

# Aggregate Implications of Microeconomic Consumption Behavior

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Largely Based on Carroll, Slacalek, Tokuoka, and White (2016)  
Thanks also to David Low, Nathan Palmer, and Alex Kaufman

In a model with 'serious' household heterogeneity ('HH'):

1. Fiscal Policy Can Be Much More Powerful than in RA model
  - ▶ But stimulative effect depends *completely* on details
    - ▶ Who Gets \$
    - ▶ When do they get it
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!
  - ▶ Algorithmic Resources and toolKit: **ARK!**
  - ▶ Initiative of U.S. Consumer Financial Protection Bureau
  - ▶ Subset: **Heterogeneous Agents Resources and toolKit:**  
<http://econ-ark.org>

## Household Heterogeneity and Aggregate Consumption

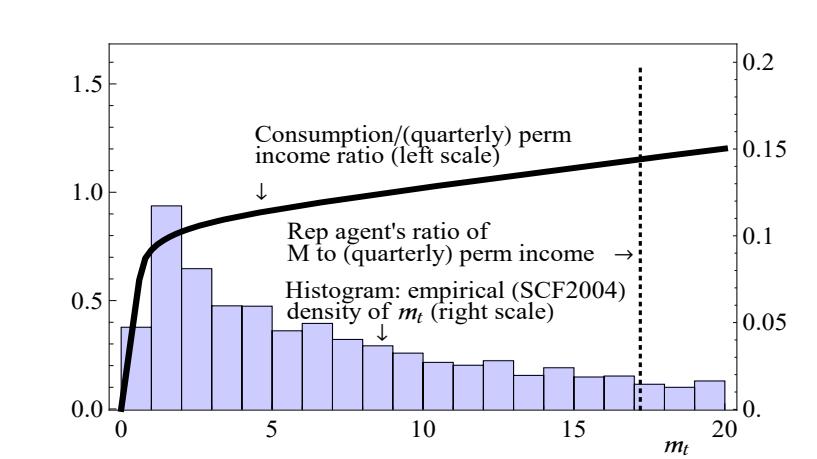
### Key Question: How Large Is 'the MPC' ( $\equiv \kappa$ )?

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 HH income process:
  - ▶ Match micro income *dynamics* and cross-section distribution
2. Match empirical wealth distribution
3. Back out optimal  $c$  and  $c'(m) = \kappa(m)$  out of transitory income
4. Is MPC in line with empirical estimates?

## Our (Micro) Income Process

Idiosyncratic (household) income process is logarithmic Friedman:

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

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

## Unemployment and Unemployment Insurance

Modifications from Carroll (1992)

Transitory income  $\xi_t$  incorporates **unemployment insurance**:

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

$\mu$  is UI when unemployed

$\tau$  is the rate of tax collected for the unemployment benefits

## Model Without Aggr Uncertainty: Decision Problem

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

(State and control variables normalized by  $p_t W$ )

## 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

$$\mathbb{D}\mathbb{E}[\psi^2] < 1$$

which holds for our parameterization (next slide)

## Parameter Values

- ▶  $\beta, \rho, \alpha, \delta, \bar{\ell}, \mu$ , 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 $\psi_t$	$\sigma_\psi^2$	$0.016 * 4/11$	Carroll (1992); SCF
Variance of Log $\theta_t$	$\sigma_\theta^2$	$0.010 \times 4$	DeBacker et al. (2013) Carroll (1992)

## Variants of Our Model—Four Dimensions

1. Discount Factor  $\beta$ 
  - ▶ ' $\beta$ -Point' model: Single discount factor
  - ▶ ' $\beta$ -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 $\beta$ -Point and $\beta$ -Dist

### ' $\beta$ -Point' model

- ▶ 'Estimate' single  $\beta$  by matching the capital–output ratio

### ' $\beta$ -Dist' model—Heterogenous Impatience

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

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

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

## Alternatives to $\beta$ Heterogeneity

Perfect foresight ‘impatience’ condition is:

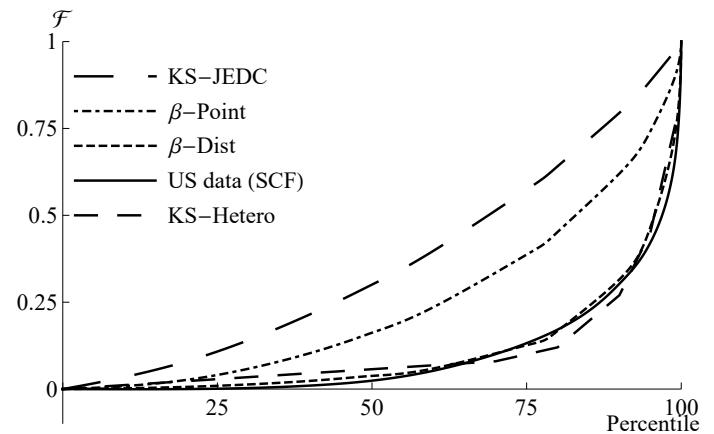
$$\left( \frac{(\beta R D)^{1/\rho}}{\Gamma} \right) < 1 \quad (1)$$

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

Point: Hetero in *beliefs*

- In PF model, about  $\Gamma, R, D$  generate *identical* consequences
- In model with uncertainty, even more options:
  - hetero. in *beliefs* about  $\sigma_\psi^2$  and  $\sigma_\theta^2$  and  $\mu$ )

## Results: Wealth Distribution

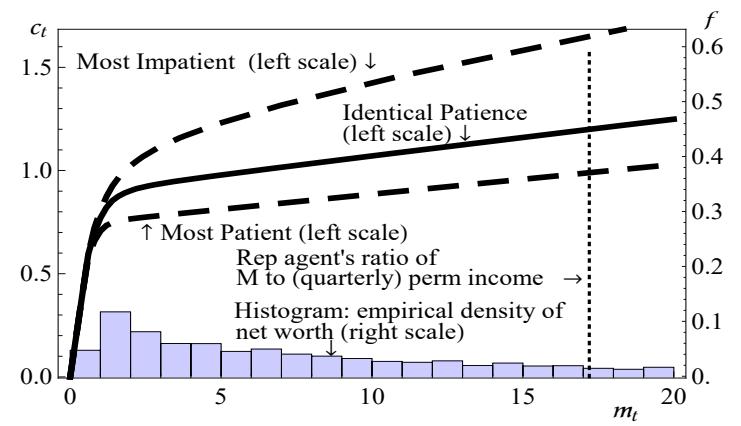


## Results: Wealth Distribution

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

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

## Marginal Propensity to Consume and Net Worth



## Empirical Estimates of MPC: $\sim 0.2\text{--}0.6$

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

Authors	Consumption Measure			Horizon	Event/Sample
	Nondurables	Durables	Total PCE		
Blundell et al. (2008b) <sup>‡</sup>	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)	~ 0.25			3 Months	2003 Child Tax Credit
Lusardi (1996) <sup>‡</sup>	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)		~ 1/3		1 Year	2008 Economic Stimulus
Shapiro and Slemrod (2009)		~ 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: <sup>‡</sup>: elasticity.

## Model Results: MPC (in Annual Terms)

	Micro Income Process		
	Friedman/Buffer Stock		KS-JEDC
	$\beta$ -Point	$\beta$ -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

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  - ▶ Overlapping Generations

## Results: MPC Is Stable Over the Business Cycle

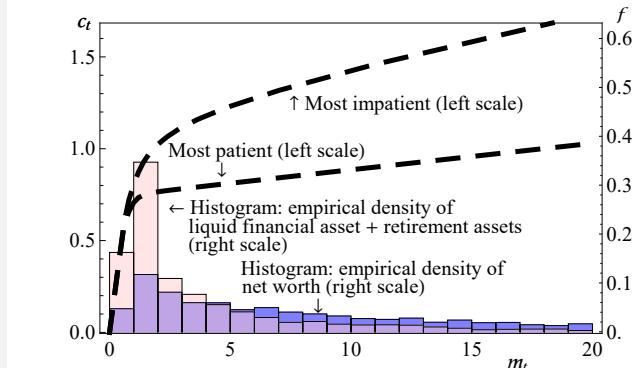
There Is Such a Thing as 'the MPC':

Model: $\beta$ -Dist	Krusell-Smith (KS)			Friedman/Buffer Stock (FBS)		
	Scenario	Base	Recssn	Expsn	Base	Large Bad Perm 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  $\equiv$  transaction accounts, CDs, bonds, stocks, mutual funds

## Match Net Worth vs. Liquid Financial Assets

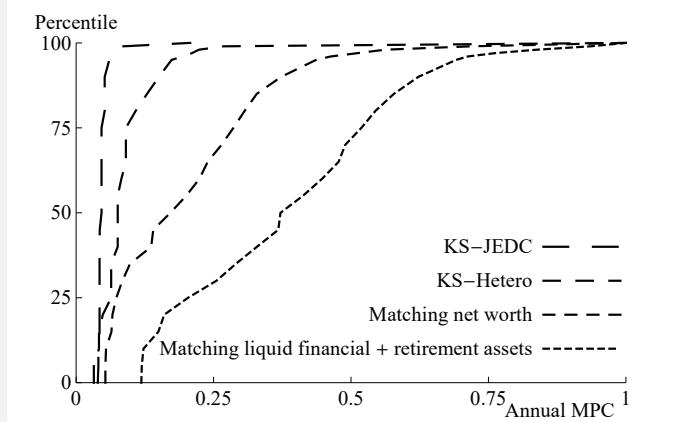
- ▶ Buffer stock saving driven by accumulation of liquidity
- ▶ May make more sense to match liquid (and retirement) assets (Hall (2011), Kaplan and Violante (2014))
- ▶ Aggregate MPC Increases Substantially:  $0.23 \uparrow 0.44$

	$\beta$ -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

$$y_t = \xi_t p_t = (1 - \tau) \theta_t p_t,$$

$$p_t = \psi_t \bar{\psi}_{es} p_{t-1}$$

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

### Household Decision Problem

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

## Macro Dynamics

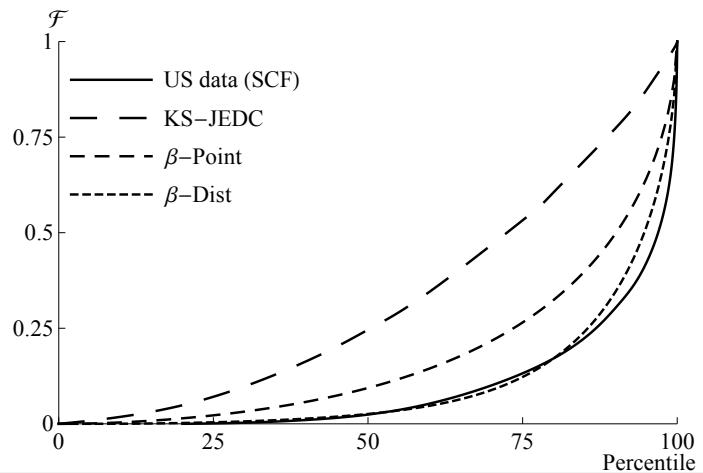
- ▶ Population growth  $N$ , technological progress  $\Gamma$
- ▶ **Tax rate** to finance social security and unemployment benefits:  
 $\tau = \tau_{SS} + \tau_U$ 

$$\tau_{SS} = \frac{\sum_{e \in \{D, HS, C\}} \left[ \theta_e \bar{p}_{e0} \sum_{t=164}^{384} ((1+\Gamma)(1+N))^{-t} \prod_{s=0}^t (\bar{\psi}_{es} D_{es}) \right]}{\sum_{e \in \{D, HS, C\}} \left[ \theta_e \bar{p}_{e0} \sum_{t=0}^{163} ((1+\Gamma)(1+N))^{-t} \prod_{s=0}^t (\bar{\psi}_{es} D_{es}) \right]}$$
- ▶  $\tau_U = u\mu$

## Calibration

Description	Parameter	Value
Coefficient of relative risk aversion	$\rho$	1
Effective interest rate	$(r - \delta)$	0.01
Population growth rate	$N$	0.0025
Technological growth rate	$\Gamma$	0.0037
Rate of high school dropouts	$\theta_D$	0.11
Rate of high school graduates	$\theta_{HS}$	0.55
Rate of college graduates	$\theta_C$	0.34
Average initial permanent income, dropout	$\bar{p}_{D0}$	5000
Average initial permanent income, high school	$\bar{p}_{HS0}$	7500
Average initial permanent income, college	$\bar{p}_{C0}$	12000
Unemployment insurance payment	$\mu$	0.15
Unemployment rate	$u$	0.07
Labor income tax rate	$\tau$	0.0942

## Results: Wealth Distribution



## Results: MPC (in Annual Terms)

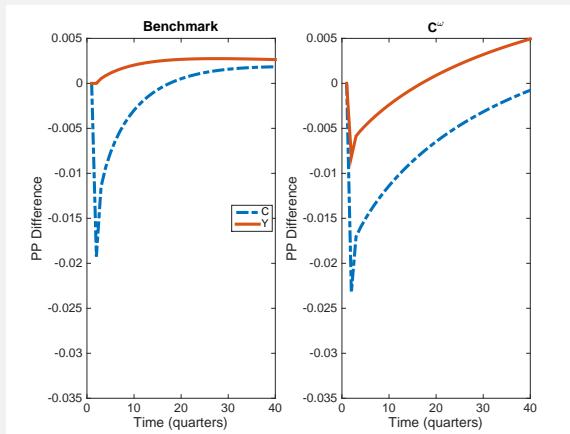
Wealth Measure	Micro Income Process		Life-Cycle Model		
	KS-JEDC Our solution NW	FBS $\beta$ -Dist NW	$\beta$ -Point NW	$\beta$ -Dist NW	$\beta$ -Dist Liquid
	Overall average	0.05	0.23	0.11	0.42
By wealth/permanent income ratio					
Top 1%	0.04	0.05	0.08	0.07	0.07
Top 20%	0.04	0.06	0.09	0.07	0.07
Top 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

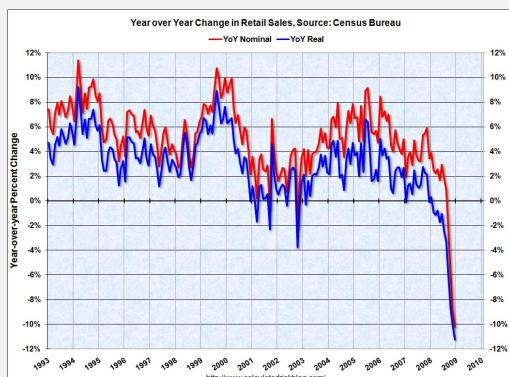
- ▶ Definition of “serious” microfoundations: Model that matches
  - ▶ Income Distribution and Income Dynamics
  - ▶ Wealth Distribution
- ▶ The model produces more plausible implications about:
  - ▶ Aggregate MPC
  - ▶ Distribution of MPC Across Households
- ▶ Can address questions like
  - ▶ Design of effective fiscal stimulus packages
  - ▶ How does conventional monetary policy work, and why
  - ▶ Which unconventional monetary policies will work
  - ▶ 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):
  - ▶  $G: 1 + \kappa + \kappa^2 + \kappa^3 + \dots = 1/(1 - \kappa)$
  - ▶  $T: \kappa + \kappa^2 + \kappa^3 + \dots = 1/(1 - \kappa) - 1$
- ▶ If  $\kappa = 0.75$  then multiplier on  $G$  is 4 and  $T$  is  $4 - 1 = 3$ 
  - ▶ Recall: some micro estimates of  $\kappa$  are this large
- ▶ If  $\kappa = 0.05$  then multiplier is only  $\approx 0.05$ 
  - ▶ This is about the size of  $\kappa$  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:

$$\Delta \log C_{t+1} = \rho^{-1}(r_{t+1} - \vartheta)$$

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
  - ▶ Not yet 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)

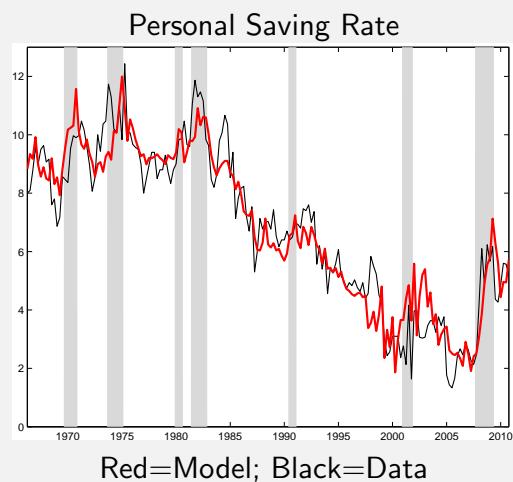
- ▶ RANK IES channel accounts for only 15 percent of effect of  $r$
- ▶ The rest reflects changes in income and wealth for groups with large  $\kappa$ 
  - ▶ Debtors
  - ▶ Young People
  - ▶ Wealthy Hand-To-Mouth

## 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

## 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>
  - ▶ Come to next week's workshop to get started!

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