The Distribution of Wealth and the Marginal Propensity to Consume

Christopher Carroll[1] Jiri Slacalek[2] Kiichi Tokuoka[3] Matthew N. White[4]

[1]Johns Hopkins University and NBER
ccarroll@jhu.edu

[2]European Central Bank
jiri.slacalek@ecb.int

[3]Ministry of Finance, Japan
kiichi.tokuoka@mof.go.jp

[4]University of Delaware
mnwecon@udel.edu

"Serious" Microfoundations $\Rightarrow$ High MPC

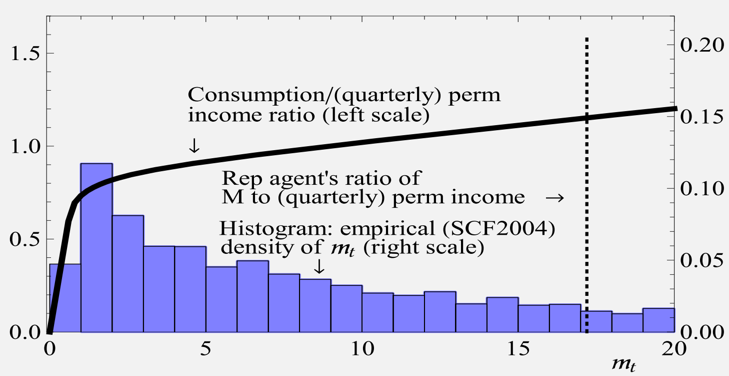
Defining 'the MPC' $(\equiv \kappa)$?

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

Elements that interact with each other to produce the result:

- Households are heterogeneous
- Wealth is unevenly distributed
- 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



Why Worry About the MPC $(\equiv \kappa)$?

Nobody trying to make a forecast in 2008–2010 would ask:

- Big 'stimulus' tax cuts
- Keynesian multipliers should be big in liquidity trap
- Crude Keynesianism: Transitory tax cut multiplier is $1/(1-\kappa)-1$
  - If $\kappa = 0.75$ then multiplier is $4 - 1 = 3$
    - 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 Rep Agent and KS models

Microeconomics of Consumption

Since Friedman's (1957) PIH:

- c chosen optimally:
  Goal: smooth c *in light of beliefs about* y fluctuations
- Single most important thing to get right is income dynamics!
- With smooth c, income dynamics drive everything!
  - Saving/dissaving: Depends on whether $\mathbb{E}[\Delta y] \uparrow$ or $\mathbb{E}[\Delta y] \downarrow$
  - Wealth distribution depends on integration of saving
- Cardinal sin: Assume crazy income dynamics
  - Throws out the defining core of the intellectual framework

Our Goal: "Serious" Microfoundations

Requires three changes to well-known Krusell–Smith (1998) model:

1. Sensible microeconomic income process: Friedman
2. Finite lifetimes: Blanchard
3. Match wealth distribution
   - Here, achieved by preference heterogeneity
   - View it as a proxy for many kinds of heterogeneity
     - Age
     - Optimism/Pessimism about Growth
     - Risk aversion
     - Rate of Return
     - ...

To-Do List

1. Calibrate realistic income process
2. Match empirical wealth distribution
3. Back out optimal C and MPC out of transitory income
4. Is MPC in line with empirical estimates?

Our Question:

Does a model that matches micro facts about income dynamics and wealth distribution give different (and more plausible) answers than KS to macroeconomic questions (say, about the response of consumption to fiscal 'stimulus')?

Friedman (1957): Permanent Income Hypothesis

$$\begin{aligned} Y_t &= P_t + T_t \\ C_t &= P_t \end{aligned}$$

Progress since then

- Micro data: Friedman description of income shocks works well
- Math: Friedman's words well describe optimal solution to dynamic stochastic optimization problem of impatient consumers with geometric discounting under CRRA utility with uninsurable idiosyncratic risk calibrated using these micro income dynamics (!)

Our (Micro) Income Process

Idiosyncratic (household) income process is logarithmic Friedman:

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

p_t = permanent income
ξ_t = transitory income
ψ_{t+1} = permanent shock
W = aggregate wage rate

Further Details of Income Process

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

$$\begin{aligned} \mathrm{v}(m_t) &= \max_{\{c_t\}} \; u + \beta\not{D}\mathbb{E}_t\left[\psi_{t+1}^{1-\rho}\mathrm{v}(m_{t+1})\right] \\ &\text{s.t.} \\ a_t &= m_t - c_t \\ a_t &\geq 0 \\ k_{t+1} &= a_t/(\not{D}\psi_{t+1}) \\ m_{t+1} &= (\daleth + r)k_{t+1} + \xi_{t+1} \\ r &= \alpha Z(K/\bar{\ell}L)^{\alpha-1} \end{aligned}$$

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

What Happens After Death?

- You are replaced by a new agent whose permanent income is equal to the population mean
- Prevents the population distribution of permanent income from spreading out

Ergodic Distribution of Permanent Income

Exists, if death eliminates permanent shocks:

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

Holds.

Population mean of p^2:

$$\mathbb{M}[p^2] = \frac{\mathsf{D}}{1 - \not{D}\mathbb{E}[\psi^2]}$$

Parameter Values

- β, ρ, α, δ, $\bar{\ell}$, μ , and u taken from JEDC special volume
- Key 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^2_ψ	0.016/4	Carroll (1992); SCF DeBacker et al. (2013)
Variance of Log θ_t	σ^2_θ	0.010×4	Carroll (1992)

Annual Income, Earnings, or Wage Variances

	σ^2_ψ	σ^2_ξ
Our parameters	0.016	0.010
Carroll (1992)	0.016	0.010
Storesletten, Telmer, and Yaron (2004)	0.008–0.026	0.316
Meghir and Pistaferri (2004)*	0.031	0.032
Low, Meghir, and Pistaferri (2010)	0.011	–
Blundell, Pistaferri, and Preston (2008)*	0.010–0.030	0.029–0.055
DeBacker, Heim, Panousi, Ramnath, and Vidangos (2013)	0.007–0.010	0.15–0.20
Implied by KS-JEDC	0.	0.038
Implied by Castaneda et al. (2003)	0.03	0.006

*Meghir and Pistaferri (2004) and Blundell, Pistaferri, and Preston (2008) assume that the transitory component is serially correlated (an MA process), and report the variance of a subelement of the transitory component. σ^2_ξ for these articles are calculated using their MA estimates.

Typology of Our Models—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

Dimension 1: Estimation of β-Point and β-Dist

'β-Point' model

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

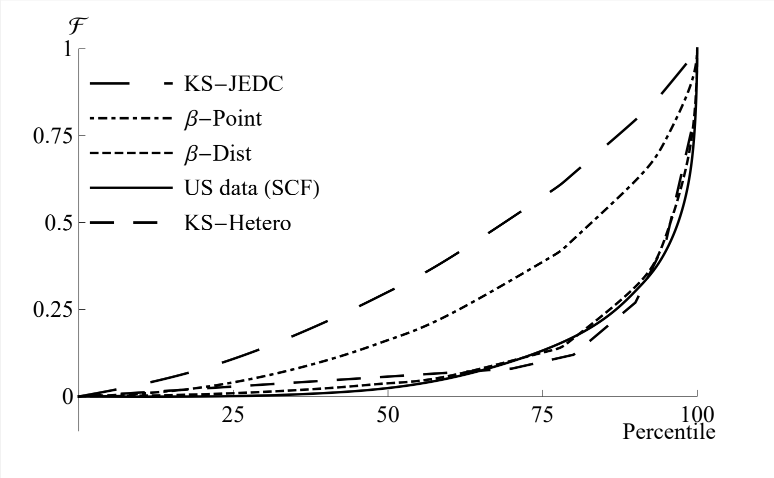
'β-Dist' model—Heterogenous Impatience

- 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

Results: Wealth Distribution

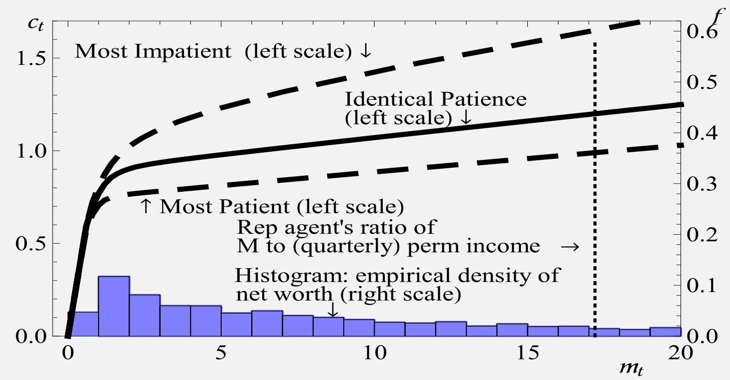


Results: Wealth Distribution

	Micro Income Process					
	Friedman/Buffer Stock		KS-JEDC	KS-Orig$^\diamond$		
	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 & Net Worth



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 $1-(1-\text{quarterly MPC})^4$.

Estimates of MPC in the Data: ∼0.2–0.6

	Consumption Measure				
Authors	Nondurables	Durables	Total PCE	Horizon	Event/Sample
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)	∼ 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)			∼ 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: ‡: elasticity.

Typology of Our Models—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

Dimension 2.a: Adding KS Aggregate Shocks

Model with KS Aggregate Shocks: Assumptions

- Only two aggregate states (good or bad)
- Aggregate productivity $Z_t = 1 \pm \triangle^Z$
- Unemployment rate u depends on the state (u^g or u^b)

Parameter values for aggregate shocks from Krusell and Smith (1998)

Parameter	Value
$\triangle^Z$	0.01
u^g	0.04
u^b	0.10
Agg transition probability	0.125

Dimension 2.b: Adding FBS Aggregate Shocks

Friedman/Buffer Stock Shocks

- Motivation:
  More plausible and tractable aggregate process, also simpler
- Eliminates 'good' and 'bad' aggregate state
- Aggregate production function: $K_t^{\alpha}(L_t)^{1-\alpha}$
  - $L_t = P_t \Xi_t$
  - P_t is aggregate permanent productivity
  - $P_{t+1} = P_t \Psi_{t+1}$
  - Ξ_t is the aggregate transitory shock.
- Parameter values estimated from U.S. data:

Description	Parameter	Value
Variance of Log Ψ_t	σ_{Ψ}^2	0.00004
Variance of Log Ξ_t	σ_{Ξ}^2	0.00001

Results

Our/FBS model

- A few times faster than solving KS model
- The results are similar to those under KS aggregate shocks

Results: MPC Over the Business Cycle

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

Results: MPC Over the Business Cycle

Krusell–Smith

- Aggregate and idiosyncratic shocks positively correlated
- Higher MPC during recessions, especially for the unemployed

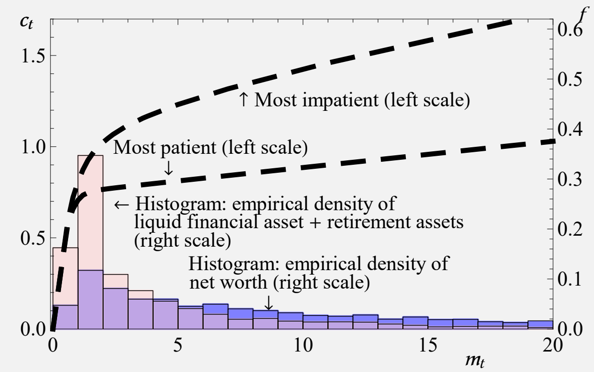
Friedman/Buffer Stock

- Shocks uncorrelated
- MPC essentially doesn't vary over BC

Typology of Our Models—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

Dimension 3: Matching Net Worth vs. Liquid Financial (and Retirement) Assets



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

Match Net Worth vs. Liquid Financial Assets

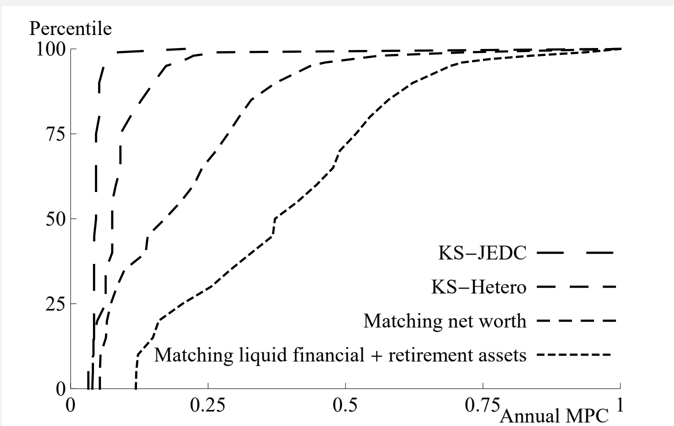
- Buffer stock saving driven by accumulation of liquidity
- May make more sense to match liquid (and retirement) assets (Hall (2011), Kaplan and Violante (2014))
- Aggregate MPC Increases Substantially: 0.23 ↑ 0.43

	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



Typology of Our Models—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

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

$$\begin{aligned} \mathrm{v}_{es}(m_t) &= \max_{c_t} u(c_t) + \beta \not{D}_{es} \mathbb{E}_t \left[\psi_{t+1}^{1-\rho} \mathrm{v}_{es+1}(m_{t+1}) \right] \\ &\text{s.t.} \\ a_t &= m_t - c_t, \\ k_{t+1} &= a_t / \psi_{t+1}, \\ m_{t+1} &= (\daleth + r) k_{t+1} + \xi_{t+1}, \\ a_t &\geq 0 \end{aligned}$$

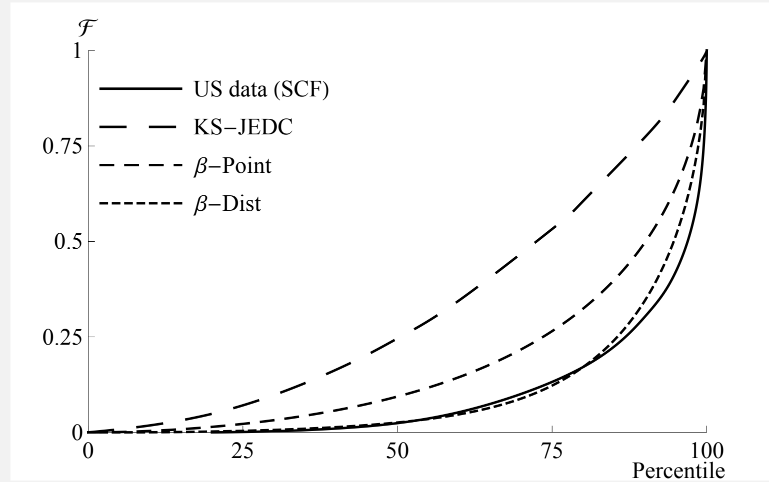
Macro Dynamics

- Population growth N, technological progress Γ
- Tax rate to finance social security and unemployment benefits: $\tau = \tau_{SS} + \tau_U$
- $\tau_{SS} = \dfrac{\sum_{e \in \{D,HS,C\}} \left[\theta_e \overline{\boldsymbol{p}}_{e0} \sum_{t=164}^{384} \left(((1+\Gamma)(1+N))^{-t} \prod_{s=0}^{t} (\overline{\psi}_{es} \not{D}_{es}) \right) \right]}{\sum_{e \in \{D,HS,C\}} \left[\theta_e \overline{\boldsymbol{p}}_{e0} \sum_{t=0}^{163} \left(((1+\Gamma)(1+N))^{-t} \prod_{s=0}^{t} (\overline{\psi}_{es} \not{D}_{es}) \right) \right]}$
- $\tau_U = u\mu$

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	$\bar{\mathbf{p}}_{D0}$	5000
Average initial permanent income, high school	$\bar{\mathbf{p}}_{HS0}$	7500
Average initial permanent income, college	$\bar{\mathbf{p}}_{C0}$	12000
Unemployment insurance payment	μ	0.15
Unemployment rate	u	0.07
Labor income tax rate	τ	0.0942

Results: Wealth Distribution

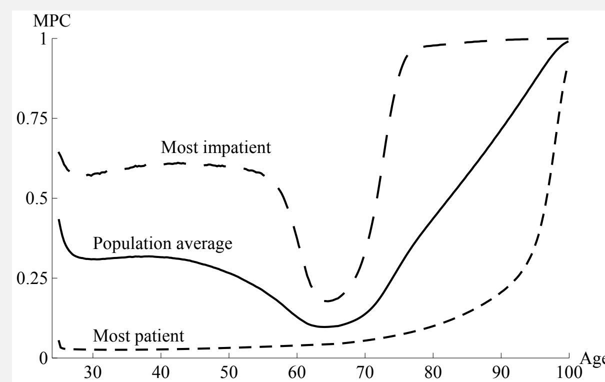


Results: MPC (in Annual Terms)

	Micro Income Process		Life-Cycle Model		
	KS-JEDC	FBS			
	Our solution	β-Dist	β-Point	β-Dist	β-Dist
Wealth Measure	NW	NW	NW	NW	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 $1-(1-\text{quarterly MPC})^4$.

Results: MPC by Age



- Initial drop in MPC: Build-up of buffer stock
- Rise while rapid income growth, fall before retirement, then incrsing mortlty risk

Conclusions

- Definition of "serious" microfoundations: Model that matches
  - Income Dynamics
  - Wealth Distribution
- The model produces more plausible implications about:
  - Aggregate MPC
  - Distribution of MPC Across Households
- Version with more plausible aggregate specification is simpler, faster, better in every way!

References I

Blundell, Richard, Luigi Pistaferri, and Ian Preston (2008): "Consumption Inequality and Partial Insurance," *American Economic Review*, 98(5), 1887–1921.

Carroll, Christopher D. (1992): "The Buffer-Stock Theory of Saving: Some Macroeconomic Evidence," *Brookings Papers on Economic Activity*, 1992(2), 61–156, http://econ.jhu.edu/people/ccarroll/BufferStockBPEA.pdf.

Castaneda, Ana, Javier Diaz-Gimenez, and Jose-Victor Rios-Rull (2003): "Accounting for the U.S. Earnings and Wealth Inequality," *Journal of Political Economy*, 111(4), 818–857.

DeBacker, Jason, Bradley Heim, Vasia Panousi, Shanthi Ramnath, and Ivan Vidangos (2013): "Rising Inequality: Transitory or Persistent? New Evidence from a Panel of U.S. Tax Returns," *Brookings Papers on Economic Activity*, Spring, 67–122.

Friedman, Milton A. (1957): *A Theory of the Consumption Function*. Princeton University Press.

Hall, Robert E. (2011): "The Long Slump," AEA Presidential Address, ASSA Meetings, Denver.

Kaplan, Greg, and Giovanni L. Violante (2014): "A Model of the Consumption Response to Fiscal Stimulus Payments," *Econometrica*, 82(4), 1199–1239.

Krusell, Per, and Anthony A. Smith (1998): "Income and Wealth Heterogeneity in the Macroeconomy," *Journal of Political Economy*, 106(5), 867–896.

Low, Hamish, Costas Meghir, and Luigi Pistaferri (2010): "Wage Risk and Employment Over the Life Cycle," *American Economic Review*, 100(4), 1432–1467.

Meghir, Costas, and Luigi Pistaferri (2004): "Income Variance Dynamics and Heterogeneity," *Journal of Business and Economic Statistics*, 72(1), 1–32.

Storesletten, Kjetil, Chris I. Telmer, and Amir Yaron (2004): "Cyclical Dynamics in Idiosyncratic Labor-Market Risk," *Journal of Political Economy*, 112(3), 695–717.