1 Overview

Income Fluctuation problem:

- - Quadratic-CEQ
    $\rightarrow$ Permanent Income
  - CARA
    $\rightarrow$ precuationary savings
  - CRRA
    $\rightarrow$ steady state inequality
  - borrowing constraints

- General Equilibrium:

  steady state capital and interest rate

2 Certainty Equivalence and the Permanent Income Hypothesis(CEQ-PIH)

2.1 Certainty

- assume $\beta R = 1$

  $T = \infty$ for simplicity

- no uncertainty:

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

$$A_{t+1} = (1+r)(A_t + y_t - c_t)$$

- solution:

$$c_t = \frac{r}{1+r}\left[A_t + y_t + \sum_{j=1}^{\infty} R^{-t} y_{t+j}\right]$$

2.2 Uncertainty: Certainty Equivalence and PIH

- tempting...

$$c_t = \frac{r}{1+r}\left[A_t + y_t + \mathbb{E}_t \sum_{j=1}^{\infty} \left(\frac{1}{1+r}\right)^t y_{t+j}\right]$$

- Permanent Income Hypothesis (PIH)
- Certainty Equivalence:

$$x \to \mathbb{E}(x)$$

- valid iff:
  - preferences: $u(c)$ quadratic and $c \in R$
- main insight:

  given "permanent" income

$$y_t^p \equiv y_t + \mathbb{E}_t \sum_{j=1}^{\infty} \left(\frac{1}{1+r}\right)^t y_{t+j}$$

- c_t function of y_t^p and not independently of y_t
- innovations

$$\Delta c_t \equiv c_t - c_{t-1} = \frac{r}{1+r} \sum_{j=0}^{\infty} \left(\frac{1}{1+r}\right)^j [\mathbb{E}_t y_{t+j} - \mathbb{E}_{t-1} y_{t+j}]$$

  $\to$ revisions in permanent income

- implications:
  - random-walk:

$$\mathbb{E}_{t-1}[\Delta c_t] = 0$$

  - no insurance...

    ...consumption smoothing $\to$ minimize Δc

- marginal propensity to consume from wealth:

$$\frac{r}{1+r}$$

- marginal propensity to consume from innovation to current income depends on persistence of income process

- example: $\{y_t\}$ is $MA(2)$

$$y_t = \varepsilon_t + \beta_1 \varepsilon_{t-1} = \beta(L)\varepsilon_t$$

$$\begin{aligned}
\Delta c_t &= \frac{r}{1+r}\sum_{j=1}^{\infty} R^{-j}\left[\mathbb{E}_t y_{t+j} - \mathbb{E}_{t-1} y_{t+j}\right] \\
&= \frac{r}{1+r}\left\{y_t - \mathbb{E}_{t-1} y_t + R^{-1}\left(\mathbb{E}_t y_{t+1} - \mathbb{E}_{t-1} y_{t+1}\right)\right\} \\
&= \frac{r}{1+r}\varepsilon_t + \frac{r}{1+r}R^{-1}\beta_1\varepsilon_t \\
&= \frac{r}{1+r}\left[1 + R^{-1}\beta_1\right]\varepsilon_t
\end{aligned}$$

where $y_t = \varepsilon_t + \beta_1\varepsilon_{t-1}$, $\mathbb{E}_{t-1} y_t = \beta_1\varepsilon_{t-1}$ and $\mathbb{E}_{t-1} y_{t+j} = 0$ for $j \geq 1$ and $\mathbb{E}_t y_{t+1} = \beta\varepsilon_t$

- ARMA

$$\alpha(L)\, y_t = \beta(L)\,\varepsilon_t$$

$$\rightarrow \Delta c_t = \frac{r}{1+r}\frac{\beta\left(R^{-1}\right)}{\alpha\left(R^{-1}\right)}\varepsilon_t$$

- persistence $\rightarrow \frac{\partial}{\partial \varepsilon_t} c_t > \frac{r}{1+r}$

- with a unit root in y_t

  $\rightarrow$ mg propensity to consume may be greater than 1

3 Estimation and Tests

3.1 CEQ-PIH

- "random walk" (martingale):

$$\begin{aligned}
\Delta c_t &= u_t \\
\mathbb{E}_{t-1} u_t &= 0
\end{aligned}$$

- u_t perfectly correlated with news arriving at t about the expected present value of future income:

$$\Delta c_t = u_t = \frac{r}{1+r} \sum_{j=0}^{\infty} \frac{1}{(1+r)^j} \left[\mathbb{E}_t y_{t+j} - \mathbb{E}_{t-1} y_{t+j} \right]$$

- Two main tests: (generally on aggregate data)
  - random walk → unpredictability of consumption
    violations = 'excess sensitivity' to predictable current income
  - propensity to consume
    too small given income perisistence = "excess smoothness"

- both tests rely on persistence of income → controversial

- aggregation issues:
  - across goods
  - agents: Euler equation typically non-linear
    Attanasio and Weber → leads to rejection on aggregate data
  - time aggregation:
    data averaged over continuous time
    → introduces serial correlation

3.2 Euler Equations

- Hall: revolutionary idea:

  forget consumption function

  find property it satisfies

  → Euler equation!

$$u'(c_t) = \beta (1+r) \mathbb{E}_t \left[u'(c_{t+1}) \right]$$

- Attanasio et al

4 Precautionary Savings

- idea: break CEQ

4.1 Two Periods

- two period savings problem:

$$\max u(c_0) + \beta \mathbb{E} U(\tilde{c}_1)$$

$$\begin{aligned} a_1 + c_0 &= Ra_0 + y_0 = x \\ \tilde{c}_1 &= Ra_1 + \tilde{y}_1 \end{aligned}$$

- subsituting:

$$\max_{a_1} \{u(x_0 - a_1) + \beta \mathbb{E} U(Ra_1 + \tilde{y}_1)\}$$

f.o.c. (Euler equation)

$$u'(x_0 - a_1) = \beta R\, \mathbb{E} U'(Ra_1 + \tilde{y}_1)$$

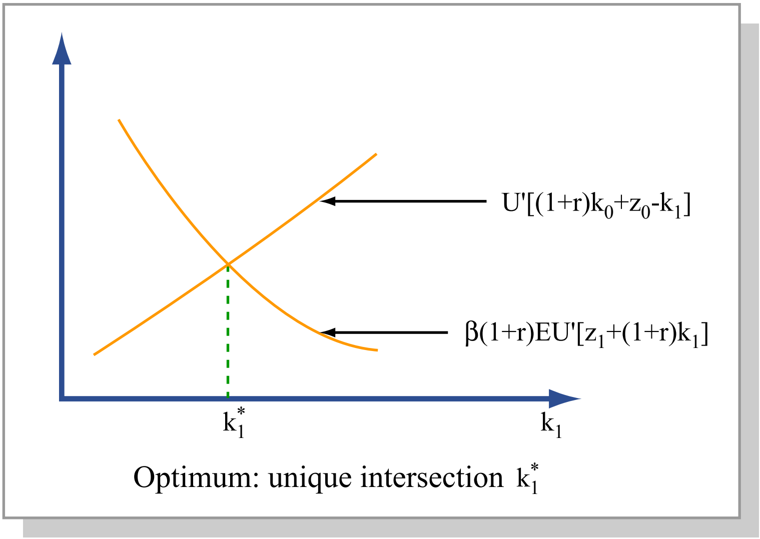
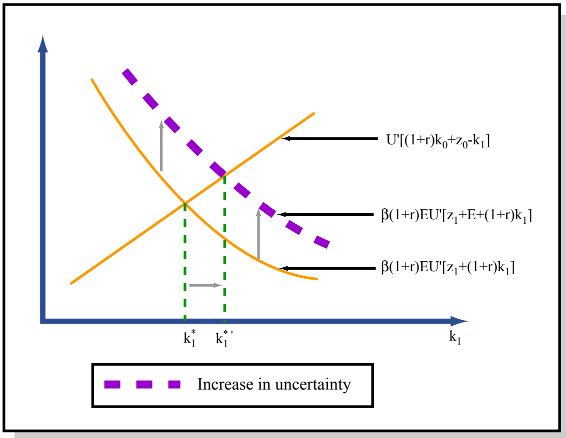


Figure 1: optimum: unique intersection k_1^*

- mean preserving spread: second order stochastic dominance

  replace $\tilde{y}_1$ with $\tilde{y}_1' = \tilde{y}_1 + \tilde{\varepsilon}$ with $\mathbb{E}(\tilde{\varepsilon} \mid y) = 0$



Comparative Static with $u''' > 0$: Mean Preserving Spread

- three possibilities:
  - $U'(\cdot)$ linear $\Rightarrow a_1^*$ constant
  - $U'(\cdot)$ convex: RHS rises $\Rightarrow a_1^*$ increases
  - $U'(\cdot)$ concave: RHS falls $\Rightarrow a_1^*$ decreases
- introspection: a_1^* increases $\Rightarrow U'(\cdot)$ is convex $U''' > 0$
- CRRA: $U'(c) = c^{-\sigma}$ for $\sigma > 0$ is convex
- somewhat unavoidable:

  $U'(c) > 0$ and $c \geq 0$

  $\Rightarrow U'(c)$ strictly convex near 0 and ∞

4.2 Longer Horizon

- i.i.d. income shocks

  $T = \infty$

- Bellman equation

$$V(x) = \max \{u(x - a') + \beta \mathbb{E} V(Ra' + \tilde{y})\}$$

- FOC from Bellman

$$u'(c) = \beta R \, \mathbb{E} V'(Ra + \tilde{y})$$

- again: V' convex $\rightarrow$ precautionary savings
- but V''' endogneous!
- result: $u''' > 0$ then $v''' > 0$ (Sibley, 1975)

4.3 CARA

- CARA preferences

$$u(c) = -\exp(-\gamma c)$$

$$V(x) = \max_a \{u(x - a') + \beta \mathbb{E} V(Ra' + \tilde{y})\}$$

- no borrowing constraints (except No-Ponzi)

  no non-negativity for consumption

- guess and verify:

$$V(x) = Au(\lambda x)$$

  where $\lambda \equiv \frac{r}{1+r}$

- note with CARA

$$u(a + b) = -u(a) u(b)$$

- verifying

$$\begin{aligned}
V(x) &= \max \{u(x - a') + \beta A \mathbb{E} u(\lambda(Ra' + \tilde{y}))\} \\
V(x) &= -u\left(\frac{r}{1+r}x\right) \max \left\{u\left(-\left(a' - \frac{1}{R}x\right)\right) + \beta A \mathbb{E} u\left(r\left(a' - \frac{1}{R}x\right) + \frac{r}{R}\tilde{y}\right)\right\} \\
V(x) &= -u\left(\frac{r}{R}x\right) \max \left\{u(-\alpha') + \beta A \mathbb{E} u\left(r\alpha' + \frac{r}{R}\tilde{y}\right)\right\}
\end{aligned}$$

where

$$\alpha' = a' - x/R \quad \text{or equivalently} \quad c = \frac{r}{1+r}x - \alpha'$$

confirms guess. Solving for A :

$$A = \max\left\{u(-\alpha') + \beta A \mathbb{E} u\left(r\alpha' + \frac{r}{R}\tilde{y}\right)\right\}$$

$$\begin{aligned} u'(-\alpha') &= r\beta A \mathbb{E} u'\left(r\alpha' + \frac{r}{R}\tilde{y}\right) \\ u(-\alpha') &= r\beta A \mathbb{E} u\left(r\alpha' + \frac{r}{R}\tilde{y}\right) \end{aligned}$$

where we used $u'(c) = -\gamma u(c)$

$$\begin{aligned} A &= u(-\alpha') + \beta A \mathbb{E} u\left(r\alpha' + \frac{r}{R}\tilde{y}\right) \\ &= u(-\alpha') + \frac{u(-\alpha')}{r} = -\frac{1+r}{r} u(-\alpha') \end{aligned}$$

(note $A > 0$)
coming back...

$$\begin{aligned} u(-\alpha') &= r\beta \frac{1+r}{r}\left(-u(-\alpha')\right) \mathbb{E} u\left(r\alpha' + \frac{r}{R}\tilde{y}\right) \\ u(-r\alpha') &= \beta(1+r) \mathbb{E} u\left(\frac{r}{R}\tilde{y}\right) \\ -\alpha' &= \frac{1}{r} u^{-1}\left(\beta(1+r) \mathbb{E} u\left(\frac{r}{R}\tilde{y}\right)\right) \\ &= \frac{1}{r} u^{-1}\left(\beta(1+r)\right) + \frac{1}{r} \mathbb{E} u\left(\frac{r}{R}\tilde{y}\right) \end{aligned}$$

- verifying $c(x) = \lambda x + \alpha$ using Euler...

$$\begin{aligned} u'(c_t) &= \beta R\, \mathbb{E}_t u'(c_{t+1}) \\ 1 &= \beta R\, \mathbb{E}_t u'(c_{t+1} - c_t) \\ 1 &= \beta R\, \mathbb{E}_t u'(c(x_{t+1}) - c(x_t)) \\ 1 &= \beta R\, \mathbb{E}_t u'(\lambda(x_{t+1} - x_t)) \end{aligned}$$

since $x_{t+1} = Ra_{t+1} + y_{t+1}$ and $a_{t+1} = \alpha' + x_t/R$

$$x_{t+1} - x_t = R(\alpha' + x_t/R) + y_{t+1} - x_t = R\alpha' + y_{t+1}$$

$$1 = \beta R\, \mathbb{E}_t u' \left(r\alpha' + \frac{r}{R} y_{t+1} \right)$$

same as before

- Verifying value function (again)

  note that $u'(c) = -\gamma u(c)$

$$u'(c_t) = \beta R\, \mathbb{E}_t u'(c_{t+1}) \iff u(c_t) = \beta R\, \mathbb{E}_t u(c_{t+1})$$

$$\mathbb{E}_t u(c_{t+1}) = (\beta R)^{-t} u(c_t)$$

  Then welfare $\iff$ current consumption:

$$V_t \equiv \sum_{s=0}^{\infty} \beta^t \mathbb{E}_t u(c_{t+s}) = \sum_{s=0}^{\infty} \beta^t (\beta R)^{-t} u(c_t) = \frac{1+r}{r} u(c_t)$$

  Verifying

$$c_t = \lambda x_t \iff V(x) = \frac{1+r}{r} u(\lambda x - \alpha')$$

- consumption function

$$c(x) = \lambda \left[x + \frac{1}{r} y^* \right] - \frac{1}{r} \frac{\log(\beta(1+r))}{\gamma}$$

$$y^* \equiv \frac{1}{\lambda} u^{-1} [\mathbb{E} u(\lambda y)]$$

- suppose $\beta R = 1$

  no CEQ...

  ...but simple deviation: constant y^*

- CARA, the good:
  - tractable
  - useful benchmark $\rightarrow$ helps understand other cases
  - good for aggregation (linearity)

- CARA, the bad:
  - negative consumption
  - unbounded inequality

5 Income Fluctuation Problem

- iid income y_t
- $c_t \geq 0$
- borrowing constraints

5.1 Borrowing Constraints: Natural and Ad Hoc

- natural borrowing constraint

  maximize borrowing given $c_t \geq 0$

  $c_t \geq 0$ + No-Ponzi

$$\Rightarrow a_t \geq -\frac{y_{\min}}{r}$$

- ad hoc borrowing constraint:

$$a_t \geq -\phi$$

$$\phi = \min\{y_{\min}/r, b\}$$

- Bellman

$$V(x) = \max_{a' \geq -\phi} \{u(x - a') + \beta \mathbb{E} V(Ra' + \tilde{y})\}$$

- change of variables

$$\begin{aligned} \hat{a}_t &= a_t + \phi \text{ and } \hat{a}_{t+1} \geq 0 \\ z_t &= R\hat{a}_t + y_t - r\phi \\ z_t &= \hat{a}_t + c_t \end{aligned}$$

- transformed problem

$$v(z) = \max_{\hat{a}' \geq 0} \{u(z - \hat{a}') + \beta \mathbb{E} v(R\hat{a}' + \tilde{y} - r\phi)\}$$

(dropping $\widehat{\ }$ notation)

$$v(z) = \max_{a' \geq 0} \{u(z - a') + \beta \mathbb{E} v(Ra' + \tilde{y} - r\phi)\}$$

5.2 Properties of Solution

$\boldsymbol{\beta} R$= 1

- CARA: $\mathbb{E}\left[a_{t+1}\right] > a_t$ and $\mathbb{E}\left[c_{t+1}\right] > c_t$
- Martingale Convergence Theorem:

  If $x_t \geq 0$ and
  $$x_t \geq \mathbb{E}\left[x_{t+1}\right]$$
  then $x_t \to \tilde{x}$ (note: $\tilde{x} < \infty$ a.e.)
- Euler
  $$u'\left(c_t\right) = \beta R \mathbb{E}\left[u'\left(c_{t+1}\right)\right]$$
  $\Rightarrow u'\left(c_t\right)$ converges

  $\Rightarrow c_t \to c$
- if $c < \infty$ contradiction with budget constraint equality
- $a_t \to \infty$ and $c_t \to \infty$

$\boldsymbol{\beta} R$< 1

- Bellman equation
  $$v\left(z\right) = \max_{a'}\left\{u\left(x - a'\right) + \beta \mathbb{E} v\left(Ra' + \tilde{y} - r\phi\right)\right\}$$
- v is increasing, concave and differentiable
- Preview of Properties
  - monotonicity of $c\left(z\right)$ and $a'\left(z\right)$
  - borrowing constraint is binding iff $z \leq z^*$
  - if
    $$\lim_{c \to 0} \frac{u''\left(c\right)}{u'\left(c\right)} = 0$$
    then assets bounded

– if $u \in HARA$ class $\Rightarrow c(z)$ is concave (Carrol and Kimball)

Figures removed due to copyright restrictions.

See figures Ia and Ib on p. 667 in Aiyagari, S. Rao. "Uninsured Idiosyncratic Risk and Aggregate Savings." *Quarterly Journal of Economics* 109, no. 3 (1994): 659-684.

- borrowing constraints
  - certainty: $[0, z^*]$ large
    approached monotonically
  - uncertainty: $[0, z^*]$ relatively small
    not approached monotonically
- concavity of v

  $\Rightarrow$ concavity of $\Phi(a') = \beta \mathbb{E} v(Ra' + \tilde{y})$

  $\Rightarrow$ standard consumption problem with two normal goods

$$\begin{aligned} v(z) &= \max_{c,a'} \{u(c) + \lneqq (a')\} \\ & \quad c + a' \leq x \\ & \quad a' \geq 0 \end{aligned}$$

$\Rightarrow c(z)$ and $a'(z)$ are increasing in z

- FOC (Euler)

$$u'(x-a') \geq \beta R \mathbb{E} v'(Ra'+\tilde{y})$$

  equality if $a'>0$

- define

$$u'(z^*) = \beta R \, \mathbb{E} v'(\tilde{y})$$

$$\begin{aligned} z \leq z^* \Rightarrow \quad & c = z \\ \Rightarrow \quad & a' = 0 \end{aligned}$$

Assets bounded above

- not a technicality...

  ...remember CARA case

- idea: take $a \to \infty$

  income uncertainty unrelated to a (i.e. absolute risk)

  $\frac{-u''}{u'} \to 0 \Rightarrow$ income uncertainty unimportant

  βR bites $\Rightarrow a' < a$ falls

Proof

exist a z^* such that $z'_{\max} = (1+r)\,a'(z) + y_{\max} \leq z$ for $z \geq z^*$

Euler

$$u'(c(z)) = \beta(1+r)\frac{Eu'(c(z'))}{u'(\bar{c}(z))}u'(\bar{c}(z))$$

where $\bar{c}(z) = c(z'_{\max}(z)) = c(a'(z) + y_{\max} - r\phi)$

$$\text{IF} \;\; \lim_{z\to\infty} \frac{E[u'(c(z'))]}{u'(\bar{c}(z))} = 1 \Rightarrow \text{DONE}$$

$$1 \geq \frac{Eu'(c(z'))}{u'(\bar{c}(z))} \geq \frac{u'(\underline{c}(z))}{u'(\bar{c}(z))} \geq \frac{u'(\bar{c}(z) - (\bar{c}(z) - \underline{c}(z)))}{u'(\bar{c}(z))}$$

since a' is increasing

$$\bar{c}(z) - \underline{c}(z) = c(Ra'(z) + y_{\max} - r\phi) - c(Ra'(z) + y_{\min} - r\phi) < y_{\max} - y_{\min}$$

$$1 \geq \frac{Eu'(c(z'))}{u'(\bar{c}(z))} \geq \frac{u'(\bar{c}(z) - (y_{\max} - y_{\min}))}{u'(\bar{c}(z))}$$

Since $z \to \infty \Rightarrow a'(z), c(z) \to \infty$ then $\bar{c}(z) = c(a'(z) + y_{\max} - r\phi) \to \infty$. Apply Lemma below. ■

Lemma. for $A > 0$

$$\frac{u'(c-A)}{u'(c)} \to 1$$

Proof. $1 \leq$

$$\begin{aligned}
\frac{u'(c-A)}{u'(c)} &= 1 + \int_0^A \frac{u''(c-s)}{u'(c)} ds \\
&= 1 - \int_0^A \frac{u'(c-s)}{u'(c)} \frac{-u''(c-s)}{u'(c-s)} ds \\
&= 1 - \int_0^A \frac{u'(c-s)}{u'(c)} \gamma(c-s)\, ds \\
&\leq 1 - \int_0^A \gamma(c-s)\, ds
\end{aligned}$$

since $\frac{u'(c-s)}{u'(c)} > 1$ for all $t > 0$

$$\int_0^A \gamma(c-s)\, ds \to 0$$

so $\frac{u'(c-A)}{u'(c)} \to 1$. ■

6 Lessons from Simulations

From Deaton's "Saving and Liquidity Constraints" (1991) paper:

- important

  borrowing constraint may bind infrequently

  (wealth endogenous)

- marginal propensity to consume

  higher than in PIH

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See Figure 1 on p. 1228 in Deaton, Angus. “Saving and Liquidity Constraints.” *Econometrica* 59, no. 5 (1991): 1221-1248.

Figure removed due to copyright restrictions.

See Figure 2 on p. 1230 in Deaton, Angus.
"Saving and Liquidity Constraints." *Econometrica* 59, no. 5 (1991): 1221-1248.

Figure removed due to copyright restrictions.

See Figure 4 on p. 1234 in Deaton, Angus.
"Saving and Liquidity Constraints." *Econometrica* 59, no. 5 (1991): 1221-1248.

- consumption
  - smoother temporary shocks
  - harder with permanent shocks

7 Invariant Distributions

- initial distribution $F_0(z_0)$
- laws of motion
$$z' = Ra'(z) + y'$$
generate
$$\begin{aligned} F_0(z_0) &\rightarrow F_1(z_1) \\ F_1(z_1) &\rightarrow F_2(z_2) \\ &\vdots \end{aligned}$$
- steady state: invariant distribution
$$F(z) \rightarrow F(z)$$
- result:
  1. exists
  2. unique
  3. stable
- key: bound on assets and monotonicity
- $A(r) \equiv E(a'(z))$
  - continuous
  - not necessarily monotonically increasing in r
    income vs. substitution; and $w(r)$ effect
    typically: monotonically increasing
  - $A(r) \rightarrow \infty$ as $R \rightarrow \beta^{-1}$

8 General Equilibrium

- GE effects of precuationary savings?
  $\rightarrow$more k, lower r
- how much?

8.1 Huggett: Endowment

- endowment economy
- no government
- zero net supply of assets
- idea: any precuationary saving translates to lower equilibrium interest rate
- computational GE exercise:
  - CRRA preferences
  - borrowing constraints

8.2 Aiygari

- adds capital
- $y_t = wl_t$ and l_t is random; w is economy-wide wage
- N is given by $N = \sum l^i p^i$
- define steady state equilibrium:
  3 equations / 3 unknowns: (K, r, w)

$$\int A(z, r, w)\, dF(z; r, w) - \phi = K$$

$$\begin{aligned} r &= F_k(K, N) - \delta \\ w &= F_N(K, N) \end{aligned}$$

- solve $w(r)$ and substitute:

$$A^{GE}(r) = \int a(z, r, w(r))\, d\mu(z; r, w(r)) = K$$

  intersect with

$$r = F_k(K, N) - \delta$$

- $A^{GE}(r)$

  – continuous

  – not necessarily monotonically increasing in r
    (a) income vs. substitution; (b) $w(r)$ effect
    typically: monotonically increasing

  – $A(r) \to \infty$ as $R \to \beta^{-1}$

Figures removed due to copyright restrictions.

See Figures IIa and IIb on p. 668 in Aiyagari, S. Rao. "Uninsured Idiosyncratic Risk and Aggregate Savings." *Quarterly Journal of Economics* 109, no. 3 (1994): 659-684.

- comparative statics

  – $\frac{\partial}{\partial b} A(0, b) > 0$
    typically: $\frac{\partial}{\partial b} A(r, b) > 0$

– $\uparrow \sigma_y^2 \Rightarrow \uparrow A$

Table removed due to copyright restrictions.

See Table II on p. 678 in Aiyagari, S. Rao. "Uninsured Idiosyncratic Risk and Aggregate Savings." *Quarterly Journal of Economics* 109, no. 3 (1994): 659-684.

- wealth distribution: not as skewed
- transition? monotonic?

9 Inequality

- CEQ-PIH and CARA
  inequality increases linearly
  unbound inequality
- CRRA
  inequality increases initially
  bounded inequality

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See Figure 2 on p. 444 in Deaton, Angus, and Christina Paxson. "Intertemporal Choice and Inequality." *Journal of Political Economy* 102, no. 3 (1994): 437-467.

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See Figure 4 on p. 445 in Deaton, Angus, and Christina Paxson. "Intertemporal Choice and Inequality." *Journal of Political Economy* 102, no. 3 (1994): 437-467.

Figure removed due to copyright restrictions.

See Figure 6 on p. 450 in Deaton, Angus, and Christina Paxson.
"Intertemporal Choice and Inequality."
Journal of Political Economy 102, no. 3 (1994): 437-467.

Figure removed due to copyright restrictions.

See Figure 1d) on p. 769 in Heathcote, Jonathan, Kjetil Storesletten, and Giovanni L. Violante. "Two Views of Inequality Over the Life-Cycle." *Journal of the European Economic Association* 3, nos. 2-3 (2005): 765-775.

Deaton and Paxson

Revisionisist (Heathcoate, Storesletten, Violante)
Guvenen
Storesletten, Telmer and Yaron:

10 Life Cycle: Consumption tracks Income

Carroll and Summers:

11 Other Features and Extensions

- Social Security:

  Hubbard-Skinnner-Zeldes (1995): “Precautionary Savings and Social Security”

  Scholz, Seshadri, and Khitatrakun (2006): “Are Americans Saving "Optimally" for Retirement?”

- Medical Shocks: Palumbo (1999)

Figure removed due to copyright restrictions.

See Figure 1 in Guvenen, Fatih.
"Learning Your Earning: Are Labor Income Shocks Really Very Persistent?"
American Economic Review. (Forthcoming)
http://www.econ.umn.edu/~econdept/learning_your_earning.pdf

Figure 9

Figure removed due to copyright restrictions.

See Figure 1 on p. 613 in Storesletten, Kjetil, Chris Telmer, and Amir Yaron.
"Consumption and Risk Sharing over the Life Cycle."
Journal of Monetary Economics 51, no. 3 (2004): 609-663.

Figure 10

Figure removed due to copyright restrictions.

See Figure 5 on p. 624 in Storesletten, Kjetil, Chris Telmer, and Amir Yaron. "Consumption and Risk Sharing over the Life Cycle." *Journal of Monetary Economics* 51, no. 3 (2004): 609-663.

Figure 11

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Figure 12

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Figure 13

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Figure 14

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Figure 15

- Learning Income Growth: Guvenen (2006)
- Hyperbolic preferences: Harris-Laibson
- Leisure Complementarity
  Aguiar-Hurst (2006): “Consumption vs. Expenditure”
- Attanasio-Weber: Demographics and Taste Shocks