

# Aggregate Implications of Microeconomic Consumption Behavior

Christopher D. Carroll  
Johns Hopkins University

http:

[//econ.jhu.edu/people/ccarroll/public/lecturenotes/consumption/AggImplicationsSlides.pdf](http://econ.jhu.edu/people/ccarroll/public/lecturenotes/consumption/AggImplicationsSlides.pdf)

Conference on Micro and Macro Saving Behavior, Istanbul, June 2008

June 8, 2008



# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate
  - ▶ Conclusion: Risk, heterogeneity change everything

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate
  - ▶ Conclusion: Risk, heterogeneity change everything
  - ▶ Criticism: No real GE analysis

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate
  - ▶ Conclusion: Risk, heterogeneity change everything
  - ▶ Criticism: No real GE analysis
- ▶ Freshwater

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate
  - ▶ Conclusion: Risk, heterogeneity change everything
  - ▶ Criticism: No real GE analysis
- ▶ Freshwater
  - ▶ Start with Rep Agent (RA) model, introduce risk

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate
  - ▶ Conclusion: Risk, heterogeneity change everything
  - ▶ Criticism: No real GE analysis
- ▶ Freshwater
  - ▶ Start with Rep Agent (RA) model, introduce risk
  - ▶ Conclusion: Risk, heterogeneity don't matter

# Broad Overview

Two approaches to microfoundations of consumption:

- ▶ Saltwater
  - ▶ Start with micro theory and data, aggregate
  - ▶ Conclusion: Risk, heterogeneity change everything
  - ▶ Criticism: No real GE analysis
- ▶ Freshwater
  - ▶ Start with Rep Agent (RA) model, introduce risk
  - ▶ Conclusion: Risk, heterogeneity don't matter
  - ▶ Criticism: Totally unrealistic micro implications

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity
- ▶ Salt and Fresh Water Frameworks are Special Cases

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity
- ▶ Salt and Fresh Water Frameworks are Special Cases
- ▶ Combines Advantages of Both Classes

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity
- ▶ Salt and Fresh Water Frameworks are Special Cases
- ▶ Combines Advantages of Both Classes
  - ▶ Wealth Distribution 'Matters'

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity
- ▶ Salt and Fresh Water Frameworks are Special Cases
- ▶ Combines Advantages of Both Classes
  - ▶ Wealth Distribution 'Matters'
  - ▶ Get 'Excess Sensitivity' of  $C$

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity
- ▶ Salt and Fresh Water Frameworks are Special Cases
- ▶ Combines Advantages of Both Classes
  - ▶ Wealth Distribution 'Matters'
  - ▶ Get 'Excess Sensitivity' of  $C$
  - ▶ High MPC for  $c$

# Tidewater!

- ▶ GE Framework With 'Serious' Heterogeneity
- ▶ Salt and Fresh Water Frameworks are Special Cases
- ▶ Combines Advantages of Both Classes
  - ▶ Wealth Distribution 'Matters'
  - ▶ Get 'Excess Sensitivity' of  $C$
  - ▶ High MPC for  $c$
  - ▶ Fully articulated GE

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior
  - ▶ Reference: Carroll [2004, 2001a]

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior
  - ▶ Reference: Carroll [2004, 2001a]
- ▶ Freshwater: The Ramsey/Cass-Koopmans Model

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior
  - ▶ Reference: Carroll [2004, 2001a]
- ▶ Freshwater: The Ramsey/Cass-Koopmans Model
  - ▶ Grad School!

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior
  - ▶ Reference: Carroll [2004, 2001a]
- ▶ Freshwater: The Ramsey/Cass-Koopmans Model
  - ▶ Grad School!
- ▶ Tidewater

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior
  - ▶ Reference: Carroll [2004, 2001a]
- ▶ Freshwater: The Ramsey/Cass-Koopmans Model
  - ▶ Grad School!
- ▶ Tidewater
  - ▶ Reference: Krusell and Smith [1998], Carroll [2000a]

# Talk Outline

- ▶ Saltwater: Microeconomic Consumption Behavior
  - ▶ Reference: Carroll [2004, 2001a]
- ▶ Freshwater: The Ramsey/Cass-Koopmans Model
  - ▶ Grad School!
- ▶ Tidewater
  - ▶ Reference: Krusell and Smith [1998], Carroll [2000a]
- ▶ Reseverations

## Micro History of Thought

- ▶ Permanent Income Hypothesis of Friedman [1957]

## Perfect Foresight Benchmark

$$\max \sum_{t=0}^{\infty} \beta^t u(C_t)$$

$$u(C) = C^{1-\rho}/(1-\rho)$$

Initial conditions:  $M_0$  and  $P_0$

$$A_t = M_t - C_t$$

$$B_{t+1} = A_t R$$

$$M_{t+1} = B_{t+1} + P_{t+1}$$

$$P_{t+1} = GP_t$$

## Perfect Foresight Solution

$$H_t = P_t \left( \frac{1}{1 - (G/R)} \right)$$

$$\kappa = (1 - (R\beta)^{1/\rho}/R)$$

$$C(M_t, P_t) = (H_t + \underbrace{M_t - P_t}_{=B_t})\kappa$$

Benchmark parameter values

$$\rho = 2$$

$$R = 1.03$$

$$\beta = 0.97$$

imply  $\kappa \approx 0.03$ .

## Idiosyncratic Uncertainty

$$\begin{aligned}M_{t+1} &= B_{t+1} + P_{t+1}\xi_{t+1} \\ P_{t+1} &= GP_t\Psi_{t+1}\end{aligned}$$

Also assume:

- ▶ iid  $\xi$  and  $\Psi$  satisfy  $E_t[\Psi_{t+n}] = E_t[\xi_{t+n}] = 1 \forall n > 0$
- ▶ With small probability  $p$ ,  $\xi = 0$  (unemployment)
- ▶ Impatience:  $R\beta E[(G\Psi)^{-\rho}] < 1$

## Normalized Solution

Problem has a solution of the form

$$C(M, P) = P \underbrace{c(M/P)}_{=m}$$

If we 'turn off' the uncertainty (assume  $\Psi_t = \xi_t = 1 \forall t$ ), the solution is

$$c(m) = (h_t + \underbrace{m_t - 1}_{b_t})\kappa$$

# Effect of Uncertainty

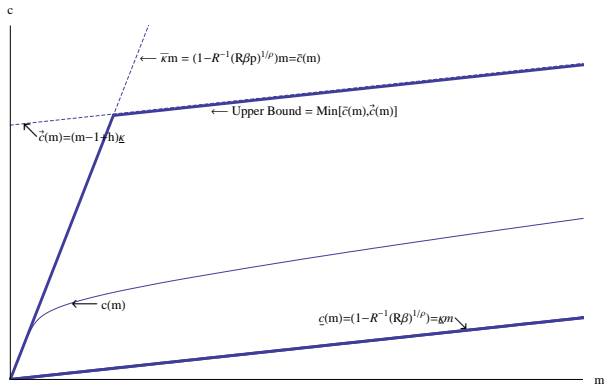


Figure: Concave  $c(m)$  and Its Bounds

# Marginal Propensity to Consume

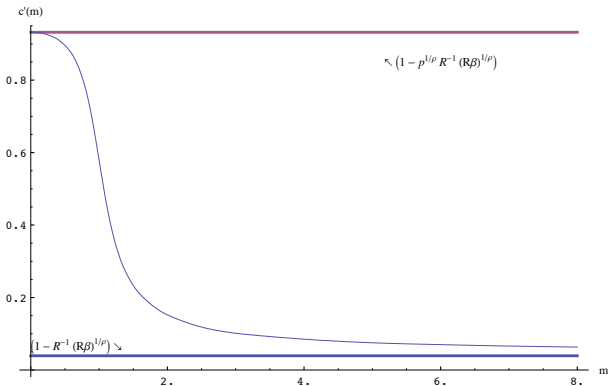


Figure: The MPC and Its Bounds

## Key Intuition

- ▶ Impatience: At  $m_t = \infty$ ,  $C > P$  so  $E_t[m_{t+1}] < m_t$
- ▶ Precaution: At  $m_t = 0$ ,  $C = 0 < P$  so  $E_t[m_{t+1}] > m_t$

These imply:

- ▶ A 'target' level of wealth exists at which impatience exactly matches prudence, and  $C = P$
- ▶ Actual wealth will be distributed around the target

# Matching the Median Household

Income Growth Factor	Mean $a$	Median $a$	Aggregate Consumption Growth	Mean MPC	Frac With $a < 0$	Frac With $a = 0$
Panel A. Baseline Model, No Constraints						
G=1.03	0.43	0.40	1.030	0.330	0.000	0.000
G=1.00	2.26	2.06	1.000	0.064	0.000	0.000
Panel B. Strict Liquidity Constraints						
G=1.03	0.28	0.24	1.030	0.361	0.000	0.070
G=1.00	2.28	2.06	1.000	0.065	0.000	0.000
Panel C. Borrowing Up To 0.3 Allowed						
G=1.03	-0.03	-0.06	1.030	0.361	0.611	0.000
G=1.00	1.94	1.71	1.000	0.064	0.023	0.000

Source: Carroll [2001b]

## Constraints Don't Matter . . .

- ▶ Under uncertainty, prudence acts like a self-imposed liquidity constraint
- ▶ Eqbm behavior of consumers in a constrained model almost indistinguishable from eqbm behavior of consumers in the corresponding unconstrained model. (Carroll [2001b])

## ...Except When They Change

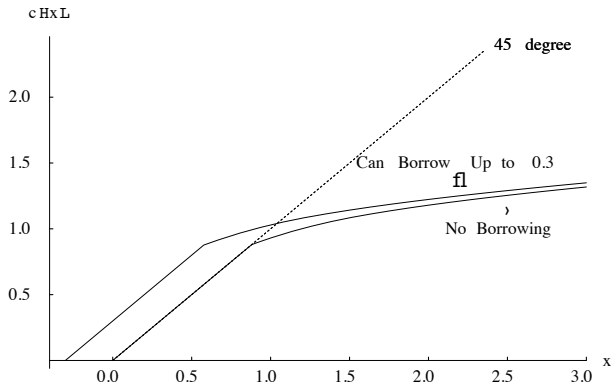


Figure: Strict and Looser Liquidity Constraints

## Summing Up

- ▶ Theory says  $c(m)$  is concave
  - ▶ High MPC for people with low wealth
  - ▶ Low MPC for people with high wealth
- ▶ Target assets  $a^*$  depend on patience
  - ▶ Small differences in  $G$  produce large  $a$  differences
- ▶ Distribution could matter a lot in SR
  - ▶ Tax changes targeting poor will have much bigger kick
- ▶ Constraints have modest long-run consequences
- ▶ Changes in constraints can have a big SR effect

# The Stochastic Growth Model

- ▶ Turn off the transitory shocks:  $\xi = 1$
- ▶ Aggregate production function:  $F(K, P) = K^\gamma P^{1-\gamma}$
- ▶ Introduce depreciation:  $K_{t+1} = A_t \bar{\Gamma}$

Normalize again, obtaining

$$\begin{aligned}k_{t+1} &= (\bar{\Gamma}/G\Psi_{t+1})a_t \\m_{t+1} &= k_{t+1} + k_{t+1}^\gamma\end{aligned}$$

# Calibrating Stochastic Growth Model

$$\alpha = 0.36$$

$$\gamma = 1.10$$

$$G = 1.00$$

$$\beta = 0.96$$

Bottom Line:

- ▶ Typically calibrated to match  $K/Y \approx 3 \sim 4$
- ▶ RA is very rich!

# In a Nutshell

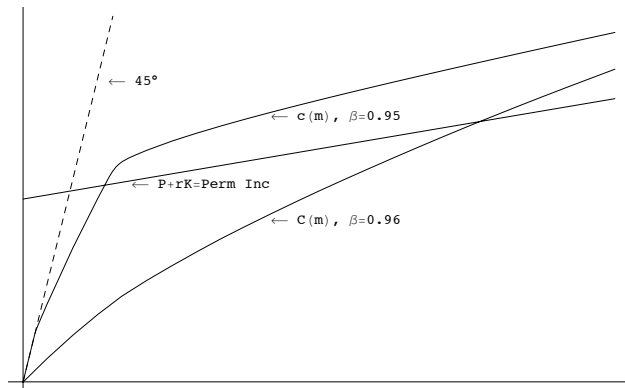


Figure: Salt and Freshwater Models

## A Tidewater Model

- ▶ Take saltwater model and allow  $F(K, L)$
- ▶ Take freshwater model and allow  $\xi_{i,t}$   
Aiyagari [1994], Krusell and Smith [1998]
- ▶ Conclusion: Looks just like freshwater model
  - ▶ Eqbm  $K$  rises maybe 1 percent
  - ▶ MPC remains small, close to value in RCK model
  - ▶ Dynamics, impulse responses indistinguishable

# Why?

Instead of 1 rep agent at SS K/Y ratio of 3.5

- ▶ Group of agents distributed around a K/Y of 3.0-4.0
- ▶ But behavior of these consumers is very similar to the RA consumer
- ▶ Looks nothing like micro data
  - ▶ Bottom 50 percent of HH's own 5 percent of wealth
  - ▶ Lots of evidence of high MPC's among them

## Solution: 'Serious' Heterogeneity

- ▶ Uninsurable shocks aren't enough
- ▶ Need some people with low 'target' wealth
- ▶ Alternatives:
  - ▶ Patient vs impatient
  - ▶ Young vs old
  - ▶ Fast-growing vs slow-growing occupations
  - ▶ Low vs high rates of return on saving
- ▶ Long run  $K^*$  will depend on 'patient'
- ▶ Short run  $C$  will depend on wealth distribution

## An Example: Krusell and Smith [1998]

- ▶ Proportion  $\lambda = 0.66$  are impatient,  $\beta = 0.90$
- ▶ Proportion  $(1 - \lambda) = 0.34$  are patient,  $\beta = 0.96$

Model	$K/W$	$K/W$ By Percentile		Agg MPC
		Bottom 66	Top 34	
Fresh	3.929	-	-	0.043
Tide	3.963	3.48	4.95	0.045
Tide+Hetero	3.910	0.39	11.06	0.187

Source: Carroll [2000a]

# Implications

- ▶ Fiscal policy
  - ▶  $c'$  much higher for low income HH's
  - ▶ Stabilizing  $C$  depends on stabilizing  $m$  at bottom
- ▶ Monetary policy
  - ▶ Mainly works through effects on the 'patient'
    - ▶ The impatient finance most  $c$  through  $y$
  - ▶ Caveat: This ignores durables

# Implications (cont.)

- ▶ Uncertainty Matters
  - ▶ Plausible Movement in Uncertainty Can Move  $C$
  - ▶ Worth trying to measure:
    - ▶ Consumer sentiment
    - ▶ Composition of spending
    - ▶ Read the newspaper!

## Reservations: Excess Smoothness

- ▶  $C$  is Still Too Predictable
  - ▶ Ludvigson and Michaelides [2001]
- ▶ Explanations:
  - ▶ Habit formation (Fuhrer [2000])
  - ▶ 'Sticky expectations' (Carroll [2003])

## Sticky Expectations

- ▶  $\text{var}(\Delta \log \psi) \approx 100\text{var}(\Delta \log \Psi)$

Suppose people only notice macro news with some probability  $\gamma$   
Then

$$\Delta \log C_{t+1} \approx (1 - \gamma)\Delta \log C_t + \epsilon_{t+1}$$

which can explain excess smoothness

## Reservations: Saving and Growth

- ▶ All these models imply  $G \uparrow \Rightarrow S \downarrow$ 
  - ▶ If you're going to be rich, why save now?
- ▶ Data say  $G \uparrow \Rightarrow S \uparrow$ 
  - ▶ Japan, Korea, HPAE's
  - ▶ OECD after pty slowdown
- ▶ Habits? (Carroll et al. [2000])

## Reservations: Bill Gates

- ▶ About 1/4 of K owned by richest 1 pct
- ▶ No standard model can match this
- ▶ Two modifications seem necessary:
  - ▶ Entrepreneurship (e.g. Quadrini [1999])
    - ▶ Bill Gates isn't rich because he's patient
  - ▶ 'Capitalist spirit' utility
    - ▶ It's fun to be rich (Carroll [2000b])

# Conclusions

- ▶ Micro
  - ▶ Tidewater model with serious heterogeneity
  - ▶ Behavior depends on wealth
- ▶ Macro Short Run
  - ▶ Excess Smoothness: Tidewater Goes Partway
  - ▶ Need Something Else
    - ▶ 'Sticky Expectations'
    - ▶ Habits
- ▶ Macro Medium Run
  - ▶ Saving and Growth
  - ▶ Capitalist Spirit

- S. Rao Aiyagari. Uninsured idiosyncratic risk and aggregate saving. Quarterly Journal of Economics, 109:659–684, 1994.
- Truman Bewley. The permanent income hypothesis: A theoretical formulation. Journal of Economic Theory, 16:252–292, 1977.
- Christopher D. Carroll. A theory of the consumption function, with and without liquidity constraints. Journal of Economic Perspectives, 15(3):23–46, Summer 2001a.  
<http://econ.jhu.edu/people/ccarroll/ATheoryv3JEP.pdf> (as published)  
<http://econ.jhu.edu/people/ccarroll/ATheoryv3NBER.pdf> (more rigorous),  
<http://econ.jhu.edu/people/ccarroll/ATheoryMath.zip> (software archive).
- Christopher D. Carroll. A theory of the consumption function, with and without liquidity constraints (expanded version). NBER Working Paper Number W8387, 2001b.  
JEP Version:  
<http://econ.jhu.edu/people/ccarroll/ATheoryv3JEP.pdf>

NBER Working Paper:

<http://econ.jhu.edu/people/ccarroll/ATheoryv3NBER.pdf>

Programs to generate all theoretical results:

<http://econ.jhu.edu/people/ccarroll/ATheoryMath.zip>.

Christopher D. Carroll. The buffer-stock theory of saving: Some macroeconomic evidence. Brookings Papers on Economic Activity, 1992(2):61–156, 1992. Available at

<http://econ.jhu.edu/people/ccarroll/BufferStockBPEA.pdf>.

Christopher D. Carroll. Theoretical Foundations of Buffer Stock Saving. NBER Working Paper No. 10867 (Status: Revise and Resubmit, Review of Economic Studies), November 2004. Available at

<http://econ.jhu.edu/people/ccarroll/BufferStockProofsNew.pdf>.

<http://econ.jhu.edu/people/ccarroll/BufferStockProofsNew.pdf>.

Christopher D. Carroll. Macroeconomic Expectations of Households and Professional Forecasters. Quarterly Journal of Economics, 118(1): 269–298, 2003. Available at

<http://econ.jhu.edu/people/ccarroll/epidemiologyQJE.pdf>.

Christopher D. Carroll. Requiem for the representative consumer? aggregate implications of microeconomic consumption behavior. American Economic Review, Papers and Proceedings, 90(2):110–115, May 2000a. Available at

<http://econ.jhu.edu/people/ccarroll/RequiemFull.pdf>.

- Christopher D. Carroll. Why Do the Rich Save So Much? In Joel B. Slemrod, editor, Does Atlas Shrug? The Economic Consequences of Taxing the Rich. Harvard University Press, 2000b. Available at <http://econ.jhu.edu/people/ccarroll/Why.pdf>.
- Christopher D. Carroll, Jody R. Overland, and David N. Weil. Saving and Growth with Habit Formation. American Economic Review, 90(3): 341–355, June 2000. URL <http://econ.jhu.edu/people/ccarroll/AERHabits.pdf>. Available at <http://econ.jhu.edu/people/ccarroll/AERHabits.pdf>.
- Angus S. Deaton. Saving and liquidity constraints. Econometrica, 59: 1221–1248, 1991.
- Milton A. Friedman. A Theory of the Consumption Function. Princeton University Press, 1957.
- Jeffrey C. Fuhrer. An optimizing model for monetary policy: Can habit formation help? American Economic Review, 90(3), June 2000.
- Per Krusell and Anthony A. Smith. Income and wealth heterogeneity in the macroeconomy. Journal of Political Economy, 106(5):867–896, 1998.
- Sydney Ludvigson and Alexander Michaelides. Does buffer stock saving explain the smoothness and excess sensitivity of consumption? American Economic Review, 91(3):631–647, June 2001.

Vincenzo Quadrini. The importance of entrepreneurship for wealth concentration and mobility. The Review of Income and Wealth, 45: 1–20, 1999.