Asset Illiquidity, MPC Heterogeneity and Fiscal Stimulus

Extremely Preliminary

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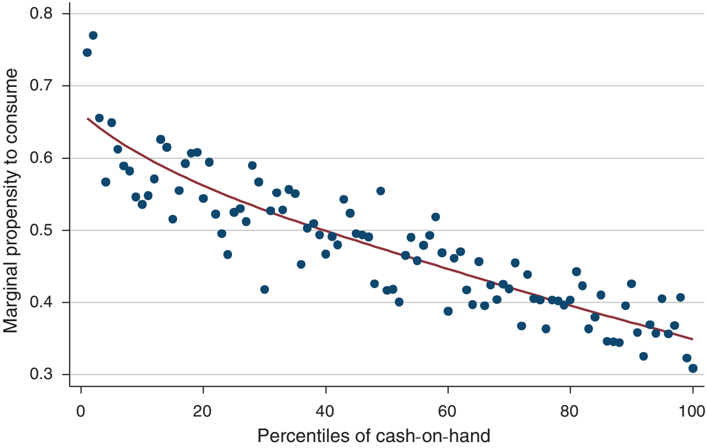
Empirical Evidence on MPCs

1. Considerable **heterogeneity in MPCs** across individuals/HHs
   - Shapiro and Slemrod (1995), Parker et al. (2013), Broda and Parker (2014), Misra and Surico (2011, 2014), Jappelli and Pistaferri (2014)
2. MPCs depend on household **balance sheet** positions...
   - Mian, Rao and Sufi (2013), Mian and Sufi (2014), Baker (2014), Jappelli and Pistaferri (2014)
3. ... and split between **liquid** and **illiquid** wealth
   - Kaplan and Violante (2014), Kaplan, Violante and Weidner (2014), Broda and Parker (2014)

MPC Heterogeneity and Liquid Wealth

Figure from Jappelli and Pistaferri (2014) using Italian data: self-reported hypothetical MPCs by cash-on-hand percentiles



▸ KVW evidence

What We Do

- Develop **new framework** for analysis of monetary and fiscal policy, consistent with
  - evidence on MPC heterogeneity
  - key facts on income risk, wealth distribution
- **New Keynesian** model with **heterogeneous households** that hold both liquid and illiquid assets

What We Do

- Develop **new framework** for analysis of monetary and fiscal policy, consistent with
  - evidence on MPC heterogeneity
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- **New Keynesian** model with **heterogeneous households** that hold both liquid and illiquid assets
- Calibrate to U.S. and use framework to assess implications of MPC heterogeneity for
  1. monetary policy shocks ("NNP" and "*r*-exposure" channels)
  2. fiscal stimulus in response to "demand-driven" recession (today only partly)
  3. conventional and unconventional monetary policy in response to "liquidity shock" (not today)

Related Literature

- **H.A.N.K.** models (= Heterogeneous Agent New Keynesian)
  - Oh and Reis (2012), Ravn and Sterk (2013), Gornemann, Kuester and Nakajima (2014), Challe et al. (2014), den Haan, Rendahl and Riegler (2014), Bayer et al. (2014), Auclert (2014), McKay and Reis (2014), McKay, Namakumara and Steinsson (2015),...
  - **Our contribution:** "better" model of MPC heterogeneity, building on Kaplan and Violante (2014)

- N.K. incarnation of **spender-saver** model
  - Gali, Lopez-Salido, Valles (2007), Campbell and Mankiw (1989)
  - **Our contribution:** refinement with endogenous spender-saver status as in data

- Also related
  - Blinder (1975), Farhi and Werning (2014), Korinek and Simsek (2014),...

Model Overview

- **Households**
  - face uninsured idiosyncratic income risk
  - can invest into two assets: liquid and illiquid
  - consume, supply labor
- **Firms**
  - monopolistic competition, sticky prices (Rotemberg)
- **Liquid assets = bonds**
  - return pinned down by monetary policy rule
- **Illiquid assets = productive capital**
  - HHs $\rightarrow$ investment funds $\rightarrow$ firms
  - return pinned down by aggregate MPK

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- Other model features
  - continuous time
  - all aggregate shocks = **"MIT shocks"**
  - first part of talk: no government, equations for stationary equilibrium, but more generally aggregates indexed by t

Households solve

$$\max_{\{c_t,\ell_t,d_t\}_{t\geq 0}} \mathbb{E}_0 \int_0^\infty e^{-\rho t} u(c_t,\ell_t) dt \quad \text{s.t.}$$

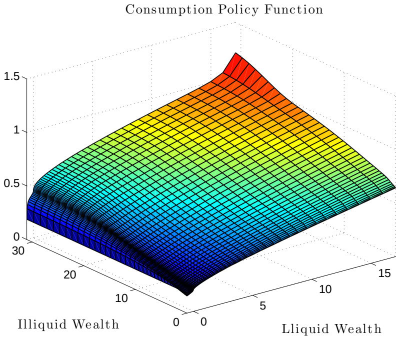
$$\begin{aligned}
\dot{b}_t &= w z_t \ell_t + r_b b_t - d_t - \chi(d_t) - c_t \\
\dot{a}_t &= r_a a_t + d_t \\
z_t &= \text{ some Markov process} \\
a_t &\geq \underline{a}, \quad b_t \geq \underline{b}
\end{aligned}$$

- c_t: consumption, ℓ_t: hours worked
- b_t: **liquid** assets with real return $r_b = i - \pi$
- a_t: **illiquid** assets with real return $r_a > r_b$
- d_t: deposits into illiquid account, $d_t < 0 =$ withdrawal
- $\chi(d_t)$: portfolio adjustment costs, both fixed and variable

$$\chi(d) = \chi_0 \mathbf{1}_{\{d\neq 0\}} + \chi_1 |d| + \chi_2 |d|^{\kappa_3}$$

- $\underline{a}, \underline{b} > -\infty$: borrowing limits e.g. if $\underline{a} = \underline{b} = 0$, can only save
- HHs described by **joint distribution** $g(a,b,z)$, CDF $G(a,b,z)$

Policy Functions



Firms

- Representative **final goods** producer

$$Y = \left(\int_0^1 y_j^{\frac{\varepsilon-1}{\varepsilon}} dj \right)^{\frac{\varepsilon}{\varepsilon-1}} \quad \Rightarrow \quad y_j = \left(\frac{p_j}{P} \right)^{-\varepsilon} Y$$

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- **Intermediate goods** producers (continuum):
  - technology: $y_j = Z k_j^{\alpha} n_j^{1-\alpha}$
  - monopolistically competitive, solve

$$\max_{\{p_t\}_{t \geq 0}} \int_0^{\infty} e^{-\rho t} \left\{ \Pi_t(p_t) - \Theta_t \left(\frac{\dot{p}_t}{p_t} \right) \right\} dt \quad \text{s.t.}$$

$$\Pi(p) = \left(\frac{p}{P} - m \right) \left(\frac{p}{P} \right)^{-\varepsilon} Y$$

$$m = \frac{1}{Z} \left(\frac{R}{\alpha} \right)^{\alpha} \left(\frac{w}{1-\alpha} \right)^{1-\alpha}$$

$$\Theta(\pi) = \frac{\theta}{2} \pi^2 Y$$

Phillips Curve

Lemma

The inflation rate implied by firms' optimal price-setting satisfies

$$\left(\rho - \frac{\dot{Y}}{Y}\right)\pi = \frac{\varepsilon - 1}{\theta}\left(\frac{\varepsilon}{\varepsilon - 1}m - 1\right) + \dot{\pi}$$

- In present value form

$$\pi_t = \frac{\varepsilon - 1}{\theta}\int_t^{\infty} e^{-\rho(s-t)}\frac{Y_s}{Y_t}\left(\frac{\varepsilon}{\varepsilon - 1}m_s - 1\right) ds$$

- Note: **exact** Phillips curve, no log-linearization

Investment Funds

- HHs deposit **illiquid assets** into investment funds
- Each fund has two sources of income
  - **capital rental**: funds use deposits to buy investment goods, accumulate capital which it rents to firms. Cashflow: $R - \delta$
  - **ownership** of intermediate producers. Cashflow:

$$\Pi - \frac{\theta}{2}\pi^2 Y, \qquad \Pi = (1-m)Y$$

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- Competition $\Rightarrow$ funds make **zero profits**, pay out all cashflows to investors in proportion to their deposits

$$\Rightarrow \quad r_a = R - \delta + (1-m)\frac{Y}{A} - \frac{\theta}{2}\pi^2\frac{Y}{A}$$

  where $A = \int a \mathrm{d}G(a,b,z)$
- **Extension:** investment funds can borrow liquid assets. Illiquid return = leveraged claim on capital stock, profits

Monetary Authority, World Bond Demand

- **Taylor rule**

$$i = \max\{i^* + \phi\pi, 0\}, \quad \phi > 1$$

- For now: no output gap in Taylor rule
- Return on liquid assets $r_b = i - \pi$

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- **World bond demand**

$$B_w = \bar{B}_w e^{\varepsilon_b r_b}, \quad \varepsilon_b \geq 0$$

- Special cases
  - $\varepsilon_b = 0$: bonds in fixed supply
  - $\varepsilon_b = \infty$: small open economy with $r_b = r_b^*$
- Rationale is three-fold
  1. realism
  2. symmetry with illiquid assets
  3. makes computations easier

Equilibrium

- **Bond market**

$$0 = B_w + \int b \mathrm{d} G(a, b, z)$$

- **Capital market**

$$K = \int a \mathrm{d} G(a, b, z)$$

- **Labor market**

$$N = \int z\ell(a, b, z) \mathrm{d} G(a, b, z)$$

Remaining Equilibrium Conditions

$$\rho v(a,b,z) = \max_{c,\ell,d}\; u(c,\ell) + \partial_b v(a,b,z)\left(wz\ell + r_b b - d - \chi(d) - c\right) + \partial_a v(a,b,z)\left(r_a a + d\right) + z\text{-terms}$$

$$0 = -\partial_a(s_a(a,b,z)g(a,b,z)) - \partial_b(s_b(a,b,z)g(a,b,z)) + z\text{-terms}$$

$$\left(\rho - \frac{\dot{Y}}{Y}\right)\pi = \frac{\varepsilon - 1}{\theta}\left(\frac{\varepsilon}{\varepsilon - 1}m - 1\right) + \dot{\pi}$$

$$r_b = \max\{i^* + \phi\pi, 0\} - \pi$$

$$r_a = \alpha m\frac{Y}{K} - \delta + (1-m)\frac{Y}{K} - \frac{\theta}{2}\pi^2\frac{Y}{K}$$

$$w = (1-\alpha)m\frac{Y}{N}$$

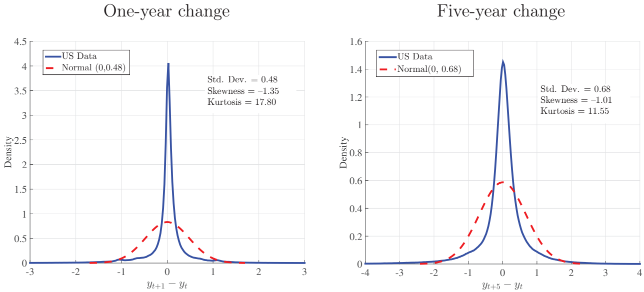
$$Y = ZK^\alpha N^{1-\alpha}$$

Roadmap for Remainder of Talk

1. Calibration of income (z) process
2. Calibration of steady state, adjustment cost function (χ)
3. Properties of steady state: policy functions, wealth distribution, MPCs
4. Effects of various shocks

Calibration of Income Process

- Goal: match std.dev. and kurtosis from Guvenen et al. (2015)



- Log income = sum of two jump processes $\log z_t = x_{1,t} + x_{2,t}$
- Arrival rates $\lambda_1 > \lambda_2$, $x_{1,t}$ = "high freq", $x_{2,t}$ = "low freq"
- Both jumps symmetric double-Paretos

$$p_i(x'|x) = \begin{cases} \frac{\zeta_i}{2} e^{-\zeta_i(x' - \rho_i x)}, & x' > x \\ \frac{\zeta_i}{2} e^{\zeta_i(x' - \rho_i x)}, & x' < x \end{cases}, \quad i = 1, 2$$

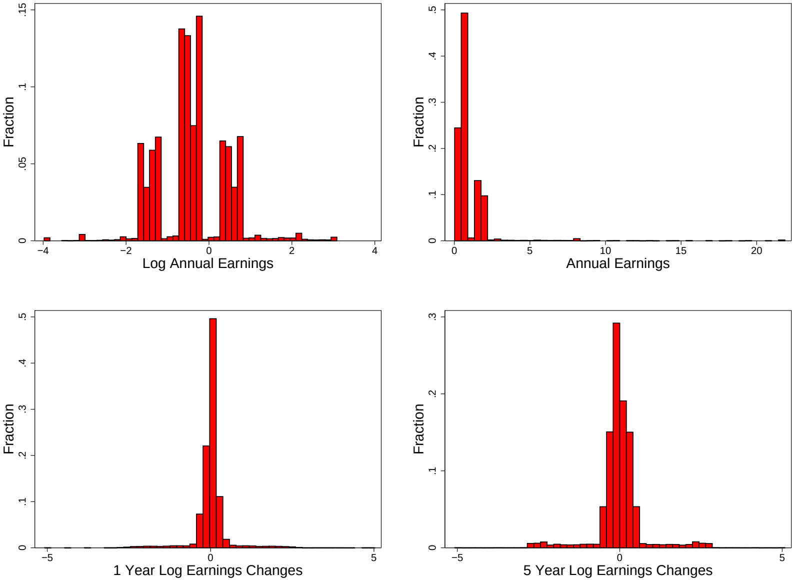
- ζ_i = inverse fatness, ρ_i = mean reversion

Calibration of Income Process

- Six parameters $(\lambda_1, \lambda_2, \zeta_1, \zeta_2, \rho_1, \rho_2)$
- Set $\lambda_1 = 0.25$ (hits every year), $\lambda_2 = 0.05$ (hits every 5 years)
- calibrate remaining four to target five moments

	Target	Model
Cross-sectional variance	0.70	0.70
Variance of 1-year changes	0.23	0.22
Kurtosis of 1-year changes	17.8	18.1
Variance of 5-year changes	0.46	0.47
Kurtosis of 5-year changes	11.6	11.1
Fraction w/ 1-year change $<$ 5%	0.35	0.38
Fraction w/ 1-year change $<$ 10%	0.54	0.51
Fraction w/ 1-year change $<$ 20%	0.71	0.72
Fraction w/ 1-year change $<$ 50%	0.86	0.92

Calibration of Income Process



Calibration of Stationary Equilibrium

- Add a few bells and whistles:
  - government, progressive tax system
  - wedge between borrowing and lending rates $r_b^- = r_b^+ + \omega$
- Functional form assumptions

$$u(c,\ell) = \frac{1}{1-\gamma}\left(c - \xi\frac{\ell^{1+1/\varphi}}{1+1/\varphi}\right)^{1-\gamma}$$

$$\chi(d) = \chi_0 \mathbf{1}_{\{d\neq 0\}} + \chi_1 |d| + \chi_2 |d|^{\kappa_3}$$

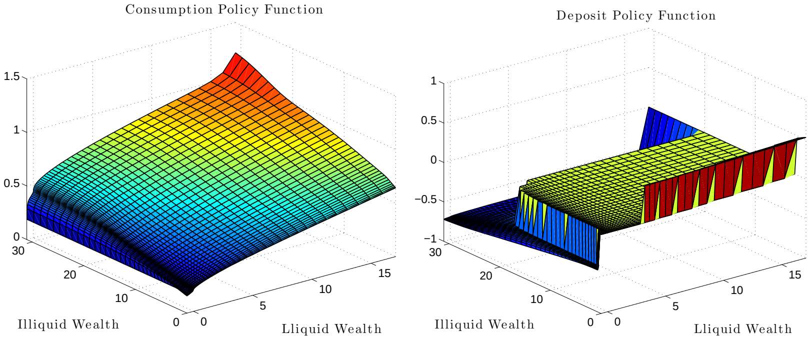
- choice of time units: **quarterly**
- **Note:** all upcoming results from toy version w/ simpler income process etc $\Rightarrow$ numbers only illustrative
- Computational method: finite-difference method based on Achdou et al. (2014)

Calibration of Stationary Equilibrium

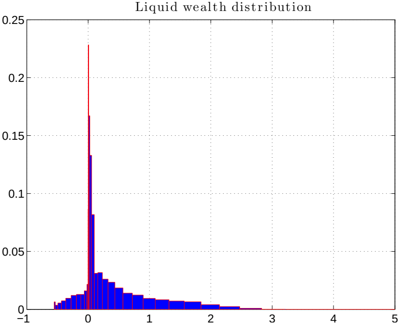
- Parameters: $(\chi_0, \chi_1, \chi_2, \chi_3, r_b^+, \omega)$
- Targets: features of wealth distribution from Kaplan, Violante and Weidner (2014) using SCF

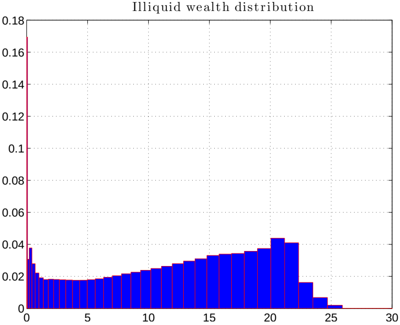
	Target	Model
Pop. share of P-Htm	0.121	?
Pop. share of W-HtM	0.192	?
Pop. share of N-HtM	0.688	?
...	?	?

Policy Functions



Wealth Distribution





Distribution of MPCs

- Define **MPC out of liquid wealth** over τ quarters as

$$\mathrm{MPC}_\tau(a,b,z,\Delta b) = \frac{C_\tau(a,b+\Delta b,z) - C_\tau(a,b,z)}{\Delta b}$$

$$C_\tau(a,b,z) = \mathbb{E}\left[\int_0^\tau c(a_t,b_t,z_t)dt | a_0 = a, b_0 = b, z_0 = z\right]$$

where c = optimal consumption policy function

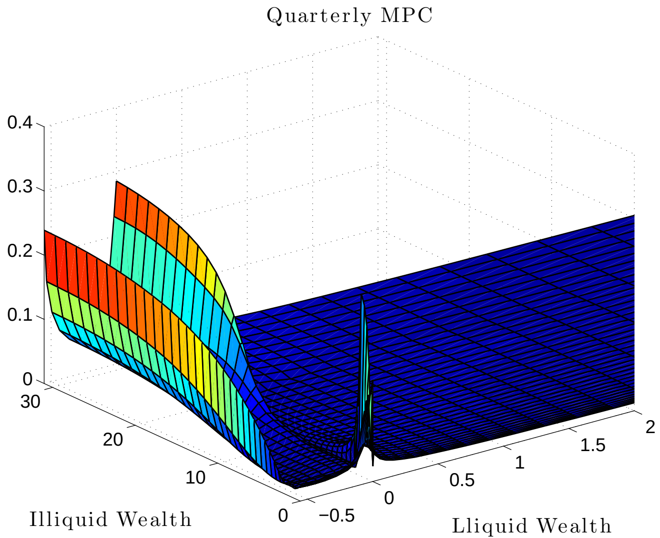
- Compute C_τ as solution to PDE ("Feynman-Kac formula")

$$\begin{aligned} 0 = c(a,b,z) &+ s_a(a,b,z)\partial_a \tilde{C}(a,b,z,t) + s_b(a,b,z)\partial_b \tilde{C}(a,b,z,t) \\ &+ z\text{-terms} + \partial_t \tilde{C}(a,b,z,t) \end{aligned}$$

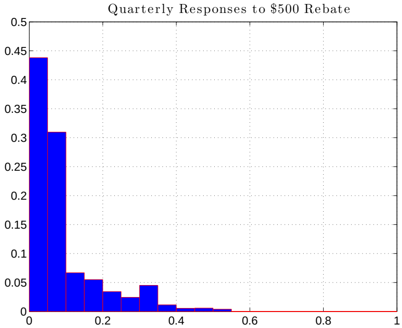
with terminal condition $\tilde{C}(a,b,z,\tau) = 0$, and where s_a, s_b = saving policy functions

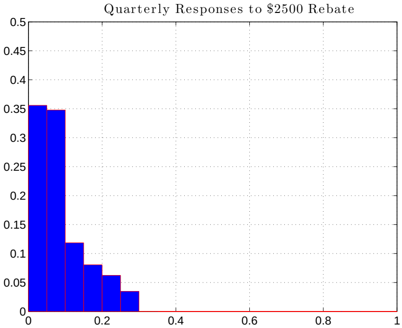
- then cumulative consumption $C_\tau(a,b,z) = \tilde{C}(a,b,z,0)$

Quarterly MPCs



Distribution of Quarterly MPCs



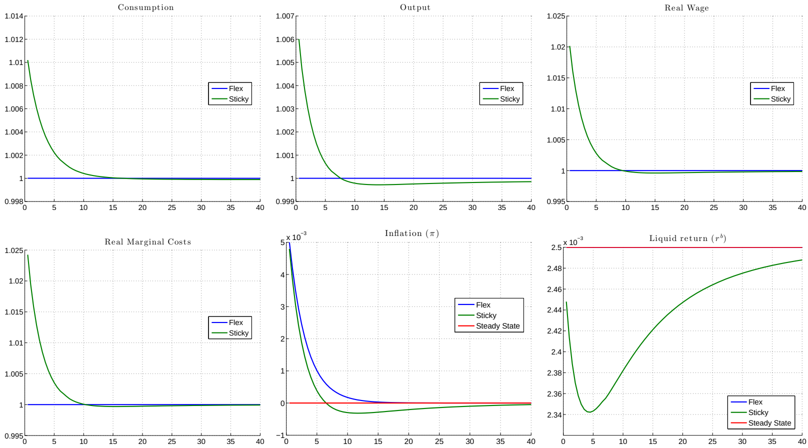


Business Cycle Properties

- Warm-up: response to **monetary policy shock**
  - purpose: make sure model performs at least as well as standard NK model
  - match standard impulse responses (qualitatively)
- Main experiment: **"demand-driven" recession**, fiscal policy
  - preference shock
- For completeness: **aggregate TFP shock**

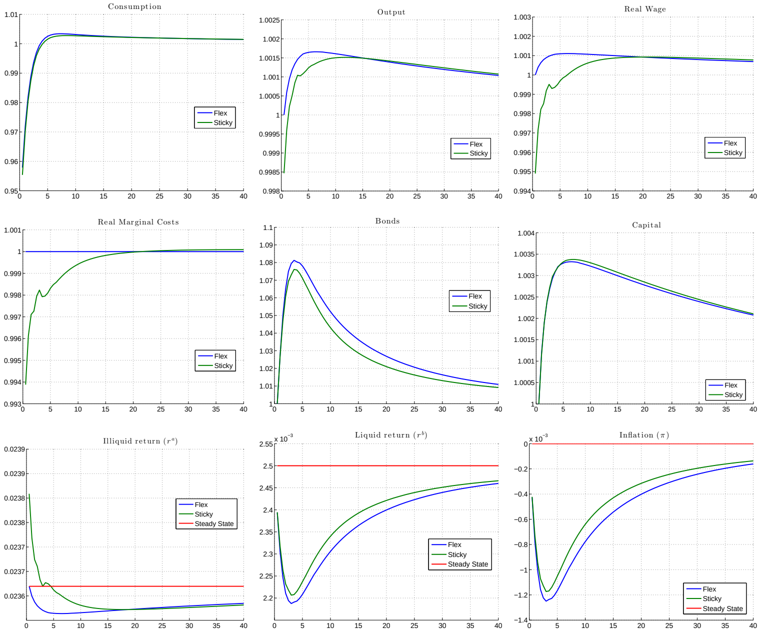
Expansionary Monetary Policy Shock

$$i_t = i^* + \phi\pi_t + v_t, \quad \text{with} \quad v_t < 0$$

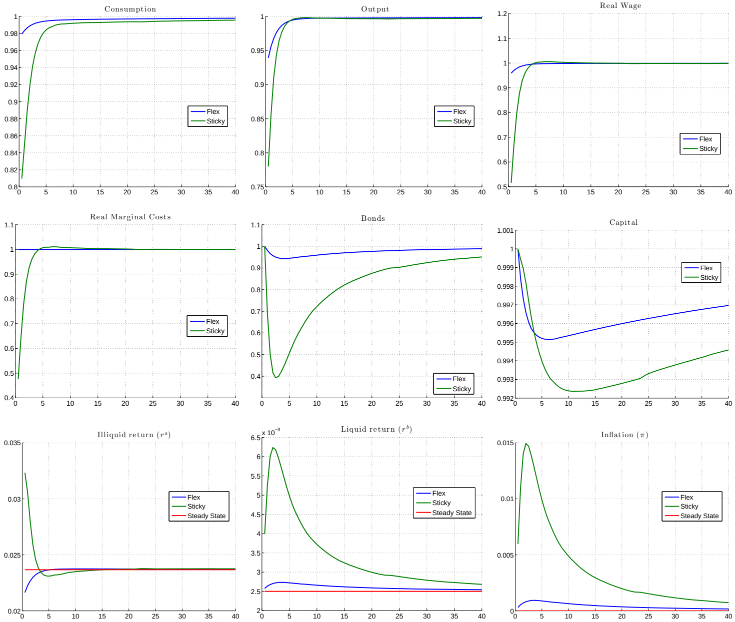


▸ Data ▸ Standard NK

Preference Shock



Aggregate TFP Shock



Conclusion

- Have developed **new framework** for analysis of monetary and fiscal policy, consistent with
  - evidence on MPC heterogeneity
  - key facts on income risk, wealth distribution
- **New Keynesian** model with **heterogeneous households** that hold both liquid and illiquid assets
- **Next Steps**
  - policy: aggregate and distributional consequences
  - e.g. targeted stimulus: **how much "bang for the buck"?**
  - other shocks, e.g. "fund deleveraging shock", "asset freeze",

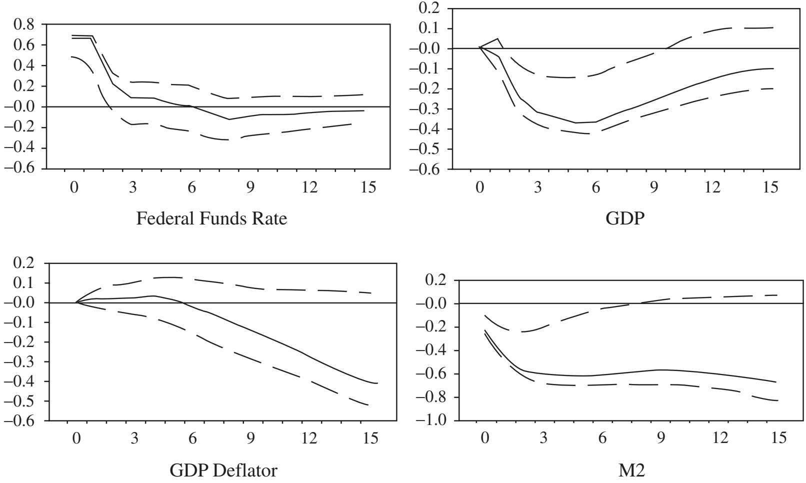
MPCs by HtM Status (Kaplan,Violante,Weidner)

back

Table 6. Marginal Propensity to Consume out of Transitory Income Shocks for Different Types of HtM Households, United States[a]

	P-HtM	*W-HtM*	*N-HtM*	*HtM-NW*	*N-HtM-NW*
Baseline	0.243***	0.301***	0.127***	0.229***	0.201***
	(0.065)	(0.048)	(0.036)	(0.054)	(0.030)
Pre-tax earnings[b]	0.131***	0.223***	0.122***	0.143***	0.164***
	(0.043)	(0.035)	(0.027)	(0.036)	(0.023)
Include food stamps[c]	0.217***	0.264***	0.105***	0.203***	0.171***
	(0.059)	(0.045)	(0.035)	(0.050)	(0.029)
Continuously married	0.095	0.193**	0.079*	–0.048	0.157***
households[d]	(0.194)	(0.079)	(0.043)	(0.129)	(0.042)
Stable marital status[e]	0.239***	0.282***	0.110***	0.190***	0.195***
	(0.085)	(0.054)	(0.038)	(0.070)	(0.033)
Households with	0.186**	0.193***	0.073*	0.150**	0.129***
male heads[f]	(0.080)	(0.058)	(0.040)	(0.064)	(0.035)
Monthly income[g]	0.229***	0.288***	0.159***	0.236***	0.199***
	(0.068)	(0.053)	(0.034)	(0.057)	(0.030)

MP Shock in Data (CEE) back



MP Shock in Standard NK Model (Gali) ‣ back