Cash and pensions: Have English households saved optimally for retirement?

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Outline for section 1

1. Introduction
2. Literature
3. Model
4. Data
5. Results
6. Conclusion
Introduction

- Strong and robust feeling among policymakers that there is undersaving for retirement in the UK (and elsewhere)
- This is despite very large stocks of wealth held in the form of private pensions
- This paper assesses whether a particular cohort of households have undersaved for retirement
- We do this using a lifecycle model in which households have access to:
  - State provided pensions
  - Private non-pension saving
  - Private pension saving
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  - State provided pensions
  - Private non-pension saving
  - Private pension saving
State pensions in the US and UK
State pensions in the US and UK
Summary of results from this paper
Summary of results from this paper

The scatter plot shows the relationship between observed wealth (in £000s) and optimal wealth (in £000s). The solid line represents the smoothed relationship, while the dashed line indicates the 45 degree line. The data points are distributed across the plot, with a concentration towards the upper right side, indicating a positive correlation between observed and optimal wealth.
Outline for section 2

1. Introduction
2. Literature
3. Model
4. Data
5. Results
6. Conclusion
Literature

- Analysis of replacement rates
  - UK: Banks et al. (2005), Crawford & O’Dea (2012)

- Consumption changes around retirement
  - Banks et al. (1998), Bernheim et al. (2001), Battistin et al. (2008)

- Issue relevant to many structural papers - ours is most closely related to:
  - Scholz et al. (2005), Gustman & Steinmeier (2006)
Literature

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Utility function

Household’s maximise the discounted expected sum of the utility of (equivilised) consumption:

\[ n_t^{eq} U \left( \frac{c_t}{n_t^{eq}} \right) \]

Utility function is standard constant relative risk aversion function
Utility function

Household’s maximise the discounted expected sum of the utility of (equivilised) consumption:

$$n_t^{eq} U\left( \frac{c_t}{n_t^{eq}} \right)$$

Utility function is standard constant relative risk aversion function
In addition to the state pension system, there are two assets:

1. Risk-free asset
2. Defined contribution pension (401k-style)

There are two choices to make each period:

1. How much to consume
2. How much to split savings between cash and the pension
In addition to the state pension system, there are two assets:

1. Risk-free asset
2. Defined contribution pension (401k-style)

There are two choices to make each period:

1. How much to consume
2. How much to split savings between cash and the pension
Uncertainty

There is uncertainty over:

- Employment
- Wages
- Return on private pension
- Survival
Wages and employment

- Wages:
  - Household log wages for each of three education types $ed$ are the sum of a fixed effect, a quadratic in age and an persistent stochastic component

$$
\ln \tilde{e}_{it} = \alpha_i + \beta_{1}^{ed} age_{it} + \beta_{2}^{ed} age_{it}^2 + u_{it} \\
u_{it} = \rho_{ed} u_{it-1} + \xi_{it} \\
\xi \sim N\left(0, \sigma_{ed}^2\right)
$$

- Employment occurs with probability $\pi$ in each period:

$$
e_{it} = \begin{cases} 
\tilde{e}_{it} & w.p. \pi_{ed} \\
0 & w.p. 1 - \pi_{ed}
\end{cases}
$$
Wages and employment

- **Wages:**
  - Household log wages for each of three education types $ed$ are the sum of a fixed effect, a quadratic in age and an persistent stochastic component

  \[
  \ln \tilde{e}_{it} = \alpha_i + \beta_{1}^{ed} \text{age}_{it} + \beta_{2}^{ed} \text{age}_{it}^2 + u_{it}
  \]
  \[
  u_{it} = \rho_{ed} u_{it-1} + \xi_{it}
  \]
  \[
  \xi \sim N\left(0, \sigma_{ed}^2\right)
  \]

- **Employment occurs with probability $\pi$ in each period:**

  \[
  e_{it} = \begin{cases} 
  \tilde{e}_{it} & \text{w.p. } \pi_{ed} \\
  0 & \text{w.p. } 1 - \pi_{ed} 
  \end{cases}
  \]
Retirement

- Household retirement happens when the male reaches 65
- Retirement involves stopping work and drawing down DC pension
  - 25% of the pension in a tax free lump sum
  - 75% is annuitised at rates that are actuarially fair after a deduction for administrative costs
Optimal consumption allocation satisfies an Euler equation in *equivilised* consumption:

\[
U'(\frac{c_t}{n_{eq_t}}) = \beta (1 + r) E \left[ U'\left(\frac{c_{t+1}}{n_{eq_{t+1}}^t}\right) \right]
\]

We set \( \beta = \frac{1}{1+r} \) such that households are no more impatient than they are compensated for in the return on risk-free saving:

\[
U'(\frac{c_t}{n_{eq_t}^t}) = E \left[ U'\left(\frac{c_{t+1}}{n_{eq_{t+1}}^t}\right) \right]
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\[ U' \left( \frac{c_t}{n_{t}^{eq}} \right) = E \left[ U' \left( \frac{c_{t+1}}{n_{t+1}^{eq}} \right) \right] \]
Outline for section 4

1. Introduction
2. Literature
3. Model
4. Data
5. Results
6. Conclusion
Data

Data source is English Longitudinal Study of Ageing (ELSA) linked with administrative data on National Insurance contributions

- English Longitudinal Study of Ageing
  - Interviewed every 2 years
  - Careful measurement of wealth (including pension wealth)
  - Similar in form and purpose to HRS (USA) and SHARE (Europe)

- National Insurance (Social Security) contributions
  - Respondents were asked for permission to link their survey data to NI records
  - Allows us obtain earnings histories (subject to some censoring)
Data

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- National Insurance (Social Security) contributions
  - Respondents were asked for permission to link their survey data to NI records
  - Allows us obtain earnings histories (subject to some censoring)
Sample is:

- Couples
- Man born in the 1940s
- Where we have NI records for both members of the couple
## Parameterisation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Symbol</th>
<th>Value/Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unemployment rate</td>
<td>$\pi$</td>
<td>6.2%</td>
</tr>
<tr>
<td>Return on safe asset</td>
<td>$r$</td>
<td>2.2%</td>
</tr>
<tr>
<td>Mean pension return</td>
<td>$\bar{\phi}$</td>
<td>4.0%</td>
</tr>
<tr>
<td>St. Dev. pension return</td>
<td>$\bar{\sigma}_\phi$</td>
<td>13.8%</td>
</tr>
<tr>
<td>Survival probabilities</td>
<td>$s^m_t, s^f_t$</td>
<td>ONS Life Tables</td>
</tr>
<tr>
<td>Administrative load on annuities</td>
<td>$q$</td>
<td>10%</td>
</tr>
<tr>
<td>Discount factor</td>
<td>$\beta$</td>
<td>$\frac{1}{1+r} = 0.978$</td>
</tr>
<tr>
<td>Coefficient of relative risk aversion</td>
<td>$\gamma$</td>
<td>1.5</td>
</tr>
<tr>
<td>Equivalence scale</td>
<td>$n$</td>
<td>Modified OECD scale</td>
</tr>
</tbody>
</table>
Outline for section 5

1. Introduction
2. Literature
3. Model
4. Data
5. Results
6. Conclusion
Summary of results from this paper

![Graph showing the relationship between observed wealth and optimal wealth](image-url)

- **Smoothed relationship**
- **45 degree line**

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Sensitivity

By Quintile
Results - excluding housing
Results - excluding housing

Baseline model:

- Proportion undersaving: 7.9%
- R-squared: 0.31

Excluding housing:

- Proportion undersaving: 25.1%
- R-squared: 0.32
Building in (exogenous) housing wealth accumulation

We add to the baseline model:

- an exogenous consumption flow coming from holding housing wealth ($r^h H_t$)
- a deduction for mortgage payments ($h_t$) from available resources

Baseline

$$ u(c) = n_t^{eq} U\left(\frac{C}{n_t^{eq}}\right) $$

$$ a_{t+1} = (1+r)(a_t+y_t-c_t-p_t) $$

Adapted

$$ u(c) = n_t^{eq} U\left(\frac{C}{n_t^{eq}}+r^h H_t\right) $$

$$ a_{t+1} = (1+r)(a_t+y_t-c_t-p_t-h_t) $$
Building in (exogenous) housing wealth accumulation

We add to the baseline model:

- an exogenous consumption flow coming from holding housing wealth \((r^h H_t)\)
- a deduction for mortgage payments \((h_t)\) from available resources

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\[
 u(c) = n_t^{eq} U \left( \frac{C}{n_t^{eq}} \right)
\]

\[
 a_{t+1} = (1+r)(a_t+y_t-c_t-p_t)
\]

Adapted

\[
 u(c) = n_t^{eq} U \left( \frac{C}{n_t^{eq}} + r^h H_t \right)
\]

\[
 a_{t+1} = (1+r)(a_t+y_t-c_t-p_t-h_t)
\]
Results - exogenous housing

Baseline model:

![Graph showing baseline model results]

Proportion undersaving: 7.9%
R-squared: 0.31

Exogenous housing:

![Graph showing exogenous housing results]

Proportion undersaving: 16.0%
R-squared: 0.24
Discussion

What’s missing from the model?

- Non-separabilities between consumption and leisure
- Home production
- Nursing home expenses
- Bequest motives
Proportion of couples with retirement income replacing less than $X\%$ of average real (gross) earnings between the age of 20 and 50:

<table>
<thead>
<tr>
<th>Replacement Rate</th>
<th>Income coming from ...</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Pensions</td>
</tr>
<tr>
<td>&lt;=67%</td>
<td></td>
</tr>
<tr>
<td>&lt;=80%</td>
<td></td>
</tr>
<tr>
<td>&lt;=100%</td>
<td></td>
</tr>
<tr>
<td>&gt;100%</td>
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<td>Pensions</td>
</tr>
<tr>
<td>&lt;=67%</td>
<td>19.6</td>
</tr>
<tr>
<td>&lt;=80%</td>
<td>35.0</td>
</tr>
<tr>
<td>&lt;=100%</td>
<td>58.6</td>
</tr>
<tr>
<td>&gt;100%</td>
<td>41.4</td>
</tr>
</tbody>
</table>
Replacement rates

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<table>
<thead>
<tr>
<th>Replacement Rate</th>
<th>Pensions</th>
<th>Annuitised non-housing wealth</th>
<th>Annuitised housing wealth</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\leq 67%$</td>
<td>19.6</td>
<td>10.0</td>
<td>2.3</td>
</tr>
<tr>
<td>$\leq 80%$</td>
<td>35.0</td>
<td>19.9</td>
<td>5.3</td>
</tr>
<tr>
<td>$\leq 100%$</td>
<td>58.6</td>
<td>41.0</td>
<td>16.0</td>
</tr>
<tr>
<td>$&gt;100%$</td>
<td>41.4</td>
<td>59.0</td>
<td>84.0</td>
</tr>
</tbody>
</table>
Outline for section 6

1. Introduction
2. Literature
3. Model
4. Data
5. Results
6. Conclusion
9 out of every 10 of those born in the 1940s have more than enough wealth to maintain living standards into retirement.

New concern is that younger cohorts are undersaving for retirement.

Maybe not such a concern if their parents have ‘oversaved’?

New work planned on younger cohorts with the Wealth and Assets Survey.
Outline for section 7

7 Extra slides
The problem solved (and therefore the decision rules obtained) are different for each household in the sample in three dimensions

1. Their earnings process (fixed effect)
2. The number and timing of children
3. State pension entitlements
## Optimal wealth and the proportion undersaving

<table>
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<tr>
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<th>Median optimal wealth</th>
<th>Prop. undersaving (cond.)</th>
<th>Median deficit (cond.)</th>
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<th>Median observed wealth</th>
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<td>All</td>
<td>77</td>
<td>7.9%</td>
<td>39</td>
<td>226</td>
<td>324</td>
</tr>
<tr>
<td>L.E. Quint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
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</tr>
<tr>
<td>L.E. Quint</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.6</td>
<td>9.5%</td>
<td>8</td>
<td>126</td>
<td>119</td>
</tr>
<tr>
<td>2</td>
<td>29</td>
<td>4.5%</td>
<td>11</td>
<td>189</td>
<td>213</td>
</tr>
<tr>
<td>3</td>
<td>73</td>
<td>6.5%</td>
<td>28</td>
<td>232</td>
<td>293</td>
</tr>
<tr>
<td>4</td>
<td>152</td>
<td>8.5%</td>
<td>79</td>
<td>283</td>
<td>392</td>
</tr>
<tr>
<td>5</td>
<td>392</td>
<td>10.6%</td>
<td>94</td>
<td>329</td>
<td>690</td>
</tr>
</tbody>
</table>
Recursive formulation

Value function and consumer problem:

\[ V_t(X_t) = \max_{c_t, d_{ct}} \left( U(c_t) + \beta s_{t+1}^m s_{t+1}^f \int V_{t+1}(X_{t+1}, h = 1) dF(X_{t+1}|X_t) \right. \]
\[ \left. + \beta s_{t+1}^m (1 - s_{t+1}^f) \int V_{t+1}(X_{t+1}, h = 2) dF(X_{t+1}|X_t) \right. \]
\[ \left. + \beta (1 - s_{t+1}^m) (s_{t+1}^f) \int V_{t+1}(X_{t+1}, h = 3) dF(X_{t+1}|X_t) \right) \]

\( X_t \) contains 6 state variables:

- Age; Wages; HH composition; Cash; DC wealth; Pension Income
Intertemporal budget constraints

- Cash:
  \[ a_{t+1} = (1 + r)(a_t + y_t - c_t - dc_t) \]

  Household income \( y_t \) is given by:
  \[ y_t = \tau(e, ra, pp, sp, h, k, dc, t) \]

- DC wealth
  \[ DC_{t+1} = (1 + \phi_t)(DC_t + dc_t) \]

  \( \phi \sim N(\bar{\phi}, \sigma_{\phi}^2) \)
Many in this cohort have wealth in older-style ‘Defined Benefit’ pensions

- Model does not contain DB pensions
- The question we are asking is what would these households had saved if given access only to the DC fund
- Much of observed wealth will have come from remittances by employers, not employees
- We augment household earnings to take account of this
## Summary statistics on wealth

<table>
<thead>
<tr>
<th>Mean wealth holdings:</th>
<th>Mean</th>
<th>£</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total net wealth</td>
<td>574,048</td>
<td>100</td>
<td></td>
</tr>
<tr>
<td>of which:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Financial</td>
<td>52,514</td>
<td>9.1</td>
<td></td>
</tr>
<tr>
<td>Prim. hous.</td>
<td>147,431</td>
<td>25.7</td>
<td></td>
</tr>
<tr>
<td>Other hous.</td>
<td>23,589</td>
<td>4.1</td>
<td></td>
</tr>
<tr>
<td>Physical</td>
<td>40,962</td>
<td>7.1</td>
<td></td>
</tr>
<tr>
<td>Priv. pen.</td>
<td>187,281</td>
<td>32.6</td>
<td></td>
</tr>
<tr>
<td>State pen.</td>
<td>122,271</td>
<td>21.3</td>
<td></td>
</tr>
<tr>
<td><strong>Sample size</strong></td>
<td>996</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table: State pension wealth, lifetime earnings, and implied average lifetime savings rates, by quintile of lifetime earnings

<table>
<thead>
<tr>
<th>Quintile</th>
<th>Mean state pension wealth</th>
<th>Mean lifetime earnings</th>
<th>Mean priv. wealth / life. earn.</th>
<th>Mean (priv + state wealth) / life. earn.</th>
</tr>
</thead>
<tbody>
<tr>
<td>All</td>
<td>122</td>
<td>1,090</td>
<td>13.5%</td>
<td>24.7%</td>
</tr>
<tr>
<td>1 (Lowest)</td>
<td>108</td>
<td>483</td>
<td>2.0%</td>
<td>24.3%</td>
</tr>
<tr>
<td>2</td>
<td>123</td>
<td>793</td>
<td>4.9%</td>
<td>20.4%</td>
</tr>
<tr>
<td>3</td>
<td>124</td>
<td>970</td>
<td>8.5%</td>
<td>21.3%</td>
</tr>
<tr>
<td>4</td>
<td>129</td>
<td>1,219</td>
<td>13.8%</td>
<td>24.4%</td>
</tr>
<tr>
<td>5 (Highest)</td>
<td>127</td>
<td>1,988</td>
<td>22.0%</td>
<td>28.4%</td>
</tr>
</tbody>
</table>
Housing

- **Cost** \((h_t)\):
  - Households are assumed to only have owned their current property
  - They are assumed to have saved 1.5% of the purchase value from the age of 20 to the year of purchase
  - They take out a 25 year mortgage for the purchase price less the value of their deposit
  - Time series of mortgage interest rates taken from Bank of England

- **Yield** \((r^h)\):
  - \(r^h = 4.4\%\) (Bank of England (2007))

- **House value** \((H_t)\):
  - Property value known at purchase and at survey date
  - Assumed to have grown at a constant rate between purchase date and survey date
  - Assumed to grow at the rate of return on riskless asset in the future (after the last survey)
## Sensitivity

<table>
<thead>
<tr>
<th></th>
<th>Median optimal wealth</th>
<th>Prop. undersaving</th>
<th>Median deficit (cond.)</th>
<th>Median surplus (cond.)</th>
<th>R squared</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>77</td>
<td>7.9%</td>
<td>39</td>
<td>226</td>
<td>0.31</td>
</tr>
<tr>
<td>Early ret</td>
<td>81</td>
<td>10.2%</td>
<td>58</td>
<td>208</td>
<td>0.28</td>
</tr>
<tr>
<td>$\gamma = 3$</td>
<td>75</td>
<td>8.2%</td>
<td>34</td>
<td>223</td>
<td>0.30</td>
</tr>
<tr>
<td>$\beta = 1$</td>
<td>301</td>
<td>42.9%</td>
<td>94</td>
<td>138</td>
<td>0.38</td>
</tr>
<tr>
<td>Comp to age 64</td>
<td>154</td>
<td>28.8%</td>
<td>105</td>
<td>191</td>
<td>0.19</td>
</tr>
<tr>
<td>1 asset</td>
<td>53</td>
<td>4.5%</td>
<td>11</td>
<td>273</td>
<td>0.26</td>
</tr>
</tbody>
</table>
Our administrative data gives us:

- Exact earnings 1997-2004
- Topcoded earnings 1975-1996 (top-coding affects 7.4% of year-individual observations)
- Number of weeks work prior to 1975

We impute data over the censoring point using a fixed-effects Tobit

- Biased
- Though Greene (2004) finds bias is minimal in panels even much shorter than ours ($T = 29$)
- Plot of quantiles before and after 1997 show only small discontinuities
Quantiles of earnings process

Figure: Selected quantiles of earnings

![Graph showing earnings process over time with different quantiles marked, including 98th, 95th, 90th, 75th, 50th, and 25th percentiles.]
Solution is by backwards recursion from a final period where the decision rules and value function are known.

Further details:
- Earnings, assets, stocks of DC assets and pension income are placed on a grid.
- Integration is by quadrature.
- Optimisation is by golden section search.
Components of the tax and benefit system

The tax and benefit function contains:

▶ Income tax
▶ National insurance
▶ Job-seekers allowance
▶ Child benefit
▶ Means-tested support in retirement
Accounting for employer pension contributions

We inflate upwards our earnings data $e^d_t$ by a proportion $\chi$:

$$
\chi = \frac{\kappa P_s}{\sum_{t}^{S-1} e^d_t (\prod_{t}^{S} (1+\phi_t))}
$$

where:

- $\kappa$ is the proportion of earnings that the employer remits to the pension fund
- $P_s$ is the pension wealth observed in survey period $S$
- $\phi_t$ is the return on DC funds in the year the particular household is of age $t$
Estimates of earnings process parameters

<table>
<thead>
<tr>
<th>Education group</th>
<th>Low</th>
<th>Middle</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\rho$</td>
<td>0.8468</td>
<td>0.9727</td>
<td>0.9527</td>
</tr>
<tr>
<td></td>
<td>(0.0838)</td>
<td>(0.0153)</td>
<td>(0.0025)</td>
</tr>
<tr>
<td>$\sigma^2_\xi$</td>
<td>0.0413</td>
<td>0.0417</td>
<td>0.0422</td>
</tr>
<tr>
<td></td>
<td>(0.0026)</td>
<td>(0.0033)</td>
<td>(0.0026)</td>
</tr>
<tr>
<td>$\sigma^2_m$</td>
<td>0.0024</td>
<td>0.0029</td>
<td>0.0066</td>
</tr>
<tr>
<td></td>
<td>(0.0021)</td>
<td>(0.0026)</td>
<td>(0.0016)</td>
</tr>
</tbody>
</table>
Results - ‘optimal’ replacement rates

Implied replacement rates of average lifetime earnings (between 20 and 50):