Aggregate Implications of Microeconomic Consumption Behavior

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In a model with 'serious' heterogeneity:

1. Fiscal Policy Can Be Much More Powerful than in RA model
   - $\Rightarrow$ austerity has much bigger medium-term effects
2. Monetary Policy Mechanism Is Radically Different
   - Effect of r mostly *not* about intertemporal substitution
   - QE works when it affects people with high MPC; otherwise, not
3. Changes in *micro* Uncertainty Can Matter A Lot
   - When Michigan $\mathbb{E}_t[\Delta U_{t+1}] \uparrow$, $C \downarrow$
   - Explains Why Saving Rate $\uparrow$ in Recessions
4. New Tools $\Rightarrow$ It's Not As Hard As You Think!
   - **A**lgorithmic **R**esources and tool**K**it: **ARK!**
   - Initiative of U.S. Consumer Financial Protection Bureau
   - Subset: **H**eterogeneous **A**gents **R**esources and tool**K**it: http://econ-ark.org

Micro Heterogeneity and Aggregate Consumption

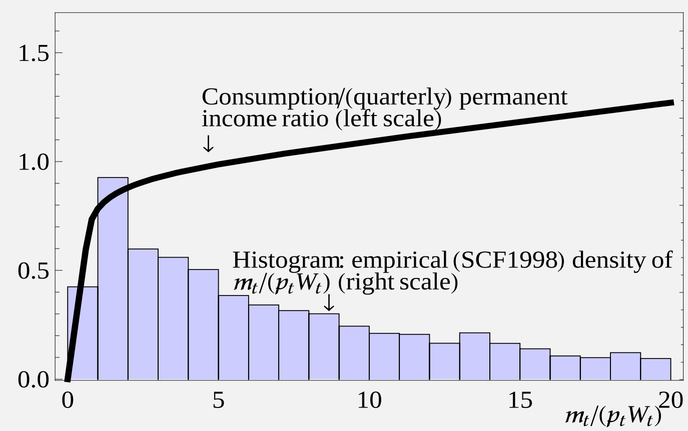
Key Question: How Large Is **'the MPC'** ($\equiv \kappa$)?

If households receive a surprise extra 1 unit of income, how much will be spent over the next year?

Elements that interact to produce the answer:

- Households are heterogeneous *ex post* and *ex ante*
- Lots of HH's who do lots of C have little wealth
- c function is highly concave
- $\Rightarrow$ Distributional issues matter for aggregate C
  Giving 1 to the poor $\neq$ giving 1 to the rich

Consumption Concavity and Wealth Heterogeneity



To-Do List

1. Calibrate realistic income process
2. Match empirical wealth distribution
3. Back out optimal c and $\mathrm{c}'(m) = \kappa(m)$ out of transitory income
4. Is MPC in line with empirical estimates?

Our (Micro) Income Process

Idiosyncratic (household) income process is logarithmic Friedman:

$$\begin{aligned} y_{t+1} &= p_{t+1}\xi_{t+1}\mathrm{W} \\ p_{t+1} &= p_t\psi_{t+1} \end{aligned}$$

$$\begin{aligned} p_t &\quad - \quad \text{permanent income} \\ \psi_{t+1} &\quad - \quad \text{permanent income} \\ \mathbb{E}_t[\xi_{t+n}] = 1 &\quad - \quad \text{transitory income} \\ \mathbb{E}_t[\psi_{t+n}] = 1 &\quad - \quad \text{permanent shock} \\ \mathrm{W} &\quad - \quad \text{aggregate wage rate} \end{aligned}$$

Generates *ex post* dist'n of y that matches cross-section data

Unemployment and Unemployment Insurance

Modifications from Carroll (1992)

Transitory income ξ_t incorporates unemployment insurance:

$$\begin{aligned} \xi_t &= \mu \text{ with probability } u \\ &= (1-\tau)\bar{\ell}\theta_t \text{ with probability } 1-u \end{aligned}$$

μ is UI when unemployed
τ is the rate of tax collected for the unemployment benefits

Model Without Aggr Uncertainty: Decision Problem

$$\begin{aligned} \mathrm{v}(m_t) &= \max_{\{c_t\}} \ \mathrm{u}(c_t) + \beta\cancel{D}\mathbb{E}_t\left[\psi_{t+1}^{1-\rho}\mathrm{v}(m_{t+1})\right] \\ &\text{s.t.} \\ a_t &= m_t - c_t \\ a_t &\geq 0 \\ k_{t+1} &= a_t/(\cancel{D}\psi_{t+1}) \\ m_{t+1} &= (\daleth + r)k_{t+1} + \xi_{t+1} \\ r &= \alpha Z(K/\bar{\ell}L)^{\alpha-1} \end{aligned}$$

(State and control variables normalized by $p_t\mathrm{W}$)

What Happens After Death?

- You are replaced by a new agent whose permanent income p is equal to the population mean
- Prevents dist'n of p from spreading out, so long as

$$\not{D}\mathbb{E}[\psi^2] < 1$$

which holds for our parameterization (next slide)

Parameter Values

- β, ρ, α, δ, $\bar{\ell}$, μ , and u taken from JEDC special volume
- Main new parameter values:

Description	Param	Value	Source
Prob of Death per Quarter	D	0.00625	Life span of 40 years
Variance of Log ψ_t	σ_ψ^2	$0.016 * 4/11$	Carroll (1992); SCF DeBacker et al. (2013)
Variance of Log θ_t	σ_θ^2	0.010×4	Carroll (1992)

Variants of Our Model—Four Dimensions

1. Discount Factor β
   - 'β-Point' model: Single discount factor
   - 'β-Dist' model: Uniformly distributed discount factor
2. Aggregate Shocks
   - (No)
   - Krusell–Smith
   - Friedman/Buffer Stock
3. Empirical Wealth Variable to Match
   - Net Worth
   - Liquid Financial Assets
4. Life Cycle
   - Perpetual Youth (*a la* Blanchard)
   - Overlapping Generations

Estimation of β-Point and β-Dist

'β-Point' model

- 'Estimate' single $\grave{\beta}$ by matching the capital–output ratio

'β-Dist' model—Heterogenous Impatience

- Assume uniformly distributed β across households
- Estimate the band $[\grave{\beta} - \nabla, \grave{\beta} + \nabla]$ by minimizing distance between model (w) and data (ω) net worth held by the top 20, 40, 60, 80%

$$\min_{\{\grave{\beta},\nabla\}} \sum_{i=20,40,60,80} (w_i - \omega_i)^2,$$

s.t. aggregate net worth–output ratio matches the steady-state value from the perfect foresight model

Alternatives to β Heterogeneity

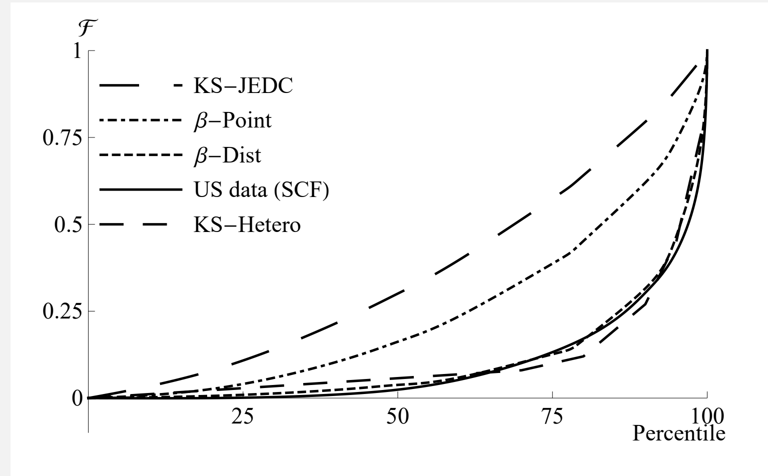
Perfect foresight 'impatience' condition is:

$$\left(\frac{(\beta R \cancel{D})^{1/\rho}}{\Gamma}\right) < 1 \tag{1}$$

'Target' m will depend on *degree* of impatience: 1-$\left(\frac{(\beta R \cancel{D})^{1/\rho}}{\Gamma}\right)$

$\Rightarrow$ heterogeneity in *beliefs* about $\Gamma, R, \cancel{D}$ generate similar results

Results: Wealth Distribution

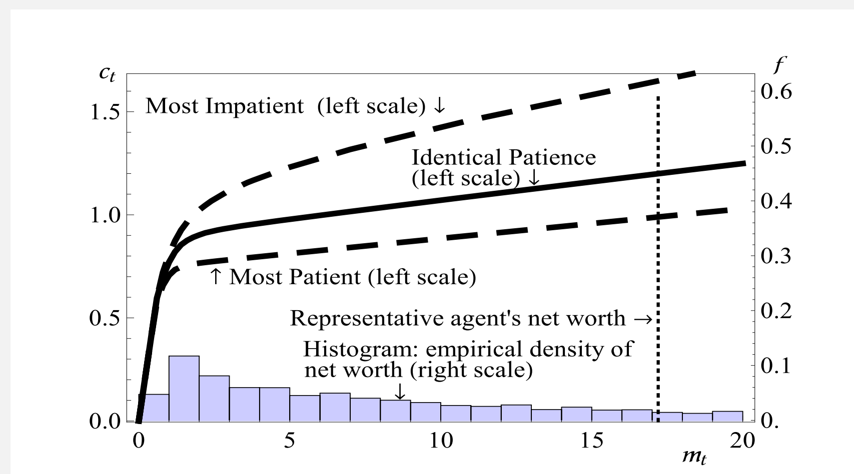


Results: Wealth Distribution

	Micro Income Process					
	Friedman/Buffer Stock		KS-JEDC	KS-Orig[◇]		
	Point Discount Factor[‡] β-Point	Uniformly Distributed Discount Factors* β-Dist	Our solution		Hetero	U.S. Data*
Top 1%	10.1	26.7	2.6	3.0	24.0	29.6
Top 20%	54.8	83.3	35.9	35.0	88.0	79.5
Top 40%	76.4	94.	60.1			92.9
Top 60%	89.6	97.6	78.5			98.7
Top 80%	97.4	99.4	92.			100.4

Notes: ‡ : $\grave{\beta} = 0.9894$. * : $(\grave{\beta}, \nabla) = (0.9867, 0.0067)$. Bold points are targeted. $K_t/Y_t = 10.3$.

Marginal Propensity to Consume and Net Worth



Empirical Estimates of MPC: ∼0.2–0.6

Friedman (1963) estimated $\kappa = 1/3$

Authors	Nondurables	Durables	Total PCE	Horizon	Event/Sample
	Consumption Measure				
Blundell et al. (2008b)[‡]	0.05				Estimation Sample: 1980–92
Coronado et al. (2005)			0.36	1 Year	2003 Tax Cut
Hausman (2012)			0.6–0.75	1 Year	1936 Veterans' Bonus
Johnson et al. (2009)	$\sim$ 0.25			3 Months	2003 Child Tax Credit
Lusardi (1996)[‡]	0.2–0.5				Estimation Sample: 1980–87
Parker (1999)	0.2			3 Months	Estimation Sample: 1980–93
Parker et al. (2011)	0.12–0.30		0.50–0.90	3 Months	2008 Economic Stimulus
Sahm et al. (2009)			$\sim$ 1/3	1 Year	2008 Economic Stimulus
Shapiro and Slemrod (2009)			$\sim$ 1/3	1 Year	2008 Economic Stimulus
Souleles (1999)	0.045–0.09	0.29–0.54	0.34–0.64	3 Months	Estimation Sample: 1980–91
Souleles (2002)	0.6–0.9			1 Year	The Reagan Tax Cuts of the Early 1980s

Notes: ‡: elasticity.

Model Results: MPC (in Annual Terms)

	Micro Income Process		
	Friedman/Buffer Stock		KS-JEDC
	β-Point	β-Dist	Our solution
Overall average	0.1	0.23	0.05
By wealth/permanent income ratio			
Top 1%	0.07	0.05	0.04
Top 20%	0.07	0.06	0.04
Top 40%	0.07	0.08	0.04
Top 60%	0.07	0.12	0.04
Bottom 1/2	0.13	0.35	0.05
By employment status			
Employed	0.09	0.2	0.05
Unemployed	0.22	0.54	0.06

Notes: Annual MPC is calculated by $1-(1-\text{quarterly MPC})^4$.

Typology of Our Models—Four Dimensions

1. Discount Factor β
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   - Net Worth
   - Liquid Financial Assets
4. Life Cycle
   - Perpetual Youth (a la Blanchard)
   - Overlapping Generations

Results: MPC Is Stable Over the Business Cycle

There Is Such a Thing as 'the MPC':

Model: β-Dist	Krusell–Smith (KS)			Friedman/Buffer Stock (FBS)		
Scenario	Base	Recssn	Expnsn	Base	Large Bad Perm Shock	Large Bad Trans Shock
Overall average	0.23	0.25	0.21	0.20	0.20	0.21
By wealth/permanent income ratio						
Top 1%	0.05	0.05	0.05	0.05	0.05	0.05
Top 10%	0.06	0.06	0.06	0.06	0.06	0.06
Top 20%	0.06	0.06	0.06	0.06	0.06	0.06
Top 40%	0.08	0.08	0.08	0.06	0.06	0.06
Top 50%	0.09	0.10	0.09	0.06	0.06	0.09
Top 60%	0.12	0.12	0.11	0.09	0.09	0.09
Bottom 50%	0.35	0.38	0.32	0.32	0.32	0.32
By employment status						
Employed	0.20	0.20	0.20	0.19	0.19	0.19
Unemployed	0.54	0.56	0.51	0.41	0.41	0.41

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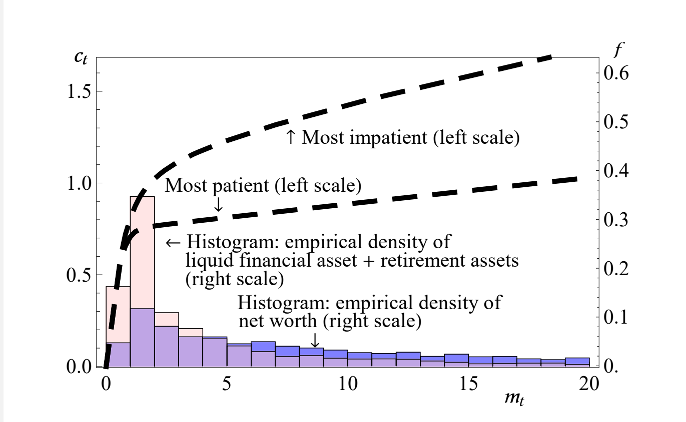
Dimension 3: Matching Net Worth vs. Liquid Assets



Liquid Assets ≡ transaction accounts, CDs, bonds, stocks, mutual funds

Match Net Worth vs. Liquid Financial Assets

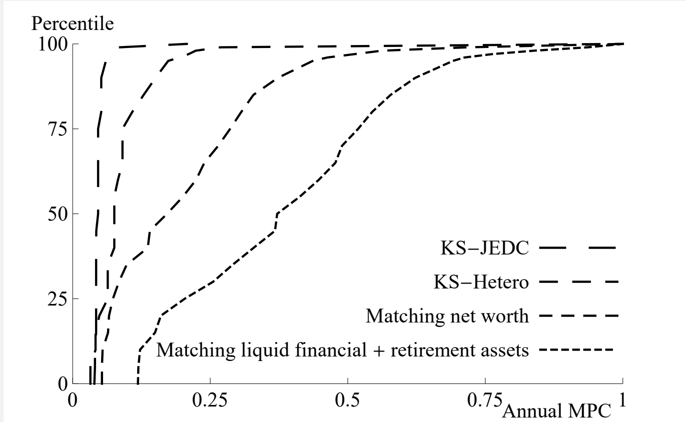
- Buffer stock saving driven by accumulation of liquidity
- May make more sense to match liquid (and retirement) assets (Hall (2011), Kaplan and Violante (2014))
- Aggregate MPC Increases Substantially: 0.23 ↑ 0.44

	β-Dist	
	Net Worth	Liq Fin and Ret Assets
Overall average	0.23	0.44
By wealth/permanent income ratio		
Top 1%	0.05	0.12
Top 20%	0.06	0.13
Top 40%	0.08	0.2
Top 60%	0.12	0.28
Bottom 1/2	0.35	0.59

Notes: Annual MPC is calculated by $1-(1-\text{quarterly MPC})^4$.

Distribution of MPCs

Wealth heterogeneity translates into heterogeneity in MPCs



Dimension 4: Overlapping Generations

Realistic Life-Cycle Model

- Three education levels: $e \in \{D, HS, C\}$
- Age/education-specific income profiles

$$\begin{aligned} y_t &= \xi_t \boldsymbol{p}_t = (1-\tau)\theta_t \boldsymbol{p}_t, \\ \boldsymbol{p}_t &= \psi_t \overline{\psi}_{es} \boldsymbol{p}_{t-1} \end{aligned}$$

  - Age-specific variances of income shocks
  - Transitory unemployment shock with prob u
- Household-specific mortality D_{es}

Household Decision Problem

$$\begin{aligned} \mathrm{v}_{es}(m_t) &= \max_{c_t} \mathrm{u}(c_t) + \beta \cancel{D}_{es} \mathbb{E}_t \left[\psi_{t+1}^{1-\rho} \mathrm{v}_{es+1}(m_{t+1}) \right] \\ &\text{s.t.} \\ a_t &= m_t - c_t, \\ k_{t+1} &= a_t / \psi_{t+1}, \\ m_{t+1} &= (\daleth + r) k_{t+1} + \xi_{t+1}, \\ a_t &\geq 0 \end{aligned}$$

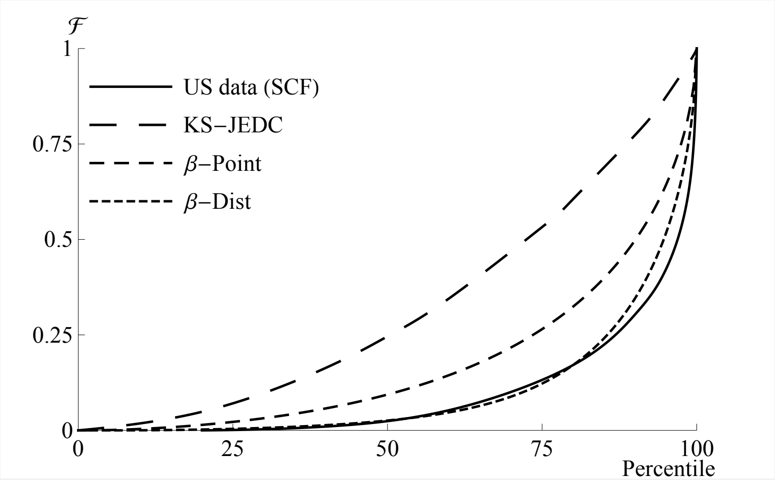
Macro Dynamics

- Population growth N, technological progress Γ
- Tax rate to finance social security and unemployment benefits: $\tau = \tau_{SS} + \tau_U$
- $\tau_{SS} = \dfrac{\sum_{e \in \{D,HS,C\}} \left[\theta_e \overline{\boldsymbol{p}}_{e0} \sum_{t=164}^{384} \left(((1+\Gamma)(1+N))^{-t} \prod_{s=0}^{t} (\overline{\psi}_{es} \cancel{D}_{es}) \right) \right]}{\sum_{e \in \{D,HS,C\}} \left[\theta_e \overline{\boldsymbol{p}}_{e0} \sum_{t=0}^{163} \left(((1+\Gamma)(1+N))^{-t} \prod_{s=0}^{t} (\overline{\psi}_{es} \cancel{D}_{es}) \right) \right]}$
- $\tau_U = u\mu$

Calibration

Description	Parameter	Value
Coefficient of relative risk aversion	ρ	1
Effective interest rate	$(r-\delta)$	0.01
Population growth rate	N	0.0025
Technological growth rate	Γ	0.0037
Rate of high school dropouts	θ_D	0.11
Rate of high school graduates	θ_{HS}	0.55
Rate of college graduates	θ_C	0.34
Average initial permanent income, dropout	$\overline{\boldsymbol{p}}_{D0}$	5000
Average initial permanent income, high school	$\overline{\boldsymbol{p}}_{HS0}$	7500
Average initial permanent income, college	$\overline{\boldsymbol{p}}_{C0}$	12000
Unemployment insurance payment	μ	0.15
Unemployment rate	u	0.07
Labor income tax rate	τ	0.0942

Results: Wealth Distribution



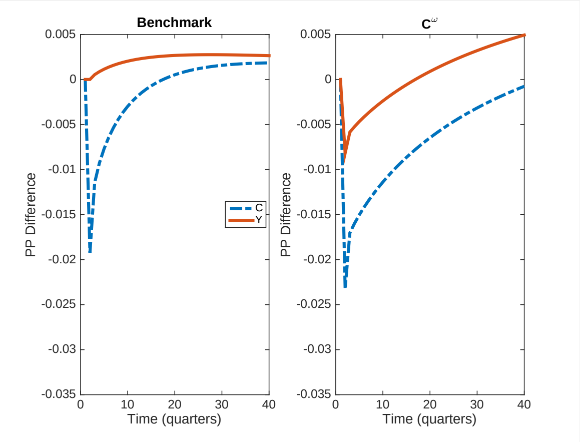
Results: MPC (in Annual Terms)

Wealth Measure	Micro Income Process: KS-JEDC Our solution NW	Micro Income Process: FBS β-Dist NW	Life-Cycle Model: β-Point NW	Life-Cycle Model: β-Dist NW	Life-Cycle Model: β-Dist Liquid
Overall average	0.05	0.23	0.11	0.29	0.42
By wealth/permanent income ratio					
Top 1%	0.04	0.05	0.08	0.07	0.07
Top 20%	0.04	0.06	0.09	0.07	0.07
Top 40%	0.04	0.08	0.08	0.07	0.11
Top 60%	0.04	0.12	0.08	0.10	0.20
Bottom 1/2	0.05	0.35	0.13	0.49	0.70
By employment status					
Employed	0.05	0.2	0.10	0.28	0.42
Unemployed	0.06	0.54	0.13	0.39	0.56

Notes: Annual MPC is calculated by $1-(1-\text{quarterly MPC})^4$.

Macro Handbook Model Like Ours, But With Multipliers

'KMP': Krueger, Mitman, and Perri (2016)
Effect of mean-preserving spread in unemployment risk:



Other Results from KMP (Macro Handbook Paper)

- Unemployment Insurance Has Big Macro Stabilization Role
- Huge Heterogeneity in Cost of Business Cycles Across HH's

Lessons

- Definition of "serious" microfoundations: Model that matches
  - Income Distribution and Income Dynamics
  - Wealth Distribution
- The model produces more plausible implications about:
  - Aggregate MPC
  - Distribution of MPC Across Households
- Can address questions like
  - Design of effective fiscal stimulus packages
  - Role of Uncertainty in C collapse
  - Macro stabilization consequences of unemployment insurance

Larry Summers' Infamous Quote about 2009-10

"Almost nothing from the academic macroeconomics literature over the prior 30 years was useful in understanding what to do"

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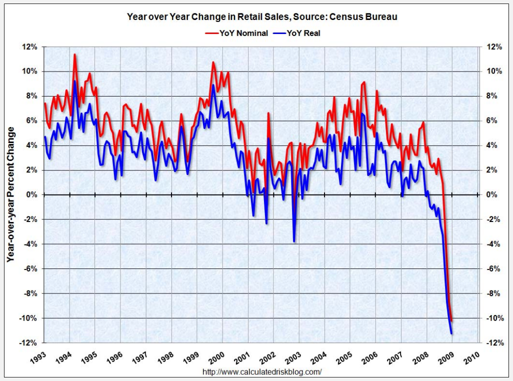


What About Pre-1979 Macro?

Keynesian multipliers should be big in liquidity trap

Crudest Keynesian Model:

- $Y = C + I + G$ and $C = (Y - T)\kappa$
  - Multipliers (if no pushback from monetary policy):
    - G: $1+\kappa + \kappa^2 + \kappa^3 + ... = 1/(1-\kappa)$
    - T: $\kappa + \kappa^2 + \kappa^3 + ... = 1/(1-\kappa) - 1$
  - If $\kappa = 0.75$ then multiplier on G is 4 and T is $4 - 1 = 3$
    - Recall: some micro estimates of κ are this large
  - If $\kappa = 0.05$ then multiplier is only ≈ 0.05
    - This is about the size of κ in RA model without habits
    - RA models with habits, more like $\kappa = 0.01$

Insights From HA Model + Pre-1978 Macro

- 'Stimulus' might be effective
  - Best kind would be G spending
  - Want to target tax-based stimulus to high-MPC groups
    - Unemployed
    - Young
    - Low-Wealth
  - 'Permanent'/persistent tax cuts more potent
  - Increase in uncertainty is a potential explanation of C collapse

Money: Representative Agent New Keynesian Models

In RANK models, log-linearized Euler equation captures almost everything ($\sim$ 95 percent) of effect of monetary policy on C dynamics:

$$\Delta \log C_{t+1} \quad = \quad \rho^{-1}(\mathrm{r}_{t+1} - \vartheta)$$

Why? When central bank makes r_{t+1} go up,

- People cut C in order to take advantage of expected higher r

Problems:

- Essentially no evidence of *any* such sensitivity
- Log-linearization of Euler equation is a mathematical crime
  - Punishable by death?

Heterogeneous Agent New Keynesian (HANK)

- Model like the one above plus New Keynesian prod fn

Monetary Policy According to HANK

Kaplan, Moll, and Violante (2016)

- RANK IES channel accounts for only 15 percent of effect of r
- The rest reflects changes in income and wealth for groups with large κ
  - Debtors
  - Young People
  - Wealthy Hand-To-Mouth

QE Works When It Affects High-MPC People

Di Maggio, Kermani, and Palmer (2016):
QE1 worked and QE2 didn't because

- QE1 affected debtors (people with high MPC)
- QE2 affected creditors (owners of Treasuries have a low MPC)
- (and capital markets are segmented)

Carroll, Slacalek, and Sommer (2013)

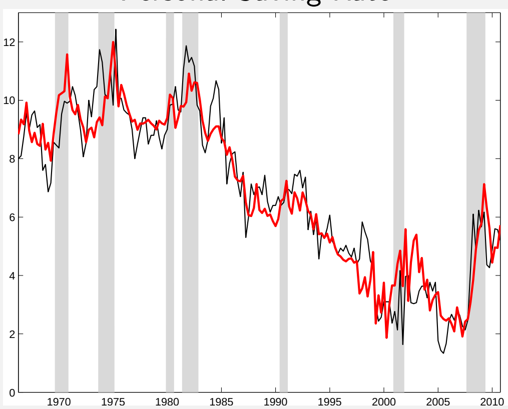
Structural model in which saving rate depends on:

- Household wealth
- Credit Availability
- Unemployment Expectations (as proxy for Uncertainty)

Results:

- Model estimated pre-2006 captures post-2006 C collapse
- In order of importance, model's explanation for C collapse is:
  1. Increase in uncertainty
  2. Collapse in household wealth
  3. Tightening of credit availability

Personal Saving Rate



Red=Model; Black=Data

Conclusion

- *Benchmark* macro models need 'serious' heterogeneity
  - It's not a 'special case'
- We know what to do
- Kernel of the technology is here:
  - `http://econ-ark.org`

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