^w) = \kappa_w \left[-N_t \int \mathcal{U}_n(c_{it}, n_{it})di - w_t N_t \frac{\varepsilon_w - 1}{\varepsilon_w} \int z_{it}\mathcal{U}_c(c_{it}, n_{it})\right] \beta \mathbb{E}_t \log(1+\pi_{t+1}^w), \tag{44}$$

where $\pi_t^w \equiv \frac{W_t}{W_{t-1}} - 1$ is the wage inflation. Price inflation, in turn, is given by $\pi_t = (1+\pi_t^w)\frac{w_{t-1}}{w_t} - 1$.[37]

Central Bank. We assume zero inflation in steady state. Outside the steady state, the central bank follows a standard Taylor rule such that

$$i_t = i^{ss} + \phi_\pi \pi_t$$

Nominal Assets. We assume that consumer loans and deposits are nominal assets paying with respective net nominal rates r_t^L and r_t^D. The latter is indirectly set by the Central Bank via its interest rate rule, i.e. $i_t = r_t^D$. Real gross returns are now given by:

$$R_t^L = \frac{1+r_t^L}{1+\pi_t}$$
$$R_t^D = \frac{1+r_t^D}{1+\pi_t}$$

The other features (equations) of the model presented in Section 2 remain unchanged.

Calibration. We set ϕ_π to the standard value of 1.5. To avoid redistributing profits from Unions, we set the implied wage markup $\frac{\varepsilon_w}{\varepsilon_w - 1} = 1$. Finally, we set $\kappa_w = 0.03$ as in Auclert *et al.* (2018).

Results. Below, we repeat Figures 13 and 14 for the three alternative economies with New Keynesian frictions. The differences in movements across models shown in Figure C.16 are remarkably similar to those shown in 13. The largest decline in investment is again observed in the "Only Banks" version, followed by the Benchmark. For consumption, the largest decline is still in the "No Banks" Economy. Quantitatively, the

[37] As in Auclert *et al.* (2023), the adjustment costs are given in utils, so as to not interfere with aggregates.

recession is larger in the New-Keynesian versions, mostly due to consumption responses being larger than in the flex-wages version.

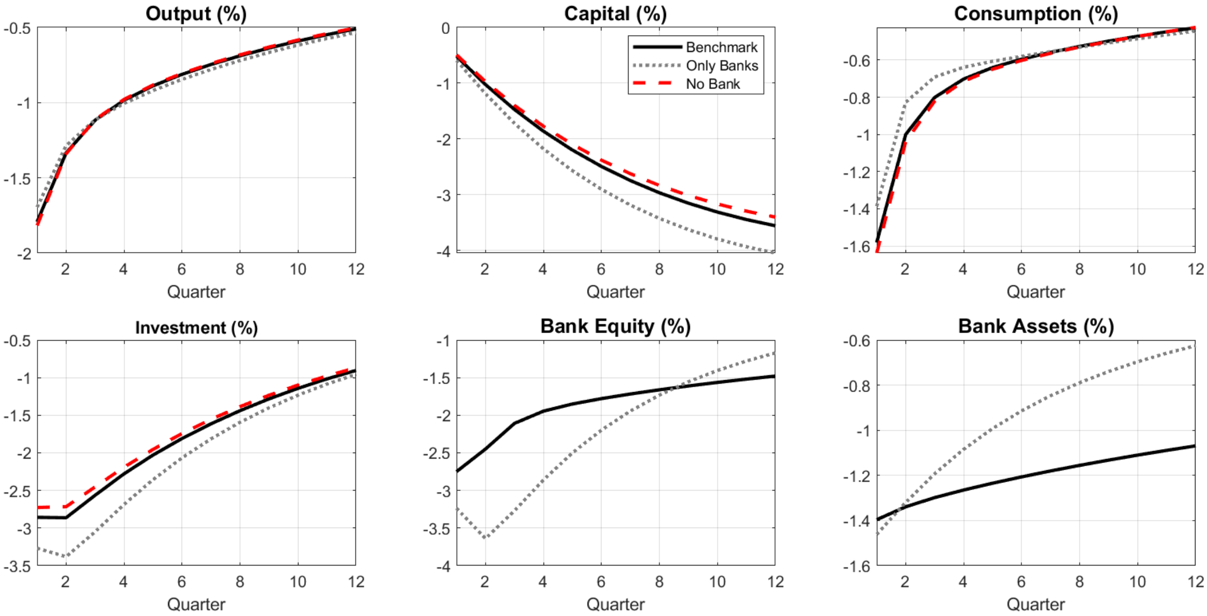


Figure C.16: Comparison Across Models - Selected Macroeconomic Variables

Note: Impulse-response functions of selected aggregate variables to a 1% TFP shock with persistence coefficient 0.9. Changes are relative to the steady-state values. This version of the model features wage rigidities.

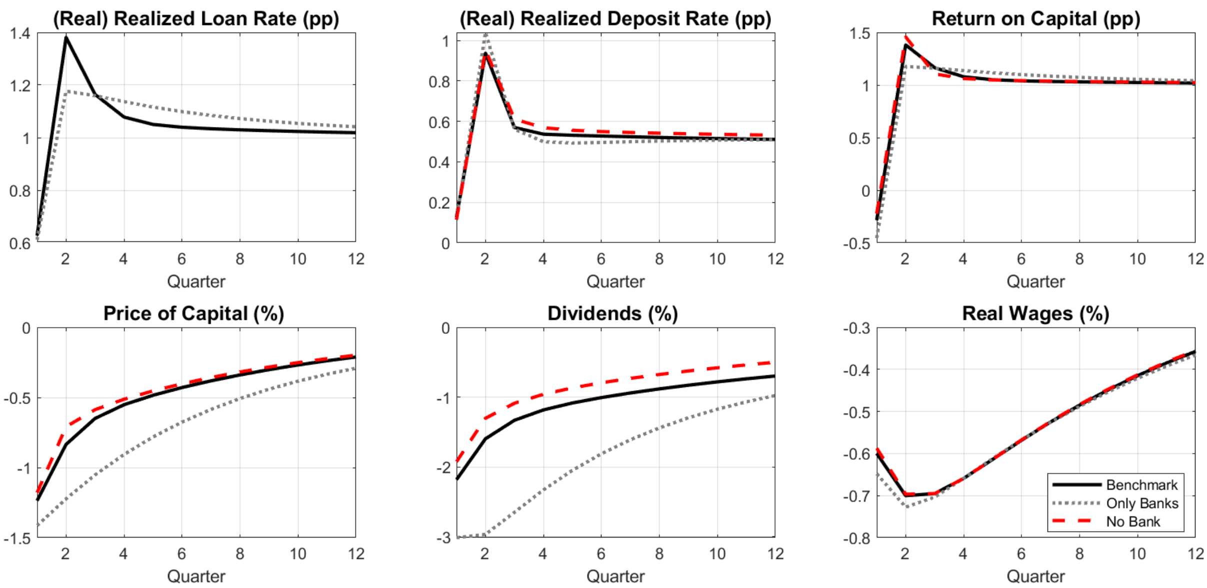


Figure C.17: Comparison Across Models - Prices and Rates

Note: Impulse-response functions of selected *real* variables to a 1% TFP shock with persistence coefficient 0.9. Rates on the top panels are displayed in percentage points, while the bottom panels display percent changes relative to steady-state values. In the *no bank* ecnonomy, loan rates are equal to deposit rates and hence omitted. This version of the model features wage rigidities.

D Empirical Appendix

D.1 Consumption and Return Data

Household-Level Data. We use household survey data from the US Consumer Expenditure Survey (henceforth CEX). The survey is available since 1980 and is based on a rotating sample of about 1,500–2,500 households selected to be representative of the US population. The CEX gathers information on household expenditures through interview and diary surveys. We focus on the former, which cover a broad set of consumption categories, while the latter only cover small but frequent purchases. Each household is interviewed once per quarter and for no more than five consecutive quarters. In each interview, separate information is collected for the previous three months. Our sample consists of the waves from 1980 to 2010. In cleaning and aggregating the micro data into expenditure categories at the household level we follow Coibion *et al.* (2017) and work with their aggregated dataset. We define household consumption as the sum of nondurable and durable expenses and services and use the OECD equivalence scale to adjust for household composition.

In addition to data on consumption, the CEX also provides information on household income, from both labor and nonlabor sources. We define total after-tax income as the sum of labor earnings, financial and business income, and transfers less taxes, where taxes are imputed using TAXSIM. We use this information to group households into income quintiles and aggregate the expenditure data into five per capita series at the quintile level, taking monthly averages across households.[38] Finally, we transform the series to quarterly frequency by summing up expenditures for each quintile across months, and we deflate the expenditures with the All Urban CPI.

Previous research (Aguiar and Bils, 2015) has shown a mismatch of the CEX with consumption reported in national accounts. We follow Cloyne *et al.* (2020) in addressing this concern: First, to ensure consistency between the survey and national accounts we compute the ratio between the national statistics series of aggregate consumption, obtained from the Bureau of Economic Analysis, and the corresponding aggregated consumption series from the CEX. We then rescale the expenditure data for each of the five groups as well as the aggregate series with the ratio of aggregate consumption in the CEX relative to the national accounts in every period. Second, all our empirical specifications feature income-quintile-specific time trends, which are aimed at capturing slow-moving changes in reporting within income brackets. This is again in line with the approach taken in Cloyne *et al.* (2020).

Bank Equity Returns. To measure conditions in the banking sector we use the index of bank equity returns provided by Baron *et al.* (2021). They show that bank equity

[38] In all aggregation steps, we apply the sample weights provided by the CEX throughout.

Table D.3: Summary Return Indices

Series	Mean	Std	Min	P25	Median	P75	Max	AC
r^B	0.0174	0.1229	-0.4666	-0.0465	0.0288	0.0943	0.2946	0.0168
r^{NF}	0.0197	0.0976	-0.2988	-0.0231	0.0347	0.0786	0.2069	0.0371

Notes: r^B: return of bank index (capital gains and dividends), r^N: return of nonfinancial corporations index (capital gains and dividends). AC: autocorrelation of series. Data series are taken from Baron *et al.* (2021) for the United States from 1980 to 2010.

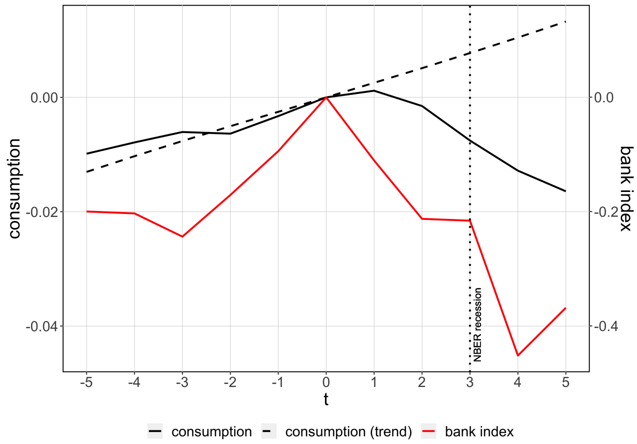
declines capture early signs of banking crises in real time and predict large and persistent contractions in output and in bank credit to the private sector. Compared to other financial variables, such as credit spreads, bank equity returns are a convenient measure of banking distress since they are more sensitive to early losses.[39] This is because bank equity has the lowest payoff priority among bank stakeholders. Baron *et al.* (2021) also show that bank equity returns have predictive content for future macroeconomic dynamics even excluding episodes with narrative evidence of panics or widespread bank failures. In addition, the use of a continuous measure to identify periods of bank distress instead of a narrative approach (**?**Laeven and Valencia, 2013) allows us to focus the analysis on a single country.[40] The bank equity index for the United States, which we use for our analysis, corresponds to the S&P 500 for banks and is adjusted for dividend payouts.

Table D.3 shows summary statistics of returns to the US bank equity index (r^B) at quarterly frequency, as well as its counterpart for nonfinancial corporations (r^{NF}).We use the index of returns on NFC stocks as a control in our regressions. The latter is also obtained from Baron *et al.* (2021) and consists of the S&P 500 Industrials adjusted for dividends. Both series feature a similar, slightly positive mean, but the banking series features more volatility, materialized in a higher standard deviation and more extreme realizations—both in the left and right tails of the return distribution. In addition, both series display very low autocorrelation, attesting to a lack of predictability based on past realizations as one would expect for financial market return series. This gives us confidence to treat sudden changes in bank equity returns as reflecting new information about the banking sector.

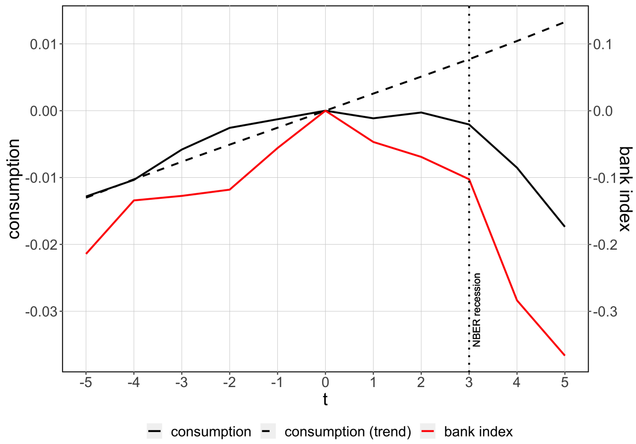
To provide some intuition for our data measures, Figure D.18 shows the evolution of the US bank equity return index (red line) and log real aggregate consumption (black

[39] Baron *et al.* (2021) document that bank equity has a better signal-to-noise ratio than other financial and macroeconomic variables, in terms of identifying banking crises in real time (identified by narrative accounts). In particular, large bank equity declines tend to precede credit spread spikes across one hundred banking crises. In addition, conditional on a particular historical crisis episode, the magnitude of the peak-to-trough bank equity decline is correlated with the economic severity of the ensuing crisis.

[40] Large bank equity declines line up closely with the narrative approach. However, Baron *et al.* (2021) show that relying on bank equity returns allows one to uncover a number of episodes of banking distress that do not appear in previous data sets.



(a) **1990**



(b) **2007**

Figure D.18: Bank Equity Return Index

Notes: Dynamics of real aggregate consumption (black solid line) and bank equity return index (red solid line) around bank equity crashes in the US. Bank equity declines are defined to begin in quarter t=0. The dotted vertical line denotes the NBER recession start date. For comparison, the average consumption trend over the full sample period is presented by the dashed black line.

solid line) around two dates of bank equity crashes over our sample period.[41] Both consumption and the bank equity return index are normalized to zero in the year of the first decline in bank equity returns (t=0), and for reference we also plot the average dynamics (trend) of consumption over the entire sample. For both episodes, bank equity starts to decline well ahead of the official start of the recession date, as identified by the NBER. In the quarters before the banking sector distress, the evolution of aggregate consumption tracks the average (trend) closely. After the decline in bank equity returns, however, consumption starts to fall slowly, opening a gap to trend growth even before the start of the NBER-dated recessions.

[41] Baron *et al.* (2021) define a bank equity crash as a decline in the bank equity index of more than 30 percent. Since 1980, there have been two of those in the United States—in 1990 and in 2007. The former corresponds to the Rhode Island banking crisis (Pulkkinen and Rosengren, 1993) and the latter to the global financial crisis.

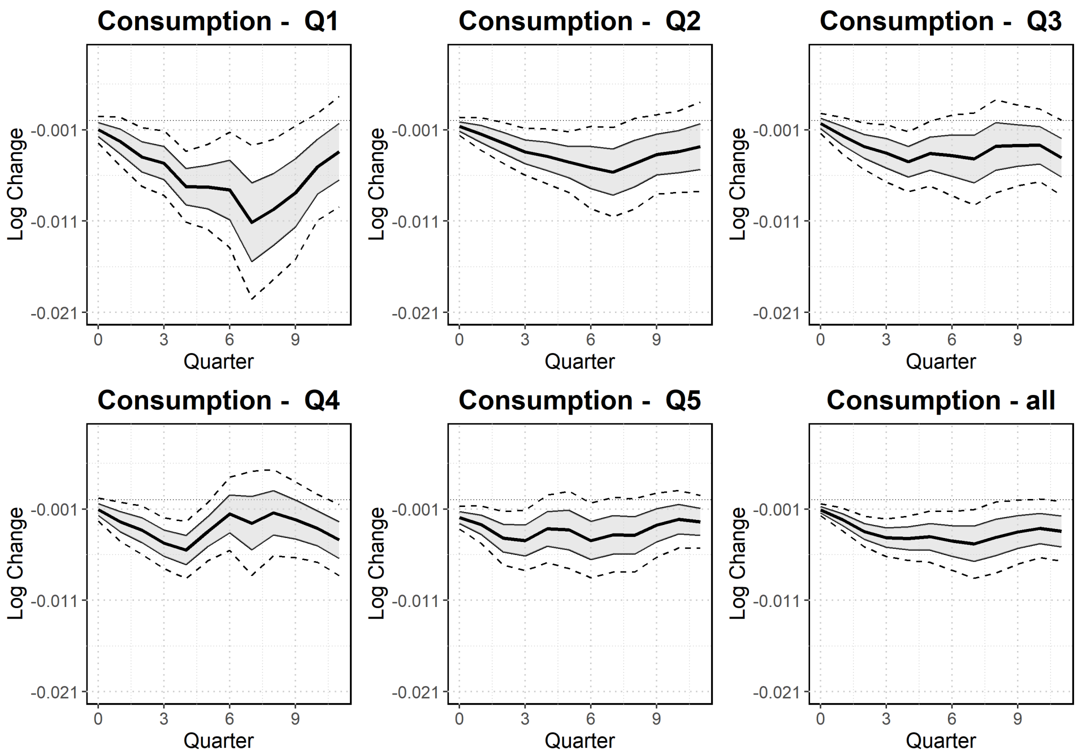


Figure D.19: Effects of Bank Equity Returns on Household Consumption
Notes: Impulse responses of household consumption by income quintile and aggregate to a negative 10% change in r^B. The shaded areas indicate one– standard deviation confidence intervals; dashed lines represent 95 percent confidence bands. Data for 1980-2010, Newey-West standard errors.

D.2 Baseline Consumption Response - IRFs

Figure D.19 below presents the impulse response of consumption for distinct income quintiles to a decline in 10% on bank equity returns, i.e. it plots the coefficients $\beta^{h,0}$ of specifications (35).

We now proceed to show that the qualitative pattern of results found in Figure D.19 is robust to a series of alternative specifications.

D.3 Additional Empirical Results

In addition to our main empirical analysis, we consider alternative specifications to test the robustness of our findings. More specifically, we provide results for the following variations of our main specification:

- Figure D.20 shows the IRFs to a similar specification as in equation (35), but with lags for each horizon h and income group i selected independently according to the optimal selection criterion in Akaike (1974).

- In Figure D.21, we consider a different definition of household income, in which rents are subtracted from our original income variable as in Aguiar and Bils (2015).

- In Figures D.22 and D.23, we restrict our definition of consumption to respectively durable and nondurable goods.

- Figures D.24 and D.25 split the sample into mortgagors and other households (renters and outright homeowners) follow Cloyne *et al.* (2020) to study the effect of homeownership.[42]

- Figures D.26 and D.27 consider respectively periods with below and above median returns to bank equities, to allow for asymmetric effects of positive and negative shocks. We modify specification (35) by including a dummy for below-median returns interacted with r^B, and plot the coefficients corresponding to this interaction. The coefficient that multiplies r^B alone then corresponds to the effect of above-median returns. For exposition, we display a response to a *positive* shock for above median returns.

All considered specification yield similar results to the baseline and emphasize the robustness of the reported patterns.

[42]Our definition of income quintiles still refers to the income distribution in the full sample, and not within housing tenure categories. The sample size is small for mortgagors at the bottom quintiles of the income distribution as mortgagors in the data tend to have higher incomes, leading to the observed loss in precision. In particular, only 21 percent of households in the bottom income quintile are mortgagors, as opposed to 58 percent in the top quintile.

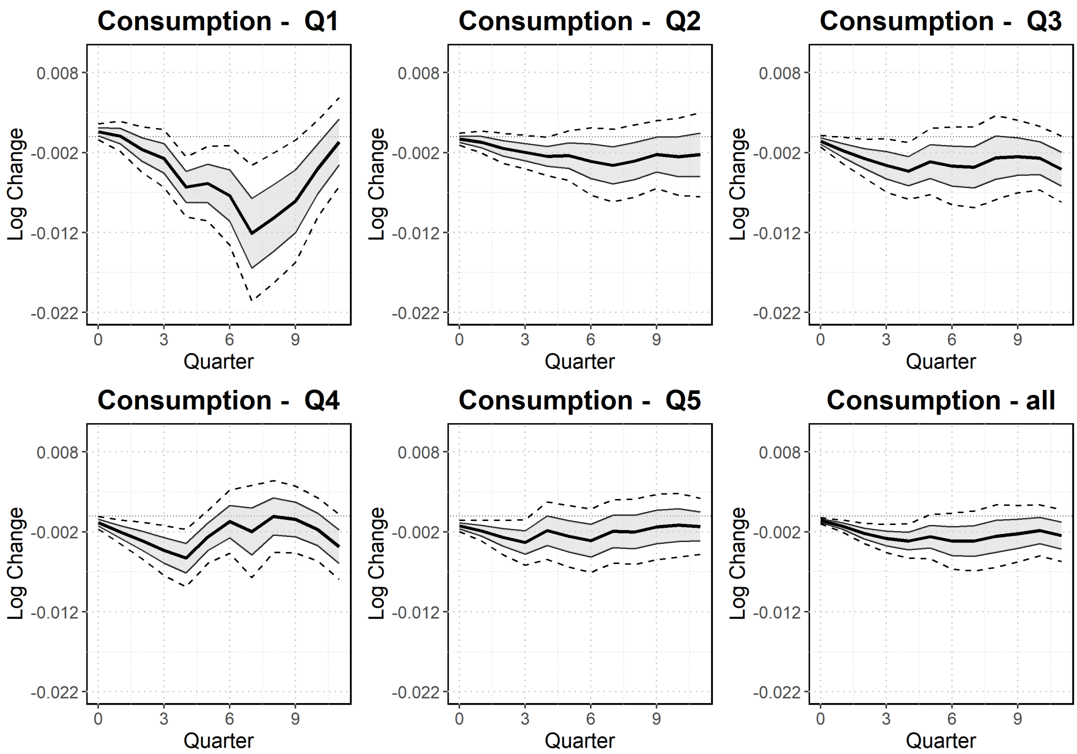


Figure D.20: Bank Equity Returns and Household Consumption—AIC

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B . The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters. Lags are selected according to Akaike (1974) optimal information criterion

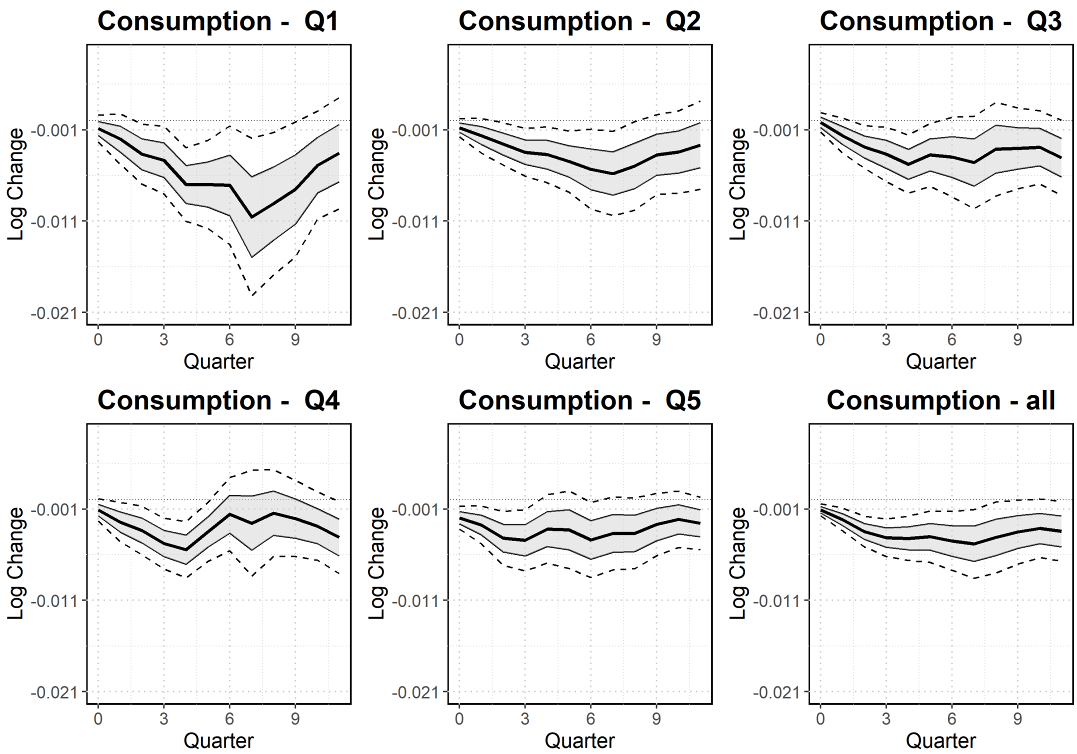


Figure D.21: Bank Equity Returns and Household Consumption—Rent

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B . The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters. Incomes are computed net of rents.

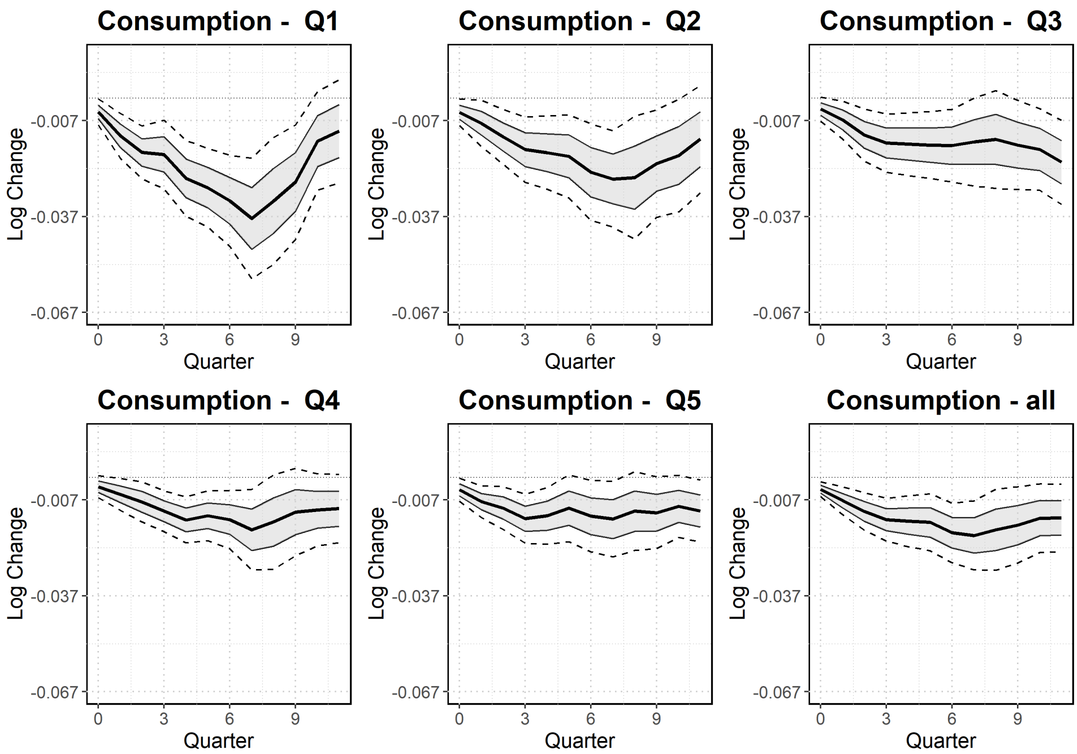


Figure D.22: Bank Equity Returns and Household Consumption—Durables

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B . The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters. Expenditures refer to durable consumption.

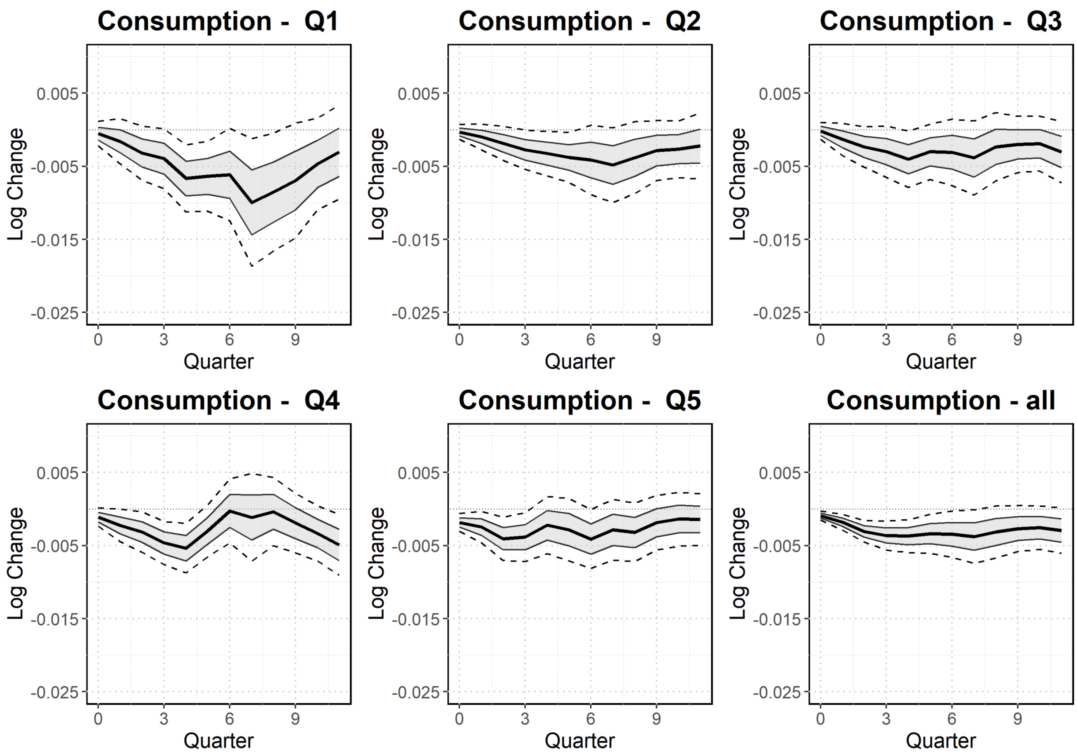


Figure D.23: Bank Equity Returns and Household Consumption—Nondurables

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B . The shaded areas indicate one standard-deviation confidence interval, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters. Expenditures refer to nondurable consumption.

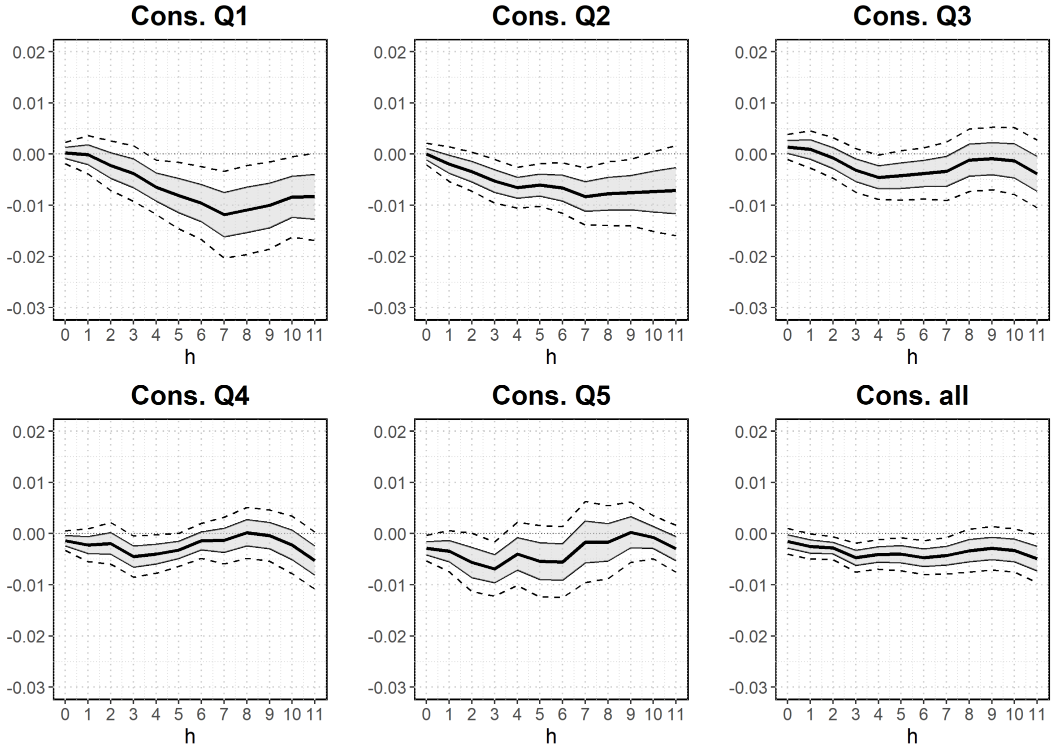


Figure D.24: Bank Equity Returns and Household Consumption—Non-Mortgagors

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B . The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters. Sample is restricted to non-mortgagors.

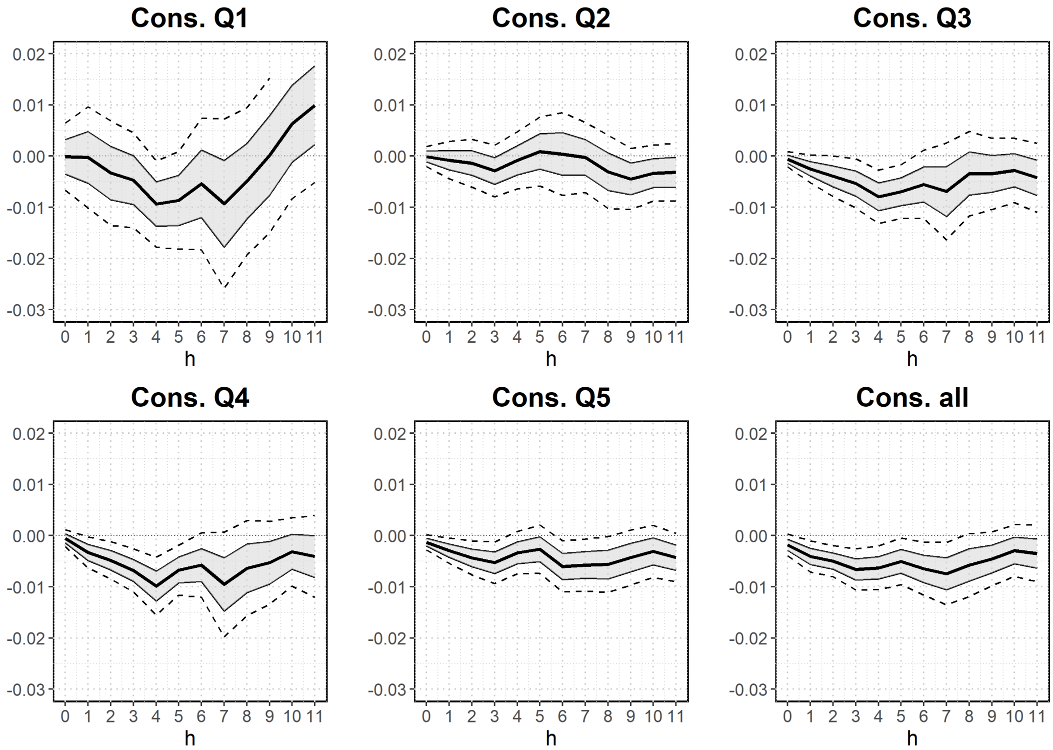


Figure D.25: Bank Equity Returns and Household Consumption—Mortgagors

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B . The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters. Sample is restricted to mortgagors.

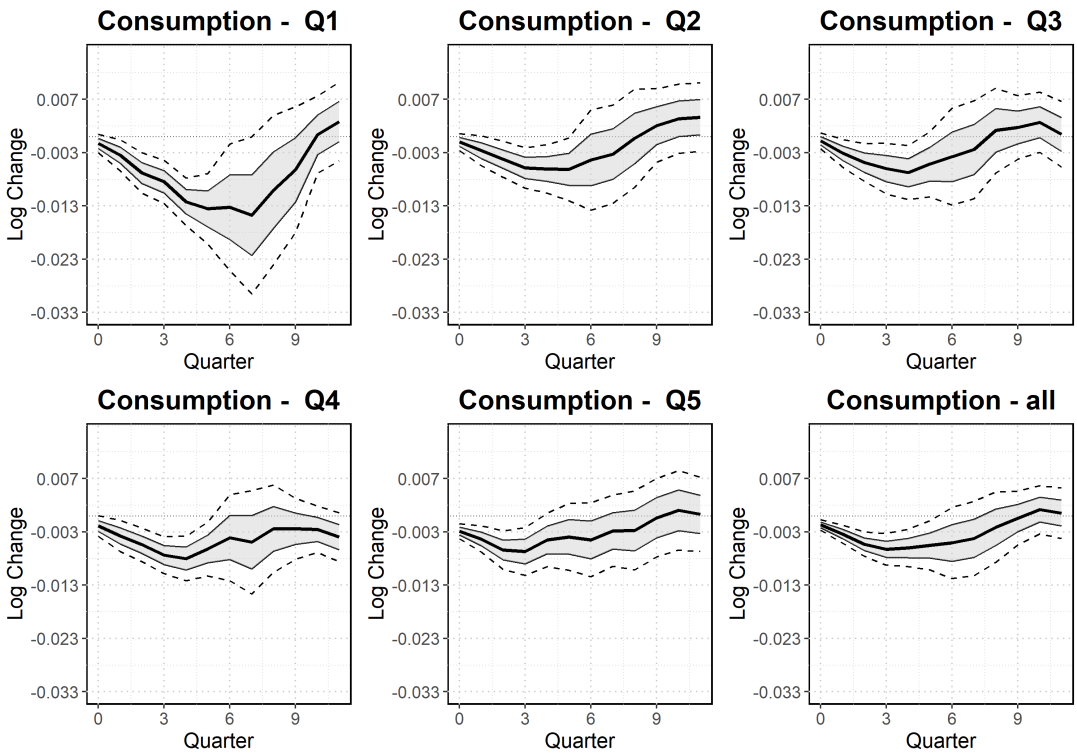


Figure D.26: Bank Equity Returns and Consumption—Below-Median Shocks

Notes: Impulse responses of household consumption by income quintiles and aggregate to a negative 10% change in r^B, interacted with a dummy corresponding to below-median returns. The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters.

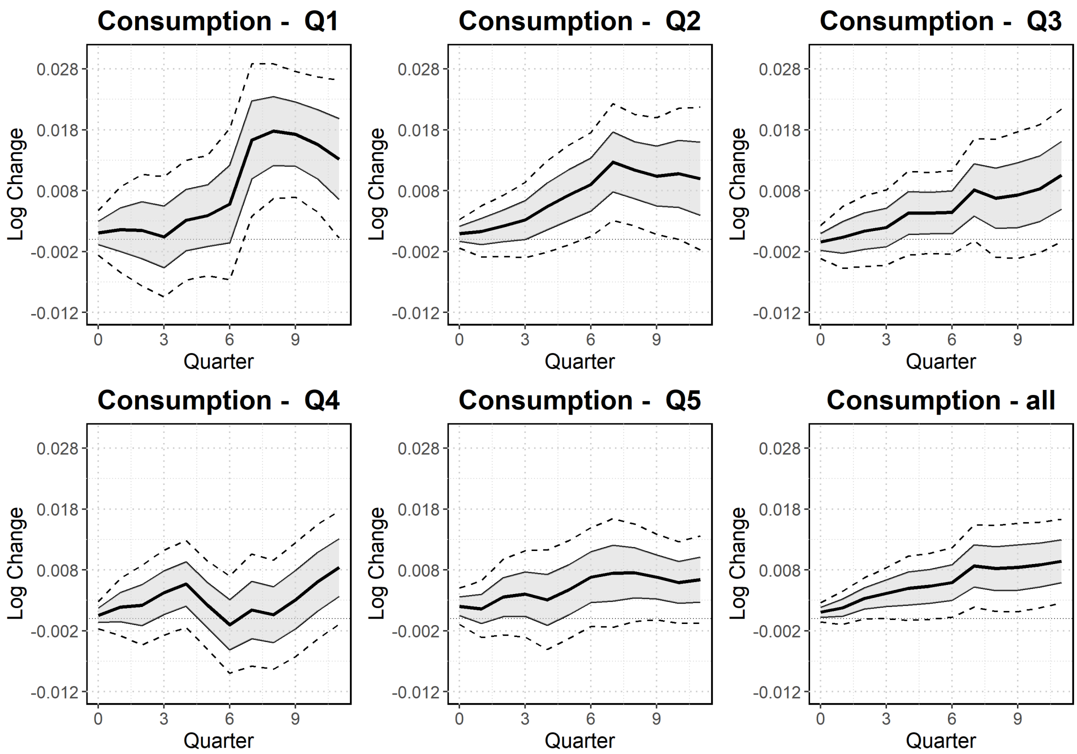


Figure D.27: Bank Equity Returns and Consumption—Above-Median Shocks

Notes: Impulse responses of household consumption by income quintiles and aggregate to a **positive** 10% change in r^B, interacted with a dummy corresponding to above-median returns. The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Data for 1980-2010, Newey-West standard errors. Time (horizontal axis) in quarters.

Figure D.28 below displays the impulse-response functions for compensation of employees, investment, consumer credit spreads, and (non-bank) stock market prices. The data series used and specification estimated for each of the subplots are the following:

- Top-left panel. Data series: US Bureau of Economic Analysis, Compensation of Employees, Received: Wage and Salary Disbursements [A576RC1], retrieved from FRED, Federal Reserve Bank of St. Louis; Regression specification is the same as equation 35, substituting consumption for the wage disbursement series adjusted by the CPI All Urban.

- Top-right panel. Data series: US Bureau of Economic Analysis, Real Gross Private Domestic Investment [GPDIC1], retrieved from FRED, Federal Reserve Bank of St. Louis; Regression specification is the same as equation 35, substituting consumption for the investment series.

- Bottom-left. Spread on credit card rate is obtained subtracting the 3-month T-bill rate from the the interest rate on credit cards. The regression specification is similar to equation 35, but substitutes consumption for the spread series and controls for credit card charge-off rates to adjust for borrowers' default risk. Series: (i) Credit card rates: Board of Governors of the Federal Reserve System (US), Commercial Bank Interest Rate on Credit Card Plans, All Accounts [TERMCBCCALLNS], retrieved from FRED, Federal Reserve Bank of St. Louis; (ii) T-bill rates: Board of Governors of the Federal Reserve System (US), 3-Month Treasury Bill Secondary Market Rate [DTB3], retrieved from FRED, Federal Reserve Bank of St. Louis (quarterly average); (iii) Charge-off rate: Board of Governors of the Federal Reserve System (US), Charge-Off Rate on Credit Card Loans, All Commercial Banks [CORCCACBS], retrieved from FRED, Federal Reserve Bank of St. Louis;

- Bottom-right: Dow Jones Industrials Share Price Index. End-of-month indices are aggreagated at the quarterly level through simple average. The regression specification is the same as in equation (35), but since we control for the lagged stock market index, we exclude r^N from the set of controls.

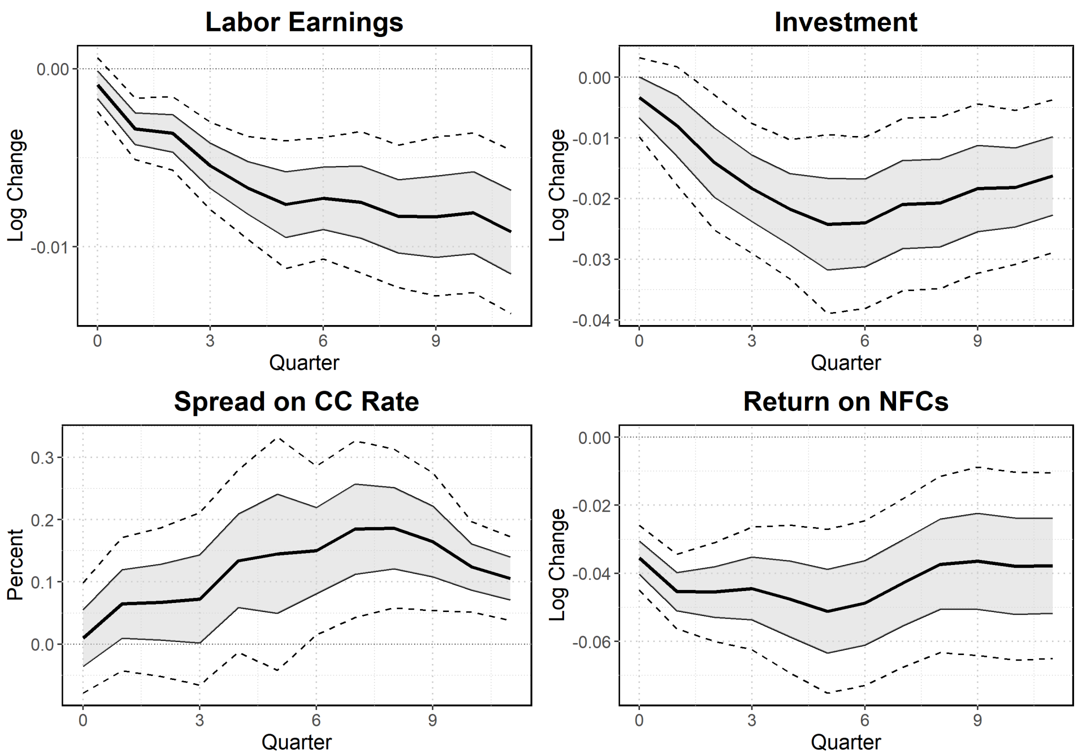


Figure D.28: Bank Equity Returns and Selected Variables

Notes: Impulse responses to select variables (described in subsection ??) 10% change in r^B . The shaded areas indicate one standard-deviation confidence intervals, dashed lines are 95-percent confidence bands. Newey-West standard errors. Time (horizontal axis) in quarters.