Reverse Mortgage Loans: A Quantitative Analysis

Makoto Nakajima[1] Irina A. Telyukova[2]

[1]Federal Reserve Bank of Philadelphia
[2]University of California, San Diego

July 8, 2011

In Progress

SED 2011, Ghent

Background

- Many people die with positive wealth (retirement saving puzzle).
- Nakajima and Telyukova (2011): when considering net worth profiles jointly with homeownership, housing and nonhousing assets, and equity debt, the puzzle is accounted for by
  - Strong bequest motives
  - Financial and nonfinancial benefits of homeownership
  - Precautionary savings for lifetime uncertainty and medical expense risk
  - Housing boom 1996-2006
- Retirees like to stay in their homes late into the life-cycle, but become constrained later in life by inability to borrow against equity, and may be forced to sell by large shocks.
- If that's the case, reverse mortgage loans (RML) have potential to relax the constraint / benefit constrained homeowners.

Take-up Rate of Reverse Mortgage Loans

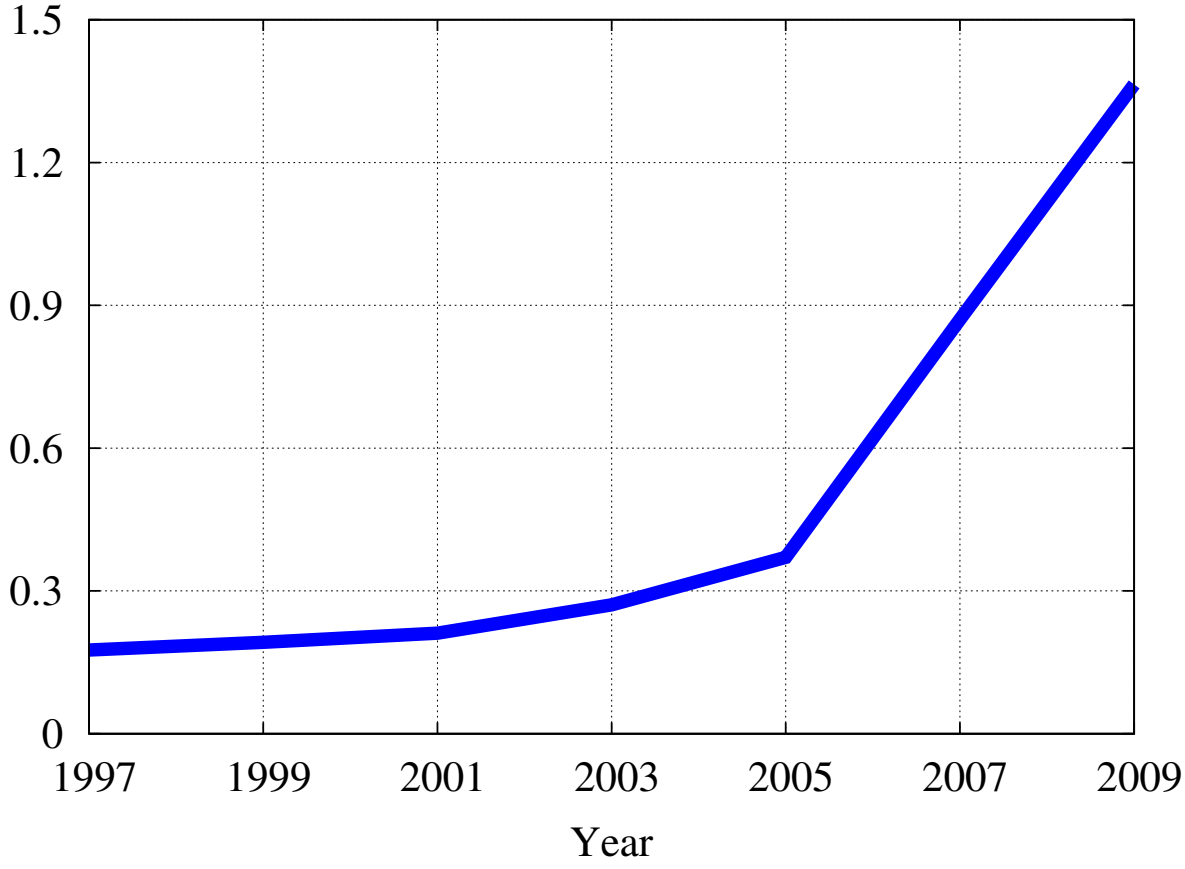


Figure: Percentage of elderly homeowners with reverse mortgage loans.

- Small (1.3%) take-up rate so far.
- Rapid growth during the last housing boom.

Questions

- Who benefits from reverse mortgages? How large are the welfare gains?
- Why is the take-up rate of reverse mortgages so low?
- How to "improve" reverse mortgage loans?

This Paper

- Use a structural model of saving, consumption, housing decisions in retirement, where retirees face various kinds of shocks
- Introduce reverse mortgage loans.
- Compare model economy with and without RML's.
  - Study the effects of RML's on borrower behavior.
  - Calculate welfare gains from availability of RML's.
- Counterfactual experiments: assess the impact on RML demand of
  - different sources of uncertainty;
  - house price expecttions;
  - bequest motive;
  - housing market boom;
  - insurance against house price shocks in the RML contract;
  - HECM Saver (newly reformed RML contract).
- (Eventually) investigate the optimal design of RML's.

Result Preview

- Beneficiaries: especially homeowners with
  - low income
  - worse health
  - lower wealth (current mortgage borrowers)
- RML demand dampened by:
  - bequest motives
  - risk of being forced into nursing home
  - house price uncertainty
- Contract changes to increase demand:
  - make RML a recourse loan (eliminate insurance aspect)
  - lower costs of insurance

Related Literature

- Reverse mortgage loans: Shan (Forthcoming), Michelangeli (2010), Redfoot et al. (2007), Davidoff and Welke (2007), Caplin (2002)
- Retirement saving puzzle / annuity puzzle: Venti and Wise (2004), Hurd (1989), De Nardi et al. (2010), Ameriks et al. (2011), Nakajima and Telyukova (2011)
- Models of mortgage choice: Chambers et al. (2009), Campbell and Cocco (2003)
- Annuity puzzle: Yaari (1965), Olivia S. Mitchell (1999), Lockwood (forthcoming), Turra and Mitchell (2004), Pashchenko (2004)

Basics of Reverse Mortgage Loans

- Borrow against already accumulated home equity (reverse).
- Government-administered HECM dominates the market ($\geq 90\%$).
- Borrower at least 62 years old.
- Due when all household members (i) die or (ii) move out.
- No interest payment or amortization until loan is due.
- Large upfront (7%) and flow costs.
- Non-recourse: insured by the government (with premium).
- Principal and interest paid by sale of the house.
- Variety of payment options:
  (i) line-of-credit (by far the most popular) , (ii) term, (iii) tenure

Model: Overview

- Life-cycle model of retirees:
  - Consumption-saving (c, a).
  - Housing (h; dual purpose: consumption and saving).
  - Warm-glow bequest motive.
  - Mortgage choice (conventional vs reverse mortgage loans).
- Subject to various shocks:
  - Health status (m)
  - Mortality ($m' = 0$)
  - Out-of-pocket medical expenditures (x)
  - Compulsory moving (n)
  - House price (p)
- Homeowner's decision:
  - At the initial period, whether to take reverse mortgage loan or not.
  - Remain an owner or become a renter (o).
  - Save, or borrow against home equity (a).
- Renter's decision:
  - Size of house to rent ($\widetilde{h}$).
  - Save (cannot borrow) (a).

Model: Renter's Problem

$$V(i, j=0, b, m, x, p, h=0, a) = \max_{\widetilde{h}, a' \geq 0} \Big\{ u(c, \widetilde{h}, 0) + \beta \sum_{m'>0, x', p'} \pi^m_{m,m'} \pi^x_{i+1,m',x'} \pi^p_{p,p'} V(i+1, 0, b, m', x', p', 0, a') + \beta \pi^m_{m,0} v(a') \Big\} \quad (1)$$

subject to:

$$\widetilde{c} + a' + r_h \widetilde{h} p + x b = (1 + r) a + b \quad (2)$$

$$c = \begin{cases} \max\{\underline{c}, \widetilde{c}\} & \text{if } a' = 0 \text{ and } \widetilde{h} = \underline{h} \\ \widetilde{c} & \text{otherwise} \end{cases} \quad (3)$$

- $\underline{c}$: consumption floor supported by the government.

Model: Preferences

Period utility function:

$$u(c, h, o) = \frac{\left(c^{\eta}(\omega_o h)^{1-\eta}\right)^{1-\sigma}}{1-\sigma} \tag{4}$$

- Utility benefit of ownership (ω_o).

Utility from bequest:

$$v(a) = \gamma \frac{(a+\zeta)^{1-\sigma}}{1-\sigma}. \tag{5}$$

Model: Homeowner's Problem: Tenure Decision

$$V(i,j,b,m,x,p,h,a) = \pi^n_{i,m} V_0(i,j,b,m,x,p,h,a) + (1-\pi^n_{i,m}) \max\{V_0(i,j,b,m,x,p,h,a), V_1(i,j,b,m,x,p,h,a)\} \tag{6}$$

- $\pi^n_{i,m}$ probability of compulsory moving shock.
- $V_0(.)$ is value conditional on moving out and becoming a renter.
- $V_1(.)$ is value conditional on staying in the same house.

Model: Homeowner's Problem (No RML): Staying

$$V_1(i, j = 0, b, m, x, p, h, a) = \max_{a'} \{u(c, h, 1)$$
$$+ \beta \sum_{m' > 0, x', p'} \pi^m_{m,m'} \pi^x_{i+1,m',x'} \pi^p_{p,p'} V(i + 1, 0, b, m', x', p', h, a')$$
$$+ \beta \pi^m_{m,0} v(hp + a') \} \quad (7)$$

subject to:

$$c + a' + xb + hp\delta = (1 + \widetilde{r})a + b \quad (8)$$
$$a' \geq -hp(1 - \lambda_i) \quad (9)$$
$$\widetilde{r} = \begin{cases} r & \text{if } a \geq 0 \\ r + \iota_m & \text{if } a < 0 \end{cases} \quad (10)$$

- λ_i: age-dependent collateral constraint.
- $hp\delta$: Maintenance cost.

Model: Homeowner's Problem (No RML): Moving-Out

$$V_0(i, j = 0, b, m, x, p, h, a) = \max_{a' \geq 0} \{u(c, h, 1)$$

$$+ \beta \sum_{m' > 0, x', p'} \pi^m_{m,m'} \pi^x_{i+1,m',x'} \pi^p_{p,p'} V(i + 1, 0, b, m', x', p', 0, a')$$

$$+ \beta \pi^m_{m,0} v(a') \} \quad (11)$$

subject to (10) and:

$$\widetilde{c} + a' + xb + hp(\kappa + \delta) = hp + (1 + \widetilde{r})a + b \quad (12)$$

$$c = \begin{cases} \max\{\underline{c}, \widetilde{c}\} & \text{if } a' = 0 \\ \widetilde{c} & \text{otherwise} \end{cases} \quad (13)$$

- $hp\kappa$: house selling cost.
- $\underline{c}$: consumption floor supported by the government.

Model: Reverse Mortgage

- Households decide whether to take a RML, in the initial period.
- Line-of-credit option: by far the most popular choice
  - $(-)$ Upfront and flow costs.
  - $(+)$ Relaxed collateral constraint.
  - $(+)$ Non-recourse (insurance against house price shocks).

Model: Reverse Mortgage Loan with Line-of-Credit Option

- Upfront cost $h(\nu_i + \nu_\ell)$ (financed by the loan itself).
- Interest and other flow costs for debt: $\widetilde{r} = r + \iota_\ell + \iota_i$.
- Collateral constraint is λ_ℓ. Not age-dependent.
- Non-recourse loan.

$$w(i, p, h, a') = \begin{cases} \max\{hp - h(\nu_\ell + \nu_i)(1 + \widetilde{r})^{i-1}, 0\} + a' & \text{if } a' \geq 0 \\ \max\{hp - h(\nu_\ell + \nu_i)(1 + \widetilde{r})^{i-1} + a', 0\} & \text{if } a' < 0 \end{cases} \tag{14}$$

Calibration Strategy

- Construct from data, mainly HRS:
  - Type distribution of age-65 households in 1996.
  - Health status and mortality shocks.
  - Out-of-pocket medical expenditure shocks.
  - Moving (nursing home) shocks.
  - House price shocks.

- Use estimated parameters from Nakajima and Telyukova (2011). (Estimated to match jointly life-cycle facts on retirees' net worth, housing and nonhousing assets, homeownership rate, home equity debt.)

- Parameters associated with RMLs:
  - Most are taken from data.
  - Use λ_ℓ to match the observed take-up rate.

Calibration: Health Status Transition

Health status transition (age 65)				
	Dead	Excellent	Good	Poor
Excellent	1.3	72.8	21.5	4.4
Good	2.2	25.8	53.3	18.7
Poor	9.6	6.1	20.7	63.7

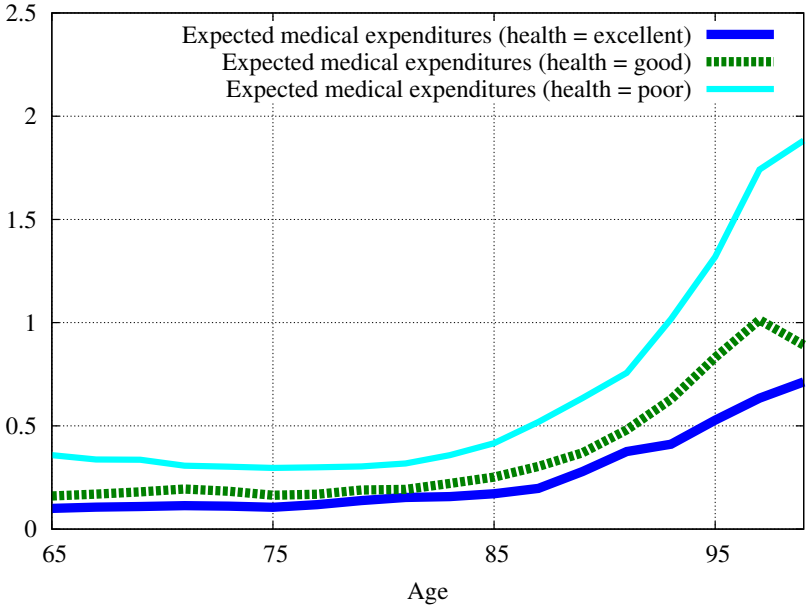
Health status transition (age 75)				
	Dead	Excellent	Good	Poor
Excellent	3.9	60.1	26.9	9.2
Good	6.6	21.1	46.9	25.4
Poor	16.3	3.8	17.6	62.3

Health status transition (age 85)				
	Dead	Excellent	Good	Poor
Excellent	10.5	46.8	27.1	15.6
Good	14.7	17.0	37.8	30.5
Poor	28.8	5.1	13.2	52.9

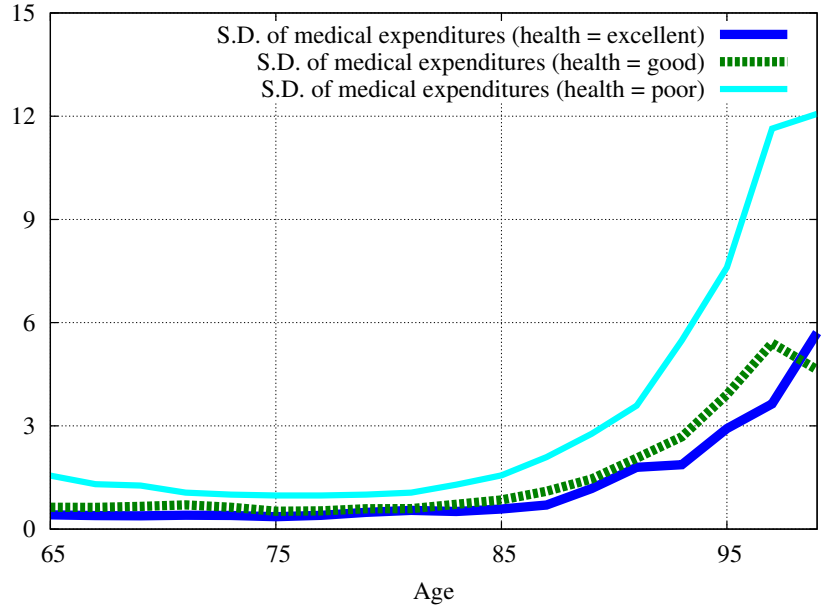
Health status transition (age 95)				
	Dead	Excellent	Good	Poor
Excellent	28.5	29.5	19.8	22.3
Good	32.9	12.9	26.8	27.5
Poor	56.9	4.2	13.6	25.3

- Mortality rate increases with age and decreases with health.
- Health status is persistent, but persistence deteriorates with age.

Calibration: Medical Expenditure Shocks



(a) Expected mean



(b) Standard deviation

Figure: Distribution of out-of-pocket medical expenditures. Source: HRS.

- Higher mean and variance for the less healthy.
- Substantial increase towards the end of life
  (De Nardi et al. (2010), Nakajima and Telyukova (2011))

Calibration: Moving Shocks

Table: Probability of Moving to Nursing Home (Percent)

	Health status		
Age	Excellent	Good	Poor
65	0.15	0.30	0.86
75	0.59	1.47	3.03
85	5.16	7.66	11.19
95	25.32	22.07	25.13

- Increases with age.
- Decreases with health status.

Calibration: Initial Type Distribution (Age 65)

Health status	
1 (excellent)	0.50
2 (good)	0.27
3 (poor)	0.23
Tenure	
Homeowner	0.89
Renter	0.11
Net financial asset position	
Saver	0.82
Borrower	0.18

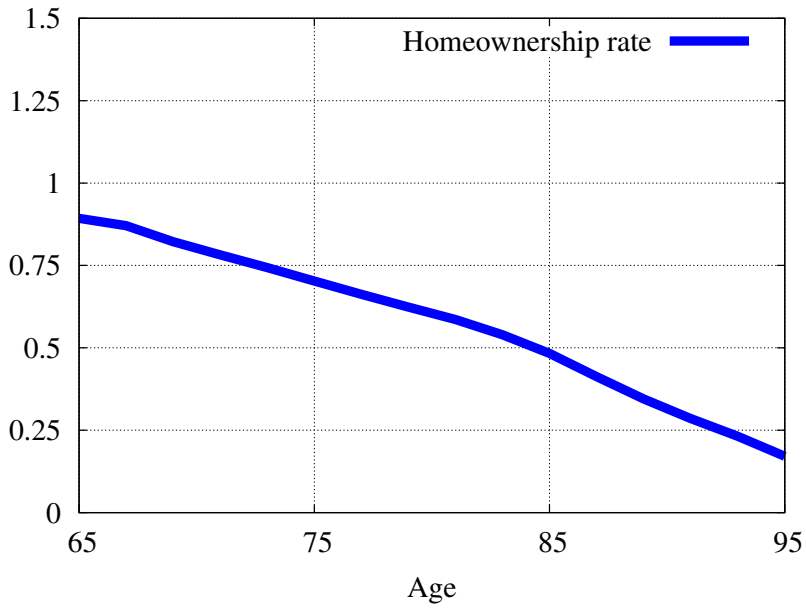
Calibration: Parameters (Not Related to Mortgages)

Parameter	Description (Annualized)	Value
β	Discount factor (biennial)	0.9148
η	Consumption aggregator	0.8489
σ	Coefficient of RRA	2.6826
ω_1	Extra-utility from ownership	3.0219
γ	Strength of bequest motive	3.7716
ζ	Curvature of utility from bequests	9675
$\underline{c}$	Consumption floor per adult	10215
δ	Maintenance cost	0.017
κ	Selling cost of the house	0.066
ρ_p	Persistence of house price shock	0.811
σ_p	Standard deviation of house price shock	0.142

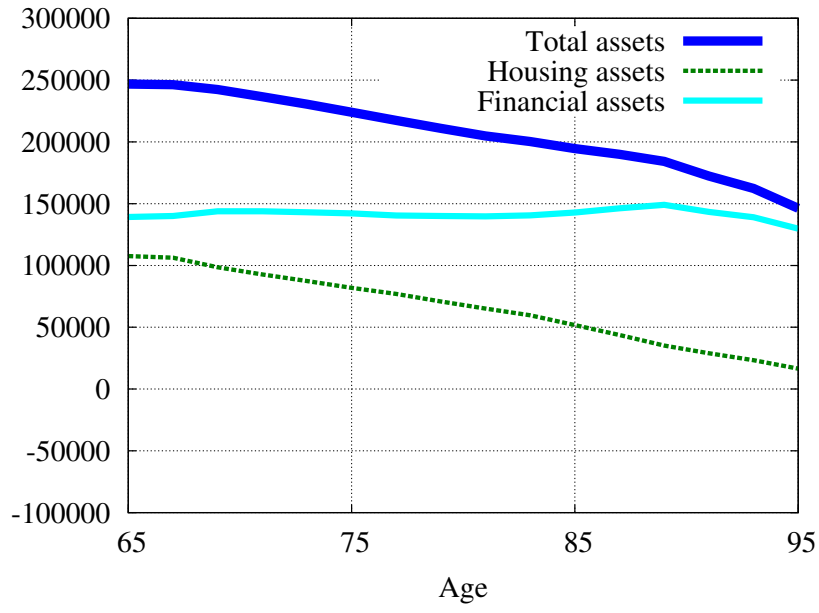
Calibration: Parameters (Mortgages)

Parameter	Description (Annualized)	Value
r	Saving interest rate	0.040
ι_m	Margin for conventional mortgage	0.016
λ_{65}	Collateral constraint for age-65	0.180
λ_{75}	Collateral constraint for age-75	0.913
λ_{85}	Collateral constraint for age-85	0.949
λ_{99}	Collateral constraint for age-99	0.984
ι_i	Annual mortgage insurance premium	0.0125
ν_i	Upfront cost of mortgage insurance premium	0.020
ι_ℓ	Margin for reverse mortgage	0.016
ν_ℓ	Upfront cost for reverse mortgage	0.050
λ_ℓ	Collateral constraint for reverse mortgage	0.160

Results: Properties of Baseline Model without RML



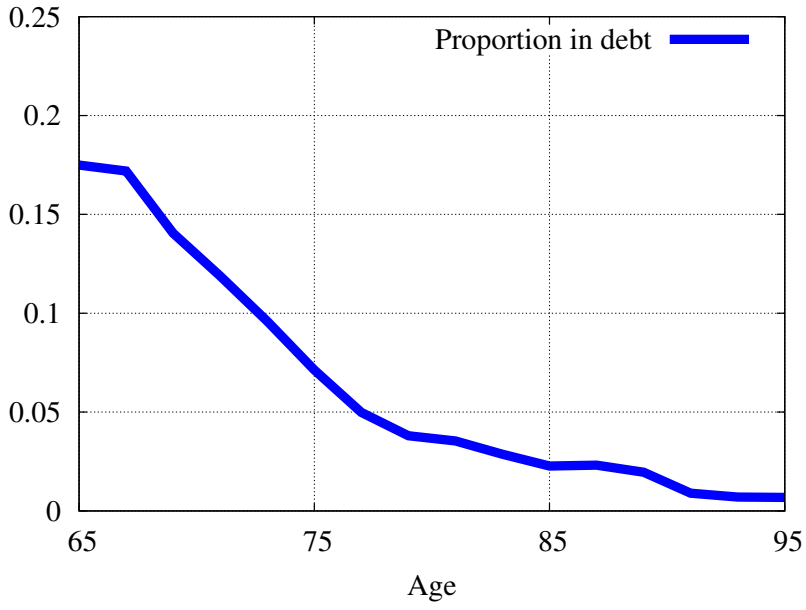
(a) Homeownership rate



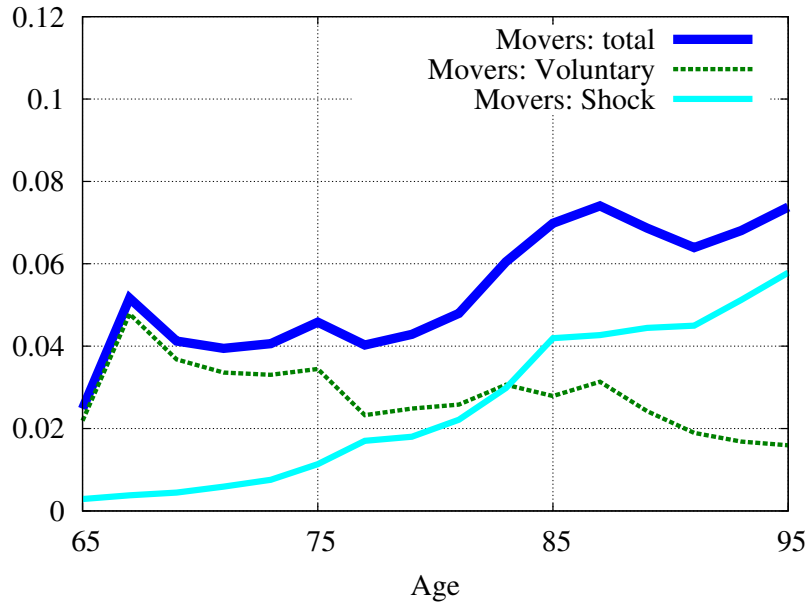
(b) Mean asset holdings

- Gradually decreasing homeownership rate.
- Slow decumulation of total assets (retirement saving puzzle).

Results: Properties of Baseline Model without RML



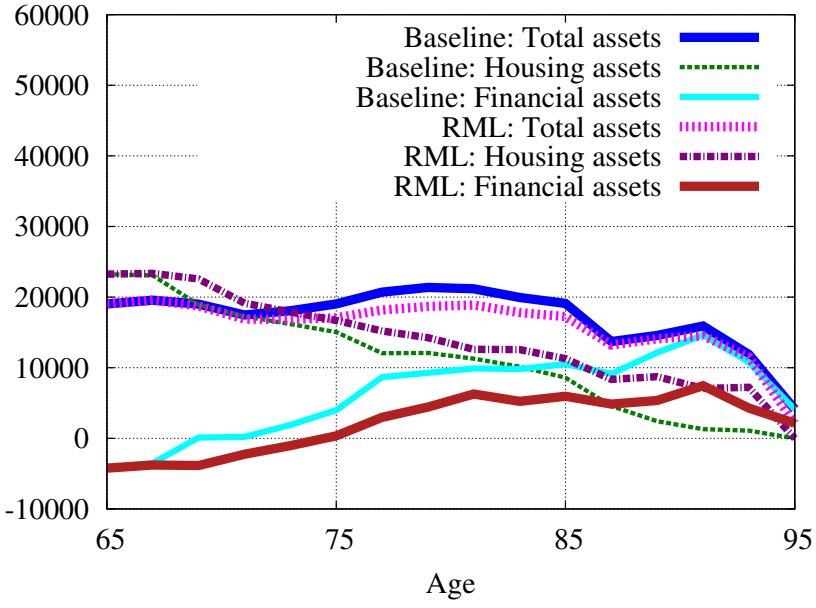
(c) Proportion in debt



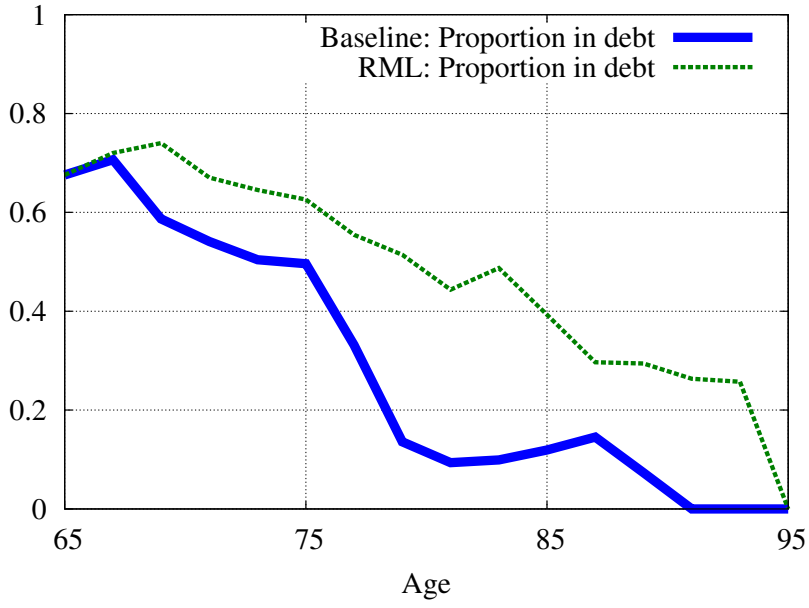
(d) Proportion of movers

- Proportion in debt declines quickly.
- More compulsory moves towards the end of life.

Results: Change in Behavior among RML Borrowers



(e) Mean asset holdings



(f) Proportion in debt

- RML's allow borrowers to keep their house longer.
- RML borrowers dissave slightly faster.

Results: Take-up Rate of Reverse Mortgages

	Take-up Rate
All households	1.23
Among homeowners	1.37
No existing mortgage	0.55
With mortgage	4.74
Low income	7.13
Middle income	0.18
High income	0.19
Poor health	1.69
Excellent health	0.73

- 1.37% of homeowners take reverse mortgage loans.
- Homeowners with lower income, in worse health, with lower wealth utilize RML's.
- Consistent with the RML borrowers in data.

Results: Welfare Gains

	Welfare gain[1]
All households	4
Households with reverse mortgages	292

[1] Measured by one-time income at age 65 which would make life-time utility of those with access to reverse mortgages to life-time utility without, in 2010 dollars.

Counterfactual Experiments: Role of Uncertainty

Take-Up Rate among Homeowners	
Baseline model	1.37
No medical expenditure risks	0.98
No medical expenditure	0.00
No moving shock	4.28
No house price shocks	3.79

- Households use RML's to pay for large medical bills.
- Compulsory moving shocks dampen RML demand (Michelangeli (2010)).
- Without house price shocks, homeowners stay in their house longer (Davidoff and Welke (2007)) – increase in RML demand.

Counterfactual Experiments: Role of Bequest Motives and Expectations

Take-Up Rate among Homeowners	
Baseline model	1.37
No bequest motives	59.06
House price boom	42.80

- Bequest motives dampen RML demand
- House price boom expectation (4.5% per year) increases RML demand

Counterfactual Experiments: Changes in RML Terms

Take-Up Rate among Homeowners	
Baseline model	1.37
HECM Saver (lower $\nu_i \rightarrow$ lower λ_I)	4.20
Lower (0.5 percent) insurance premium	6.35
No insurance (recourse)	14.58

- Large gain from eliminating mortgage insurance since few households benefit from insurance in the model.
- HECM Saver (smaller upfront cost but lower withdrawal limit) raises the take-up rate.

Summary and Going Forward

- We construct a structural model of household decision in retirement with an option to take reverse mortgages.
- The model generates the observed small take-up rate.
  - Bequest motives.
  - Moving shocks.
  - House price shocks.
  - High costs.
- RML's benefit borrowers by allowing them to:
  - Extract home equity.
  - Pay for medical expenditures with home equity.
  - Stay in the house longer.
- House price boom expectation generates strong RML demand.
- Homeowners do not value insurance built into RMLs and would borrow more without it.
- Going forward...
  - Optimal design of the RML's.
  - Equilibrium pricing of RML's.

APPENDIX

References

Ameriks, John, Andrew Caplin, Steven Paufer, and Stijn van Nieuwerburgh, "The Joy of Giving or Assisted Living? Using Strategic Surveys to Separate Public Care Aversion from Bequest Motives.," *Journal of Finance*, 2011, *66* (2), 519–561.

Campbell, John and Joao F. Cocco, "Household Risk Management and Optimal Mortgage Choice," *Quarterly Journal of Economics*, 2003, *118* (4), 1449–1494.

Caplin, Andrew, "Turning Assets into Cash: Problems and Prospects in the Reverse Mortgage Market," in Olivia S. Mitchell, Zvi Bodie, Brett Hammond, and Steve Zeldes, eds., *Innovations in Retirement Financing*, Philadelphia, PA: University of Pennsylvania Press, 2002, chapter 3, pp. 234–253.

Chambers, Matthew, Carlos Garriga, and Don E. Schlagenhauf, "The Loan Structure and Housing Tenure Decisions in an Equilibrium Model of Mortgage Choice," *Review of Economic Dynamics*, 2009, *12* (3), 444–468.

Davidoff, Thomas and Gerd Welke, "Selection and Moral Hazard in the Reverse Mortgage Market," 2007. Unpublished.

De Nardi, Mariacristina, Eric French, and John Bailey Jones, "Why Do the Elderly Save? The Role of Medical Expenses," *Journal of Political Economy*, 2010, *118* (1), 39–75.

Hurd, Michael D., "Mortality Risk and Bequests," *Econometrica*, 1989, *57* (4), 779–813.

Lockwood, Lee M., "Bequest Motives and the Annuity Puzzle," *Review of Economic Dynamics*, forthcoming.

Michelangeli, Valentina, "Does It Pay to Get a Reverse Mortgage?," 2010. Unpublished.

Nakajima, Makoto and Irina A. Telyukova, "Home Equity Withdrawal in Retirement," 2011. Federal Reserve Bank Working Paper No. 11-15.

Pashchenko, Svetlana, "Accounting for Non-Annuitization," 2004. Federal Reserve Bank of Chicago Working Paper No. 2010-03.

Poterba, Mark J. Warshawsky Olivia S. Mitchell James M., "New Evidence on the Money's Worth of Individual Annuities," *American Economic Review*, 1999, *89* (5), 1299–1318.

Redfoot, Donald L., Ken Scholen, and S. Kathi Brown, "Reverse Mortgages: Niche Product or Mainstream Solution? Report on the 2006 AARP National Survey of Rverse Mortgage Shoppers," 2007. AARP Public Policy Institute.

Shan, Hui, "Reversing the Trend: The Recent Expansion of the Reverse Mortgage Market," *Real Estate Economics*, Forthcoming.

Turra, Cassio M. and Olivia S. Mitchell, "The Impact of Health Status and Out-of-Pocket Medical Expenditures on Annuity Valuation," 2004. Pension Researhc Council Working paper No. 2004-02, The Wharton School of the University of Pennsylvania.

Venti, Steven F. and David A. Wise, "Aging and Housing Equity: Another Look," in David A. Wise, ed., *Perspectives on the Economics of Aging*, Chicago: University of Chicago Press, 2004, chapter 3, pp. 127–175.

Yaari, Menahem E., "Uncertain Lifetime, Life Insurance, and the Theory of the Consumer," *Review of Economic Studies*, 1965, *32* (2), 137–150.