Supplementary Material for Household portfolios and financial preparedness for retirement

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This document is part of the online supplementary material for Crawford, R. & O'Dea, C, "Household Portfolios and Financial Preparedness for Retirement". Section 1 gives an overview of the data we use and how to apply to get access to it. Section 2 gives details of the code, which is uploaded along with this Supplementary Material. Section 3 give some additional material which has been included to shorten the length of the typeset online Appendix.

1 Data Access

The data used in this paper are:

1. The English Longitudinal Study of Ageing (ELSA)
2. Linked National Insurance contribution records for ELSA respondents (NI data)

ELSA is available from the UK Data Service: `https://beta.ukdataservice.ac.uk/datacatalogue/series/series?id=200011`

The NI data is restricted administrative data that can only be accessed with special permission and in a secure environment. For this project the data was temporarily available in the secure enclave at the Institute for Fiscal Studies. Those wishing to access the ELSA-NI linked data need to apply to the ELSA Linked Data Access Committee (ELDAC). For more information see https://www.elsa-project.ac.uk/accessing-elsa-data. This application can be started through emailing elsadata@natcen.ac.uk requesting access to the 'National Insurance data, linked to ELSA'.

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We would be very happy to engage with any interested authors to discuss our experience getting access to, and using this data. Please email: rowena_c@ifs.org.uk and cormac.odea@yale.edu for details.

2 Code

This section gives detail on the code - first, in Section 2.1, on the dynamic model and then, in Section 2.2, on the analysis.

2.1 Dynamic Model

2.1.1 Code Structure

The model is solved using Fortran, supported by the Numerical Algorithms Group libraries. The Fortran Code contains 11 Fortran `.f90` files, each containing a single module, in turn containing several subroutines and functions. These are:

1. `globalvalues.f90`: sets globals (described below)
2. `incomeprocess.f90`: used to obtain the approximated earnings processes
3. `main.f90`: main files
4. `pension.f90`: contains the routines relevant to DC and DB pensions
5. `precisions.f90`: set the kind types
6. `routines_generic.f90`: A set of routines, which are generic in that they do not need `globalvalues.f90` but they do need `precicions.f90`
7. `routines_specific.f90`: A set of routines, which do need `globalvalues.f90` in addition to `precisions.f90`
8. `simulate.f90`: Simulates behavior
9. `types.f90`: A set of derived types
10. `types_generic.f90`: A set of derived types, which are generic in that they do not need `globalvalues.f90` but they do need `precicions.f90`
11. `vfi.f90`: Solves the model by value function iteration

2.1.2 NAG library

Some code relies on the (commerical) numerical library provided by the Numerical Algorithms Group. The commands in the attached code are those from the library's Mark 26 (the precise implementation is FLW6I26DE). The files contain (commented out) code labeled appropriately that can be used for NAG Mark 24.

2.1.3 Setting model parameters and reading data in

Data is fed to the Fortran program through two channels. The first is through globals declared in file `globalvalues.f90`. The second is through text files that are read in. We describe each of these in turn.

Globals

1. `whichModel` sets the asset structure of the model. This takes a value between 1 and 4 (with 4 being the baseline).

   (a) `whichModel=1` solves a model with only a single (risk-free) asset,

   (b) `whichModel=2` solves a model with the risk free asset and the Defined Contribution (DC) retirement account,

   (c) `whichModel=3` solves a model with the risk free asset and the DC retirement account, but deducts an assumed mortgage payment from income and, when estimating discount factors, does so excluding housing wealth,

   (d) `whichModel=4` is the baseline. It solves a model with the risk free asset, whose return is calculated comprising both cash and housing and the DC retirement account.

2. `solveForBeta` governs whether β is estimated. If set to `.true.` then β is estimated using the wealth data (results in Table 4, 5, 6, 9 and Figure 1 to 4 as well as Figure 6). If it is set to `.false.` the discount rate is set equal to the risk free rate of return.

3. `useInputtedBetaAsStartingPoint` governs whether a previously estimated set of β estimates is used as a starting point for estimation. These will be read in from a file call `foundbetas.txt`.

4. `usePreviousEstimatedBeta`, when set to `.true.` and when `solveForBeta` is set to `.false.` will solve the model with each household given its previously-estimated beta (read in via `foundbetas.txt`)

5. `noPenTaxAdv` is set to `.false.` in the baseline. When it is set to `.true.` the Defined Contribution tax advantage is removed (results in Table 7).

The rest of the globals in this document do not need to be changed for replicating the paper's results. They are (in self contained blocks), with each individual global labeled:

1. Some globals for approximation and simulation

2. The parameters that govern the housing return

3. Some switches for sensitivity/robustness

4. Some globals which will be set automatically depending on value of whichModel

5. Some globals that will be used in estimating the discount factor

Text files Data is also entered via text files which read in either parameters of the model, or features of the data. These are read in from lines 64 to 139 of `routines_specific.f90`. The first of these, included in our supplementary material is `points.txt`. These are parameters of the model. Its elements are outlined below. The other files cannot be shared as they either contain secure data, or could together be disclosive about selection into the secure data.

`points.txt` contains 59 elements. Most of these are features of the tax and benefit system (a spreadsheet points.xlsm is also included which shows what each element represents). Elements that do not pertain to the tax and benefit system are listed below:

- Elements 1 to 3: Number of grid points for i) non-pension wealth, ii) pension wealth and iii) earnings

- Element 4: Power of 10 in stopping criterion in tolerance.

- Element 5: Unemployment Pay.

- Element 6 to 7: Mean and standard deviation of DC return.

- Element 8: DC Tax Free Lump.

- Element 10: Quadrature dimension for integration over DC.
- Elements 13 to 22: DC contribution options.
- Element 41: A toggle for suppressing check of stochastic discount factors (for speed).
- Element 42: A toggle for suppressing check of value function sign (for speed).
- Element 43: Unemployment risk.
- Element 44: A toggle for whether we use the equivalence scale.
- Element 45: Proportion of pension that is inherited by surviving spouse.
- Element 45: A toggle for whether to multiply utility function by the equivalence scale. See utility function in paper..
- Element 58: Administrative load on annuity.

2.2 Code for Analysis of the Model Output

There are two files that conduct the anlaysis and produce the tables and figures in the paper.

1. `getdata.do`. This file draws together the outputs of the model simulations into one long dataset, with the version of the model identified by the variable "spec". Empirical data (on wealth holdings) from the ELSA and derived data on pension entitlements from the ELSA-NI data are matched in.

   The following is the mapping from the versions of the model as denoted in the code (the 'spec') and the versions of the model referenced in the paper.

   The main specifications referenced in the paper are:

   - Spec 1 is a single-asset model, where the single asset accrues only the risk-free rate of return. Discount factors are estimated by matching simulated wealth to a comprehensive measure of wealth in the data (cash, housing and pension wealth).
   - Spec 2 is a two-asset model (risk-free asset and tax-favored pension), where the non-pension asset accrues only the risk-free rate of return. Discount factors are estimated by matching simulated wealth to a comprehensive measure of wealth in the data (cash, housing and pension wealth).

- Spec 3 is a two-asset model (risk-free asset and tax-favored pension), where the non-pension asset accrues only the risk-free rate of return. Discount factors are estimated by matching simulated wealth to a measure of wealth that does not include housing wealth (cash and pension wealth).
- Spec 4 is the baseline. It is a two-asset model (risk-free asset and tax-favored pension), where the non-pension asset comprises both cash and housing and earns a combination of the return on each. Discount factors are estimated by matching simulated wealth to a comprehensive measure of wealth in the data (cash, housing and pension wealth).

The estimated discount factors from Spec 1, Spec 2 and Spec 4 are given in the first, second and third row, respectively of Table 4. Spec 3 is compared to baseline in Table 10 in Appendix B.

Other specifications (specs) in the paper are:

- Spec 11 is a version of Spec 1 but in which the discount factor is not estimated - it is set equal to the risk free rate. See Figure 5 (left).
- Spec 12 is a version of Spec 2 but in which the discount factor is not estimated - it is set equal to the risk free rate. See Figure 5 (middle).
- Spec 14 is a version of Spec 4 but in which the discount factor is not estimated - it is set equal to the risk free rate. See Figure 5 (right).
- Spec 15 is a version of Spec 1 but in which the discount factor is not estimated - it is set equal to the risk free rate and in which DB income is modeled as an exogenous process. See Appendix C, first row of Table 11.
- Spec 16 is a version of Spec 2 but in which the discount factor is not estimated - it is set equal to the risk free rate and in which DB income is modeled as an exogenous process. See Appendix C, second row of Table 11.
- Spec 17 is a version of Spec 3 but in which the discount factor is not estimated - it is set equal to the risk free rate and in which DB income is modeled as an exogenous process. See Appendix C, third row of Table 11.
- Spec 18 is a version of Spec 4 but in which the discount factor is not estimated - it is set equal to the risk free rate and in which DB income is modeled as an exogenous process. See Appendix C, fourth row of Table 11.

- Spec 23 solves and simulates the baseline model with the estimated discount factors per the baseline (spec 4), but in which the (risky) pension asset is no longer tax advantaged. See the second row of each panel of Table 7.
- Spec 26 solves and simulates the baseline model with the estimated discount factors per the baseline (spec 4), but there is no pension asset. See the third row of each panel of Table 7.
- Spec 40 solves and simulates the baseline model with the estimated discount factors per the baseline (spec 4), but there is no pension asset and the non-pension asset accrues only the return on cash (that is there is no accounting for housing). See the fourth row of each panel of Table 7.

2. `results.do` This file uses the dataset compiled by getdata.do and computes the results tables and figures in the paper. The particular Table and Figure created by each block of code is noted.

3 Additional Material

3.1 Annuity Rates

This section gives the (standard) formula for the actuarially fair annuity rate used in the paper.

Let j index education group (low, medium high) and let $\bar{j}$ index the combination of education levels of each member of a couple (and so takes one of nine values). Let $P_t^{\bar{j},c}$ be the present value of the expected payout by the annuity provider who, in period t, guarantees an annuity with a (real) value of £1 starting in period $t+1$ until the death of one member of a couple, with survivor benefits of £0.5 thereafter until the death of the survivor. Let $P_t^{j,\omega}$ for $\omega \in \{m, f\}$ be the expected payout for a unit annuity to a single male/female of education j.

We can write the present value of expected payout for the provider recursively as follows. In period $T-1$ we have:

$$
\begin{aligned}
P_{T-1}^{\bar{j},c} &= \frac{s_T^{j,m} s_T^{j,f}(1) + s_T^{j,m}(1 - s_T^{j,f})(0.5) + s_T^{j,f}(1 - s_T^{j,m})(0.5)}{1+r} \\
P_{T-1}^{j,m} &= \frac{s_T^{j,m}}{1+r} \\
P_{T-1}^{j,f} &= \frac{s_T^{j,f}}{1+r}
\end{aligned}
$$

In period $T-\tau$ we have

$$\begin{aligned}
P_{T-\tau}^{\bar{j},c} &= \frac{s_{T-(\tau+1)}^{j,m} s_{T-(\tau+1)}^{j,f}(1+P_{T-(\tau+1)}^{\bar{j},c})}{1+r} + \\
&\quad \frac{s_{T-(\tau+1)}^{m}(1-s_{T-(\tau+1)}^{j,f})(0.5)(1+P_{T-(\tau+1)}^{;m}) + s_{T-(\tau+1)}^{j,f}(1-s_{T-(\tau+1)}^{j,m})(0.5)(1+P_{T-(\tau+1)}^{j,f})}{1+r} \\
P_{T-\tau}^{j,m} &= \frac{s_{T-(\tau+1)}^{j,m}(1+P_{T-(\tau+1)}^{j,m})}{1+r} \\
P_{T-\tau}^{j,f} &= \frac{s_{T-(\tau+1)}^{j,f}(1+P_{T-(\tau+1)}^{j,f})}{1+r}
\end{aligned}$$

Let the annuity rate (for a couple of type $\bar{j}$) be $q_t^{\bar{j},c}$ be defined as follows:

$$q_t^{\bar{j},c} = \frac{1(1-z)}{P_t^{\bar{j},c}}$$

which is the value of the annual flow of income (which is paid until one member of the couple dies at which point the flow would half) which would lead to zero profits if an annuity was purchased for £1 when there are proportionate administrative costs of z.