

De Nardi, French & Jones (2010) - Why do the Elderly Save? The Role of Medical Expenses

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Brief description of replication of De Nardi, French, and Jones (2010). I make few notational changes, mainly that age is j here instead of t in the original. This is not intended as a full description of the model, so much as making it clear how the model is expressed in terms of the VFI Toolkit; for a full description of the model you should consult the original paper.

The model is a 31 period life-cycle model, representing ages 70 to 100. The model is essentially a standard consumption-savings exogenous life-cycle model, with some more complicated shock processes and parameters. The model has three exogenous states, a markov and an i.i.d on medical expenses, and a further markov on health. The model has ten permanent types, representing two genders (female and male) crossed with five income quintiles.

The household problem is,

$$V(a, h, \zeta, \xi) = \max_{c, a'} (1 + \delta h) \frac{c^{1-v} - 1}{1 - v} + s_{i,j,h} \beta E[V(a', h', \zeta', \xi') | h, \zeta] + (1 - s_{i,j,h}) \beta \theta \frac{(estate + k)^{1-v}}{1 - v}$$

subject to

$$\begin{aligned} c + a' &= a + aftertaxincome + govtransfers - m \\ govtransfers &= \max(0, cfloor + m - aftertaxincome) \\ taxableincome &= r * a + earnings_{i,j} \\ m &= \exp(m_{coef} f_{i,j,h} + sigma_{coef} f_{i,j,h} * \psi), \quad \psi = \zeta + \xi \\ \zeta' &= \rho \zeta + \epsilon, \quad \epsilon \sim N(0, \sigma_{\zeta, \epsilon}^2) \\ \xi &\sim N(0, \sigma_{\xi}^2) \\ a' &\geq 0 \end{aligned}$$

where c is consumption, a is assets, $m_{i,j,h}$ is medical expenses. $earnings_{i,j}$ is exogenous earnings, and depends on age, gender and income quintile.

The calculation of *aftertaxincome* from *taxableincome* is omitted here but is just a straightforward calculation based on seven tax brackets and associated marginal tax rates.

Note, the government lump-sum transfer *govtransfers* is typically zero, and will only be positive if it is needed for the household to reach the consumption floor *cfloor* (after accounting for m and *aftertaxincome*). If *govtransfers* > 0 , then it is enforced that $c = cfloor$ and $a' = 0$ (not shown in eqns above).

$estate$ is a' after deducting estate taxes, $estate = \max(0, (1 - \tau_e) * (a' - estateexemption))$; estate taxes have a tax rate τ_e and an exemption $estateexemption$ (DFJ2010 called these $tautilde$ and $xtilde$, respectively).

Because VFI Toolkit cannot handle conditional survival probabilities that depend on the state, we have to implement $s_{i,j,h}$ in an alternative fashion. We use just β as the discount factor. We extend h to have two further values, $h = 2$ is death and $h = 3$ is dead (we also need to give the warm-glow of bequests with probability $s_{i,j,h}$, hence we need to distinguish the period of death, when the warm-glow of bequests is received, from 'dead' which just gives return of zero). We then set up the transitions between $h = 0$ (good health) and $h = 1$ (bad health) following the health transition probabilities of DFJ2010, and set transition probabilities from $h = 0, 1$ to $h = 2$ following (one minus the) conditional survival probabilities $s_{i,j,h}$. Transitions from $h = 2$ to $h = 3$ occur with probability one, and $h = 3$ is an absorbing state (so probability 1 of staying in it once you are there). This is slightly wasteful computationally (we will end up carrying around all the dead households), but model is easy enough to solve that it won't be an issue.

The main complication for setting up this model is that many of these parameters depend on age, permanent type (both gender and income quintile), and some even depend on health status (good or bad). This means that the number of parameters in this model is over two-thousand. This is not difficult per se (you largely just set up the parameters as age-depedent vectors, and set different ones for each permanent type, the code will handle them trivially)¹ but it does take quite a lot of lines of code to write out.

References

Mariacristina De Nardi, Eric French, and John Jones. Why do the elderly save? the role of medical expenses. Journal of Political Economy, 118(1), 2010. doi: <https://doi.org/10.1086/651674>.

¹Depdence on health status is trickier, but since it is just good or bad we just create two parameters, and then in the ReturnFn etc. we juse have an if-statement on healt status that selects which of the two is relevant.