Inequality, Leverage and Crises*

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Abstract

The paper studies how high leverage and crises can arise as a result of changes in the income distribution. Empirically, the periods 1920-1929 and 1983-2007 both exhibited a large increase in the income share of the rich, a large increase in leverage for the remainder, and an eventual financial and real crisis. The paper presents a theoretical model where these features arise endogenously as a result of a shift in bargaining powers over incomes. A reduction in income inequality, through an increase in the bargaining power of the lower income group or through other redistributional policies, can lead to a sustained reduction in crisis risk.

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1. Introduction

The United States experienced two major economic crises over the past century—the Great Depression starting in 1929 and the Great Recession starting in 2007. A striking and often overlooked similarity between these two crises is that both were preceded by a sharp increase in income and wealth inequality, and by a similarly sharp increase in debt-to-income ratios among lower- and middle-income households. When those debt-to-income ratios started to be perceived as unsustainable, they contributed to triggering the crisis. In this paper, we first document these facts, and then present a dynamic stochastic general equilibrium model in which a crisis driven by income inequality can arise endogenously. The crisis is the ultimate result, after a period of decades, of a shock to the relative bargaining powers over income of two groups of households, investors who represent the top 5% of the income distribution, and whose bargaining power increases, and workers who represent the bottom 95% of the income distribution.

The model is kept as simple as possible in order to allow for a clear understanding of the mechanisms at work. The key mechanism is that investors, rather than using all of their increased income for higher consumption and more physical investment, use a large share of it to purchase additional financial assets backed by loans to workers. By doing so, investors allow workers to limit the drop in their consumption following their loss of income, but the large and highly persistent rise of workers' debt-to-income ratios generates financial fragility which eventually makes a financial crisis more likely.

Prior to the crisis, increased saving at the top and increased borrowing at the bottom results in consumption inequality increasing significantly less than income inequality. Saving and borrowing patterns of both groups create an increased need for financial services and intermediation. As a consequence the size of the financial sector, as measured by the ratio of banks' liabilities to GDP, increases. The crisis is characterized by large-scale household debt defaults and an abrupt output contraction as in the recent U.S. financial crisis. Because crises are costly, redistribution policies that give workers the means to repay their obligations over time, and that therefore reduce crisis-risk ex-ante, can be more desirable from a macroeconomic stabilization point of view than ex-post policies such as bailouts or debt restructurings.

To our knowledge, our model is the first to provide an internally consistent mechanism linking the empirically observed rise in income inequality between high income households and poor to middle income households, the increase in household debt-to-income ratios among the latter group, and the risk of a financial crisis. In doing so it also provides a very general framework for investigating the role of income inequality as an independent source of macroeconomic fluctuations.

Our model economy consists of investors, workers, and firms that operate a production technology which combines the capital supplied by investors with the labor supplied by workers. The relative bargaining powers of the two household groups determine their shares in aggregate income. To capture the propensity of the rich to save additional income - a key transmission channel of our model - we follow Carroll (2000) and others by assuming that investors value asset holdings as well as consumption. We show that under a plausible baseline calibration a negative shock to the bargaining power of workers can generate an increase in workers' debt-to-income ratios of the order of magnitude observed in the data, thereby leading to a significant increase in crisis risk. The mechanism is very robust to alternative specifications. It holds in the case of a persistent but slowly mean reverting negative shock to the bargaining power of workers, but also in the case of a permanent shock. A number of factors can aggravate the increase in debt-to-income ratios and crisis risk, including larger or more persistent losses in workers' bargaining power, a greater aversion by workers to drops in consumption, and a lower propensity by investors to use their income gains for physical rather than financial investment. Default during crises provides some relief to workers, but if it is accompanied by a collapse in real activity the effect on workers' debt-to-income ratios can be small, because of falling real wages and high post-crisis interest rates. An orderly debt restructuring, by minimizing the output costs and therefore the drop in real wages in crises, can reduce debt-to-income ratios more significantly. But it does not prevent debt from resuming an upward trajectory after the crisis if workers see few prospects of an early recovery in bargaining power. Restoration of the lower income group's bargaining power on the other hand implies a sustained downward path of debt-to-income ratios.

The paper integrates two strands of the literature that have largely been evolving separately, the literature on income and wealth distribution and the literature on financial fragility. The first literature is mostly focused on accurately describing long run changes in the distribution of income and wealth (Piketty and Saez (2003), Piketty (2010)). One of its main findings is that the most significant change in the U.S. income distribution has been the evolution of top income shares. This feature is taken on board in our model, which features two groups representing the top stratum and the remainder of the income distribution.

A companion literature seeks to uncover the fundamental factors shaping the change in the income distribution in the United States over the last thirty years. Lemieux, MacLeod and Parent (2009) find that an increase in the share of performance pay (e.g. bonuses) can explain 20% of the growth in the variance of male wages between the late 1970s and the early 1990s, and almost all of the growth in wage inequality at the very top end of the income distribution.[1] Lemieux (2006) shows that the dramatic increase in the return to post-secondary education plays an important role in the increase in income inequality and can explain why wage gains are disproportionately concentrated at the top of the distribution. Card, Lemieux and Riddell (2004) find that changes in unionization can explain around 14% of the growth in the variance of male earnings in the United States. Borjas and Ramey (1995) and Roberts (2010) point to the role of foreign competition and jobs offshoring in the rise of income inequality. Finally, Hacker and Pierson (2010) stress the role of government intervention in support of the rich.

Our paper focuses only on the macroeconomic implications of increased income inequality. Therefore, rather than taking a stand on the microeconomic reasons for that increase, it represents more fundamental shocks by way of a shock to the relative bargaining powers of the two income groups. A similar reduced-form modeling device is employed by Blanchard and Giavazzi (2003), where labor market deregulation is formalized as a reduction in the bargaining power of workers.

The literature on financial fragility has so far ignored the role of income heterogeneity in creating crisis risk. In the canonical Diamond and Dybvig (1983) crisis model, the relevant heterogeneity is that between patient and inpatient consumers, which also features prominently in financial accelerator models applied to household debt and housing cycles (Iacoviello (2005)). In this paper we argue that, because increases in household debt-to-income ratios, which increase financial fragility, have been strongly heterogenous between the rich and all remaining households, heterogeneity in incomes is a key additional feature that should be explored in models of household debt and financial fragility.

The link between income inequality, household indebtedness and crises has been recently discussed in opinion editorials by Paul Krugman, and in books by Rajan (2010) and Reich (2010). Both authors suggest that increases in borrowing have been a way for the poor and the middle-class to maintain or increase their level of consumption at times when their real

[1] See also Gabaix and Landier (2003), who document a six-fold increase in CEO pay between 1990 and 2003.

earnings were stalling. But these authors do not make a formal case, in the form of a general equilibrium model, to support that argument. We think that this matters. The reason is that the current debate about the driving forces behind the historical increase in U.S. household debt is conducted among competing partial equilibrium views. On the one hand, Rajan (2010) emphasizes the role of (government supported) credit demand. His argument is that growing income inequality created political pressure, not to reverse that inequality, but instead to encourage easy credit to keep demand and job creation robust despite stagnating incomes. On the other hand Acemoglu (2011)[2] claims that the main driving force was an increase in credit supply that was caused by financial deregulation. Our model can reconcile these views in a general equilibrium framework. It comes to the conclusion that, in general, at any given interest rate credit demand and credit supply increased simultaneously due to a more fundamental shock, a shift in bargaining powers over income away from the poor and the middle-class. But the relative importance of credit demand and credit supply depend on the nature of the shock process and the nature of preferences. For a baseline specification, the increase in credit demand is due to lower income households' attempts to smooth consumption in the face of temporarily lower incomes, while the increase in credit supply reflects additional financial investments by the rich in the face of increasing incomes.

There are of course other candidate explanations for the origins of the 2007 crisis, and many have stressed the roles of excessive financial liberalization and of asset price bubbles.[3] Typically these factors are found to have been important in the final years preceding the crisis, when debt-to-income ratios increased more steeply than before. But it can also be argued, as done in Rajan (2010), Reich (2010) and this paper, that much of this was simply a manifestation of an underlying and longer-term dynamics driven by income inequality.

It has been suggested that the increase in wealth of the richest households has played a role in increasing the demand for investment assets. In our model, the financial sector intermediates funds between the increasingly richer top fraction and the increasingly more indebted bottom fraction of the population. As the flow of funds between the two groups increases, so does the size of the financial sector as measured by total assets or total liabilities over GDP. This fact is consistent with recent findings by Philippon (2008).

[2] See also Levitin and Wachter (2010).

[3] Keys, Mukherjee, Seru and Vig (2010) discuss the adverse effects of increased securitization on systemic risk. Taylor (2009) claims that the interaction of unusually easy monetary policy with excessive financial liberalization caused the crisis. Obstfeld and Rogoff (2009) claim that the interaction of these factors with global current account imbalances helped to create a "toxic mix" that helped to set off a worldwide crisis.

A recent literature has related the rise in income inequality to the increase in household debt (Krueger and Perri (2006), Iacoviello (2008)). In these authors' approach an increase in the variance of idiosyncratic income shocks across all households generates a higher demand for insurance through credit markets, thereby increasing household debt. Their approach therefore emphasizes an increase in income inequality experienced within household groups with similar characteristics, while our paper focuses on the rise in income inequality between two household groups. There is a lively academic debate concerning the relative roles of within- and between-group factors in shaping inequality. But our paper only focuses on changes in one specific type of between-group inequality that can be clearly documented in the data, namely inequality between high income households and everyone else. Furthermore, we focus on differences in income that are persistent over the medium and longer run rather than on transitory differences at business cycle frequencies. This emphasis is supported by the recent work of Kopczuk, Saez and Song (2010), who show that the increase in the variance of annual earnings observed since 1970 reflects an increase in the variance of permanent rather than transitory earnings.

The rest of the paper is organized as followed. Section 2 discusses a number of key stylized facts. Section 3 presents the model. Section 4 shows model simulations, to study the effects of increasing income inequality, and to discuss policy implications. Section 5 concludes.

2. Stylized Facts

This section documents a number of key stylized facts regarding the evolution of the distribution of income and consumption, changes in household debt-to-income ratios overall and for different groups, and the size of the financial sector.

Income Inequality and Household Debt: 1929 vs. 2007

Figure 1 plots the evolution of U.S. income inequality and household debt-to-income ratios in the decades preceding the 1929 and 2007 crises. In both periods income inequality experienced a sharp increase of similar magnitude: the share of total income (excluding capital gains) commanded by the top 5% of the income distribution increased from 24% in 1920 to 34% in 1928, and from 22% in 1983 to 34% in 2007. During the same two periods, the ratio of household debt to GNP or to GDP increased dramatically. It almost doubled between 1920 and 1932, and also between 1983 and 2007, when it reached much higher levels than in 1932. In short the joint evolution of income inequality across high and low income groups on the one hand, and of household debt-to-income ratios on the other hand, displays a remarkably similar pattern in both pre-crisis eras.

Income Inequality and Consumption Inequality

The macroeconomic consequences of rising income inequality, and especially its implications for debt and financial fragility, depend critically on how consumption inequality responds to income inequality.[4]

Figure 2, which is based on a comprehensive dataset compiled by Heathcote, Perri and Violante (2010), plots the cumulative percentage changes in real male annual earnings between 1980 and 2005 for three deciles of the distribution of wage earnings: the bottom decile, the decile surrounding the median, and the top decile. It illustrates the large widening of wage inequality over recent decades. Real earnings of the top decile increased sharply by a cumulative 42%, real earnings around the median declined by around 7%, while earnings of the bottom decile declined strongly, by around 31%. Inequality between the median and the bottom decile reflects not only a lower hourly real wage, which for this group declined by around 25% over the same period, but also lower hours and unemployment. Inequality between the median and the top decile reflects the sharp divergence in compensation patterns mentioned in Section 1 (Lemieux (2006), Lemieux, MacLeod and Parent (2009)). In the context of our theoretical framework, we take a stylized representation of this change in the relative distribution of earnings as the key shock to our model economy.

Figure 3, which is based on data from Krueger and Perri (2006), documents the evolution of inequality in disposable incomes and in consumption between 1980 and 2006. The graph plots the ratio of disposable incomes and the ratio of non-durable consumption levels between the top and the bottom decile of the disposable income distribution. An important finding, already stressed by Slescnik (2001), is that the increase in income inequality has been much more pronounced than the increase in consumption inequality.[5]

Income Mobility

To better understand the different evolutions of income inequality and consumption inequality, it is important to assess the importance of intra-generational income mobility. In theory, if increasing income inequality was accompanied by an increase in income mobility, the dispersion in lifetime earnings might be much smaller than the dispersion in annual

[4]The rise in U.S. income inequality has been documented since at least Gottschalk and Moffit (1994).

[5]This fact has been confirmed in Heatcote, Perri and Violante (2010) and Blundell, Pistaferri and Preston (2008). Aguiar and Bils (2011) point out however that differences between the evolution of consumption inequality and income inequality can be partly driven by measurement issues.

earnings, as agents move up and down the income ladder throughout their lives. This is a potential explanation for why consumption inequality has been lower than income inequality. However, the data show that income mobility has not been increasing in the United States over the last 40 years, including mobility between the top income group and the remainder that we care about in this paper.

A recent study by Kopczuk, Saez and Song (2010)[6] shows that measures of short-term and long-term income mobility in the United States have been either stable or slightly worsening since the 1950s. First, these authors find that the surge in top earnings is not accompanied by increased mobility between the top income group and other groups, as the probability of staying among the top 1% of earnings after 1, 3 or 5 years shows no overall trend since the top share started to be coded in Social Security Data (1978). Second, measuring earnings inequality as the variance of annual log earnings, they show that virtually all of the increase in that variance over recent decades has been due to an increase in the variance of permanent earnings (five-year log-earnings) rather than the variance of transitory earnings (five-year log earnings deviation).[7] This implies that the evolution of annual income inequality over time is very close to the evolution of longer-term income inequality. Figure 4, which uses the data of Kopczuk, Saez and Song (2010), illustrates this result by plotting, starting in 1980, the variances of annual log-earnings, permanent earnings and transitory earnings.

These findings together provide support for one of our simplifying modeling choices, the assumption of two income groups with fixed memberships.

Income Inequality and Household Debt-to-Income Ratios

In the absence of changes in the valuation of household assets and liabilities, a smaller increase in consumption inequality relative to income inequality must imply that households at the bottom of the distribution of income are becoming more indebted than households at the top. Figure 5 shows this by plotting the evolution of debt-to-income ratios for the top 5% and bottom 95% of households, ranked by income, between 1983 and 2007.[8]

In 1983, the top income group is somewhat more indebted than the bottom group, with a gap of around 10 percentage points. In 2007, the situation is dramatically reversed: the debt-

[6] See also Bradbury and Katz (2002).

[7] Their results are based on Social Security micro-level data. They differ strongly from the previous results, based on PSID data, of Gottschalk and Moffit (1994) and Blundell, Pistaferri and Preston (2008), who attribute a much larger role to increases in the variance of transitory earnings.

[8] The debt-to-income ratios are computed using micro-level data from the Survey of Consumer Finance. They equal the ratios, for the two household groups separately and for the overall economy, between the sum of all gross debt liabilities and the sum of all incomes including capital gains.

to-income ratio of the bottom group, at around 150% compared to an initial value of 64%, is now more than twice as high as the debt-to-income ratio of the top group. Between 1983 and 2007, the debt-to-income ratio of the bottom group has therefore more than doubled while the ratio of the top group has remained fluctuating around 60%.[9] As a consequence almost all of the increase in the aggregate debt-to-income ratio is due to the bottom group of the income distribution. Once again this provides strong motivation for introducing income heterogeneity into a model of household indebtedness and financial fragility.

It is sometimes argued that the more recent increases in household debt, which consisted mostly of mortgage loans, represented borrowing against houses whose fundamental value had risen, so that net debt increased much less than gross debt, and debt-to-net-worth ratios would give a better indication of debt burdens than debt-to-income ratios. There are two responses to this argument. First, a similar pattern to Figure 5 is also observed in debt-to-net worth ratios. Second, the direction of causation between credit and house prices is of critical importance. Two recent empirical papers, Mian and Sufi (2009) and Favara and Imbs (2010), argue that causation ran from credit to house prices, specifically that credit supply shocks caused house prices to increase above fundamental values.[10] Consequently, when credit contracted after 2007, mortgage delinquencies reached magnitudes unprecedented since the Great Depression, with the share of past due mortgage loans surging past 10% in 2009.

In light of these facts we abstract from collateralized borrowing and focus on debt-to-income ratios, both in our discussion of the data and in our theoretical model. The model features default probabilities that increase with debt-to-income ratios.

The Size of the U.S. Financial Sector

In our theoretical framework, the increase in debt of the bottom 95% of the income distribution generates an increasing need for financial intermediation. Figure 6 plots two measures of the size of the U.S. financial sector between 1980 and 2007. The left panel plots the standard measure of private credit by deposit banks and other financial institutions to GDP. It more than doubled over the period, increasing from 90% in 1981 to 210% in 2007. The right panel plots the share of the financial sector in GDP as constructed by Philippon (2010). According to this measure the financial sector almost doubled in size between 1981

[9] A very similar graph is obtained when households are ranked by wealth percentiles rather than by income percentiles.

[10] Mian and Sufi (2009) also document that, in U.S. counties with a high share of subprime loans, income growth and credit growth were negatively correlated. This suggests that, as in our model, low incomes rather than high house prices drove the increase in credit.

and 2007, and most recently accounted for an extraordinary 8% of U.S. GDP. A similar pattern was again observed prior to the Great Depression.

3. The Model

The model economy consists of two groups of infinitely-lived households, referred to as investors and workers, and of firms that operate a production technology which combines the capital supplied by investors with the labor supplied by workers.

A. Investors

The share of investors in the overall population equals χ, which we will calibrate at 0.05. They derive utility from consumption and wealth.

Utility from consumption c_t^i features an intertemporal elasticity of substitution parameter σ_i, but differs from the conventional CRRA form in that it is subject to a subsistence, or minimum acceptable, level of consumption $\tilde{c}_{\min}^i$ that we set equal to 50% of investors' initial steady state consumption. The interpretation of subsistence consumption is that most individuals have arranged their affairs in such a manner that a precipitous drop in consumption would be disastrous, such as a drastic loss of status or, in the case of workers below, destitution and homelessness. The effect of subsistence consumption is to reduce the effective intertemporal elasticity of substitution below σ_i and thereby to amplify the consumption responses to bargaining power shocks. Similar increases in debt-to-income ratios to the ones we report for our baseline of fixed subsistence consumption can therefore be obtained by assuming conventional CRRA utility functions (for both investors and workers) with very low intertemporal elasticities, and also by assuming CRRA utility functions with conventional values for intertemporal elasticities but combined with larger bargaining power shocks. The main reason for specifying a baseline with fixed subsistence consumption is that this provides a natural starting point for our subsequent discussion of time-varying adaptive subsistence consumption, which represents an alternative to habit persistence, as part of our sensitivity analysis.

Wealth in the utility function has been used by a number of authors including Carroll (2000), who refers to it as the "capitalist spirit" specification, Reiter (2004), and Piketty (2010). The reason for introducing this feature is that models with standard preferences have difficulties accounting for the saving behavior of the richest households. For instance, for the United States Carroll (2000) shows, using data from the Survey of Consumer Finance, that the life cycle/permanent income hypothesis model augmented with uncertainty proposed by Hubbard, Skinner and Zeldes (1994) can match the aggregate saving behavior only by over-predicting the saving behavior of median households and by underpredicting the saving behavior of the richest households.[11] By contrast models featuring wealth in the utility function can match both the aggregate data and the wealth accumulation patterns of the wealthiest households. Piketty (2010) shows similar results for France. Reiter (2004) confirms the finding of Carroll (2000) but also suggests a role for the idiosyncratic return risk that rich households face from closely held businesses. Kopczuk (2007) shows that terminally ill wealthy individuals actively care about the disposition of their estates, but that this preference is dominated by the desire to hold on to their wealth while alive. Finally, Dynan, Skinner and Zeldes (2004) find little empirical support for models in which heterogeneities in saving behavior reflect only differences in rates of time preference.

Wealth in the utility function can represent a number of different saving motives. One is as a reduced form for precautionary savings, because wealth provides security in the presence of uninsurable lifetime shocks. Our preferred interpretation is that agents derive direct utility from the prestige, power and social status conferred by wealth.

Wealth in our model can take two forms, physical capital held from period t to $t+1$ and denoted by k_t, and financial investments, or deposits, held from t to $t+1$ and denoted by d_t. Financial intermediation turns deposits into loans to workers $\ell_t = (\chi/ (1-\chi))d_t$. Utility from deposits is assumed to take the log-form that is common in studies of money demand. Utility from physical capital is assumed to take a Stone-Geary form, with utility derived from the logarithm of the sum of physical capital and a constant κ that determines the sensitivity of desired capital investment to changes in income. We will study how our results depend on the value taken by κ. In the event of a crisis, which happens with a probability π_t that will be discussed below, at the beginning of period $t+1$ a share $1-\gamma_{k_t} \geq 0$ of physical capital is destroyed and a share $1-\gamma_\ell > 0$ of loans is defaulted upon, meaning that investors lose the deposits backed by those loans.

[11] An alternative model of saving behavior is the dynastic model (Barro (1974)), in which dynasties maximize the discounted sum of life-time utilities of current and future generations. Carroll (2000) surveys evidence suggesting that this model does not do well in explaining the saving decisions of the richest households.

The lifetime utility function is

$$U_0^i = E_0 \sum_{t=0}^{\infty} \beta_i^t \left[\frac{(c_t^i - \tilde{c}_{\min}^i)^{\left(1-\frac{1}{\sigma_i}\right)}}{\left(1-\frac{1}{\sigma_i}\right)} + \xi_d \log(d_t) + \xi_k \log(\kappa + k_t) \right] , \tag{1}$$

where ξ_d and ξ_k are the utility weights attached to wealth holdings.[12] With this specification wealth in the utility function has two major effects in our model. First, it means that a unique steady state for financial investments d_t can be determined.[13] Second, investors are prepared to support a much larger debt accumulation by workers, through their willingness to acquire utility-yielding financial assets backed by loans to workers.

Investors are the owners of the economy's entire stock of physical capital, whose law of motion is given by

$$k_t = (1-\delta)\Im_{k_t} k_{t-1} + I_t \ . \tag{2}$$

Here I_t represents physical investment, and $\Im_{k_t}$ is an index that equals γ_{k_t} in the event of a crisis, and 1 otherwise. The parameter of capital destruction $(1 - \gamma_{k_t})$ in our model is almost identical to the crisis-related shock to the quality of capital in Gertler and Kiyotaki (2010) and Gertler and Karadi (2010), or to the shock used by Gourio (2010) to characterize the real effects of rare disasters.[14] Gertler and Kiyotaki (2010) interpret this disturbance as obsolescence rather than just physical depreciation. An alternative interpretation is that crises are typically periods of large and costly reallocations of people and equipment within and across sectors (Ellis and Francois (2003)), and periods of destruction of intangible capital embodied in matches between firms, banks, employees and consumers (Gourio (2010)).

Turning to the budget constraint, we assume that investors do not engage in wage labor, and instead derive all of their income from their ownership of the physical capital stock and from interest on loans to workers. This assumption is made to keep the model parsimonious, but it is not strictly necessary for our main results and could be relaxed to allow for some

[12] In the standard model with wealth in the utility function (Caroll (2000)), life is finite and agents value end-of-life wealth. In our model agents are infinitly-lived and derive utility from holding wealth in every period. The utility weights ξ_d and ζ_k therefore have a different interpretation.

[13] Because physical capital is held exclusively by investors, a unique steady state capital stock exists without capital entering the utility function. But capital in the utility function is nevertheless desirable given the above mentioned empirical arguments, and also because it will give us a natural way to discuss the effects of "financialization" of the economy below. When the two assets enter the utility function additively, a unique steady state for financial assets does not exist.

[14] This feature is borrowed from Merton (1973), who used it to introduce an exogenous variation in the value of capital. In Gertler and Kiyotaki (2010) and Gourio (2010), the shock takes the form $k_t = \Im_{k_t}((1-\delta)k_{t-1} + I_t)$, so that both inherited and newly installed capital are destroyed.

wage labor in this sector. If modeled as a third factor of production, this could for example capture the role of highly paid corporate executives.

We let q_t be the time t price of a deposit that pays off one unit of output in period $t+1$, $\Im_{\ell_t}$ equals γ_ℓ in the event of a crisis and 1 otherwise, and we denote the return to capital k_{t-1} by r_t^k. Then the investor's budget constraint is given by

$$d_t q_t = \Im_{\ell_t} d_{t-1} + r_t^k \Im_{k_t} k_{t-1} - c_t^i - I_t \; . \tag{3}$$

Investors maximize (1) subject to (2) and (3). Letting λ_t^i be the multiplier of the budget constraint, the optimality conditions for consumption, capital and deposits are given by

$$\left(c_t^i - \tilde{c}_{\min}^i\right)^{-\frac{1}{\sigma_i}} = \lambda_t^i \;\; , \tag{4}$$

$$\begin{aligned} 1 \;\; = \;\; & (1-\pi_t)\,\beta_i E_t^{nocr}\left(\frac{\lambda_{t+1}^{i,nocr}\left(r_{t+1}^{k,nocr}+1-\delta\right)}{\lambda_t^i}\right) \\ & +\pi_t\beta_i E_t^{cr}\left(\frac{\lambda_{t+1}^{i,cr}\left(r_{t+1}^{k,cr}+1-\delta\right)\gamma_{k_t}}{\lambda_t^i}\right)+\frac{\xi_k}{\lambda_t^i\left(\kappa+k_t\right)} \;\; , \end{aligned} \tag{5}$$

$$1 = (1-\pi_t)\,\beta_i E_t^{nocr}\left(\frac{\lambda_{t+1}^{i,nocr}}{\lambda_t^i q_t}\right) + \pi_t\beta_i E_t^{cr}\left(\frac{\lambda_{t+1}^{i,cr}\gamma_\ell}{\lambda_t^i q_t}\right) + \frac{\xi_d}{\lambda_t^i d_t q_t} \;\; , \tag{6}$$

where the superscripts *nocr* and *cr* refer to variables, and the corresponding expectations operators, conditional on being in the no-crisis and crisis states in period t+1. These optimality conditions represent investors' three margins for investing additional funds gained in bargaining over incomes, namely higher consumption, higher physical investment, and higher financial investment.

B. Workers

The share of workers in the overall population equals $1-\chi$, which we will calibrate at 0.95. They derive utility from consumption, with the same functional form as investors' consumption utility, and the same type of subsistence consumption level equal to 50% of initial steady state consumption. We use the same notation as for investors, with the index

w replacing the index i. Wealth does not enter utility.[15] Workers inelastically supply one unit of labor per capita. Lifetime utility is given by

$$U_0^w = E_0 \sum_{t=0}^{\infty} \beta_w^t \frac{\left(c_t^w - \tilde{c}_{\min}^w\right)^{\left(1-\frac{1}{\sigma_w}\right)}}{\left(1-\frac{1}{\sigma_w}\right)} . \tag{7}$$

Workers maximize this utility subject to the budget constraint

$$\ell_t q_t = \Im_{\ell_t} \ell_{t-1} + c_t^w - w_t , \tag{8}$$

where ℓ_t denotes loans obtained from investors and w_t is the real wage.

Workers default on their loan obligations at time $t+1$ with a positive probability π_t that is taken as given by all households, known by time t, and increasing in workers' debt-to-income ratio according to a logistic function plus a very small positive constant ε. We will henceforth refer to the debt-to-income ratio as leverage. Because default events, or financial crises, are assumed to be accompanied by real crises in which the capital stock is impaired, we will refer to π_t not as the default probability but more broadly as the crisis probability. Part of our analysis will consist of experiments that vary the relative sizes of the financial and real components of crises.

The logistic function bounds the crisis probability between ε and 1, and over the relevant range it implies a crisis probability that is convex in leverage. The leverage that affects the probability of a crisis in period $t+1$ equals the ratio of workers' loans outstanding at the end of period t to their net income in period t, where the latter is defined as their time t wage income minus their net interest obligations on loans outstanding between periods t and $t+1$. We have

$$\pi_t = \varepsilon + \frac{\exp\left(\phi_0 + \phi_1\left(\frac{\ell_t}{w_t - \left(\frac{1}{q_t}-1\right)\ell_t}\right)\right)}{1+\exp\left(\phi_0 + \phi_1\left(\frac{\ell_t}{w_t - \left(\frac{1}{q_t}-1\right)\ell_t}\right)\right)} \quad , \quad \pi_t \leq 1 . \tag{9}$$

The presence of the constant ε ensures that the default probability reaches one at a finite level of debt, and therefore imposes an upper debt limit.[16] A lower debt limit follows from the presence of deposits in investors' utility function, which implies that investors are always

[15] Alternatively, workers may have a wealth motive, but at the levels of wealth they attain this motive is not operative. See Carroll (2000).

[16] See Aiyagari et al. (2002) on debt limits in models with non-contingent debt. The precise value of the upper debt limit is $\bar{\ell}_t = \Psi w_t / \left(1 + \Psi\left((1/q_t) - 1\right)\right)$, where $\Psi = \left(\ln\left((1-\varepsilon)/\varepsilon\right) - \phi_0\right)/\phi_1$.

willing to lower lending interest rates sufficiently to keep deposits and therefore debt positive. With these debt limits it can be shown that a standard transversality condition on debt holds. We adopt the simple specification (9) of the leverage-crisis link in the interest of keeping the model tractable.[17] A relationship between leverage and crisis probability such as (9) arises endogenously in crisis models such as Schneider and Tornell (2004).[18]

At this point it is useful to point out that, while our simple specification of π_t gives us a useful and intuitive way to link high leverage and crises, the main contribution of this paper is in modeling the mechanism whereby higher inequality causes high leverage. This link does not depend on the specific way in which we model crises, and in fact, as we will demonstrate, the model can easily be simulated assuming that the probability of crises is constant and independent of leverage. This however would miss an important aspect of the problem, as high leverage is clearly linked empirically to higher financial fragility and therefore to the probability of crises.

Workers' optimality conditions for consumption and loans are given by

$$\left(c_t^w - \tilde{c}_{\min}^w\right)^{-\frac{1}{\sigma_w}} = \lambda_t^w \ , \tag{10}$$

$$1 = \left(1-\pi_t\right)\beta_w E_t^{nocr}\left(\frac{\lambda_{t+1}^{w,nocr}}{\lambda_t^w q_t}\right) + \pi_t \beta_w E_t^{cr}\left(\frac{\lambda_{t+1}^{w,cr}\gamma_\ell}{\lambda_t^w q_t}\right) \ . \tag{11}$$

These conditions represent the two margins available to workers for absorbing negative income shocks, namely a reduction in consumption and increased borrowing.

C. Firms

Firms are owned by investors, and operate the economy's aggregate production technology, which is given by

$$y_t = A\left(\chi \Im_t^k k_{t-1}\right)^\alpha \left(h_t\right)^{1-\alpha} \ , \tag{12}$$

where A is a scale factor that will be used to normalize the economy's calibrated steady state output level. We assume that the number of firms equals the number of workers, and

[17] Davig, Leeper and Walker (2010) have, in a different context, adopted an almost identical approach. In their paper the probability of collapse of an initial fiscal regime follows an exogenous logistic function that is increasing in tax rates, and upon collapse the tax rate defaults to an exogenous constant value.

[18] One possibility for a more complex framework is that financial intermediaries borrow short-term from investors in order to lend long-term to both entrepreneurs (project loans) and households (mortgages). In that case a self-fulfilling run on bank liabilities, along the lines of Diamond and Dybvig (1983), could simultaneously generate costly capital liquidations and household debt defaults due to fire sales.

that all firms, and all workers, are identical. Factor returns are determined by the outcome of a decentralized but segmented Nash bargaining problem over the real wage, where firms negotiate on behalf of their owners, investors. Specifically, at the beginning of each period each firm is matched with exactly one worker, and each pair then bargains over the real wage. If bargaining fails, no output is produced, no wage is paid, and agents have to wait one period before being able to bargain again. Workers' outside option is assumed to be zero. Denoting workers' bargaining power by η_t, we have

$$\underset{w_t}{Max} \quad (W_{h_t})^{\eta_t} (K_{h_t})^{1-\eta_t} \ , \tag{13}$$

where $W_{h_t} = \lambda_t^w w_t$ is the workers' surplus, and $K_{h_t} = f_{h_t} - w_t$ is the investors' surplus. The marginal product of labor f_{h_t} is in turn given by $f_{h_t} = (1-\alpha) y_t / h_t$. The first-order condition of the bargaining problem simplifies to

$$w_t = \eta_t f_{h_t} \ . \tag{14}$$

In other words, the real wage equals workers' bargaining power times the marginal product of labor. This implies that η_t can fall into the interval $\eta_t \in [0, \frac{1-\chi}{1-\alpha}]$. The standard competitive (and efficient) outcome obtains at a bargaining power of one. We assume that workers' bargaining power follows an autoregressive stochastic process that is given by

$$\eta_t = (1-\rho)\,\bar{\eta} + \rho \eta_{t-1} + e_t^{\eta} \ . \tag{15}$$

D. Equilibrium

In equilibrium investors and workers maximize their respective lifetime utilities, and the following market clearing conditions for goods, labor and financial claims hold:

$$y_t = \chi \left(c_t^i + I_t \right) + (1-\chi)\, c_t^w \ , \tag{16}$$

$$h_t = 1 - \chi \ , \tag{17}$$

$$(1-\chi)\, \ell_t = \chi d_t \ . \tag{18}$$

E. Calibration

Because our study concerns longer-run phenomena, we calibrate the model at the annual frequency. Utility from consumption takes an identical form across agents, with intertemporal elasticity parameters equal to $\sigma_i = \sigma_w = 0.5$. Together with a subsistence level of consumption equal to 50% of steady state consumption this implies that the effective intertemporal elasticity of substitution is considerably smaller than 0.5. The steady-state real interest rate $((1/\bar{q}) - 1)$ is fixed at 5% per annum, similar to values typically used by the RBC literature, by endogenizing workers' time preference β_w. Given the presence of positive capitalist spirit terms in the utility function of investors, β_i is lower than β_w. The utility weight on financial wealth ξ_d is then determined by imposing an initial steady-state loans-to-income ratio for workers of 64%, consistent with the U.S. value in 1983. The utility weight on physical capital is determined by imposing an initial steady-state gross financial return to capital of 15% per annum, equal to the sum of the real interest rate and the depreciation rate δ, which equals 10% per annum. Finally, the Stone-Geary constant in the utility for physical capital,which affects the elasticity of capital's response to bargaining power shocks, is set at $\kappa = -30$. We will experiment with alternative values for κ.

In the aggregate technology, we normalize steady-state output to one through our choice of the parameter A. We set the capital share parameter equal to $\alpha = 0.27$, which generates a steady-state investment-to-GDP ratio of 18%, consistent with U.S. data. It also implies an initial steady-state income share of investors of 29.8%. As mentioned in Section 2, in the United States this income share equalled 22% in the early 1980s and 34% in recent times. By assuming a steady state bargaining power of $\bar{\eta} = 1$ we replicate the competitive outcome, and the standard deviation of bargaining power shocks is assumed to equal $\sigma_\eta = 0.01$. As there is little guidance from the literature regarding an appropriate value for σ_η, we will also present the case $\sigma_\eta = 0$ in our baseline simulation, so that the implications of intermediate values of σ_η can be inferred by comparing the two simulations. In the same baseline simulation we will also explore the case of $\sigma_\eta = 0$ combined with π_t constant and equal to the crisis risk in the original steady state.

A crisis event is characterized by the probability of its occurrence, and by the size of the collapses in loans and capital, and therefore in output, if it does occur. We set the two coefficients of the logistic function to $\phi_0 = -7.5$ and $\phi_1 = 3$. As illustrated in Figure 7, this produces a baseline crisis probability of 0.38% at a leverage of 64%, and a convex relationship between leverage and the crisis probability that reaches almost 5% at a leverage of 150%.

This range is consistent with the probability of major disaster events estimated by Barro (2006), who finds a range of 1%-2.5%, and by Rancière, Tornell and Westermann (2008), who estimate 4% for the period 1980-2000.[19] Next we calibrate the size of disaster events, that is of major defaults on loans and of output collapses. Based on International Monetary Fund (2009), the reductions in the level of output associated with major financial crises that coincided with real crises have averaged 3.4%. We generate a comparable output collapse by assuming capital destruction in the event of a crisis equal to 10% of the pre-existing capital stock, $\gamma_{k_t} = 0.9$. Given the capital share parameter in the technology this leads to an output collapse of around 2.7%. Clearly the ability of our simple model to generate large output collapses is limited by the fact that it does not allow for increases in unemployment at times of crises. To test the sensitivity of our results to the assumption of $\gamma_{k_t} = 0.9$ we will also explore an alternative scenario where the capital destruction only equals 1%, or $\gamma_{k_t} = 0.99$. The percentage of loans defaulted upon during the crisis is based on the U.S. experience, up to this point, with the financial crisis that started in 2007. This crisis has seen mortgage past due rates approaching 10%. We therefore set $\gamma_\ell = 0.9$.

We impose two boundedness conditions that ensure that shocks never get large enough to make the subsistence inequality constraints $c_t^i - \tilde{c}_{\min}^i \geq 0$ and $c_t^w - \tilde{c}_{\min}^w \geq 0$ binding. First, we assume that γ_{k_t} is bounded such that capital destruction shocks can at most reduce the capital stock to $\underline{k}$, where $\underline{k}$ equals 80% of the economy's initial steady state capital stock. Specifically, $\gamma_{k_t} = \gamma_k = 0.9$ if $k_{t-1} \geq \underline{k}/\gamma_k$, $\gamma_{k_t} = \underline{k}/k_{t-1}$ if $k_{t-1} \in (\underline{k}, \underline{k}/\gamma_k)$, $\gamma_{k_t} = 1$ otherwise. Second, we truncate the distribution of bargaining power shocks such that $\eta_t \in [0.8, 1.15]$.

F. Solution Method

The above model has two features that make it unsuitable for the application of conventional perturbation methods. The first is the presence of large and discrete crisis events, which under our calibration imply jumps in state variables of up to 10%. The second is the fact that the model's two endogenous state variables, capital and loans, are extremely persistent, and are then subjected to large bargaining power shocks, which means that they can drift far away from their original steady state for a very long period. It is therefore necessary to apply a global solution method.

[19] Applied to the 2007 crisis this quite low perceived probability seems appropriate given the evident surprise of a majority of commentators at the outbreak of the crisis. It is a separate question whether this assessment was realistic, given the historically unprecedented household leverage ratios in 2007, even when compared to the Great Depression.

Our model has three continuous state variables (capital, loans and bargaining power) and one binary state variable (crisis or no crisis). This is sufficiently tractable to permit the use of functional iteration on a discretized state space to compute solutions. Specifically, we use the monotone map method of Coleman (1991), which has recently been used in a number of papers by Davig, Leeper and Walker.[20] The monotone map method discretizes the state space and finds a fixed point in decision rules for each grid point in the state space. It substitutes a set of conjectured decision rules into the model's intertemporal Euler equations, and iterates until the iteration improves the current decision rule at any given state vector by less than some ϵ. As initial conjectures we use decision rules computed by DYNARE for a first-order approximation of the model. These conjectures are applied to a version of the nonlinear model with only a small fraction of the full standard deviation σ_η, and with a narrow grid for the state space, based on the fact that for a sufficiently small standard deviation the solutions are approximately linear. Both the standard deviation and the grid width are then sequentially increased, and at each step the results of the previous iteration, appropriately scaled up or down to account for the wider spacing of grid points, are used as initial guesses. Numerical integration is used to compute expectations.

In our baseline simulation we present 50-year impulse responses for a standardized realization of bargaining power and crisis shocks, namely an initial decline in workers' bargaining power from $\bar{\eta} = 1$ over a period of 10 years, followed by a very gradual return to $\eta = 1$, and a crisis event in year 30. This can be thought of as a highly stylized representation of the events preceding either 1929 or 2007. Sensitivity analysis varies a number of aspects of this shock sequence.

4. Simulated Scenarios

Figure 8 presents a baseline simulation, and Figures 9-13 present a number of alternatives. The objective of these simulations, which broadly replicate the patterns observed prior to 1929 and 2007, is to illustrate the different mechanisms by which higher income inequality can lead to higher leverage and higher crisis risk, and to discuss different channels through which high leverage can eventually be reduced. The sensitivity analysis highlights the dependence of our conclusions on the size and persistence of bargaining power shocks, the structure and calibration of household preferences, and other aspects of calibration and model structure.

[20] See Davig (2004), Davig and Leeper (2006, 2007) and Davig, Leeper and Walker (2010).

We find that our core mechanism is very robust to these alternatives, some of which are in the interest of brevity only discussed verbally.[21]

The horizontal axis represents time, with the shock hitting in year 1 and the final period shown being year 50. Simulations are initiated at the state vector of the steady state of the model with $\sigma_\eta = 0$, so that the simulations represent not only the effects of a particular sequence of shocks, but also the effects of a transition from a regime with stable bargaining power to a regime with volatile bargaining power. The vertical axis shows percent deviations from the initial steady state for real stock and flow variables, percentage point deviations for rates of return, percentage points for leverage, crisis probability, the interest expense to income ratio, and the income and consumption shares of investors, and simple ratios for the relative per capita income and consumption levels of investors and workers.

A. Baseline Scenario

Overview

Figure 8 presents our baseline scenario, which features a cumulative 7.5% decline in workers' bargaining power over the first 10 years, followed by a very slow reversal back to $\eta = 1$ determined by the autogressive parameter $\rho = 0.96$. The crisis event happens in year 30, and features 10% collapses in loans and capital, $\gamma_\ell = \gamma_k = 0.9$.

The black solid line represents the case of $\sigma_\eta = 0.01$ and endogenous crisis risk π_t, the red dashed line represents the case of $\sigma_\eta = 0$ and endogenous crisis risk π_t, and the green dotted line represents the case of $\sigma_\eta = 0$ and crisis risk π_t held constant at its initial steady state value, and therefore independent of leverage.

Apart from some important details that we will discuss in the next subsection, the simulation results with and without bargaining power uncertainty are very similar. The real wage over the initial decade collapses by close to 6%, while the return to capital increases by over 2 percentage points. Workers' consumption however declines by only around two thirds of the decline in wage income, as workers borrow the shortfall from investors, who have surplus funds to invest following their increase in bargaining power. Over the 30 years prior to the crisis, loans therefore double to bring workers' leverage, or debt-to-income ratio, from 64% to around 130%, with the crisis probability in year 30 around 2.5%. The loan interest rate for most of this initial period is up to 1.75 percentage points above its initial value, as lenders

[21] Simulations for these alternatives are available from the authors upon request.

arbitrage the return to lending with the now higher return to capital investment.[22]

Investors' share of the economy's income increases from initially less than 30% to over 35%. They have three ways to dispose of the extra income, and they utilize all three in a way that equalizes their marginal contributions to utility. First, their consumption increases by eventually over 20% prior to the outbreak of the crisis. Second, capital investment increases by around 15%, and so does the physical capital stock. The increase in capital raises the economy's output by eventually close to 4%. And third, loans increase by almost 100%, which means that investors' consumption share increases by only around 2.5 percentage points, compared to over 5 percentage points for their income share. These last two points are closely related, because with 71% of the economy's final demand coming from workers' consumption, the economy's output cannot be sold unless a significant share of the additional income accruing to investors is recycled back to workers by way of loans. With workers' bargaining power, and therefore their ability to service and repay loans, only recovering very gradually, the increase in loans is extremely persistent.

The initial gain in investors' rate of return of more than 2 percentage points is thereafter pared back by two factors. First, the large increase in investment reduces the marginal product of capital, and second, the gradual return of workers' bargaining power increases their wage and thus reduces what is left for capital. By year 30 profitability has in fact declined below its initial level. The crisis in year 30, by destroying large amounts of existing capital, temporarily increases the return to capital. But the respite for investors is only temporary in the presence of the ongoing recovery in workers' bargaining power. This implies a prolonged period of low profitability, in the sense of rates of return that remain below those in the initial steady state.

In the build-up to the crisis workers' balance sheets deteriorate, with the interest portion of debt service increasing from initially around 3% to 6% of their income at the time of the crisis. Prospects for an early reduction in leverage are very low given the slow recovery in bargaining power. The crisis however barely improves workers' situation. While their loans drop by 10% due to default, their wage also drops significantly due to the collapse of the real economy, and furthermore the real interest rate on the remaining debt shoots up to raise debt servicing costs to 9% of income. As a result their leverage ratio barely moves, and for the present calibration it could in fact increase further later on depending on the degree of

[22] As discussed below, when this scenario is augmented with a simultaneous financial liberalization that increases the supply of credit, interest rates can fall instead of rise.

bargaining power uncertainty. For the case of $\sigma_\eta = 0$ we observe that by year 50 leverage rises above its pre-crisis level, with a very slow reduction thereafter[23], while for $\sigma_\eta = 0.01$ we observe an extremely slow reduction in leverage after the crisis. It is however clear that these last results depend critically on the relative sizes of the loan default versus the collapse in the real economy. As we will see below, when the crisis mainly affects loans, it does bring more significant relief to workers.

Interestingly, quite similar results to the above baseline can be generated by assuming a shock not to relative bargaining powers over income, but rather to capital's share in technology α. However, in light of our discussion of the possible causes of higher income inequality in Section 1, we find this specification to be less compelling. Specifically, given the decline of U.S. manufacturing and its replacement with mostly low value added service sector job (Roberts (2010)), it is not clear that the U.S. economy's technological share of physical capital (or even of human capital) has increased. We therefore prefer a specification where technology never changes.

Subsistence consumption, and also the alternative habit persistence which we will discuss later, increases workers' incentive to borrow when faced with temporarily lower incomes. But, as illustrated in Figure 9, a combination of zero subsistence consumption (in other words standard CRRA consumption utility functions for both investors and workers) with larger shocks to bargaining power generate increases in leverage and crisis risk of the same order of magnitude observed in our baseline. This simulation assumes that cumulative negative shocks to bargaining power by year 10 are around 12.5%, instead of 7.5% as in the baseline. In this case the increase in debt is accompanied by a much larger increase in the share of income going to investors, of around 10 percentage points.

Uncertainty

The simulations in Figure 8 show that there are a number of interesting differences between the full model under uncertainty, the model with no bargaining power uncertainty $\sigma_\eta = 0$ but endogenous crisis risk π, and the model with $\sigma_\eta = 0$ and exogenous, fixed π.

One is that at the outset investors under uncertainty briefly but sharply reduce consumption to permit a boost in capital investment, thereby supporting a faster increase in the capital stock. Loans also initially increase at a faster rate. The reason is that we have initialized both simulations at the state vector of the steady state under $\sigma_\eta = 0$. Under un-

[23] We have limited the display of impulse responses to 50 years for clarity of exposition. While capital and loans are still growing at that horizon for $\sigma_\eta = 0$, they are not explosive and return to their long-run means in all simulations.

certainty however, investors would prefer higher capital and loan stocks even in the absence of realized negative shocks to η. This is because volatile bargaining power, by affecting the volatility of incomes, increases consumption risk and thus lowers the expected utility of consumption. Investors can reduce their exposure to that risk by switching from consumption to holdings of capital and loans, which also offer utility, but which at low levels of crisis risk are not equally affected by changes in bargaining power. In our baseline simulation the long-run value for workers' leverage is therefore around 90% rather than 64% as in the steady state at $\sigma_\eta = 0$, and around a third of the increase in leverage observed over the pre-crisis period is due to convergence to this higher long-run value, with the other two thirds accounted for by the negative realized shocks to η. The relative effects of uncertainty versus realized η on the capital stock are similar. Putting this differently, if our simulations under uncertainty were initialized at the steady state under $\sigma_\eta = 0.01$ rather than the steady state under $\sigma_\eta = 0$, the effects of realized bargaining power shocks on leverage and the capital stock over the first 30 years would be relatively smaller, but still very large in absolute terms.

Another interesting difference between the simulations with and without bargaining power uncertainty concerns the longer-run behavior of capital and especially loans, which under uncertainty are noticeably lower at the 50-year horizon. The reason is that, at the very high levels of debt and capital reached by that time, and more importantly at the much higher crisis probabilities reached at that time, the convexity of the crisis probability function assumes increasing importance. It implies that under uncertainty about future bargaining power the expected probability of a crisis is significantly higher, and therefore the willingness of investors to be exposed to such a crisis, through high stocks of loans and capital, is significantly lower.

By comparing the dashed and dotted lines in Figure 8, we observe that holding the crisis probability π fixed at its initial steady state value affects the loan interest rate, which now no longer features a default risk premium that increases with leverage. Lower interest charges have a cumulative beneficial effect on levels of debt and leverage, and therefore favor workers' consumption at the expense of investors' consumption. However, all of these effects are small. The reason is that a 2 percentage point increase in crisis probability, at a 10% default rate, adds at most around 10 to 20 basis points to real interest rates. This is small relative to the overall changes in real interest rates that the economy experiences in our scenarios.

B. Aggravating Factors

The baseline scenario sees leverage increasing to around 130% by the time of the crisis, and remaining in the neighborhood of that value for decades afterwards, with a crisis probability of around 2% for several decades. This outcome however depends on a number of aspects of the calibration of the model and of the specification of shocks, and changes to these can make the outcome for leverage worse or better. We describe the factors aggravating crisis risks in this subsection.

In the baseline, workers are partly compensated for their loss of bargaining power by the fact that investors invest part of their additional income in physical capital, which over time helps to raise the real wage. In an alternative simulation the marginal benefit to investors of doing so is reduced, so that more of their gains from higher bargaining power are either consumed or invested in financial assets. Specifically, by setting $\kappa = -33$ instead of $\kappa = -30$, capital accumulation is reduced by one third over the first 30 years, and output growth is reduced accordingly.[24] One result is a further one percentage point increase in the consumption share of investors, as they consume instead of investing. The other is that leverage now reaches around 140% rather than 130% by the time of the crisis, and thereafter stays nearly constant for decades. Furthermore, the crisis itself is now characterized by a smaller decrease in leverage and in crisis probability. The longer-run crisis probabilities are significantly higher than in the baseline. The use of the additional income by investors is therefore a critical determinant of the sustainability of lower worker bargaining power. If a large share of the funds is invested productively, higher debt is more sustainable because it is supported by higher income. If instead the majority of the funds goes into investors' consumption, or into loan growth, in other words an increasing "financialization" of the economy, the system becomes increasingly unstable and prone to crises.

While we do not explicitly model financial intermediaries, an exogenous credit supply shock associated with financial liberalization can be represented in the model as a positive shock to the weight of financial assets in investors' utility function ξ_d. In another alternative simulation ξ_d is assumed to increase over the final decade preceding the crisis. This makes investors more willing to lend at lower interest rates, while reducing their consumption and physical investment. Faced with lower borrowing costs, workers increase their consumption and take on far more debt, so that leverage at crisis time is significantly higher than in the

[24] It can therefore be seen that setting κ much closer to zero would imply a clearly implausible response of capital accumulation to income shocks.

baseline. This is one possible way to generate the accelerating increase in household leverage in the final pre-crisis decade that we observed when studying the data.

A second aspect of the baseline calibration that might be too optimistic is the rate at which workers' bargaining power is restored, after the initial period of declining bargaining power of 10 years. With $\rho = 0.96$, 50% of the loss of bargaining power is reversed by year 27. This was not an obvious feature of the pre-1929 and pre-2007 periods. Figure 11 therefore considers an alternative scenario with $\rho = 0.99$, which is close to permanent, with the half-life of bargaining power equal to 80 years instead of 27 years. In this case the initial loss of bargaining power is assumed to be smaller, with η dropping to 0.95 by year 10, rather than to 0.925 as in the baseline. Given the smaller initial drop in η, the increase in leverage and crisis probability by year 30 is of course smaller. But more interesting for our purposes is the fact that thereafter leverage keeps increasing further, and the crisis probability keeps climbing. It can in fact be shown that for this scenario the crisis probability does not peak until 50 years after the first crisis. This illustrates a key concern. If workers see virtually no prospects of restoring their earnings potential even in the very long run, and if investors remain willing to lend to them because they wish to invest part of their additional income in financial assets, high leverage and high crisis risk become an almost permanent feature of the economy.

The third modification of the baseline that can give rise to higher crisis risk is a higher subsistence level of consumption, or equivalently, as mentioned above, a lower intertemporal elasticity of substitution. Both result in workers borrowing more aggressively than in the baseline to avoid a drop in consumption, leading to higher leverage by year 30.

We have also explored the sensitivity of our results to alternative calibrations of the crisis probability function (9). We found that, even when the probability of a crisis around year 30 and beyond is twice as large as in the baseline, the qualitative results are identical, and the quantitative results change little except that long-run debt levels are somewhat lower. The reasons for this small difference were discussed in our comments on the impulse responses in Figure 8 at the end of Section 4.A.

C. Alternative Mechanisms

In the simplest possible permanent income model a permanent negative shock to the incomes of a group of households results in a permanent reduction in their consumption, with no increase in debt. A persistent increase in leverage therefore requires a departure from that canonical setup. In our model there are two main possibilities, one based mainly on the behavior of workers (borrowers), or credit demand, and the other on the behavior of investors (lenders), or credit supply.

The first possibility is that, as in our baseline, the negative shock to income is not permanent but rather highly persistent. In that case workers have an incentive to smooth consumption by borrowing until incomes recover. This credit demand effect is made quantitatively stronger by the presence of a subsistence level of consumption that reduces the effective intertemporal elasticity of substitution. However, the fact investors value financial wealth per se is also very important, as it implies that investors respond to higher incomes by investing a share of them in financial assets backed by loans to workers.

The second possibility, illustrated in Figure 11, shows that this credit supply channel can be dominant under permanent negative income shocks. For permanent shocks investors' optimality conditions call for a permanent increase in financial (and real) investments, while workers no longer have an incentive to borrow to smooth out temporary income shocks.

But there can be alternative incentives for workers to borrow. Specifically, whenever the subsistence level is rigid relative to an initial steady state that features a more favorable income distribution for workers than following the bargaining power shocks, the effect of that rigidity is similar to external habit persistence. In the extreme case where the subsistence level moves one for one with actual consumption, and is therefore always equal to 50% of actual consumption, this credit demand channel is minimized. But when workers' preferences are such that they initially resist a sudden drop in living standards, and are only prepared to lower their consumption in the longer run after experiencing a prolonged period of low incomes, this generates additional credit demand during a lengthy transition period.

Specifically, we assume that workers' subsistence level is not fixed at $\tilde{c}^w_{\min}$, but rather that it is replaced by a $\tilde{c}^w_t$ that changes gradually over time in response to prolonged experiences of lower consumption levels.[25] We assume a long-run subsistence level equal to 50% of consumption by setting $\tilde{c}^w_t = 0.5 * \check{c}^{ma}_t$, where $\check{c}^{ma}_t = \left(\check{c}^w_t \left(\check{c}^{ma}_{t-1}\right)^{\psi}\right)^{1/(1+\psi)}$. Here $\check{c}^w_t$ is the aggregate per capita value of workers' consumption, which is taken as given by the individual worker, and $\check{c}^{ma}_t$ is a moving average of past actual consumption levels, with the parameter ψ determining the speed at which the subsistence level responds to changes in actual consumption. We compare two values of the moving-average parameter ψ. The dashed

[25] This captures the simple idea that the level of consumption at which agents would consider themselves destitute is not independent of their past consumption experience.

line represents the case of $\psi = 0$, which implies that subsistence consumption is always equal to 50% of actual consumption. The solid line represents the case of $\psi = 20$, which implies that moving average consumption only adjusts to reductions in actual consumption over a period of decades.[26] This creates additional demand for credit while workers resist a lowering of their living standards. To keep the computational solution tractable, we also assume that for investors $\tilde{c}^i_{\min}$ remains fixed, and furthermore that it is equal to zero. With these assumptions the model has four continuous and one binary state variable.

Figure 11 assumes initial realizations of bargaining power shocks identical our baseline, but with $\rho = 1$ instead of $\rho = 0.96$. The results for the two different ψ are almost identical, with leverage just prior to the crisis rising by 41 percentage points under immediately-adjusting subsistence consumption, and by only 3 percentage points more under slowly-adjusting subsistence. This demonstrates that under permanent bargaining power shocks the main driving force behind the increase in debt is increased credit supply due to investors permanently increasing their financial investments, with increased credit demand from workers resisting a lowering of their living standards only making a small additional contribution.

The initial effects of the permanent bargaining power shock on real factor returns, consumption and investment are broadly similar to the baseline. The main differences are that the increase in loans during the pre-crisis period is smaller, while the tendency for loans to keep growing in the post-crisis period is stronger. The main reason for the different behavior during the pre-crisis period is that investors' effective intertemporal elasticity of substitution is assumed to be higher in this simulation than in the baseline, which leads them to consume a larger fraction of their additional income, and to correspondingly invest a smaller fraction into financial assets. Leverage therefore only rises to around 110% by year 30. However, this effect is not much smaller than in the model with recovering bargaining power. The tendency for loans to keep growing in the post-crisis period is due to the fact that the economy is in transition between two different stock equilibria, with the final equilibrium characterized by permanently higher stocks of capital and financial assets. Such transitions optimally take decades, because a more rapid movement to the new equilibrium would require suboptimally large fluctuations in consumption. The fact that the longer-run increase in leverage is of a similar magnitude as in the case of temporary income shocks is an important result, because it shows that, despite the small effects of permanent income shocks on credit demand, and despite investors' higher intertemporal elasticity of consumption in this scenario, increased

[26] The dotted line added to the plot for workers' consumption shows the very gradual adjustment of $\tilde{c}^w_t$ for the case of $\psi = 20$.

credit supply alone can lead to higher leverage and higher crisis risk. In fact, given that credit supply is permanently higher, and real wages are permanently lower, the end result is an economy with permanently higher crisis risk.

An alternative to subsistence consumption is habit persistence, where workers keep their consumption high and borrow, not to stay away from a lower subsistence consumption level, but rather to stay close to a higher historically experienced consumption level. There are however some drawbacks to assuming habit persistence. Like moving average subsistence consumption, habit persistence introduces additional state variables for each household group where it is introduced, which is computationally costly. Furthermore, habit persistence has typically only been used to explain business cycle dynamics, rather than the longer run phenomena studied in this paper, and in the business cycle literature the habit parameter is typically estimated at around 0.7 in quarterly models (Boldrin, Christiano and Fisher (2001)). We have found that, to generate borrowing levels similar to those observed in our baseline, for an otherwise identical calibration, requires an (internal) habit parameter that would equal around 0.95 for both investors and workers in a quarterly model.

Figure 11 is the only set of simulations in this paper that considers permanent shocks and a variable level of subsistence. We now return, for the two remaining simulations, to the baseline specification of temporary shocks and a fixed level of subsistence.

D. Solutions

The currently much talked about deleveraging of households can in the present model take only two forms, a debt reduction, and ideally an "orderly" debt reduction, or an increase in workers' earnings to allow them to work their way out of debt over time. We address each of these in this subsection.

We first consider the option of an orderly debt reduction. What we have in mind here is a situation where a crisis and large-scale defaults have become unavoidable, but where policy is used to limit the collateral damage to the real economy. Figure 12 illustrates the case where the destruction of physical capital at crisis time only equals 1% instead of 10%, leaving all other aspects of the baseline calibration unchanged. The main difference to the baseline is that in this case the debt reduction is not accompanied by a significant income reduction, as the real wage drops very little. As a result, leverage drops by 13.5 percentage points, compared to 3 percentage points in the baseline. Minimizing spillovers from the financial to the real sector during a widespread debt restructuring to deal with excessive leverage is therefore critical to the success of that restructuring.

In this context it should be mentioned that a financial sector bailout such as the one performed in the United States in 2008-2009 does not represent a debt restructuring in the sense of Figure 12. A bailout principally benefits the creditors of financial institutions, in other words the investors of our model, by compensating them for loan losses. The financing for such a bailout however comes from higher future general tax revenue that will be used to service higher government debt, and these taxes will to a significant extent fall on workers. Indeed, preliminary results from the Survey of Consumer Finance 2010 by Kennickell suggest that, while wealth decreased during the crisis, the distribution of wealth shares varied very little (Kennickell (2011)).

Figure 13 illustrates the alternative to a debt restructuring, an increase in workers' earnings through a restoration of their original bargaining power. In this case the evolution of the economy is identical to the baseline until period 30, but at that time a program is implemented whereby workers' bargaining power immediately and permanently returns to $\eta = 1$. The first result is an upward jump in the real wage to about 4% above its value in period 0, due to the now much higher capital stock. Leverage drops by 8 percentage points on impact, but this is now not due to a lower, restructured loan stock, but rather to a higher income level, which is of course helped by the fact that this turn of events is assumed to head off a collapse in capital and output. The main difference to Figure 12 however is observed following period 30, where under a loan restructuring leverage and default probability resume an upward trajectory for another 15 years, with only a very slow decline thereafter, while under the bargaining power solution both immediately go onto a declining path. By year 50 leverage is more than 20 percentage points lower under the bargaining power solution than under the loan restructuring solution. For long-run sustainability a permanent flow adjustment, giving workers the means to repay their obligations over time, is therefore much more successful than a stock adjustment, unless the latter is extremely large. Any success in reducing income inequality could therefore be very useful in order to reduce the likelihood of future crises.

Figure 13 also emphasizes the very persistent dynamics generated by this model. After year 30 there are no further shocks, yet the adjustment back to the model's long-run equilibrium takes many decades. This is because the shocks have caused substantial changes in debt (and capital), but unlike in many other models with non-contingent debt, leverage returns to a long-run equilibrium determined by the presence of financial assets in investors' utility function. That adjustment requires stock changes in capital and financial investments that are optimally spread out over time in order to minimize consumption volatility.

This section has focused on possible solutions for an economy where leverage has already risen to very high levels. But the model can also be used to think about how to prevent high leverage from arising in the first place. Because both investors and workers do not take into account the effect of their lending transactions on the aggregate crisis probability π_t, there is a case for internalizing this effect. This could be done through taxes on lending to affect interest rates and thus lending incentives. Furthermore, if the resulting tax revenue was distributed to workers, this could help to reduce income inequalities. We leave further exploration of this topic to future work.

E. Discussion

Our model has been kept deliberately simple, first in order to clearly identify the key transmission channels from higher income inequality to higher leverage to a higher probability of crises, and second for computational reasons, as a higher number of shocks or endogenous state variables would quickly make the monotone map method impractical. It is nevertheless useful to close this section by briefly commenting on how various additions to the model could improve details of its predictions.

By adding an open economy dimension, with net foreign assets as an additional state variable and foreign savings preferences as an additional shock, the model would be better able to replicate the fact that the United States experienced a consumption boom over much of the period of interest, much of which was facilitated by the availability of foreign rather than only domestic savings. The addition of contractionary technology and investment demand shocks would replace the upward spike in investment at crisis time with a large and persistent post-crisis reduction in investment, as observed in the United States after 2007.[27] Finally, the addition of a shock to workers' labor supply would help to address an important issue raised by Reich (2010), who emphasizes that in the United States households faced with higher income inequality have employed two other important coping mechanism apart from higher borrowing, namely higher female labor force participation and longer hours. This allowed them to replace some of the lost income, and therefore to limit the amount of additional borrowing.

[27] The brief spike in investment is also absent in a variant of the model where capital does not enter the utility function.

5. Conclusions

This paper has presented stylized facts and a theoretical framework that explore the nexus between increases in the income advantage enjoyed by high income households, higher debt leverage among poor and middle income households, and vulnerability to financial crises. This nexus was prominent prior to both the Great Depression and the recent crisis. In our model it arises as a result of increases in the bargaining power over incomes of high income households. The key mechanism, reflected in a rapid growth in the size of the financial sector, is the recycling of part of the additional income gained by high income households back to the rest of the population by way of loans, thereby allowing the latter to sustain consumption levels, at least for a while. But without the prospect of a recovery in the incomes of poor and middle income households over a reasonable time horizon, the inevitable result is that loans keep growing, and therefore so does leverage and the probability of a major crisis that, in the real world, typically also has severe implications for the real economy. More importantly, unless loan defaults in a crisis are extremely large by historical standards, and unless the accompanying real contraction is very small, the effect on leverage and therefore on the probability of a further crisis is quite limited. By contrast, restoration of poor and middle income households' bargaining power can be very effective, leading to the prospect of a sustained reduction in leverage that reduces the probability of a further crisis.

The framework we have presented uses a closed economy setting. In ongoing work we are extending this to an open economy. The objective is to explain not only why higher income inequality tends to be associated with larger current account deficits in a cross section of countries, but also to explain important exceptions to this rule such as China.

References

[1] Acemoglu (2011), "Thoughts on Inequality and the Financial Crisis", Presentation at the 2011 AEA Meetings, Denver.

[2] Aiyagari, R., Marcet A., Sargent, T. J., and Seppälä, J. (2002), "Optimal Taxation without State-Contingent Debt", *Journal of Political Economy,* **110(6)**, 1220-1254.

[3] Aguiar M., and Bils, M., "Has Consumption Inequality Mirror Income Inequality", *mimeo* University of Rochester.

[4] Barro, R. (1974), "Are Government Bonds Net Wealth?", *Journal of Political Economy*, **82(6)**, 1095-1117.

[5] Barro, R., (2006), "Rare Disasters and Asset Markets in the Twentieth Century", *Quarterly Journal of Economics,* **121(3)**, 823–866.

[6] Blanchard, O. and Giavazzi, F. (2003), "Macroeconomic Effects Of Regulation And Deregulation In Goods And Labor Markets", *Quarterly Journal of Economics*, **118(3)**, 879-907.

[7] Blundell, R., L. Pistaferri, and Preston, I. (2008), "Consumption Inequality and Partial Insurance", *American Economic Review,* **98(5),** 1887-1921.

[8] Boldrin, M., Christiano, L.J. and Fisher, J. (2001), "Habit Persistence, Asset Returns and the Business Cycle", *American Economic Review*, **91(1)**, 149-166.

[9] Borjas, G. and Ramey, V. (1995), "Foreign Competition, Market Power and Wage Inequality", *Quarterly Journal of Economics*, **110(4)**, 1075-1110.

[10] Bradbury, K. and Katz, J. (2002), "Are Lifetime Incomes Growing More Unequal? Looking at New Evidence on Family Income Mobility", *Regional Review,* **12(4)**.

[11] Card, D., Lemieux, T. and Riddell, D. (2004), "Unions and Wage Inequality", *Journal of Labor Market Research,* **25(4),** 520-562.

[12] Carroll, C.D. (2000), "Why Do the Rich Save So Much?", in Joel B. Slemrod, Ed., *Does Atlas Shrug? The Economic Consequences of Taxing the Rich*, Cambridge, MA: Harvard University Press.

[13] Coleman, J. (1991), "Equilibrium in a Production Economy with an Income Tax", *Econometrica*, **59**, 1091-1104.

[14] Davig, T. (2004), "Regime-Switching Debt and Taxation", *Journal of Monetary Economics*, **51**, 837-859.

[15] Davig, T. and Leeper, E. (2006), "Fluctuating Macro Policies and the Fiscal Theory", *NBER Macroeconomics Annual*, **21**, 247-298.

[16] Davig, T. and Leeper, E. (2007), "Generalizing the Taylor Principle", *American Economic Review*, **97(3)**, 607-635.

[17] Davig, T., Leeper, E. and Walker, T. (2010), "Unfunded Liabilities and Uncertain Fiscal Financing", *Journal of Monetary Economics* (forthcoming).

[18] Diamond, D. and Dybvig, P. (1983), "Bank Runs, Deposit Insurance, and Liquidity", *Journal of Political Economy*, **91(3)**, 401-419.

[19] Dynan, K., Skinner, J. and Zeldes, S. (2004), "Do the Rich Save More?", *Journal of Political Economy*, **112(2)**, 397-444.

[20] Ellis, H. and Francois, P. (2003), "Animal Spirits Through Creative Destruction", *American Economic Review*, **93 (3)**, 530-550.

[21] Favara, G. and Imbs, J.M. (2010), "Credit Supply and the Price of Housing", CEPR Discussion Paper No. 8129.

[22] Gabaix, X. and Landier, A., (2008), "Why Has CEO Pay Increased So Much?", *Quarterly Journal of Economics,* **123(1),** 49-100.

[23] Gertler, M. and Karadi, P. (2010), "A Model of Unconventional Monetary Policy", Working Paper, New York University.

[24] Gertler, M. and Kiyotaki, N. (2010), "Financial Intermediation and Credit Policy in Business Cycle Analysis", *Handbook of Monetary Economics* (forthcoming).

[25] Gottschalk, P. and Moffit, R., (1994), "The Growth of Earnings Instability in the U.S. Labor Market", *Brookings Papers on Economic Activity,* **2**, 217-254.

[26] Gourio, F. (2010), "Disaster Risk and Business Cycles", Working Paper, Boston University.

[27] Hacker, J. and Pierson, P. (2010), *Winner-Take-All Politics*, New York: Simon & Schuster.

[28] Heathcote,J., Perri, F. and Violante, G.L. (2010), "Unequal We Stand: An Empirical Analysis of Economic Inequality in the United States: 1967-2006", *Review of Economic Dynamics*, **13(1)**, 15-51.

[29] Hubbard, R., Skinner, J. and Zeldes, S. (1994), "The Importance of Precautionary Motives in Explaining Individual and Aggregate Saving", *Carnegie-Rochester Conference Series on Public Policy,* **40**, 59-125.

[30] International Monetary Fund (2009), "Crises and Recovery", Chapter 3 in *World Economic Outlook, April 2009.*

[31] Iacoviello, M. (2005), "House Prices, Borrowing Constraints, and Monetary Policy in the Business Cycle", *American Economic Review*, **95(3)**, 739-764.

[32] Iacoviello, M. (2008), "Household Debt and Income Inequality, 1963-2003", *Journal of Money, Credit and Banking*, **40(5)**, 929-965.

[33] Kennickell, A. (2011), "Tossed and Turned: Distributional Shifts in the U.S 2007-2009", Working Paper, Federal Reserve Board.

[34] Keys, B.J., Mukherjee, T., Seru, A. and Vig, V. (2010), "Did Securitization Lead to Lax Screening? Evidence from Subprime Loans", Quarterly Journal of Economics, **125(1)**, 307-62.

[35] Kopczuk, W. (2007), "Bequest and Tax Planning: Evidence from Estate Tax Returns", *Quarterly Journal of Economics*, **122(4)**, 1801-1854.

[36] Kopczuk, W., Saez, E. and Song, J. (2010), "Earnings Inequality and Mobility in the United States: Evidence from Social Security Data since 1937", Quarterly Journal of Economics, **125(1)**, 91-128.

[37] Krueger, D. and Perri, F. (2006), "Does Income Inequality Lead to Consumption Inequality? Evidence and Theory", *Review of Economic Studies*, **73(1)**, 163-193.

[38] Lemieux, T. (2006), "Post-Secondary Education and Increasing Wage Inequality", *American Economic Review*, **96(2)**, 195-199.

[39] Lemieux, T., MacLeod, B. and Parent, D. (2009), "Performance Pay and Wage Inequality", *Quarterly Journal of Economics*, **124(1)**, 1-49.

[40] Levitin, A. and Wachter, S. (2010), "Explaining the Housing Bubble", Georgetown Business, Economics and Regulatory Law Research Paper No. 10-16.

[41] Merton, R. (1973), "An Intertemporal Capital Asset Pricing Model", *Econometrica,* **41(5)**, 867-887.

[42] Mian, A. and Sufi, A. (2009), "The Consequences of Mortgage Credit Expansion: Evidence from the U.S. Mortgage Default Crisis", *Quarterly Journal of Economics*, **124(4)**, 1449-1496.

[43] Obstfeld, M. and Rogoff, K. (2009), "Global Imbalances and the Financial Crisis: Products of Common Causes", Working Paper, UC Berkeley and Harvard University.

[44] Philippon, T. (2008), "The Evolution of the U.S. Financial Industry from 1860 to 2007", Working Paper, New York University.

[45] Piketty, T. (2010), "On the Long-Run Evolution of Inheritance: France 1820-2050", Working Paper, Paris School of Economics.

[46] Piketty, T. and Saez, E. (2003), "Income Inequality in the United States, 1913-1998", *Quarterly Journal of Economics*, **118,** 1-39.

[47] Rajan, R. (2010), *Fault Lines: How Hidden Fractures Still Threaten the World Economy*, Princeton: Princeton University Press.

[48] Rancière, R., Tornell, A. and Westermann, F. (2008), "Systemic Crises and Growth", *Quarterly Journal of Economics,* **123(1)**, 359-406.

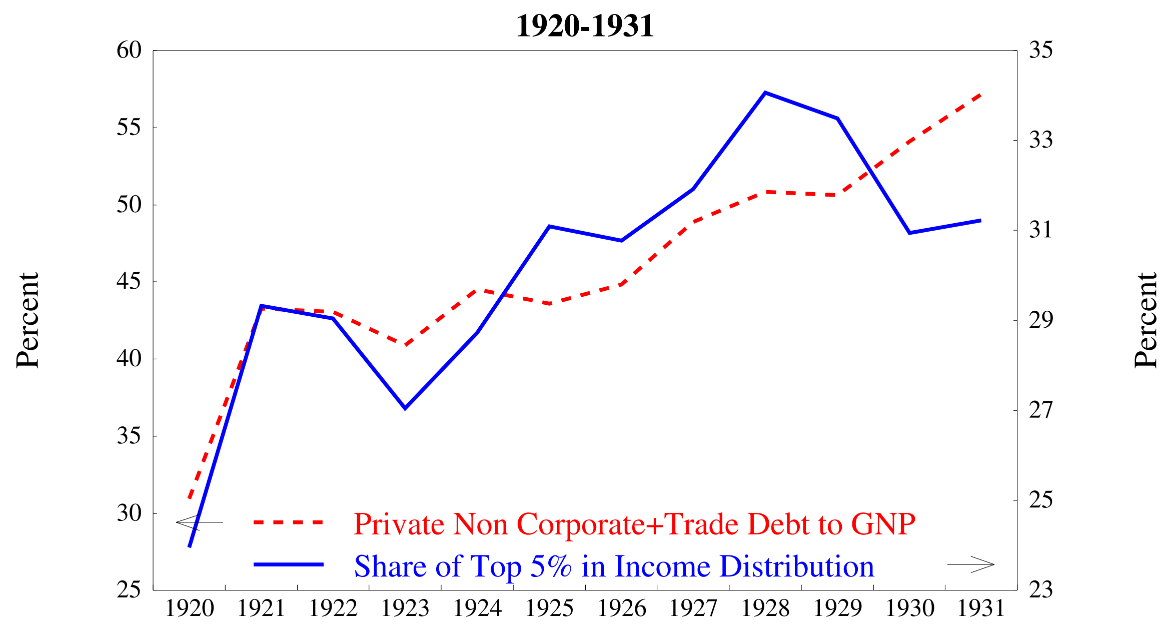
[49] Reich, R. (2010), *Aftershock: The Next Economy and America's Future*, New York: Random House.

[50] Reiter, M. (2004), "Do the Rich Save too Much? How to Explain the Top Tail of the Wealth Distribution", Working Paper, Universitat Pompeu Fabra.

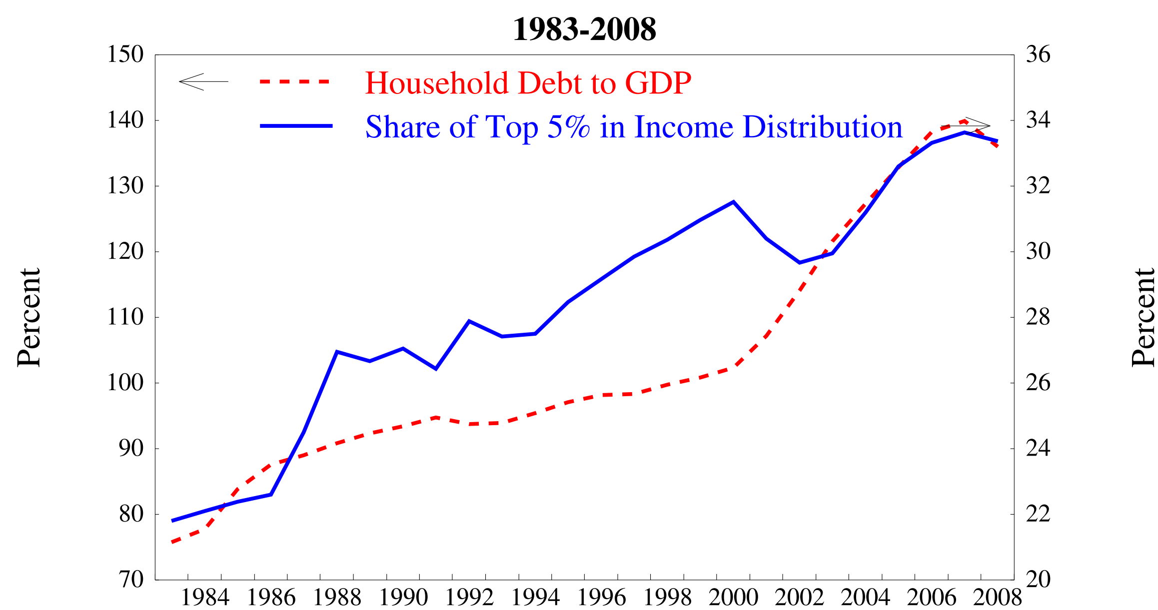
[51] Roberts, P.C. (2010), *How the Economy Was Lost*, AK Press.

[52] Schneider, M. and Tornell, A. (2004), "Balance Sheet Effects, Bailout Guarantees and Financial Crises", *Review of Economic Studies,* **71**, 883-913.

[53] Taylor, J.B. (2009), *Getting Off Track: How Government Actions and Interventions Caused, Prolonged, and Worsened the Financial Crisis*, Hoover Institution Press.

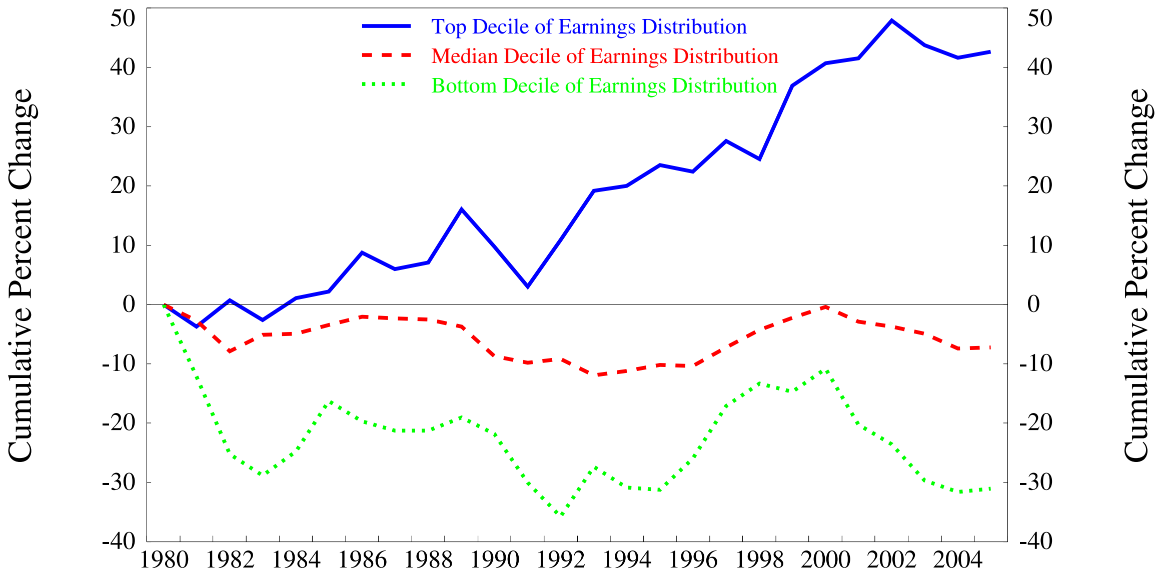


Source: Statistical Abstract of the United States, U.S. Department of Commerce.



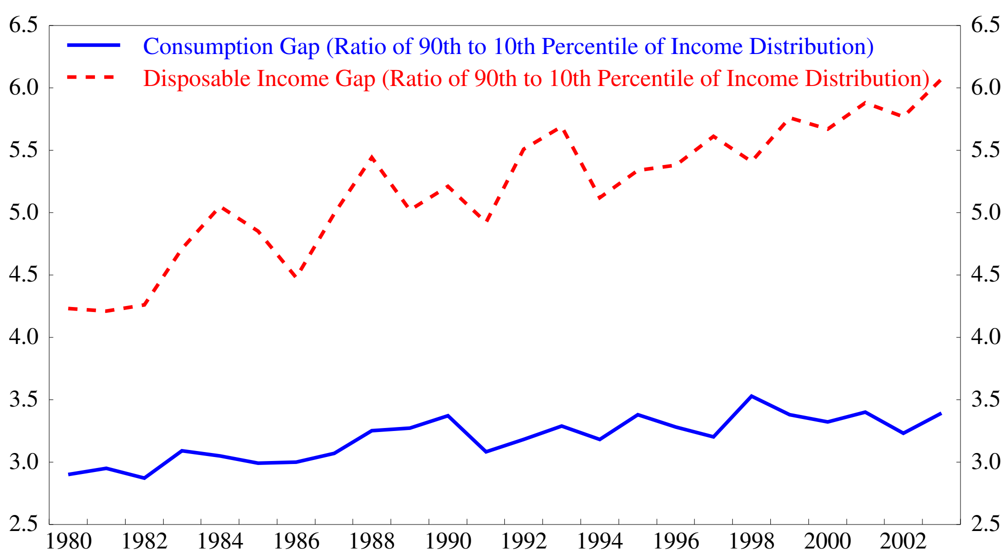
Sources: Income shares from Piketty and Saez (2003, updated). Income excludes capital gains. Debt-to-income ratios from Flows of Funds database, Federal Reserve Board. Income excludes capital gains.

Figure 1: Income Inequality and Household Leverage



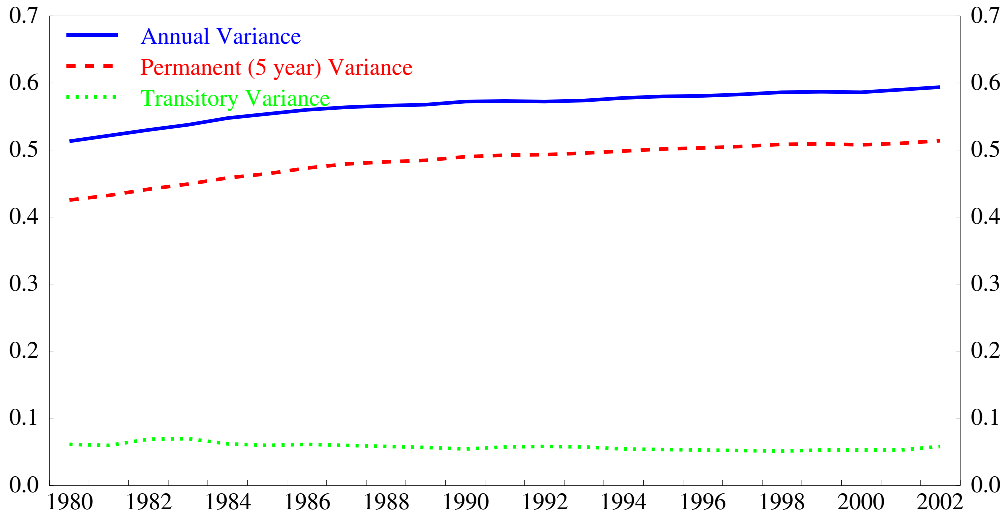
Source: Heathcote, Perri and Violante (2010), based on micro-level data from the U.S. Consumer Population Survey. Male annual earnings includes labor income plus two-thirds of self-employment income. Male hourly wages are computed as male annual earnings divided by annual hours. The price deflator used is the Bureau of Labor Statistics CPI-U series, all items.

Figure 2: Real Income Inequality



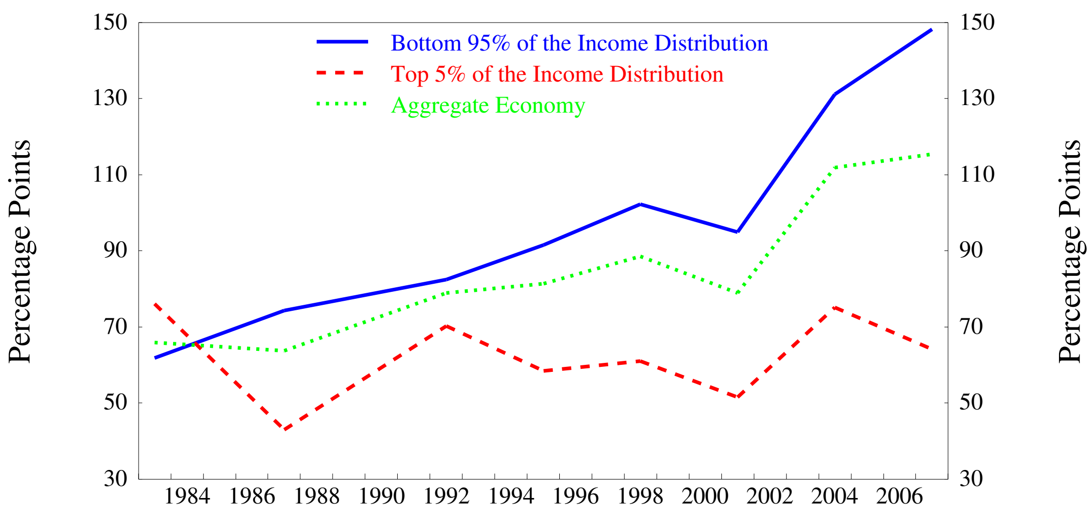
Source: Krueger and Perri (2006), based on micro-level data from the U.S Consumer Expenditure Survey. Income corresponds to disposable income and consumption to the sum of non-durable consumption measured from expenditures and the value of service flows inputed from the stock of durables of households.

Figure 3: Income Inequality and Consumption Inequality



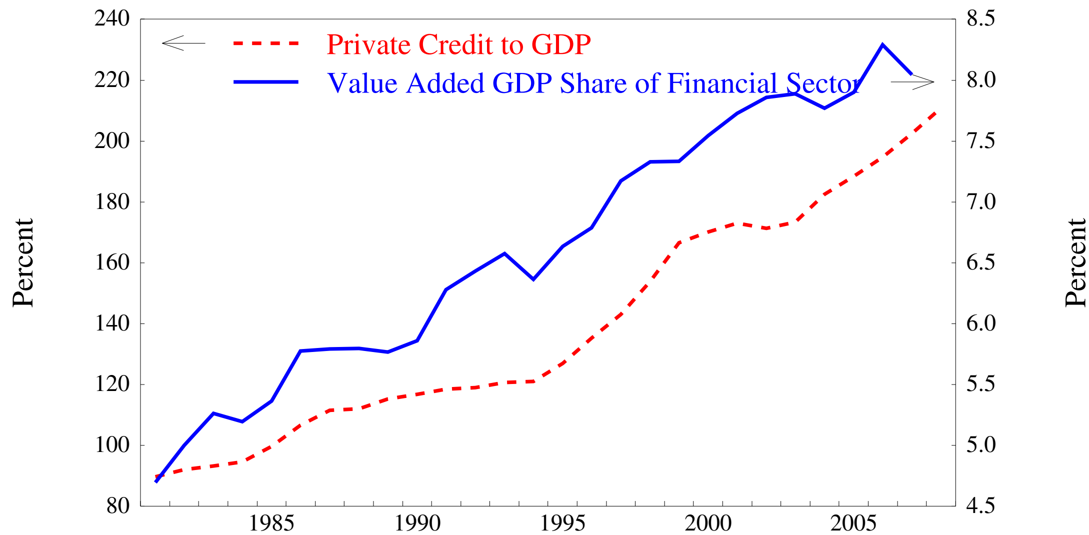
Source: Kopczuk, Saez and Jong (2010), based on Social Security Administration longitudinal earnings micro data. Earnings include all wages or self-employement earnings subject to social security taxes. The transitory variance is defined as the variance of the difference between (log) annual earnings and (log) five-year average earnings.

Figure 4: The Variance of Annual, Permanent, and Transitory (log) Earnings



Source: Survey of Consumer Finance (triennal), 1983-2007. Debt corresponds to the stock of all outstanding household debt liabilities. Income corresponds to annual income before taxes, including capital gains and transfers, in the year preceding the survey.

Figure 5: Debt to Income Ratios



Sources: Private Credit to GDP from World Bank Financial Structure Database (real private credit by deposit banks and other financial institutions, relative to GDP). Value Added GDP Share of Financial Sector from Philippon (2008).

Figure 6: The Size of the U.S. Financial Sector

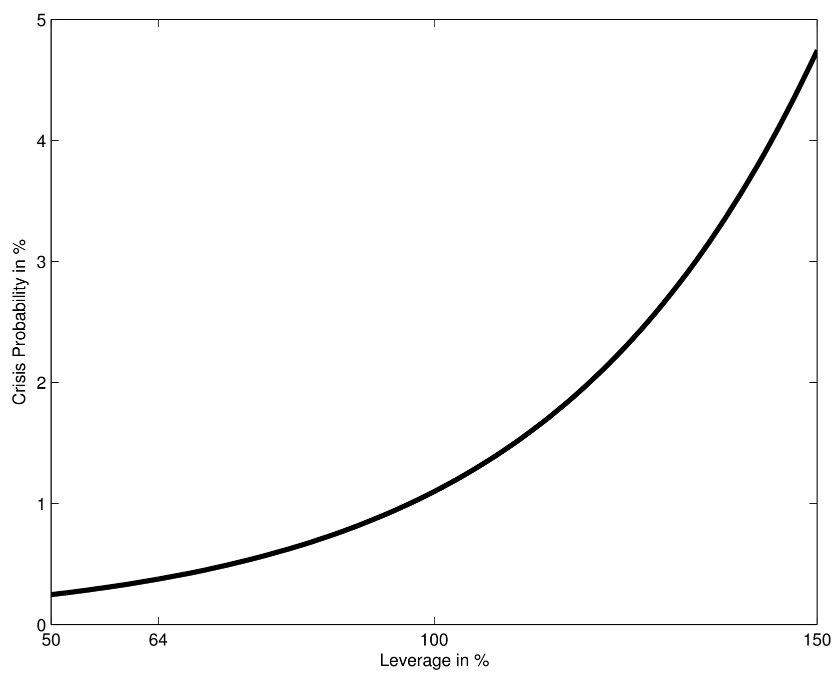


Figure 7: Leverage and Crisis Probability in the Model

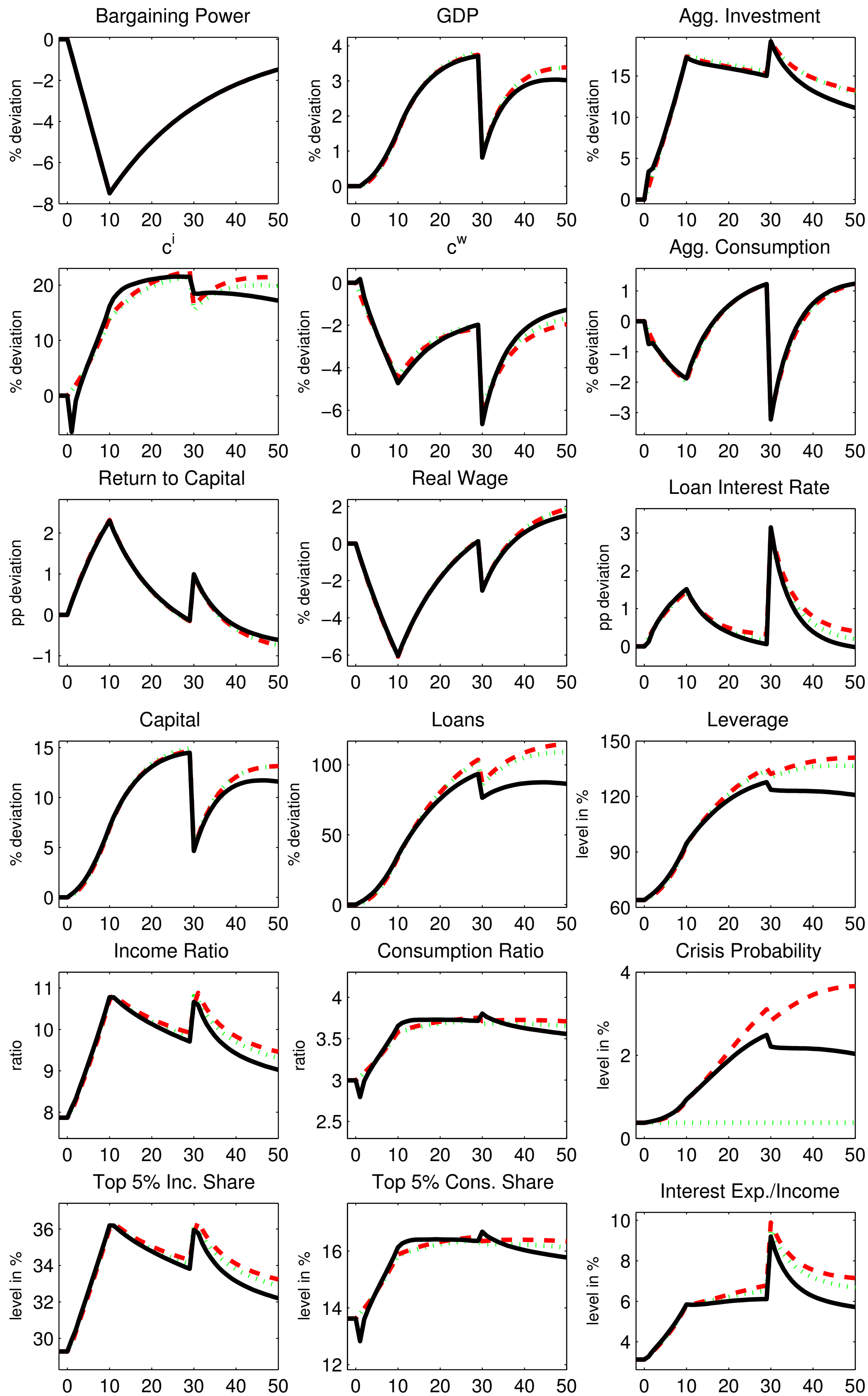


Figure 8: Baseline Scenario - Fixed Subsistence, Transitory Bargaining Power Shock
(_ : $\sigma_\eta = 0.01$ & π endog., - - : $\sigma_\eta = 0$ & π endog., ... : $\sigma_\eta = 0$ & π exog.)

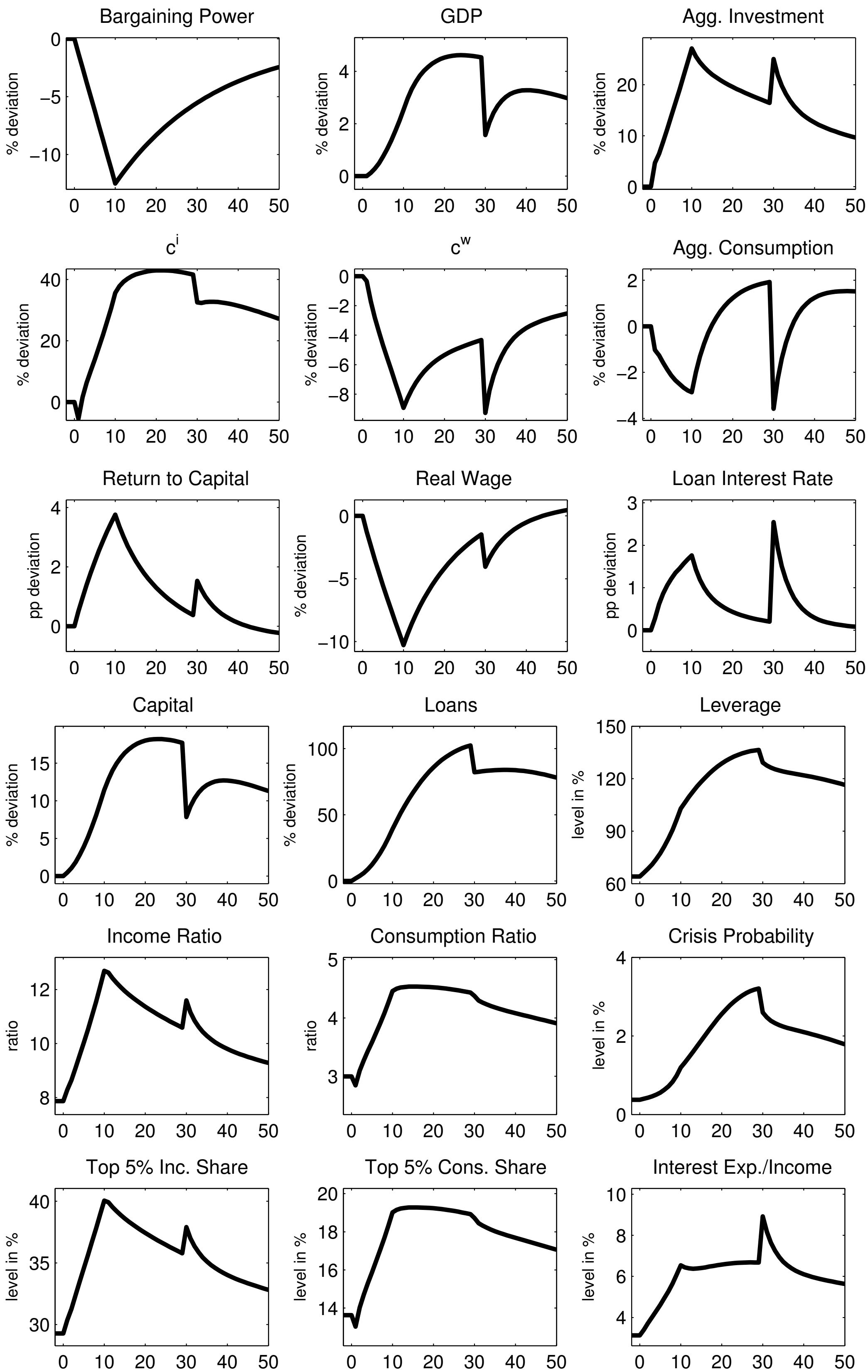


Figure 9: Zero Subsistence, Larger Bargaining Power Shock
($\sigma_\eta = 0.015$)

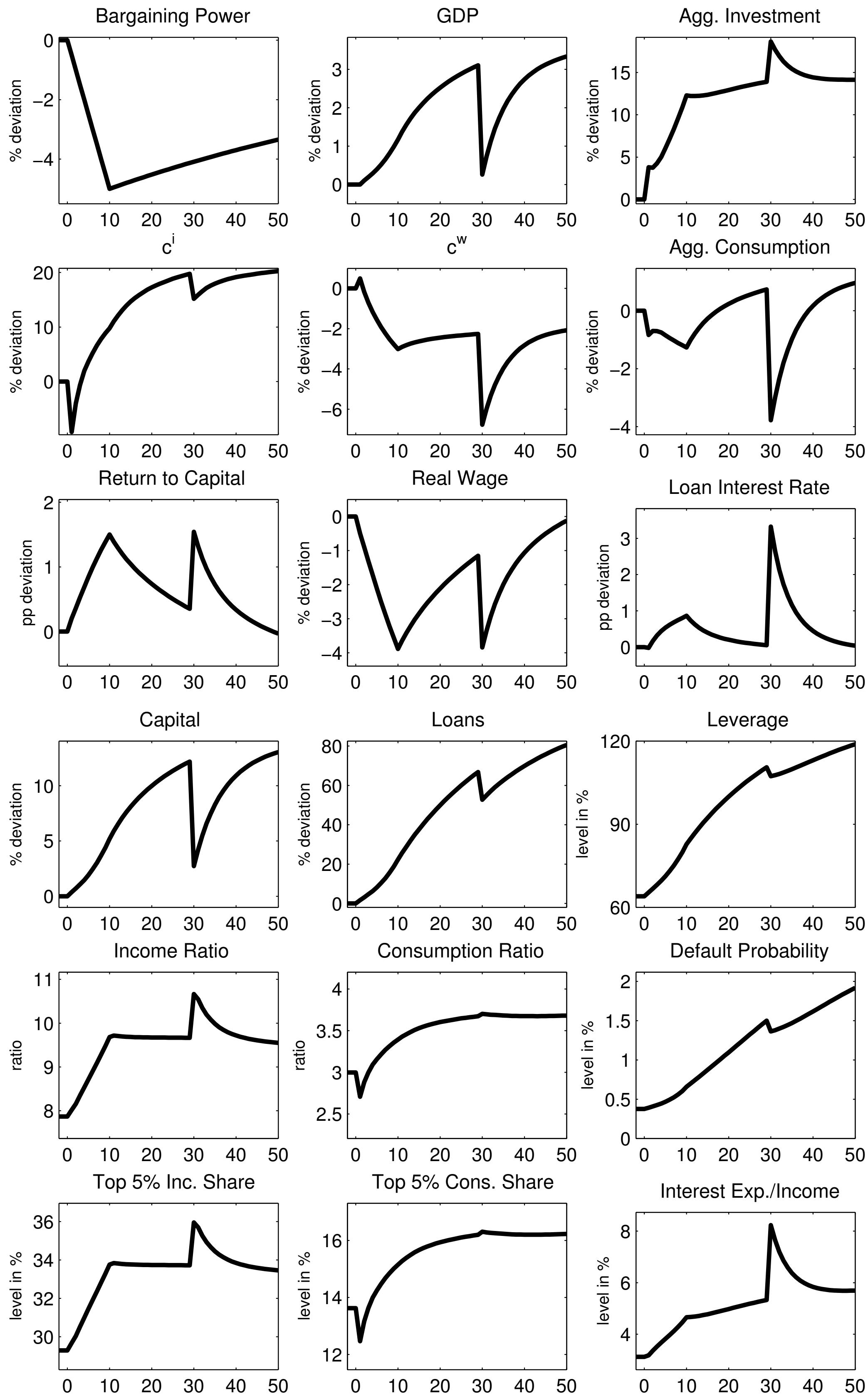


Figure 10: Fixed Subsistence, Nearly Permanent Bargaining Power Shock ($\sigma_\eta = 0.01$)

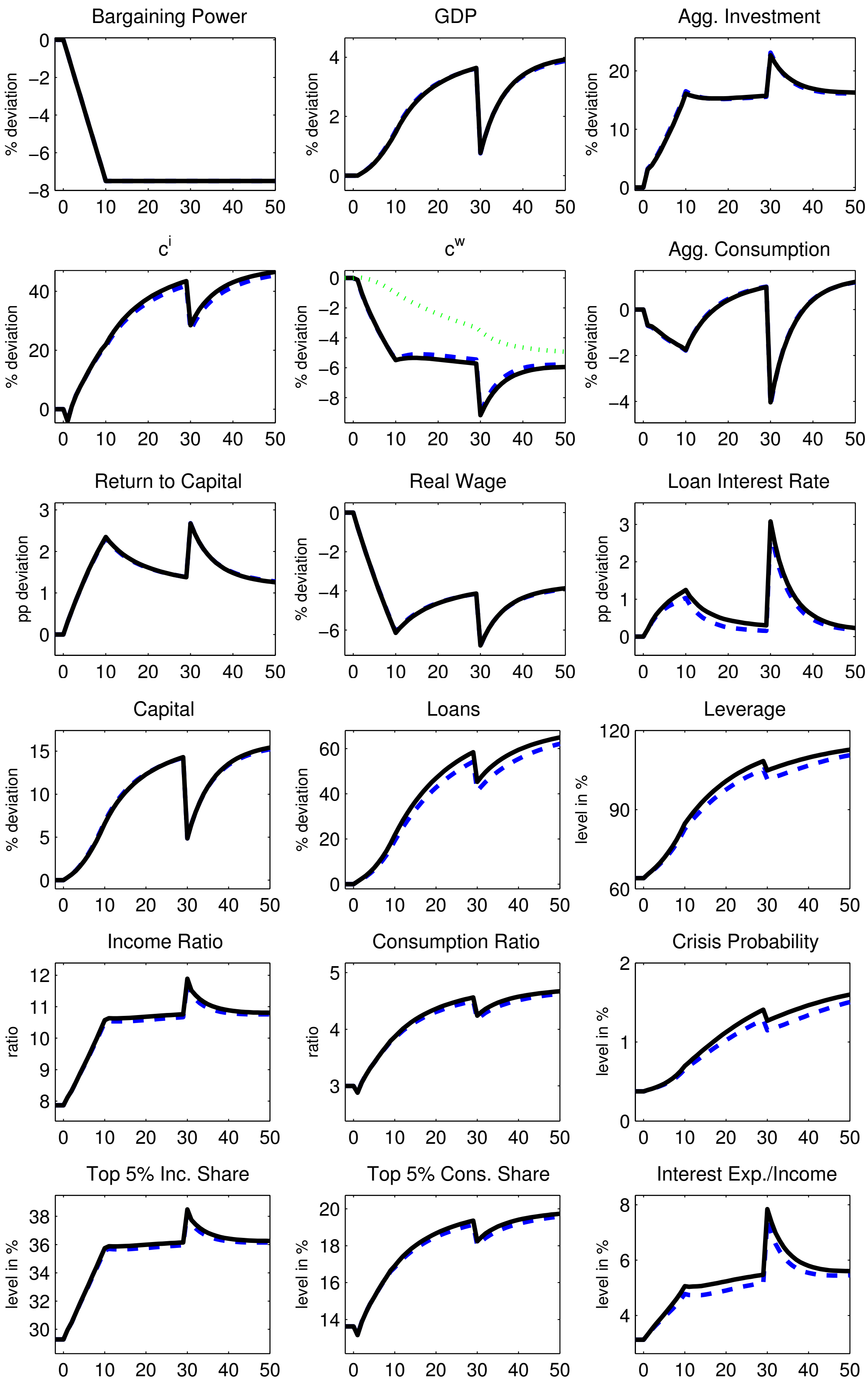


Figure 11: Variable Subsistence, Permanent Bargaining Power Shock
(_ : $\sigma_\eta = 0.01$ & $\psi = 20$, - - : $\sigma_\eta = 0.01$ & $\psi = 0$)
(The figure plotting the consumption of workers includes a dotted line representing the subsistence level of consumption $\tilde{c}^w_t$ for the case $\sigma_\eta = 0.01$ & $\psi = 20$.)

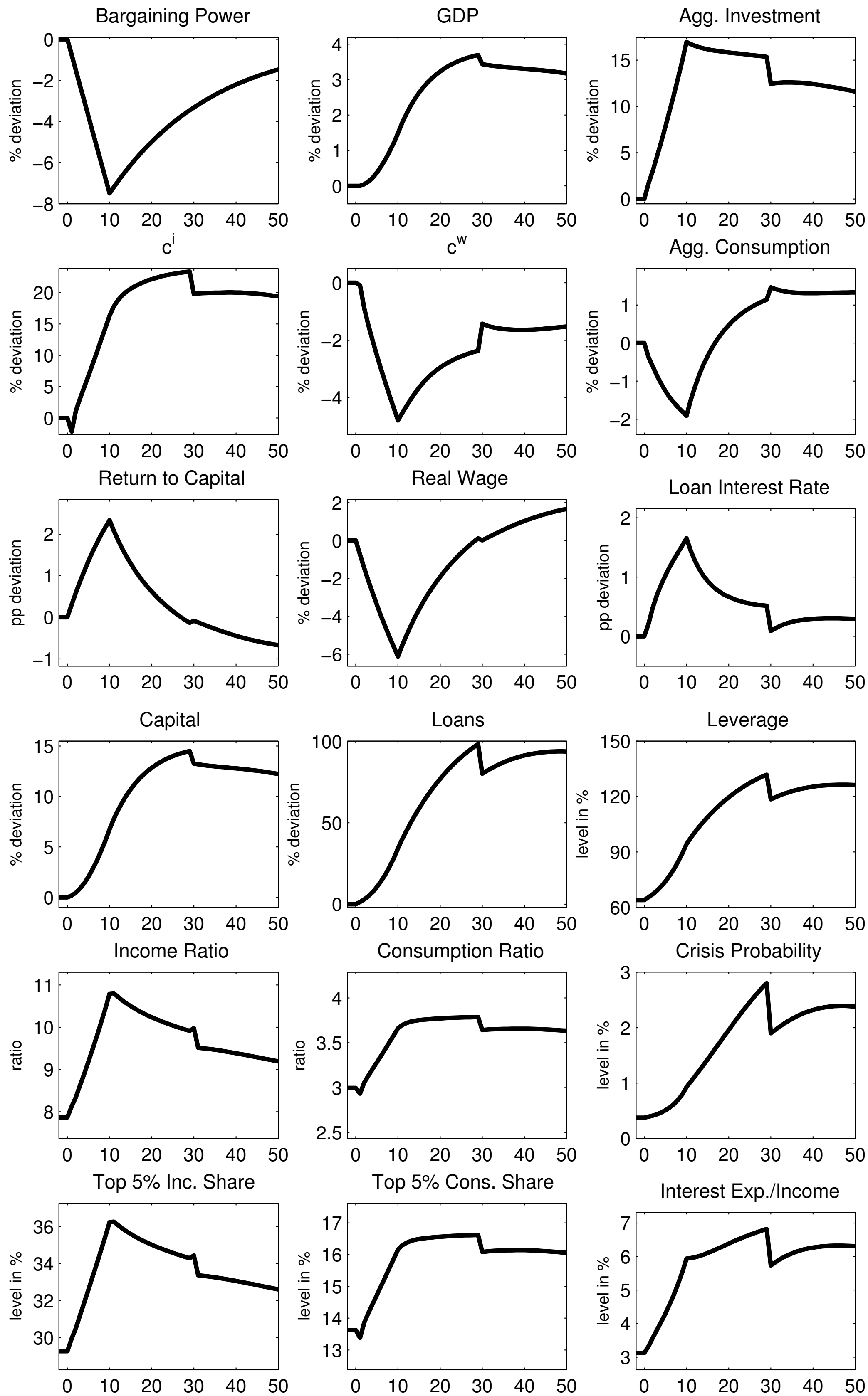


Figure 12: Fixed Subsistence, Orderly Debt Restructuring
$(\sigma_\eta = 0.01)$

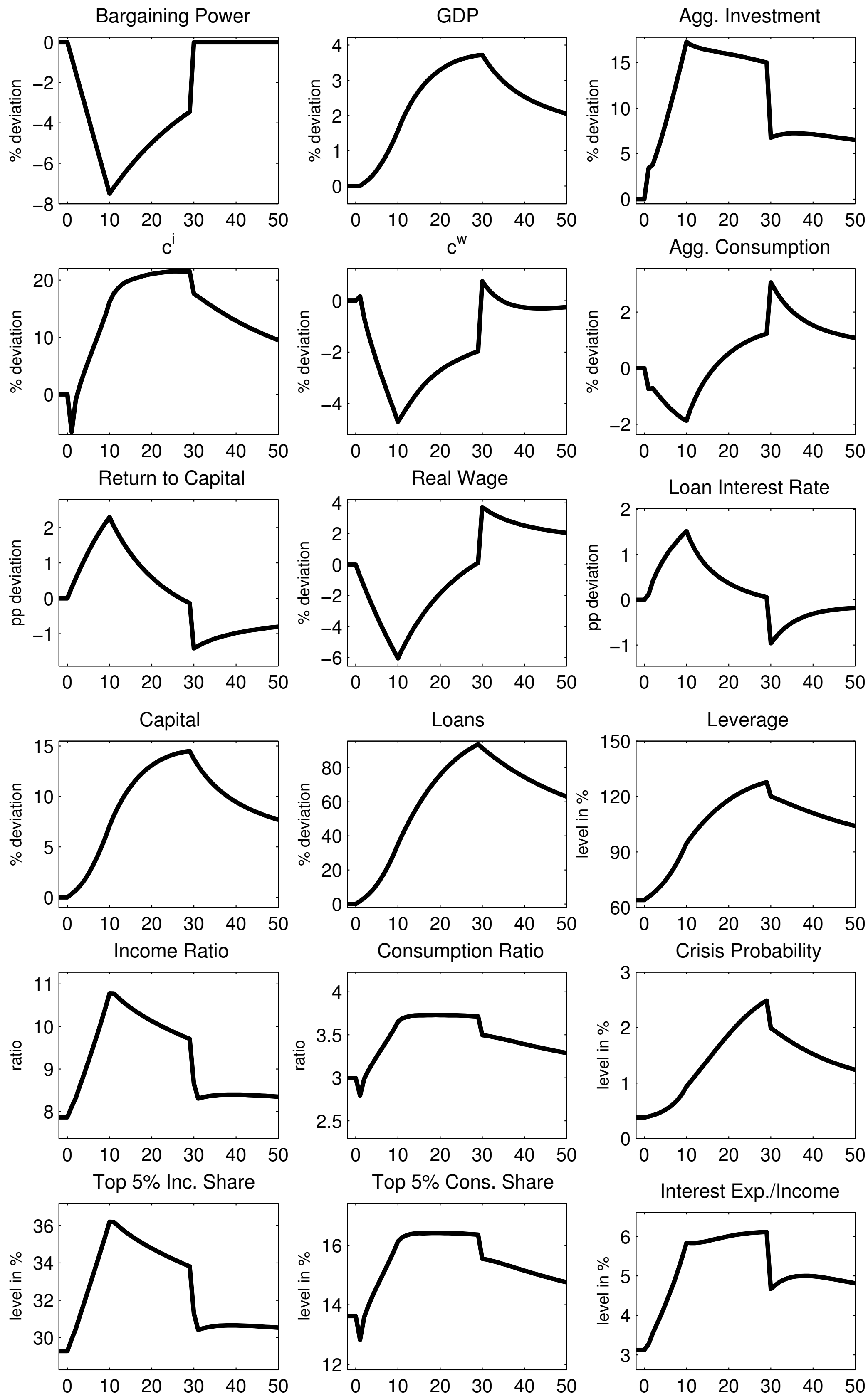


Figure 13: Fixed Subsistence, Restoration of Workers' Bargaining Power ($\sigma_\eta = 0.01$)