Distributive Effects of Banking Sector Losses*

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Abstract

Using data from the Consumer Expenditure Survey, we document that in response to declines in bank equity returns the consumption of low-income households decreases by roughly twice as much as that of the average household. To understand this result, we develop a heterogeneous-agent model featuring rich income and portfolio heterogeneity and a banking sector subject to financial frictions. The model matches the empirically observed inequality in consumption responses following a shock to banks' asset returns. Households at the bottom of the income distribution suffer from losses in labor earnings and from an increase in the cost of borrowing. In contrast, high-income consumers can take advantage of temporarily low asset prices and high future returns and increase their savings to sustain higher consumption in the medium term. In fact, a fraction of households benefit from distress in the banking sector. A debt-financed asset purchase program can improve welfare, especially for low-income individuals, by dampening the increase in credit spreads and stabilizing investment.

Keywords: Banking Crises, Financial Frictions, Household Heterogeneity, Incomplete Markets, Consumption Dynamics. JEL: D31, E21, G01, G21.

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1 Introduction

Which households are most exposed to severe disruptions to the financial sector? Do shocks to banks increase inequality? The severe economic distress in the wake of the 2007–9 financial crisis renewed interest in the consequences of large disruptions to banks and sparked a debate about the unequal impact of recessions. Inequality is now a critical concern for policy makers: in its 2020 strategy review, the Federal Reserve emphasizes the importance of considering the distributive consequences of economic fluctuations.[1] A comprehensive analysis of the real economic consequences of financial sector distress must therefore contemplate its heterogeneous effects across households.

Disruptions in the banking sector cause a reduction in financial intermediation, fluctuations in interest rate spreads and asset prices, and ultimately a general decline in economic activity (Gertler and Kiyotaki, 2010). Households are exposed to these factors in heterogeneous ways, depending on the composition of their income between labor earnings and financial returns, whether they are savers or borrowers, and how exposed they are to interest rate and asset price changes. A clear assessment of these heterogeneous effects is critical for understanding which households are impacted the most by banking sector disruptions, and consequently who ultimately benefits from government support to distressed financial institutions.

While the implications of severe impairments to banks' intermediation for aggregate economic outcomes are widely studied, the literature is silent about the distributive effects of banking sector losses on household consumption and welfare. Our paper fills this gap. First, we document a novel empirical fact about banking sector conditions and household consumption: Banking sector distress is associated with a stronger consumption response at the bottom of the income distribution, relative to the aggregate. Second, we build a model economy featuring rich household heterogeneity and an explicit banking sector. The model replicates the empirically observed consumption responses to banking sector losses along the income distribution. In addition, it allows us to uncover the mechanisms behind those movements, to consider

[1] In the press conference following the release of the Fed's *Statement on Longer-Run Goals and Monetary Policy Strategy*, Jerome Powell referred to the benefits that a strong economy brings to *low- and moderate-income communities* (Powell, 2020).

the welfare implications of bank losses, and to evaluate the role of policy interventions.

Our empirical analysis combines consumption data from the Consumer Expenditure Survey with the bank equity index provided by Baron *et al.* (2021). We estimate local projections of consumption by quintile of total after-tax income in response to changes in bank equity returns, controlling for the return to nonfinancial equities. Thus, our results capture the response to banking sector conditions over and above the impact of overall economic conditions.

We find that the decline in consumption for households in the lowest income quintile is almost twice as strong as the aggregate, while responses are roughly homogeneous over the upper half of the income distribution. On average, a one–standard deviation drop in returns is associated with a cumulative decline in consumption of 4.9 percent over the following twelve quarters. Focusing on transmission mechanisms, we find that declines in bank returns are associated with falls in investment, labor earnings, and asset prices, as well as an increase in consumer credit spreads.

To understand these findings, we construct a two-asset heterogeneous-agent model featuring a banking sector subject to financial frictions. Households face uninsurable income risk and a portfolio decision between assets with different degrees of liquidity: deposits are liquid and can be adjusted in every period, while capital holdings are subject to liquidity frictions. Banks collect deposits and lend funds both to nonfinancial firms and to households. They are subject to a leverage constraint restricting their future liabilities to a fraction of their assets. These features allow us to capture the interactions between banks and households and to explore the effects of banking sector losses on consumption and welfare along the income distribution.

We calibrate the model to US data and use it to study the effects of an unanticipated, exogenous shock to banks' asset returns. The shock causes a decline in banks' net worth of 20 percent on impact, corresponding to the fifth percentile of equity returns in the data—i.e., an episode of severe distress in the banking sector. It severely impairs banks' intermediation capacity, resulting in a fire sale of their assets to reduce the size of their balance sheet and satisfy their leverage constraint. In equilibrium, lending spreads increase and asset prices decline, generating further losses and triggering a financial accelerator (Bernanke *et al.*, 1999). Ultimately, the reduced investment activity causes a decline in output and a recession. The responses are in line with our empirical results on potential transmission mechanisms.

Importantly, the model-implied consumption responses across income quintiles also align with our empirical findings, both qualitatively and quantitatively: While consumption of all income groups declines on impact and gradually recovers from the shock, households in the lowest income quintile experience the largest change. They see their consumption decrease by a cumulative 14 percent over twelve quarters, roughly twice as much as the average fall. Over the upper half of the income distribution, consumption responses are homogeneous, again consistent with our empirical findings.

We decompose the consumption responses into the contributions of different transmission mechanisms. Low-income households are especially exposed to fluctuations in the cost of borrowing and in labor earnings. They are often borrowers, are poorly insured against income shocks, and are highly dependent on labor income to finance their consumption. In contrast, for high-income households movements in financial income, particularly in the returns to holding capital, are the most important drivers of the observed responses. A substantial portion of the initial decline in their consumption is due to an increase in savings following temporarily low asset prices and high future returns on holding deposits and capital.

In addition, we study how banking sector losses affect consumers' welfare. On average, households would be willing to permanently give up 0.4 percent of their consumption to avoid the consequences of the shock. While those in the lowest income quintile would forgo 1 percent of their consumption to avoid the shock, those in the top quintile would only give up 0.1 percent. In fact, we find that 11 percent of the population stands to gain from the shock. These are typically high-income, wealthy households, with a high proportion of their income stemming from financial sources.[2] Despite their exposure to the initial sharp decline in asset prices, they are able to make up for their losses by adjusting their savings behavior. Overall, they take advantage of movements in financial variables, enabling them to sustain higher future consumption. This is why the heterogeneity in welfare changes is even more pronounced than that in the response of consumption.

[2] A small fraction of the wealthiest households in our economy hold claims to banks' dividend payments and suffer substantially from their direct exposure to the banking sector.

Finally, we study the distributive consequences of a policy intervention aimed at alleviating the impact of banking sector losses. We consider an asset purchase program along the lines of the Troubled Asset Relief Program (TARP) instituted by the US government in the aftermath of the Great Recession. Similarly to Gertler and Karadi (2011), in response to losses in the banking sector the government intervenes and temporarily acts as a financial intermediary, issuing bonds to households and financing investments. Such an intervention dampens the increase in the lending spread as well as the decline in investment activity and asset prices caused by initial bank losses. Our baseline policy, calibrated to the size of TARP, is able to reduce the welfare impact of the original shock by 23 percent, with gains concentrated in the bottom quintile of the income distribution.

1.1 Related Literature

Our paper relates to the empirical literature studying micro-level consumption dynamics 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. Coibion *et al.* (2017) and Cloyne *et al.* (2020) study consumption responses to monetary policy shocks. In contrast to this literature, our contribution is to examine the inequality in consumption in response to changes in banking sector conditions. In this regard, our paper is similar to Baron *et al.* (2021), which studies the dynamics of macroeconomic aggregates in response to banking sector distress and from which we draw our measure of conditions in the banking sector.

We also contribute to a series of contemporaneous works combining heterogeneous households and a banking sector: Arslan *et al.* (2020) study a house price boom and bust in a small open economy framework; Ferrante and Gornemann (2021) analyze the heterogeneous pass-through of exchange rate shocks; Fernández-Villaverde *et al.* (2019) show how interacting financial frictions and household heterogeneity can generate endogenous aggregate volatility; Lee *et al.* (2021) study how countercyclical borrowing wedges amplify business cycles. We share with them the joint consideration of financial intermediaries and household heterogeneity, but our focus lies on understanding the distributive effects of losses originating in the banking sector. Our model differs from those of the above studies in that households can hold capital both directly and indirectly (through bank deposits). This allows them to rebalance their portfolio in response to asset price movements, an important mechanism driving our results.

More generally, we build on the seminal work of Kiyotaki and Moore (1997) and Bernanke *et al.* (1999), as well as subsequent studies on the consequences of financial shocks (e.g., Eggertsson and Krugman, 2012; Jermann and Quadrini, 2012; Christiano *et al.*, 2014; Justiniano *et al.*, 2019) and frictions in the financial intermediation sector (e.g., Gertler and Kiyotaki, 2010; Gertler and Karadi, 2011; Brunnermeier and Sannikov, 2014; He and Krishnamurthy, 2019; Iacoviello, 2015; Mendicino *et al.*, 2020) for the aggregate economy. While this line of research has not focused on the role of household heterogeneity, a parallel strand of the literature studies the implications of aggregate shocks for heterogeneous households (e.g., Krusell and Smith, 1998; Krueger *et al.*, 2016; Kaplan *et al.*, 2018; Glover *et al.*, 2020). This literature either abstracts from a banking sector and financial frictions entirely or considers exogenous movements in borrowing limits or credit spreads (Guerrieri and Lorenzoni, 2017; Antunes *et al.*, 2020). Considering both an explicit banking sector and household heterogeneity, we generate endogenous movements in credit spreads and asset prices and provide novel results on the distributional consequences of financial recessions.[3]

The remainder of the paper is structured as follows: Section 2 describes our empirical analysis; Section 3 presents the model; Section 4 discusses the model's quantitative implementation; Section 5 presents the dynamics of the economy in response to a shock to banks' asset returns; and Section 6 explores the consequences of credit policy interventions.

2 Bank Losses and Consumption Inequality

We begin with an empirical assessment of how changes in banking sector conditions affect consumption along the income distribution. Using household-level data from the Consumer Expenditure Survey and a measure of bank equity returns from Baron *et al.* (2021), we doc-

[3] Methodologically, we also build on heterogeneous-agent models with endogenous portfolio choices (e.g., Kaplan and Violante, 2014; Bayer *et al.*, 2019). Our work expands on their framework in that we explicitly model a financial intermediation sector that transforms illiquid capital holdings into liquid deposits.

ument a novel fact: households at the bottom of the income distribution exhibit a stronger consumption response to changes in bank returns.

2.1 Data

Household-Level Data. We use household survey data from the US Consumer Expenditure Survey (henceforth CEX). The survey is available monthly 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 closely Coibion *et al.* (2017). 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.[4] 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 and the corresponding aggregate consumption from the CEX and rescale the expenditure data for each of the five groups as well as the aggregate series

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

with the (same) factor. With this transformation, the source of variation in aggregate consumption in our data is the national accounts, whereas the relative variation in consumption across income quintiles originates from the micro data. 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 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.[5] The use of a continuous measure to identify periods of bank distress instead of a narrative approach (Reinhart and Rogoff, 2009; Laeven and Valencia, 2013) allows us to focus our analysis on a single country.[6] 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. This is because bank equity has the lowest payoff priority among bank stakeholders.[7] In addition, Baron *et al.* (2021) show that bank equity returns have predictive content for future macroeconomic dynamics even excluding episodes with narrative evidence of panics or widespread bank failures.

Table 1 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}).[8] 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

[5]Their 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.

[6]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.

[7]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.

[8]We use the index of returns on NFC stocks as a control in our regressions, as we explain below. The latter is also obtained from Baron *et al.* (2021) and consists of the S&P 500 Industrials adjusted for dividends.

Table 1: 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.

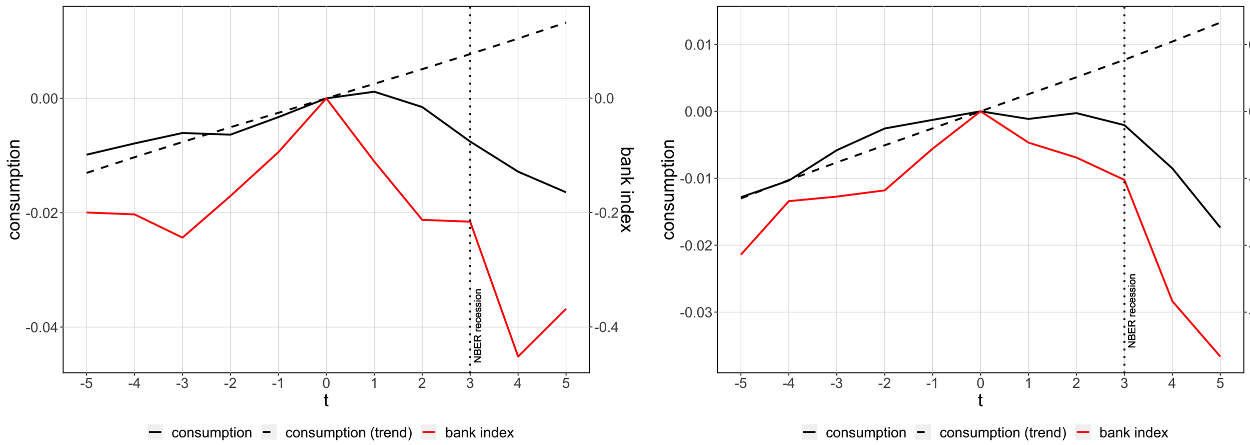
the return distribution. In addition, both series display very low autocorrelation, attesting to a lack of predictability based on past realizations as one would expect for financial market return series. This gives us confidence to treat sudden changes in bank equity returns as reflecting new information about the banking sector.

To provide some intuition for our data measures, Figure 1 shows the evolution of the US bank equity return index (red line) and log real aggregate consumption (black solid line) around two dates of bank equity crashes over our sample period.[9] 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. With this descriptive evidence in mind, we now proceed to a formal investigation of the dynamic relation between equity returns and consumption.

2.2 Estimation Strategy

To examine the predictive power of bank equity returns for household consumption at different points of the income distribution, we follow Baron *et al.* (2021) and estimate the ensuing local

[9] 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.



(a) **1990** (b) **2007**

Figure 1: 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.

projections specification in the spirit of Jordà (2005):

$$c_{i,t+h} = \alpha_i^h + \gamma_i^h(t+h) + \sum_{j=0}^{J} \beta_i^{h,j} r_{t-j}^B + \sum_{s=0}^{S} \delta_i^{h,s} r_{t-s}^{NF} + \sum_{k=0}^{K} \lambda_i^{h,k} c_{i,t-k} + \epsilon_{i,t}^h. \tag{1}$$

Here $c_{i,t+h}$ is the log of real household consumption by income quintile $i \in \{1,2,3,4,5\}$, $h \in \{0,1,2,...,H\}$ denotes horizons ahead of t, r_t^B and r^{NF} are returns to the bank and nonfinancial corporation indices respectively, and J, S, and K are the number of lags included for each series.[10] Our baseline specification includes one lag on each variable; i.e., $J = S = K = 1$. Coefficients α and γ represent a constant and a time trend, which are specific to the income quintile. The baseline specification is estimated for total household consumption.

The key parameters of interest are $\{\beta_i^{h,0}\}_{i,h}$, 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 nonfinancial returns r_t^{NF} to adjust for the influence of contemporaneous (and lagged) general economic conditions (Stock and Watson,

[10]Our baseline results are based on a smoothed version of $c_{i,t}$ using a four-quarter moving average as in Cloyne *et al.* (2020). This adjustment is meant to absorb noise inherent to the survey data. In the baseline specification we use a centered moving average. Results are also robust to the use of a forward- or backward-looking moving average and (qualitatively) to other means of seasonal adjustment such as X-13-ARIMA-SEATS.

2003). Hence, coefficients $\{\beta_i^{h,0}\}_{i,h}$ capture the response of household consumption over and above the response to overall stock market conditions.

2.3 Results

Figure 2 displays the impulse-response functions for a one–standard deviation *decline* in bank returns by income quintile, as well as aggregate consumption in the bottom-right panel. The bands correspond to one–standard deviation and 95 percent confidence intervals respectively. Responses for every quintile, as well as the aggregate, are statistically significant for at least one quarter at the 95 percent level. We find that a one–standard deviation decline in quarterly bank stock returns (0.123) is associated with a cumulative fall of 5.6 log points in aggregate consumption over a three-year horizon, an economically sizable response.[11]

The main takeaway from Figure 2 and from our empirical analysis is that the consumption response for households at the bottom of the income distribution to changes in bank equity returns is stronger than that of other households. We are the first to document this empirical relationship. The peak response of consumption of households in the first quintile is twice as strong as that of the highest income group. Similarly, the cumulative three-year-horizon response is roughly twice as high for low-income households compared to their high-income counterparts. Figure 3 compares the cumulative responses over time. After twelve quarters, the bottom income quintile exhibits a cumulative response of 9 log points, while the responses for the other quintiles stay between 5.2 and 4.5 log points.

Robustness Checks. We estimate a range of alternative specifications to test for robustness of our main result. These include using a monthly series, varying lag structures based on the Akaike criterion, analysis by consumption categories (durables, nondurables), splitting the sample according to housing tenure, and restricting the bank returns to below-median returns to test for nonlinearities. We provide detailed results in Appendix A.1. Our main finding is robust across all alternative specifications considered: consumption is more responsive to bank equity returns at the bottom of the income distribution.

[11] Recall that the source of variation for the aggregate series comes from the national accounts and not from the CEX.

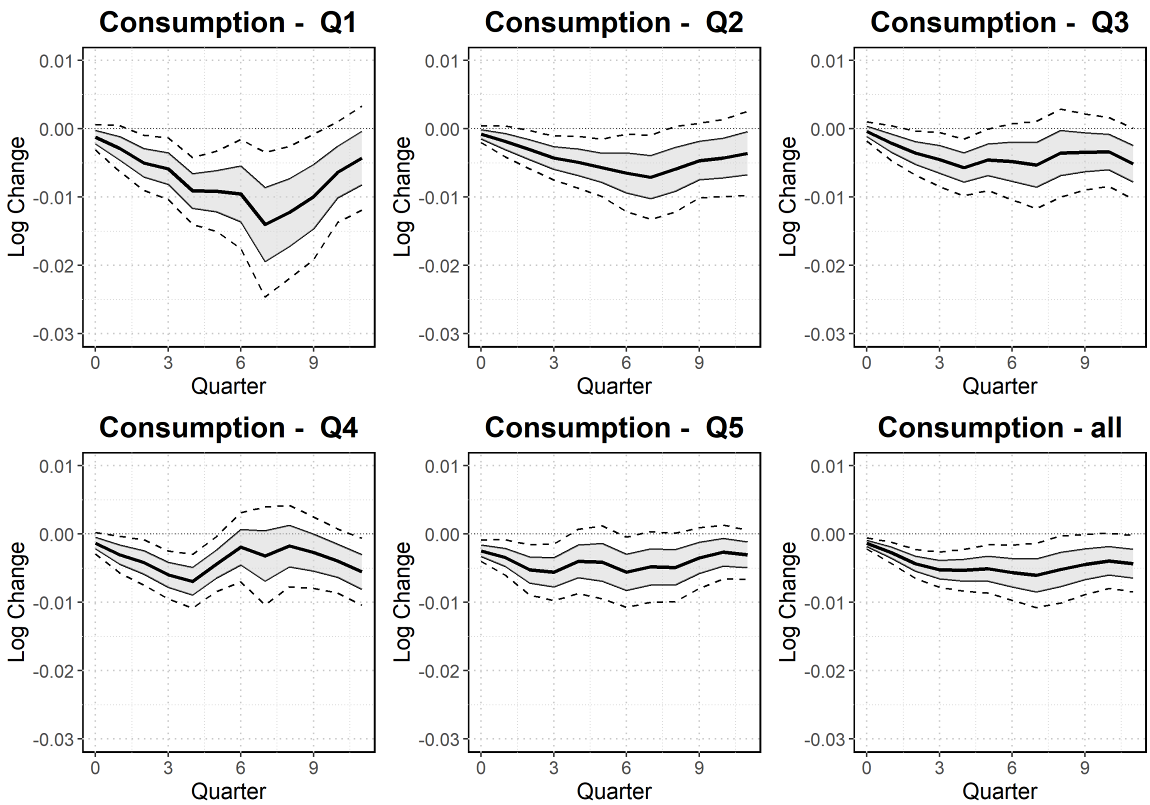


Figure 2: Effects of Bank Equity Returns on Household Consumption

Notes: Impulse responses of household consumption by income quintile and aggregate using data starting for 1980–2010 to a negative one–standard deviation change in r^B. The shaded areas indicate one– standard deviation confidence intervals; dashed lines represent 95 percent confidence bands. Robust, Newey-West standard errors.

Mechanisms. Figure 4 provides some evidence on potential transmission mechanisms following movements in bank equity returns. We repeat the same local projection as in (1) for the following dependent variables: total compensation of employees, the credit card rate spread, real investment, and the Dow Jones Industrials index as a proxy for asset prices. Details of the specifications and the data series are provided in Appendix A.2. Negative bank returns are associated with a decline in the total wage bill, investment, and the Dow Jones Industrials index. Credit card spreads, on the other hand, rise following negative bank returns, reflecting the deterioration in credit conditions (Baron *et al.*, 2021).

In sum, our empirical analysis provides new evidence on the dynamic relation between bank equity returns and consumption across the income distribution. We find that low-income

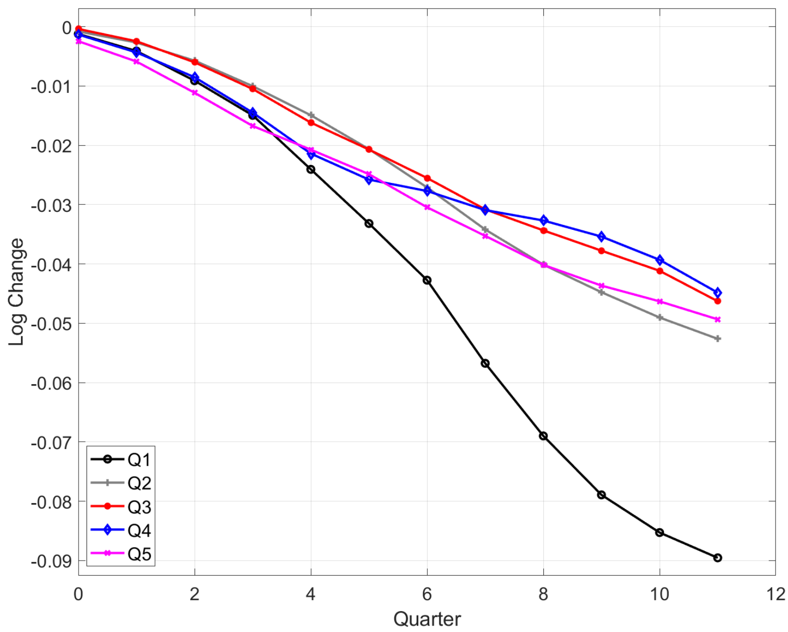


Figure 3: Cumulative Responses of Consumption by Quintile

Notes: Cumulative impulse responses of household consumption by income quintile, using data for 1980–2010, for a one–standard deviation decline in r^B.

households are more responsive to banking sector conditions, particularly in the lowest income quintile. We also provide suggestive evidence on the mechanisms operating behind these responses, and we find that banking sector distress is associated with declines in aggregate labor income, investment, and the stock market, as well as an increase in the consumer credit spread. Building on these findings, we now move on to analyzing the distributive effects of banking sector distress through our model.

3 Model

To analyze the distributive effects of banking sector losses in more detail, we build a model economy featuring both household heterogeneity and an explicit banking sector. The model enables us to go beyond the empirical exercise: we consider how the observed heterogeneity in consumption responses translates into changes in welfare, study the relative contribution of

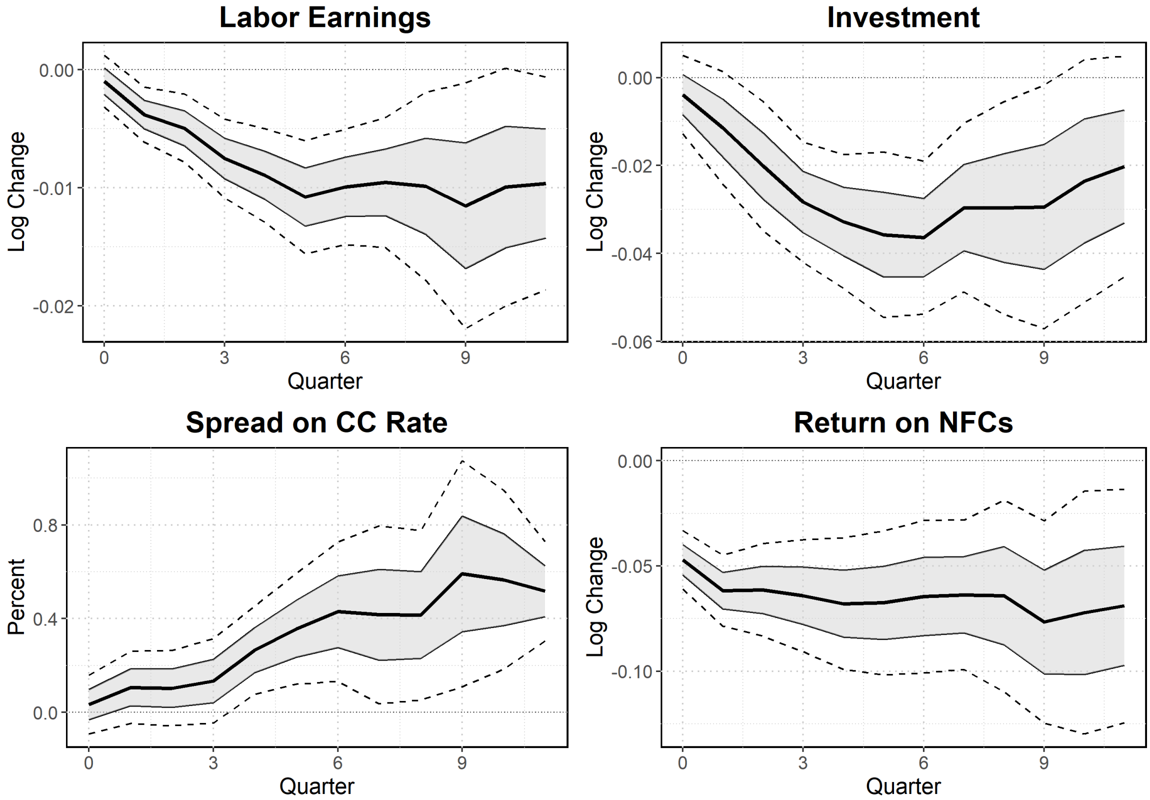


Figure 4: Effects of Bank Equity Returns on Selected Variables
Notes: Impulse responses of total employment compensation, investment, the spread on credit card rates, and the Dow Jones Industrials index for a one–standard deviation decline in r^B. Details of the data series are provided in Appendix A.2. The shaded areas indicate one–standard deviation confidence intervals; dashed lines represent 95 percent confidence bands. Robust, Newey-West standard errors.

different transmission mechanisms, and evaluate policy responses to banking sector losses.

The model economy features five types of agents: 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; a continuum of ex ante identical households facing idiosyncratic income risk can save or borrow through a liquid asset intermediated by banks and can also invest directly in illiquid capital; finally, banks collect deposits from and lend to households, invest directly in capital, and are subject to a leverage constraint. We outline the problems solved by each type of agent in detail below.

3.1 Production

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

$$Y_t = A_t K_t^{\alpha} N_t^{1-\alpha}, \tag{2}$$

where A_t represents total factor productivity.

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

$$w_t = p_t^I (1-\alpha) A_t K_t^{\alpha} N_t^{-\alpha} \tag{3}$$

$$r_t^K = p_t^I \alpha A_t K_t^{\alpha-1} N_t^{1-\alpha}. \tag{4}$$

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

$$c_{j,t}^R = \left(\frac{p_{j,t}}{P_t}\right)^{\frac{\mu}{1-\mu}} c_t. \tag{5}$$

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

$$p_t^I = \frac{1}{\mu}. \tag{6}$$

Retailers' profits are distributed to households as dividends given by

$$div_t^Y = \frac{\mu-1}{\mu} Y_t. \tag{7}$$

Capital Producers. A continuum of identical, competitive capital producers transform the final consumption good into the next period's capital, which they sell to households and banks at price q. They live for one period and are subject to adjustment costs relative to the stock of capital in steady state K^{SS} and choose investment I to maximize profits

$$\max_{I_t} \left\{ (q_t - 1) I_t - \frac{\phi_K}{2} \left(\frac{I_t}{K^{SS}} - \delta \right)^2 K^{SS} \right\}. \tag{8}$$

The resulting first-order optimality condition yields the price of capital as

$$q_t = 1 + \phi_K \left(\frac{I_t}{K^{SS}} - \delta \right). \tag{9}$$

This pricing equation highlights how adjustment costs to the aggregate capital stock are important to generate fluctuations in the price of capital. Capital producers' optimality implies a steady-state value of $q = 1$, while $q > 1$ whenever investment is above its steady-state level ($I > \delta K^{SS}$) and $q < 1$ whenever investment is below its long-run level ($I < \delta K^{SS}$). The profits from capital production given by equation (8) are distributed to households as dividends div_t^I.

3.2 Banking Sector

Banks are run by managers, which are assumed to be of zero mass and whose discount factor is β_B. Banks fund their investments through short-run deposits D, along with their own net worth E. They hold two types of assets: claims to nonfinancial capital K^B, and consumer loans L. Managers maximize the following objective function:

$$V_t^B(E_t) = \max_{\substack{K_{t+1}^B \geq 0,\, L_{t+1} \geq 0 \\ D_{t+1} \geq 0,\, div_t^B \geq 0}} \log(div_t^B) + \beta_B \mathbb{E}_t V_{t+1}^B(E_{t+1}), \tag{10}$$

subject to

$$E_t = \underbrace{(1 + r_t^L) L_t}_{\text{repayment from borrowing HHs}} + \underbrace{((1 - \delta) q_t + \xi_t^B r_t^K) K_t^B}_{\text{repayments from NFCs}} - \underbrace{(1 + r_t^D) D_t}_{\text{repaying depositors}} \tag{11}$$

$$div_t^B + L_{t+1} + q_t K_{t+1}^B = D_{t+1} + E_t \tag{12}$$

$$\underbrace{(1 + r_{t+1}^D) D_{t+1}}_{\text{future liabilities}} \leq \chi \underbrace{\mathbb{E}_t \left((1 + r_{t+1}^L) L_{t+1} + ((1 - \delta) q_{t+1} + \xi_{t+1}^B r_{t+1}^K) K_{t+1}^B \right)}_{\text{expected future assets}}. \tag{13}$$

Equation (11) is the law of motion for banks' beginning-of-period equity E_t. The shock ξ_t^B is a disturbance to the productive capacity of banks' capital holdings, similar to the capital quality shock in Gertler and Kiyotaki (2010) but restricted to the capital intermediated by banks. We take this as a reduced-form way to generate losses in the banking sector, and we assume $\xi_{SS}^B = 1$. In the context of the model, this shock can be interpreted as an (unexpected) realization of lower returns on bank equity, triggering a recession.[12]

Equation (12) represents banks' flow of funds identity, with assets (and dividends) on the left-hand side and liabilities on the right-hand side. Finally, equation (13) imposes a leverage constraint, restricting future bank liabilities to a fraction of the expected value of future assets.[13]

Bankers' optimal behavior implies a no-arbitrage condition between lending to households and holding capital given by

$$\mathbb{E}_t \left(\frac{(1-\delta) q_{t+1} + \xi_{t+1}^B r_{t+1}^K}{q_t} \right) = 1 + r_{t+1}^L. \tag{14}$$

Note here that the bank forms expectations about the future return to capital, while the return on lending to households (as well as the interest paid on deposits) is predetermined. In addition, the leverage constraint creates a wedge between deposit and lending rates:

$$r_{t+1}^L - r_{t+1}^D = \frac{1}{\chi \gamma_{t+1} + \frac{\mathbb{E}_t div_{t+1}^B}{\beta^B div_t^B}} - \frac{1}{\gamma_{t+1} + \frac{\mathbb{E}_t div_{t+1}^B}{\beta^B div_t^B}} > 0. \tag{15}$$

This wedge is positive as long as the leverage constraint is binding, and thus the associated multiplier γ is positive.

Since bank managers are assumed to be of zero mass, the payments they receive require zero resources and will not affect the resource constraint of the economy. Dividends from banking activities are distributed in full to households.

[12]In the appendix to their paper, Baron *et al.* (2021) provide a brief description of the banking crises identified in their data set, with references to detailed accounts. Common causes are exposure to (ex post) troubled sectors, either domestically or internationally. Our shock thus can be interpreted as exposure to a particular sector whose assets turned out to produce returns below expected.

[13]Our setup for the banking sector follows closely Iacoviello (2015).

3.3 Households

The demand side of the economy is modeled similarly to Bayer *et al.* (2019). Households are ex ante identical but ex post heterogeneous due to idiosyncratic shocks to their labor productivity z. They can save (deposit) or borrow in a liquid asset a and invest directly in capital k. Investment in capital is subject to a stochastic illiquidity: in any given period, the utility cost of adjusting θ_t is determined by an i.i.d. draw from a logistic distribution with mean μ_θ and variance σ_θ^2. Households in productivity state $z = z^*$, which we refer to as *capitalists*, receive additional income in the form of dividends $div_t = \frac{div_t^Y + div_t^I + div_t^B}{\sum_{(a,k)} \lambda_t(a,k,z^*)}$.[14] Here, λ denotes the distribution of households across the idiosyncratic state space at the beginning of each period and hence the term $\sum_{(a,k)} \lambda_t(a,k,z_*)$ summarizes the mass of capitalist households. Throughout the paper, we refer to noncapitalist households as *workers*.

At the beginning of a period, households are aware of their current portfolio position and learn about the realization of their idiosyncratic productivity state z, as well as their current cost of adjusting the illiquid portfolio. They first decide on whether to adjust their capital holdings in this period (extensive margin), and in a second stage they decide jointly on borrowing/saving in the liquid asset a, investing in capital k (intensive margin, if they chose to adjust), and consuming.

A non-adjusting household does not incur the utility cost θ but must keep capital holdings constant at $k_{t+1} = k_t$. It solves the dynamic optimization problem given by

$$V_t^n(a_t, k_t, z_t) = \max_{c_t \geq 0, a_{t+1} \geq \underline{a}} \left\{ u(c_t) + \beta \mathbb{E}_t V_{t+1}(a_{t+1}, k_t, z_{t+1}) \right\} \tag{16}$$

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

with $\underline{a}$ as the (exogenous) borrowing limit. The return on the liquid asset $r_t^{HH}(a_t)$ depends on whether the household holds deposits ($a_t \geq 0$) or is a borrower ($a_t < 0$):

$$1 + r_t^{HH}(a_t) = \begin{cases} 1 + r_t^D & \text{if } a_t \geq 0 \\ 1 + r_t^L + \tau & \text{if } a_t < 0 \end{cases} \tag{17}$$

[14] As in Bayer *et al.* (2019), households can transition into and out of the capitalist state. We detail this process in Section 4, when we describe the model's quantitative implementation.

Here $\tau > 0$ is a proportional transaction cost of issuing a loan, which is treated as a deadweight loss. The return to capital less the replacement cost of depreciation is credited to households' liquid account; i.e., the liquidity friction only applies to households' stock of capital. Value functions are indexed by t as they depend on prices, which might fluctuate over time.

If households instead chose to incur the utility costs of adjusting, they can select any positive value of k_{t+1}. With all notation as above, their problem is given by

$$V_t^a(a_t, k_t, z_t) = \max_{c_t \geq 0, a_{t+1} \geq \underline{a}, k_{t+1} \geq 0} \left\{ u(c_t) + \beta \mathbb{E}_t V_{t+1}(a_{t+1}, k_{t+1}, z_{t+1}) \right\} \tag{18}$$

$$\text{s.t. } c_t + a_{t+1} + q_t k_{t+1} \leq (1 + r_t^{HH}(a_t))a_t + ((1-\delta)q_t + r_t^K)k_t + w_t z_t + \mathbb{I}_{z_t = z^*} div_t. \tag{19}$$

The value function of a household after the revelation of its current labor productivity z_t and portfolio adjustment cost draw θ_t is given by

$$V_t(a_t, k_t, z_t, \theta_t) = \max\{V_t^a(a_t, k_t, z_t) - \theta_t, V_t^n(a_t, k_t, z_t)\}. \tag{20}$$

Here the max operator summarizes households' decision of whether or not to adjust their portfolios. Before the current draw for adjustment costs is revealed, the probability of adjusting conditional on state (a, k, z) is hence given by

$$F_\theta\left(V_t^a(a_t, k_t, z_t) - V_t^n(a_t, k_t, z_t)\right),$$

where F_θ is the CDF of the logistic distribution.

The framework with capital holdings subject to illiquidity frictions at the household level provides an explicit microfoundation for why households are willing to hold capital indirectly through banks. The adjustment friction paired with idiosyncratic income risk makes the liquidity provided by holding deposits valuable to households. Contrary to models featuring banks and representative households, there is no need to abstract from households' ability to invest in capital directly in order to allow for a wedge between deposit rates and the return on capital. In fact, households in our model economy—as in the data—hold both deposits and capital simultaneously.

3.4 Market Clearing

Market clearing requires that the quantities chosen by bankers align with households' choices of the liquid asset such that

$$L_{t+1} = \sum_{(a_t,k_t,z_t)} \mathbb{I}_{a_{t+1}(a_t,k_t,z_t)<0} \left(-a_{t+1}(a_t,k_t,z_t)\right) \lambda_t(a_t,k_t,z_t) \tag{21}$$

$$D_{t+1} = \sum_{(a_t,k_t,z_t)} \mathbb{I}_{a_{t+1}(a_t,k_t,z_t)\geq 0} \; a_{t+1}(a_t,k_t,z_t)\lambda_t(a_t,k_t,z_t). \tag{22}$$

In addition, aggregate capital holdings of households are given by

$$K^{HH}_{t+1} = \sum_{(a_t,k_t,z_t)} k_{t+1}(a_t,k_t,z_t)\lambda_t(a_t,k_t,z_t). \tag{23}$$

Total efficiency units of capital demanded have to equal total capital supplied such that

$$K_t = \xi^B_t K^B_t + K^{HH}_t, \tag{24}$$

where capital supplied by bankers is adjusted for the capital productivity shock ξ^B_t. Additionally, the law of motion for total capital in the economy has to be consistent with the investment choices of capital-producing firms,

$$K^{HH}_{t+1} + K^B_{t+1} = I_t + (1-\delta)(K^{HH}_t + K^B_t). \tag{25}$$

Market clearing in the goods market requires

$$C_t + I_t + \Xi_t = Y_t, \tag{26}$$

where Ξ_t consists of a series of deadweight losses from the cost of capital adjustment and loan issuance given by

$$\Xi_t = \frac{\phi_K}{2}\left(\frac{I_t}{K_{ss}} - \delta\right)^2 K_{ss} + \tau L_t. \tag{27}$$

Finally, as households inelastically supply z_t effective labor units, labor market clearing is given by

$$N_t = \sum_{(a_t,k_t,z_t)} z_t\lambda_t(a_t,k_t,z_t). \tag{28}$$

We define an equilibrium in the economy formally in Appendix B.

4 Quantitative Implementation

In this section, we outline our quantitative implementation of the model. We start by describing the solution method, and we then discuss the calibration strategy and quantitative fit of the model.

4.1 Solution Method

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.[15] 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 $a = 0$.

Beyond the market clearing conditions (equations (21)–(26)), computing the steady state involves satisfying both the banker's leverage constraint and consistency in the implied dividends. We iterate on r^D and on div^B using a quasi-Newton method, extracting the remaining equilibrium prices from firms' and bankers' optimality conditions, until a fixed point is achieved.

As our setup for the banking sector features the standard financial accelerator, we solve

[15] This 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 test our solutions for concavity and find it to be preserved both in the steady state and along all transition paths for our calibration.

for transitional dynamics of the economy exactly to account for nonlinearities in response to aggregate shocks.[16] We begin by selecting a horizon T, after which we assume the economy has returned to its steady state. We set $T = 1000$. We then guess a path of endogenous variables, compute the deviations from the equilibrium conditions at each $t = \{1, 2, ..., 1000\}$, and iterate on the endogenous variables until all equilibrium conditions are satisfied. We obtain an update for the path of endogenous variables again 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).

4.2 Calibration

We assume a model period corresponds to one quarter. For the calibration we proceed in two steps: First, we set a range of parameters to values commonly used in the literature. We assume CRRA utility such that $u(c) = \frac{c^{1-\sigma}}{1-\sigma}$, and we set $\sigma = 2$. Furthermore, we set the capital share to $\alpha = 0.33$ and the capital adjustment cost to $\phi_K = 40$, in line with the elasticity of investment with respect to the price of capital reported in Gertler and Karadi (2011). Similarly to Kaplan *et al.* (2018), we set households' borrowing limit $\underline{a}$ to average quarterly earnings, which we normalize to 1 by scaling households' labor productivity process.

Earnings Process. The process for idiosyncratic income is split into two components: The first is a process for *workers'* idiosyncratic labor productivity z. This process is crucial in determining households' incentives to hold each type of asset. Households subject to high earnings risk tend to hold a relatively larger portion of liquid assets in their portfolio to insure against the risk of negative income realizations. To capture this important channel and match the rich earnings dynamics present in the data as precisely as possible, we assume that labor productivity follows an AR(1) process with innovations consisting of a mixture of normal distributions, given by

$$\log(z_t) = \rho \log(z_{t-1}) + \varepsilon_t,$$

[16] For instance, a shock with 50 percent of the magnitude of our baseline shock produces a 60 percent lower initial decline in bank equity.

with

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

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

Our baseline calibration 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). The moments are computed from the PSID waves for 1962 to 1992, restricting attention to households whose head is aged between twenty-five and sixty.[17] Household-level earnings are adjusted by year fixed effects, as well as family size.[18]

The model-implied moments are obtained by simulating the evolution of quarterly earnings for a panel of workers and aggregating them to annual frequency. We are able to match all five targets precisely with implied parameter values $\rho = 0.963$, $\sigma_1 = 0.50$, $\sigma_2 = 0.01$, $p = 0.156$, $\mu_1 = -0.105$, and $\mu_2 = 0.019$. We discretize the workers' labor productivity on a grid with eleven earnings states, using the algorithm introduced in Farmer and Toda (2017). Table 2 summarizes the results of the earnings process calibration.

For the second component of idiosyncratic income, we assume the existence of a *capitalist* state at the top of the discretized labor productivity process. Households under this category are the claimants to all dividends in the economy.[19] 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

[17] The PSID provides annual data only up until 1992 and was adjusted to lower frequency afterward.

[18] 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.

[19] Castaneda *et al.* (2003) were the first to introduce a top earner state to account for US income and wealth inequality. Distributing dividends at the top of the income distribution is in line with Bayer *et al.* (2019), whose calibration strategy we follow.

Table 2: 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 are computed with annual log earnings using the PSID waves from 1962 to 1992, restricted to households whose head is of age twenty-five to sixty. Associated parameter values are $\rho = 0.963$, $\sigma_1 = 0.50$, $\sigma_2 = 0.01$, $p = 0.156$, $\mu_1 = -0.105$, and $\mu_2 = 0.019$.

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. In a second step, the remaining parameters (δ, β, τ, μ, β_B, χ, $\mu_\theta, \sigma_\theta$) are calibrated internally. We target an annual $\frac{K}{Y}$ ratio 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 percent, and the wedge between deposits and lending rates is calibrated to $r^L - r^D = 2$ percent annually, in line with the results of Philippon (2015) on the returns to intermediation. We target an (annual) $\frac{L}{Y}$ ratio of 3 percent, as in Kaplan *et al.* (2018), as well as a $\frac{D}{Y}$ ratio of 0.4 and $\frac{K^B}{Y}$ ratio of 0.6 to match data on deposit-taking institutions' balance sheets from the Federal Reserve Board's data table H.8 for 2004. In addition, we target a Gini coefficient for net wealth of 0.8 from the 2004 wave of the Survey of Consumer Finances (SCF).[20]

Even though the internal calibration procedure identifies all parameters jointly, each one is more closely related to some of the targets. The depreciation rate is immediately pinned down from the intermediate producer's capital demand in combination with bankers' arbitrage

[20]The Gini coefficient for net worth is computed based on households with positive net worth both in the data and in the model.

conditions, given our targets for capital-to-output ratio and r^L. The household discount factor β regulates the overall desire to save and thus is identified by the deposit-to-output ratio, given a target for r^D. The parameter μ regulates the relative share of profits in the economy. A higher μ increases the dividend income of capitalist households and by consequence their equilibrium wealth as well as the degree of wealth inequality in the economy. The patience of bank managers affects their required equilibrium return on equity. The latter is determined by the lending spread, thus identifying β_B. The parameter χ is selected to ensure that the banker's leverage constraint (13) holds with equality, given our targets for deposits, consumer loans, banker's capital, and interest rates. The parameter τ affects the cost of consumer credit and thus is identified by total borrowing in the economy. The parameter μ_θ regulates the cost of adjusting capital holdings, which ultimately determines total demand for capital by households, thus strongly affecting $\frac{K^{HH}}{K} = 1 - \frac{K^B}{K}$. We are left with the parameter σ_θ, which regulates the dispersion in households' probability of adjusting their capital holdings. Since empirical evidence on this moment is scarce, we set $\sigma_\theta = 4$ but ensure that our results are not driven by this choice by repeating our main counterfactual with different values of σ_θ.[21] We find reasonable variations on this parameter to be inconsequential for our results.

The data moments and their model counterparts, as well as the complete set of parameter values, are reported in Table 3.

[21] Bayer *et al.* (2019) use a value of $\sigma_\theta = 22,500$, achieved by targeting the second quintile of portfolio liquidity. In practice, we find that σ_θ has little influence over that moment in the model, which motivates our decision to set it exogenously.

Table 3: 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	$\chi = 0.6318$	Fed H.8 2004
(Liquid) Debt-to-Output $\frac{L}{Y}$	3%	3%	$\tau = 1.23\%$	Fed H.8 2004
Bank Investment-to-Output $\frac{K^B}{Y}$	0.60	0.60	$\mu_\theta = 5.453$	Fed H.8 2004
Annual r^D	2%	2%	$\beta = 0.9676$	Annualized 3M Tbill rate
Annual Spread $(r^L - r^D)$	2%	2%	$\beta_B = 0.9816$	Philippon (2015)
Net-Worth Gini	0.80	0.80	$\mu = 1.122$	SCF 2004
Risk Aversion			$\sigma = 2$	see text
Capital Share			$\alpha = 0.33$	see text
K Adjustment Cost			$\phi_K = 40$	Gertler and Karadi (2011)
Borrowing Limit			$\underline{a} = -1$	Kaplan *et al.* (2018)
P(Entering Star Earner)			$\nu^i = 0.025$	1% of households are capitalists
P(Quitting Star Earner)			$\nu^o = 0.0625$	Guvenen *et al.* (2021), Bayer *et al.* (2019)
Dispersion of Adjustment Cost			$\sigma_\theta = 4$	see text

Notes: The first block of parameters is calibrated internally by matching the reported data targets. The second block of parameters is set externally. See text for explanations.

Model Validation. Table 4 compares untargeted distributional statistics in the model with their data counterparts. All wealth data are from the 2004 wave of the Survey of Consumer Finances, while income data are obtained from the Congressional Budget Office. We define liquid wealth as the sum of checking, savings, and money market accounts net of credit card debt. We then compute illiquid assets residually by subtracting liquid assets from net worth.[22] Income is defined as total after-tax household income, including labor earnings and business and financial income. The first two sets of columns refer respectively to the quintile shares of the distribution of liquid assets and total net worth, and the last two columns report the distribution of income. Recall that the only moments of the wealth distribution that we target in the calibration are the Gini coefficient of net worth as well as the aggregate amount of debt, deposits, and capital held by households, while for income we only target moments of the distribution of labor earnings (growth).

The calibration does a very good job in matching not only the distribution of overall net worth, but also the quintile shares of the distribution of liquid asset holdings. In addition, it matches almost exactly the bottom-quintile share of liquid assets, as well as the share of

[22]Consistent with our definition of deposits, we do not include bonds and stocks as liquid assets. In computing the moments in the data we only keep households whose head is aged between twenty-five and sixty-five.

Table 4: Moments of the Wealth Distribution—Model vs. Data

	Liquid		**Net Worth**		**Total Income**	
	Model (1)	Data (2)	Model (3)	Data (4)	Model (5)	Data (6)
Q1	-7.9	-7.7	-0.8	-0.2	4.0	7.0
Q2	0.1	0.0	1.6	1.1	8.9	10.5
Q3	4.0	1.4	5.3	4.2	13.8	14.9
Q4	11.9	7.9	11.9	11.5	20.1	20.8
Q5	91.9	98.5	82.1	83.3	53.11	47.7

Notes: Data for columns 1–4 come from the 2004 wave of the Survey of Consumer Finances. Data for columns 5–6 come from the Congressional Budget Office, (The Distribution of Household Income, publication no. 56575). Quintile shares are for 2004.

households with negative liquid holdings—25.5 percent in the model versus 25.2 percent in the data (not reported in Table 4). Matching these two moments is important in capturing households' exposure to changes in lending rates. The model can also match the substantial degree of concentration in liquid assets (columns 1–2) and each of the five shares of the distribution of net worth (columns 3–4). Finally, columns 5–6 show that it also does well in capturing the distribution of total after-tax household income (including both labor earnings and financial returns).

To evaluate the joint distribution of liquid and illiquid assets, Figure 5 plots the average portfolio composition for distinct quintiles of the distribution of net worth. We are able to capture the general pattern of portfolio composition in the data, especially for the bottom quintile. Low-net-worth individuals hold a lower share of their savings in the form of illiquid assets. Yet we understate 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, instead of households'.[23]

[23]Our choice is conservative for the analysis we conduct, as 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.

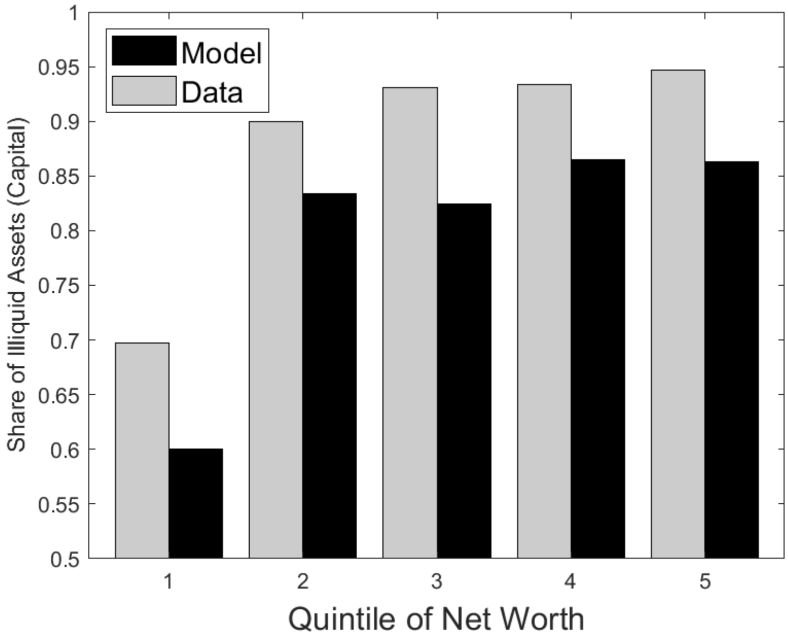


Figure 5: Portfolio Composition by Quintile of Net Worth

Notes: Data come from the Survey of Consumer Finances in 2004 and authors' own calculations. Both model and data samples are restricted to households with strictly positive net worth. Furthermore, the model sample is restricted to households with non-negative liquid assets, and (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 total net worth.

5 Quantitative Results

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' capital productivity ξ_t^B, reverting back to its steady state value of 1 at rate ρ_ξ. Specifically, we assume

$$\xi_t^B = \begin{cases} \epsilon \text{ if } t = 1 \\ (1-\rho_B) + \rho_\xi \xi_{t-1}^B \text{ if } t > 1. \end{cases}$$

We calibrate ϵ and ρ_ξ to jointly generate an initial decline in bank equity corresponding to the fifth percentile of empirical bank equity returns and the twelve-quarter cumulative consumption response to a shock of that magnitude.[24] This corresponds to a roughly 20 percent decline in initial bank equity and a cumulative decline of 8.6 percent in aggregate consumption. The implied parameter values are $\epsilon = 0.5$ and $\rho_\xi = 0.72$.

Note that only the banking sector is directly exposed to this shock. Its impact on households works entirely through the general-equilibrium responses of market prices, interest rates, and dividends. Our analysis thus isolates the distributive effects of banking sector losses. In complex advanced economies, households might be directly exposed to the same sources of disturbances as the banking sector, with reinforcing or mitigating effects in addition to those highlighted below. We abstract from this direct exposure to focus on the bank loss channel.

5.1 Aggregate Responses

We begin by reporting the dynamics of macroeconomic aggregates. Figure 6 reports responses of the components of banks' balance sheet. On impact, the shock causes a surprise loss to bankers' beginning-of-period net worth. In response, banks have to reduce the size of their balance sheet and increase the cost of borrowing r^L sharply while reducing the interest paid on deposits r^D, causing a decline both in deposits D and in banks' claims on productive capital K^B (movements in prices are shown in Figure 8). Despite an increase in the cost of borrowing, household loans L increase, driven by households' desire to smooth consumption over time.

Figure 7 reports the dynamics of aggregates in the real economy. As banks are forced to reduce their balance sheet, investment falls in response to the shock and in consequence so does the aggregate capital stock in the economy. The decline in the demand for investment leads to a sharp drop in the price of capital, as seen in Figure 8. Investment falls by less than the capital held by the banking sector, as households' aggregate capital holdings increase in response to capital's lower price and ensuing high returns going forward. Since the value of banks' assets depends on the price of capital, a decline in q further constrains banks' intermediation capacity, amplifying the decline in investment and the increase in spreads.[25] Finally, aggregate output declines, both because the shock leads to a fall in the effective units of capital available for

[24]We rescale the impulse response reported in the bottom-right panel of Figure 1 by a factor of 1.74, as the fifth percentile of bank returns (r^B) corresponds to 1.74 standard deviations.

[25]This is the standard financial accelerator mechanism (Gertler and Kiyotaki, 2010).

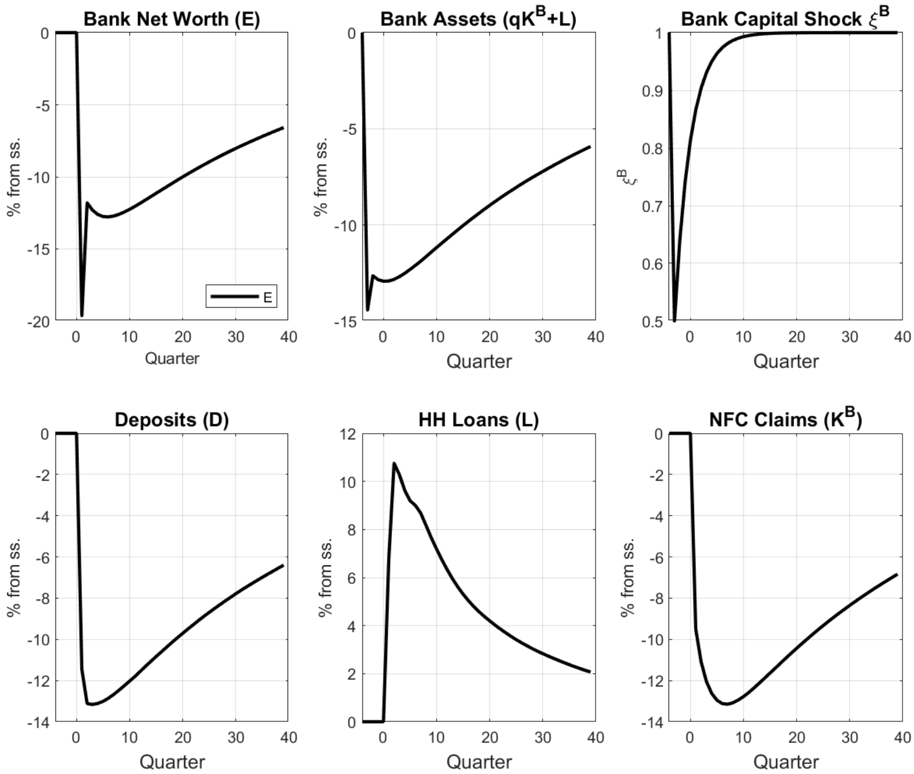


Figure 6: Dynamics of Banks' Balance Sheet

Note: Responses of components of banks' balance sheet. The shock is plotted in the top-right panel.

production and because of the reduction in investment activity, and aggregate consumption falls, albeit by less than output and investment.

Figure 8 shows the effects of the shock on interest rates, prices, and dividends. As mentioned, on impact the interest charged on borrowing (r^L) increases and the return on deposits r^D falls as the leverage constraint tightens and banks reduce their balance sheet. r^D increases shortly afterward as banks have to compete with a now-higher return on holding capital R^K, defined as $R_t^k \equiv \frac{r_t^K+(1-\delta)q_t}{q_{t-1}} - 1$, in order to collect deposits. These higher returns on capital are partly driven by an increase in the marginal product of capital r^K, as capital effectively becomes scarcer, and partly driven by capital gains from an increasing price of capital q as it recovers from its sharp drop. Dividends experience a steep decline, driven by both the decline in output and the reduction in proceeds from banks' intermediation. Finally, wages decrease as the

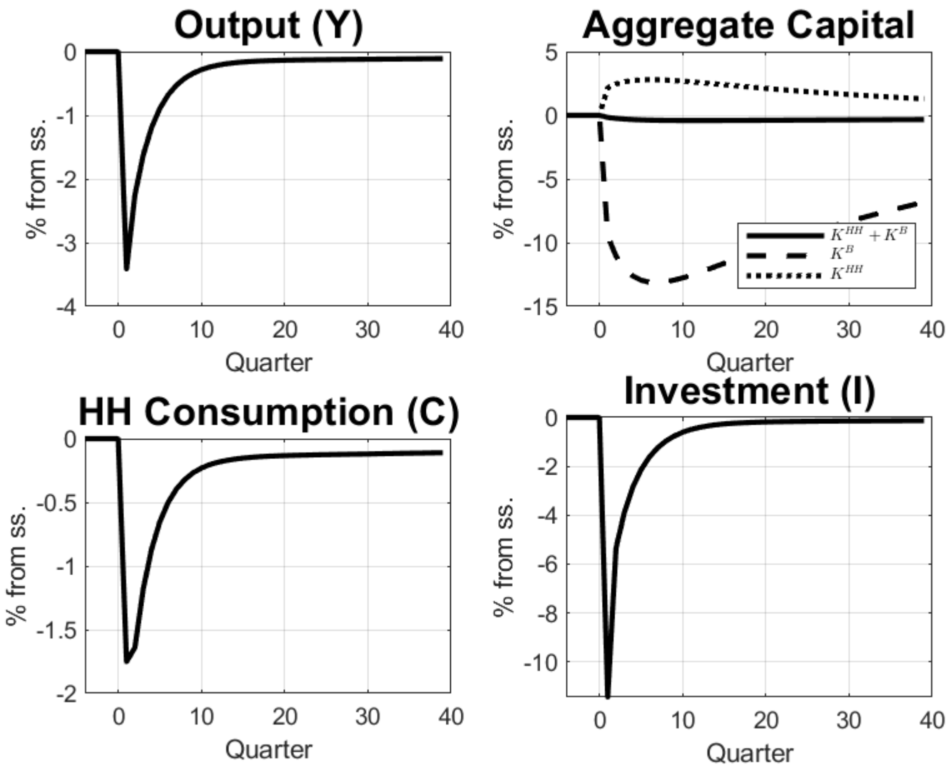


Figure 7: Dynamics of Macroeconomic Aggregates

Note: Responses of macroeconomic aggregates to the shock on banks' asset returns. All variables reported in percentage deviation from their respective steady-state levels.

marginal productivity of labor falls with the capital stock.

5.2 The Distributive Implications of Banking Sector Losses

In Section 2, we showed that in the data households at different income levels react heterogeneously to bank losses. To relate our model to these results, Figure 9 reports the model-implied consumption responses by quintile of total (labor and financial) income, as well as aggregate consumption in the bottom right.[26]

[26]To compute the impulse responses by income quintile, we follow households belonging to each group over time and compare their realized path of consumption to the counterfactual scenario in which the shock never materializes. For each state triplet we compute the expected value of consumption over time in the steady state and in the case of the shock. We then take the relative difference between these two series and aggregate within each group using the steady-state distribution over idiosyncratic states. This is equivalent to following a large panel of households over time.

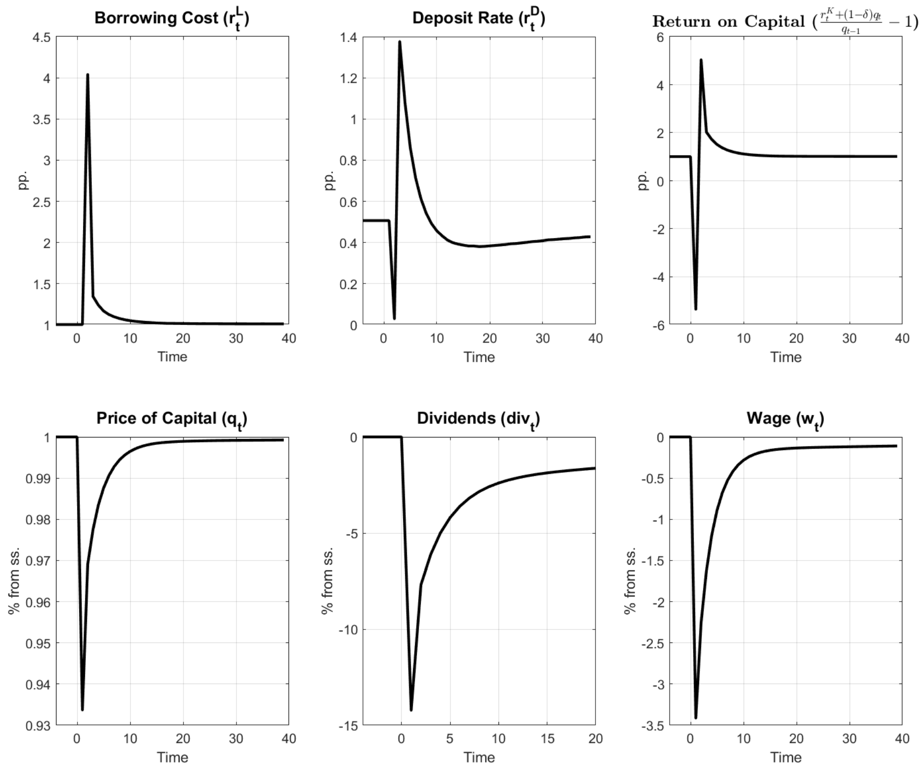


Figure 8: Dynamics of Equilibrium Prices

Note: Model-implied general equilibrium responses of prices. The top three panels are measured in percentage points. The three bottom panels consist of percent deviations from their respective steady-state values. The return on capital is defined as $R_t^k \equiv \frac{r_t^K+(1-\delta)q_t}{q_{t-1}} - 1$

The heterogeneous responses along the income distribution align well with our empirical results: First, while consumption of all income groups declines on impact and gradually recovers from the shock, households in the lowest income quintile experience the largest decline. In addition, over the upper half of the income distribution, consumption responses resemble each other when measured against steady-state consumption levels, similarly to our findings in Section 2. Finally, our model can also account for the quantitative magnitude of differences in consumption responses in the data. Figure 10 compares the model-implied cumulative impulse responses with their empirical counterparts.[27] The overall magnitude of the cumulative decline

[27] In this figure, we rescale the impulse responses shown in Figure 1 to match the size of the shock in the model.

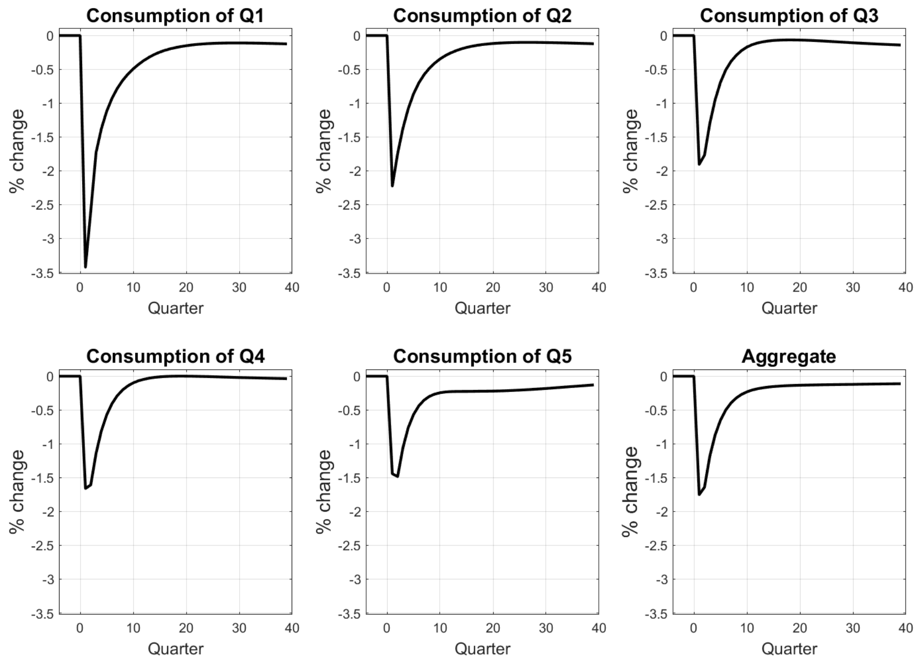


Figure 9: Consumption Responses by Income Quintile

Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of the shock. Income quintiles sorted based on total income in the steady state, including earnings, interest received, and dividends.

aligns well in each of the six panels.

Having matched the empirical patterns of consumption responses along the income distribution, we now investigate how consumption responses translate into changes in households' welfare as well as which transmission channels explain the heterogeneity displayed in Figures 1, 9, and 10.

Measuring Welfare Changes. To measure the welfare implications of banking sector losses, we compute households' expected value functions immediately after the shock is realized and compare them with the respective values in steady state. To express welfare changes as consumption equivalence units, we follow Bayer *et al.* (2019) and normalize the difference by the expected value of the discounted consumption stream for each household state triplet.[28]

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

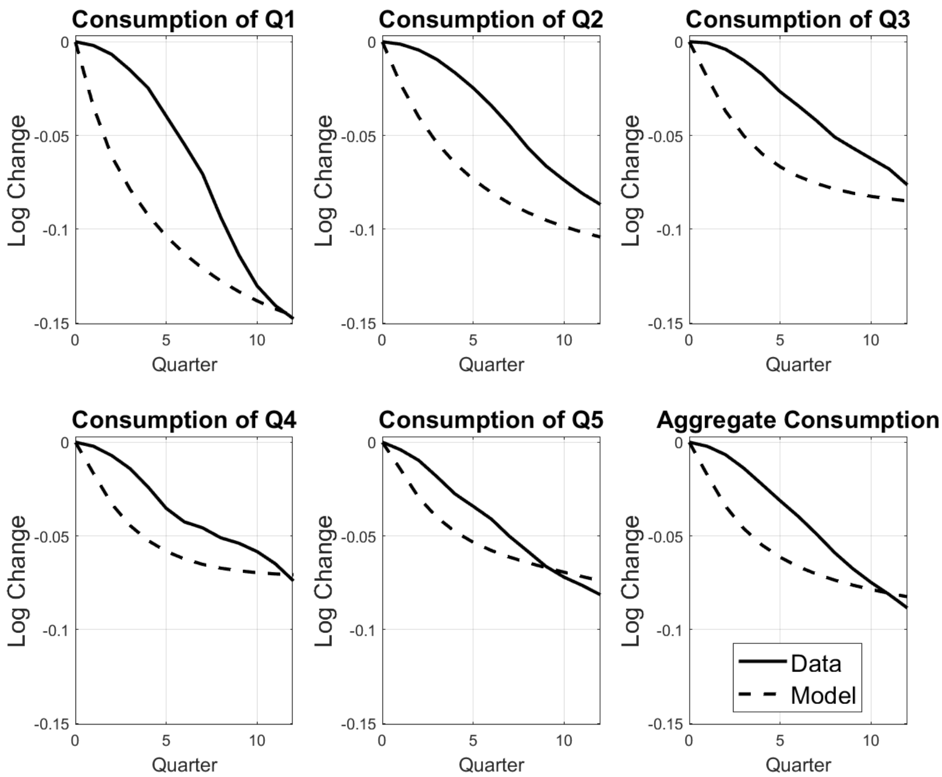


Figure 10: Consumption Responses by Income Quintile—Model vs. Data

Note: Model- and data-implied consumption responses. The former are obtained by rescaling the responses in Figure 1 by a factor of 1.72 to match the shock size in the model. The model- and data-implied responses are represented as log deviations from steady state.

This allows us to interpret changes in welfare as the fraction of consumption a household would be willing to forgo permanently to avoid the consequences of the shock and have the economy remain in steady state.

In percentage terms, the consumption-equivalent (CE) measure is calculated as follows:

$$CE(a,k,z) = 100 \times \left[\left(\frac{V_1(a,k,z) - V^{ss}(a,k,z)}{\mathbb{E}U(a,k,z)} + 1 \right)^{\frac{1}{1-\sigma}} - 1 \right]. \tag{29}$$

Here,

$$\mathbb{E}U(a,k,z) = \mathbb{E} \sum_{t=0}^{\infty} \beta^t u(c_t^{ss}(a,k,z)).$$

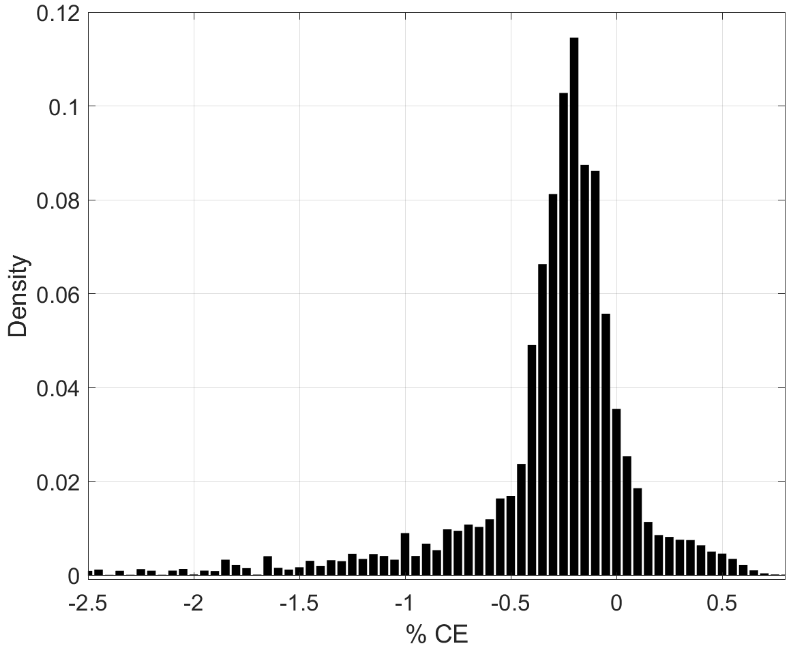


Figure 11: Distribution of Welfare Changes
Note: Distribution of welfare changes, measured in consumption equivalent units, as in equation 29.

In the expressions above, V_1 and V^{ss} refer respectively to households' associated value functions after the shock hits and in steady state respectively. In addition, $\mathbb{E}U(a, k, z)$ is the expected discounted utility from consumption in the steady state.

Distribution of Welfare Changes. Figure (11) represents the distribution of welfare changes as computed by equation 29. The figure has two main takeaways: First, there is considerable heterogeneity in welfare changes. Second, even though the distribution is centered around a negative value—the average CE change is -0.39 percent—11 percent of households exhibit a positive change in welfare and are actually better off in the presence of the bank shock.

Table 5 compares households who are worse off following the shock with those who benefit from it. Relative to the former group, individuals who experience a positive welfare change are more productive, wealthier, more dependent on income from financial sources, and have a more liquid portfolio.

Table 5: Characteristics of Gainers and Losers from Bank Losses

	Negative CE	Positive CE
Average Liquid Assets	0.41	5.7
Average Capital Holdings	0.4	3.9
Average Earnings	0.98	1.14
Average (Total) Income	0.94	1.44
Average Portfolio Liquidity	0.98	1.12
Dependence on Labor Income	95%	62%

Note: "Dependence on labor income" refers to the average share of earnings in households' total income. With the exception of the last row, numbers are displayed as a multiple of economy-wide averages.

Table C.1 in the appendix shows the breakdown of household characteristics for quintiles of the distribution of welfare changes. Overall, the conclusions are the same as those from Table 5: losses are decreasing in wealth, earnings, and portfolio liquidity and increasing in households' reliance on labor income. Before we investigate the mechanisms behind these results, we turn our attention to heterogeneity in welfare changes along the income distribution and how they compare to the observed consumption responses.

Welfare Changes along the Income Distribution. Figure 12 shows that the changes in welfare caused by the shock are more unevenly distributed than those of consumption. For welfare (black bars), there is a clear monotonic pattern with households at the bottom of the income distribution suffering the largest welfare losses. While agents in the first quintile (Q1) would be willing to permanently forfeit 1 percent of their consumption to avoid the consequences of the shock, households at the top would give up only 0.08 percent. On the other hand, the inequality in initial consumption responses is not nearly as pronounced: while the total decline for Q1 is 14.7 percent, for the fifth quintile (Q5) it is 7.4 percent.

Transmission Mechanisms. What mechanisms explain the patterns in Figure 12? Why do the rich suffer much less than what their initial consumption response suggests? How can a considerable fraction of households gain from a negative shock to the economy? To examine these questions, following Kaplan *et al.* (2018), we decompose the general-equilibrium responses of consumption and welfare into their partial-equilibrium changes due to movements in different

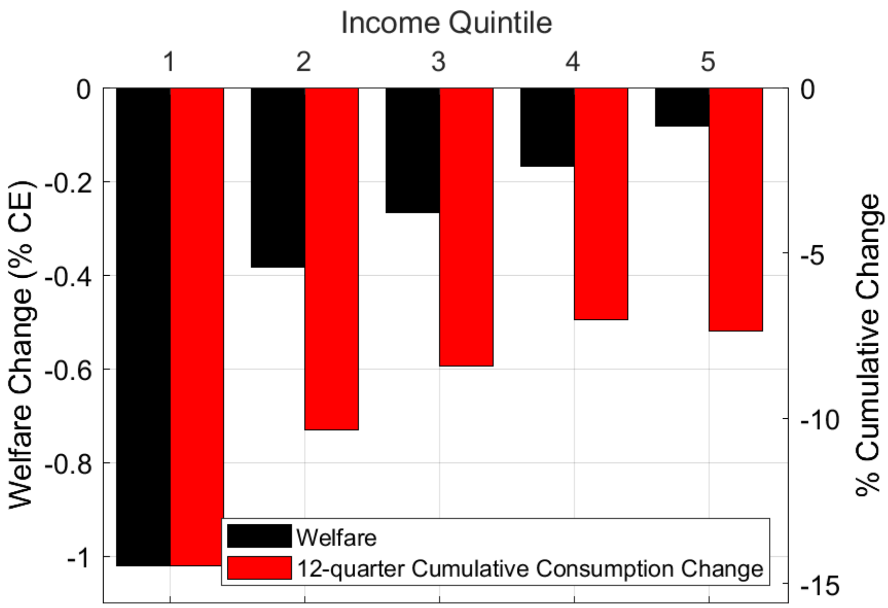


Figure 12: Welfare and Consumption Changes by Income Quintile

Note: Welfare changes, whose scale is on the left y-axis, are computed according to equation (29) and aggregated within each income quintile. The twelve-quarter cumulative consumption changes are measured on the right y-axis.

prices, interest rates, and dividends. We compute counterfactuals in which we change *only* (i) labor earnings (w_t), (ii) the cost of borrowing (r_t^L), or (iii) financial income (r_t^D, R_t^K, and div_t jointly) to their realized general-equilibrium path and keep all other prices, rates, and dividends at their steady-state level.

Figure 13 decomposes the welfare changes by income quintile into these three 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 more than half 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, although all quintiles are substantially affected by changes in wages, those at the bottom are once again more exposed to wage variation. This is due both to their inability to insure against income shocks and to the fact that wages account for a larger proportion of household income for them. Financial variables, on the other hand, display a positive contribution for all

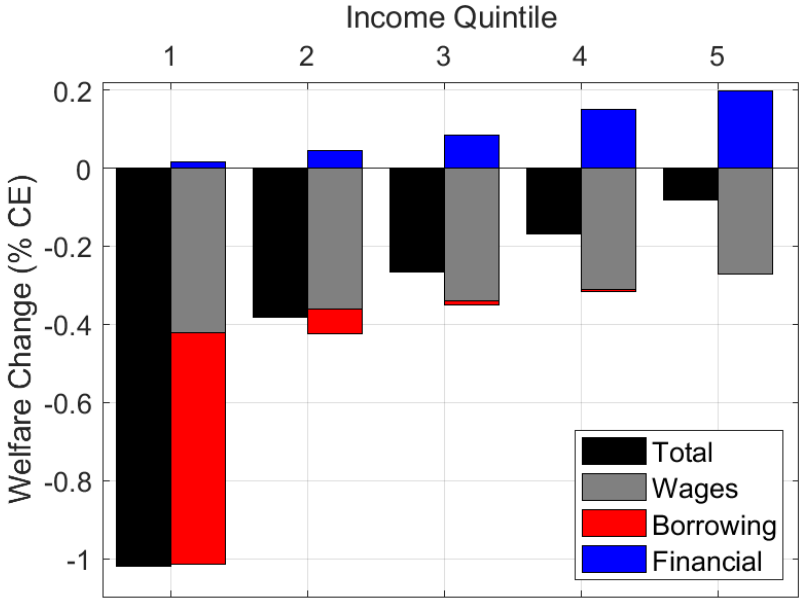


Figure 13: Decomposition of Welfare Changes by Income Quintile

Note: Decomposition of welfare changes due to wages $\{w_t\}_{t=0}^T$, the lending rate $\{r_t^L\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$). The black bar represents the general-equilibrium welfare changes, replicating Figure 12. Each of the gray and colored bars is obtained by simulating the economy in response to the general-equilibrium path of one variable (or all four, in the case of financial variables).

the quintiles, with welfare gains increasing in household income.[29]

Figure 14 shows the consumption counterpart to the decomposition described above. In line with the decomposition for welfare, consumption at the bottom is mostly affected by the cost of borrowing and by labor income, while these channels have a limited impact on consumption at the top.

Financial income, on the other hand, plays a lesser role for the consumption responses of low-income households but increases in importance the further we move up the income distribution. Note that in response to movements in financial variables, households initially reduce their consumption. In the future, however, consumption overshoots for all quintiles

[29]Capitalists are included throughout, and their income places them in the fifth quintile. Figure C.2 in the appendix presents capitalists, which represent 1 percent of the population, as a separate category. For them, the contribution of financial variables is negative due to the losses in dividends.

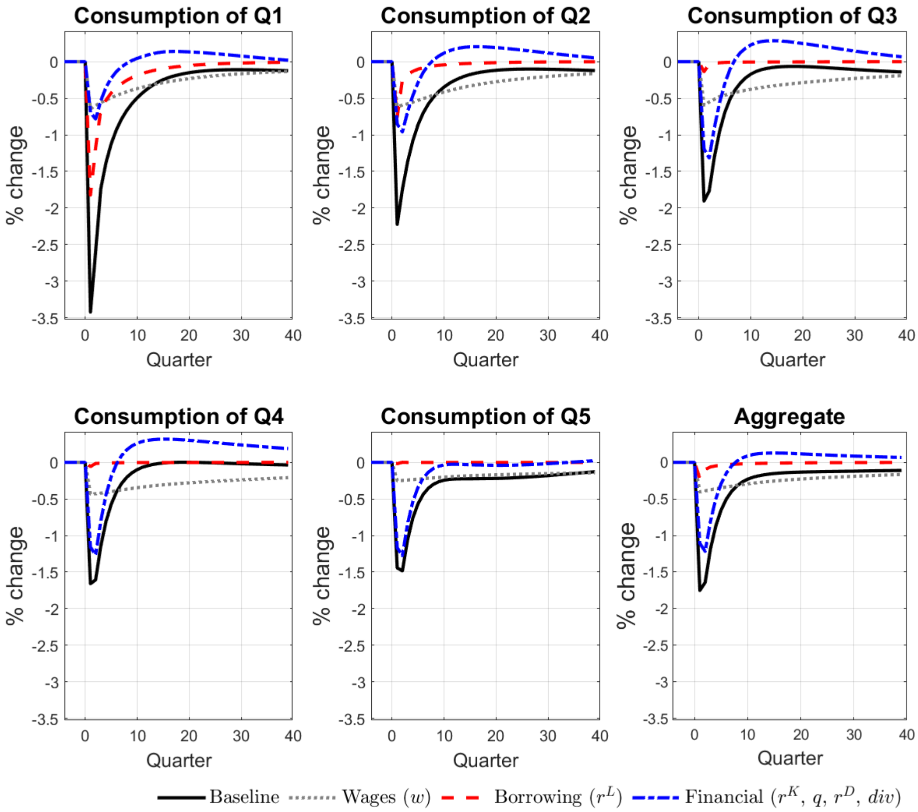


Figure 14: Consumption Decomposition by Income Quintile

Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. Income quintiles are sorted based on total income in steady state, including earnings, interest received, and dividends. Consumption responses are decomposed into partial-equilibrium effects of wages $\{w_t\}_{t=0}^T$, the lending rate $\{r_t^L\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$)

except Q5. As we shall see, this overshooting is behind the positive changes in welfare induced by movements in financial variables.

The Role of Financial Variables. Figure 15 breaks down the financial component of welfare changes into those due to deposit rates r_t^D, the return on holding capital R_t^K, and dividends. The welfare impact of changes in deposit rates is positive for the first two quintiles and negative for the remaining ones. This is due to the initial decline and later overshooting in deposit rates. Households in the two lowest quintiles are largely insulated from the consequences of the initial decrease because they hold little savings and many of them are borrowers. They

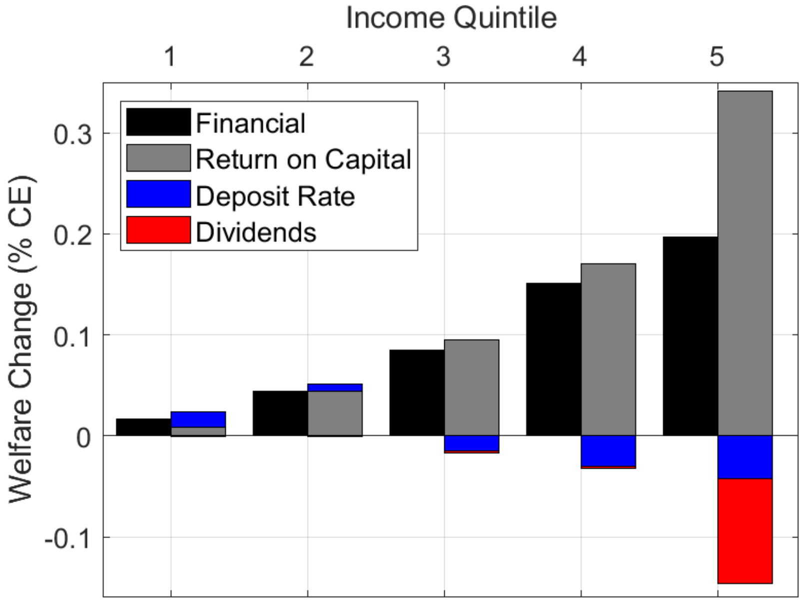


Figure 15: Decomposition of Welfare Changes—Financial Variables

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).

benefit from future increases in r^D because this gives them the opportunity to save at a higher return in the future. In contrast, high-income individuals suffer from movements in r^D. This is because even though their portfolios consist mostly of capital, such households do hold a considerable amount of deposits, exposing them to the initial decline in rates.

Movements in the return on capital, on the other hand, benefit households across the board, and particularly those at the top of the income distribution. High-income households in fact take advantage of movements in the price of capital q_t as well as in the increased return on capital r_t^K and invest to finance higher consumption moving forward. This is clearly seen in Figure 16, where we contrast the general-equilibrium consumption responses with a counterfactual scenario in which the return on savings is kept fixed. In other words, for this counterfactual we fix both the return on holding deposits, r_t^D, and the return on holding capital, given by

$R^k_t \equiv \frac{r^K_t+(1-\delta)q_t}{q_{t-1}} - 1$, at their steady-state values.

Across the entire income distribution, the immediate impact of the shock on consumption is reduced for the case of fixed returns on saving, relative to the general-equilibrium responses. This is because part of the initial decline in consumption is driven by households' increased desire to save when future returns are high. This mechanism becomes more important as we move up the income distribution, as low-income households often want to dis-save or borrow, as illustrated by the difference between the dotted and solid lines on impact ($t = 1$), which is largest for Q5 and smallest for Q1.

While changes in the return on savings have a very limited effect on low-income households' future consumption, they have important consequences for those at the top. This can be seen from the difference between the two lines for high-income households: absent changes in returns to savings, their consumption would be substantially lower in the medium term. In other words, high-income individuals take advantage of the movements in financial variables and save more on impact to sustain a relatively higher future consumption.

Finally, returning to Figure 15, we see that the decline in dividends imposes a direct income loss to some households at the top of the distribution—the capitalists. Movements in dividends explain why the consumption response to financial variables by households in Q5 (Figure 14) does not overshoot as it does for the other quintiles. The reduction in dividends persists for some time (see Figure 8) as long as both output and banks' net worth are suppressed, which contributes to lower consumption in Q5 in response to financial variables. Note that, on average, high-income agents still benefit from movements in financial markets, even though some of them are hurt by a drop in dividends.

Heterogeneity along the Distribution of Net Worth. Table 6 compares changes in welfare across quintiles of income and net worth. Net worth is defined as the sum of capital, liquid assets, and the net present value of the stream of dividends.[30] Welfare falls even more for the bottom quintile of the distribution, if sorted by net worth instead of income. This is because these households are mostly borrowers and therefore exposed to variations in r^L. Heterogeneity across the other quintiles of the net-worth distribution closely resembles that of

[30]Figure C.1 displays the responses of consumption by quintile of net worth.

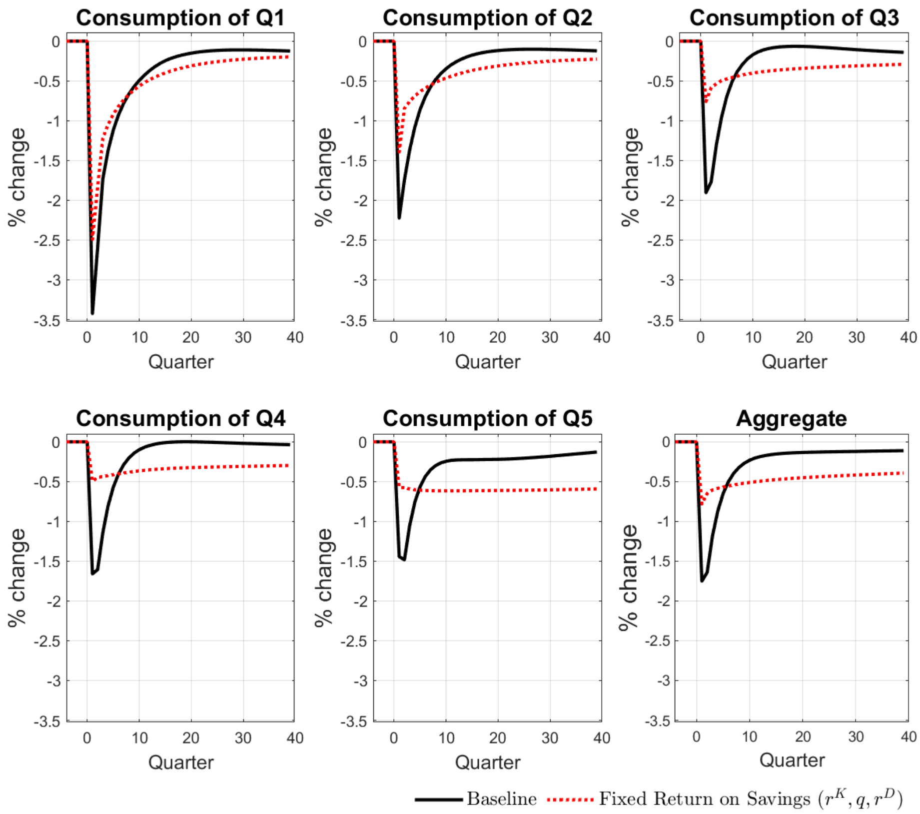


Figure 16: Consumption Decomposition—The Role of Savings Returns

Note: Model-implied consumption responses in general equilibrium (solid line) and partial equilibrium (dotted line). Income quintiles are sorted based on total income in steady state, including earnings, interest received, and dividends. Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. The dotted line shows the partial-equilibrium response to changes *only in* wages, the lending rate, and dividends $(\{w_t, r_t^L, div_t\}_{t=0}^T)$.

the income distribution. Remarkably, those in the top quintile of the distribution of net worth on average benefit from the shock. This once again highlights the role of financial income in helping these households cushion—and in fact take advantage of—disruptions to the banking sector.

Taken together, the results in this section show that disruptions to banks have substantial redistributive consequences. Along with those who hold a direct claim to bank dividends, the ultimate losers from bank losses are low-income households, who are highly exposed to changes

Table 6: Welfare Changes—Heterogeneity

Quintile	Q1	Q2	Q3	Q4	Q5
by Income	-1.021	-0.383	-0.266	-0.167	-0.081
by Net Worth	-1.169	-0.363	-0.239	-0.150	0.012

Notes: Changes in welfare measured in consumption equivalent units, as in equation 29.

in wages and in the lending rate. Rich households, on the other hand, take advantage of movements in returns to savings. Even though these individuals experience a significant decline in consumption on impact, this is compensated by relatively higher future consumption. Thus, the welfare impact of the shock on high-income individuals is small, with some of them even standing to gain from disruptions to the banking sector.

6 Policy Response

In this section we examine which households benefit from policy interventions in response to banking sector losses. We consider an asset purchase program along the lines of the US government's Troubled Asset Relief Program (TARP).[31]

Government. To study policy interventions, we need to introduce a government into the model. We assume that the government can (i) impose a system of taxes and transfers on households and (ii) engage in financial intermediation by issuing debt in form of one-period *liquid* bonds to fund loans to NFCs. The government promises to pay the deposit rate r^D_{t+1} on the bond and earns the market return on holding capital for its loans. Let B_{t+1} be the total value of government-intermediated assets—i.e., the total amount of short-run debt issued to households. At the end of period t, the government then holds claims to K^g_{t+1} units of capital:

$$K^g_{t+1} = \frac{B_{t+1}}{q_t}.$$

[31]TARP was introduced in the Emergency Economic Stabilization Act of 2008 to support the US financial sector in the global financial crisis through purchases or guarantees of distressed assets by the Department of Treasury. Until 2011, about $410 billion was disbursed. The Congressional Budget Office estimates that the government has earned a net profit on its support to financial institutions through TARP during the crisis (CBO, 2021).

As in Gertler and Karadi (2011), the government is not subject to a leverage constraint. Further, we assume that the productivity of government-intermediated capital equals $\xi^G \in [0,1]$. This assumption captures the fact that the government might face higher costs of raising funds or have difficulties in identifying productive projects. We experiment with different values of ξ^G.

Our objective is to derive positive implications concerning a particular credit policy intervention, with a focus on its redistributive effects. For that reason, we consider an exogenously set policy where the government immediately reacts to the shock by issuing $B_2 = \bar{B}$ in the first period of the transition ($t = 1$) and deterministically repays the debt according to

$$B_{t+1} = \rho_b B_t, \ \rho_b \in (0, 1).$$

The government is subject to a budget constraint given by

$$\left\{ \left[\xi^G r_t^k + (1-\delta) q_t\right] K_t^g - (1 + r_t^d) B_t \right\} = \mathcal{T}_t.$$

The left-hand-side term consists of the excess return on intermediation (in braces) and (ii) transfers $\mathcal{T}_t$. So long as bankers' leverage constraint binds—which is the case throughout our simulations—the government actually makes positive revenues from intermediation, which are transferred back to other economic agents; hence the term $\mathcal{T}_t$. The way in which these resources are rebated matters for the redistributive consequences of the proposed credit policy. For this reason, we consider three distinct possibilities: (i) a lump-sum transfer to all households, (ii) a transfer to all households that is proportional to their total income, and (iii) a transfer to banks.[32] In Appendix C.3 we describe how households' budgets, model aggregation, and equilibrium conditions change when we include the government.

We consider a policy in which in response to the shock the government's intervention is of similar magnitude to TARP—roughly $400 billion, or 10 percent of quarterly GDP. The parameter ρ_b is set to the same value as the autoregressive coefficient of the shock; i.e., the government policy is phased out as the banking sector distress fades. In our baseline specification, proceeds from intermediation are rebated lump sum and $\xi^G = 1$.[33]

[32] The proportional transfer (ii) is meant to capture a reduction in overall tax rates made feasible through profits from intermediation.

[33] In Appendix C.3 we report the results from alternative schemes.

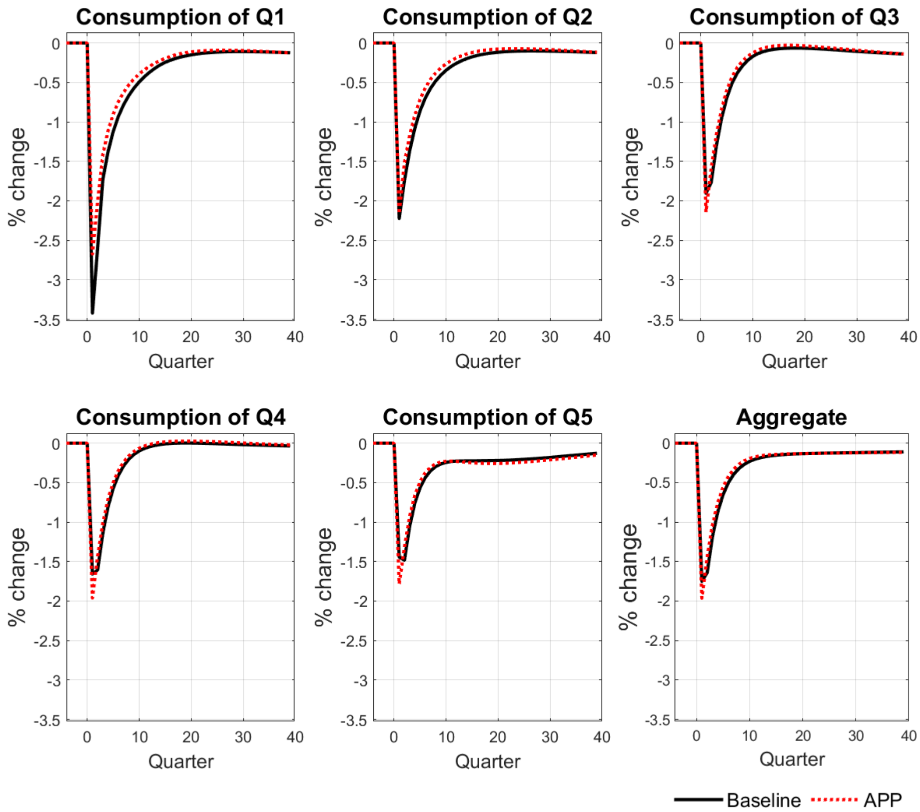


Figure 17: Consumption Responses—Credit Policy

Note: Model-implied consumption responses to the baseline shock, with the policy (red dotted line) and in its absence (black solid line). Income quintiles are sorted based on total income in the steady state, including earnings, interest received, and dividends. Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of the shock.

By absorbing a portion of the demand for liquid assets in the economy, the credit intervention makes it easier for banks to reduce their leverage (see Figure C.15 in the appendix). As a consequence, the equilibrium increase in the spread is lower than it would be absent the policy. This mechanism is responsible for the lower decline in consumption at the bottom of the income distribution, as seen in Figure 17. Furthermore, the increased deposit rate is responsible for a steeper decline in initial consumption for households at the top of the income distribution as well as in the aggregate. The resulting heterogeneity in consumption responses is smaller.

The policy increases the on-impact decline in consumption, which is compensated by higher investment driven by government's capital holdings. This ensures higher future output. As a

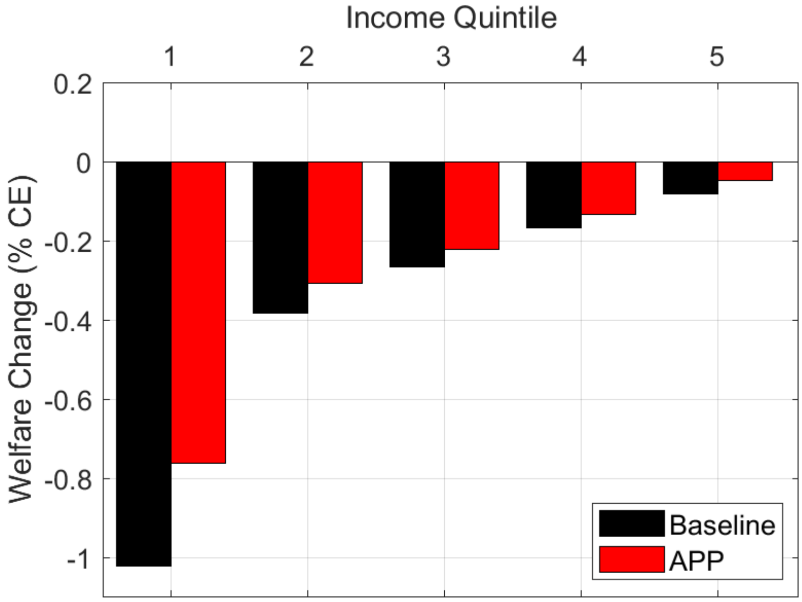


Figure 18: Welfare Changes—Credit Policy

Note: Welfare changes due to shock as in Section 5, with the policy (gray bars) and in its absence (black bars), computed according to equation (29) and aggregated within which income quintile.

consequence, the credit policy reduces the overall welfare losses from banking sector distress by roughly one-fourth (from -0.39 percent to -0.30 percent). The reduction in welfare losses is remarkable, given that the government is unable to counter the decline in banks' capital productivity directly.[34] But it can prevent the consequences of a sudden and severe contraction on bank intermediation and dampen the associated price fluctuations.

As for the distribution of welfare gains from the policy intervention, the impact of the shock is strongly mitigated especially for those at the bottom of the income distribution. The welfare impact of the shock when the credit policy is in place is compared to our baseline results in Figure 18.

Last, the capitalists—claimants to banks' dividends—are worse off after a policy intervention. While this may seem counterintuitive, it is because government-intermediated assets

[34]The reason for the relatively large reduction in the welfare decline is not that government's capital is more productive than banks'. The second row of Table C.4 shows that if the government-financed capital were as productive as the banks', the credit policy would still mitigate a fifth of the welfare consequences of the shock.

crowd out deposits, which causes a reduction in spreads and a slower recovery of banks. This particular result can, however, be overturned under other rebate schemes (see Table C.4 in the appendix).

7 Conclusion

In this paper, we examine the distributive effects of banking sector losses. We document a novel empirical relationship between consumption along the income distribution and conditions in the banking sector: distress in the latter is associated with a stronger consumption response at the bottom of the income distribution. To understand these results, we build a two-asset heterogeneous-agent model featuring banks subject to a leverage constraint. The model is successful in replicating the pattern of heterogeneity observed in the data following a disruption in the banking sector.

We find that the relevant transmission channels vary substantially with income: low-income households suffer from an increase in borrowing cost and a decline in labor earnings; high-income households increase their savings in response to temporarily low asset prices and high future returns to sustain higher consumption in the medium term. This is why we find 11 percent of households to be better off after the shock. These are high-income, wealthy individuals, with a high share of income from financial sources.

Finally, we study the effects of a credit policy intervention aimed at alleviating the impacts of banking sector losses, along the lines of the Troubled Asset Relief Program. The policy reduces the negative welfare effect of bank losses by roughly one-fourth, with gains concentrated among low-income households.

While in this paper we take a positive approach in analyzing government interventions, understanding how the design of optimal policy should account for its redistributive effects is a promising avenue for future research.

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Appendix

A Empirical Appendix

A.1 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 A.1 shows the analogue impulse response for monthly series.
- Figure A.2 shows the IRFs to a similar specification as in equation (1), but with lags for each horizon h and income group i selected independently according to the optimal selection criterion in Akaike (1974).
- In Figure A.3, 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 A.4 and A.5, we restrict our definition of consumption to respectively durable and nondurable goods.

To examine if our results are driven by households' home-ownership status, we follow Cloyne *et al.* (2020) and divide our sample into mortgagors and other households (renters and outright homeowners).[35] Results are displayed in figures A.6 and A.7. A comparison between the bottom-right panels of these two figures does not reveal differences in overall consumption responses by ownership status. Focusing on the response of non-mortgagors (figure A.6) we see that response of Q1 is once again stronger than that of the other households, especially compared to Q3-5. In other words, the main takeaway of our analysis—that households at the

[35] Our definition of income quintiles still refers to the income distribution in the full sample, and not within housing tenure categories.

bottom exhibit a stronger response to bank equity returns—is not driven by the response of mortgagors. In fact, figure A.7 reveals a pattern of heterogeneity that is less pronounced than in our baseline results, with the response of Q1 displaying large error bands. The sample size is particularly small for mortgagors at the bottom quintiles of the income distribution, which leads to the observed loss in precision. This is because mortgagors tend to have higher income than their counterparts. In particular, only 21 percent of households at the bottom of the income distribution are mortgagors, as opposed to 58 percent at the top quintile.

Finally, we analyse the effect of below- and above-median bank returns, plotted respectively in figures A.8 and A.9. We modify specification (1) 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. The aggregate response of consumption is similar in both cases. On the other hand, in the case of below-median returns, the response of consumption for the bottom quintile is stronger—relative to the aggregate one—than in the case of above-median returns.

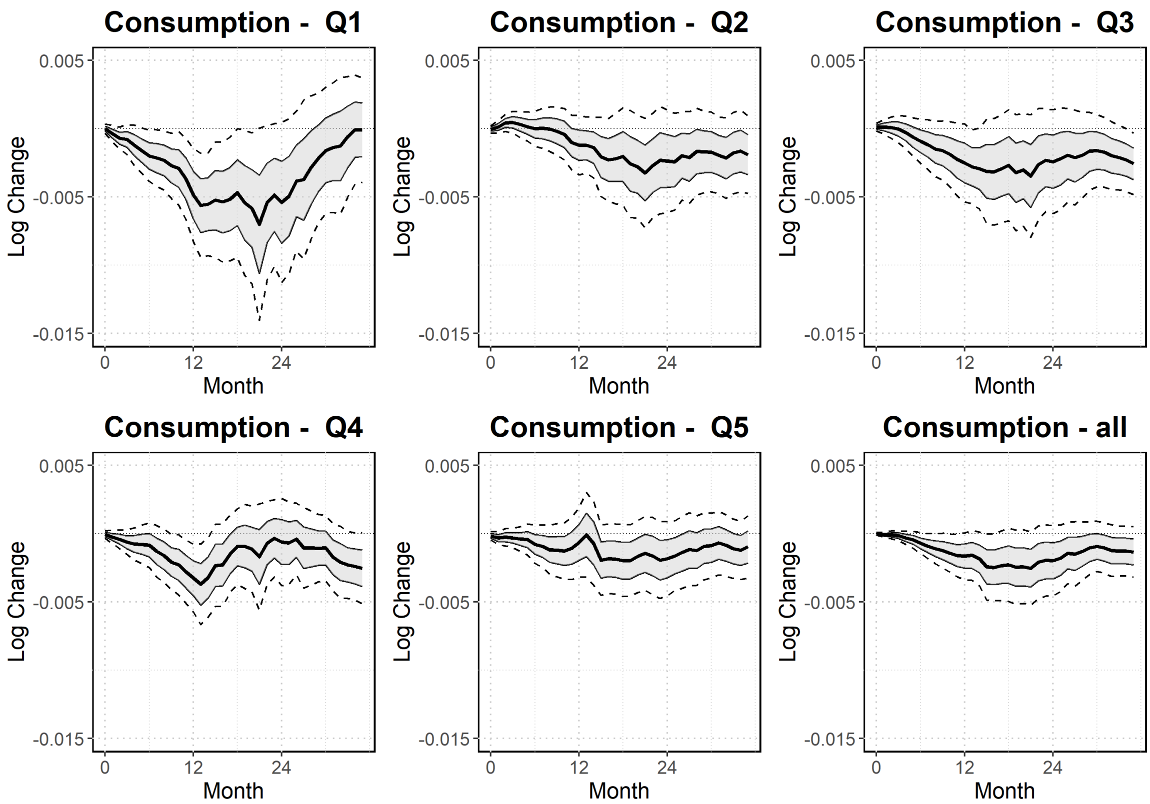


Figure A.1: Bank Equity Returns and Household Consumption—Monthly

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

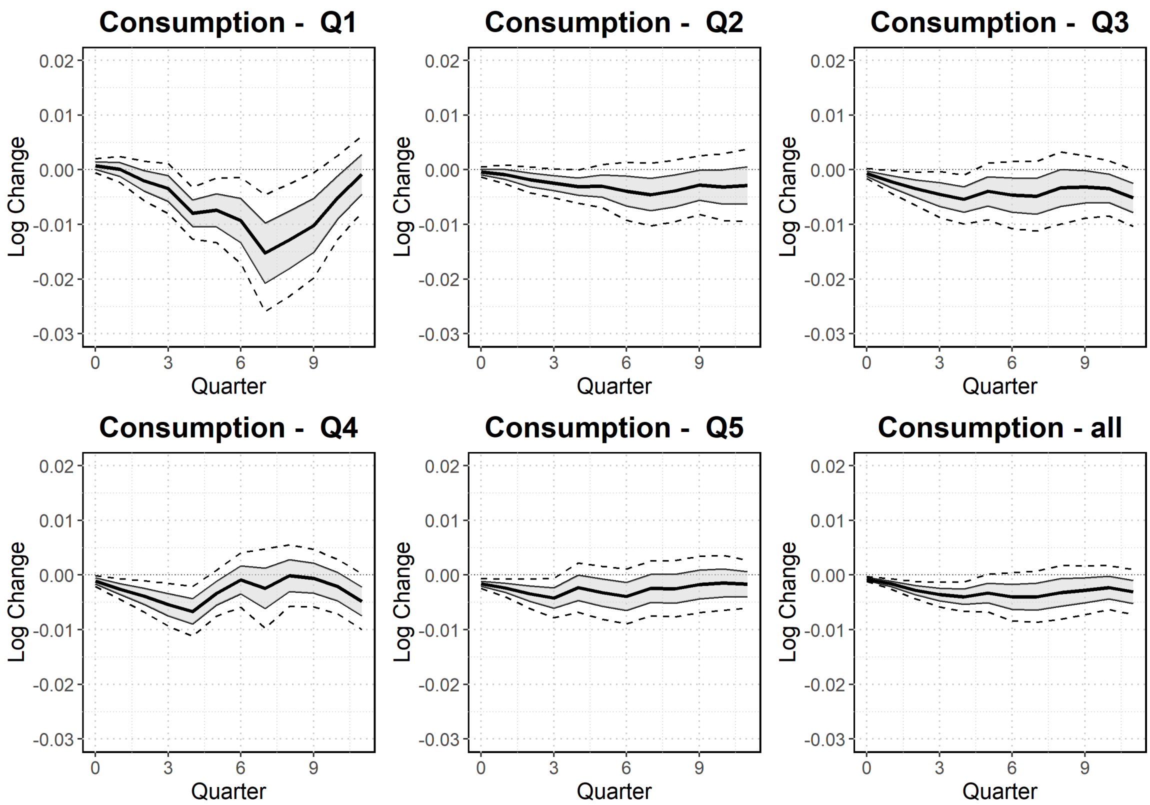


Figure A.2: Bank Equity Returns and Household Consumption—AIC

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

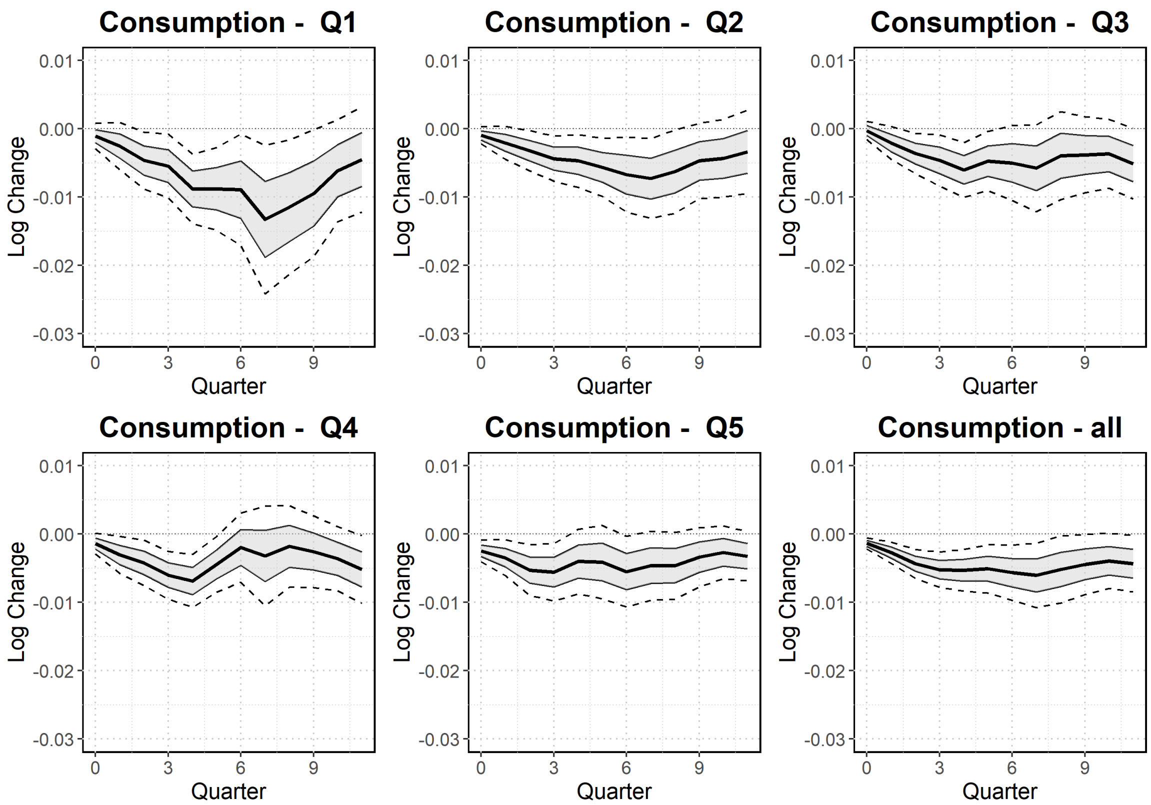


Figure A.3: Bank Equity Returns and Household Consumption—Rent Adj.

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

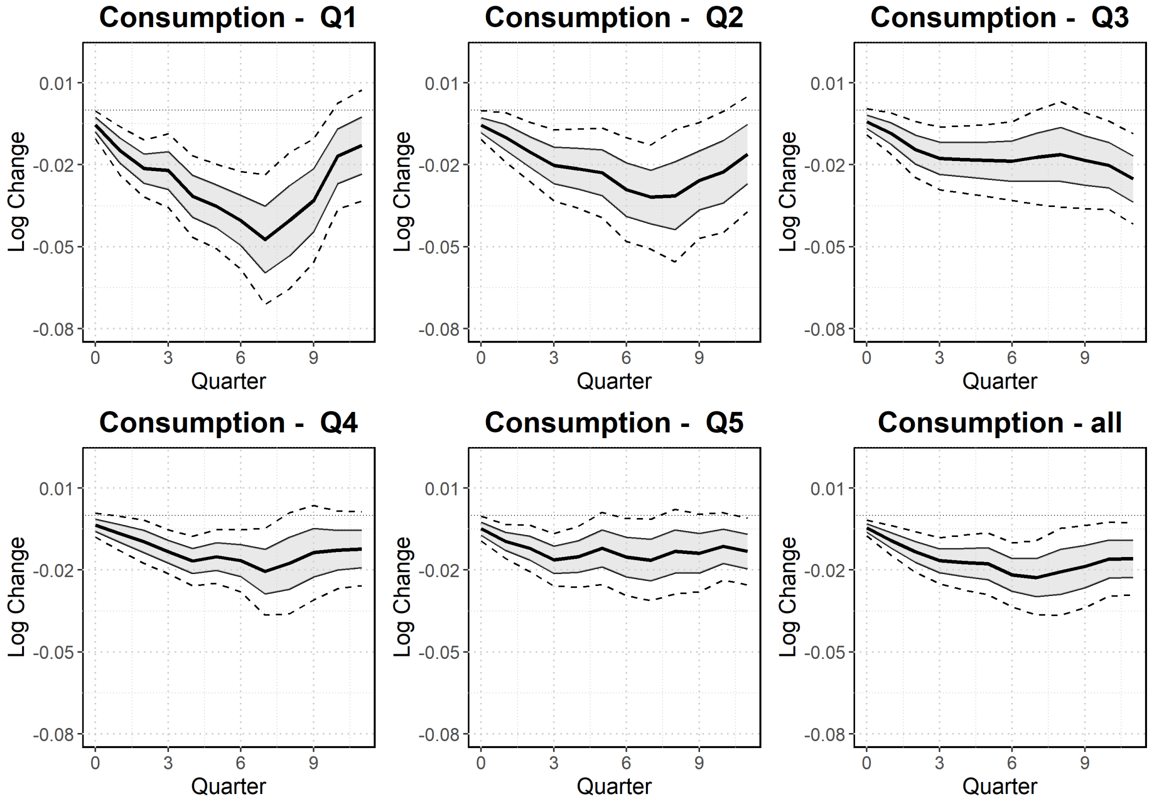


Figure A.4: Bank Equity Returns and Household Consumption—Durables

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

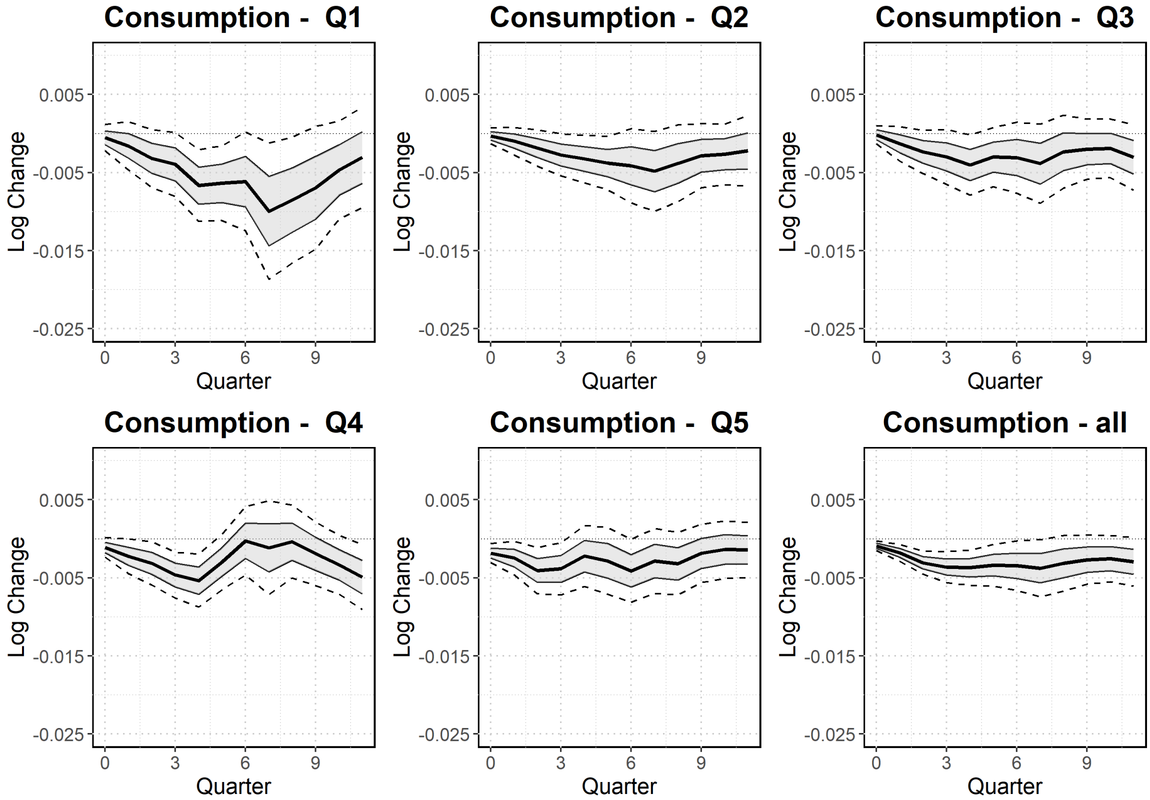


Figure A.5: Bank Equity Returns and Household Consumption—Nondurables

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

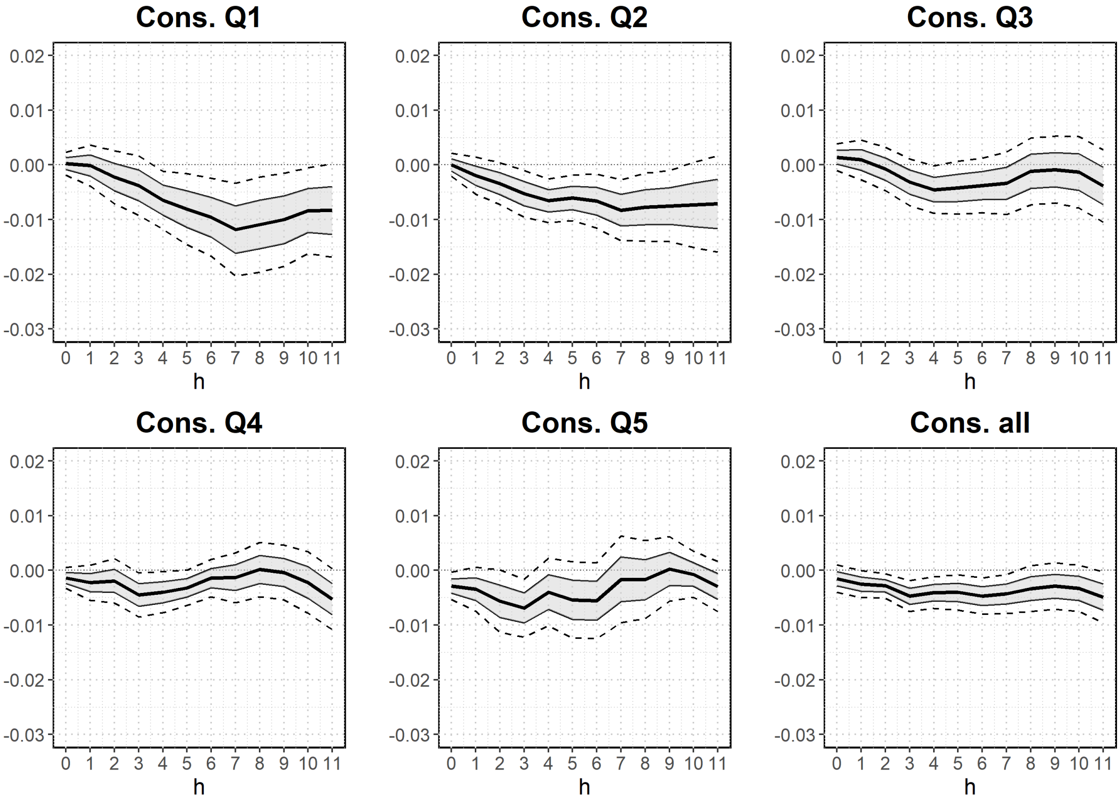


Figure A.6: Bank Equity Returns and Household Consumption—Non-Mortgagors

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

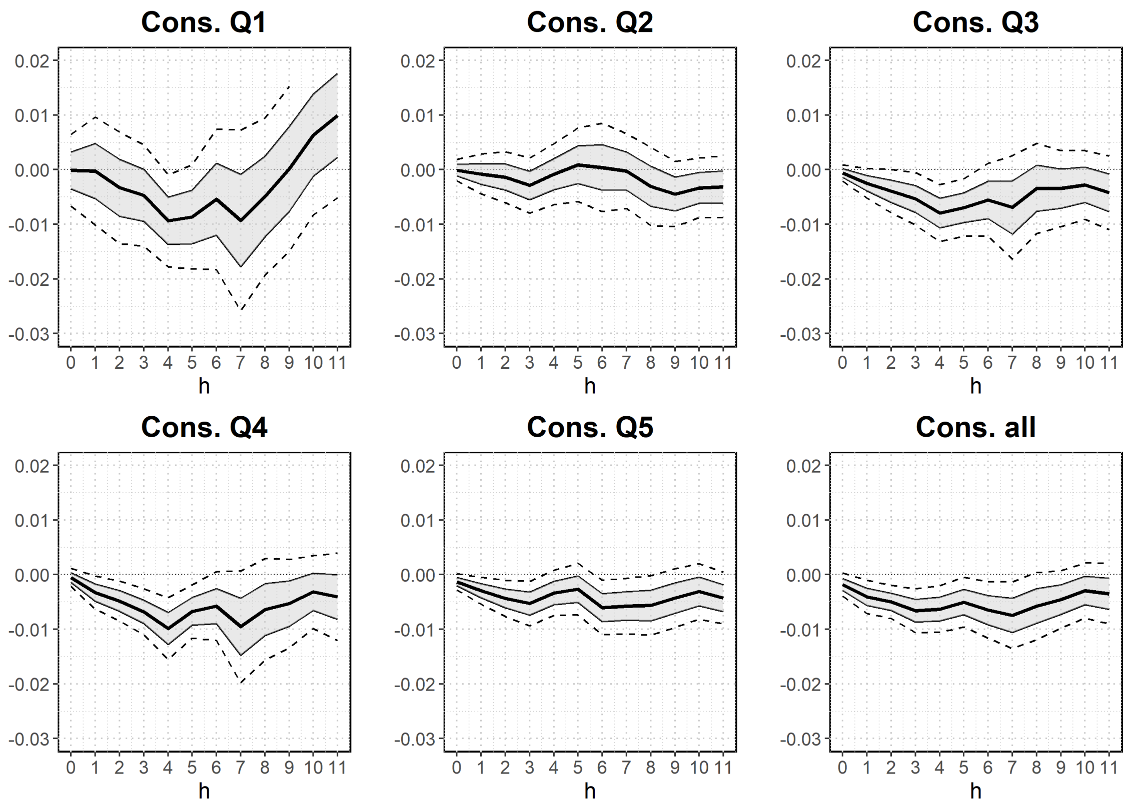


Figure A.7: Bank Equity Returns and Household Consumption—Mortgagors

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

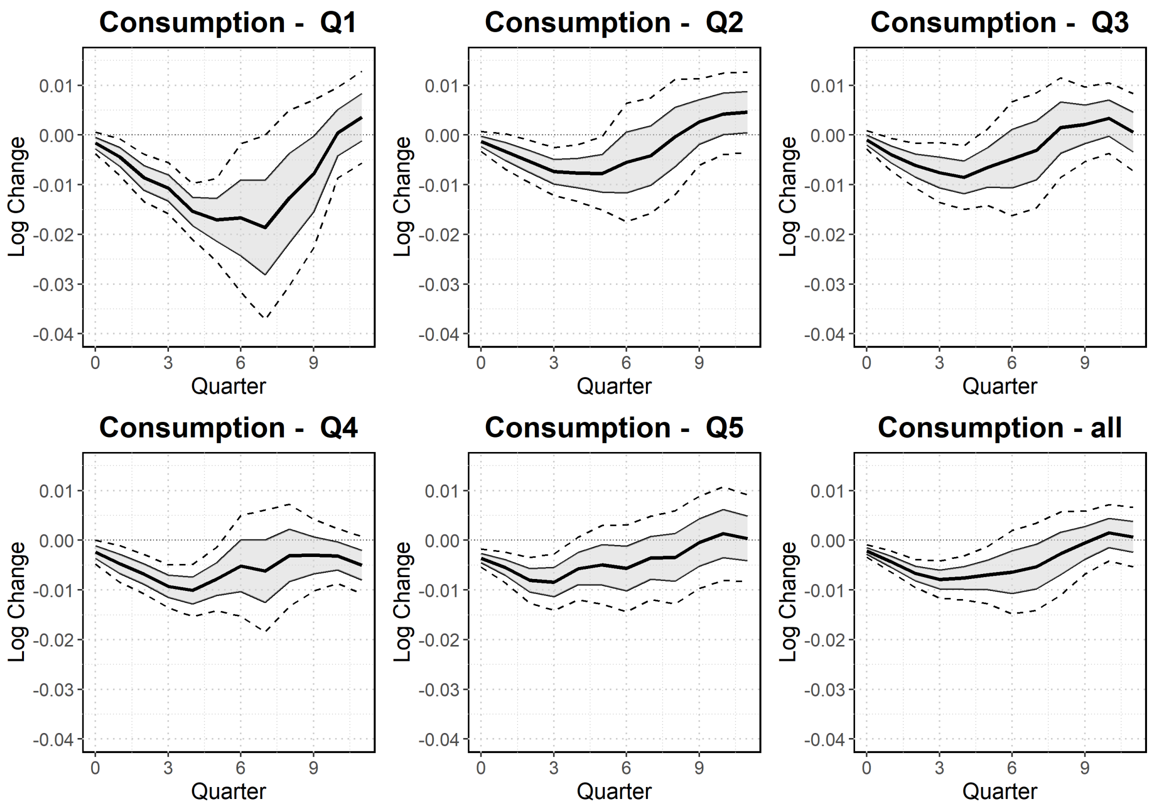


Figure A.8: Bank Equity Returns and Consumption—Below-Median Shocks

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

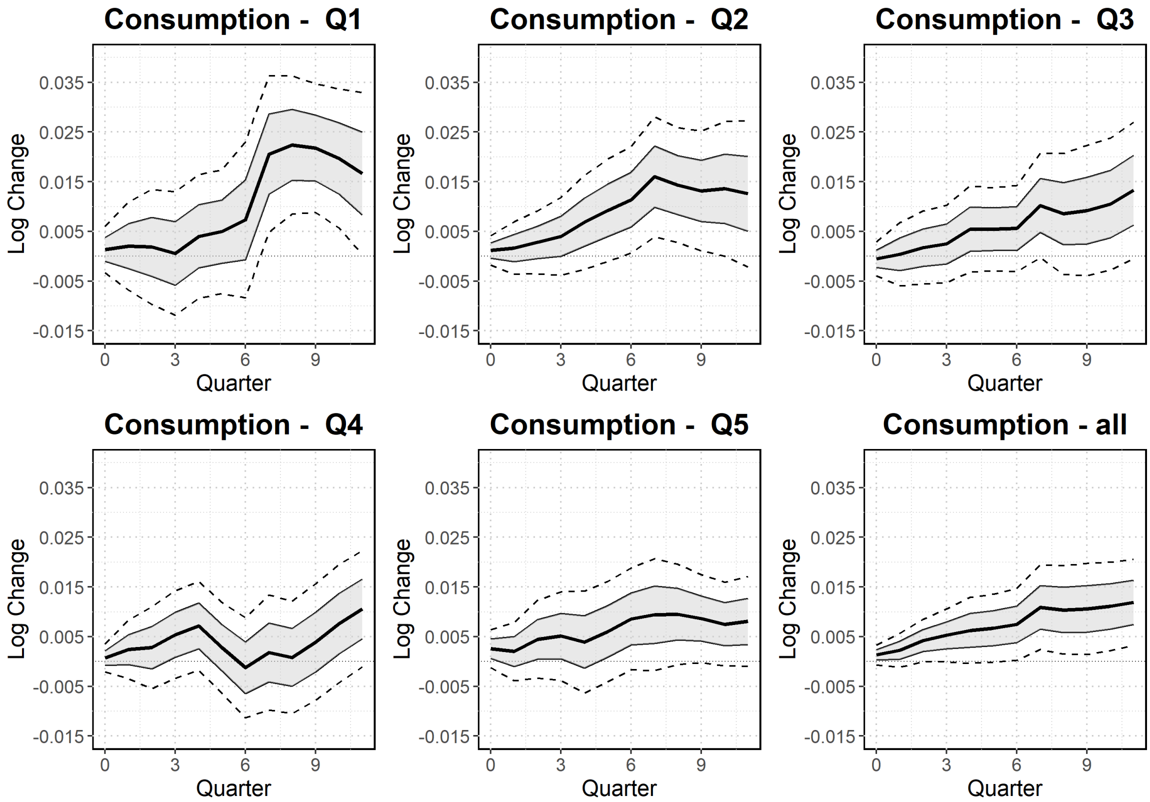


Figure A.9: Bank Equity Returns and Consumption—Above-Median Shocks

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

A.2 Details on Aggregate Data Series

Data series and details on specifications for Figure 4:

- 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 1, 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 1, 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 1, 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 (1), but since we control for the lagged stock market index, we exclude r^N from the set of controls.

B Equilibrium Definition

An equilibrium in our model economy consists of a stream of prices $\{r_t^D, r_t^L, q_t, w_t, r_t^K\}$, stocks $\{L_t, D_t, K_t^{HH}, K_t^B\}$, flows $\{C_t, I_t, Y_t, N_t, div_t^K, div_t^B, div_t^Y\}$, value functions $\{V_t^n, V_t^a, V_t, V_t^B\}$, a measure over idiosyncratic states $\lambda_t(a_t, k_t, z_t)$, and a path of exogenous shocks $\{A_t, \xi_t^B\}$ where for initial conditions $\lambda_0(a_t, k_t, z_t)$, K_0^B, K_0^{HH}, and r_0^D, r_0^L:

1. Given prices and shocks, households and bank managers solve their problems in (18), (16), and (10)
2. The measure over states is induced by households' policy functions.
3. Dividends are determined by (7), (8), and (12)
4. K^B respects the bankers' leverage constraint (13) and K^{HH} respects (23)
5. Output Y_t is given by (2)
6. Bankers' equity evolves according to (11)
7. Loans (21), deposits (22), capital (24), goods (26), and labor (28) markets clear.
8. Investment is determined by (25)
9. The equations that jointly determine prices are: (3), (4), (9), (14), and (15).

C Additional Quantitative Results

C.1 Baseline Results - Additional Figures and Tables

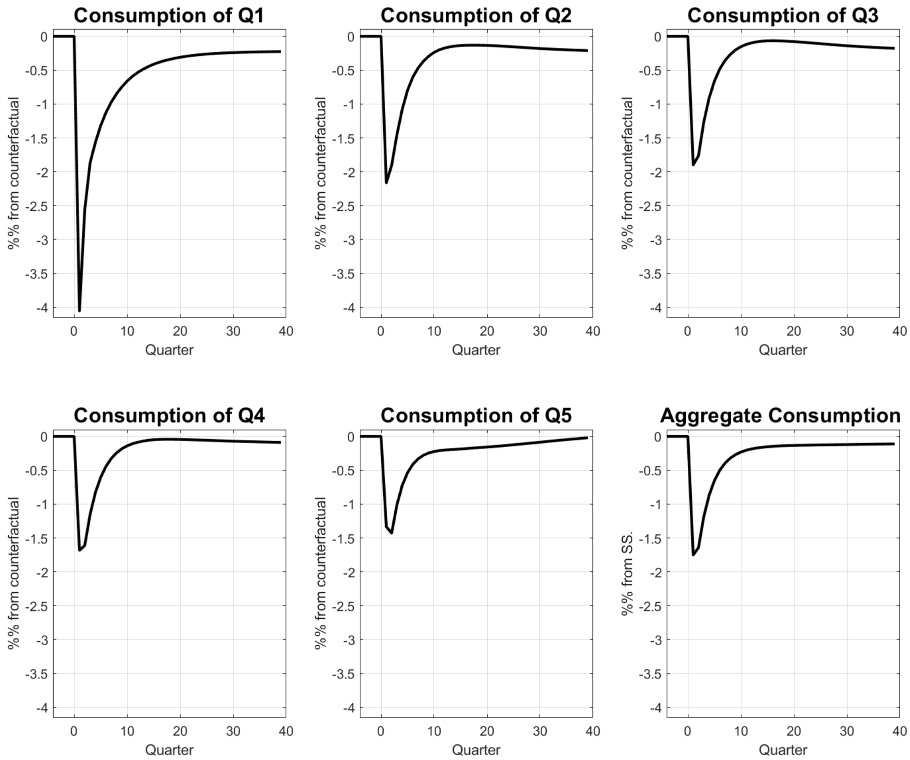


Figure C.1: Consumption Responses by Quintile of Net Worth

Note: Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of the shock. Quintiles based on total net worth in the steady state.

Table C.1: Household Characteristics by Quintile of Welfare Change

Average Income	Q1	Q2	Q3	Q4	Q5
	1.02	0.70	0.92	1.07	1.28
Average Capital	Q1	Q2	Q3	Q4	Q5
	0.50	0.22	0.39	0.70	3.16
Average Networth	Q1	Q2	Q3	Q4	Q5
	0.77	0.23	0.36	0.64	2.98

Note: Lowest quintile corresponds to largest welfare losses. Characteristics represented as multiple of economy-wide average.

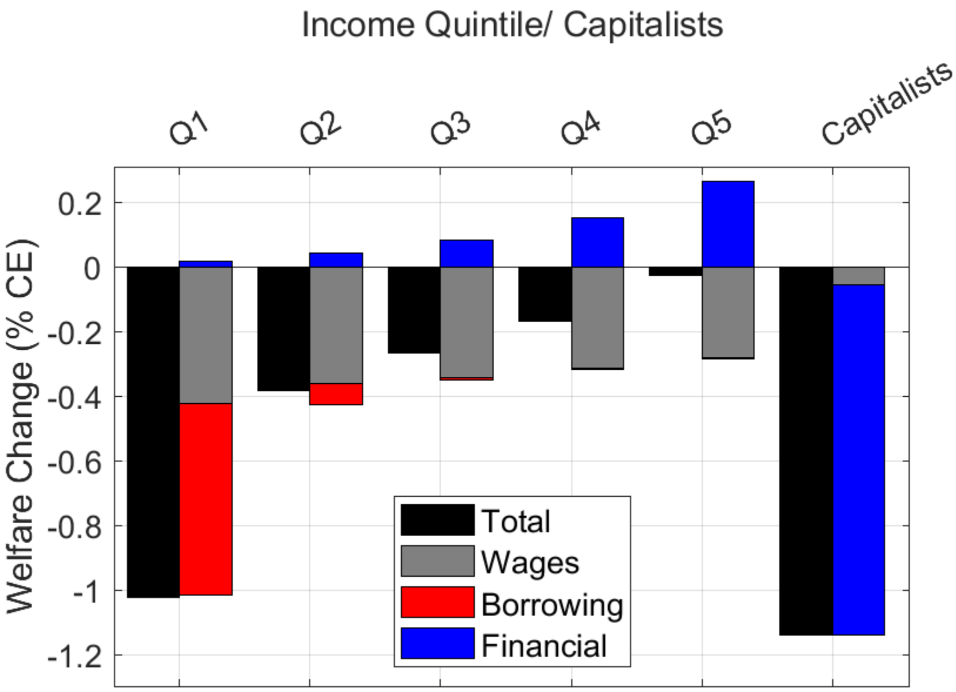


Figure C.2: Decomposition of Welfare Changes by Income Quintile

Note: Decomposition of welfare changes due to wages $\{w_t\}_{t=0}^T$, the lending rate $\{r_t^L\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$). The black bars represent the general equilibrium welfare changes. Each of the gray and colored bars is obtained by simulating the economy in response to the general equilibrium path of one variable (or all four, in the case of financial variables).

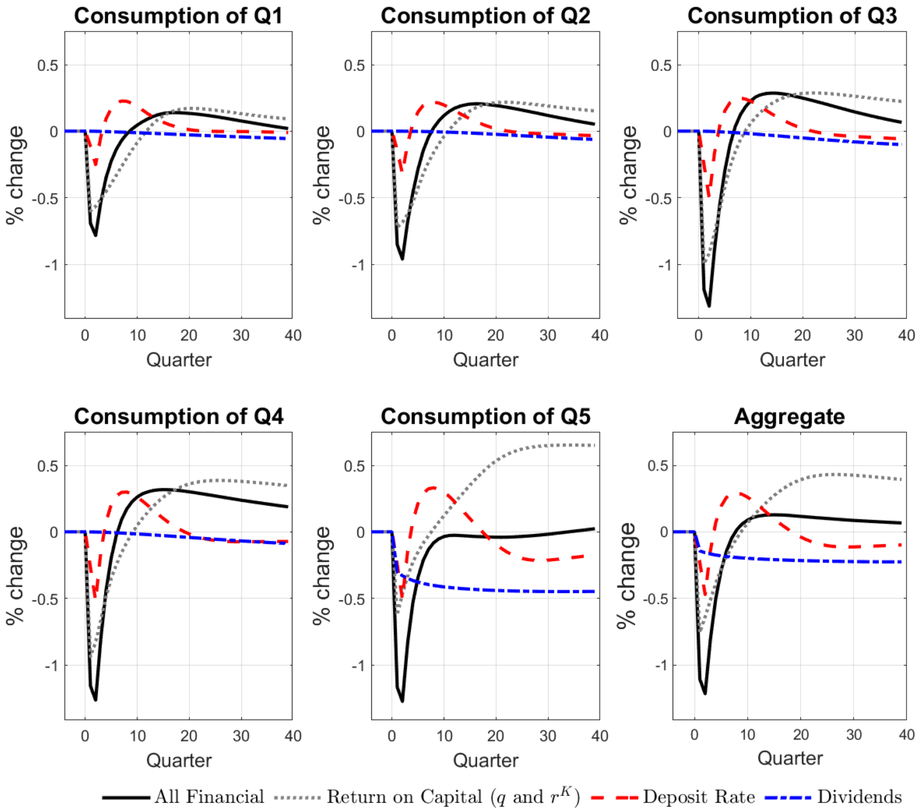


Figure C.3: Consumption Decomposition—Financial Variables

Note: Model-implied consumption responses to changes in *financial variables*. Income quintiles sorted based on total income in steady state, including earnings, interest received, and dividends. 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 return on capital $\{q_t, r_t^k\}_{t=0}^T$, the deposit rate $\{r_t^D\}_{t=0}^T$, dividends $\{div_t\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$).

C.2 Alternative Shock—A Direct Bank Equity Loss

We now consider an alternative shock to induce bank losses: A direct bank equity shock. This is a reduced form way to capture unexpected losses in bank equity, without (directly) affecting production. In this sense, this shock provides a "clean" exercise in which only beginning-of-period bank equity is affected, but the consequences of the shock will be felt throughout the economy due to general equilibrium effects. The loss to bank equity is, however, a deadweight loss to the economy's resource constraint and could be interpreted as the banking sector incurring some depreciation on external assets not affecting the economy directly. The presence of this shock changes two expressions in the model. Equation (11) becomes:

$$E_t = \underbrace{(1+r_t^L)L_t}_{\text{repayment from borrowing HHs}} + \underbrace{((1-\delta)q_t + \xi_t^B r_t^K)K_t^B}_{\text{returns of holding capital}} - \underbrace{(1+r_t^D)D_t}_{\text{repaying depositors}} - \underbrace{\varepsilon_t}_{\text{Equity Shock}}$$

and equation (27) is now:

$$\Xi_t = \frac{\phi_K}{2}\left(\frac{I_t}{K_{ss}} - \delta\right)^2 K_{ss} + \tau L_t + \varepsilon_t$$

Together with the bank equity shock, we consider a demand externality as in Krueger *et al.* (2016), which makes output partially demand-driven and enables its endogenous response on impact.[36] Namely, equation (2) becomes:

$$Y_t = \widehat{A}_t K_t^{\alpha} N_t^{1-\alpha}$$

where $\widehat{A}_t$ is total factor productivity A_t adjusted for an externality from aggregate demand (consumption C plus investment I) such that:

$$\widehat{A}_t = A_t \left(\frac{C_t + I_t}{C^{SS} + I^{SS}}\right)^{\phi_Y}$$

Finally, factor payments (equations (3) and (4)) are adjusted accordingly.

[36]The presence of the demand externality does not impact the distributive results. Simulations without it are available upon request. See Bai *et al.* (2019) for microfoundations via search for quantities in the goods market. A possible interpretation is the following: there are some sectors in the economy (especially services, but also e.g. customized investment goods) that are unable to produce for inventory and hence require immediate demand for input factors to be productive. Cooper and Ejarque (2000) introduce a similar externality by assuming complementarity of the output of multiple firms based on the work of Baxter and King (1991).

We calibrate the magnitude and persistence of the bank equity shock to again match a 20 percent decline in bank equity on impact and a 12-quarter cumulative response of 8.6 percent. We reproduce all figures and tables from Section 5 below (Figures C.4, C.5, C.6, C.7, C.8, C.9, C.10, C.11, C.12, C.13, and C.14, together with Tables ?? and C.3).

Overall, the conclusions from Section 5 remain intact: Consumption and welfare responses are heterogeneous, low-income households along with claimants to dividends are the biggest losers, and high-income individuals take advantage of movements in financial markets, with some (7 percent) standing to gain. This is because the transmission channels are very similar to the ones following the bank capital productivity shock.

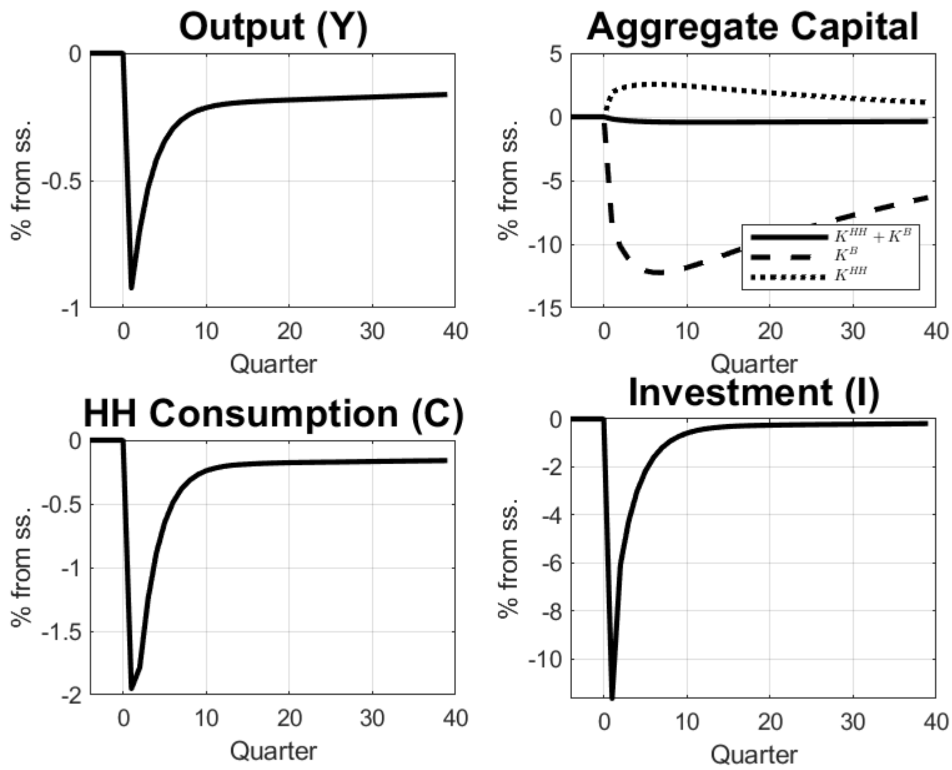


Figure C.4: Dynamics of Macroeconomics Aggregates
Note: Responses of macroeconomic aggregates to the bank equity shock. All variables reported in percentage deviation from their respective steady state levels.

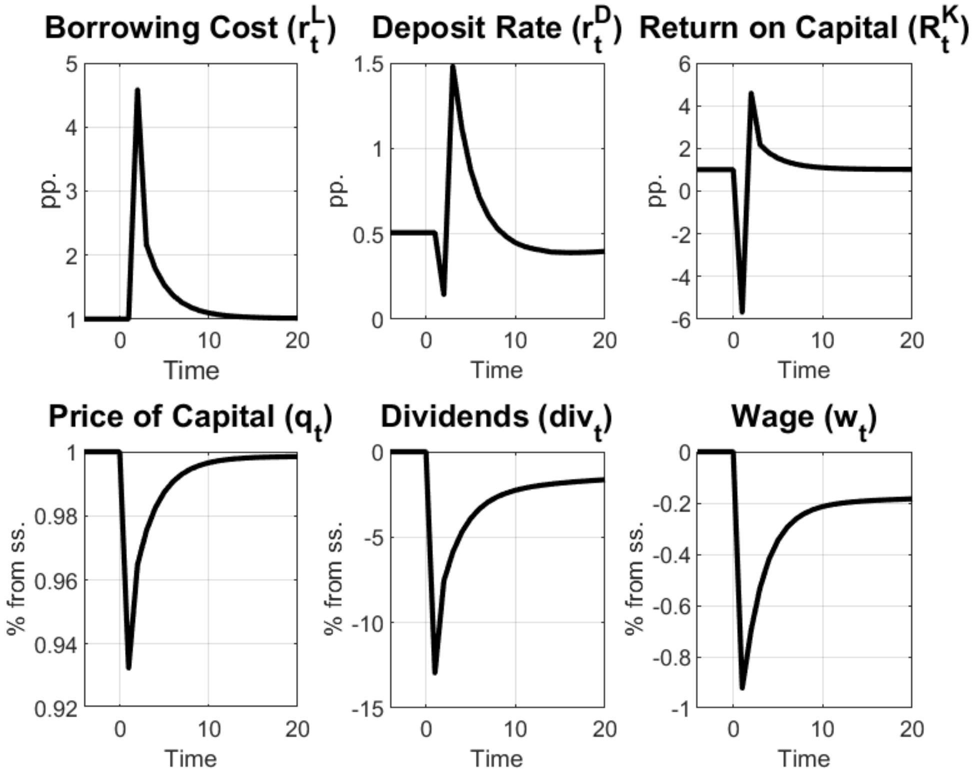
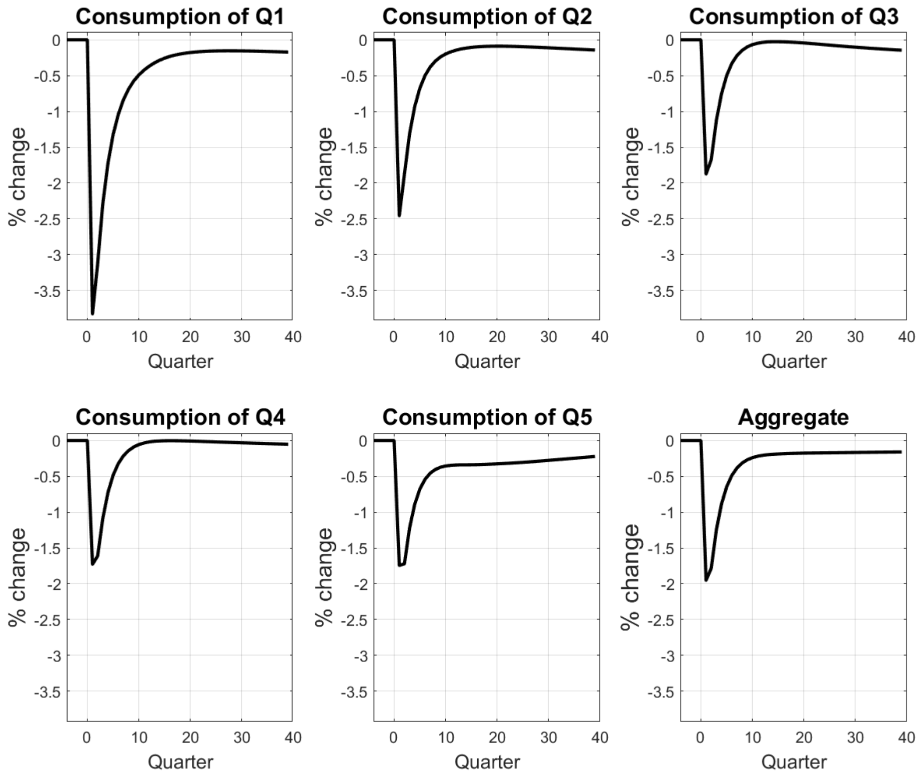


Figure C.5: General Equilibrium Price Responses

Note: Model-implied general equilibrium response of prices to the bank equity shock. The top three panels consist of rates. The three bottom panels consist of percent deviations from their respective steady-state values. The return on capital is defined as $R_t^k \equiv \frac{(r_t^K + (1-\delta)q_t}{q_{t-1}} - 1$

Figure C.6: Consumption Responses by Income Quintile



Note: Model-implied consumption responses to the bank equity shock. Income quintiles are sorted based on total income in the steady state, including earnings, interest received, and dividends. Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of the shock.

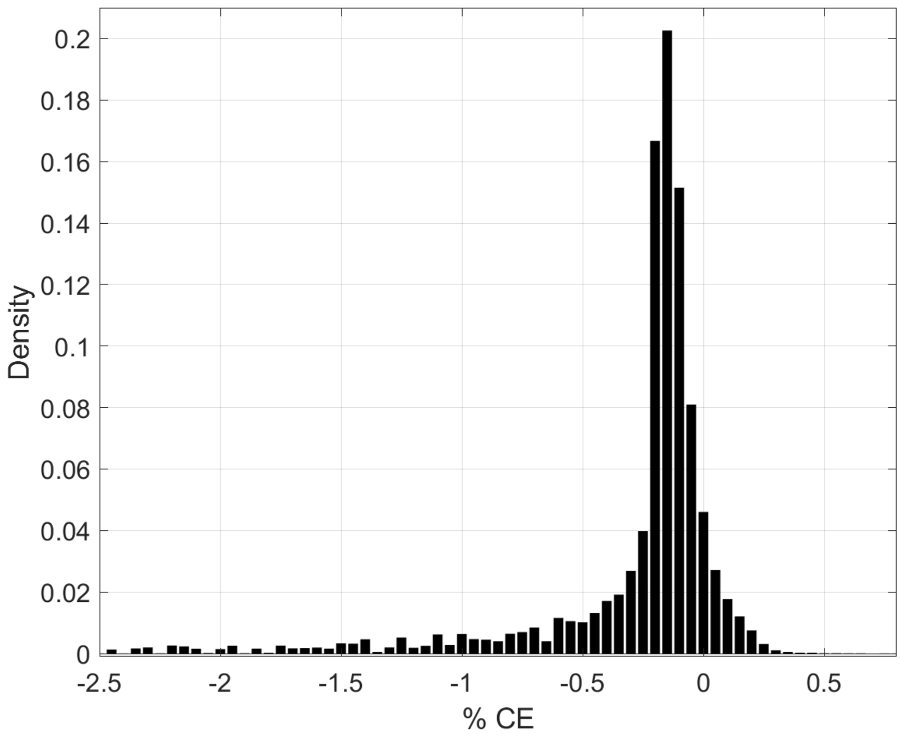


Figure C.7: Distribution of Welfare Changes - BE

Note: Distribution of welfare changes due to the bank equity shocl, measured in consumption equivalent units, as in equation 29.

Table C.2: Characteristics of Gainers and Losers from the Bank Equity Shock

	Negative CE	Positive CE
Average liquid assets	0.52	7.22
Average capital holdings	0.56	3.9
Average Earnings	0.97	1.41
Average (total) income	0.95	1.65
Average Portfolio Liquidity	0.94	1.61
Dependence on labor income	92%	65%

Note: "Dependence on labor income" refers to the average share of earnings in households' total income. With the exception of the last row, numbers are displayed as a multiple of economy-wide averages.

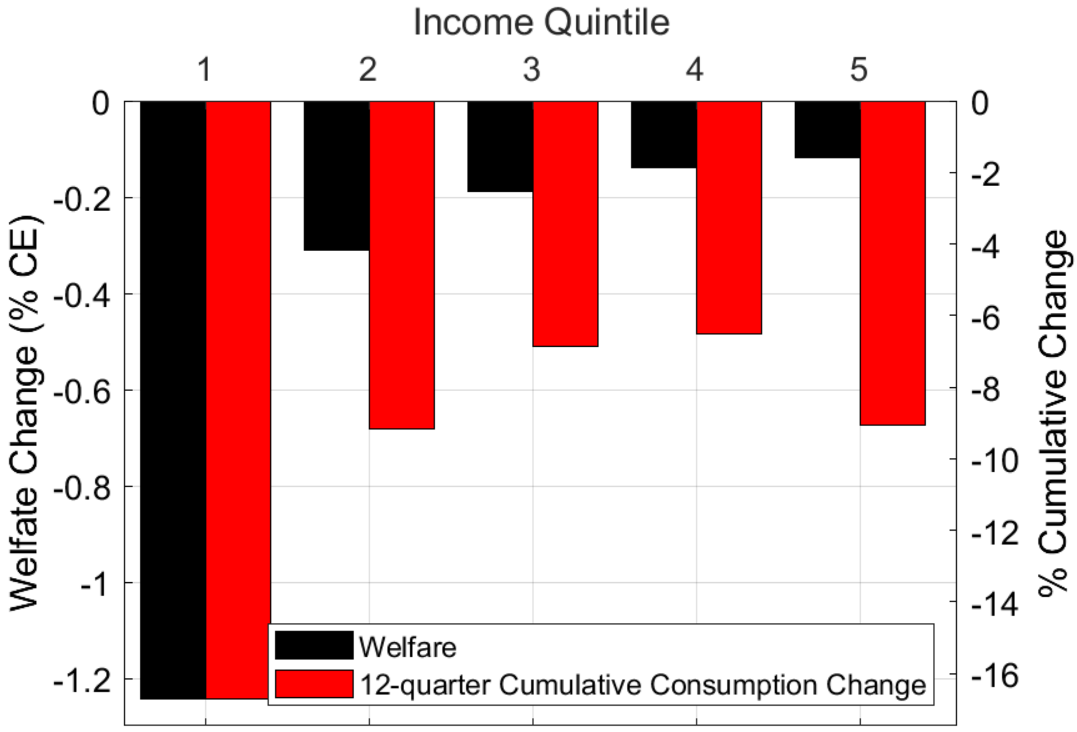


Figure C.8: Welfare and Consumption Changes - Bank Equity Shock

Note: Welfare changes, whose scale is on the left y-axis, are computed according to equation (29) and aggregated within each income quintile. Cumulative consumption changes are measured on the right y-axis.

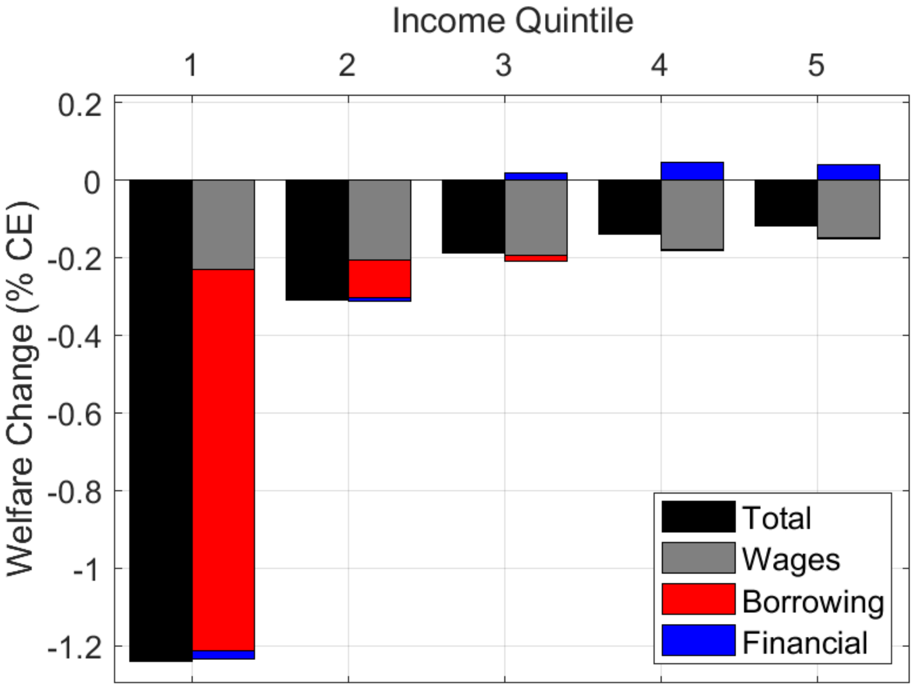


Figure C.9: Decomposition of Welfare Changes by Income Quintile

Note: Decomposition of welfare changes due to wages $\{w_t\}_{t=0}^T$, the lending rate $\{r_t^L\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$) in response to the bank equity shock. The black bar represents the general equilibrium welfare changes, replicating figure C.8. Each of the gray and colored bars is obtained by simulating the economy in response to the general equilibrium path of one variable (or all four, in the case of financial variables).

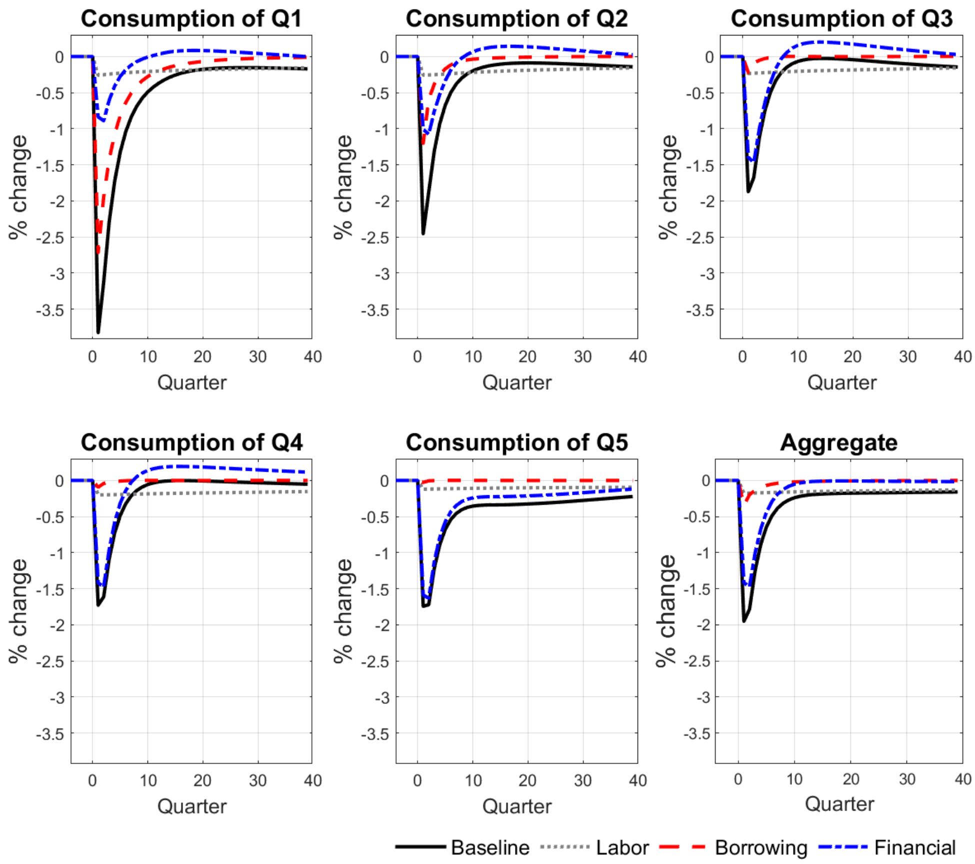


Figure C.10: Consumption Decomposition

Note: Model-implied consumption responses to the bank equity shock. Income quintiles are sorted based on total income in steady-stat, including earnings, interest received, and dividends. 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 wages $\{w_t\}_{t=0}^{T}$, the lending rate $\{r_t^L\}_{t=0}^{T}$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^{T}$).

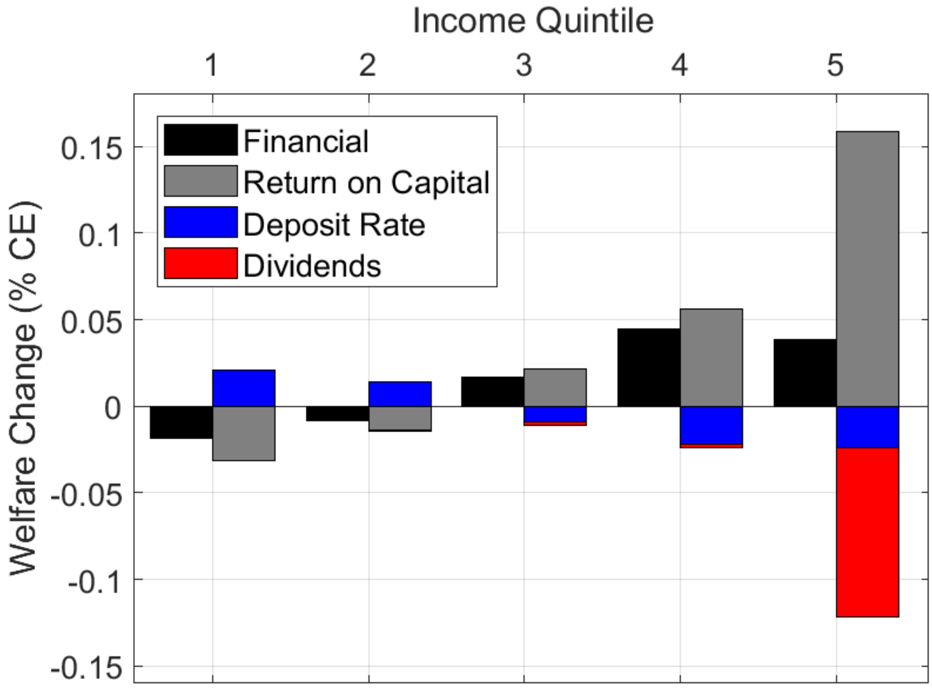


Figure C.11: Decomposition of Welfare Changes by Income Quintile

Note: Decomposition of welfare changes (in response to the bank equity shock) due to wages 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).

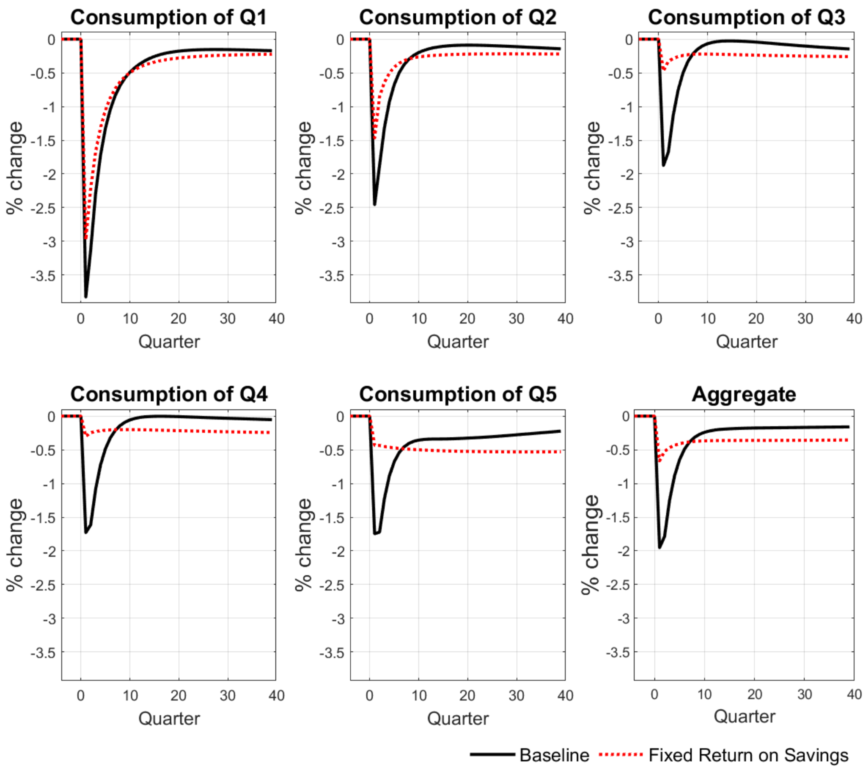


Figure C.12: Consumption Decomposition - The Role of Savings Returns

Note: Model-implied consumption responses to the bank equity shock in general equilibrium (solid line) and partial equilibrium (dotted line). Income quintiles sorted based on total income in steady state, including earnings, interest received, and dividends. Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of any price variation. The dotted line shows the partial-equilibrium response to changes *only in* wages, the lending rate, and dividends ($\{w_t, r_t^L, div_t\}_{t=0}^T$).

Table C.3: Welfare Changes due to Bank Equity Shock - Heterogeneity

Quintile	Q1	Q2	Q3	Q4	Q5
by Income	-1.242	-0.311	-0.189	-0.139	-0.117
by Net Worth	-1.315	-0.239	-0.184	-0.144	-0.119

Notes: Changes in welfare measured in consumption equivalent units, as in equation 29.

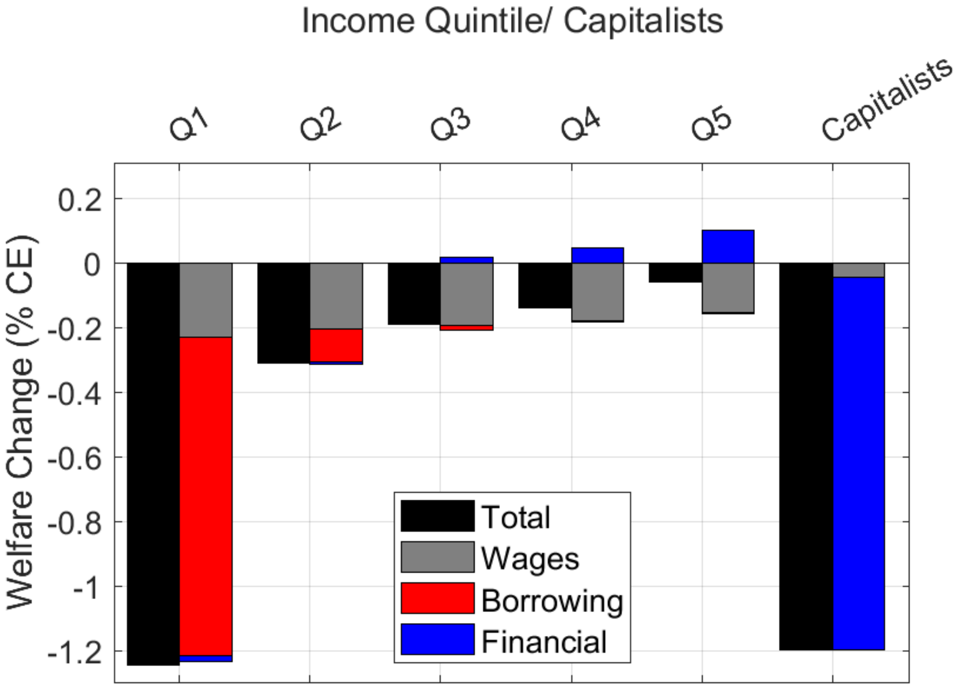


Figure C.13: Decomposition of Welfare Changes by Income Quintile

Note: Decomposition of welfare changes (due to the bank equity shock) due to wages $\{w_t\}_{t=0}^T$, the lending rate $\{r_t^L\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$). The black bars represent the general-equilibrium welfare changes. Each of the gray and colored bars is obtained by simulating the economy in response to the general-equilibrium path of one variable (or all four, in the case of financial variables).

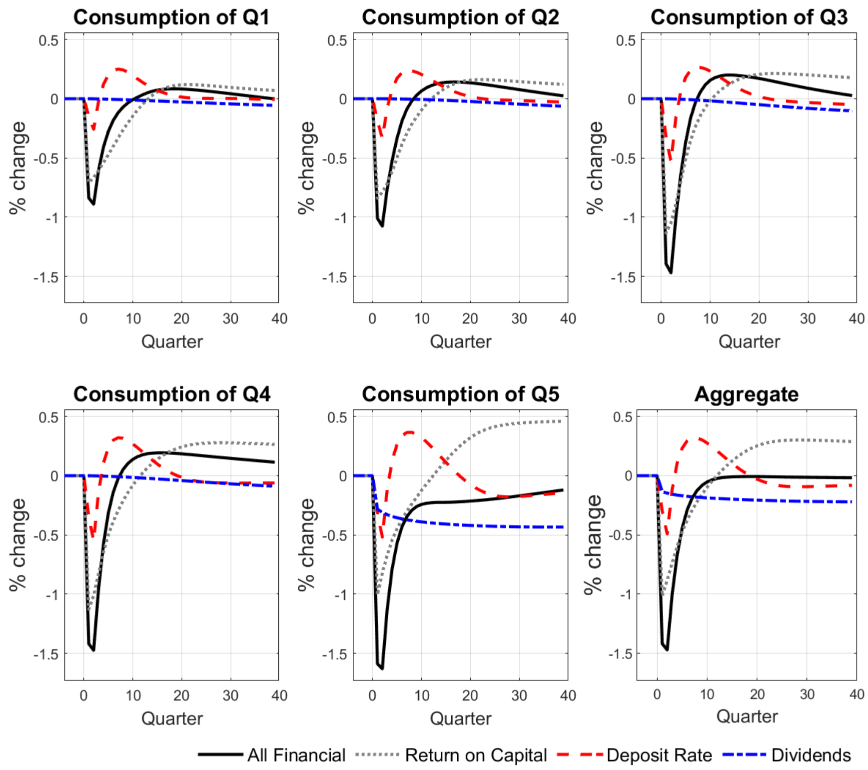


Figure C.14: Consumption Decomposition - Bank Equity Shock -Financial Variables

Note: Model-implied consumption responses to the bank equity shock to changes in variables. Income quintiles are sorted based on total income in steady state, including earnings, interest received, and dividends. 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 return on capital $\{q_t, r_t^k\}_{t=0}^T$, deposit rates $\{r_t^D\}_{t=0}^T$, dividends $\{div_t\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$).

C.3 Credit Policies - Additional Details

C.3.1 Description of Alternative Policy Interventions

Lump-Sum Rebate. In the case of the lump-sum rebate, we introduce a transfer T_t^{ls} to the right-hand side of households' budgets. Since there is a unit measure of households, $T_t^{ls} = \mathcal{T}_t$.

Proportional Rebate. For the proportional rebate, we introduce the following term to the right-hand-side of consumers' budgets:

$$T_t^p(a,k,z) = \eta_t \left[r_t^D a_t \mathbb{I}(a_t \geq 0) + w_t z + \mathbb{I}(z = z^*) div_t + (r_t^k - (1-\delta) q_t) k \right]$$

Budget balance requires $\mathcal{T}_t = \sum_{a,k,z} T_t^p(a,k,z) d\lambda(a,k,z)$, which is achieved by selecting the adequate sequence of η_t.

Rebate to Banks. In this case, equation (11) is modified to:

$$E_t = \underbrace{(1 + r_t^L) L_t}_{} + \underbrace{((1-\delta) q_t + \xi_t^B r_t^K) K_t^B}_{} - \underbrace{(1 + r_t^D) D_t}_{} + \mathcal{T}_t$$

C.3.2 Baseline Credit Policy - Additional Figures

Below we compare the transmission mechanisms (prices, interest rates, dividends) with and without the baseline credit policy intervention (lump sum rebate, $\xi^G = 1$).

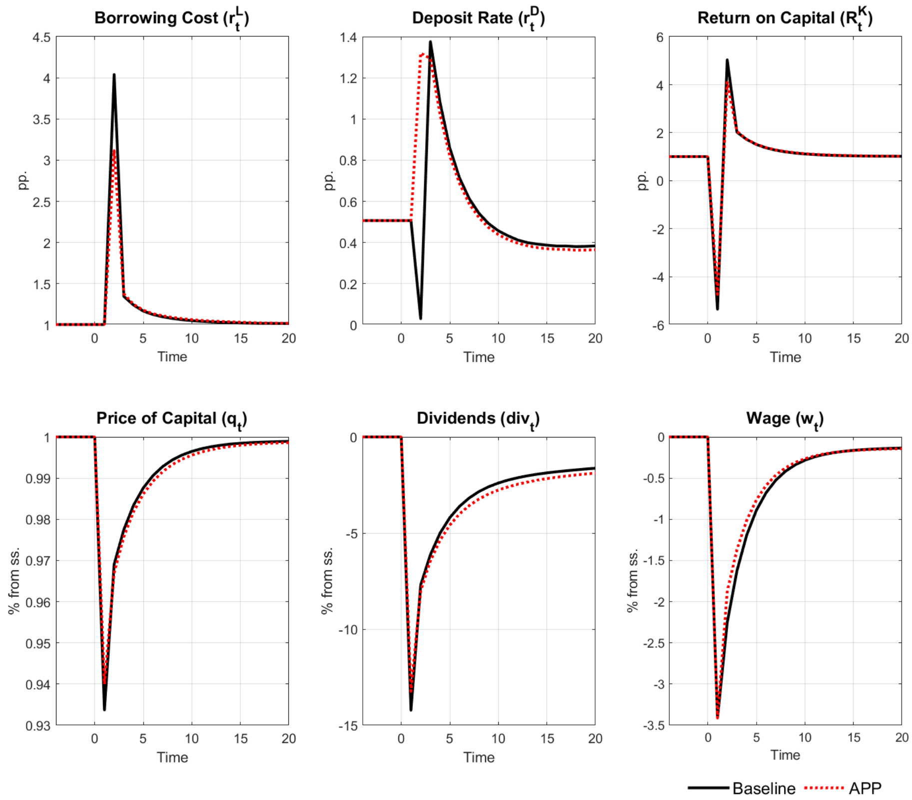


Figure C.15: General Equilibrium Price Responses

Note: Model-implied general-equilibrium responses of prices to baseline shock in the presence (red dotted line) and absence (solid black line) of the credit policy described in 6. The top three panels consist of rates. The three bottom panels consist of percent deviations from their respective steady-state values. The return on capital is defined as $R_t^k \equiv \frac{(r_t^K + (1-\delta)q_t}{q_{t-1}} - 1$

C.3.3 Alternative Credit Policies - Results

Table C.4 below compares the welfare impacts of the credit policy proposed in section 6 under distinct assumptions regarding the productivity of capital financed by the government and how the proceeds from intermediation are rebated. In all cases, the credit policy improves welfare, with gains concentrated at the bottom of the income distribution.

Table C.4: Welfare Responses - Credit Policies

	Q1	Q2	Q3	Q4	Q5	Aggregate	Capitalists
Lump sum, $\xi^G = 1$	0.2718	0.0758	0.0459	0.0349	0.0312	0.0927	-0.0155
Lump sum, $\xi^G = \xi^B$	0.2284	0.0560	0.0324	0.0265	0.0277	0.0749	-0.0208
Prop. Tax, $\xi^G = 1$	0.1956	0.0569	0.0386	0.0337	0.0357	0.0727	0.0063
Prop. Tax, $\xi^G = \xi^B$	0.1855	0.0454	0.0283	0.0258	0.0302	0.0636	-0.0090
Banks, $\xi^G = 1$	0.1861	0.0465	0.0279	0.0245	0.0297	0.0635	0.0207
Banks, $\xi^G = \xi^B$	0.1802	0.0396	0.0224	0.0206	0.0269	0.0586	-0.0008

Note: Change in welfare when credit policy is available, compared to the baseline shock. Welfare is measured according to equation 29. Different rebating schemes are described above. $\xi^G = \xi^B$ denotes the case when the productivity of government-intermediated capital equals that of the bank-intermediate capital.

C.4 Distributive Consequences of TFP Shocks

We now compare the distributive consequences of our baseline shock that *only* affects the banking sector with a recession of the same magnitude, but induced by a decline in aggregate productivity (A_t). This allows us to understand how large the distributive consequences of recessions uniquely originated in the banking sector are, relative to a disruption that affects all sectors in the economy equally. In other words, it gives us an idea of whether the bank loss channel amplifies or dampens the distributive impact of business cycles as a whole. For comparison, we calibrate the magnitude and the persistence of the TFP shock to match the same on-impact and 12-quarter-cumulative declines in aggregate consumption as in our baseline specification in Section 5.

Figure C.16 compares the two consumption responses across income quintiles. The TFP shock has substantially less impact for households at the bottom, with their on-impact consumption decline reduced by 0.67 percentage points, or 24 percent. For the other quintiles, differences are smaller. Figure C.17 however shows that welfare changes are more evenly distributed in the case of a TFP shock: For quintiles 1-2, the TFP shock is less harmful than the baseline, whereas the opposite is true for Q3-Q5.

Even though the transmission mechanisms described in Section 5 are still operative—the bank also suffers from the decline in aggregate productivity— the increases in the spread and in the future returns on capital are not as strong (Figure C.18). This is because the banks' losses in net worth associated with the TFP shock are much smaller (Figure C.19). The less severe consequences for the banking sector lead to a smaller decline in welfare for low-income households. In contrast, high-income individuals cannot benefit as much from movements in financial variables as in the case of the bank capital shock (Figure C.20) and hence face a larger decline in their welfare.

Taken together, these results suggest that even though the consumption responses to an aggregate TFP shock are similar to those in response to banking sector losses, this masks differences in welfare inequality due to the underlying transmission mechanisms.

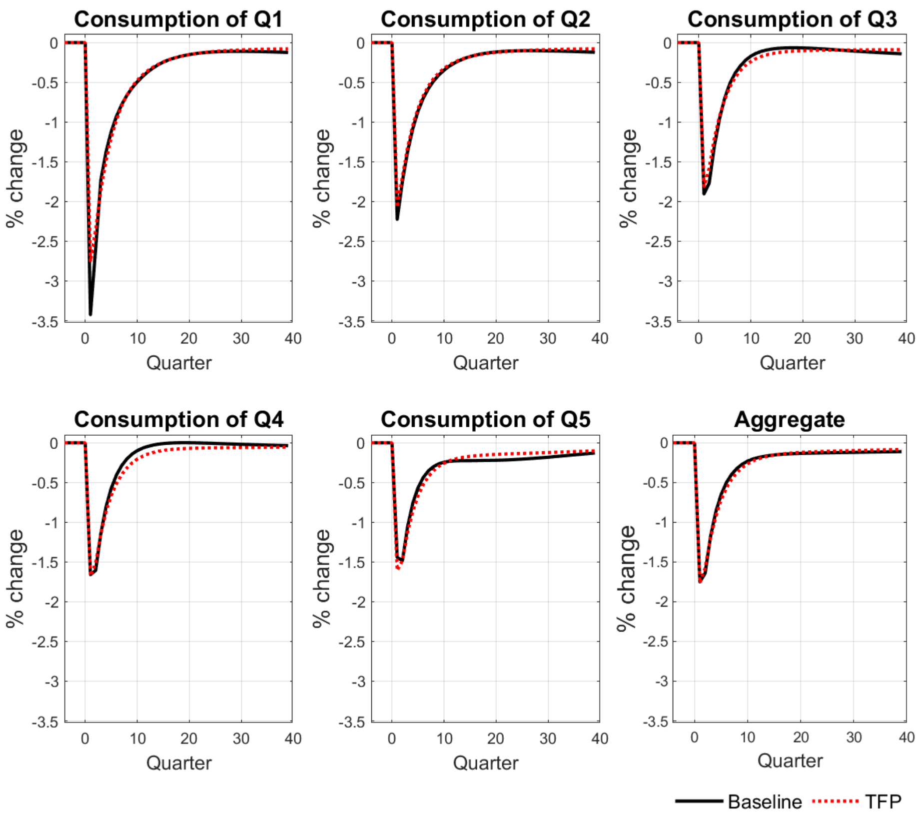


Figure C.16: Consumption Responses - TFP Shock

Note: Model-implied consumption responses to the TFP shock. Income quintiles are sorted based on total income in the steady state, including earnings, interest received, and dividends. Impulse responses are displayed relative to the counterfactual evolution of consumption for each group in the absence of the shock.

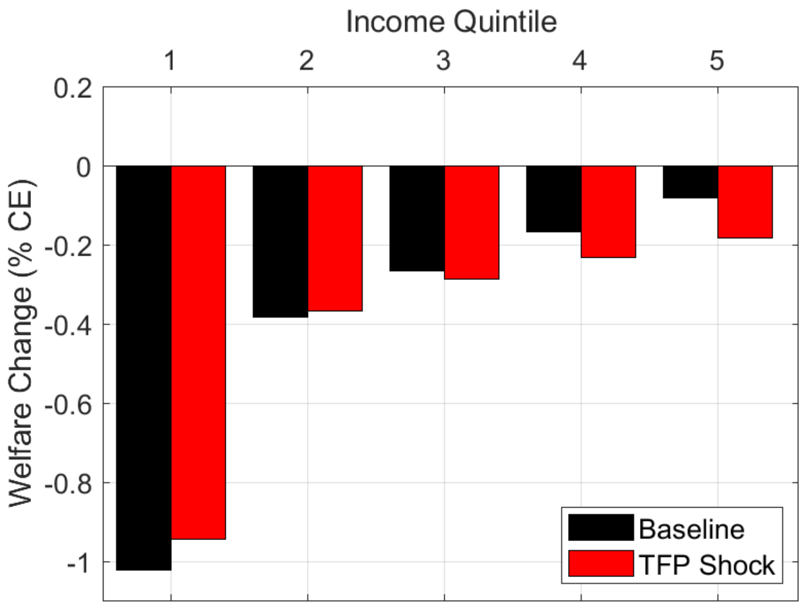


Figure C.17: Welfare Changes - Baseline vs. TFP Shock

Note: Welfare changes, computed according to equation (29) and aggregated within which income quintile, for baseline and TFP shocks.

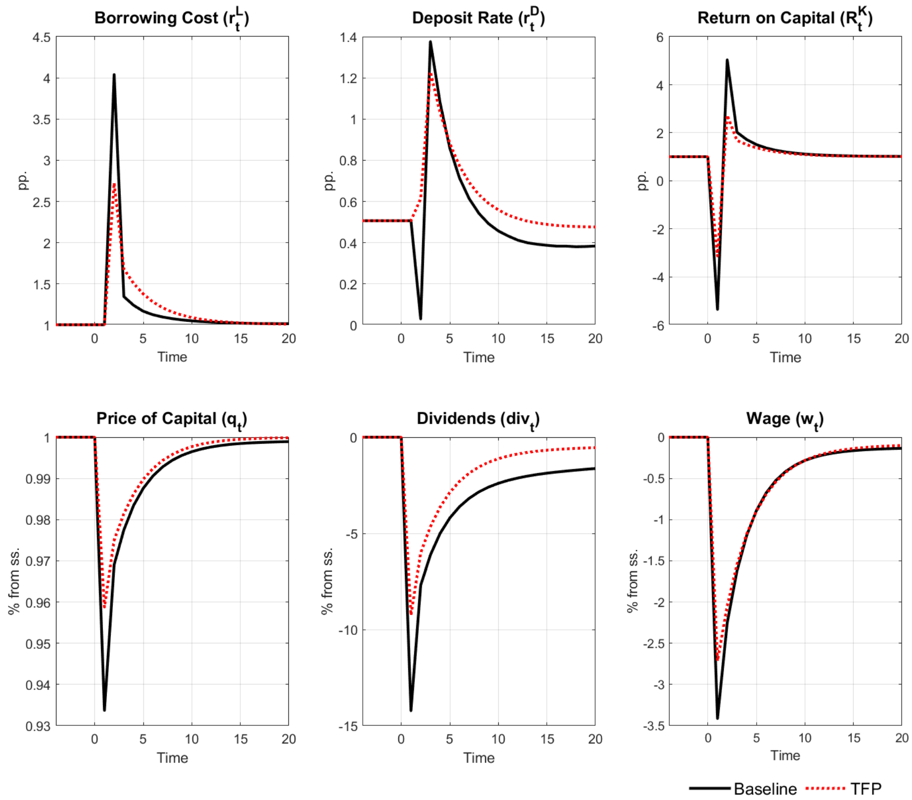


Figure C.18: General Equilibrium Price Responses

Note: Model-implied general-equilibrium response of prices to baseline and TFP shocks. The top three panels consist of rates. The three bottom panels consist of percent deviations from their respective steady-state values. The return on capital is defined as $R_t^k \equiv \frac{(r_t^K + (1-\delta)q_t}{q_{t-1}} - 1$

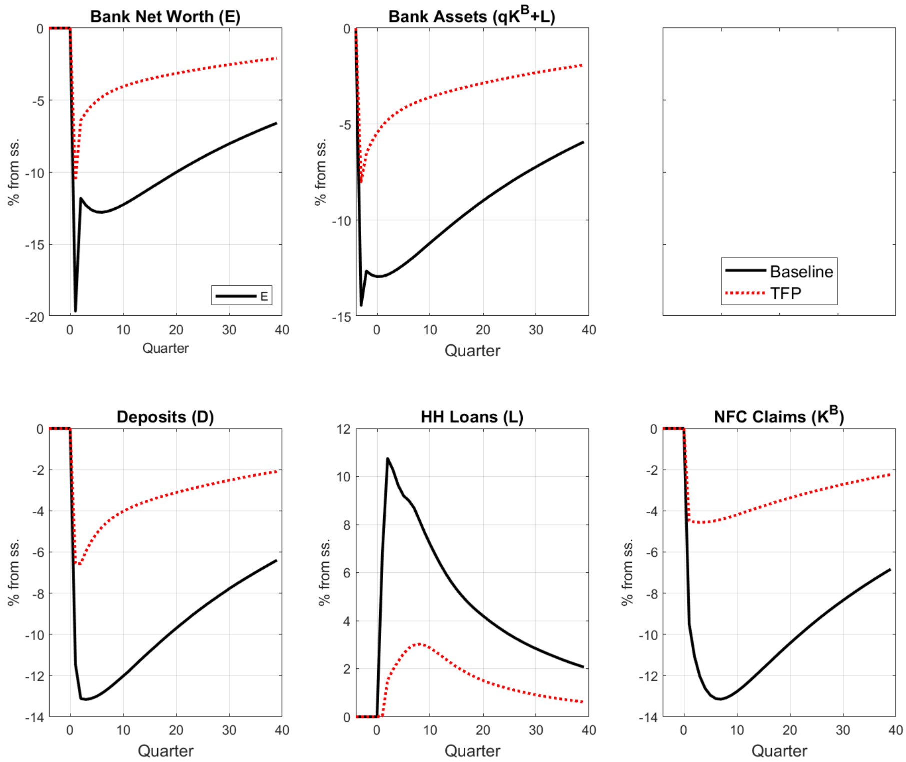


Figure C.19: Evolution of Banks' Balance Sheet Components

Note: Responses of components of the banks' balance sheets to the baseline and the TFP shock, itself represented in the top-right panel.

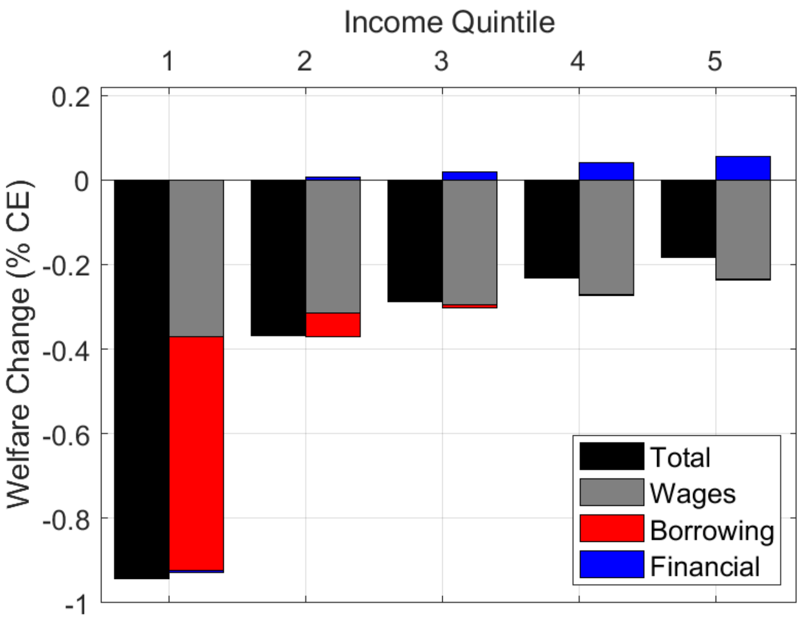


Figure C.20: Decomposition of Welfare Changes by Income Quintile - TFP Shock

Note: Decomposition of welfare changes due to wages $\{w_t\}_{t=0}^T$, the lending rate $\{r_t^L\}_{t=0}^T$, and financial variables (jointly $\{r_t^D, r^K, q_t, div_t\}_{t=0}^T$) in response to a TFP shock. The black bar represents the general-equilibrium welfare changes. Each of the gray and colored bars is obtained by simulating the economy in response to the general-equilibrium path of one variable (or all four, in the case of financial variables).