Heterogeneity in time preference among older households

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Paris Seminar in Economic Demography
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Motivation

- **Heterogeneity in time preference is key in many settings**
  - pension reforms (Samwick 1998, Gustman and Steinmeier, 2005)

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  - capital income taxation (Saez 2002, Golosov et al. 2011, Diamond and Spinnewijn 2011)
  - health care spending (Hall and Jones, 2007)

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  - pension reforms (Samwick 1998, Gustman and Steinmeier, 2005)
  - capital income taxation (Saez 2002, Golosov et al. 2011, Diamond and Spinnewijn 2011)
  - health care spending (Hall and Jones, 2007)
- **The discounted-utility model (Samuelson 1937)**
  - A person maximises an inter-temporal utility function:

$$\max_{c_1, c_2} \quad U(c_1) + \frac{1}{1+\rho} U(c_2)$$

where ρ is the *discount rate*
and $\beta = \frac{1}{1+\rho}$ is the *discount factor*

Measuring discount rates

- **Two broad approaches**
  1. A very large experimental literature
     - Clean, controlled data
     - Small stakes
     - Hard to to separate ‘pure’ discounting from other different phenomenon (e.g. intertemporal arbitrage, uncertainty)

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     - Estimation of a lifecycle model of consumption and saving
     - Usually assumption of homogenous discount rate

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     - Estimation of a lifecycle model of consumption and saving
     - Usually assumption of homogenous discount rate
- **No consensus**
  - Survey from Frederick et al. (2002):
    "*there is tremedous variability in the estimates (the corresponding implicit annual discount rates range from -6% to infinity)*"

Our approach

- **Estimating Euler equations**
  - A well-known equation (the Euler equation) links successive observations on consumption with the discount rate

$$U'(c_t) = \frac{1+r}{1+\rho} U'(c_{t+1}) \tag{1}$$

  - BUT panel data on total household consumption is rare

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  - A well-known equation (the Euler equation) links successive observations on consumption with the discount rate
$$U'(c_t) = \frac{1+r}{1+\rho} U'(c_{t+1}) \tag{1}$$
  - BUT panel data on total household consumption is rare
- **Our approach in this paper**
  - Use good panel data on income and assets to compute consumption
  - Estimate time-varying discount rates
  - Analyse distribution of discount rates by education and numeracy

Outline

1. Related literature
2. Theory and empirical approach
3. Data
4. Calculation of consumption data
5. Results
6. Conclusion

Related literature

1. **Creation of panel data on total consumption**
   - Browning et al. (1985)
   - Skinner (1987), Blundell et al. (2008)
   - Ziliak (1998), Browning & Leth-Peterson (2003)

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   - Ziliak (1998), Browning & Leth-Peterson (2003)
2. **Use of the Euler equation and consumption data to recover preference parameters**
   - Attanasio & Weber (1993, 1995), Attanasio et al. (1999)
   - Carroll (2001)
   - Alan & Browning (2003), Low & Attanasio (2005)

Related literature

3. **Estimation of heterogeneity in discount rates**
    - Large heterogeneity in discount rates
        - Samwick (1998); Gustman and Steinmeier (2005): field data
        - Dohmen et al. (2010): lab experiments

Related literature

3. **Estimation of heterogeneity in discount rates**
    - Large heterogeneity in discount rates
        - Samwick (1998); Gustman and Steinmeier (2005): field data
        - Dohmen et al. (2010): lab experiments
    - Higher educated have lower discount rates?
        - Warner and Pleeter (2001): severance pay as lump-sum or annuity
        - Harrison et al. (2002); Dohmen et al. (2010): lab experiments
        - Lawrance (1991): using food consumption

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A standard lifecycle model

Our estimation is based on a life-cycle model where agents choose consumption each period to maximise their utility

- The decision-making unit (the 'agent') is the benefit unit
- Agents have identical utility functions between two periods
- Agents face identical returns on each type of assets
- Agents have heterogenous and time-varying discount rates
  $\Rightarrow$ discounting behaviour that departs from the standard model are not ruled out

A standard lifecycle model

The problem faced by agents is:

$$\max_{\{X^j_{is}, c_{is}\}_{s=t}^{T}} \quad u_t(c_{it}) + \sum_{\tau=t+1}^{T} \left(\prod_{s=1}^{\tau-t} \frac{1}{1+\rho_{it+s}} \right) E\left[u_\tau(c_{i\tau})\right]$$

$$\begin{aligned} s.t \quad (i) \quad & p_\tau c_{i\tau} + \sum_j p^j_{\tau+1} X^j_{i\tau+1} = \\ & e_{i\tau} + t_{i\tau} + \sum_j r^j_{i\tau+1} X^j_{i\tau} + \sum_j p^j_{\tau+1} X^j_{i\tau} \quad \forall\, \tau \qquad (2) \\ (ii) \quad & X^j_{i\tau+1} \geq b^j_{i\tau+1} \quad \forall\, \tau, j \qquad (3) \end{aligned}$$

Optimal condition – Euler equation

Agents' optimal consumption choices will satisfy the Euler equation (First Order Condition)

$$\frac{\mathrm{d}u_t(c_{it})}{\mathrm{d}c_{it}} \geq \frac{1}{(1+\rho_{it+1})} E\left[\frac{(p^j_{t+1}+r^j_{t+1})}{p^j_t}\frac{p_t}{p_{t+1}}\frac{\mathrm{d}u_{t+1}(c_{it+1})}{\mathrm{d}c_{it+1}}\right] \tag{4}$$

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For households not liquidity constrained

$$\frac{\mathrm{d}u_t(c_{it})}{\mathrm{d}c_{it}} = \frac{1}{(1+\rho_{it+1})} E\left[(1+r^0_{t+1})\frac{p_t}{p_{t+1}}\frac{\mathrm{d}u_{t+1}(c_{it+1})}{\mathrm{d}c_{it+1}}\right] \tag{5}$$

Mortality

Utility function

We use the constant relative risk aversion (CRRA) utility function:

$$U(c) = \frac{c^{1-\gamma}}{1-\gamma}$$

$$U_c(c) = c^{-\gamma}$$

$\frac{1}{\gamma}$ is the elasticity of intertemporal substitution

Identifying the discount factor

The utility function and Euler equation yield the following expression:

$$\rho_{t+1} = E\left[(1 + r^0_{t+1})\frac{p_t}{p_{t+1}}\left(\frac{c_t}{c_{t+1}}\right)^{\gamma}\right] - 1. \qquad (6)$$

If we had:

- An estimate of γ
  - We take from 1.25 Attanasio & Weber (1993)
- Knowledge of the interest rate r^0_{t+1} Rates
- Panel data on consumption c_t, c_{t+1}

then we could identify the discount rate ρ

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English Longitudinal Study of Ageing (ELSA)

- **English version of old-age surveys**
  - Representative survey of the English population aged 50 and above
  - Similar to HRS, SHARE, JSTAR, etc.
  - 12,000 respondents in 2002
- **Comprehensive survey**
  - Detailed information on health, pension rights
  - Matched with administrative data on earnings
  - Comprehensive data on income and assets
- **Panel data**
  - Interview every 2 years
  - We use waves 1 to 4 (2002/03; 2004/05; 2006/07; 2008/09)

Asset components in ELSA data

Asset	Mean (Uncond.)	Mean (Cond.)	Med (Cond.)	Proportion with asset
Cash Savings	12,111	13,474	4,000	90.1%
Cash ISAs	2,436	7,452	6,000	34.1%
TESSAs	1,457	9,796	9,000	16.7%
National savings	832	11,547	3,000	9.2%
Bonds	2,837	29,425	16,000	11.6%
Shares	6,650	22,087	3,500	31.6%
S&S ISAs	1,551	11,982	7,000	14.8%
PEPs	2,792	18,158	9,000	17.2%
Invest. trusts	2,379	26,483	12,000	10.9%
Life ins. savings	2,267	22,470	10,000	12.0%
Other savings	2,179	40,458	15,000	7.4%
Total	38,346	41,258	12,152	93.1%

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Calculation of consumption data

- Using the budget constraint to calculate consumption:

$$p_t c_t = e_t + t_t + \sum_j r^j_{t+1} X^j_t + \sum_j p^j_{t+1} (X^j_t - X^j_{t+1})$$

- We can re-arrange to make clear data requirements:

$$\begin{aligned} p_t c_t &= e_t + \sum_j r^j_t p^j_t X^j_t + t_t \\ &\quad + \sum_j \left(\frac{p^j_{t+1}}{p^j_t} p^j_t X^j_t - p^j_{t+1} X^j_{t+1} \right) \end{aligned}$$

▸ Missing data

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Sample selection

- **Selection rules**
  - Exclude if income not known in waves t and t+1
  - Exclude if large change in physical wealth
  - Exclude if house sold or bought
  - Exclude if household composition changed

▸ Selection

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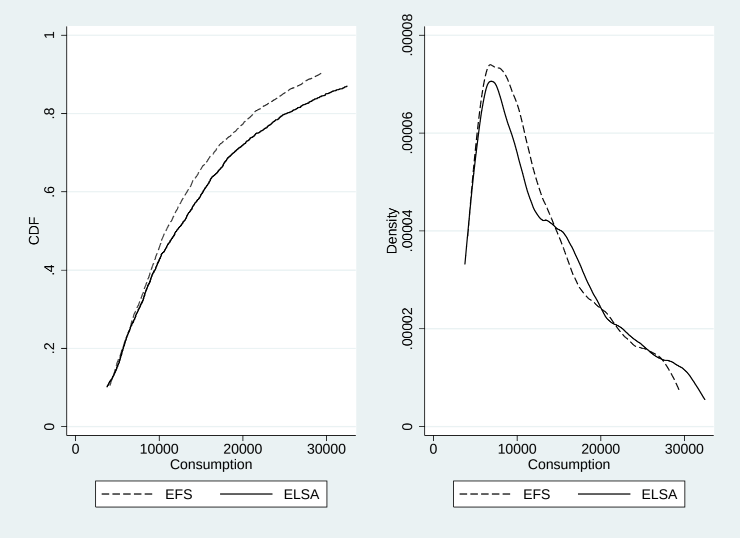
▸ Selection

- **A non-representative sample**
  - Very-old over represented, less wealthy under-represented
  - We weight our results by age, marital status, education, income and wealth
  - Unobserved heterogeneity between those in our sample and those not may be important

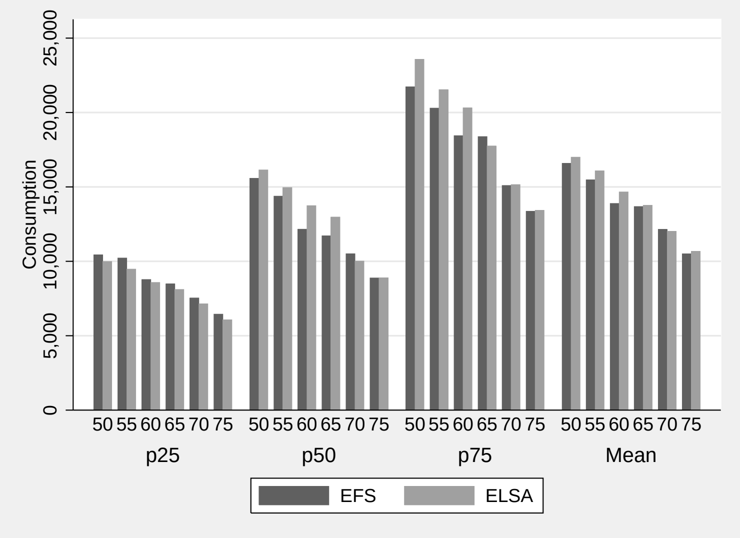
Consumption in ELSA vs EFS

- **The Expenditure and Food Survey (EFS)**
  - UK's household budget survey
  - Data collected annually and nationally representative
- **Comparison ELSA vs EFS**
  - Sample of household whose head is 50 and above from EFS 2003
  - Consumption calculated from ELSA 2002/03 and 2004/05

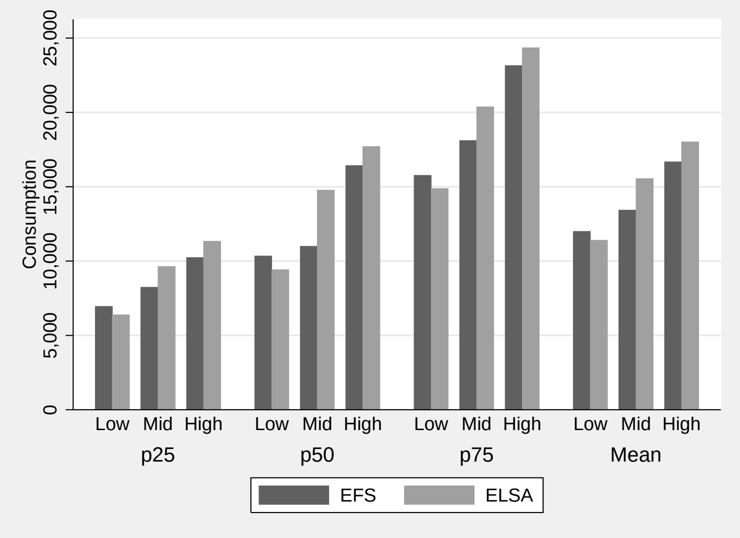
Consumption in ELSA vs EFS



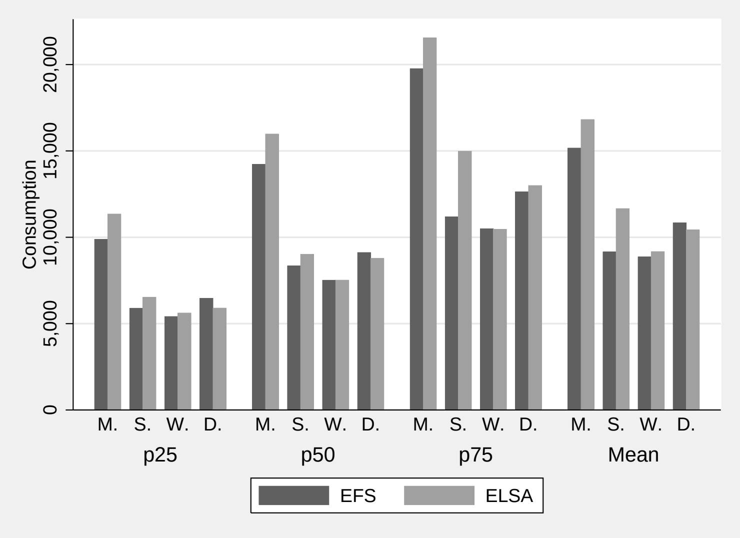
Consumption in ELSA vs EFS: by age



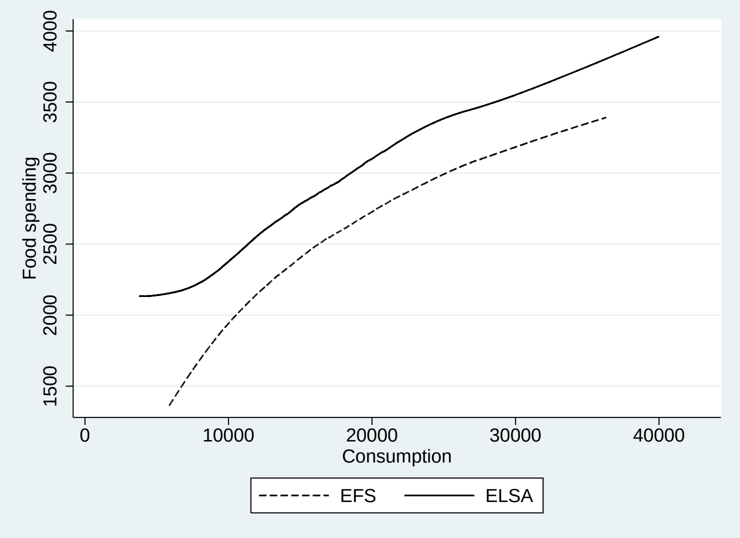
Consumption in ELSA vs EFS: by education



Consumption in ELSA vs EFS: by marital status



Relationship between food spending and consumption



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Results (1): *ex post* discount rates

- **Distribution of *ex post* discount rates**

$$\left[(1 + r^0_{t+1})\frac{p_t}{p_{t+1}}\left(\frac{c_t}{c_{t+1}}\right)^\gamma\right] - 1 \tag{7}$$

  - This would be the discount rate if c_{t+1} was perfectly forecasted

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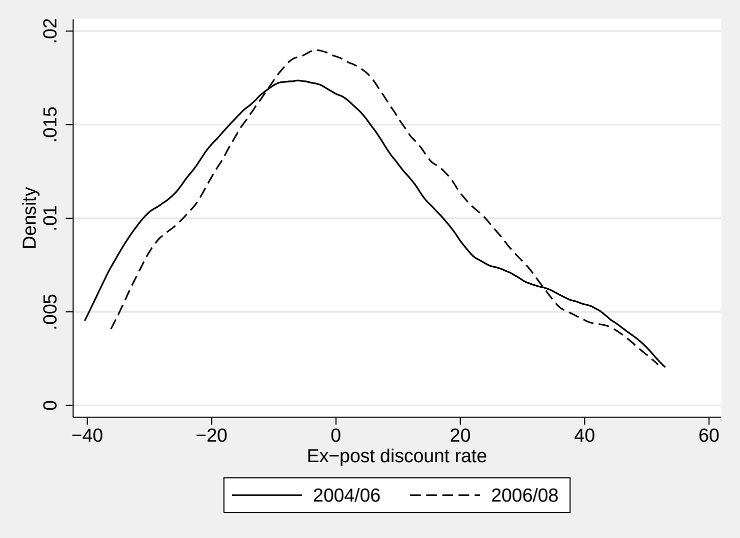
- **Summary statistics**
  - 4 waves of data, 3 observations of consumption, 2 observations of discount rate
  - Median: -3% in first period, 0% in second period
  - Low levels compared to the literature
  - Large heterogeneity

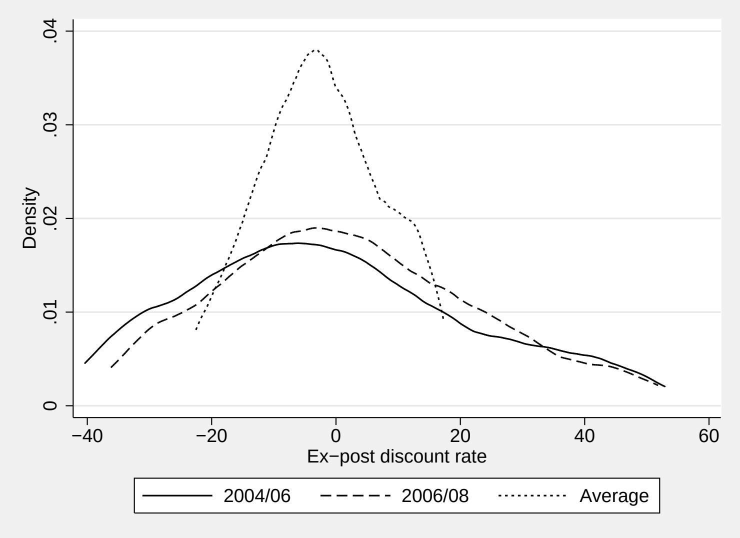
Distribution of ex post discount rates



Distribution of ex post discount rates

- **Large heterogeneity**
  - Differences in the degree of patience between individuals
  - Differences in the degree of patience over time
  - Expectational errors
  - Measurement errors

Distribution of average ex post discount rates



How do these results compare with others reported in literature

- No direct comparisons are possible (geography/age group in (small) literature different)
- But worth comparing our results to those from the two papers with models that most closely correspond (Samwick (1998) and Gustman & Steinmeier (2005))

Discount rate	**Samwick**	**GS**	**Ours 04-06**	**Ours 06-08**	**Ours Ave**
$<$5%	38%	40%	60%	56%	67%
5%-10%	25%	21%	5%	6%	8%
10%-15%	10%	6%	4%	6%	7%
$>$15%	25%	33%	30%	32%	18%

Ex post discount rate by education and numeracy

Education	$\hat{\rho}$	σ	Numerical ability	$\hat{\rho}$	σ
Low	-3.4	1.0	1 (Lowest)	-2.9	2.0
Mid.	-1.8	2.3	2	-3.4	1.1
High	5.7	5.7	3	-0.8	2.7
			4 (Highest)	-1.3	4.0
All	-2.5	1.0	All	-2.3	1.0

◂ Numeracy

Results (2): *ex ante* discount rates

- **Estimating *ex ante* discount rates**
  - Using grouping estimator to estimate the expectation in:

$$\rho_{t+1} = E\left[(1 + r^0_{t+1})\frac{p_t}{p_{t+1}}\left(\frac{c_t}{c_{t+1}}\right)^{\gamma}\right] - 1.$$

  - Compute sample analogue for a particular group (by age, marital status, education, numerical ability)

Ex ante discount rate by education and numeracy

Education	$\bar{\rho}$	σ	**Numerical ability**	$\bar{\rho}$	σ
Low	-2.5	0.7	1 (Lowest)	-3.5	1.4
Mid.	0.9	1.4	2	-2.3	0.8
High	6.7	3.0	3	1.7	1.5
			4 (Highest)	2.0	2.4
All	-1.0	0.6	All	-1.0	0.6

Conclusion

- We use panel data on asset and income to obtain panel data on consumption
- We compute individual time-varying ex post discount rates on a representative sample of the English population aged 50 and above
- We compute ex ante discount rates using grouping estimator by education and numeracy levels
- We find large heterogeneity in discount rates
- We find that low education groups *within this sample* tend to exhibit lower discount rate (greater patience) than those with high education

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Success rate of consumption calculation

	Proportions of balanced panel		Proportions of wave 1 sample	
Computation status	Obs.	Percentage	Obs.	Percentage
Have consumption	3,541	58.8%	3,541	44.8%
Calculation failed	2,298	38.2%	2,298	29.1%
Negative consumption	183	3.0%	183	2.3%
Attrited	-	-	1,872	23.7%
Total	6,022	100.0	7,894	100.0%

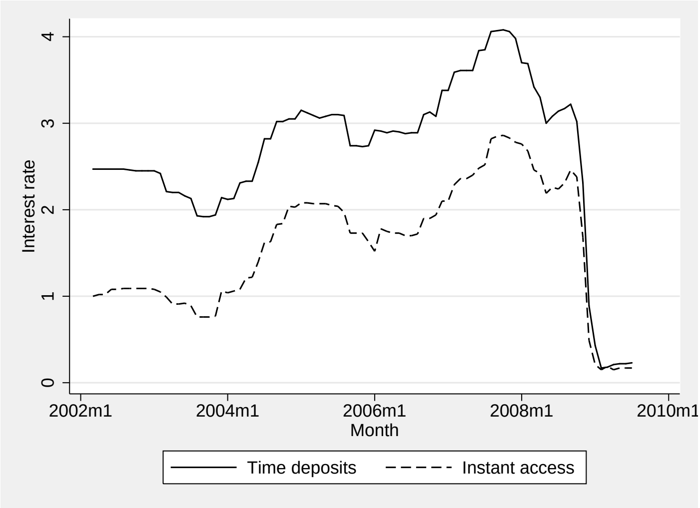
Reasons for consumption calculation failing

Reasons	Percentage	
Consumption calculation failed	2,532	51.8
Consumption less than £3000	780	16.0
Benefit unit composition changed	1,103	22.6
Labour supply changed	690	14.1

Back

Interest rates: Nominal return on cash - 2002-2008

Back



What about death? (1)

- If we took explicit account of probability of death, and assumed no bequest motive:

$$U'(c_t) = \beta_i P(s_{t+1})(1+r)V'(a_{t+1})$$

  where
  - $P(s_{t+1})$ is the probability of survival to period $t+1$, conditional on having survived to period t
  - V() is the value function
- This implies a particular interpretation on the coefficient:
  - It is a product of a 'pure' discount factor and the probability of survival
  - In principle the 'pure' discount factor could be recovered with data on the probability of survival

What about death? (2)

- If assume that there is a bequest function $B(.)$ then the (simplified) Euler equation is:

$$U'(c_t) = \beta_i(1+r)\left(P(s_{t+1})V'(a_{t+1}) + (1-P(s_{t+1}))B'(a_{t+1})\right)$$

- We will, erroneously, be using:

$$U'(c_t) = \beta_i(1+r)V'(a_{t+1})$$

though bias will be small as long as $P(s_{t+1})$ is big or $V'(a_{t+1}) \approx B'(a_{t+1})$.

Back

What's missing in the data?

- **Income data for the year between waves**
  - We interpolate linearly between the two waves to get the missing income (taking account of state pension age)
- **Transfer data for for the year between waves**
  - We assume zero transfers in the missing year
- **Capital gains**
  - For most – assets are largely safe – use FTSE for risky
- **Some missing data on assets (don't knows etc.)**
  - If asset data is not know, we assume no flows in and out since previous waves
- **Some missing data on income (don't knows etc.)**
  - We use a combination of imputed income and sample selection ◂ Back

Numerical Ability in ELS

1. If you buy a drink for 85 pence and pay with a one pound coin, how much change should you get?
2. In a sale, a shop is selling all items at half price. Before the sale a sofa costs £300. How much will it cost in the sale?
3. If the chance of getting a disease is 10 per cent, how many people out of £1,000 would be expect to get the disease?
4. A second hand car dealer is selling a car for £6,000. This is two-thirds of what it cost new. How much did the car cost new?
5. If 5 people all have the winning numbers in the lottery and the prize is £2 million, how much will each of them get?
6. Let's say you have £200 in a savings account. The account earns ten per cent interest per year. How much will you have in the account at the end of two years?

Sensitivity of ex ante discount rate by education

	(1)		(2)		(3)		(4)	
Education	$\bar{\rho}$	σ	$\bar{\rho}$	σ	$\bar{\rho}$	σ	$\bar{\rho}$	σ
Low	-1.1	0.9	-0.5	0.8	-1.9	0.8	-2.6	1.2
Mid.	3.8	1.8	1.0	1.5	1.9	1.7	3.2	2.5
High	10.5	3.6	12.2	3.4	2.2	4.1	-1.5	6.9
All	2.3	0.8	1.6	0.7	-0.9	0.8	-1.3	1.2

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