Managing Retirement Risks with Reverse Mortgage Loans and Long-Term Care Insurance

Adam W. Shao[1], Hua Chen[2], Michael Sherris[1]

1. ARC Centre of Excellence in Population Ageing Research (CEPAR)
University of New South Wales, Australia

2. Temple University, U.S.

11th International Longevity Risk and Capital Markets Solutions Conference
7 - 9 September 2015, Lyon France

ARC CENTRE OF EXCELLENCE IN POPULATION AGEING RESEARCH

Topic Coverage

Topic coverage

Research Motivation

- Two important risks in individuals' retirement planning: **health shocks** and house price risk
- LTC costs are increasingly higher and the increasing trend is projected to continue (Congressional Budget Office, 2004; Shi and Zhang, 2013)
- LTC costs funding scheme
  - Australia: lifetime stop-loss mechanism
  - U.S.: Medicaid and Medicare + private insurance + personal payment
- The private LTC insurance market is an important supplement (Glendinning *et al.*, 2004; Colombo *et al.*, 2011)
- Important to take into account health risk in a lifecycle model (Ameriks *et al.*, 2011; Yogo, 2009)

Research Motivation

- Two important risks in individuals' retirement planning: health shocks and **house price risk**
- Large component of wealth in home equity (Home-ownership rate: 80% for 65^{+})
- House price dynamics in the optimal portfolio choice field
  - Not taking into account housing asset (Ameriks *et al.*, 2011)
  - Unrealistic model: Deterministic, Binomial, Log-Normal (Yogo, 2009; Davidoff, 2010; Yao and Zhang, 2005; Li and Yao, 2007)
- Motivation for use of a more realistic time series model, borrowing ideas from studies in other fields (e.g., Chen *et al.*, 2010; Lee *et al.*, 2012; Yang, 2011)
- Path dependent house price dynamics - complexity in lifecycle model
- Asset rich but cash poor: Role for equity-release products

Research Questions

- How can retirees use reverse mortgage and private long-term care insurance (LTCI) to better manage retirement risks?
- What is the impact of house price and health risks on retirees' optimal portfolio choice?
- What is the welfare gain when reverse mortgage and/or private LTCI are added to the menu?
- What are the interacting effects between reverse mortgage and private LTCI?

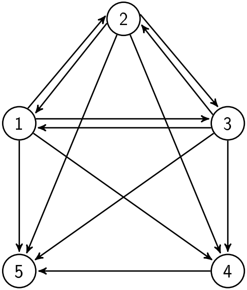
Topic coverage

Overiew

- Financial assets
  - Risk-free asset
  - House
  - Reverse mortgage loans
  - Long-term care insurance
- Risks
  - Health dynamics and mortality risk: Markov model
  - House price: ARIMA-GARCH

Health Dynamics

- 1 - Healthy (difficulty in no ADLs)
- 2 - Mildly disabled (difficulty in 1 ADL) and staying at home
- 3 - Severely disabled (difficulty in 2+ ADLs) and staying at home
- 4 - Institutionalized
- 5 - Dead



- Assumption: moving into a nursing home is non-reversible
- Health transition rates/probabilities estimated using GLM (Fong *et al.*, 2013)
- Data: Health and Retirement Studies (HRS)

Long-Term Care Insurance

- LTC costs
  - depend on health states $i \in \{2, 3, 4\}$
  - increase at the inflation rate f_s

$$LTC_t^i = LTC^i \exp\left(\sum_{s=1}^{t} f_s\right) \tag{1}$$

- Public LTC insurance: $GI = 10\%$ (Different from empirical 71% covered by Medicare and Medicaid)
- Private LTC insurance
  - paying premium at age 65
  - choosing coverage $[0,\ 1 - GI]$
  - actuarially fair premium calculated using estimated health dynamics
  - funds LTC costs when severely disabled (State 3) or moving to LTC facilities (State 4)

House Value Model

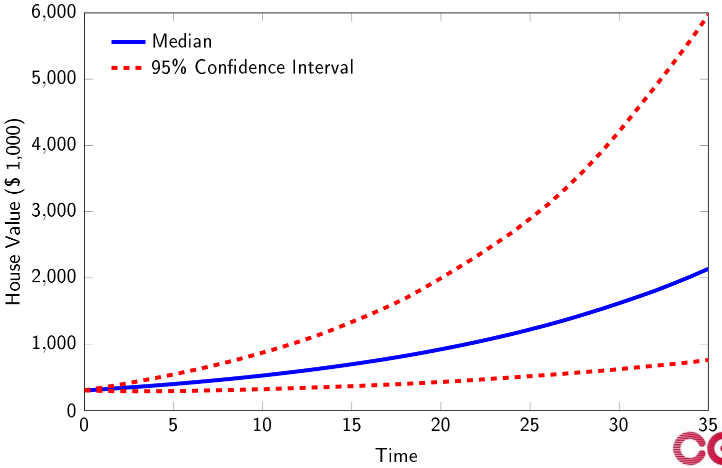
- Housing consumption: Lower when moving into LTC facilities
- Capital Growth: ARMA-GARCH

$$
\begin{aligned}
y_t &= \psi_y + \sum_{i=1}^{p} \phi_i y_{t-i} + \sum_{j=1}^{q} \theta_j z_{t-j} + z_t, \\
\sigma_t^2 &= \psi_{\sigma^2} + \sum_{i=1}^{m} \mu_i \sigma_{t-i}^2 + \sum_{j=1}^{n} \nu_j z_{t-j}^2,
\end{aligned} \tag{2}
$$

  - y_t: house price growth rate
  - σ_t^2: conditional variance given information up to $t-1$
  - We select the optimal lags in the ARMA-GARCH model (Li *et al.*, 2010; Chen *et al.*, 2010)
  - The optimal specification is a ARMA(2,4)-GARCH(1,1)

House Price Projection

Figure. House value projections based on the ARMA(2,4)-GARCH(1,1) model of house value growth rates. The current house value is assumed to be \$300,000.



Reverse Mortgage

Reverse mortgage loan balance

$$RMLB_t = \begin{cases} RM \cdot e^{(r_f+\pi)t}, & \Lambda_t \in \{1,2,3\} \\ 0, & \Lambda_t \in \{4,5\} \end{cases} \tag{3}$$

- RM: lump sum reverse mortgage loan at age 65
- r_f: risk-free rate
- π: mortgage insurance premium rate for providing no-negative equity guarantees (Shao *et al.*, 2015; Chen *et al.*, 2010)
- Repayment is triggered when admitted to LTC facilities (State 4) or dead (State 5)

$$\min\{RMLB_t,\ HV_t\} \tag{4}$$

Topic coverage

Utility and Bequest

- Contemporary utility

$$U(C_t, H_t) = \frac{\left(C_t^{\eta} H_t^{1-\eta}\right)^{1-\gamma}}{1-\gamma}, \tag{5}$$

  - C_t: non-housing consumption
  - H_t: housing consumption
  - γ: the risk aversion parameter
  - η: Cobb-Douglas aggregation parameter

- Bequest motive

$$B(W_t) = \beta \frac{W_t^{1-\gamma}}{1-\gamma}, \tag{6}$$

  - β: bequest motive strength
  - W_t: bequest wealth

Utility Maximization

$$V(t,i,G_t)=\max_{O_t}\mathbb{E}\left[U(C_t,H_t)+\alpha\left(\sum_{j\neq 5}p^{ij}_{x+t}V(t+1,j,G_{t+1})+p^{i5}_{x+t}B(W_{t+1})\right)\,\middle|\,\mathcal{F}_t\right]$$

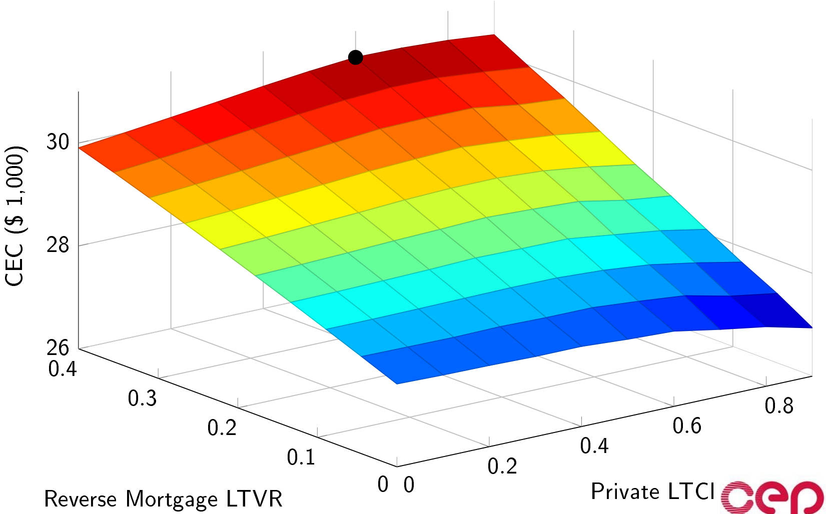
s.t. Wealth Dynamics

- $O_t=(C_t,\ RM,\ PI)$: choice variables
- i: health state
- $G_t=(B_t,\ HV_{1:t})$: non-health state variables
- p^{ij}_{x+t}: annual probability of transitions from State i to State j
- $V(t,i,G_t)$: value function
- Optimization methods:
    - **Endogenous Grid Method** to avoid time-consuming root-finding routine
    - **Regression method** to allow for path dependent house price dynamics and avoid the "Curse of Dimensionality"

Topic coverage

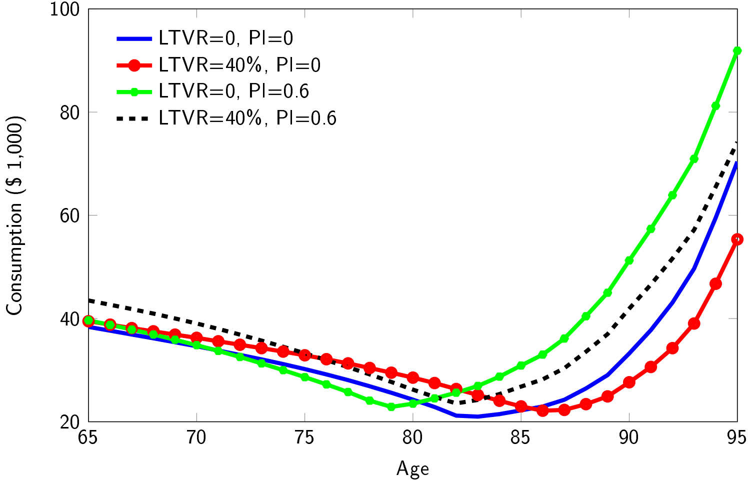
Optimal RM and Private LTCI

Certainty Equivalent Consumption (CEC) for a 65-year-old female endowed with $500k initial liquid wealth and a house worth $300k.



Optimal Consumption Path

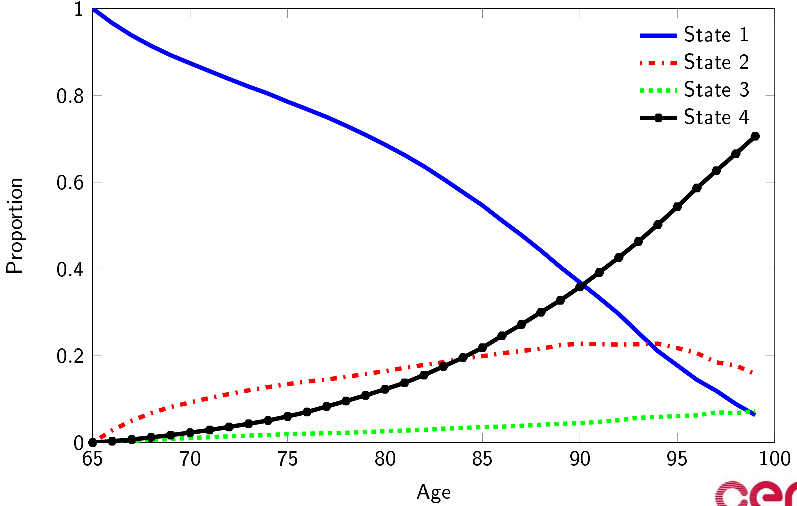
$500k initial liquid wealth and a house worth $300k



- 'LTVR': ratio of reverse mortgage loan to house value
- 'PI': long-term care insurance coverage

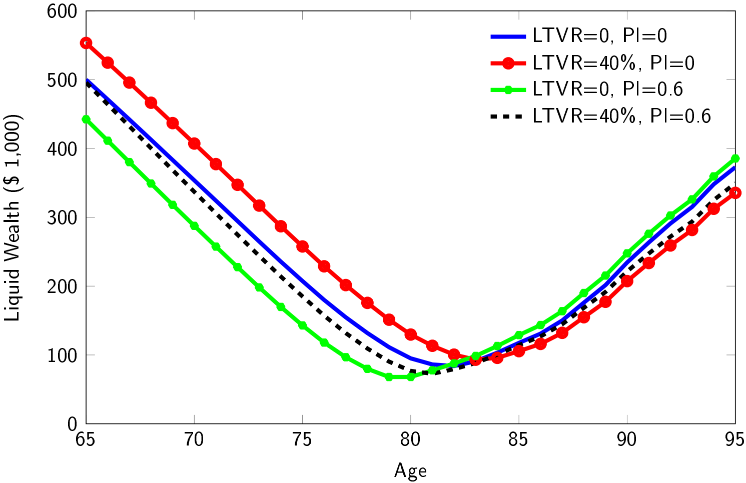
Proportion of the Alive

Starting with a cohort of 100,000 65-year-old healthy females



Optimal Liquid Wealth Path

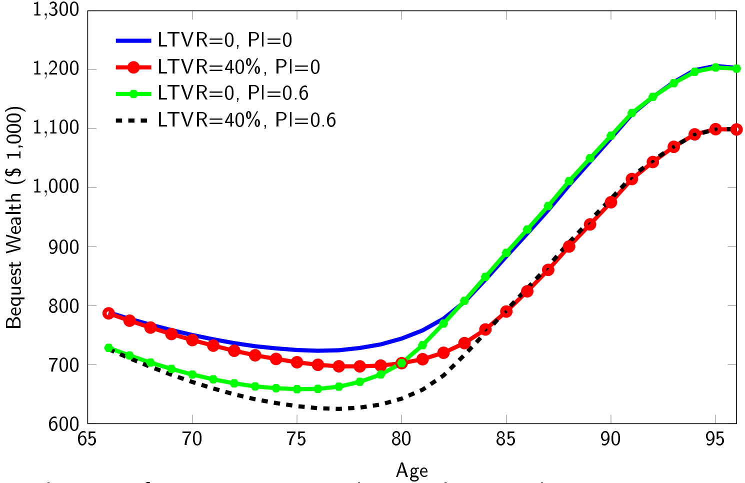
$500k initial liquid wealth and a house worth $300k



- 'LTVR': ratio of reverse mortgage loan to house value
- 'PI': long-term care insurance coverage

Optimal Bequest Wealth Path

\$500k initial liquid wealth and a house worth \$300k



- 'LTVR': ratio of reverse mortgage loan to house value
- 'PI': long-term care insurance coverage

Welfare Analysis

Table. Percentage increase of the value function achieved when retirees have access to reverse mortgage loans and/or long-term care insurance.

	No Private LTCI	**With Private LTCI**
No Reverse Mortgage	0	0
With Reverse Mortgage	5.74%	7.07%

Table. Retirees' willingness to pay for having access to reverse mortgage loan and/or long-term care insurance ($1,000).

Reverse Mortgage	**Private LTCI**	**Both**
72.48	-4.91	90.20

- Home equity substitutes LTCI
- Bundle reverse mortgage and private LTCI

Topic coverage

Conclusion

- We use a discrete time life-cycle model, taking into account health shocks and house price risk
- A more realistic (path dependent) house price process is used
- Optimal portfolio choice with respect to consumption, reverse mortgage, and private long-term care insurance
- Welfare gains for having access to both products
- Insights into product designs of combining reverse mortgage and private LTCI: Demand side
- What about supply side?
  - Reduced adverse selection
  - E.g., people with bad health – higher risk for LTCI but lower risk for reverse mortgage

References

Ameriks, J., Caplin, A., Laufer, S., and van Nieuwerburgh, S. (2011). The joy of giving or assisted living? Using strategic surveys to separate public care aversion from bequest motives. *Journal of Finance*, **66**(2), 519–561.

Chen, H., Cox, S. H., and Wang, S. S. (2010). Is the home equity conversion mortgage in the United States sustainable? Evidence from pricing mortgage insurance permiums and non-recourse provisions using the conditional Esscher transform. *Insurance: Mathematics and Economics*, **46**(2), 371–384.

Colombo, F., Llena-Nozal, A., Mercier, J., and Tjadens, F. (2011). *Help wanted? Providing and paying for long-term care*. OECD Health Policy Studies. OECD Publishing, Paris, France.

Congressional Budget Office (2004). Financing long-term care for the elderly. Availabe at http://www.cbo.gov/publication/15584.

Davidoff, T. (2010). Home equity commitment and long-term care insurance demand. *Journal of Public Economics*, **94**, 44–49.

Fong, J. F., Shao, A. W., and Sherris, M. (2013). Multi-state actuarial models of functional disability. UNSW Australian School of Business Research Paper No. 2013ACTL14.

Glendinning, C., Davies, B., Pickard, L., and Comas-Herrera, A. (2004). *Funding long-term care for older people: Lessons from other countries*. Joseph Rowntree Foundation, York, U.K.

Lee, Y.-T., Wang, C.-W., and Huang, H.-C. (2012). On the valuation of reverse mortgages with regular tenure payments. *Insurance: Mathematics and Economics*, **51**(2), 430–441.

Li, J. S.-H., Hardy, M. R., and Tan, K. S. (2010). On pricing and hedging the no-negative-equity guarantee in equity release mechanisms. *Journal of Risk and Insurance*, **77**(2), 499–522.

Li, W. and Yao, R. (2007). The life-cycle effects of house price changes. *Journal of Money, Credit and Banking*, **39**(6), 1375–1409.

Shao, A. W., Hanewald, K., and Sherris, M. (2015). Reverse mortgage pricing and risk analysis allowing for idiosyncratic house price risk and longevity risk. *Insurance: Mathematics and Economics*, **63**, 76–90. Forthcoming, DOI: 10.1016/j.insmatheco.2015.03.026.

Shi, P. and Zhang, W. (2013). Managed care and health care utilization: Specification of bivariate models using copulas. *North American Actuarial Journal*, **17**(4), 306–324.

Yang, S. S. (2011). Securitisation and tranching longevity and house price risk for reverse mortgage products. *The Geneva Papers on Risk and Insurance-Issues and Practice*, **36**(4), 648–674.

Yao, R. and Zhang, H. H. (2005). Optimal consumption and portfolio choices with risky housing and borrowing constraints. *Review of Financial studies*, **18**(1), 197–239.

Yogo, M. (2009). Portfolio choice in retirement: Health risk and the demand for annuities, housing, and risky assets. National Bureau of Economic Research Working Paper Series No. 15307.