Expectations-Based Reference-Dependent Life-Cycle Consumption

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May 23, 2013

Motivation

- Koszegi and Rabin (2006, 2007, 2009) develop a new utility specification: changes in expectations or "news" about present and future consumption generate instantaneous utility
- The preferences are consistent with micro evidence in many domains:
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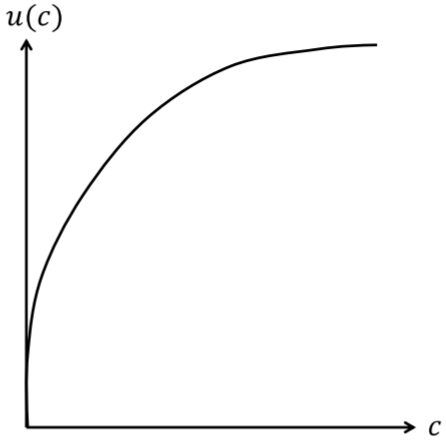
Introduction to prospect theory

The standard model of utility



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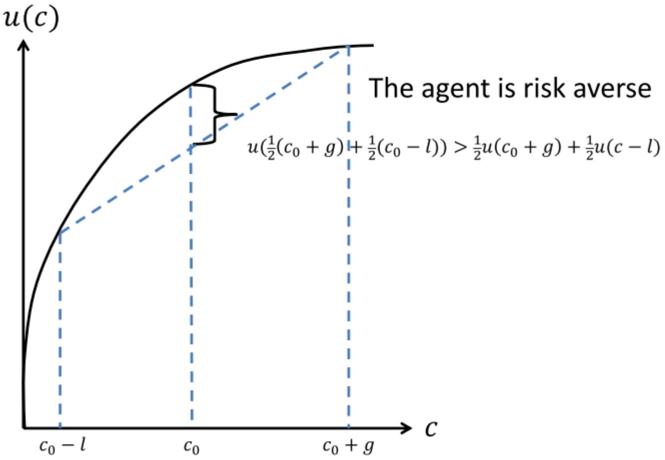

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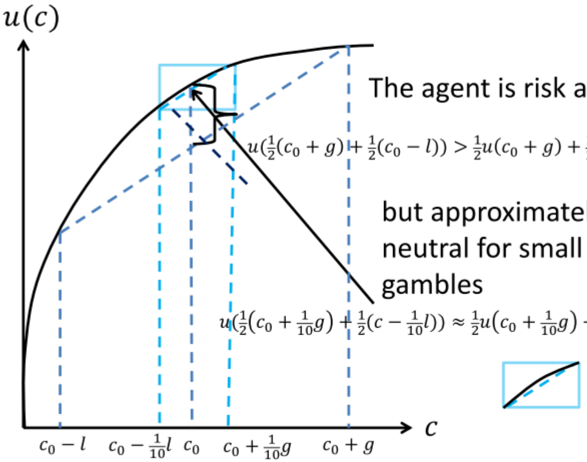


The agent is risk averse

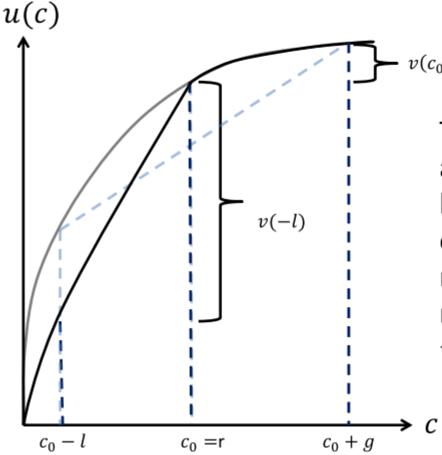
$u(\frac{1}{2}(c_0+g)+\frac{1}{2}(c_0-l)) > \frac{1}{2}u(c_0+g)+\frac{1}{2}u(c-l)$

but approximately risk neutral for small gambles

$u(\frac{1}{2}(c_0+\frac{1}{10}g)+\frac{1}{2}(c-\frac{1}{10}l)) \approx \frac{1}{2}u(c_0+\frac{1}{10}g)+\frac{1}{2}u(c-\frac{1}{10}l)$

Introduction to prospect theory

The prospect-theory model of utility: A descriptive theory for decision-making under risk



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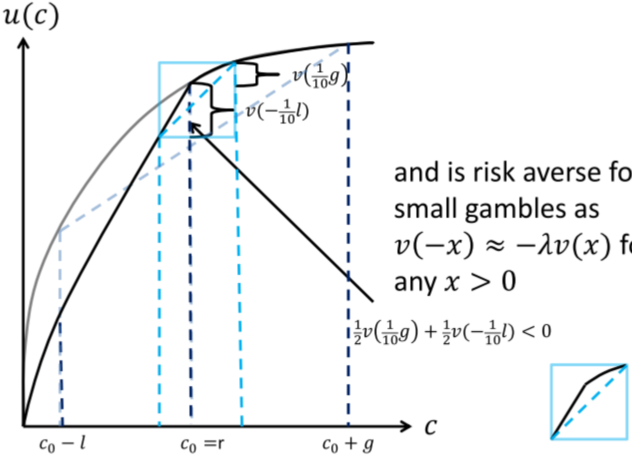

and is risk averse for small gambles as $v(-x) \approx -\lambda v(x)$ for any $x > 0$

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  - The reference point is given by past expectations
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  - News utility is proportional to consumption utility
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News-utility life-cycle predictions

1. Excess smoothness and excess sensitivity in consumption
   - The agent delays painful cuts in consumption to let his reference point decrease
2. A hump-shaped life-time consumption profile results from the net of two effects:
   - Early in life: consumption increases as additional precautionary savings reduce painful future gain-loss fluctuations
   - Late in life: consumption declines due to a time inconsistency: today the agent increases his consumption above expectations, whereas yesterday he considered the increase in expectations
3. A drop in consumption at retirement
   - After retirement, overconsumption is associated with a sure loss in future consumption, eliminating the time inconsistency

* Excess smoothness increases in the agent's horizon

* Consumption is excessively smooth for transitory shocks only in the absence of permanent shocks

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Comparison to the literature

- The excess-smoothness and -sensitivity puzzles:
  - Michaelides (2002), Reis (2006), Chetty and Szeidl (2010): habit formation and adjustment costs in consumption
  - Deaton (1991), Laibson et al (2012): liquidity constraints
- The hump-shaped consumption profile:
  - Gourinchas and Parker (2002), Carroll (2001), Laibson et al (2012): hump-shaped income profile and impatience

* I propose a unified preference-based explanation independent of other environmental assumptions
* The results' intuitions combine several prominent ideas (expectations as endowments, habit formation, precautionary savings, hyperbolic discounting)

- Koszegi and Rabin (2009) anticipate the additional precautionary-savings motive and the uncertainty-based time inconsistency in a two-period, two-outcome model.

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Expectations-based reference-dependent preferences

The agent's "beliefs" about any variable $Z_{t+\tau}$ are defined as $F^{t}_{Z_{t+\tau}}(z) = Pr(Z_{t+\tau} < z | I_t)$ with I_t being period t information

- Instantaneous utility in period t (Koszegi and Rabin (2009))

$$U_t = u(C_t) + n(C_t, F^{t-1}_{C_t}) + \gamma \sum_{\tau=1}^{T-t} \beta^{\tau} \mathbf{n}(F^{t,t-1}_{C_{t+\tau}})$$

- consumption utility $u(C_t)$
- contemporaneous gain-loss utility $n(C_t, F^{t-1}_{C_t})$ depends on the realized consumption C_t and the agent's prior beliefs about C_t, $F^{t-1}_{C_t}$
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Contemporaneous and prospective gain-loss utility

- Prospect-theory inspired gain-loss function

$$\mu(c-r) = \begin{cases} \eta(c-r) \text{ if } c \geq r \\ \eta\lambda(c-r) \text{ otherwise} \end{cases} \quad \text{with } \eta > 0 \text{ and } \lambda > 1$$

- Contemporaneous gain-loss utility in period t

$$n(C_t, F_{C_t}^{t-1}) = \int_{-\infty}^{\infty} \mu(u(C_t) - u(c))dF_{C_t}^{t-1}(c)$$

$$= \eta \int_{-\infty}^{C_t} (u(C_t) - u(c))dF_{C_t}^{t-1}(c) + \eta\lambda \int_{C_t}^{\infty} (u(C_t) - u(c))dF_{C_t}^{t-1}(c)$$

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The model environment

- A partial-equilibrium life-cycle model: the agent lives for T periods and earns
  - stochastic labor income Y_t in periods $t \in \{1, 2, ..., T - Ret - 1\}$, a function of a permanent shock $\tilde{Y}_t^P$ and a transitory shock $\tilde{Y}_t^T$, with realizations $\tilde{y}_t^P$ and $\tilde{y}_t^T$
  - deterministic retirement income in periods $t \in \{T - Ret, ..., T\}$
- Each period, the agent decides on consumption C_t and risk-free savings $X_t - C_t$ and his budget constraint is

$$X_{t+1} = (X_t - C_t)R + Y_{t+1}$$

- I solve for the recursive rational-expectations equilibrium in closed form for exponential utility and by numerical backward induction for power utility

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Excess smoothness and excess sensitivity

Consider a two-period model with exponential utility $u(C) = -\frac{1}{\theta}e^{-\theta C}$ and $X_1 = Y_1 = \tilde{y}_1^P$, $Y_2 = \tilde{y}_1^P + \tilde{Y}_2^P$ with $\tilde{Y}_1^P, \tilde{Y}_2^P \sim F_{\tilde{Y}}$

- The standard agent's FOC

$$u'(C_1^s) = \beta R E_1[u'(C_2^s)]$$

$$\Rightarrow e^{-\theta C_1^s} = \beta R E_1[e^{-\theta((\tilde{y}_1^P - C_1^s)R + \tilde{y}_1^P + \tilde{Y}_2^P)}] = \beta R e^{-\theta((\tilde{y}_1^P - C_1^s)R + \tilde{y}_1^P)} E_1[e^{-\theta \tilde{Y}_2^P}]$$

- results in the consumption function

$$C_1^s = \tilde{y}_1^P - \frac{1}{\theta(1+R)}\Lambda^s = \tilde{y}_1^P - \frac{1}{\theta(1+R)} log(R \underbrace{\beta E_1[e^{-\theta \tilde{Y}_2^P}]}_{=Q})$$

- marginal utility of tomorrow's shock: $Q = \beta E_1[u'(\tilde{Y}_2^P)]$

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Consider a two-period model with exponential utility $u(C) = -\frac{1}{\theta}e^{-\theta C}$ and $X_1 = Y_1 = \tilde{y}_1^P$, $Y_2 = \tilde{y}_1^P + \tilde{Y}_2^P$ with $\tilde{Y}_1^P, \tilde{Y}_2^P \sim F_{\tilde{Y}}$

- The standard agent's FOC

$$u'(C_1^s) = \beta R E_1[u'(C_2^s)]$$

$$\Rightarrow e^{-\theta C_1^s} = \beta R E_1[e^{-\theta((\tilde{y}_1^P - C_1^s)R + \tilde{y}_1^P + \tilde{Y}_2^P)}] = \beta R e^{-\theta((\tilde{y}_1^P - C_1^s)R + \tilde{y}_1^P)} E_1[e^{-\theta \tilde{Y}_2^P}]$$

- results in the consumption function

$$C_1^s = \tilde{y}_1^P - \frac{1}{\theta(1+R)}\Lambda^s = \tilde{y}_1^P - \frac{1}{\theta(1+R)} log(R \underbrace{\beta E_1[e^{-\theta \tilde{Y}_2^P}]}_{=Q})$$

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$$C_1 = \tilde{y}_1^P - \frac{1}{\theta(1+R)}\Lambda_1$$

- and Λ_1 results from the FOC

$$\Rightarrow e^{-\theta C_1}(1 + \underbrace{\eta F_{\tilde{Y}}(\tilde{y}_1^P) + \eta\lambda(1 - F_{\tilde{Y}}(\tilde{y}_1^P))}_{\text{contemporaneous gain-loss}})$$

$$\underbrace{= Re^{-\theta((\tilde{y}_1^P - C_1)R + \tilde{y}_1^P)}(Q + \Omega}_{\text{marginal value of savings}} + \underbrace{\gamma Q(\eta F_{\tilde{Y}}(\tilde{y}_1^P) + \eta\lambda(1 - F_{\tilde{Y}}(\tilde{y}_1^P)))}_{\text{prospective gain-loss}}$$

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Excess smoothness and excess sensitivity

- Tomorrow's marginal gain-loss utility is constant, as tomorrow's reference point adjusts to today's consumption plan, whereas today's marginal gain-loss utility varies, as today's reference point is given by yesterday's expectations
- The agent wants to smooth gain-loss utility: if marginal gain-loss utility is relatively high (low) today but constant tomorrow, the agent consumes more (less) and thus delays part of the adverse (good) income shock
- $\frac{\partial \Lambda_1}{\partial \tilde{y}_1^P} > 0$ and consumption growth is $\Delta C_2^s = \tilde{y}_2^P + \frac{1}{\theta}\Lambda^s$ and $\Delta C_2 = \tilde{y}_2^P + \frac{1}{\theta}\Lambda_1$

The news-utility agent's consumption is excessively smooth – the marginal propensity to consume is less than one $\frac{\partial C_t}{\partial \tilde{y}_t^P} < 1$, and excessively sensitive – consumption responds with a lag to innovations in income $\frac{\partial \Delta C_{t+1}}{\partial \tilde{y}_t^P} > 0$.

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The additional precautionary-savings motive

- Expected gain-loss fluctuations can be reduced by additional precautionary savings, as the agent will bounce around a less steep part of the utility function
- Recall that the marginal value of savings equals $Q + \Omega$: Q captures the standard precautionary-savings motive

$$Q = \beta E_1[u'(\tilde{Y}_2^P)] > \beta u'(E_1[\tilde{Y}_2^P]) \text{ iff } u''' > 0$$

- and Ω captures expected marginal gain-loss utility

$$\Omega = \beta E_1[\eta(\lambda - 1) \int_{\tilde{Y}_2^P}^{\infty} \underbrace{(u'(\tilde{Y}_2^P) - u'(y))}_{>0 \text{ iff } u''(\cdot)<0} F_{\tilde{Y}}(y)] > 0 \text{ iff } u'' < 0$$

- The additional precautionary-savings motive is first order $\frac{\partial(\tilde{y}_1^P - C_1)}{\partial \sigma_P}|_{\sigma_P=0} > 0$, whereas the standard one is second order $\frac{\partial(\tilde{y}_1^P - C_1)}{\partial \sigma_P}|_{\sigma_P=0} = 0$
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The hump-shaped consumption profile

- The first-order additional precautionary-savings motive accumulates in the agent's horizon $\Rightarrow$ early in life, news utility is likely to increase consumption growth
- But, there is a beliefs-based time inconsistency: marginal gain-loss utility is always positive

$$\eta F_{\tilde{Y}}(\tilde{y}_1^P) + \eta\lambda(1 - F_{\tilde{Y}}(\tilde{y}_1^P)) \in [\eta, \eta\lambda]$$

as the agent always likes to increase consumption above expectations and over-weights contemporaneous gain-loss utility for $\gamma < 1 \Rightarrow$ late in life, news utility is likely to decrease consumption growth

If $\gamma < 1$ and $\beta R \approx 1$ then for any σ_P in a strictly positive range $\underline{\sigma_P} < \sigma_P < \overline{\sigma_P}$ the news-utility agent's life-time consumption profile is hump shaped.

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Life-cycle consumption during retirement

- Without uncertainty, the agent does not experience actual gain-loss utility in a rational-expectations equilibrium
- Thus, the expected-utility-maximizing consumption path is given by the standard agent's one
- But, since the agent takes his beliefs as given, he is inclined to surprise himself with some extra consumption each period

  $$u'(C_1)(1+\eta) \leq \beta R u'(C_2)(1+\gamma\eta\lambda)$$

  if $\gamma \geq \frac{1}{\lambda}$ the associated future loss of deviating today prevents the agent from doing so, and the deterministic case is observationally equivalent to the standard model
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The drop in consumption at retirement

- Post retirement, a surprise with present consumption would be associated with a sure loss in future consumption, and the agent stays on track
- Pre retirement, the agent overconsumes because he allocates house money, labor income he was not sure whether to receive or not, and thus likes to surprise himself with extra consumption iff $\gamma < 1$

$$u'(C_1)(1 + \eta F_{\tilde{Y}}(\tilde{y}_1^P) + \eta\lambda(1 - F_{\tilde{Y}}(\tilde{y}_1^P)))$$

$$= \beta R u'(C_2)(1 + \gamma(\eta F_{\tilde{Y}}(\tilde{y}_1^P) + \eta\lambda(1 - F_{\tilde{Y}}(\tilde{y}_1^P))))$$

Iff $\gamma < 1$ the news-utility agent's consumption path is characterized by a drop at retirement as pre-retirement consumption growth is negative and smaller than post-retirement consumption growth

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Calibration

- The exponential utility income process is additive with normal permanent and transitory shocks and permanent income P_t: $Y_t = P_{t-1} + \tilde{y}_t^P + \tilde{y}_t^T$
- The power utility income process is multiplicative with log-normal permanent and transitory shocks, the probability p of zero income, deterministic income growth G_t, and permanent income P_t: $Y_t = P_{t-1} G_t \tilde{y}_t^P \tilde{y}_t^T$

Calibration of income processes

exponential		power						
σ_P	σ_T	σ_P	σ_T	p	μ_P	μ_T	r	$\frac{A_0}{P_0}$
5%	7%	0.1	0.1	1%	0	0	2%	0.3/1

Calibration of preference parameters

β	θ	η	λ	γ	T	Ret
0.978	2	1	2	0.75	50	5

Excess smoothness and excess sensitivity

I follow Campbell and Deaton (1989) and run the regression $\Delta log(C_{t+1}) = \alpha + \beta_1 \Delta log(Y_{t+1}) + \beta_2 \Delta log(Y_t)$ and the excess smoothness ratio as defined in Deaton (1986) is $\frac{\sigma(\Delta log(C_{t+1}))}{\sigma_P}$

- I use NIPA consumption and disposable labor income data (Ludvigson and Michaelides (2001))

Excess smoothness and excess sensitivity results

news-utility		standard		habit		data
β_1	β_2	β_1^s	β_2^s	β_1^h	β_2^h	$\hat{\beta}_2$
0.67	0.27	0.93	0.01	0.69	0.38	0.23
86.7	*34.2*	*187*	*1.32*	*141*	*76.3*	*2.95*
0.74		0.95		0.80		0.68

Average results of 1000 regressions with $N = 200$ simulated data points

The quantitative predictions match the empirical evidence in magnitude

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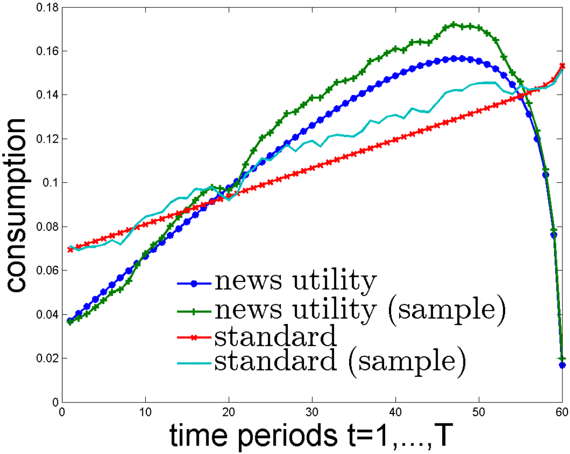
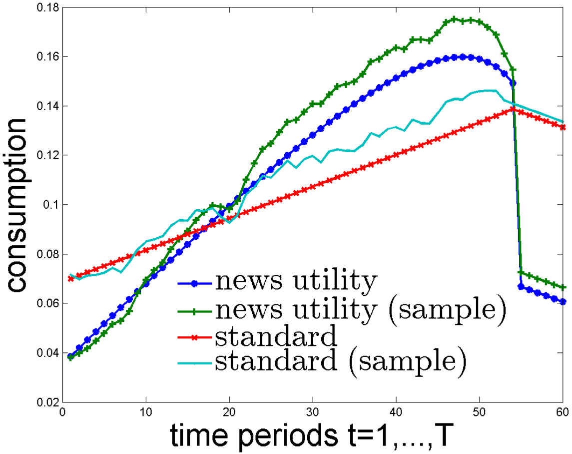
Exponential-utility model: the precautionary savings motive and beliefs-based present bias generate a hump-shaped consumption profile



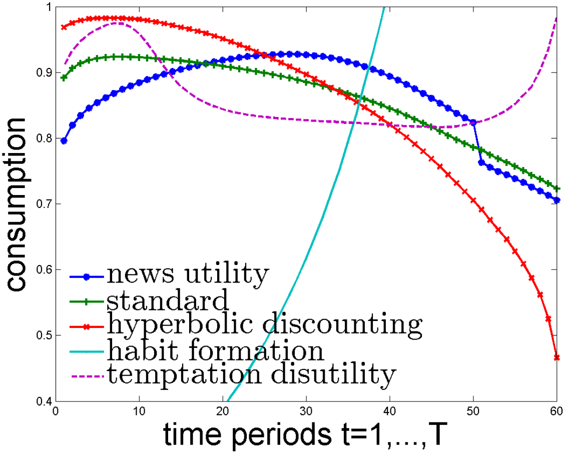
The drop in consumption at retirement

Exponential-utility model: after retirement, the agent allocates consumption optimally, thus consumption drops at retirement



Comparison to other preference specifications

Power-utility model: news-utility, standard, hyperbolic-discounting, habit-formation, and temptation-disutility consumption profiles



Structural estimation

I estimate the model in two stages using the method of simulated moments (Gourinchas and Parker (2002) and Laibson et al (2012))

- I generate pseudo-panel data from the Consumer Expenditure Survey (CEX) for the years 1980 to 2002 by averaging individual observations at each age

First-stage parameter estimation results

$\hat{\mu}_P, \hat{\mu}_T$	$\hat{\sigma}_P$	$\hat{\sigma}_T$	$\hat{p}$	$\hat{G}_t$	$\hat{r}$	$\hat{a}_0$	$\hat{Ret}$	$\hat{T}$
0	0.19	0.15	0.31%	$e^{Y_{t+1}-Y_t}$	3.1%	1%	11	54

Second-stage news utility $\chi^2 = 9.73$

$\hat{\beta}$	$\hat{\theta}$	$\hat{\eta}$	$\hat{\lambda}$	$\hat{\gamma}$
0.97	0.77	0.97	2.33	0.59
0.0002	*0.007*	*0.04*	*0.006*	*0.008*

standard 75.7

$\hat{\beta}$	$\hat{\theta}$
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The estimated preference parameters match existing experimental and non-experimental evidence

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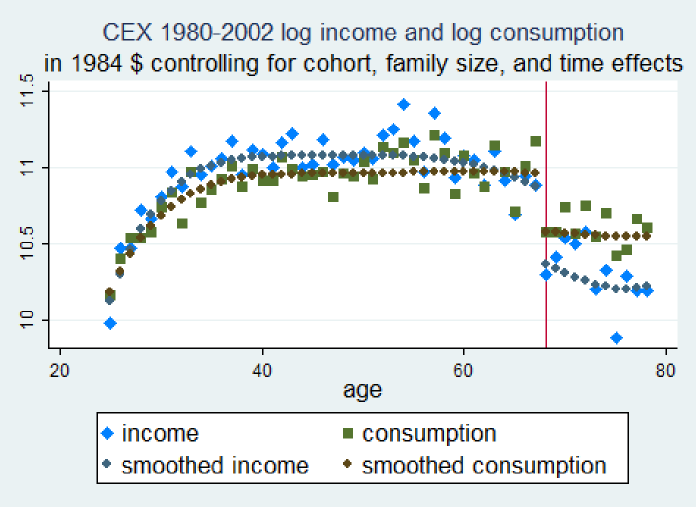
Structural estimation

The empirical consumption and income profiles



Extensions

- Simultaneous illiquid savings and credit-card borrowing: news utility is the only model which generates the excess-consumption puzzles, the hump, and the drop as I assume borrowing up to accumulated illiquid savings
- Endogenous labor supply: in the event of a bad shock, the agent can maintain higher consumption by reducing savings or increasing labor supply ⇒ labor expenditures are "sticky"
  - If the agent's labor supply elasticity is high consumption is more excessively smooth but less sensitive
- Portfolio choice: the agent's portfolio share is potentially zero, increasing in the agent's horizon, and decreasing in the return realization ⇒ portfolio holdings are "sticky"
  - In the event of a bad return realization the agent can delay the realization of losses in future consumption until his expectations have decreased by increasing his portfolio share

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The model environment

- A partial-equilibrium life-cycle model with portfolio choice: the agent lives for T periods and earns
  - stochastic labor income Y_t in periods $t \in \{1, 2, ..., T - Ret - 1\}$
  - deterministic retirement income in periods $t \in \{T - Ret, ..., T\}$
- Each period, the agent decides on consumption C_t, savings $X_t - C_t$, and his risky-asset share $\alpha_t \Rightarrow$ his budget constraint is

$$X_{t+1} = (X_t - C_t)R^p_{t+1} + Y_{t+1}$$

  with the portfolio return R^p_{t+1} determined by the realization of the risky asset's return R_{t+1}: $R^p_{t+1} = (1 - \alpha_t)R^f + \alpha_t R_{t+1}$
- I solve for the recursive rational-expectations equilibrium by numerical backward induction
- In the absence of labor income uncertainty, the model can be solved in closed form for power utility

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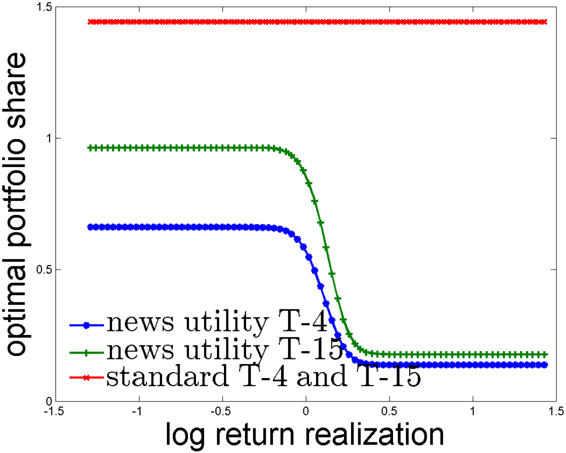
Portfolio Choice

The portfolio share is shifted down, potentially zero, increases in the agent's horizon, and decreases in the return realization



Portfolio Choice

- **The portfolio share is shifted down and potentially zero (stock market non-participation)**
  - The agent dislikes the associated uncertainty in consumption
- **The portfolio share increases in the agent's horizon**
  - The agent prefers the accumulated outcome of independent gambles over the individual gambles
- **The portfolio share decreases in the return realization**
  - In the first-order condition, the agent trades off his long-term risk preferences and prospective gain-loss utility
  - In the event of a bad return realization, the agent increases his portfolio share to not realize all the associated losses in future consumption
  - Stickiness in portfolio choice (Calvet, Campbell, and Sodini (2009) or Brunnermeier and Nagel (2008))

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- **Beliefs-based time inconsistency for risk**
  - The agent behaves more risk averse when he pre-commits his portfolio share
- **Background risk** in the form of stochastic labor income weakens my results
  - Stock market risk does not appear to be as painful on a generally uncertain consumption path
- **Rational inattention, extrapolative expectations, and overconfidence**
  - As fluctuations in beliefs are painful in expectation the agent prefers to look up his portfolio only sporadically
  - If the agent knows the market is going down he prefers to not look up his portfolio (ostrich effect)
  - The agent's behavior is based on an old and too favorable information set

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Conclusion

- Expectations-based reference-dependent preferences provide a unified explanation for three macro consumption facts beyond matching micro evidence
    - Loss aversion, a robust experimental risk preference and a popular explanation for the equity premium puzzle, generates excess sensitivity and excess smoothness in consumption
    - The interplay of risk and time preferences generate a hump-shaped consumption profile and a drop in consumption at retirement
- The model's quantitative predictions match empirical evidence in magnitude and the structural estimation results match existing micro evidence