Macroeconomics II, Lecture XII:
The Buffer-Stock Savings Model

Erik Öberg

Introduction

- Last lecture: theoretical implications of uninsurable income risk for consumption-savings dynamics

  1. With incomplete markets, ex-ante homogeneous households will be **ex-post heterogeneous** in terms of $\{C, A, Y\}$ $\Rightarrow$ no aggregation into representative agent

  2. With incomplete markets, consumption dynamics influenced by a **precautionary savings** motive

- Today: using incomplete-markets consumption-savings theory for quantitative empirical analysis

  - Research program pioneered by Deaton, Zeldes and Carroll

  - Builds on foundational work by Friedman, Modigliani, Hall and others

Agenda

1. Formulating and solving the canonical buffer-stock savings model
   - Recursive formulation
   - Solution algorithm
   - Calibration

2. Consumption-savings dynamics in the buffer-stock savings model
   - Consumption-savings dynamics without income risk
   - Consumption-savings dynamics with income risk

3. 2 famous applications
   1. Gourinchas-Parker (Ecmtra 2002): Consumption over the Life Cycle
   2. Kaplan-Violante (Ecmtra 2014): A Model of the Consumption Response to Fiscal Stimulus Payments

The canonical buffer-stock savings model

- Buffer-stock savings model = income-fluctuations problem with persistent shocks
  - Key papers: Zeldes (JPE 1989; QJE 1989), Deaton (Ecmta 1991, Book 1992), Carroll (QJE 1997)

- Household problem:

$$
\begin{aligned}
\max_{C_t, A_{t+1}} \quad & E_0 \sum_{t=0}^{\infty} \beta^t \frac{C_t^{1-\sigma}}{1-\sigma} \\
\text{s.t.} \quad & C_t + A_{t+1} = Y_t + RA_t \\
& Y_t = P_t e^{\epsilon_t} \\
& P_t = P_{t-1} G e^{\nu_t} \\
& A_{t+1} \geq -\underline{A} \\
& C_t \geq 0
\end{aligned}
$$

- Terminology:
  - P_t — permanent income
  - ν_t — permanent income shocks
  - ϵ_t — transitory income shocks

- We assume that ϵ_t, ν_t are known at the time of choosing C_t, A_{t+1}

Comments

- G is a constant for simplicity
  - ▶ It can be any deterministic function
  - ▶ In many applications, it is a function of age, education, ability etc.

- Why a permanent-transitory formulation of the income process?
  - ▶ In the data, we see that some changes to residualized income are very persistent, whereas others are very short-lived
  - ▶ Permanent-transitory formulation provides a parsimonious parameterization of household income process that captures these features
  - ▶ For some applications, estimating the persistence of income shocks can be important
    - ★ E.g., business-cycle applications (typically quarterly models) with unemployment shocks

- CRRA utility: reasonable baseline + big tractability gains
  - ▶ allows us to normalize the problem w.r.t. to permanent income

Recursive formulation

- The model cannot be solved analytically

- To solve the problem, and to investigate the properties of the solution, we need to recast the problem on its recursive form

- Introduce cash on hand $M_t = Y_t + RA_t$

- Recursive formulation

$$
\begin{aligned}
V(\quad) &= \max_{C,A'} U(C) + \beta EV(\quad) \\
\text{s.t.} \quad & A' = M - C \\
& M' = P'e^{\epsilon'} + RA' \\
& P' = GPe^{\nu'} \\
& A' \geq -\underline{A} \\
& C \geq 0
\end{aligned}
$$

- Which are the state variables?
  - ▶ What information, known at time t, is useful for the household in choosing C, A' and compute $U(C) + \beta EV'()$?

Recursive formulation

- The model cannot be solved analytically

- To solve the problem, and to investigate the properties of the solution, we need to recast the problem on its recursive form

- Introduce cash on hand $M_t = Y_t + RA_t$

- Recursive formulation

$$
\begin{aligned}
V(M, P) &= \max_{C, A'} U(C) + \beta EV(M', P') \\
\text{s.t.} \quad & A' = M - C \\
& M' = P'e^{\epsilon'} + RA' \\
& P' = GPe^{\nu'} \\
& A' \geq -\underline{A} \\
& C \geq 0
\end{aligned}
$$

- Which are the state variables?
  - What information, known at time t, is useful for the household in choosing C, A' and compute $U(C) + \beta EV'()$?

Normalization w.r.t. permanent income

- It appears that the state variables are cash on hand M and permanent income P

- With $U(C) = \frac{C^{1-\sigma}}{1-\sigma}$ being CRRA, permanent income is actually not a state variable

- Define
  - $m = \frac{M}{P}$
  - $c = \frac{C}{P}$
  - $a' = \frac{A'}{P}$
  - $\underline{a} = \frac{\underline{A}}{P}$
  - $v(M, P) = \frac{V(M,P)}{P^{1-\sigma}}$

Normalization w.r.t. permanent income II

- Household problem

$$
\begin{aligned}
V(M, P) &= \max_{C, A'} \frac{C^{1-\sigma}}{1-\sigma} + \beta E V(M', P') \\
\text{s.t.} \quad A' &= M - C \\
M' &= P' e^{\epsilon'} + R A' \\
P' &= G P e^{\nu'} \\
A' &\geq -\underline{A} \\
C &\geq 0
\end{aligned}
$$

- Using our definitions

$$
\begin{aligned}
P^{1-\sigma} v(M, P) &= \max_{c, a'} \frac{(cP)^{1-\sigma}}{1-\sigma} + \beta E P'^{1-\sigma} v(M', P') \\
\text{s.t.} \quad a'P &= mP - cP \\
m'P' &= P' e^{\epsilon'} + R a' P \\
P' &= G P e^{\nu'} \\
a'P &\geq -\underline{a}P \\
cP' &\geq 0
\end{aligned}
$$

Normalization w.r.t. permanent income III

- Dividing through

$$v(M, P) = \max_{c, a'} \frac{c^{1-\sigma}}{1-\sigma} + \beta E \left(\frac{P'}{P} \right)^{1-\sigma} v(M', P')$$

$$\text{s.t.} \quad a' = m - c$$

$$m' = e^{\epsilon'} + Ra' \frac{P}{P'}$$

$$\frac{P'}{P} = Ge^{\nu'}$$

$$a' \geq -\underline{a}$$

$$c \geq 0$$

- Substituting the law-of-motion for permanent income:

$$v(M, P) = \max_{c, a'} \frac{c^{1-\sigma}}{1-\sigma} + \beta E \left(Ge^{\nu'} \right)^{1-\sigma} v(M', P')$$

$$\text{s.t.} \quad a' = m - c$$

$$m' = e^{\epsilon'} + \frac{Ra'}{Ge^{\nu'}}$$

$$a' \geq -\underline{a}$$

$$c \geq 0$$

Normalized recursive program

- Normalized household problem:

$$
\begin{aligned}
v(M, P) \quad &= \quad \max_{c, a'} \frac{c^{1-\sigma}}{1-\sigma} + \beta E_t \left(G e^{\nu'} \right)^{1-\sigma} v(M', P') \\
\text{s.t.} \quad & a' = m - c \\
& m' = e^{\epsilon'} + \frac{R a'}{G e^{\nu'}} \\
& a' \geq -\underline{a} \\
& c \geq 0
\end{aligned}
$$

- Which are the state variables?

Normalized recursive program

- Normalized household problem:

$$v(m) \quad = \quad \max_{c,a'} \frac{c^{1-\sigma}}{1-\sigma} + \beta E_t \left(G e^{\nu'} \right)^{1-\sigma} v(m')$$

$$\text{s.t.} \quad a' = m - c$$

$$m' = e^{\epsilon'} + \frac{Ra'}{G e^{\nu'}}$$

$$a' \geq -\underline{a}$$

$$c \geq 0$$

- Which are the state variables?

What did we just learn?

- The sufficient state variable is $m = \frac{M}{P}$

- Economics:
  - Decision functions in normalized problem: $c = c(m), a' = a'(m)$
  - Un-normalized decision functions $C = Pc(m), A' = Pa'(m)$
  - Implication: A permanent-income rich household will consume the same amount of an increase in his normalized cash-on-hand as permanent-income poor household

- Computations:
  - We have reduced a two-dimensional function equation to a one-dimensional functional equation
  - Big computational gain of dimension reduction when solving the problem numerically

- Key assumptions: CRRA utility (or, more generally, a power-function utility) and linear constraints

Properties of solution

- Solution given by a consumption function $c(m)$ and a savings function $a'(m) = m - c(m)$

- As usual, an interior solution $c(m)$ must satisfy the Euler equation

$$c^{-\sigma} = \beta R E \left(\left(G e^{\nu'} c' \right)^{-\sigma} \right)$$

- Else, the credit constraint is binding and $c(m) = m + \underline{a}$

- Given some parametric restrictions, the Bellman equation defines a contraction mapping, and we can solve the equation using value function iteration

Value function iteration

- Construct a discrete grid $\hat{m} = \{\hat{m}_1, \hat{m}_2, ..., \hat{m}_N\}$

- Guess a discrete value function $\hat{v}^0 = \{\hat{v}_1^0, \hat{v}_2^0, ..., \hat{v}_N^0\}$

- For each $\hat{m}_k$, $k = 1, ..., N$, solve the decision problem

$$\max_{c, a'} \quad \frac{c^{1-\sigma}}{1-\sigma} + \beta \sum_i \sum_j \pi(\eta_i)\pi(\epsilon_j) \left(Ge^{\nu_i'}\right)^{1-\sigma} \hat{v}^0 \left(e^{\epsilon_j} + \frac{Ra'}{Ge^{\nu_i}}\right)$$

$$\text{s.t.} \quad a' = \hat{m}_k - c$$

$$a' \geq -\underline{a}$$

$$c \geq 0$$

  using a standard numerical maximization method (e.g. Newton-Raphson)

- If $\hat{m}_k < e^{\epsilon_j} + \frac{Ra'}{Ge^{\nu_i}} < \hat{m}_{k+1}$ for some $k < N \Rightarrow$ interpolate v_k^0, v_{k+1}^0 to compute $\hat{v}^0 \left(e^{\epsilon_j} + \frac{Ra'}{Ge^{\nu_i}}\right)$

- The maximum of the objective function is your new guess $\hat{v}_k^1$

- Repeat until convergence

Parameterization

- Parameters: $\beta, \sigma, G, R, \underline{a}$ and the distribution of ϵ', ν'

- How to select parameter values?

- G and R can be directly observed in the data

- Data at hand: panels of income and consumption
  - Survey data, e.g., PSID (US)
  - Register data, e.g., Swedish income and wealth registers

- The distribution of ϵ', ν' can be estimated using panel data on household income

- Calibrate $\beta, \sigma, \underline{a}$ typically done by method of moments
  - Given preferences, our model defines a mapping from an income process to an allocation of assets and consumption at the household level
  - Populate an economy with, say 1000 households, and simulate the economy using the stochastic shock processes and the decision functions retrieved from solving the household problem
  - Set parameters so implied model moments fit data moments
    - ★ Example moments: mean asset holdings, share with negative assets, consumption-income profiles...

Income process estimation

- Standard practice: parametric assumption + method of moments
- In logs ($\tilde{x} = \log X$), our process is

$$Y_t = P_t e^{\epsilon_t}, \qquad y_t = p_t + \epsilon_t$$
$$P_t = P_{t-1} G e^{\nu_t}, \qquad p_t = p_{t-1} + g + \nu_t$$

which give us

$$\Delta y_t = g + \nu_t + \epsilon_t - \epsilon_{t-1}$$
$$\Delta y_{t-1} = g + \nu_{t-1} + \epsilon_{t-1} - \epsilon_{t-2}$$

which means that

$$Var(\Delta y_t) = Var(\nu_t) + 2Var(\epsilon_t)$$
$$CoV(\Delta y_t, \Delta \tilde{y}_{t-1}) = -Var(\epsilon_t)$$

- Typically, we apply this estimator to income growth residuals in household panel data
- This method can be generalized in several dimensions (and recent admin data has taught us a lot!):
  - ▶ Guvenen-Karahan-Ozkan-Song (Ecmtra 2021): income growth residuals exhibits fat tails and significant skewness (normality is a bad assumption)
  - ▶ Carter Braxton-Herkenhoff-Rothbaum-Schmidt (AER 2025): permanent earnings risk has evolved differently across the skill distribution over time
  - ▶ Harmenberg-Lizarraga (2025): a generalized square root process capture earnings dynamics at the top of the distribution very well

Consumption-savings dynamics in the buffer-stock savings model

- Now we know how to solve and parameterize our model

- Next step: look at how households behave in the model

- Recall:
  - state variable: $m = \frac{M}{P} = \frac{Y + RA}{P}$
  - law of motion: $m' = e^{\epsilon'} + \frac{Ra'(m)}{Ge^{\nu'}}$
  - decisions: $c = c(m)$ and $a' = a'(m) = m - c(m)$
  - unnormalized decisions: $C = c(m)P$ and $A' = a'(m)P$

- Defining features of the model: uninsurable income risk and potentially binding credit constraint

- To understand the implications of these features, we first remind ourselves about consumption-savings dynamics in a frictionless perfect-foresight model

Perfect-foresight model

- Set $\epsilon = \nu = 0$ and $\underline{a} = \underline{a}^{nbl}$, where $\underline{a}^{nbl}$ is the natural borrowing limit

- Perfect-foresight Bellman equation:

$$
\begin{aligned}
v(m) &= \max_{c,a'} \frac{c^{1-\sigma}}{1-\sigma} + \beta G^{1-\sigma} v(m') \\
\text{s.t.} \quad a' &= m - c \\
m' &= 1 + \frac{Ra'}{G} \\
a' &\geq -\underline{a}^{nlb} \\
c &\geq 0
\end{aligned}
$$

Perfect-foresight model

- As we will iterate on the budget constraint, I now reintroduce time subscripts

- As $\underline{a} = \underline{a}^{nbl}$, we will always have an interior solution

- Interior solution satisfies

$$c_t^{-\sigma} = \beta R \left(G c_{t+1} \right)^{-\sigma}$$

- For simplicity, set σ so that $(\beta R)^{-\frac{1}{\sigma}} G = 1 \Rightarrow$

$$c_t = c_{t+1}$$

Perfect-foresight model: solution

- To solve for $c = c(m)$, iterate on the budget constraint and the law-of-motion for m:

$$a_{t+1} = m_t - c_t$$
$$m_{t+1} = 1 + \frac{Ra_{t+1}}{G}$$

which gives us

$$m_{t+1} = 1 + \frac{R}{G}(m_t - c_t)$$

$$\Rightarrow \quad m_t = c_t - \frac{G}{R} + \frac{G}{R}m_{t+1}$$

$$\Rightarrow \quad m_t = c_t - \frac{G}{R} + \frac{G}{R}\left(c_{t+1} - \frac{G}{R} + \frac{G}{R}m_{t+2}\right)$$

...

$$\Rightarrow \quad m_t = \sum_{k=0}^{\infty}\left(\frac{G}{R}\right)^k c_{t+k} - \sum_{k=1}^{\infty}\left(\frac{G}{R}\right)^k + \lim_{T\to\infty}\left(\frac{G}{R}\right)^T m_{t+T}$$

$$\Rightarrow \quad m_t = c_t\frac{1}{1 - \frac{G}{R}} - \frac{G}{R}\frac{1}{1 - \frac{G}{R}}$$

where we have used that $c_{t+k} = c_t$ for all k and the transversality condition
$\lim_{T\to\infty}\left(\frac{G}{R}\right)^T m_{t+T} = 0$

Perfect-foresight model: solution II

- Therefore, we get

$$c_t = \left(1 - \underbrace{\frac{G}{R}}_{\text{eff. disc. rate}} \right) \left(\underbrace{m_t}_{\text{c.o.h.}} + \underbrace{\frac{G}{R}\frac{1}{1 - \frac{G}{R}}}_{\text{NPV future norm. inc.}} \right)$$

- $\Rightarrow$ household behave according to permanent-income hypothesis (PIH)

Perfect-foresight model: MPC out of transitory income shocks

- Consider a marginal change in M, holding P constant:
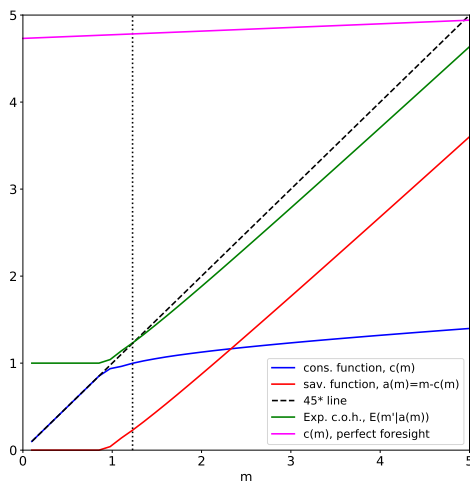 - I.e., consider a transitory shock to current income

$$\frac{\partial C}{\partial M} = \frac{\partial \left(c(m) P \right)}{\partial \left(mP \right)}$$
$$= \frac{P \partial \left(c(m) \right)}{P \partial m}$$
$$= \frac{\partial c(m)}{\partial m}$$

which gives us

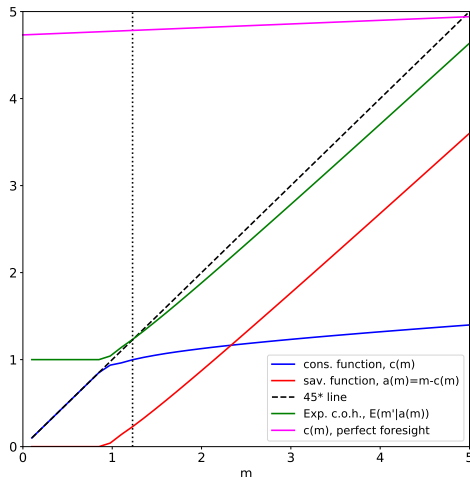$$\frac{\partial C}{\partial M} = \left(1 - \frac{G}{R} \right)$$

- Insights:
  - Marginal propensity to consume (MPC) out of current income is constant
  - For reasonable parameters: MPC out of current income is very small

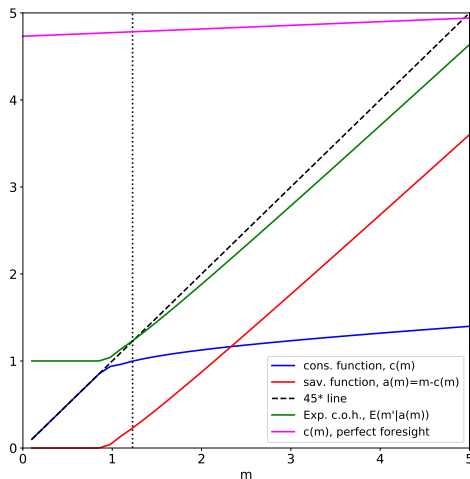# Consumption dynamics in the buffer-stock savings model

- Parameter values: $\beta = 0.95$. $\sigma = 1.5$, $R = 1.04$, $G = 1.03$, $\underline{a} = 0$, $\sigma_\epsilon, \sigma_\nu$ taken from Gourinchas-Parker (Ecmtra, 2002)
- Code available by email

Consumption dynamics in the buffer-stock savings model

- Result 1: with income risk, households consume less than if no income risk
  - with income risk, having assets have insurance value
  - without income risk, household run down current assets quickly due to impatience
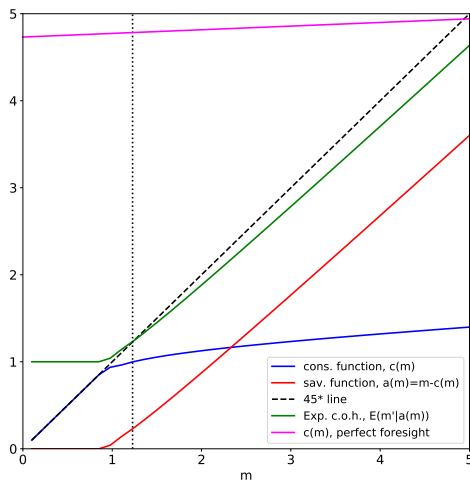
Consumption dynamics in the buffer-stock savings model

- Result 2: with income risk, consumption function is concave
  - ▸ Equivalently: with income risk, MPC out of current income is larger and decreasing
  - ▸ As household approaches constraint, MPC out of current income grows to 1
  - ▸ With a lot of assets, households behaves as if no income risk and $MPC \to \left(1 - \frac{G}{R}\right)$

Consumption dynamics in the buffer-stock savings model

- Result 3: because of concavity, there exists a target buffer stock of assets
  - ▶ To insure themselves, households seek to hold a certain amount of money relative to their permanent income
  - ▶ With a lot of assets, households dissave

Using the buffer-stock savings model

- Now we understand the basic properties of the buffer-stock savings model

- Move on to analyze how to use to model to interpret the data

- Early literature (Zeldes, Deaton, Carroll and others) focused on testing buffer-stock model against PIH model (description does not fit all papers)
  - ▶ Perhaps ex post unsurprisingly, PIH was rejected in several dimensions
  - ▶ In late 80's/early 90's, numerical solutions were still difficult ⇒ calibrated/estimated models were not used much

- We will focus on second-generation literature

- Two influential applications:
  1. Gourinchas-Parker (Ecmtra 2002): Consumption over the Life Cycle
  2. Kaplan-Violante (Ecmtra 2014): A Model of the Consumption Response to Fiscal Stimulus Payments

- I use my notation and will make some simplifications when discussing these papers

Gourinchas-Parker: overview

- Q: how does consumption-savings dynamics evolve over the life-cycle?
  - ▶ Does buffer-stock savings behavior or permament-income hypothesis provide better fit of the data? Does it depend on age?

- Method: Estimate structural life-cycle model with idiosyncratic income risk
  - ▶ Estimate income processes in PSID data
  - ▶ Construct consumption-income age profiles using CEX data
  - ▶ Estimate model to match profiles
  - ▶ Decompose savings behavior over the life cycle using estimated model

Gourinchas-Parker: Model

- Life-cycle version of the model we have described:

$$\max_{C_t, A_{t+1}} \quad E_0 \sum_{t=0}^{T} \beta^t \frac{C_t^{1-\sigma}}{1-\sigma}$$
$$\text{s.t.} \quad C_t + A_{t+1} = Y_t + RA_t$$
$$A_{t+1} \geq 0$$
$$C_t \geq 0$$

- For $0 \leq t \leq N$, households are working and income process is

$$Y_t = P_t e^{\epsilon_t}$$
$$P_t = P_{t-1} G_t e^{\nu_t}$$

note that G_t has t subscript

- For $N+1 \leq t \leq T$, households are retired and Y_t is deterministic

Gourinchas-Parker: Calibration

- $R = 1.034$ taken from average return on safe bond assets

- For other parameters, use micro data
  - PSID (panel with rich info on income but small sample)
  - CEX (rich consumption data and larger sample, but weak panel dimension)

- Income process:
  - Estimate age-income profile G_t by regressing income on age dummies with various controls
  - Estimate permanent-transitory income shocks from income growth residuals

- Consumption-income profiles
  - Estimate consumption-income age profiles in the data
  - Set β and σ so that model mimics (as close as possible) this profile

- GP do this procedure for 16 different educational-occupational groups, but we only focus on the results for the total population here

Gourinchas-Parker: Estimated consumption-income profile
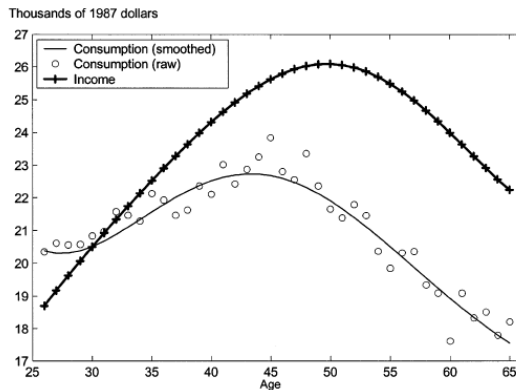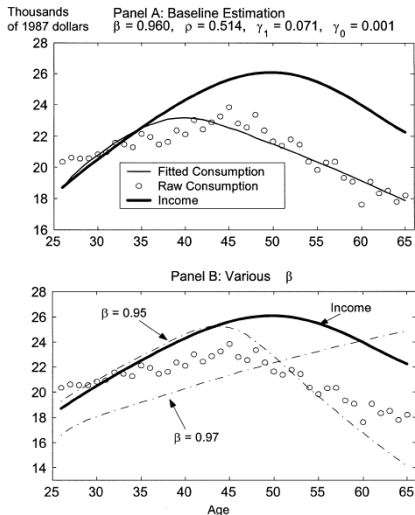

Thousands of 1987 dollars

FIGURE 2.—Household consumption and income over the life cycle.

- Hump-shape in consumption directly rejects that working-age hosueholds have full insurance - why?

Gourinchas-Parker: Matching model to estimated consumption-income profile

Thousands of 1987 dollars

Panel A: Baseline Estimation
$\beta = 0.960$, $\rho = 0.514$, $\gamma_1 = 0.071$, $\gamma_0 = 0.001$

Fitted Consumption
Raw Consumption
Income

Panel B: Various β

$\beta = 0.95$
Income
$\beta = 0.97$

Age

- Matching consumption-income profile pins down β and σ

Gourinchas-Parker: Results

Thousands of 1987 dollars

Panel A: Life Cycle and Buffer Saving

Life Cycle Saving

Buffer Saving

Panel B: Life Cycle and Buffer Wealth

Total Wealth

Buffer Wealth

Life Cycle Wealth

Age

- By turning on and off income risk in the model, GP decompose households savings behavior into its *life-cycle* and *precautionary* components

Gourinchas-Parker: Results

- Young households are buffer-stock savers, old households are similar to PIH savers

- Young households: start with no buffer and and retirement is far away $\Rightarrow$ saving primarily reflect precautionary behavior

- Middle-age housholds: already have a buffer and retirement is near $\Rightarrow$ saving primarily reflect consumption-smoothing w.r.t. retirement

Gourinchas-Parker: Discussion

- Early paper estimating a consumption-savings model to match key moments in micro data

- Large literature has followed

- Two semi-recent (job market) papers:
  - Boar (ReStud 2021): Estimate OLG-version of the model using PSID data
    - Finds that significant part of household buffers is explained by childrens' income risk

  - Druedahl and Martinello (ReStat 2020): Use Swedish register data to estimate consumption response to exogenous bequest shocks
    - Find that households quickly consume these bequests $\Rightarrow$ suggests low β
    - Still, these household typically have sizable wealth holdings.
    - Matching these moments suggests that risk aversion is much higher than previously estimated

Kaplan-Violante (Ecmtra 2014): Motivation

- Natural experiments suggest that the within-a-quarter *aggregate* MPC out of transitory income shocks is quite large
  - In 2001 and 2007-2008, US government provided cash transfers to households as part of stimulus program, with random timing of the transfer
  - Johnson-Parker-Souleles (AER 2006) and Parker-Souleles-Johnson-McClelland (AER 2011) exploits random timing to estimate MPCs of approximately 0.25
  - See also Misra-Surico (AEJmacro, 2014) and Jappelli-Pistaferri (AEJmacro, 2014)

- We know from buffer-stock theory that individual MPC can be large among wealth-poor households

- However, households with little net assets account for small share of total consumption $\Rightarrow$ cannot explain why aggregate MPC is large

- How to make sense of this?

- Aggregate MPC is a key moment for understanding business cycles and the macroeconomic effect of stablization policies

Kaplan-Violante: Overview

- Idea: even though many households have substantial wealth holdings, much of this wealth is *illiquid*
  - Housing wealth, retirement accounts...

- It is primarily the access to liquid wealth that should determine the ability of households to insure against transitory income shocks

- Introduce the concept of "wealthy hand-to-mouth" (wealthy HtM) households: households with a lot of assets but little liquid assets

- Two contributions:
  1. Document that up to 1/4 of US households can be classified as wealthy HtM households
  2. Extend buffer-stock savings model to have both liquid and illiquid savings
     - ★ Calibrate to match documented evidence
     - ★ Assess whether model can explain quasi-experimental evidence on aggregate MPC

Kaplan-Violante: Descriptive evidence on asset holdings

	Median ($2001)	Mean ($2001)	Fraction Positive	Return (%)
Earnings plus benefits (age 22–59)	41,000	52,745	–	–
Net worth	62,442	150,411	0.90	1.7
Net liquid wealth	2,629	31,001	0.77	−1.5
Cash, checking, saving, MM accounts	2,858	12,642	0.92	−2.2
Directly held MF, stocks, bonds, T-Bills	0	19,920	0.29	1.7
Revolving credit card debt	0	1,575	0.41	–
Net illiquid wealth	54,600	119,409	0.93	2.3
Housing net of mortgages	31,000	72,592	0.68	2.0
Retirement accounts	950	34,455	0.53	3.5
Life insurance	0	7,740	0.27	0.1
Certificates of deposit	0	3,807	0.14	0.9
Saving bonds	0	815	0.17	0.1

[a]Authors' calculations based on the 2001 Survey of Consumer Finances (SCF). The return reported in the last column is the real after-tax risk-adjusted return. MM: money market; MF: mutual funds. See Appendix B.1 for additional details.

- Define HtM household as a household with liquid assets $< 1/2$ of monthly earnings
- Define wealthy HtM as a HtM households with net illiquid assets $> x$ dollars ($x = 0, 1000, 3000$)
- Depending on x and the definition of illiquid assets, you find that wealthy HtM households make up $7 - 24\%$ of the population

Kaplan-Violante: (simplified) Model

- A simplified version of KV's life-cycle model

$$\max_{C_t, A_{t+1}} \quad E_0 \sum_{t=0}^{T} \beta^t U(c_t)$$

$$\text{s.t.} \quad C_t + A_{t+1}^{\text{liq}} + A_{t+1}^{\text{ill}} = Y_t + R^{\text{liq}} A_t^{\text{liq}} + R^{\text{ill}} A_t^{\text{ill}} - AC(A_{t+1}^{\text{ill}}, A_t^{\text{ill}})$$

$$AC(A_{t+1}^{\text{ill}}, A_t^{\text{ill}}) = \left\{ \begin{array}{ll} 0 & \text{if } A_{t+1}^{\text{ill}} = RA_t^{\text{ill}} \\ \kappa & \text{if } A_{t+1}^{\text{ill}} \neq RA_t^{\text{ill}} \end{array} \right.$$

$$Y_t = P_t e^{\epsilon_t}$$

$$P_t = P_{t-1} G e^{\nu_t}$$

$$A_{t+1}^{\text{ill}}, C_t \geq 0$$

$$A_{t+1}^{\text{liq}} \geq -\bar{A}$$

- Their full model also include
  - ▶ Utility flow from illiquid assets (think housing)
  - ▶ Different interest rate on borrowing compared to saving
  - ▶ Taxes and transfers
  - ▶ Richer income process

- When taking model to the data, the key difficulty lies in calibrating κ

Kaplan-Violante: Behavior of a wealthy HtM household

(a) Life-cycle asset accumulation (b) Life-cycle income and consumption path
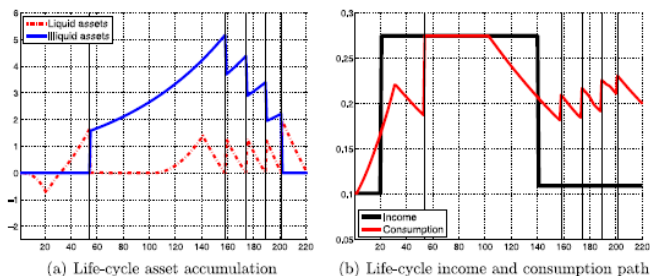
FIGURE 2.—Example of life-cycle of a wealthy hand-to-mouth agent in the model.

- A model period is a quarter, period 0 is age 20.
- Since $R^{ill} > R^{liq}$, saving in illiquid assets maximizes life-time consumption
- Fixed cost κ means that you want to make as few transactions in illiquid assets as possible $\Rightarrow$ illiquid assets provide poor insurance
- If return difference is large enough, household put in all cash-on-hand into illiquid asset account when investing, becoming liquidity constrained for several periods thereafter

Kaplan-Violante: Implications for the aggregate MPC

(a) Rebate coefficient

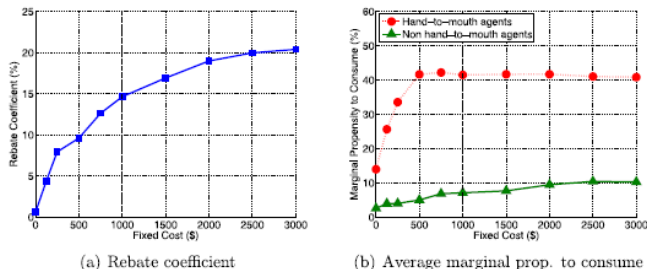(b) Average marginal prop. to consume

FIGURE 5.—Rebate coefficient and marginal propensity to consume, by transaction cost.

- Matching average returns on liquid and illiquid savings, KV finds that even with modest fixed cost, the model can explain high aggregate MPC
- KV also show that this model can match cross-sectional evidence on the distribution of MPC across income and wealth

Kaplan-Violante: Discussion

- In conventional (rep-agent) macro models, MPC is low and fluctuations in income therefore plays little role for fluctuations in aggregate demand
  - ▶ This is counterintuitive and at odds with micro-level evidence
  - ▶ KV provides a theory for why income fluctuations may matter
  - ▶ Important for the development of Heterogeneous-Agent New-Keynesian (HANK) models (more about this later...)

- An alternative theory to explain high aggregate MPC: some households are just not very optimizing and consume directly what they get independently of their financial situation
  - ▶ See, e.g., Campbell-Mankiw (NBER annual, 1989)
  - ▶ Fagereng-Holm-Natvik (AEJmacro 2021): Using Norwegian register data on consumption response to lottery winnings, they show aggregate MPC is smoothly declining with time
  - ▶ Auclert-Rognlie-Straub (JPE 2025): Alternative behavioral theory has a hard time explaining the time pattern in MPC, but KV's two-asset model can

- Recent explorative approaches to understanding heterogeneity in MPC
  - ▶ Aguiar-Bils-Boar (REStud 2025), Colarieti-Mei-Stantcheva (2025), Carlsson-D'Amico-Öberg-Skans-Walentin (2025)

Summing up

- Buffer-stock savings model provides a powerful framework for quantitative and empirical research of consumption-savings dynamics

- Big literature - we've only glanced at some applications today.

- Accompied with big literature on estimating household earnings dynamics

- Research in this area operates at the intersection of theory and micro data, often using both structural and reduced-form approaches

- So far, our investigation has been focused on microeconomics: how households behave taking prices, shocks and policy as given

- Next lecture: how does incomplete-market households interact with the aggregate economy?
  - ▶ We need to develop a general equilibrium model