Doves for the Rich, Hawks for the Poor? Distributional Consequences of Monetary Policy

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Motivation

- Theoretical:
  - The redistribution effects of monetary policy have been recognized.
  - Literature somewhat limited, especially with RBC/DSGE model with nominal frictions, central banks' policy workhorse.

- Empirical:
  - Coibion et al. (2012) (CGKS) found that a contractionary monetary policy shock ($R \uparrow$) increases inequality of income and consumption.
  - Need DSGE model with monetary policy shocks.

What We Do

- We extend the standard RBC/DSGE model by introducing:
  - Market incompleteness
  - Nominal frictions
  - Labor market frictions

- We investigate:
  - Heterogeneous effects of monetary policy shocks.
    - Are model implications consistent with CGKS?
  - Heterogeneous welfare effects of monetary policy rule.

Summary of Findings

1. A contractionary MP shock increases inequality.
   - Income composition channel.
   - Broadly consistent with CGKS.

2. Heterogeneous welfare effects of a contractionary MP shock.
   - Wall Street gain ($\uparrow$ financial income).
   - Main Street suffer ($\downarrow$ labor income).

3. Heterogeneous welfare effects of a stronger response to a recession.
   - Wall Street suffer.
   - Main Street gain.

4. (Counterintuitive) long-run effects of accommodative MP.
   - Long-run: Everybody loses.
   - Transition: Wall Street gain, while Main Street lose.

Comparison with Related Literature

- We study monetary policy and market-incompleteness in DSGE.
  $\leftrightarrow$ No existing literature combines the two.
  - Fiscal policy and market-incompleteness
    (Heathcote, Costain-Reiter, McKay-Reis)
  - Monetary policy with representative agent (∞).

- We study short-run heterogeneous effects of monetary policy.
  $\leftrightarrow$ Existing literature studies long-run effects.

- We focus on income composition channel.
  $\leftrightarrow$ Existing literature studies other channels.
  - Savings redistribution channel (Doepke-Schneider, Meh et al.)
  - Portfolio channel (Erosa-Ventura, Albanesi)
  - Financial segmentation channel (Williamson, Ledoit)
  - Earnings heterogeneity channel

Related Literature

- Empirical work:
  - Monetary policy shocks dampen aggregate activity: Christiano et al. (2005), Romer and Romer (2004).
  - Monetary policy shocks increase various inequality measures: Coibion et al. (2012).
  - Sizable savings redistribution due to surprise inflation: Doepke and Schneider (2006b).
  - Earnings inequality widens sharply in recessions, linked to unemployment: Heathcote et al. (2009).
- Theoretical work:
  - DSGE models with nominal and labor market frictions: Galí (2010), Trigari (2009), Walsh (2005), Kuester (2010).
  - Real effects of redistribution of wealth due to surprise inflation: Doepke and Schneider (2006a), Meh et al. (2010).
  - Heterogeneous effects of steady-state inflation: Erosa and Ventura (2002), Albanesi (2007).
  - Heterogeneous-agent model with labor market frictions: Nakajima (2012), Krusell et al. (2010).

Model: Agents

- Households
  - Infinitely-lived.
  - Subject to idiosyncratic unemployment and productivity shocks.
  - Self-insurance, using shares of the mutual funds.
  - Borrowing constrained ($\underline{a} = 0$).
  - Heterogeneous with respect to (e, s, a).
- Representative Mutual Funds
  - Hold equity of all firms, and nominal bonds.
  - Shares are held by households.
  - Profits from firms are distributed to households as dividends.
- Central Bank
  - Determine interest rate of nominal bonds.
  - Taylor rule with: ρ_{Π}, ρ_u, and monetary policy shocks.
- Government
  - Run unemployment insurance program.
  - Adjust τ to keep period-by-period budget balance.

Model: Firms

- Labor Firm (Mortensen-Pissarides)
  - Post a vacancy and hire a worker (search friction).
  - Rent out labor services in a competitive market.
  - Separate at probability λ.
- Capital Firm
  - Make investment and accumulate capital.
  - Rent out capital in a competitive market.
- Intermediate Good Firm (NK-DSGE)
  - Use capital and labor to produce intermediate goods.
  - Subject to aggregate TFP shocks.
  - Sell intermediate goods to final good firms.
  - Monopolistically competitive.
  - Subject to quadratic nominal price adjustment cost.
- Final Good Firm (NK-DSGE)
  - Use differentiated intermediate goods to produce final goods.
  - Final goods are used for consumption and investment.

Model: Employed Household

$$W(X, 1, s, a) = \max_{c, a' \geq 0} u(c) +$$
$$\beta \mathbb{E}[(1 - \lambda + \lambda f) W(X', 1, s', a') + \lambda(1 - f) W(X', 0, s', a')] \quad (1)$$

subject to:

$$c + p_a a' = (p_a + d_a) a + ws(1 - \tau) \quad (2)$$

- $X = (K, N, Z, D, \mu)$.
- $(p_a(X), d_a(X))$: (price, dividends) of a Mutual Fund share.
- $w(X)$: real wage.
- λ: separation rate.
- $f(X)$: job-finding rate.
- $\tau(X)$: proportional UI tax rate.

Model: Unemployed Household

$$W(X, 0, s, a) = \max_{c, a' \geq 0} u(c) + \beta \mathbb{E}[f\, W(X', 1, s', a') + (1 - f)\, W(X', 0, s', a')] \quad (3)$$

subject to:

$$c + p_a a' = (p_a + d_a) a + bs \quad (4)$$

Model: Mutual Fund

- Households own shares of the representative mutual fund (MF), instead of making portfolio choice decision.
- The MFs own and trade with each other:
  - Equity of all firms.
  - Risk-free nominal bonds, whose return is controlled by central bank.
- Each period, the MFs pay the profits as dividends ($= d_a$) to households, in proportion to share holdings.
- Mutual funds aggregate households' heterogeneous preferences.

$$Q(X, X') = \beta \int_{\mathcal{M}} a \frac{u'(c')}{u'(c)} \, d\,\mu$$

Model: Central Bank

The risk-free nominal rate R is determined following a Taylor rule:

$$\log\left(\frac{R}{\overline{R}}\right) = \rho_{\Pi}\log\left(\frac{\Pi}{\overline{\Pi}}\right) - \rho_{u}\left(\frac{u}{\overline{u}}\right) + D \tag{5}$$

$$\log(D') = \rho_{D}\log(D) + \epsilon_{D}\ \text{, where } \epsilon_{D} \sim \text{i.i.d. } N(0, \sigma_{D}^{2}) \tag{6}$$

- D: Monetary policy shock (tighter/looser policy than usual).
- $\rho_{\Pi} = 1.2$: Systematic policy response wrt inflation.
- $\rho_{u} = 0, 0.25$: Systematic policy response wrt unemployment. (Blanchard and Galí (2010))
- $\rho_{D} = 0.7$
- $\sigma_{D} = 25 bps$ per year
- $\overline{\Pi} = 2\%$ per year
- $\overline{u} = 6\%$

Model: Government

- The government runs the UI program.
- τ is adjusted to satisfy the budget constraint:

$$\tau \int_{\mathcal{M}} \mathbb{1}_{e=1} ws \; d\mu = \int_{\mathcal{M}} \mathbb{1}_{e=0} bs \; d\mu \tag{7}$$

Model: Labor Firm

$$J_L(X,s) = (h-w)s + \mathbb{E}Q(X,X')(1-\lambda)J_L(X',s') \tag{8}$$

$$\kappa = \frac{M(U+\lambda N, V)}{V}\mathbb{E}J_L(X,s) \tag{9}$$

- $V(X)$ is determined by the zero profit condition.
- $h(X)$: rental cost of labor per efficiency unit.
- $Q(X,X')$: Aggregate discount factor.
- κ: vacancy posting cost.
- $M(U+\lambda N, V)$: matching function.
- $w(X)$ is determined by ad-hoc wage function ($\epsilon_w = 0.45$):

$$\log(w) = \log(\overline{w}) + \epsilon_w(\log(y) - \log(\overline{y}))$$

Model: Capital Firm

$$J_K(X,k) = \max_{v,i,k'} \left\{ rkv - i + \mathbb{E}\, Q(X,X')\, J_K(X',k') \right\}$$

subject to:

$$k' = (1-\delta(v))k + \zeta\left(\frac{i}{k}\right)k$$

- k: capital stock.
- i: investment.
- v: capacity utilization (for smoother response of marginal costs).
- $r(X)$: rental rate of capital.
- $\delta(v)$: depreciation rate (increasing in v).
- $\zeta(.)$: investment adjustment cost.

Model: Intermediate Good Firm

$$J_I(X, P_{j,-1}) = \max_{P_j, \ell_j, k_j} y_j(X, P_j) \left(\frac{P_j}{P} - \frac{\phi_\Pi}{2} \left(\frac{P_j}{P_{j,-1}} - \bar{\Pi} \right)^2 \right) - rvk_j - h\ell_j + \mathbb{E}\beta_E J_I(X', P_j)$$

subject to:

$y_j = Zk_j^\theta \ell_j^{1-\theta}$

- Monopolistically competitive, facing quadratic price adj cost.
- P_j: price of a good j.
- P: price of a final good (aggregate price level).
- (k_j, ℓ_j): capital and labor used for producing good j.
- ϕ_Π: parameter for quadratic price adjustment cost.

Model: Final Good Firm

$$\max_{y, y_j \in [0,1]} P(X)y - \int_0^1 P_j y_j \, dj$$

subject to:

$$y = \left(\int_0^1 y_j^{\frac{\epsilon-1}{\epsilon}} \, dj \right)^{\frac{\epsilon}{\epsilon-1}}$$

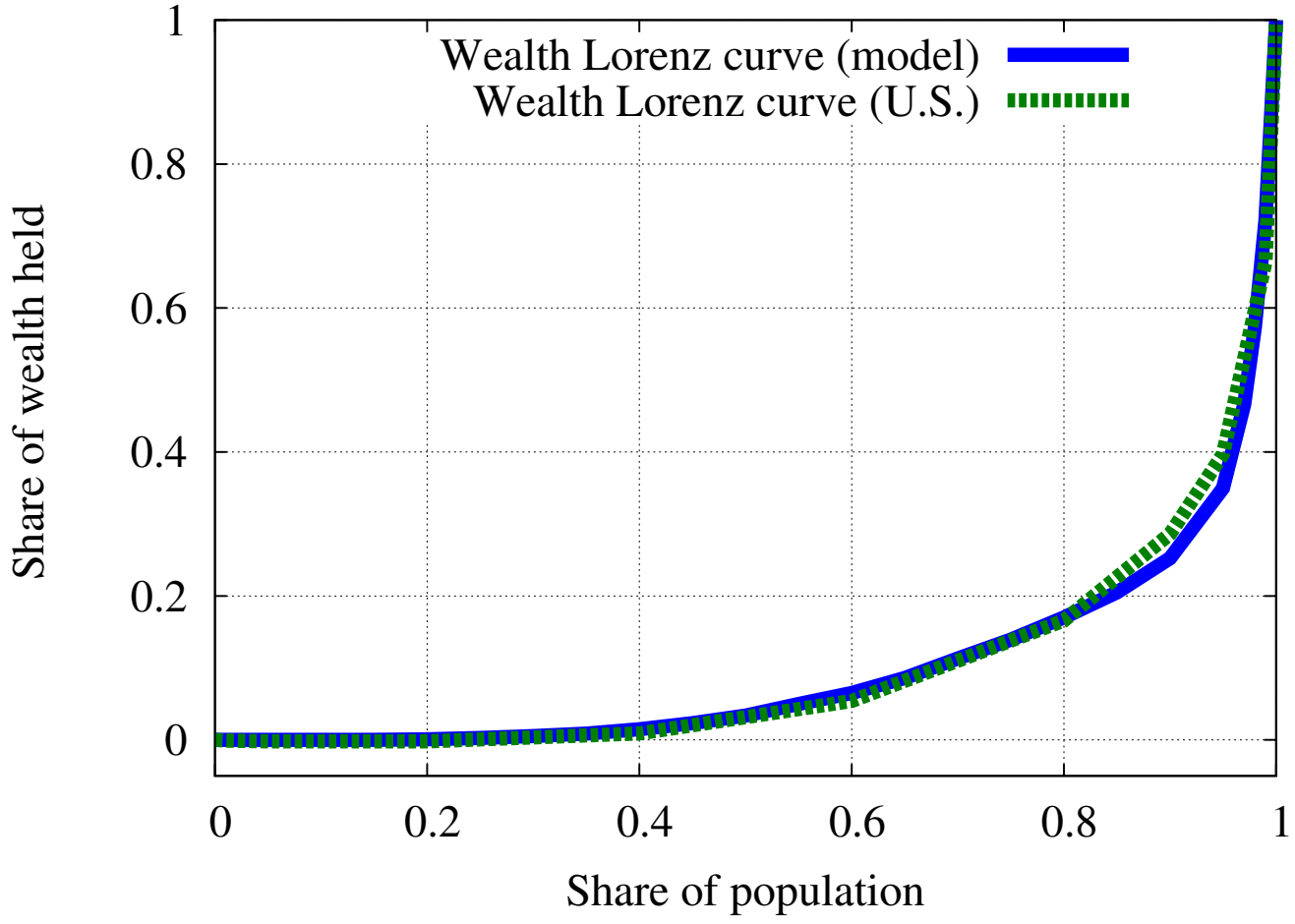
- Dixit-Stiglitz production function with intermediate goods j.
- Chooses output of final goods, y, and inputs y_j.
- Yields the demand schedule for each intermediate good $y_j(X, P_j)$.

Calibration: Remarks

- One period = one quarter.
- Individual productivity shock is calibrated to match:
  - Wealth Gini $= 0.82$.
  - Earnings Gini $= 0.64$.
  - Annual autocorrelation of earnings $= 0.95$.
  - Proportion of borrowing-constrained households $= 0.1$
  - Proportion of super-skilled $= 0.01$
- UI benefit replacement rate: $b = 0.7$.
- Ad-hoc wage function with real-wage stickiness ($\epsilon_w = 0.45$):
  $\rightarrow$ Amplification of U volatility

Calibration: Wealth Distribution

- Model replicates U.S. wealth distribution (SCF).
- 10% of households are borrowing-constrained.
  (lower bound of empirical estimates)



Business Cycle Statistics: Output and its Components

	SD%	SD/SD(Y)	Corr with Y	AR(1)
US: 1984Q1-2008Q3				
Output (Y)	1.36	1.00	1.00	0.92
Consumption	0.77	0.56	0.84	0.82
Investment	4.77	3.49	0.93	0.85
Capacity utilization	1.87	1.36	0.75	0.91
Baseline model				
Output (Y)	1.37	1.00	1.00	0.64
Consumption	0.55	0.40	0.96	0.74
Investment	4.18	3.05	0.99	0.73
Capacity utilization	1.00	0.73	0.78	0.28

- Model replicates cyclical properties of output and its components.
- Consumption: less volatile than output and procyclical.
- Investment: much more volatile than output and procyclical.

Business Cycle Statistics: Labor Market

	SD%	SD/SD(Y)	Corr with Y	AR(1)
US: 1984Q1-2008Q3				
Employment	0.50	0.36	0.81	0.94
Unemployment	8.48	6.20	-0.84	0.94
Vacancies	10.05	7.34	0.89	0.91
Job finding rate	5.84	4.27	0.75	0.78
Baseline model				
Employment	0.57	0.42	0.93	0.68
Unemployment	9.63	7.03	-0.92	0.67
Vacancies	10.62	7.75	0.83	0.18
Job finding rate	4.64	3.36	0.91	0.42

- Model replicates cyclical properties of labor market data.
- Large volatility of unemployment and vacancies replicated.
- Countercyclical unemployment and procyclical vacancies.

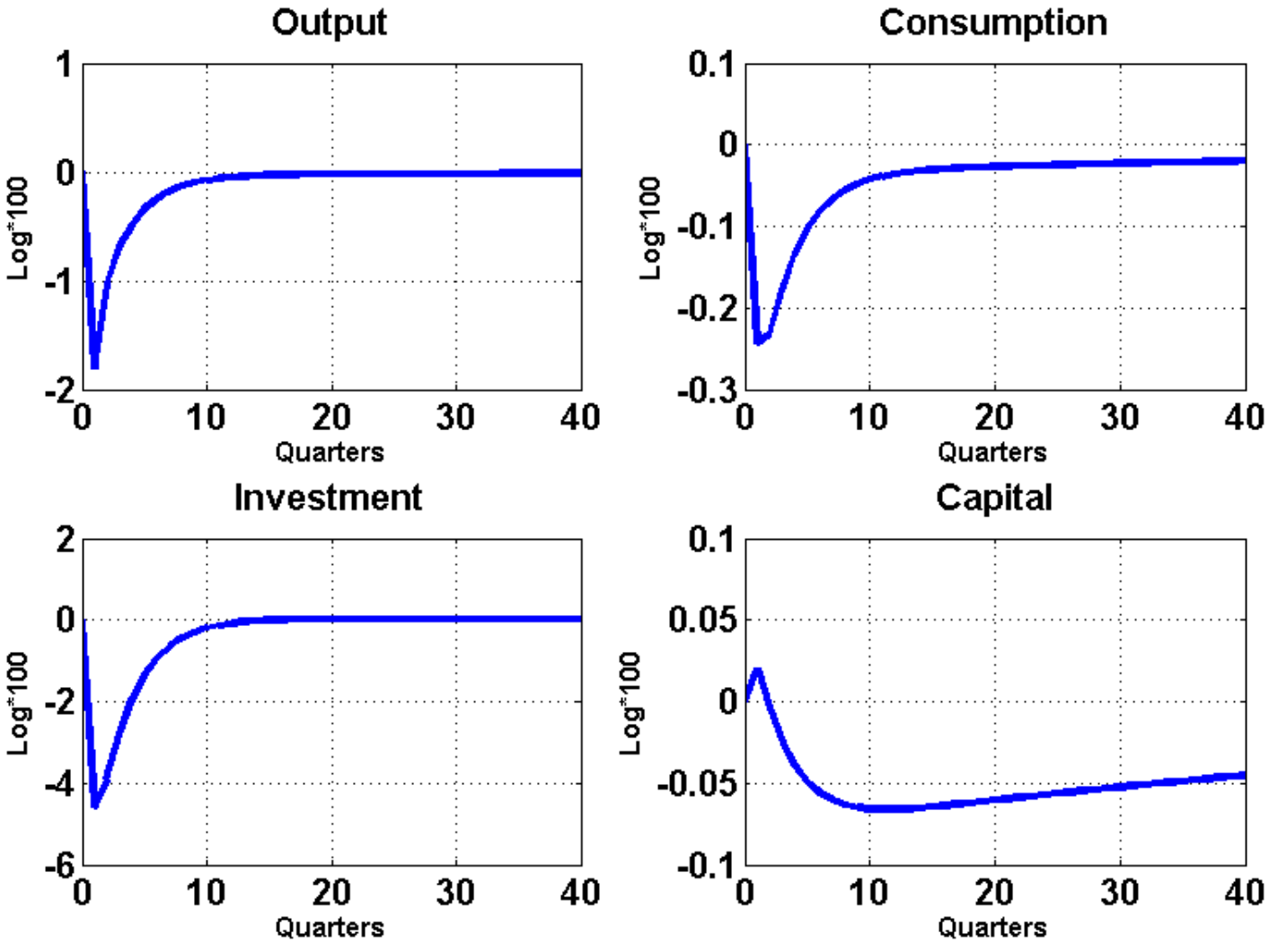
Business Cycle Statistics: Productivity and Prices

	SD%	SD/SD(Y)	Corr with Y	AR(1)
US: 1984Q1-2008Q3				
Output per worker	0.93	0.68	0.89	0.84
Wage per worker	0.89	0.65	0.49	0.84
Nominal interest rate	0.29	0.21	0.60	0.92
Inflation	0.17	0.12	0.22	0.16
Baseline model				
Output per worker	0.86	0.63	0.97	0.61
Wage per worker	0.62	0.45	1.00	0.64
Nominal interest rate	0.05	0.04	0.09	0.29
Inflation	0.09	0.07	0.27	0.40

- Model succeeds in generating moderately volatile and procyclical productivity and wage.
- Not-so-volatile nominal interest rate and inflation.
  $\rightarrow$ Typical for a model with only two shocks.

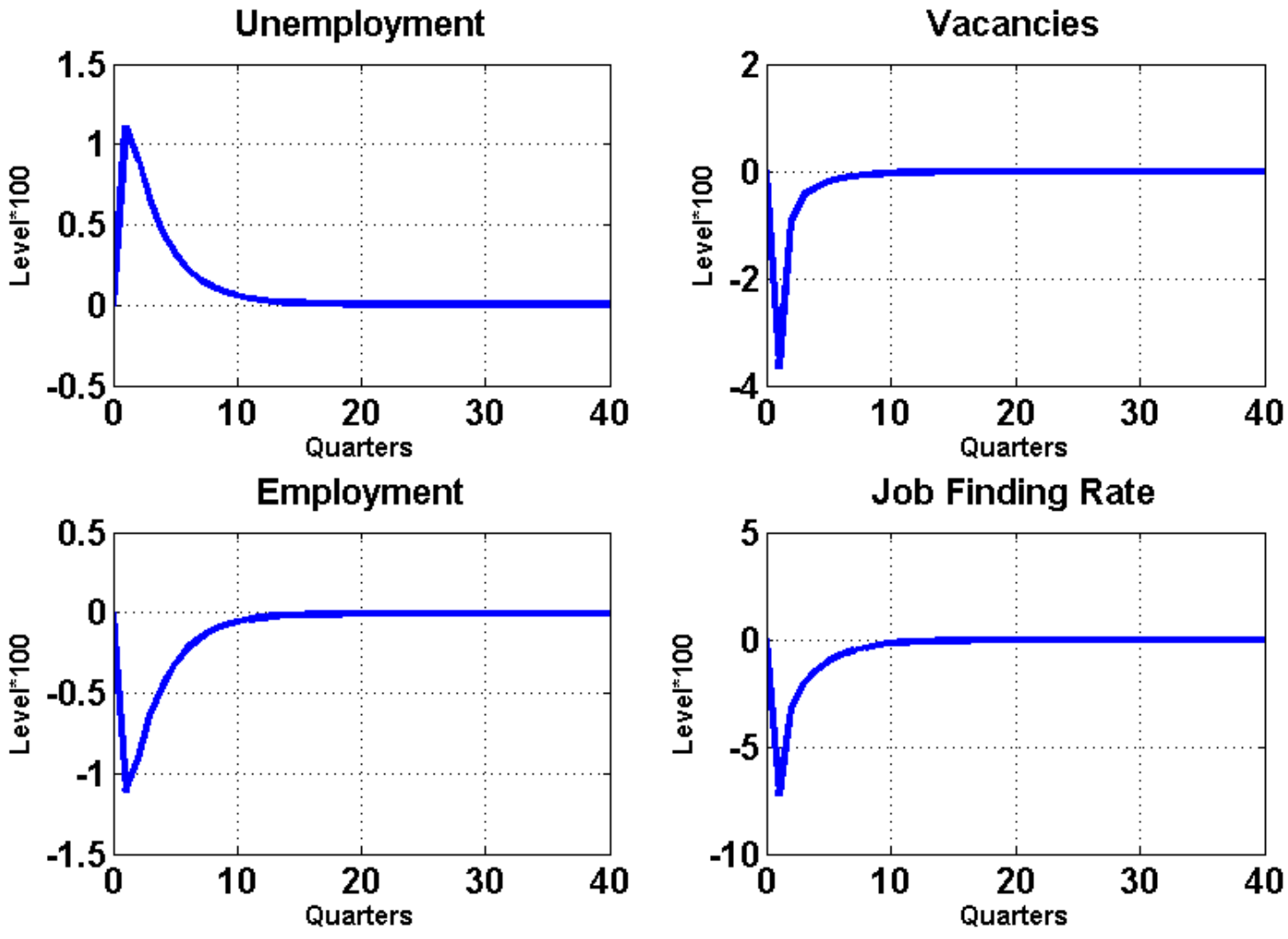
Impulse Response to MP Shock: Output

- 25bps (annual 1%) increase in the policy rate ($\times 4$ S.D.)
- Y (-1.8%), C and I fall.



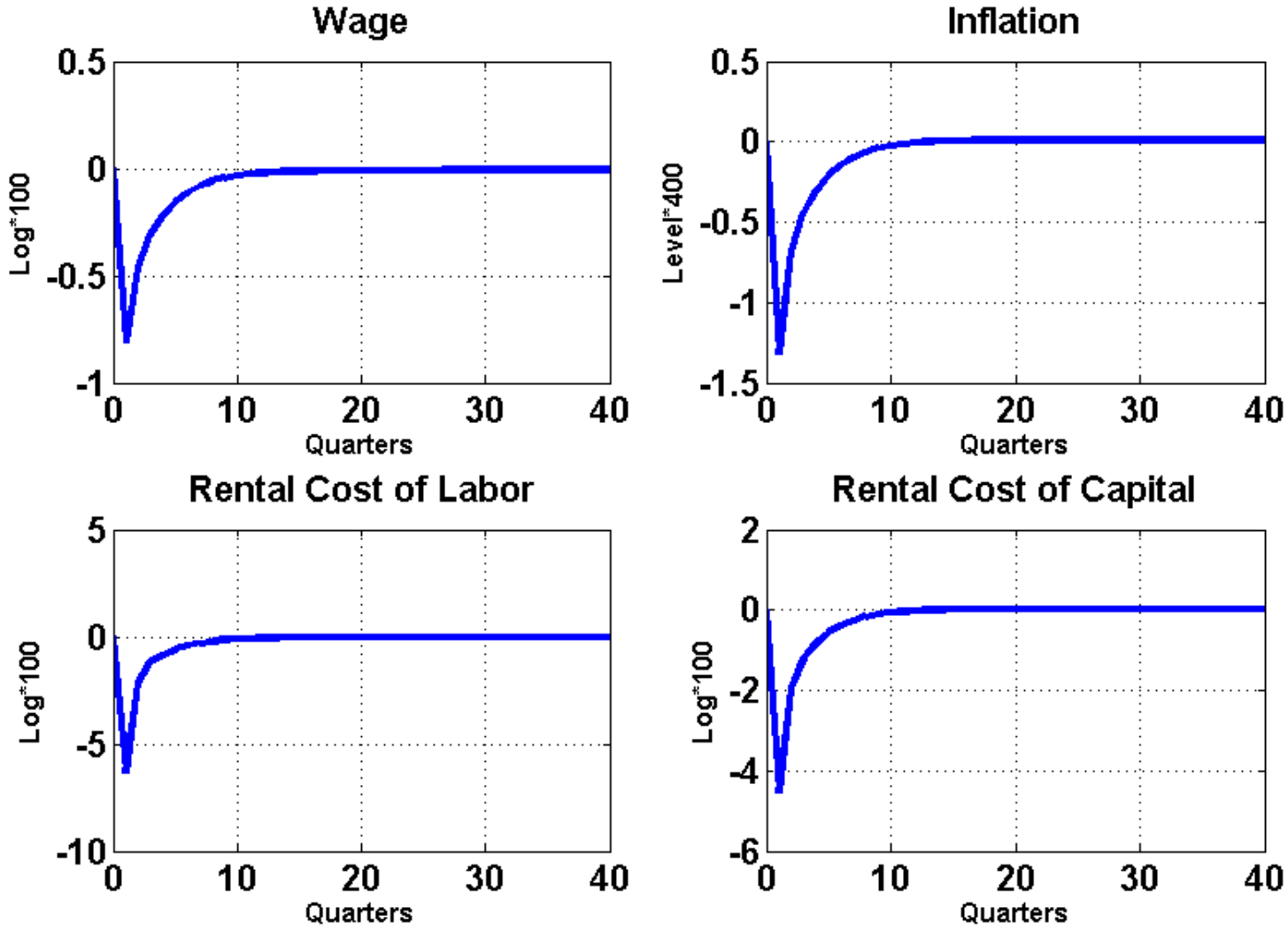
Impulse Response to MP Shock: Labor Market

- Sharp increase in unemployment rate (+1.1%).
  ← Large shock and strong amplification.



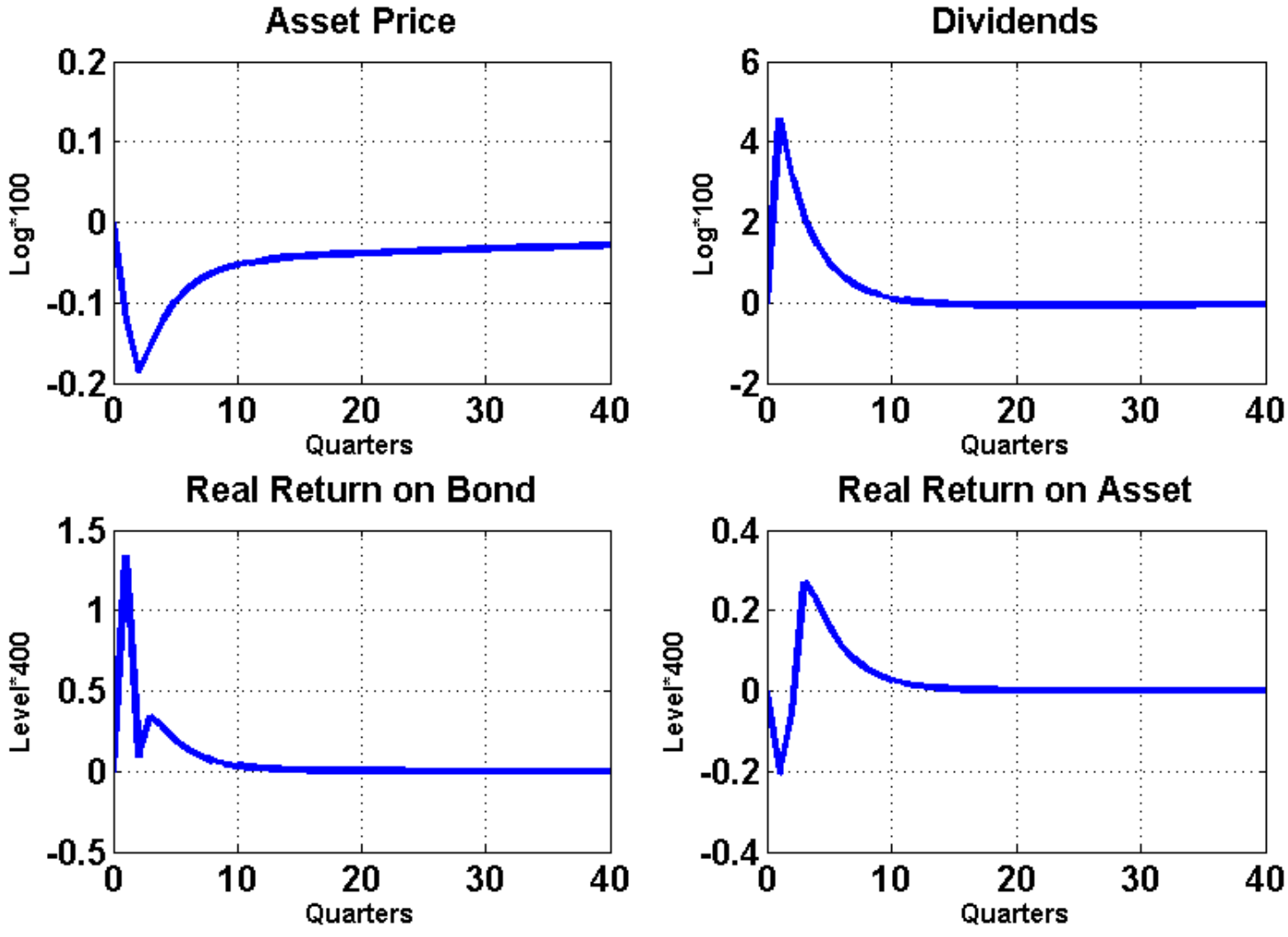
Impulse Response to MP Shock: Prices

- Inflation and rental prices of factors decline as demand weakens.



Impulse Response to MP Shock: Financial Markets

- Discount rate increases $\rightarrow$ Front-loading of dividends.
  $\rightarrow$ Financial income increases in the short-run.



Result 1: Impulse Response to MP Shock (+1%)

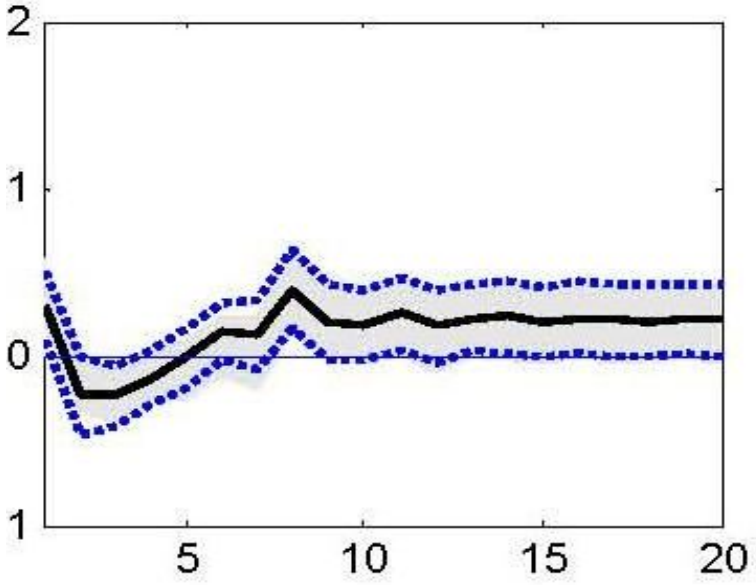
- $\uparrow$ Nominal interest rate $\Rightarrow$ $\uparrow$ Real interest rate $\Rightarrow$ $\downarrow$ demand $\Rightarrow$ $\downarrow$ investment and vacancy postings $\Rightarrow$ $\uparrow$ dividends.

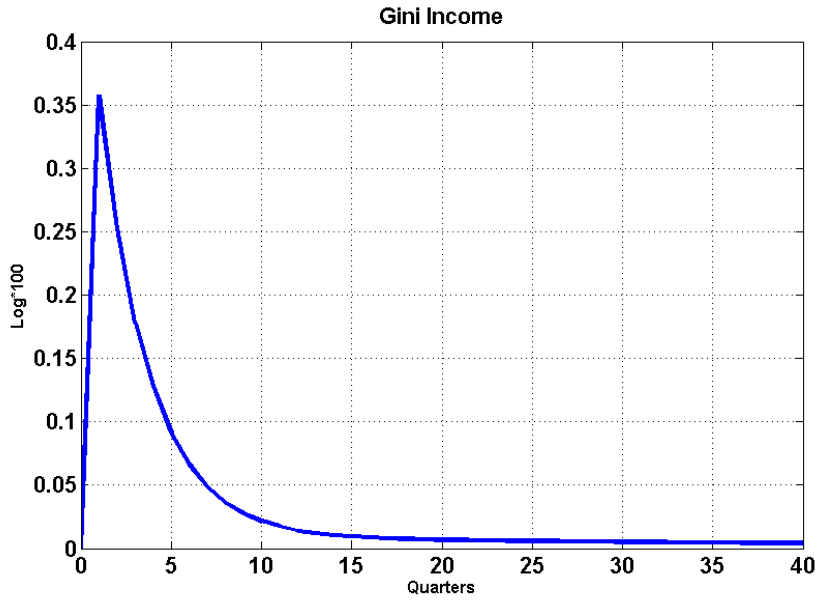
- Income inequality rises due to income composition effect.
  - Wall Street's income rises due to a spike in dividends.
  - Main Street's income declines from lower labor income. (lower wage and higher unemployment)

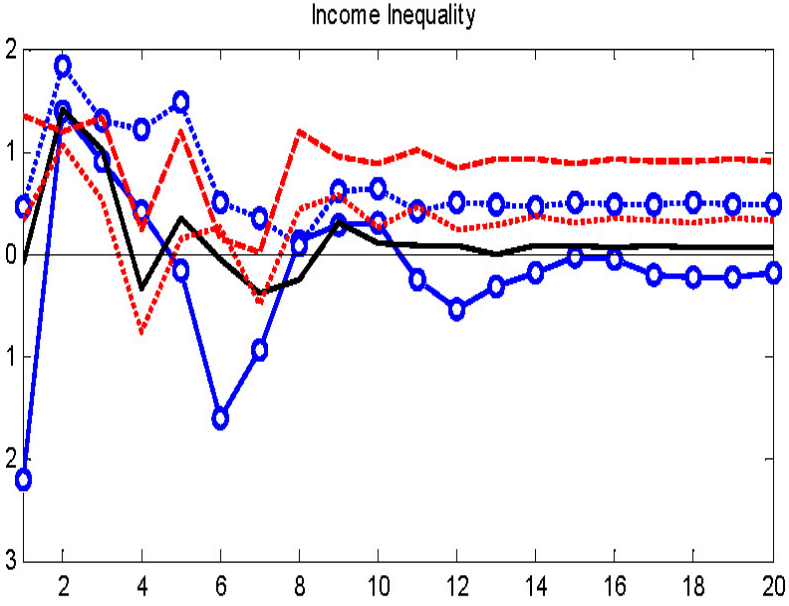
- Consumption inequality rises as well.
  - Rising income inequality.
  - Borrowing constraint for lower-income households.

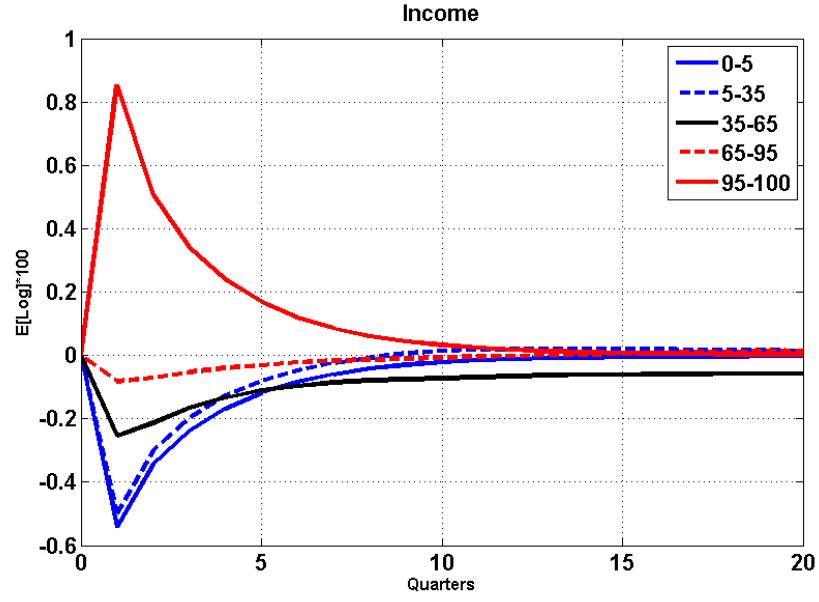
- Consistent with CGKS.

Impulse Response to MP Shock (+1%): Income Inequality





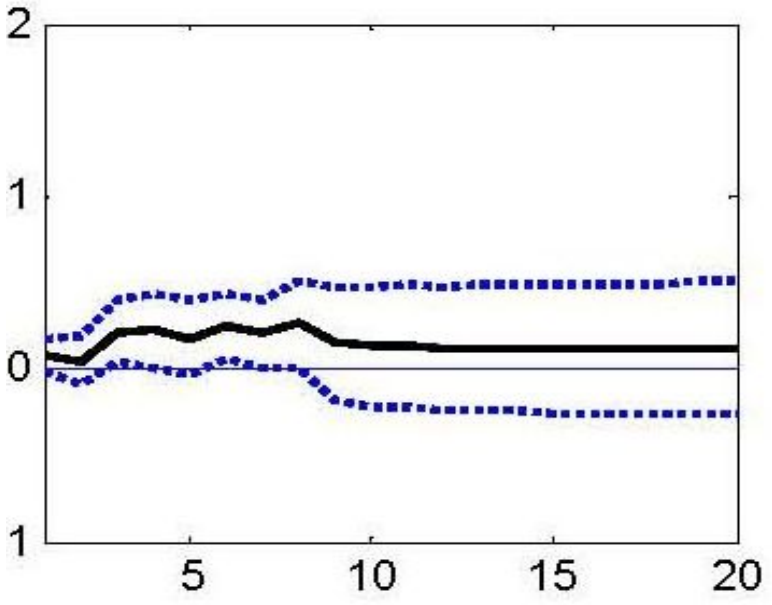


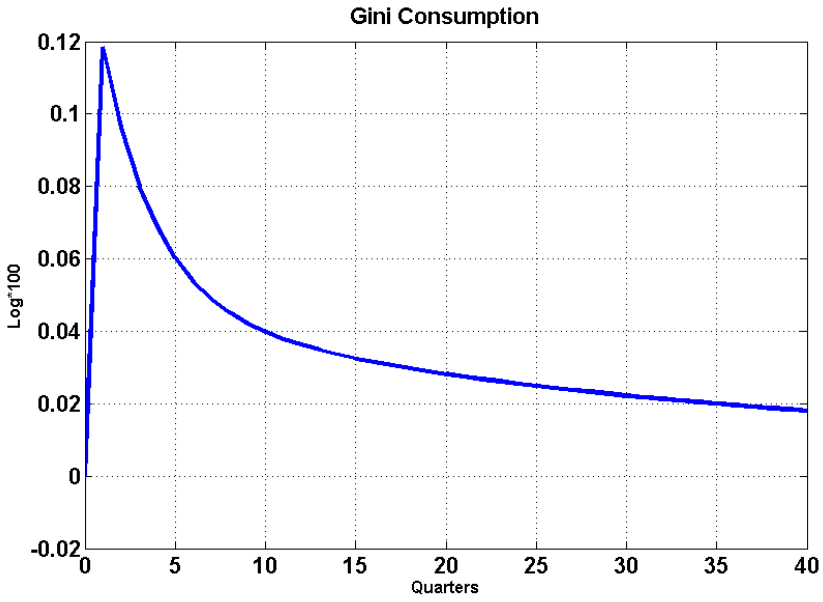


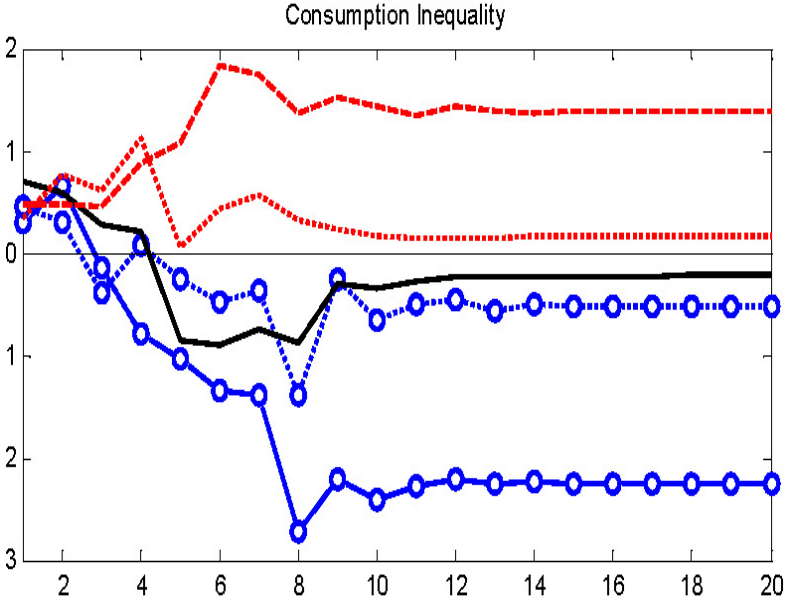
CGKS

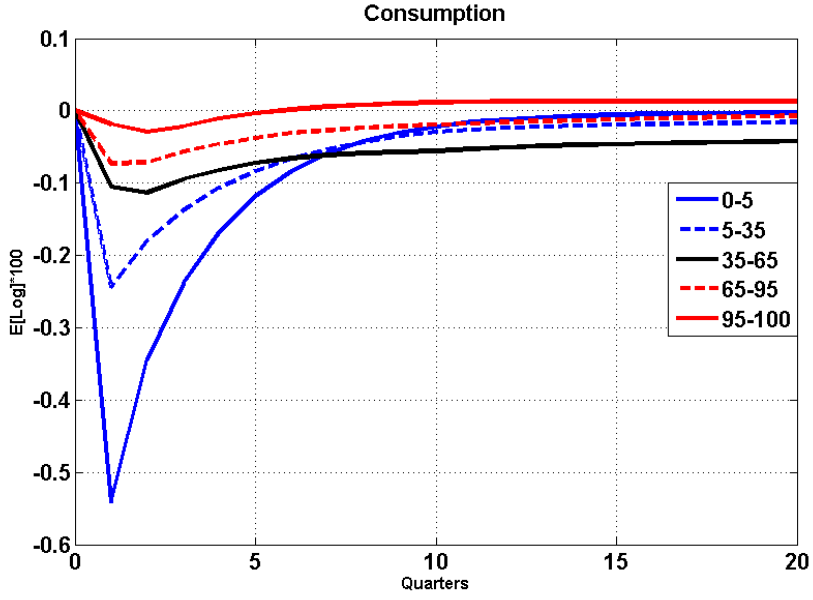
Model

Impulse Response to MP Shock (+1%): Cons Inequality





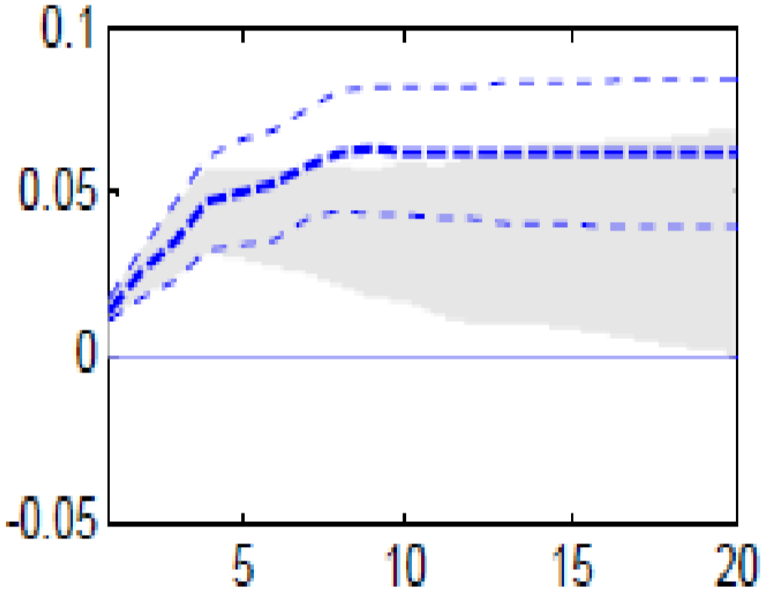




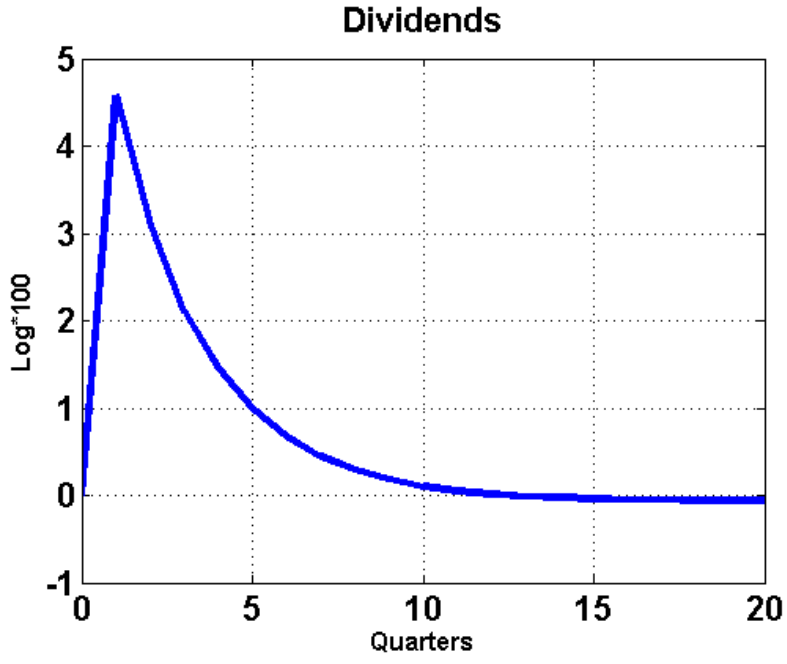
CGKS

Model

Impulse Response to MP Shock (+1%): Financial Income



CGKS



Model

Figure: Response to Contractionary Monetary Policy Shock (1%)

Result 2: Heterogeneous Welfare Effects of a MP Shock

- A contractionary (1%) monetary policy shock.
- Large differences in welfare effects across households.
  - Wall Street: gain from ↑ dividends.
  - Main Street: lose from ↓ wage and employment.
- Divergence between RA and HA welfare.
- A positive TFP shock "lifts all the boats."

%Δ in flow consumption	MP Shock	TFP Shock
Social Welfare		
Representative Agent (RA)	–0.029	0.411
Average of all HHs (HA)	–0.084	0.601
By Wealth Holdings		
Top 5%	0.056	0.411
5–20%	–0.032	0.524
20-40%	–0.061	0.564
40-60%	–0.070	0.581
60-80%	–0.108	0.641
80-95%	–0.165	0.720
Bottom 5%	–0.180	0.742

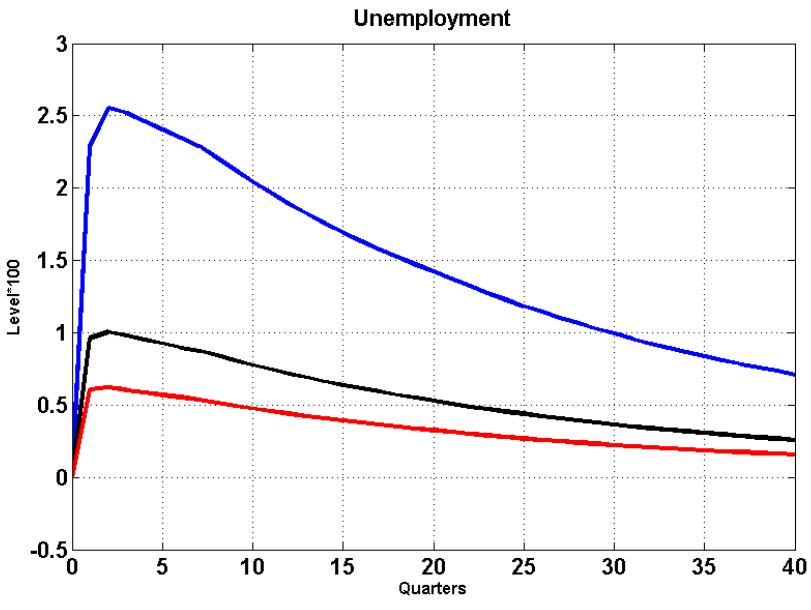
Result 3: Heterogeneous Welfare Effects of Great Recession

- $\downarrow$ TFP shock calibrated such that output declines by 8.3%.
- Stronger response of MP favors Main Street.
- Wall Street lose as firms are incentivised to invest/hire.
- HA welfare gains are larger than RA welfare gains.

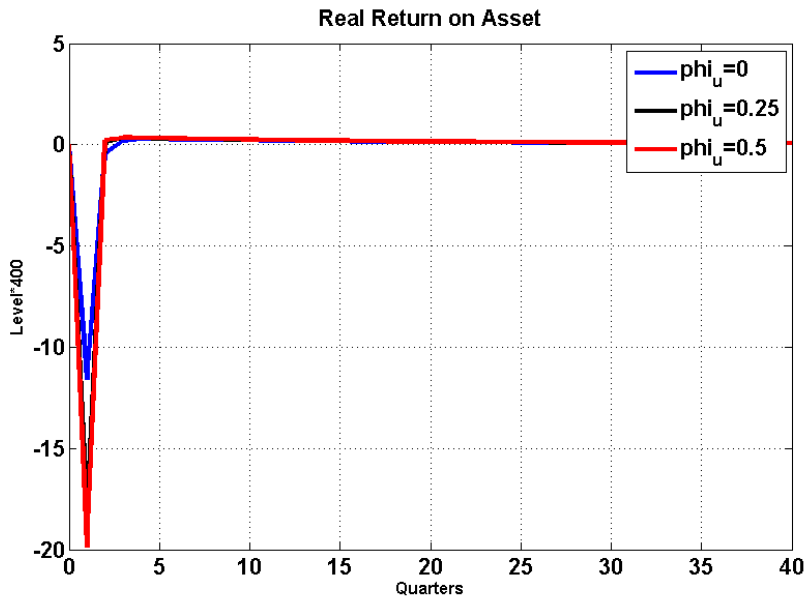
%Δ in flow consumption	$\rho_u = 0$ (base)	$\rho_u = 0.25$
Social Welfare		
Representative Agent (RA)	–2.09	–1.95
Average of all HHs (HA)	–3.04	–2.51
By Wealth Holdings		
Top 5%	–2.10	–3.24
5–20%	–2.66	–2.71
20-40%	–2.85	–2.56
40-60%	–2.94	–2.48
60-80%	–3.24	–2.36
80-95%	–3.63	–2.32
Bottom 5%	–3.73	–2.32

Result 3: Heterogeneous Welfare Effects of Great Recession

- Main Street gain from lower unemployment rate and smaller drop in wages.
- Wall Street lose from lower return on assets.



Unemployment



Real Return on Assets

Result 4: Long-Run Welfare Effects of Accommodative MP

- Welfare effects of $\rho_u = 0.0 \rightarrow 0.25$.
- Two opposite effects:
  - Welfare gain from smaller economic fluctuations.
  - Welfare loss from spending more to adjust nominal prices.
- Wall Street: short-run (on the transition path) gains.

%Δ in flow consumption	Short-run	Long-run
Social Welfare		
Representative Agent (RA)	0.046	–0.024
Average of all HHs (HA)	0.019	–0.062
By Wealth Holdings		
Top 5%	0.161	–0.015
5–20%	0.067	–0.045
20-40%	0.038	–0.054
40-60%	0.023	–0.060
60-80%	–0.011	–0.072
80-95%	–0.043	–0.085
Bottom 5%	–0.051	–0.088

Summary

- We investigate heterogeneous effects of monetary policy, using an extended RBC/DSGE model featuring market incompleteness, labor market frictions, and nominal frictions.

- Main findings
  - Consistent with CGKS, a contractionary MP shock magnifies inequality through income composition channel.
  - Wall Street gain while Main Street lose, in response to a contractionary MP shock.
  - A stronger response to a recession redistributes income from Wall Street to Main Street, thus generating a sizable welfare effects.
  - Long-run: Wall Street gains, while Main Street loses?

Model: State Variables

- Aggregate state variables: $X = (K, N, Z, D, \mu)$
  - K: capital stock
  - N: employment
  - Z: TFP shock
  - D: monetary policy shock
  - μ: type distribution of households
- Approximate equilibrium (Krusell and Smith (1998))
  - Assume that agents know (K, N, Z, D) but not μ.
- Individual state variables:
  - e: employment status (0: unemployed, 1: employed)
  - s: skill level
  - a: holdings of shares of the mutual fund (MF)

Model: Equilibrium

Definition (Recursive Equilibrium)

1. Optimality of decisions of households and all firms.
2. Dividends d_a are consistent with the budget constraint of the representative mutual fund.
3. Formula for the aggregate discount factor is exogenously given.
4. Wage function is exogenously given.
5. τ satisfies the government budget constraint.
6. R follows the Taylor rule.
7. Consistency of aggregate laws of motions.
8. All markets clear.
9. Symmetry across all intermediate goods: $P_j = P_{j'} (= P)$.

Calibration: Table 1/2

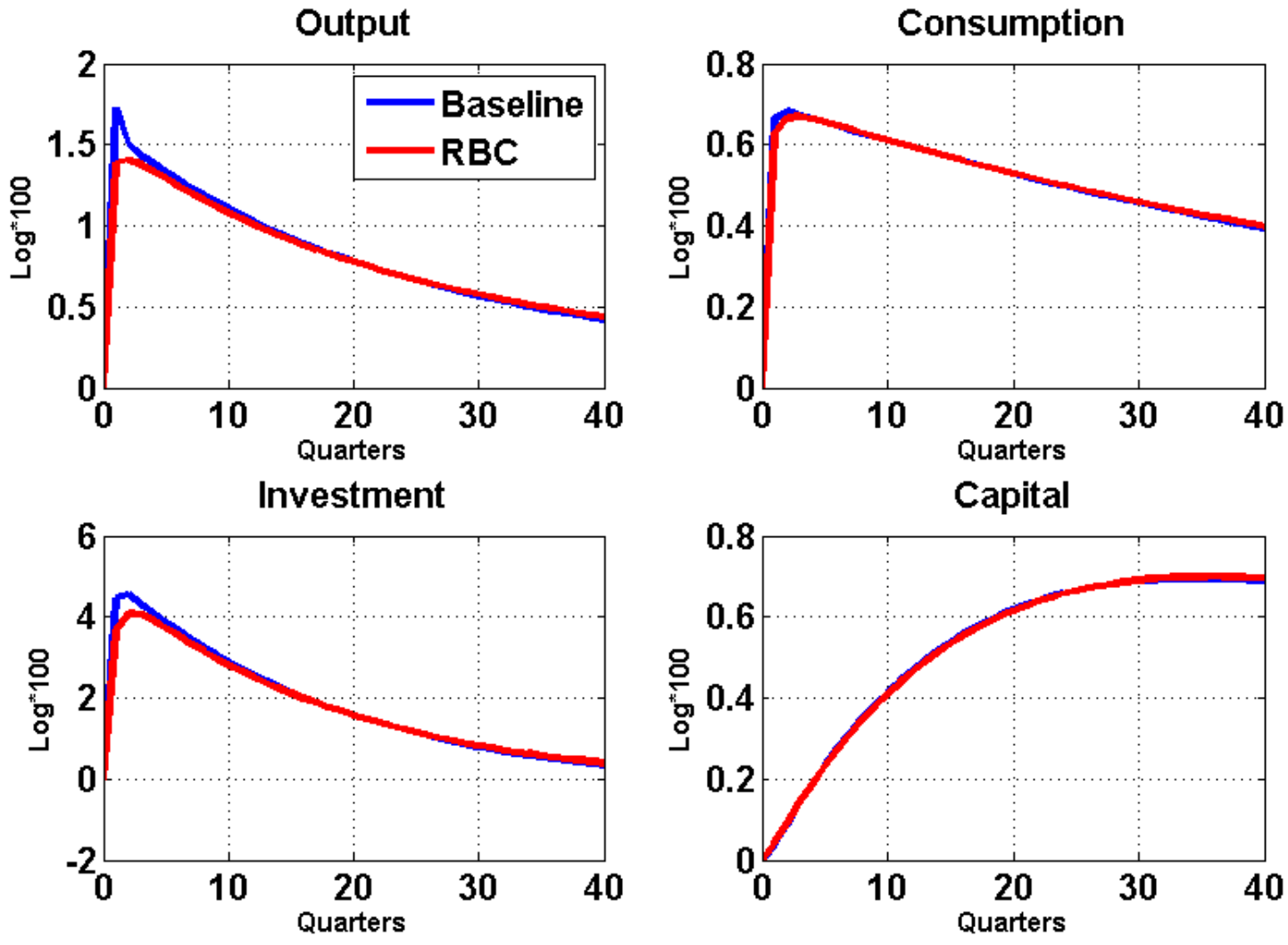
Parameter	Value	Description
Households		
σ	1.5	Relative risk aversion.
β	0.966	Time-discount factor.
Capital services		
ζ_0	0.730	Parameter for capital adjustment cost.
ζ_1	0.100	Parameter for capital adjustment cost.
ζ_2	–0.0017	Parameter for capital adjustment cost.
δ_0	0.015	Parameter for utilization cost function.
δ_1	0.030	Parameter for utilization cost function.
δ_2	0.040	Parameter for utilization cost function.
Intermediate goods		
ϵ	21.00	Elas of subst across intermed goods
θ	0.330	Capital share for production.
ϕ_Π	690.0	Slope of price adjustment cost.
ρ_Z	0.950	Persistence of TFP shock.
σ_Z	0.006	SD of TFP shock.

Calibration: Table 2/2

Parameter	Value	Description
Labor services and labor market		
λ	0.100	Separation rate
α	0.600	Matching elasticity.
γ	0.645	Matching efficiency
$\overline{w}$	0.637	Average wage.
ϵ_w	0.450	Wage elasticity w.r.t. output.
κ	0.240	Vacancy posting cost.
Monetary policy and fiscal policy		
$\overline{\Pi}$	1.005	Target inflation rate.
$\overline{u}$	0.06	Target unemployment rate.
$\overline{R}$	1.020	Steady-state Risk-free nominal interest rate.
ρ_Π	1.200	Response of MP to inflation.
ρ_u	0 or 0.25	Response of MP to unemployment.
ρ_D	0.700	Persistence of MP shock.
σ_D	6.25e-4	SD of MP shock
b	0.446	UI benefits per efficiency unit.

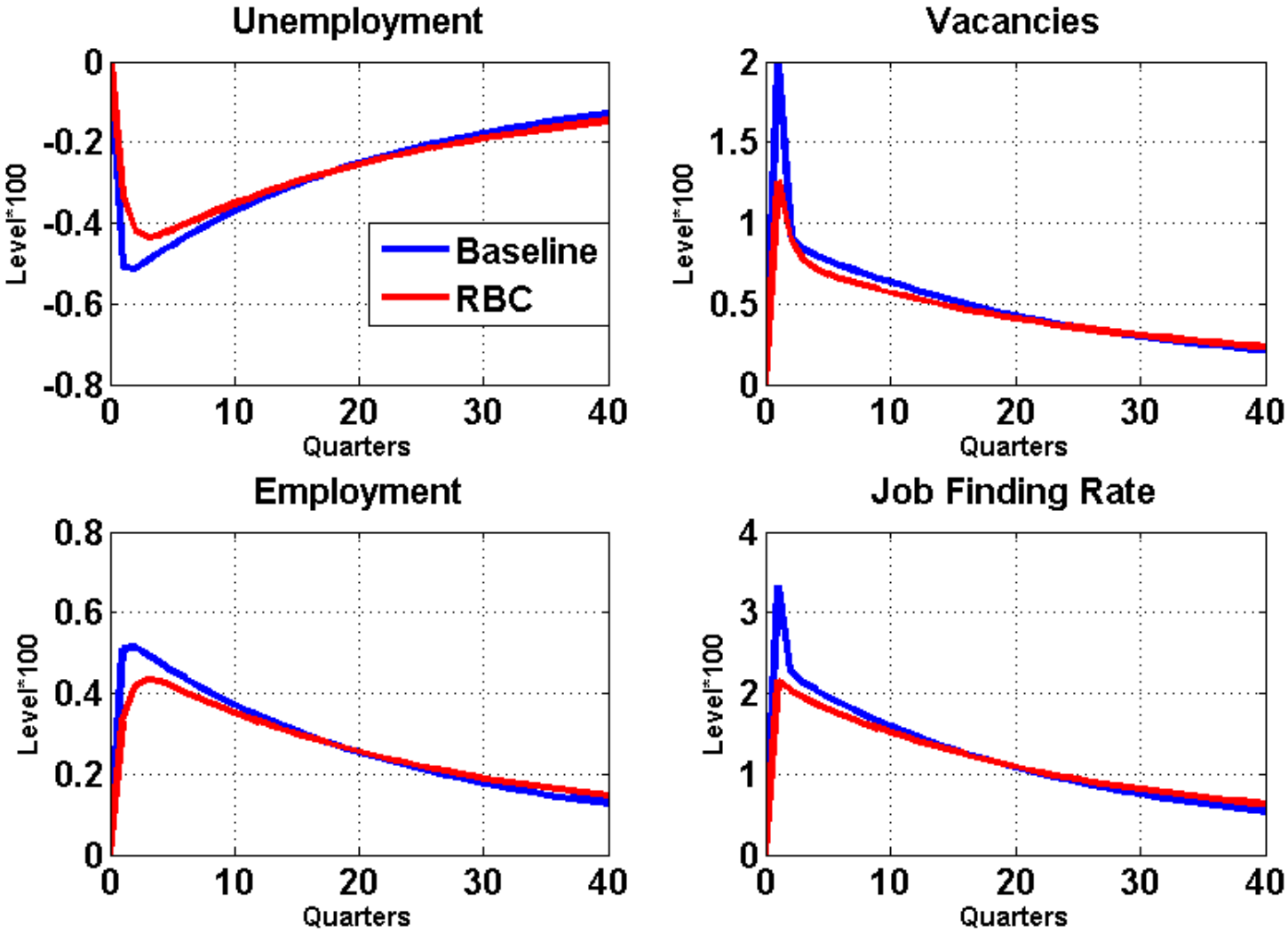
Impulse Response to TFP Shock: Output

- The impulse responses are similar between the baseline and the RBC (no nominal frictions).



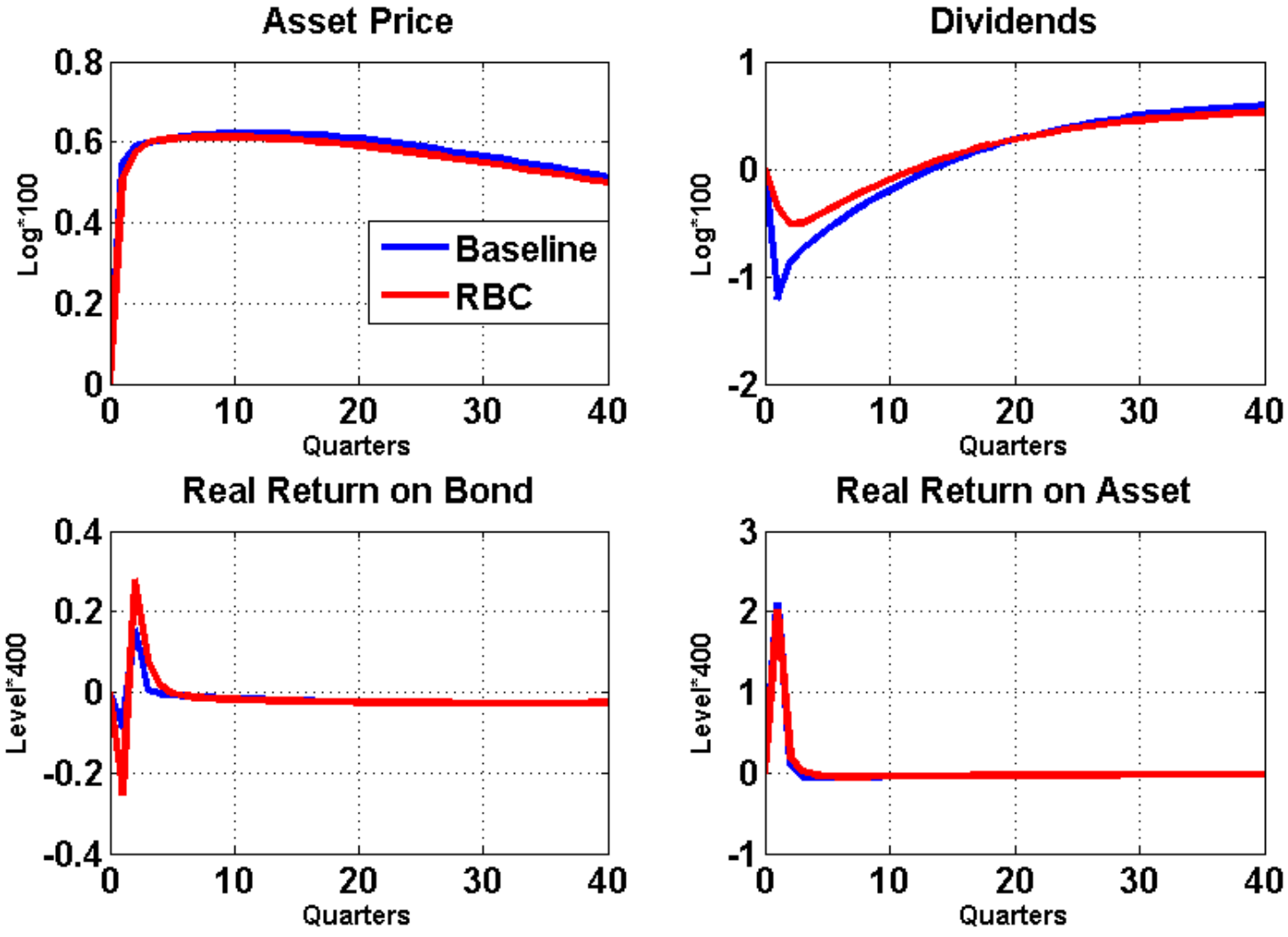
Impulse Response to TFP Shock: Labor Market

- Strong and persistent responses of unemployment.



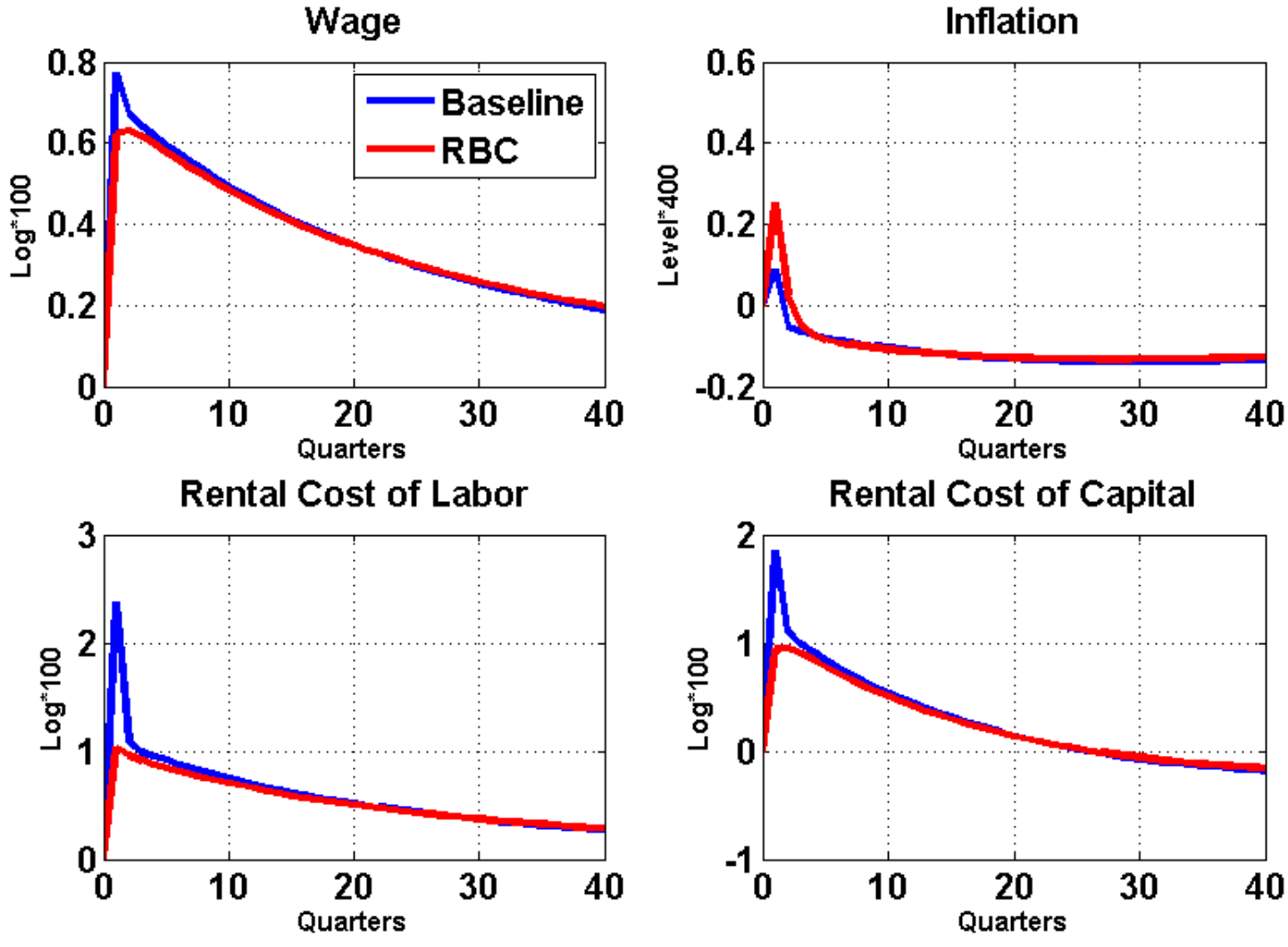
Impulse Response to TFP Shock: Financial Markets

- Dividends (short-run) $\downarrow$: Firms increase investment or hiring.
- Dividends (long-run) $\uparrow$: Output increases persistently.
- Asset prices: Persistent positive response.



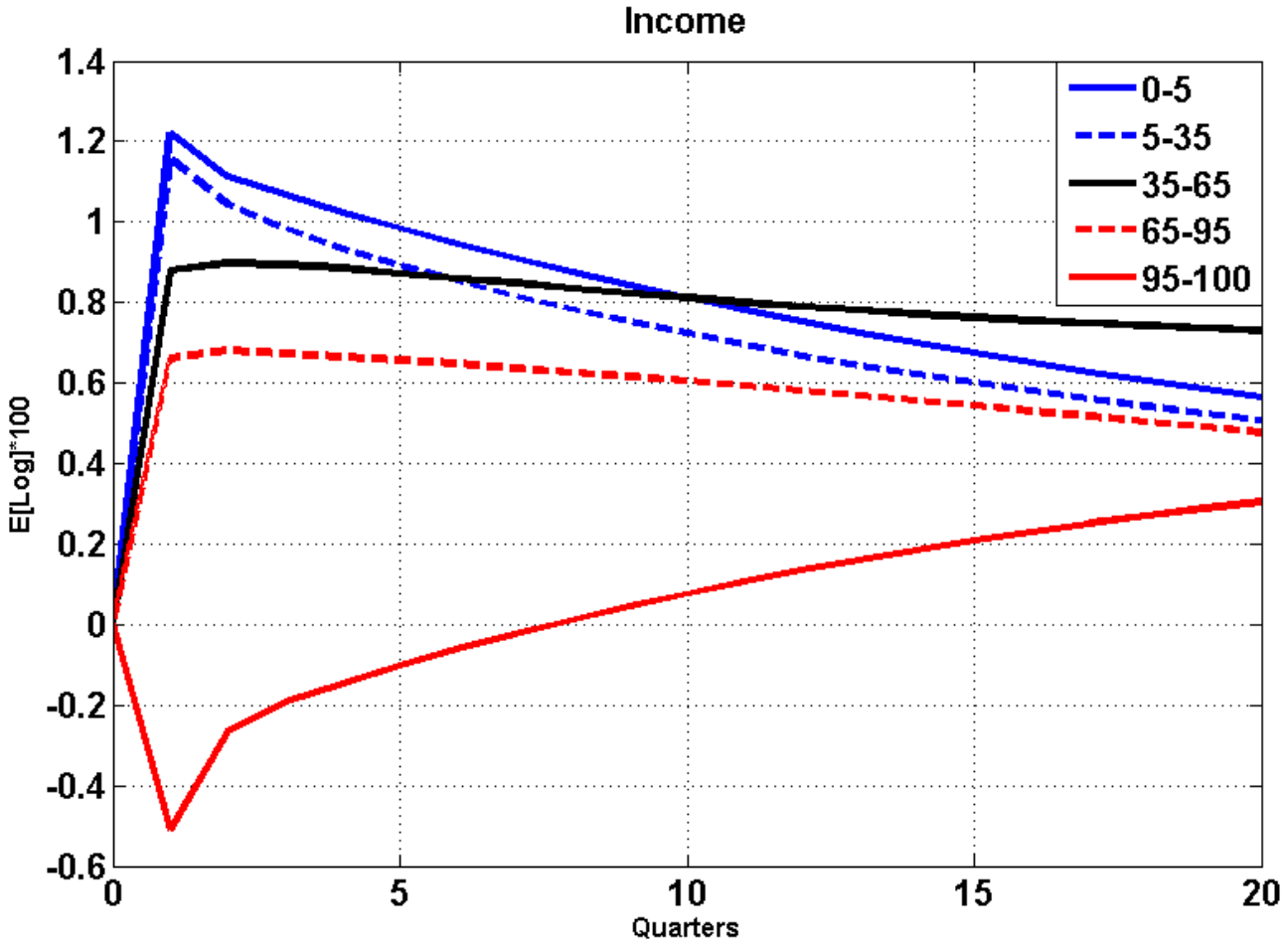
Impulse Response to TFP Shock: Prices

- Negative response of inflation, as costs of producing goods fall.



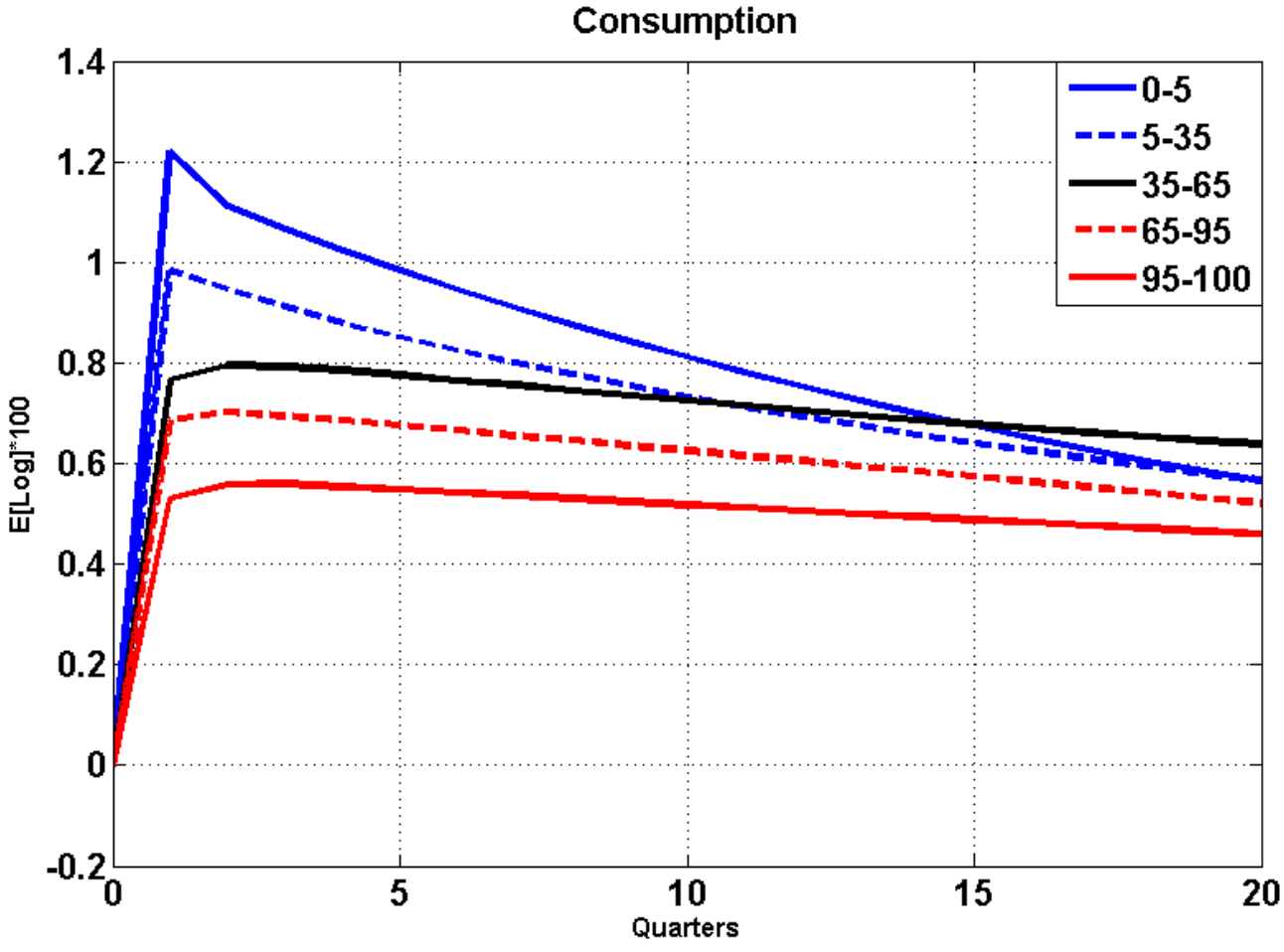
Impulse Response to TFP Shock: Income Cross-Section

- Income composition effect.
  - Labor income ↑
  - Financial income ↓ in the short-run.



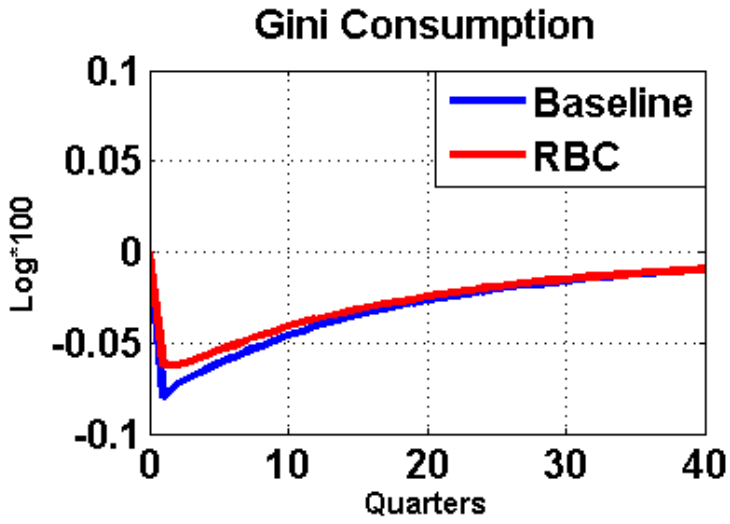
Impulse Response to TFP Shock: Cons Cross-Section

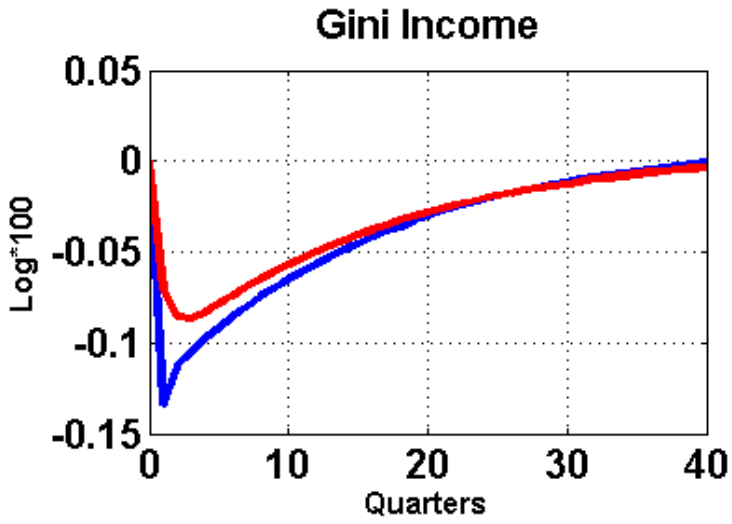
- Lower-consumption households benefit the most from lower unemployment and smaller loss from dividends.

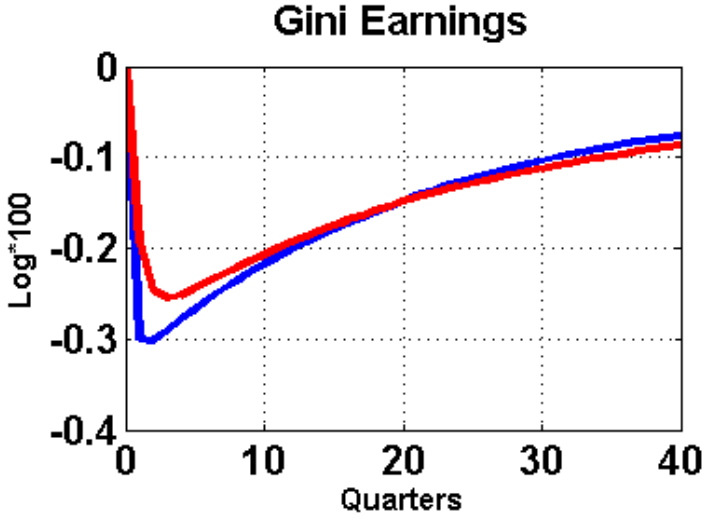


Impulse Response to TFP Shock: Inequality Measures

- Decline in income Gini (-1.3%) and consumption Gini (-0.08%).







Heterogeneous Welfare Effects of TFP Shocks

- A positive TFP shock (+1%).
- Wall Street gain with unemployment stabilization through MP.
- Main Street lose from unemployment stabilization.

%Δ in flow consumption	$\rho_u = 0$ (base)	$\rho_u = 0.25$	$\rho_u = 0.50$
Social Welfare			
Representative Agent (RA)	0.411	0.384	0.375
Average of all HHs (HA)	0.601	0.496	0.469
By Wealth Holdings			
Top 5%	0.411	0.642	0.697
5–20%	0.524	0.536	0.537
20-40%	0.564	0.507	0.491
40-60%	0.581	0.491	0.468
60-80%	0.641	0.464	0.420
80-95%	0.720	0.457	0.390
Bottom 5%	0.742	0.459	0.386

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