The Welfare Cost of Asymmetric Information: Evidence from the U.K. Annuity Market

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Motivation

- Theoretical literature on adverse selection emphasizes private market inefficiency and potential for welfare improving government policy
- Empirical work mainly focused on detection of asymmetric information
  - Recent emphasis on importance of preference heterogeneity in addition to risk heterogeneity
- Little / no empirical work on the magnitude:
  - of efficiency costs of asymmetric information
  - of welfare costs of government intervention (e.g., mandates)
Motivate the more structural approach we take by showing that in markets with asymmetric information and preference heterogeneity, the extent of efficiency cost of asymmetric information cannot be inferred from reduced form evidence of how “adversely selected” the market is.

Use insurance data on choices and risk experience, as well as some modeling assumptions, to recover distribution of risk type and preferences.

Compute welfare at observed equilibrium and compare to two counterfactual scenarios:

- Symmetric information (first best)
- Mandatory social insurance (no contract choice)
Semi-compulsory U.K. annuity market

- Individuals with tax preferred retirement savings required to annuitize their accumulated balance at retirement
  - £6 billion in new funds annuitized in 1998
- Choice of annuity contract, i.e. guarantee length (during guaranteed period, annuity payments are unconditional):
  - Private/unpriced information about risk type
  - Preference for “wealth after death”

Advantages of setting:

- Important market; implications for Social Security reform
- Relatively simple contracts (0, 5, or 10 year guarantee)
- Evidence that asymmetric information affects guarantee choice (Finkelstein and Poterba, 2004)
- Negligible moral hazard (attractive for estimation/identification)
Both preferences and risk type are important determinants of guarantee choice.

Cost of asymmetric information along guarantee choice:
- Reduces welfare relative to a first-best symmetric information benchmark by £127 million per year, or 2% of annual premiums.

Effect of government mandates (eliminate guarantee choice):
- May reduce welfare by as much as £107 million annually or increase by as much as £127 million annually, depending on contract mandated.
  - Optimal mandate not apparent from equilibrium choices.
Motivating Theory

- By construction, estimating welfare/efficiency requires modeling and estimation of individuals’ preferences and risk types.
- But can we make any inference about efficiency costs from reduced form evidence of the risk experience of individuals in different insurance markets? e.g., from observing how “adversely selected” the market appears?
- We derive, by examples, an “impossibility result”: without strong additional assumptions, reduced form relationship between insurance coverage and risk occurrence is not informative even for qualitative statements about where efficiency costs likely to be relatively large.
- In a similar spirit, mandates can decrease or increase welfare, and the reduced form is not sufficient to know which is the optimal mandate.

Einav, Finkelstein, and Schrimpf (Stanford and NBER, MIT and NBER, MIT)
Setup

- Two key (realistic) additions to standard asymmetric analysis (e.g. Rothschild and Stiglitz): preference heterogeneity and loads
- Adopt simplest framework possible to generate our “null” result
  - Exogenous binary choice of full insurance or not (no partial coverage)
  - Two types $H$, $L$ with risks $p_H > p_L$ and risk aversion $r_H$ and $r_L$ (private information). Loss if it occurs is identical
  - $F \geq 0$ is fixed cost of insurance
## Examples of All Four Cases

<table>
<thead>
<tr>
<th>Key assumptions</th>
<th>Efficient allocation</th>
<th>Equilibrium allocation</th>
<th>First best?</th>
<th>Positive correlation?</th>
</tr>
</thead>
<tbody>
<tr>
<td>( F=0, r_L = r_H )</td>
<td>( H ) and ( L ) both insured</td>
<td>Only ( H ) insured</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>( F&gt;0, r_L = r_H )</td>
<td>Only ( H ) insured</td>
<td>Only ( H ) insured</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>( F&gt;0, r_L &gt; r_H )</td>
<td>Only ( L ) insured</td>
<td>H and L both insured</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>( F&gt;0, r_L &gt; r_H )</td>
<td>Only ( L ) insured</td>
<td>Only ( L ) insured</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>

Notes:
Assumptions listed are not sufficient
\( F \) is fixed cost of insurance
\( r_H \) (\( r_L \)) is risk aversion of high (low) risk type

In a similar spirit, one could show that mandates can decrease or increase welfare, and that the reduced form is not sufficient to know which is the optimal mandate.
Model and Estimation

- Goal: recover distribution of preferences and risk types
- Observe: menu of guarantee choices, annuitants’ choices, and mortality
- How to think about choice of guarantee:
  - Longer guarantee $\rightarrow$ lower annuity payout while alive
  - Longer guarantee more attractive to someone who:
    - is more likely to die sooner (adverse selection)
    - has higher value for “wealth after death”
- Joint distribution of risk type and preferences identified from relationship between mortality and guarantee choice in the data
Key idea: ex-post mortality realization identifies risk type, so guarantee choice can be used to identify preference heterogeneity and correlation with risk

Intuition most clearly seen in two steps (estimated jointly in practice):

1. Individual’s (ex-post) mortality experience provides information on her (ex-ante) mortality rate
   - Individual who dies sooner more likely to have had a higher (ex-ante) mortality rate
   - This is where the assumption of no moral hazard (mortality not a function of guarantee choice) is important

2. Conditional on individual’s mortality rate, individual’s guarantee choice provides information on preferences and how they correlate with observed mortality
Guarantee Choice Model

- Standard annuity framework:
  - Fully rational, forward looking, risk averse retirees
  - Retirees with stock of wealth face stochastic mortality parameterized by $\alpha_i$
  - Time separable CRRA utility

$$U(\{c_t, w_t\}_{t=0}^T) = \sum_{t=0}^{T} \delta^t (s_t(\alpha_i)u(c_t) + \beta_i f_t(\alpha_i) b(w_t))$$

- Heterogeneity in
  - risk type, $\alpha_i$ – mortality rate
  - preferences, $\beta_i$ – weight placed on wealth at death

- Given $\alpha_i, \beta_i$, individual chooses annuity contract that maximizes lifetime utility (given optimal consumption path)

  - Optimal guarantee length increases with mortality ($\alpha_i$) and preference for wealth after death ($\beta_i$)
We are agnostic about structural interpretation of $\beta$ (bequests? ex ante regret? etc.)

Note that $\beta$ is not separately identified from risk aversion ($\gamma$), discount rate ($\delta$), etc. except by functional form.

- perform several robustness tests to make sure that our choice to throw all preference heterogeneity on $\beta$ is not what drives the results.

Gompertz survival function with shape parameter $\lambda$ and shift parameter $\alpha$

$\alpha$ and $\beta$ are joint lognormally distributed

CRRA utility function for both $u(c)$ and $b(w)$ with same coefficient of relative risk aversion

- implies that the optimal guarantee length does not depend on initial wealth (which we do not observe)

$\gamma = 3$

fraction of wealth annuitized $= 0.2$
Estimation

- Estimate (by ML) $\lambda$ using mortality data
- Calculate cutoff given $\lambda$ using guarantee choice model
- Estimate (by ML) distribution of $\alpha$ and $\beta$ using cutoffs, guarantee data, and mortality data
Data

- From one of the five largest annuity providers in the U.K.
- Data on guarantee choices, age, gender, and subsequent mortality experience
- All annuities purchased between January 1, 1988 and December 31, 1994 that were still active as of January 1, 1998
  - Mortality experience through December 31, 2005
- Limit analysis to:
  - Single-life annuities
  - Age at purchase of 60 or 65
  - Accumulated funds within the company
  - Nominal annuities
### Summary Statistics

<table>
<thead>
<tr>
<th></th>
<th>60 Females</th>
<th>65 Females</th>
<th>60 Males</th>
<th>65 Males</th>
<th>All</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. of obs.</td>
<td>1,800</td>
<td>651</td>
<td>1,444</td>
<td>5,469</td>
<td>9,364</td>
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<tr>
<td>Share of 0</td>
<td>14.0</td>
<td>16.0</td>
<td>15.3</td>
<td>7.0</td>
<td>10.2</td>
</tr>
<tr>
<td>Share of 5</td>
<td>83.9</td>
<td>82.0</td>
<td>78.7</td>
<td>90.0</td>
<td>86.5</td>
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<tr>
<td>Share of 10</td>
<td>2.1</td>
<td>2.0</td>
<td>6.0</td>
<td>3.0</td>
<td>3.2</td>
</tr>
<tr>
<td>Fraction who die:</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Entire sample</td>
<td>8.4</td>
<td>12.3</td>
<td>17.0</td>
<td>25.6</td>
<td>20.0</td>
</tr>
<tr>
<td>Among 0</td>
<td>6.7</td>
<td>7.7</td>
<td>17.7</td>
<td>22.8</td>
<td>15.7</td>
</tr>
<tr>
<td>Among 5</td>
<td>8.7</td>
<td>13.3</td>
<td>17.0</td>
<td>25.9</td>
<td>20.6</td>
</tr>
<tr>
<td>Among 10</td>
<td>8.1</td>
<td>7.7</td>
<td>16.1</td>
<td>22.9</td>
<td>18.5</td>
</tr>
</tbody>
</table>

- 5 year guarantee is by far the most common
- Individuals choosing 5 year guarantee have the highest mortality (pattern that also holds in various hazard models)
Annuity Pricing

- Linear prices: price is quoted as an annual annuity payout rate for each pound annuitized
- Rates at a given point in time only depend on (observed) guarantee, age, and gender
- Rates vary over time due to fluctuations in real interest rate, expected inflation, and expected mortality
- We obtained the rates used by the company at the beginning of each year
  - Could be useful variation, but need to account for temporal variation in the value function used by individuals to choose guarantees
  - Unclear how to model this temporal variation – e.g. do individuals’ interest and discount rates move with firm’s?
Ignore temporal variation and just use payment, interest, and inflation rates from January 1992:

<table>
<thead>
<tr>
<th>Guarantee Length</th>
<th>60 Females</th>
<th>65 Females</th>
<th>60 Males</th>
<th>65 Males</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0.1078</td>
<td>0.1172</td>
<td>0.1201</td>
<td>0.1330</td>
</tr>
<tr>
<td>5</td>
<td>0.1070</td>
<td>0.1155</td>
<td>0.1178</td>
<td>0.1287</td>
</tr>
<tr>
<td>10</td>
<td>0.1049</td>
<td>0.1115</td>
<td>0.1127</td>
<td>0.1198</td>
</tr>
</tbody>
</table>

To be consistent, use 1992 to calibrate other parameter values \((r = 0.043, \delta = 0.043, \pi = 0.05)\)

Results robust to other dates.
## Parameter Estimates

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Estimate</th>
<th>Std. Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\mu_\alpha$</td>
<td>60 Females</td>
<td>-5.76</td>
</tr>
<tr>
<td></td>
<td>65 Females</td>
<td>-5.68</td>
</tr>
<tr>
<td></td>
<td>60 Males</td>
<td>-4.74</td>
</tr>
<tr>
<td></td>
<td>65 Males</td>
<td>-5.01</td>
</tr>
<tr>
<td>$\sigma_\alpha$</td>
<td></td>
<td>0.054</td>
</tr>
<tr>
<td>$\lambda$</td>
<td></td>
<td>0.110</td>
</tr>
<tr>
<td>$\mu_\beta$</td>
<td>60 Females</td>
<td>9.77</td>
</tr>
<tr>
<td></td>
<td>65 Females</td>
<td>9.65</td>
</tr>
<tr>
<td></td>
<td>60 Males</td>
<td>9.42</td>
</tr>
<tr>
<td></td>
<td>65 Males</td>
<td>9.87</td>
</tr>
<tr>
<td>$\sigma_\beta$</td>
<td></td>
<td>0.099</td>
</tr>
<tr>
<td>$\rho$</td>
<td></td>
<td>0.881</td>
</tr>
<tr>
<td>No. of Obs.</td>
<td></td>
<td>9,364</td>
</tr>
</tbody>
</table>

Einav, Finkelstein, and Schrimpf (Stanford and NBER, MIT and NBER, MIT)

Welfare Cost of Asymm. Info.

Cowles, June 2007
Graphical illustration (for 65 Males)

Einav, Finkelstein, and Schrimpf (Stanford and NBER, MIT and NBER, MIT)

Cowles, June 2007

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Model Fit

Within sample fit:

- Fit guarantee choice proportions nearly perfectly
- Match unconditional probability of dying during the sample period very well
- Do not reproduce non-monotone relationship between guarantee choice and mortality

Out of sample fit:

- Life expectancies slightly higher than a proxy for market average (but also true within sample)
- EPDV of annuity payments ranges from 19.7 to 20.7
Parameter estimates allow us to calculate welfare in observed equilibrium and in various counterfactuals:

- Symmetric information (first best)
- Mandatory social insurance program (no choice over guarantee)

Quantify welfare in terms of wealth-equivalents (*weq*):

- The *weq* is wealth a person would need to have without an annuity so utility with annuity is the same
- Recall we use 100 for initial wealth, and 20% annuitized
- Higher *weq* $\Rightarrow$ higher welfare, *weq* < 100 $\Rightarrow$ prefer not to annuitize

Compare average *weq* under observed equilibrium and each counterfactual

- Convert difference to annual pounds using amount annuitized in 1998 (£6 billion)
- In the paper we also provide relative (to the relevant guarantee margin) welfare measure
## Welfare Estimates

<table>
<thead>
<tr>
<th></th>
<th>60 Females</th>
<th>65 Females</th>
<th>60 Males</th>
<th>65 Males</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Observed equilibrium:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average wealth-equivalent</td>
<td>100.24</td>
<td>100.40</td>
<td>99.92</td>
<td>100.17</td>
<td>100.16</td>
</tr>
<tr>
<td>Absolute difference (M £)</td>
<td>43.7</td>
<td>72.0</td>
<td>82.1</td>
<td>169.8</td>
<td>126.5</td>
</tr>
<tr>
<td><strong>Symmetric information:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average wealth-equivalent</td>
<td>100.38</td>
<td>100.64</td>
<td>100.19</td>
<td>100.74</td>
<td>100.58</td>
</tr>
<tr>
<td>Absolute difference (M £)</td>
<td>43.7</td>
<td>72.0</td>
<td>82.1</td>
<td>169.8</td>
<td>126.5</td>
</tr>
<tr>
<td><strong>Mandate 0 year guarantee:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average wealth-equivalent</td>
<td>100.14</td>
<td>100.22</td>
<td>99.67</td>
<td>99.69</td>
<td>99.81</td>
</tr>
<tr>
<td>Absolute difference (M £)</td>
<td>-30.1</td>
<td>-53.2</td>
<td>-73.7</td>
<td>-146.1</td>
<td>-107.3</td>
</tr>
<tr>
<td><strong>Mandate 5 year guarantee:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average wealth-equivalent</td>
<td>100.25</td>
<td>100.42</td>
<td>99.92</td>
<td>100.18</td>
<td>100.17</td>
</tr>
<tr>
<td>Absolute difference (M £)</td>
<td>2.8</td>
<td>6.0</td>
<td>1.7</td>
<td>1.6</td>
<td>2.1</td>
</tr>
<tr>
<td><strong>Mandate 10 year guarantee:</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Average wealth-equivalent</td>
<td>100.38</td>
<td>100.64</td>
<td>100.19</td>
<td>100.74</td>
<td>100.58</td>
</tr>
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<td>72.1</td>
<td>82.3</td>
<td>170.0</td>
<td>126.7</td>
</tr>
</tbody>
</table>
Symmetric Information (first best):

- Average welfare loss due to asymmetric information = £127 million annually (2% of premiums, 25% of relevant guarantee margin)
- Welfare loss is due to distortion in choices: under symmetric information, all individuals choose 10 year guarantee

Government Mandates:

- Mandate can increase welfare by £127 million or decrease by £107 million depending on which contract is mandated
- Not ex-ante obvious that 10 year guarantee would be optimal mandate (rarely chosen in equilibrium)
Robustness

- Bottom line welfare estimates are qualitatively similar across a wide range of specifications:
  - Functional form choices (mortality distribution; joint distribution of $\alpha$ and $\beta$)
  - Parameter choices (risk aversion; real interest rate; etc.)
  - Heterogeneity in other parameters
    - Allow greater flexibility in distribution of $\beta$ (based on observables or unobservables)
    - Alternative model with heterogeneity in $\gamma$ instead of $\beta$
  - Assumptions about liquidity of wealth portfolio outside annuity
  - A different population ("externals")
  - Allow a fraction of individuals to "always choose the middle"

- Results:
  - Welfare cost of asymm info: £127 in baseline; ranges from £115-£137, except when add 50% of wealth annuitized through social security (raises welfare cost to £257 - less flexibility)
  - Mandate: 10 year guarantee always the best.
Summary

- First attempt, to our knowledge, to empirically estimate welfare costs of asymmetric information in insurance markets and welfare consequences of mandatory social insurance.
- Cannot be estimated from reduced form equilibrium relationship between insurance coverage and risk occurrence.
- Welfare Estimates:
  - Asymmetric information in U.K. annuity market reduces welfare relative to a first best symmetric information benchmark by £127 million per year (2% of premiums)
  - Government mandates:
    - May reduce welfare by £107 million or increase by £127 million annually depending on contract chosen
    - Determining best mandate difficult ⇒ achieving welfare gains through mandatory insurance may be difficult in practice
Applications to Other Markets

- Similar approach could be applied in other insurance markets
  - Data requirements are same as what are frequently being used to detect asymmetric information in various markets (auto, health, long term care, etc.)
  - Choice model may have to be customized to the particular context

- Moral hazard:
  - Some other markets may also have little or no moral hazard (e.g. nursing home use)
  - For markets where moral hazard is likely to be important, additional source of variation in data probably required
  - Recent work using dynamic insurance data