

Inequality, Leverage and Crises

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1 Introduction

Empirical Motivation: Similarities of 1929 and 2007 Pre-Crisis Periods

- Sharply increasing income inequality.
- Sharply increasing debt leverage among lower/middle classes.
- High leverage was a key factor in large financial and real crash.

Theoretical Explanation: New DSGE Model

- Shock: Persistent increase in income bargaining powers of the rich.
- Response of the rich (top 5% of incomes):
 1. Higher consumption.
 2. Higher physical investment.
 3. Much higher financial investment = recycling gains back to losers.
- Response of the lower/middle class (bottom 95% of incomes):
 1. Lower consumption.
 2. Much higher borrowing from the rich = higher leverage over decades.
- Result: Higher financial fragility \Rightarrow risk of financial crisis \Rightarrow eventual crash.

2 Literature

Empirical Literature on Inequality, Leverage and Crises

- Rajan (2010), Reich (2010).
- Present stylized facts related to ours below.
- No theoretical modeling framework.

Empirical Literature on Income and Wealth Distribution

- Focus: Description of long run changes in income/wealth distribution.
- Piketty and Saez (2003), Piketty (2010).
- Key finding: Most significant changes concern the evolution of top income shares, as in our model.
- Companion literature focuses on causative factors: College premium, technology/automation, jobs offshoring, relative bargaining power.

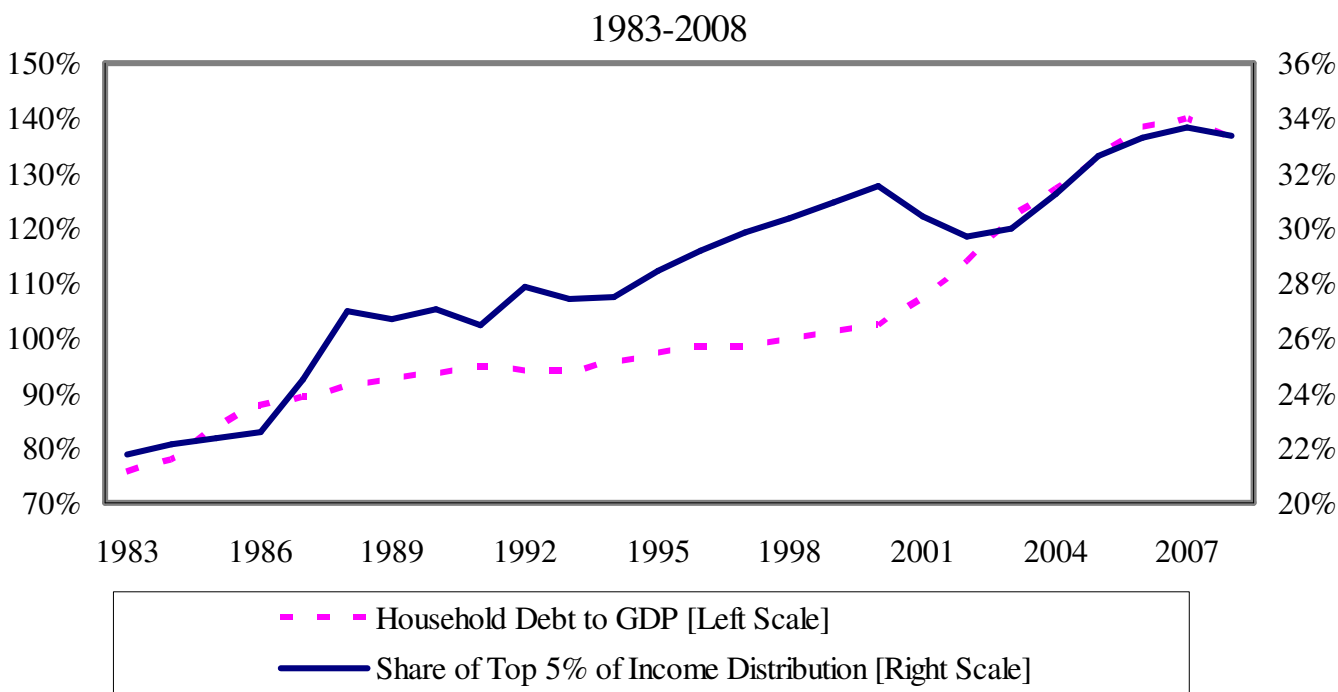
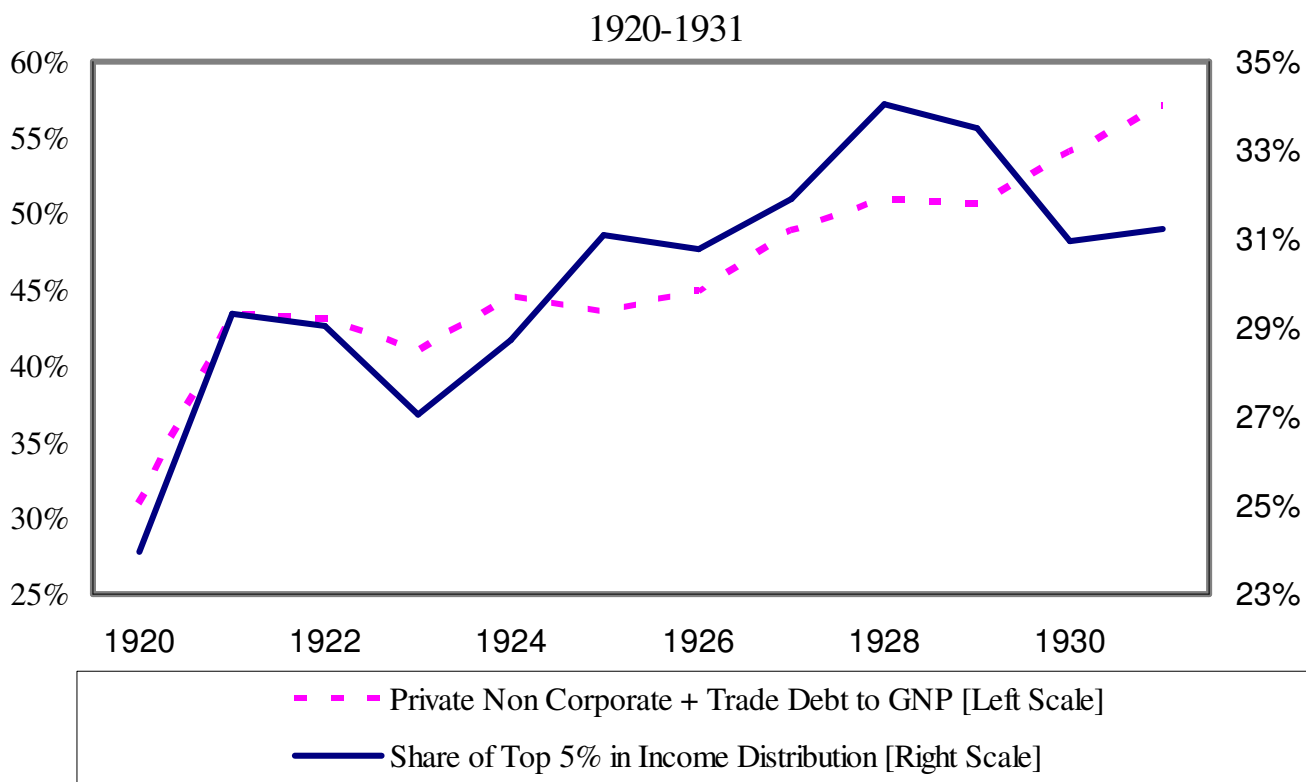
Theoretical Literature on Financial Fragility

- No role for heterogeneity in *incomes*.
- Instead typically heterogeneity in *patience* (Diamond/Dybvig (1983), Iacoviello (2005, 2008)).
- Why income heterogeneity? Increases in leverage and thus crisis risk have been strongly heterogenous if you focus on the rich versus all others.

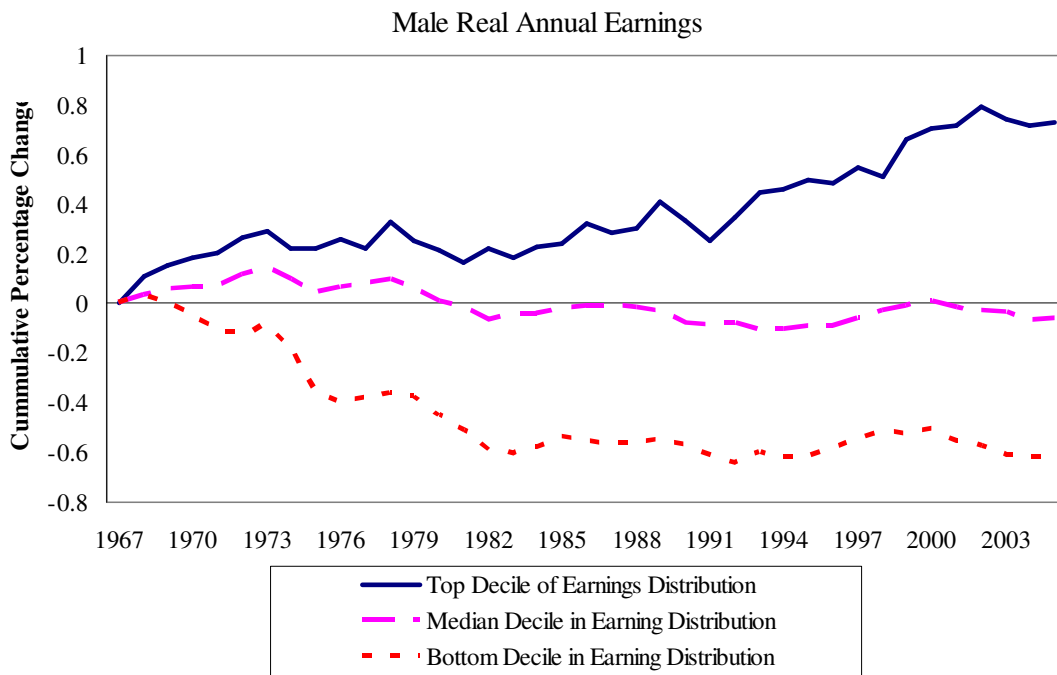
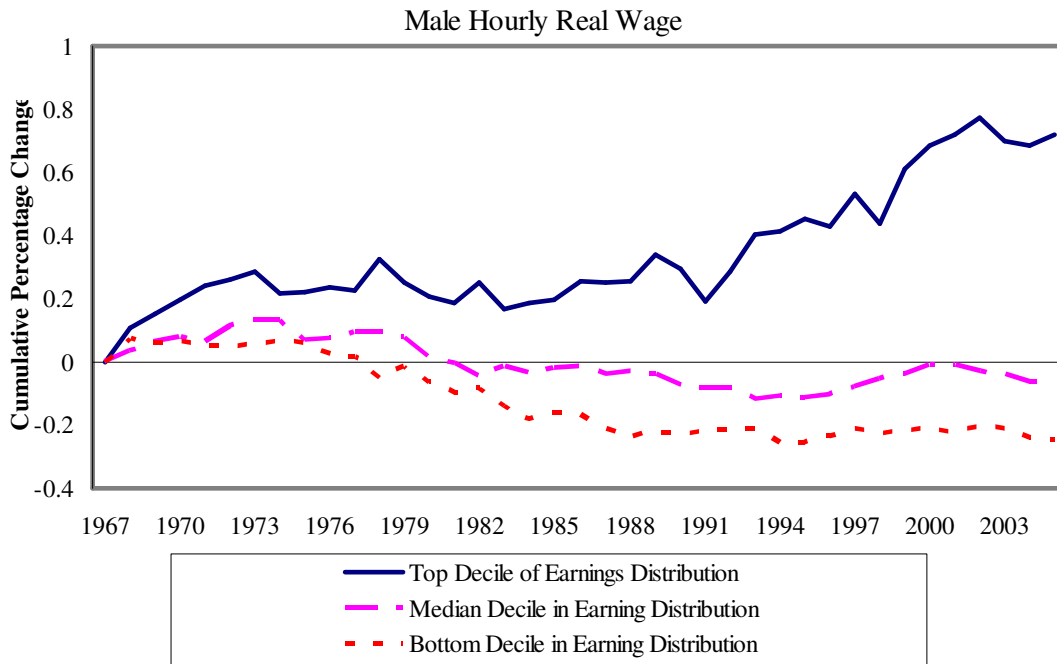
Theoretical Literature on Income Distribution

- Krueger and Perri (2006).
- More volatile idiosyncratic income \Rightarrow insurance demand \Rightarrow more debt.
- Contrast:
 - Krueger and Perri: *Within-group* inequality is key.
 - Kumhof and Ranci re: *Between-group* inequality is key.
 - Between-group inequality of **rich versus all others** has increased strongly.

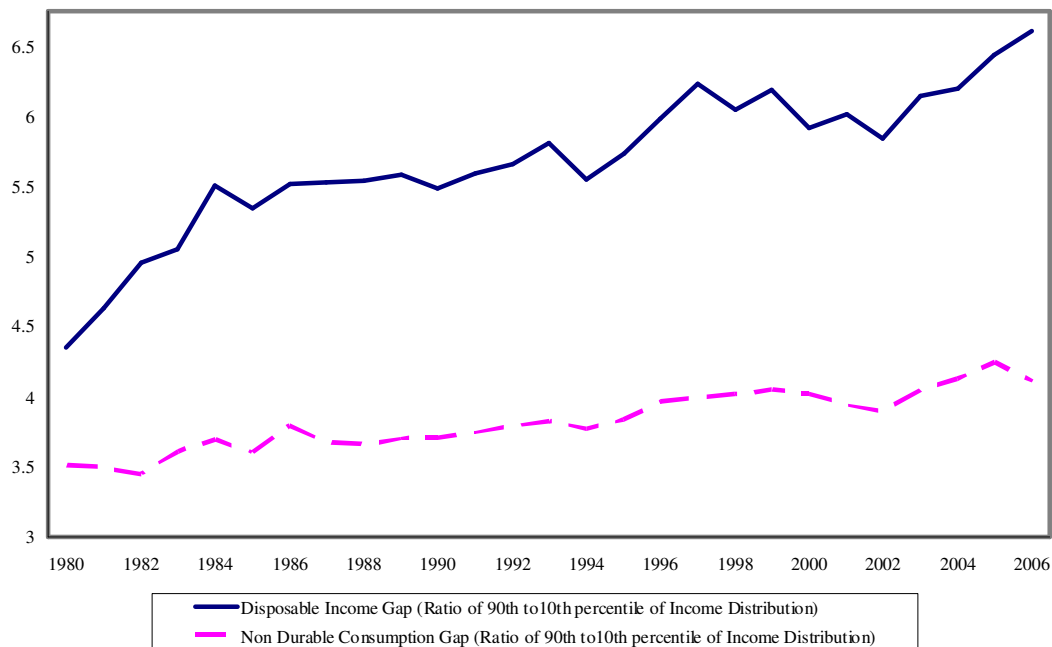
3 Stylized Facts



Income Inequality and Household Leverage: (i) Moved up together pre-crisis. (ii) Both pre-1929 and pre-2007.



Income Inequality by Cohort: (i) Sharply higher inequality pre-crisis. (ii) Decline in real earnings for the median group.

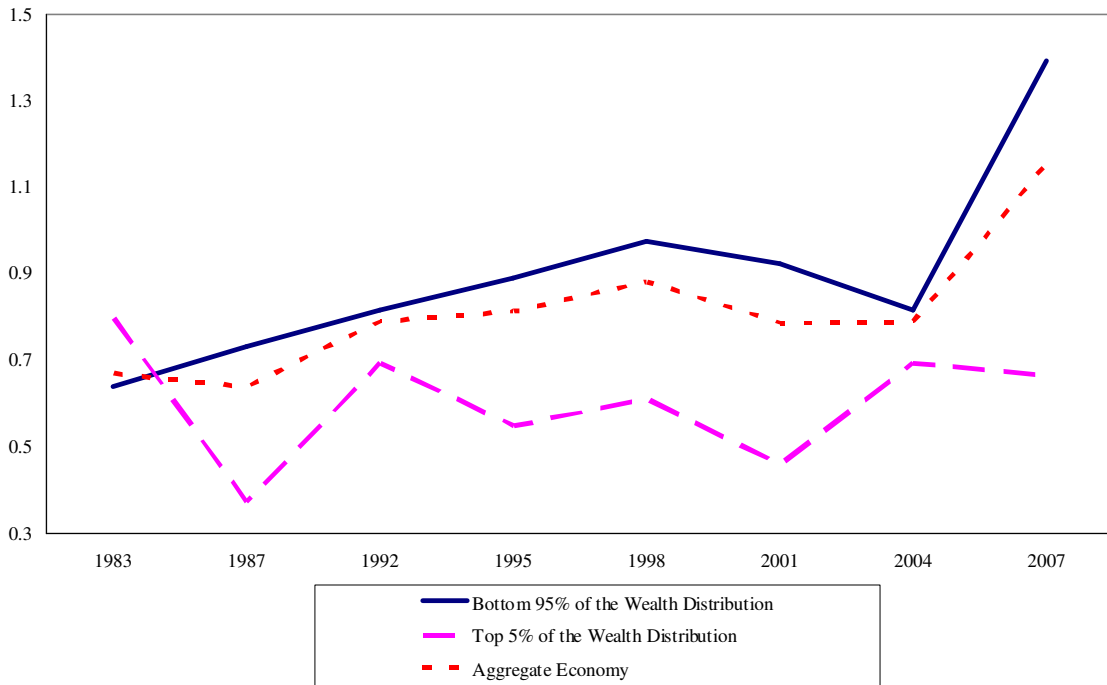


Income Inequality and Consumption Inequality:

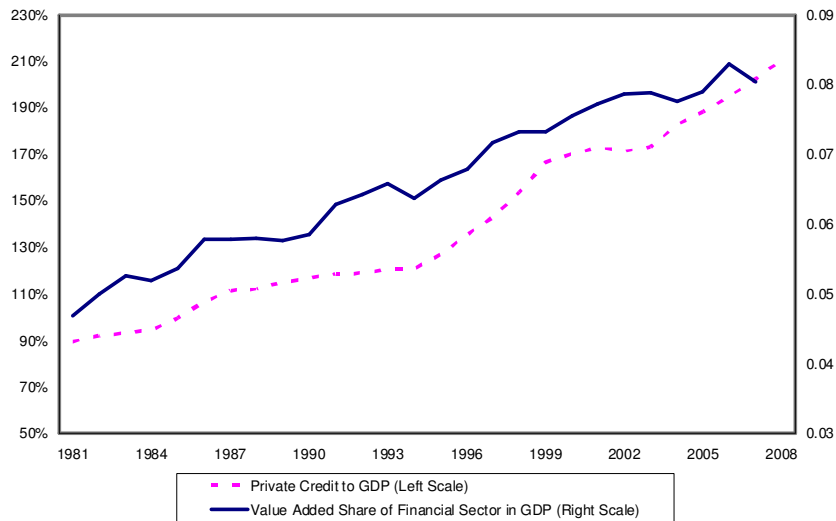
(i) Consumption inequality is much lower and increased much less. (ii) This implies lots of borrowing at the bottom.

Income Mobility:

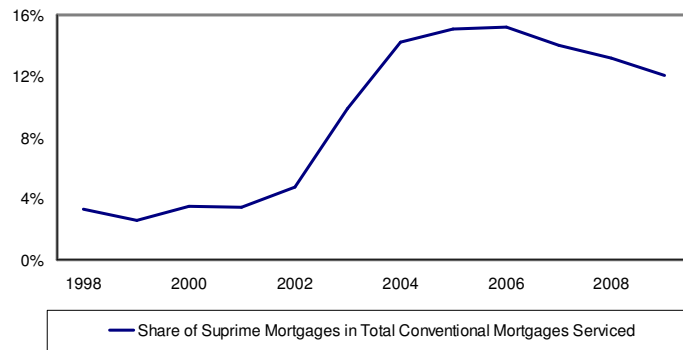
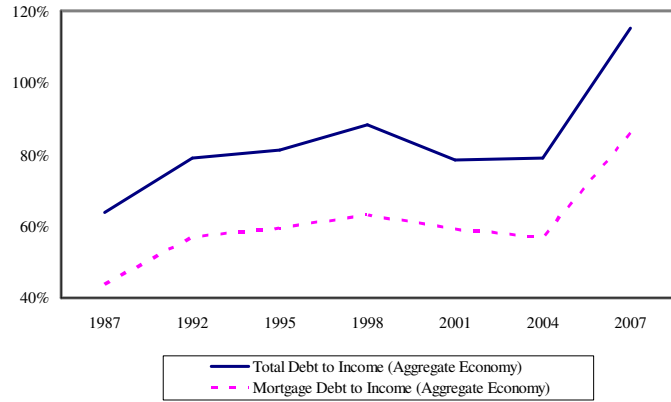
- Higher income inequality not accompanied by higher income mobility, to the contrary (Bradbury and Katz (2002)).
- Implication: Income differentials are persistent and translate into unequal lifetime incomes.
- Model takes the extreme case: Two income groups with fixed memberships.



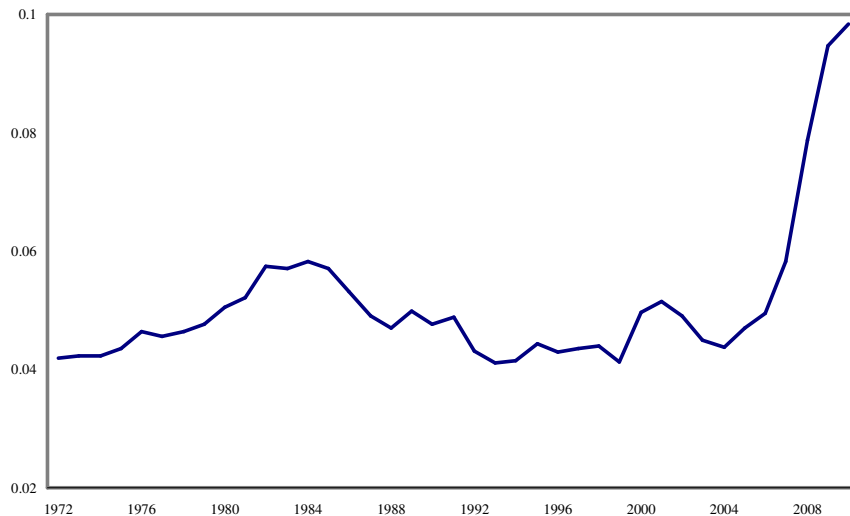
Debt to Income Ratios: (i) Lower or flat for the rich.
(ii) Sharply higher for the remainder.



Size of the U.S. Financial Sector: (i) Private Credit to GDP more than doubled. (ii) Banks' share in GDP more than doubled.



Mortgage Debt: (i) Key driver of higher leverage.
(ii) Recent subprime borrowing sharply increased crisis risks.



Mortgage Default - Share of Past Due Loans: Past due loans near 10% = default rate assumed in our model.

4 Model: Capital Owners

- Share in population $\chi = 5\%$.

- Lifetime utility function:

$$U_0^k = E_0 \sum_{t=0}^{\infty} \beta_k^t \left[\frac{(c_t^k - \tilde{c}_t^k)^{\left(1 - \frac{1}{\sigma_k}\right)}}{\left(1 - \frac{1}{\sigma_k}\right)} + \xi_d \log(d_t) \right. \\ \left. + \xi_k \log\left(\bar{k} + k_t (1 - (1 - \gamma_k) \pi_t)\right) \right]$$

- Subsistence consumption:

- * Large drop in consumption = catastrophe.
- * \tilde{c}_t^k either fixed or moving-average.

- Wealth in utility function, “capitalist spirit”:

- * Necessary to rationalize the saving behavior of the richest households.
- * Carroll (2000), Reiter (2004), Piketty (2010), ...
- * d_t = deposits, k_t = capital.
- * π_t = crisis probability, $(1 - \gamma_k)$ = capital destroyed in crisis.

- Capital accumulation ($\Delta_{k_t} = \gamma_k < 1$ if crisis, 1 otherwise):

$$k_t = (1 - \delta)\Delta_{k_t}k_{t-1} + I_t^k$$

- Budget constraint ($\Delta_{l_t} = \gamma_l < 1$ if crisis, 1 otherwise):

- All income derived from capital and loans.
- No wage labor.

$$d_t q_t = \Delta_{l_t} d_{t-1} + r_t^k \Delta_{k_t} k_{t-1} - c_t^k - I_t^k$$

- Optimality conditions:

$$\left(c_t^k - \tilde{c}_t^k\right)^{-\frac{1}{\sigma_k}} = \lambda_t^k$$

$$1 = \beta_k E_t \left(\frac{\lambda_{t+1}^k}{\lambda_t^k} \right) \frac{(1 - (1 - \gamma_\ell) \pi_t)}{q_t} + \frac{\xi_d}{\lambda_t^k d_t q_t}$$

$$1 = \beta_k E_t \left(\frac{\lambda_{t+1}^k}{\lambda_t^k} \right) (r_{t+1}^k + 1 - \delta) (1 - (1 - \gamma_k) \pi_t) + \frac{\xi_k (1 - (1 - \gamma_k) \pi_t)}{\lambda_t^k (\bar{k} + k_t (1 - (1 - \gamma_k) \pi_t))}$$

5 Model: Workers

- Share in population $1 - \chi = 95\%$.

- Lifetime utility function:

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

- Budget constraint:

– Inelastic supply of one unit of labor.

– $l_t =$ loans, $w_t =$ real wage.

$$l_t q_t = \Delta_{l_t} l_{t-1} + c_t^w - w_t$$

- Crisis probability:

$$\pi_t = \frac{\exp\left(\phi_0 + \phi_1 \left(\frac{l_t}{w_t - \left(\frac{1}{q_t} - 1\right) l_t}\right)\right)}{1 + \exp\left(\phi_0 + \phi_1 \left(\frac{l_t}{w_t - \left(\frac{1}{q_t} - 1\right) l_t}\right)\right)}$$

- Time $t + 1$ probability is function of time t loans to net income ratio.
- Probability bounded between 0 and 1, convex in leverage.
- Schneider and Tornell (2004) show how to endogenize such a function.



Leverage and Crisis Probability in the Model

- Optimality conditions:

$$(c_t^w - \tilde{c}_t^w)^{-\frac{1}{\sigma_w}} = \lambda_t^w$$

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

6 Model: Technology

- Aggregate production function:

$$y_t = A \left(\chi \Delta_t^k k_{t-1} \right)^\alpha (1 - \chi)^{1-\alpha}$$

- Nash bargaining over real wage:

$$\underset{w_t}{Max} \left(W_{h_t} \right)^{\eta_t} \left(K_{h_t} \right)^{1-\eta_t}$$

– η_t = workers' bargaining power.

– W_{h_t} = workers' surplus, K_{h_t} = capital owners' surplus.

- First-order condition: Real wage = bargaining power times MPL!

$$w_t = \eta_t f_{h_t}$$

- Stochastic process for bargaining power:

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

7 Model: Market Clearing

- Goods Market:

$$y_t = \chi (c_t^k + I_t^k) + (1 - \chi) c_t^w$$

- Financial Market:

$$(1 - \chi) \ell_t = \chi d_t$$

8 Calibration

- Annual frequency.
- Intertemporal elasticities: $\sigma_k = \sigma_w = 0.5$.
- Subsistence consumption: 50% of steady state in baseline (80% for moving-average subsistence).
- Steady state real interest rate: 5%.
- Steady state loans to net income ratio: 64%.
- $\bar{k} = -30$.
- Capital share parameter $\alpha = 0.27$:
 - \Rightarrow Steady state investment/GDP = 18%.
 - \Rightarrow Steady state income share of capital owners: 29.8% (data: 22% in early 1980s, 34% recently).

- Bargaining power shocks:
 - **Competitive outcome** in steady state: $\bar{\eta} = 1$.
 - **Standard deviation**: $\sigma_{\eta} = 0.015$ (will also look at $\sigma_{\eta} = 0$, intermediate cases can be inferred).
- Crisis event:
 - **Probability of occurrence**: 0.38% in steady state, 5% at leverage of 150% (Barro (2006), Rancièrè, Tornell and Westermann (2008)).
 - **Size**:
 1. 10% loan defaults: $\gamma_{\ell} = 0.9$.
 2. 10% capital destruction: $\gamma_k = 0.9$. Implies 2.7% output collapse (IMF(2009)).
 3. Sensitivity analysis: 10% loan defaults, 1% capital destruction.

9 Solution Methods

- Conventional local approximation methods are unsuitable:
 1. Large, discrete crisis events, jumps in state variables of 10 percent.
 2. State variables capital and loans are extremely persistent.
- Global Solution Method A: Functional iteration.
 - Monotone map method (Coleman (1991)).
 - Discretize the state space.
 - Find fixed points in decision rules at each grid point.
 - Initial conjectures: DYNARE decision rules. Works very well!
 - Numerical integration to compute expectations.
- Global Solution Method B: Perfect foresight.
 - TROLL Newton-based stacking algorithm.
 - Needed for variable subsistence version (5 continuous state variables).
 - Allows inference for cases between $\sigma_\eta = 0.015$ and $\sigma_\eta = 0$.

10 Scenarios

- 50-year impulse responses.
- Standardized realization of shocks:
 1. Decline in bargaining power over first 10 years.
 2. Very slow return to $\eta = 1$ thereafter.
 3. Crisis event in year 30.
- Colors:
 - Black = perfect foresight.
 - Red = monotone map (uncertainty).

11 Baseline

- Specification:
 - 7.5% cumulative decline in workers' bargaining power over first 10 years.
 - Reversal back to $\eta = 1$ determined by $\rho = 0.96$.
 - Crisis event features 10% collapses in loans and capital.
- Incomes:
 - Real wage collapses by close to 6%.
 - Return to capital increases by over 2 percentage points.
- Workers' Response:
 - Consumption declines by only two thirds of the decline in income.
 - Workers borrow the shortfall from capital owners.
 - Loans more than double by year 30, leverage reaches 140%.
 - Crisis probability exceeds 3% by year 30.
 - Loan interest rate rises to match the higher return to phys. investment.
 - Loan service cost rises from 3% to 6% of income.

- Capital Owners' Response:

- Their income share increases from less than 30% to over 35%.

- Three ways to spend extra income:

- 1. Consumption increases by eventually over 20%.

- 2. Capital investment increases by over 15% \Rightarrow output rises.

- 3. Loans increase by over 100%.

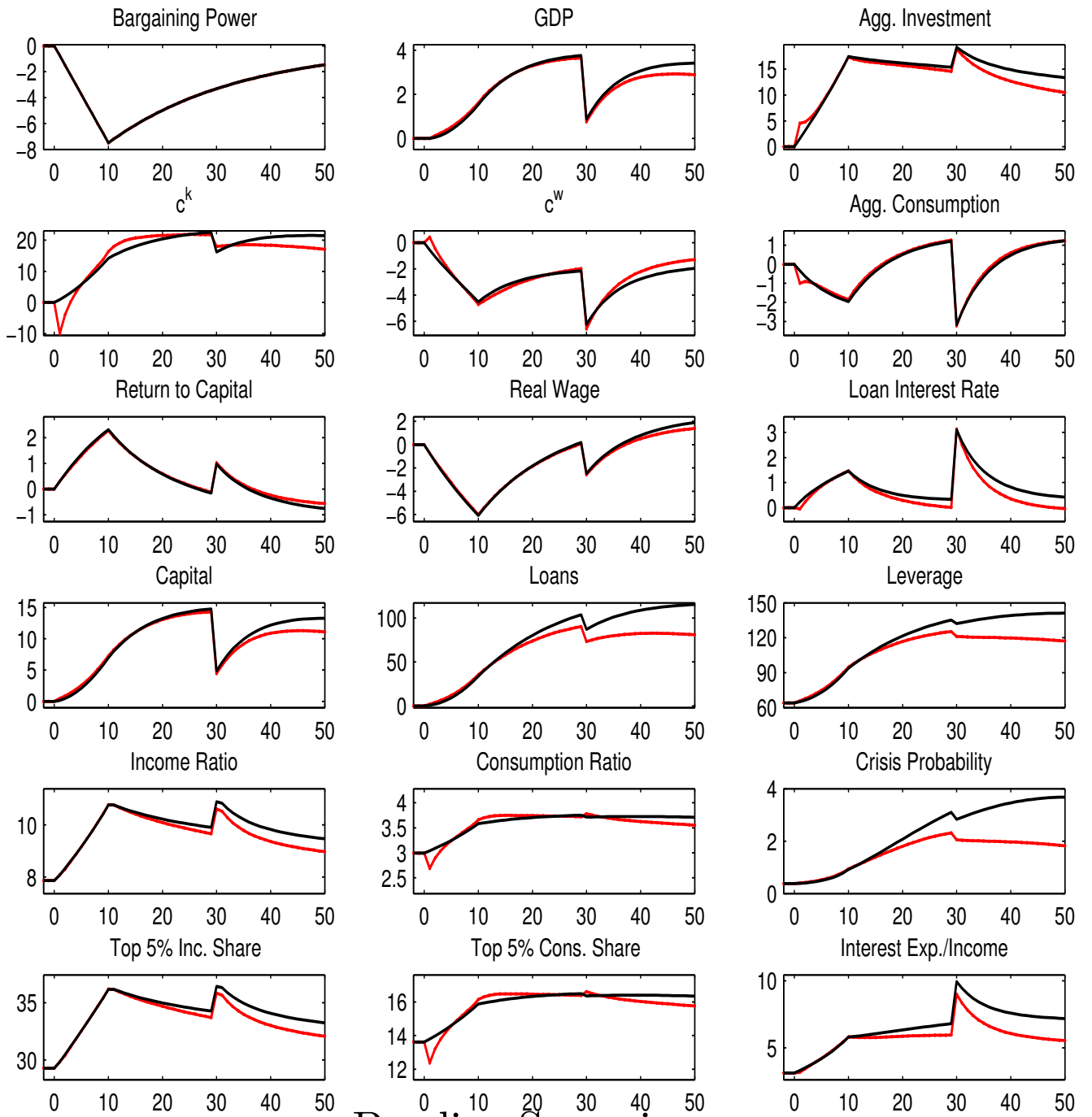
- Why are these loans critical?

- * 71% of final demand comes from workers' consumption.

- * To sustain demand capital owners must recycle gains back to workers.

- Declining Profits over Time:
 - **Two reasons:**
 1. Higher investment reduces marginal product of capital.
 2. Gradual return of workers' bargaining power.
 - **Two possible responses:**
 1. Another round of increasing capital owners' bargaining power.
 2. Major crisis that destroys large amounts of existing capital (year 30).

- Does the Crisis Help?
 - Loans drop by 10% due to default.
 - But wage also drops significantly due to real collapse.
 - Plus real debt servicing costs shoot up to 9% of income.
 - Leverage ratio barely drops.
 - Leverage ratio starts increasing again for another 20 years.



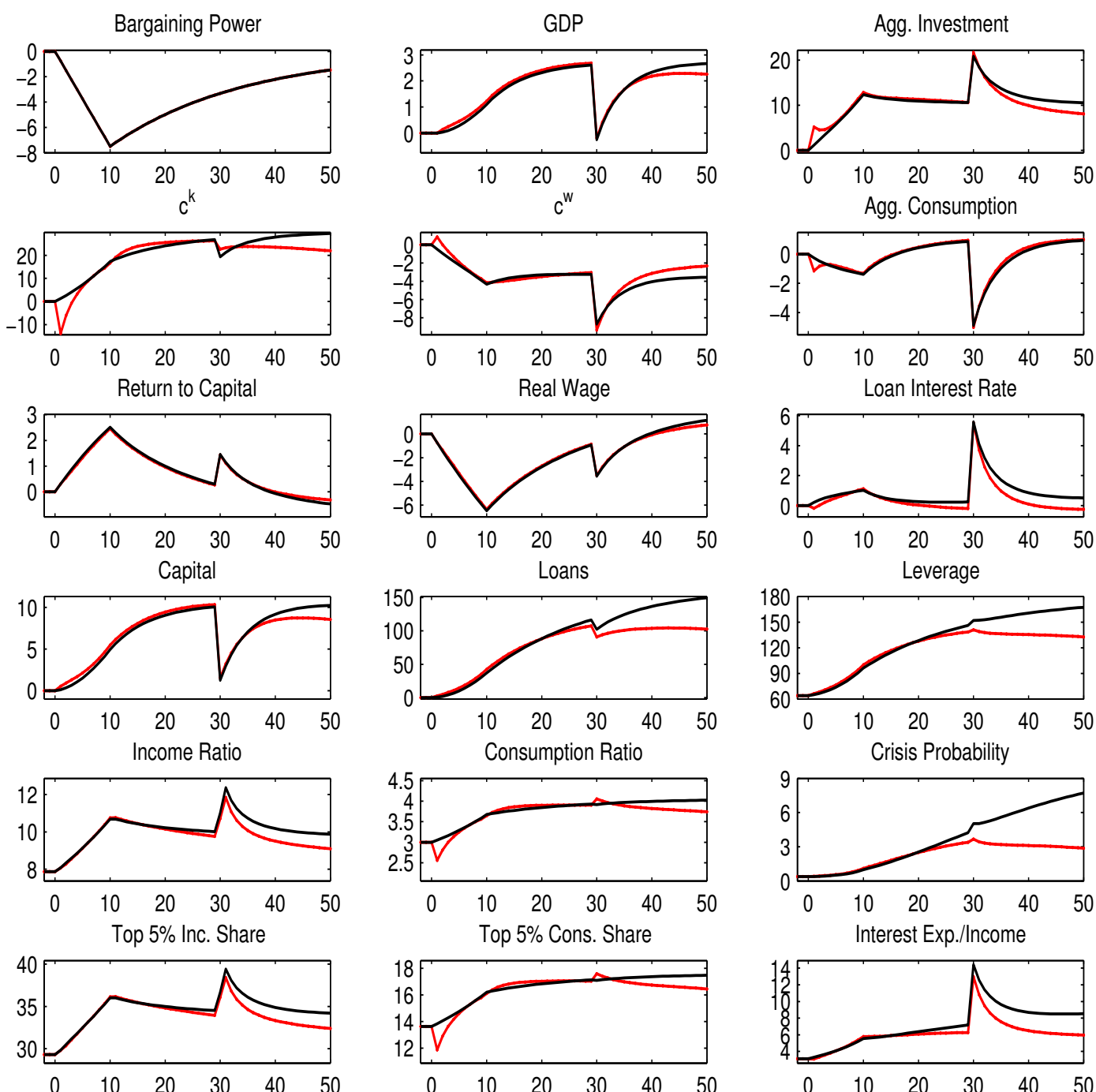
Baseline Scenario

12 Effects of Uncertainty

1. Very long run loan and capital stocks are higher:
 - 90% instead of 64% of workers' income.
 - Volatile bargaining power increases consumption risk.
 - Reduce exposure to that risk by switching to asset holdings.
2. Post-shock loan and capital stocks rise by less:
 - Typical difference is 10 to 20 percentage points by year 50.
 - Convexity of $\pi_t + \text{uncertain } \eta_t = \text{higher expected } \pi_t$.
 - Reduce exposure to crisis by holding fewer loans and capital.

13 Sensitivity 1: Lower Phys. Investment ($\bar{k} = -33$)

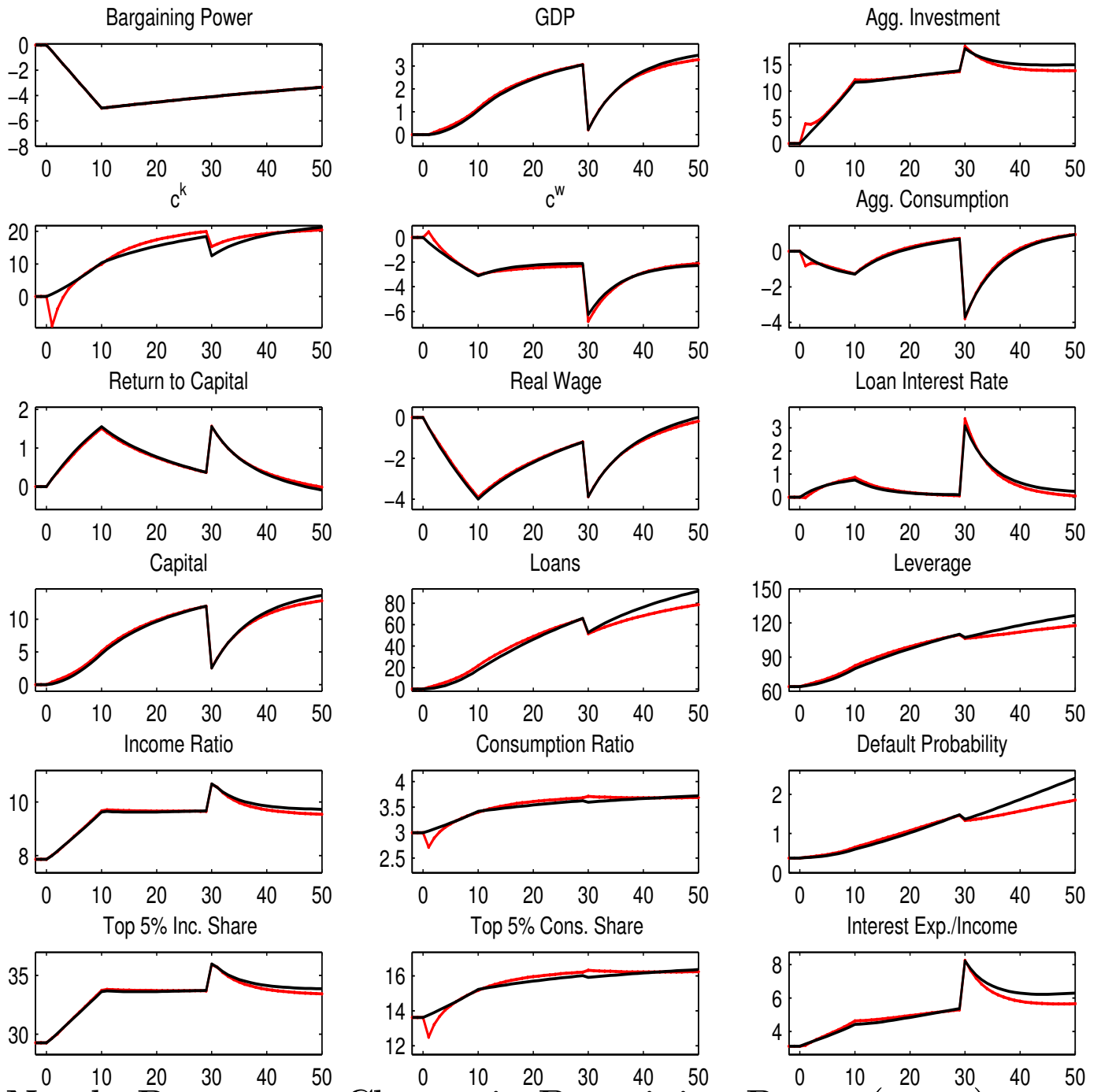
- Much higher leverage at crisis time, and also thereafter.
- Crisis now increases rather than decreases leverage.
- Lessons:
 - If capital owners' gains are productively invested, risk increases less.
 - Reason: Workers' income is supported.
 - If gains instead lead to “financialization”, risk increases significantly.



Less Capital Investment ($\bar{k} = -33$)

14 Sensitivity 2: More Persistent Loss of Bargaining Power ($\rho = 0.99$)

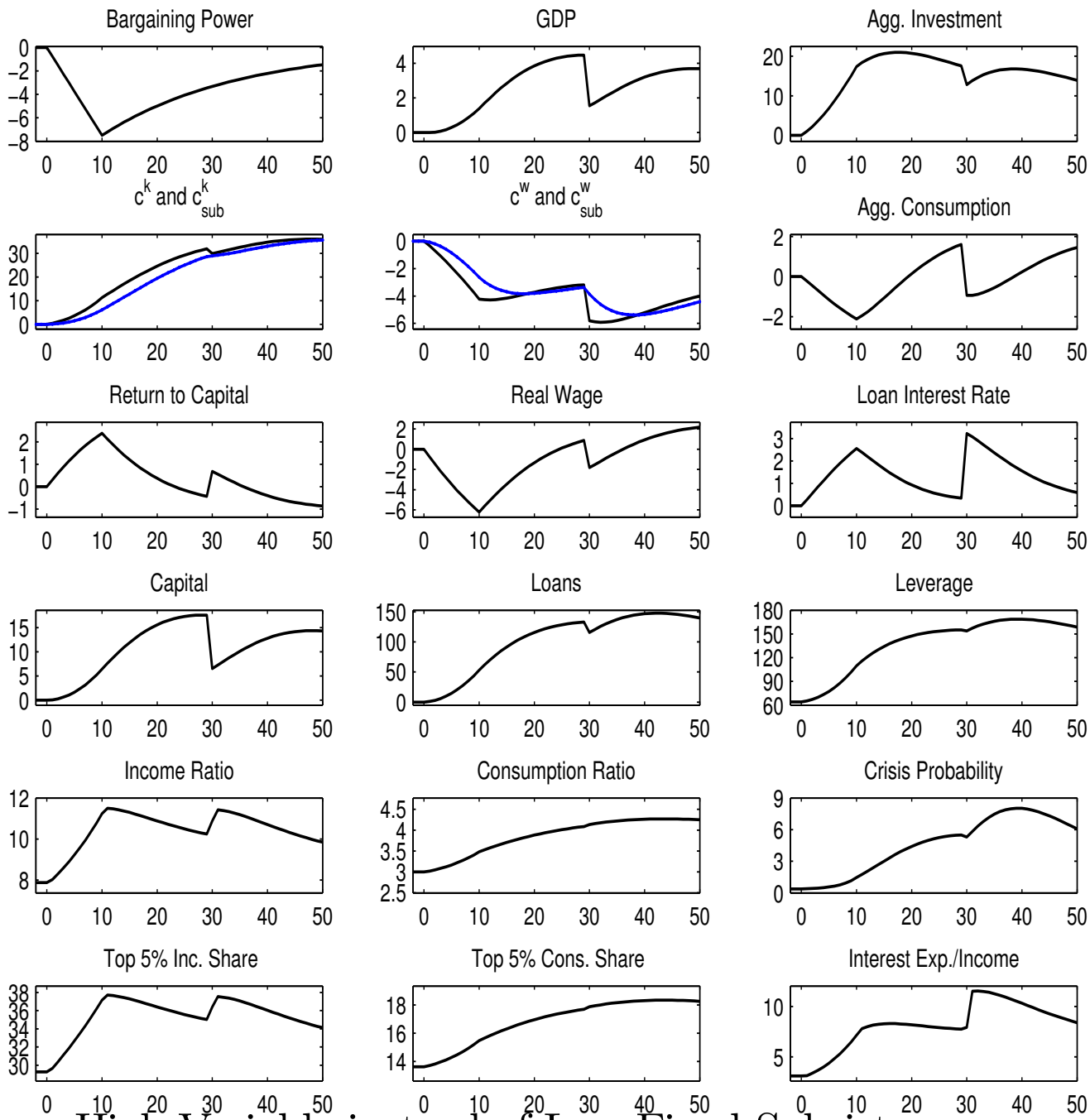
- Post-crisis leverage keeps increasing for decades.
- Lesson: If workers see virtually no prospects of restoring their earnings potential even in the very long run, high leverage and high crisis risk become an almost permanent feature of the economy.



Nearly Permanent Change in Bargaining Power ($\rho = 0.99$)

15 Sensitivity 3: Higher Subsistence Consumption (80% Variable)

- Households borrow much more aggressively.
- Much higher leverage by crisis-time.

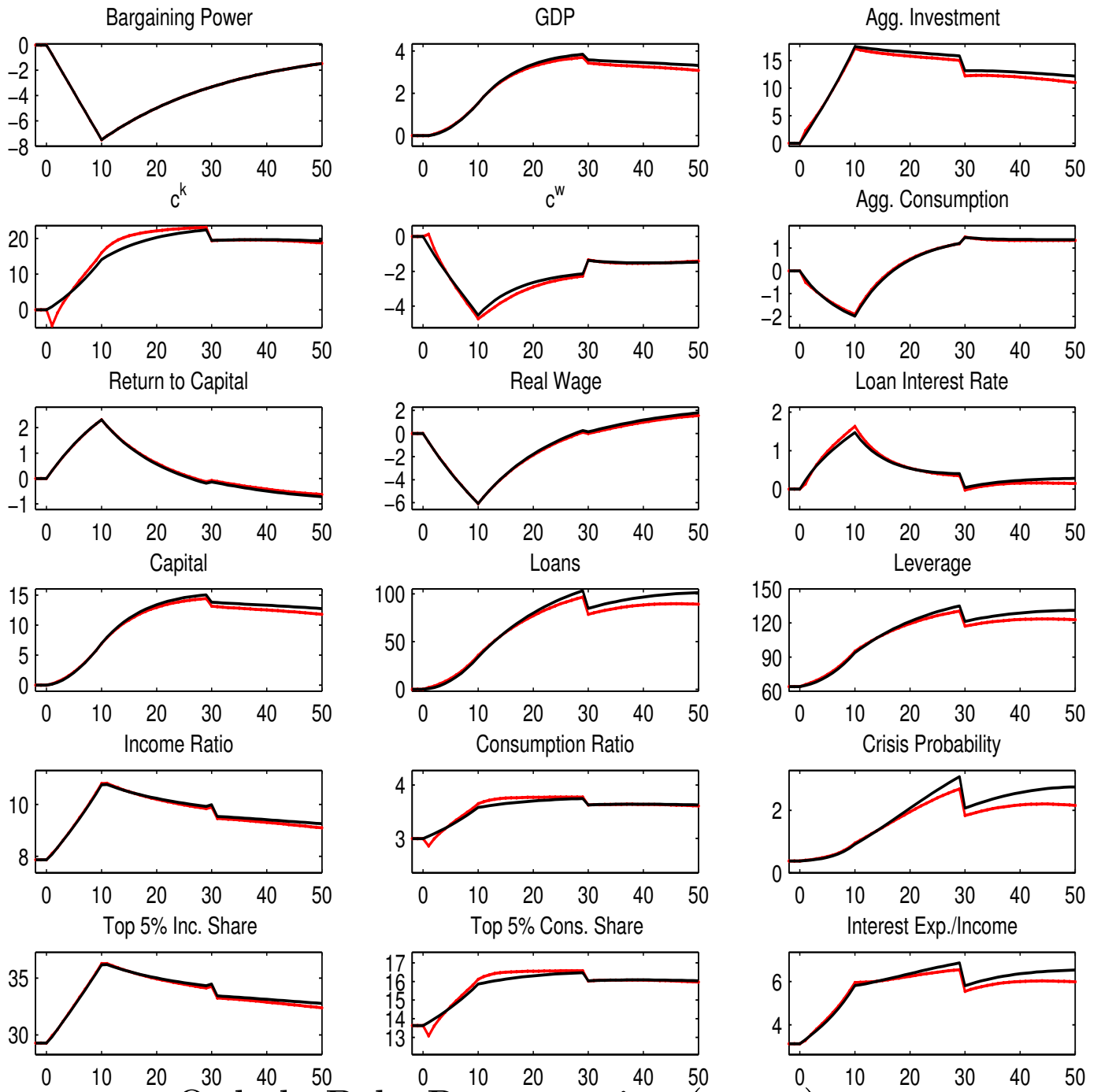


High Variable instead of Low Fixed Subsistence
Consumption

16 Solutions 1: Orderly Debt Restructuring

$$\left(\gamma_k = 0.99 \right)$$

- Debt reduction in year 30 not accompanied by a significant income reduction.
- Leverage therefore drops by 13.5 pp instead of 3 pp.
- But leverage does not go on a downward path for decades.

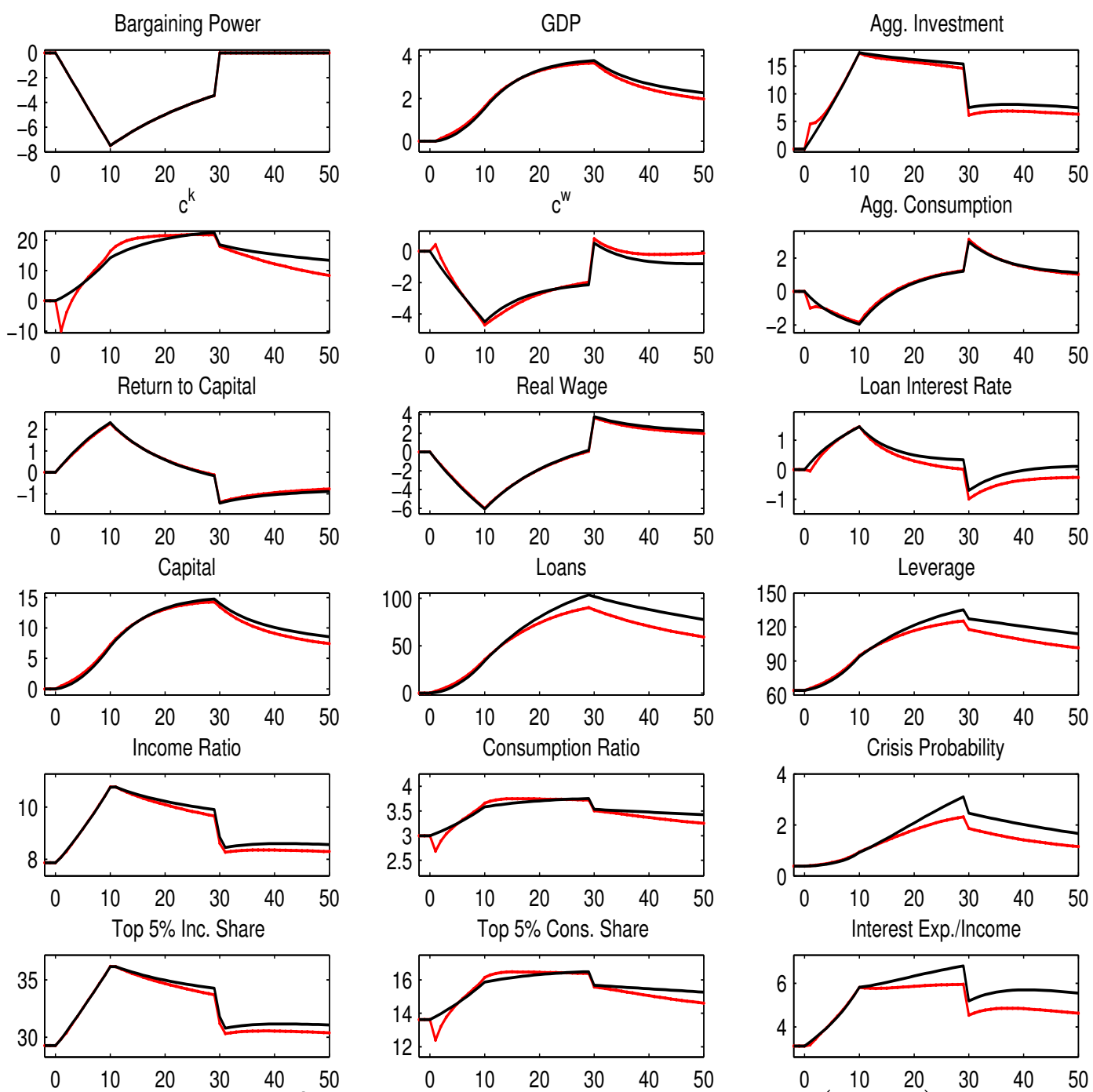


Orderly Debt Restructuring ($\gamma_k = 0.99$)

17 Solutions 2: Restoration of Bargaining Power

$$\left(\eta_{30+} = 1 \right)$$

- Real wage increases significantly.
- Leverage drops by 8 pp due to higher income.
- After period 30 leverage immediately goes on a downward path.
- Lesson: Permanent flow adjustment much more powerful than stock adjustment unless the latter is extremely large.



Restoration of Workers' Bargaining Power ($\eta_{30+} = 1$)

18 Summary

- **Empirical Link:** Higher income inequality \Rightarrow higher leverage \Rightarrow large crises.
- **Theoretical Model:** To make sense of that link.
- **Shock:** Persistent increase in bargaining power of high income households.
- **Mechanism:**
 - Recycling of income gain back to losers as loans.
 - Reflected in rapid growth in size of financial sector.
- **Aggravating Factors:**
 1. **“Financialization”:** Non-productive investment of gains.
 2. **“Hopelessness”:** No prospect for recovery of bargaining power.
 3. **“Desperation”:** High subsistence consumption (loss = catastrophe).

- Solutions:
 1. **Orderly Restructuring:** But leverage keeps rising post-crisis.
 2. **Restoration of Bargaining Power:** Sustained reduction in leverage.

- Extensions: Open Economy
 - Higher lending now also goes to foreign households.
 - Implies current account deficit in foreign country.
 - Imbalances triggered by increasing inequality in surplus countries.