Developing Equity Release Markets: Risk Analysis for Reverse Mortgage and Home Reversion

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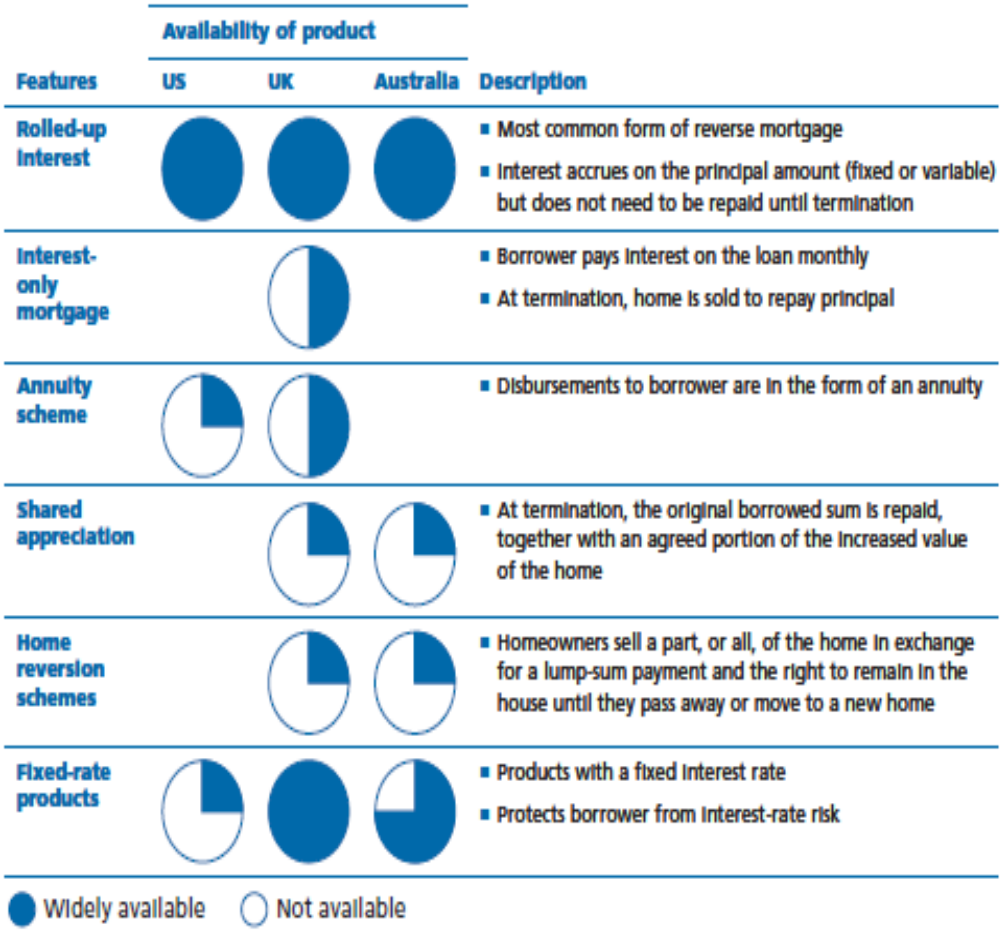
Introduction

- Home equity release products
  - Allow retirees to convert a previously illiquid asset into cash payments which can be used for home improvements, regular income, debt repayment, aged care and medical treatments etc.

- Reverse mortgage
  - Boehm and Ehrhardt (1994), Chinloy and Megbolugbe (1994), Szymanoski (1994), Rodda et al. (2004), Ma and Deng (2006), Wang et al. (2007), Chen et al. (2010), Sherris and Sun (2010)

- Home reversion
  - Little research has been done on the risk analysis of other equity release products, such as home reversion contracts.

Introduction



Features	Availability of product: US	UK	Australia	Description
Rolled-up interest	●	●	●	▪ Most common form of reverse mortgage ▪ Interest accrues on the principal amount (fixed or variable) but does not need to be repaid until termination
Interest-only mortgage		◑		▪ Borrower pays interest on the loan monthly ▪ At termination, home is sold to repay principal
Annuity scheme	◔	◑		▪ Disbursements to borrower are in the form of an annuity
Shared appreciation		◔	◔	▪ At termination, the original borrowed sum is repaid, together with an agreed portion of the increased value of the home
Home reversion schemes		◔	◔	▪ Homeowners sell a part, or all, of the home in exchange for a lump-sum payment and the right to remain in the house until they pass away or move to a new home
Fixed-rate products	◔	●	◔	▪ Products with a fixed interest rate ▪ Protects borrower from interest-rate risk

● Widely available ○ Not available

Source: FSA Factsheet – UK Equity Release Market, FSA, Equity Release Schemes in the UK; Datamonitor; Equity Release Schemes in Australia, Datamonitor, Oliver Wyman analysis

- US
  - Reverse mortgage products dominate.
  - HECM accounts for 95% of the market (Ma and Deng, 2006).
- UK
  - Reverse mortgages, home reversion and other equity release products have been available for between 10 and 30 years
  - Reverse mortgage: 75%; home aversion: 25% (ASIC 2005).

RM and HR

- Reverse Mortgage
  - The provider lends the customer cash and obtains a mortgage charge over the customer's property (or a share of the property).
  - The contract is terminated upon the death or permanent moveout of the customer, at which time the property is sold and the proceeds are used to repay the outstanding loan.
  - Typically, a no negative equity guarantee (NNEG) is included in the contact.

- Home Reversion
  - The provider purchases the ownership right over the customer's property (or a share of the property).
  - The home is sold at discount, and the contract includes a lease for life agreement.

Major Risks in RM and HR

- Risks of RM
  - Termination Risk
    - Longevity risk, mobility risk, refinancing risk
  - Loan Interest Rate risk
  - House Price Depreciation Risk

- Risks of HR
  - Termination Risk
    - Longevity risk, mobility risk, refinancing risk
  - Rental yield appreciation risk
  - House Price Depreciation Risk

Markov Termination Model

- Assume a single, female policyholder.

- Contract termination is determined by two proportionality constants on female population mortality.

$$\mu_x^c = (\theta + \rho)\mu_x$$

where θ is the at-home mortality proportionality constant

ρ is non-mortality driven proportionality constant

- Assume a Gompertz structure for the population force of mortality

$$\mu_x = \lambda \exp(\gamma x)$$

Parameter Calibration

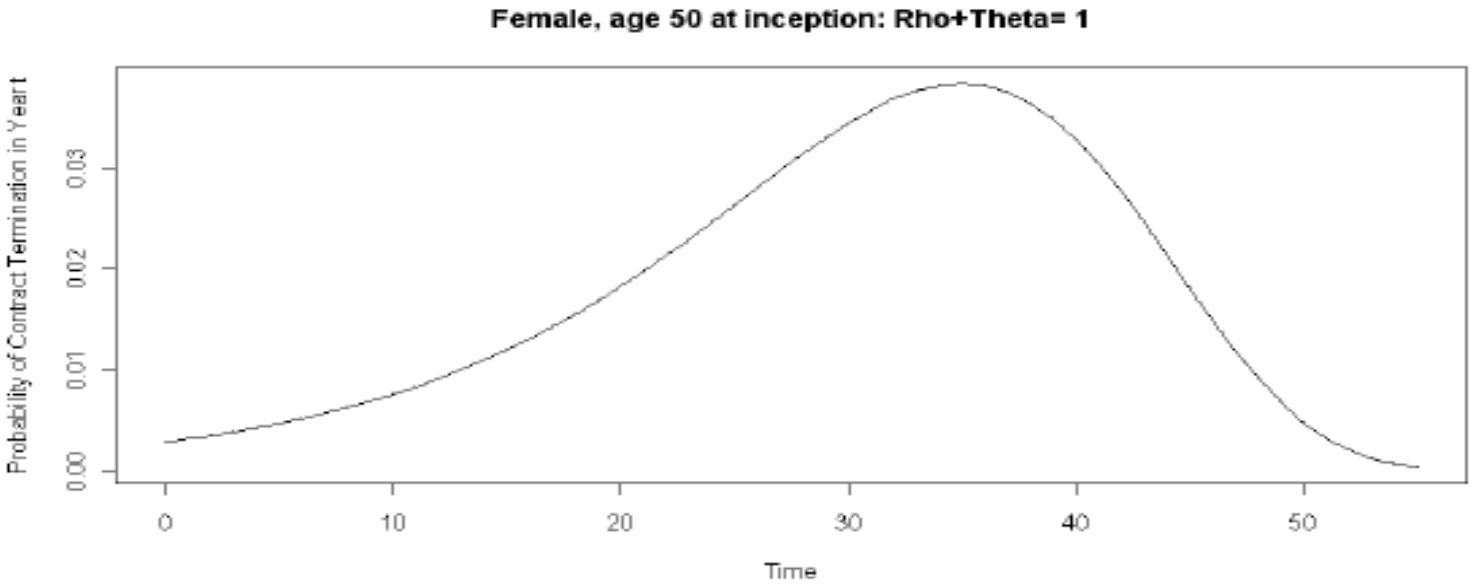
- λ and γ
  - Use data from the Human Mortality Database: ages 50-105 and calendar years 1950-2009 from Australian females.
  - Fit both an ordinary linear regression (LR) on the log-transformed mortality rates as well as a Poisson regression (PR) on death counts with an appropriate exposure offset.
  - The results are very similar; we use PR results

$$\hat{\lambda}^{(LR)} = 0.000217; \hat{\lambda}^{(PR)} = 0.000171; \hat{\gamma}^{(LR)} = 0.0993; \hat{\gamma}^{(PR)} = 0.1017$$

- θ and ρ
  - Values are taken from Ji et al. (2012)

Age	ρ^f	θ^f
≤70	0.10	0.95
80	0.20	0.90
90	0.33	0.85
≥ 100	0.46	0.80

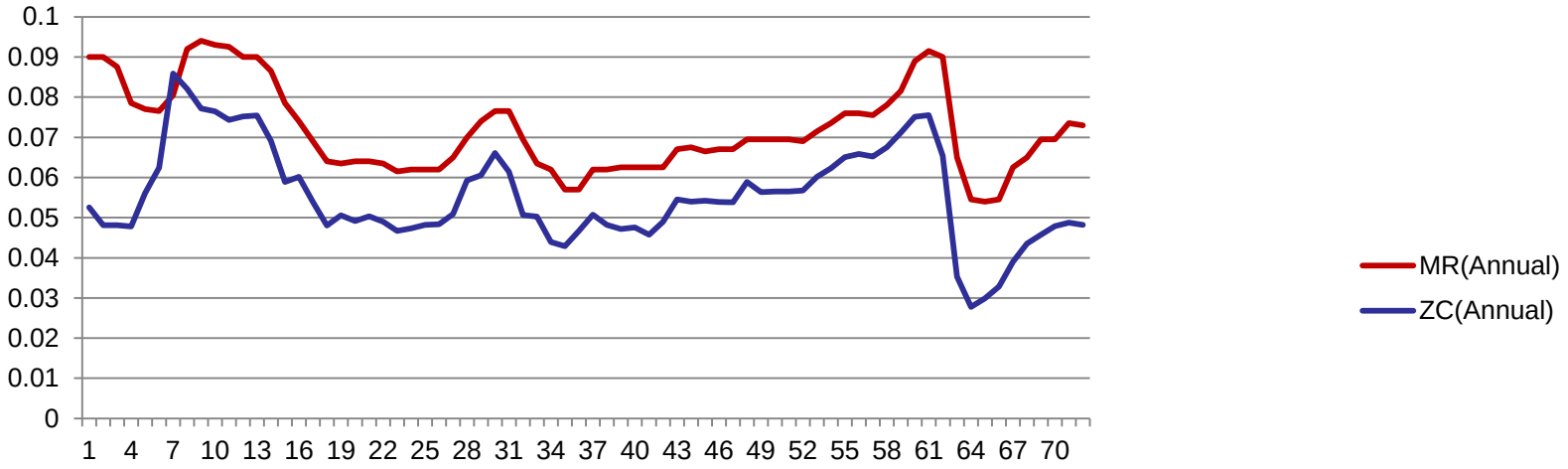
Termination Probabilities



VAR Economic Model

- Raw data: quarterly data from June 1993 to June 2011
  - zero-coupon interest rates (3-month and 10-year)
  - standard variable mortgage rate (MR)
  - Sydney house price index (HI)
  - Sydney rental index (RI).
  - Sydney GDP

- the mortgage rate and the 3-month zero coupon rates are highly correlated



VAR (1)

$$z_{t+1} = c + Bz_t + \Sigma\zeta_{t+1}$$

where Σ is a lower triangular matrix,

$$\zeta_{t+1} \sim N(0, I)$$

Z includes the following variables:

- 3-month zero coupon rate (mortgage rate can be expressed as the 3-month zero coupon rate plus a fixed margin)
- Term structure spread = 10-year ZC rate – 3-month ZC rate
- dln(HI)
- dln(RI)
- dln(GDP)

Stochastic Discount Factors

- We define the stochastic discount factor as (Cochrane and Piazzesi 2005)

$$m_{t+1} = \exp - \left(\delta_0 + \delta_1 z_t + \frac{1}{2} \lambda_t' \lambda_t + \lambda_t' \zeta_{t+1} \right)$$

- $\delta_0 + \delta_1 z_t$ is the short rate in the VAR model

  where $\delta_0 = 0$ and $\delta_1' = (1,0,0,0,0)$

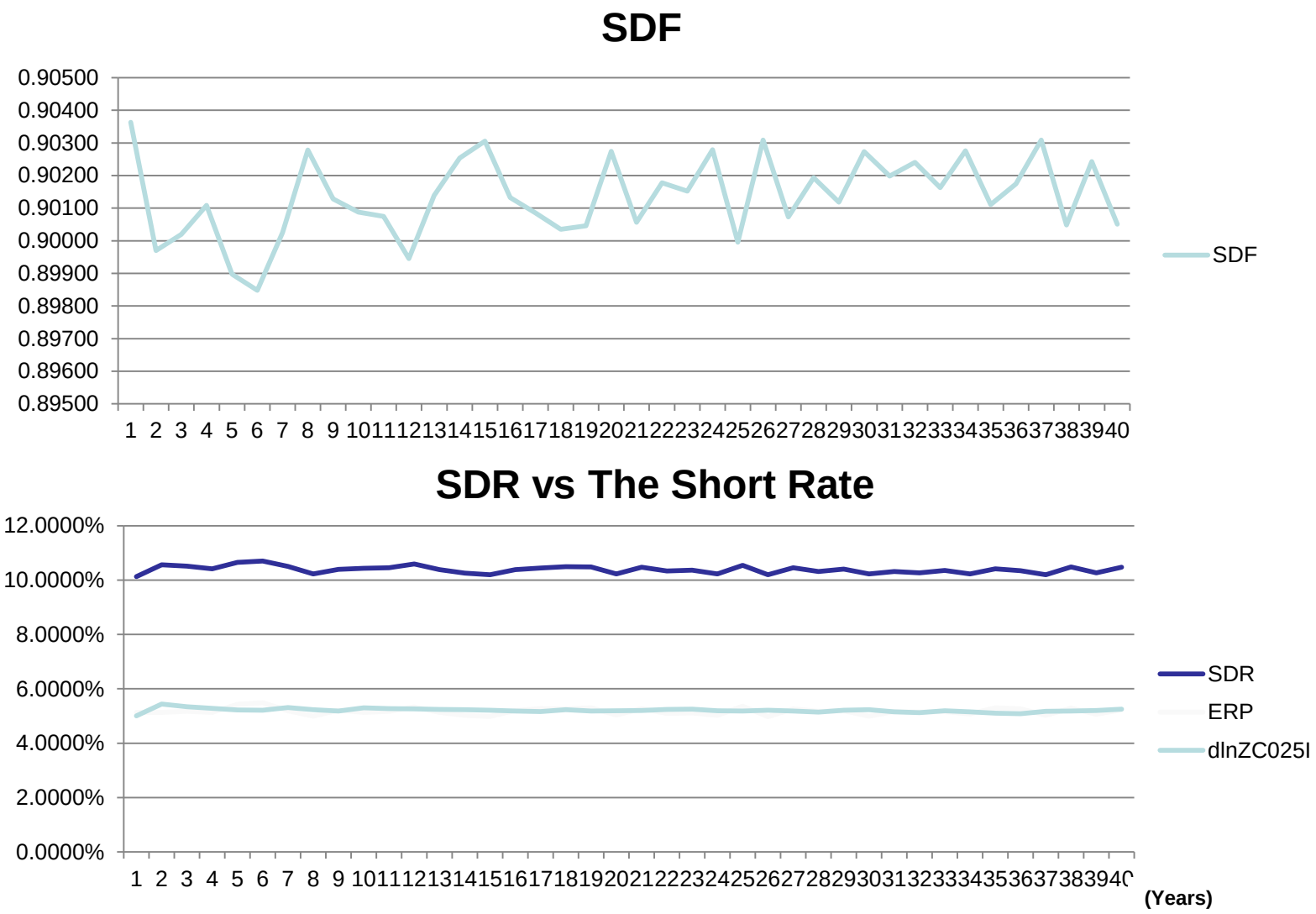
- $\frac{1}{2} \lambda_t' \lambda_t + \lambda_t' \zeta_{t+1}$ relates shocks in the state variables to the pricing kernel

  where $\lambda_t = \lambda_0 + \Lambda_1 z_t$ is a time-varying vector of market price of risk

- The price of an asset at time t : $P_t = E_t \left[m_{t+1} X_{t+1} \right]$

- Recursively, $P_0 = E \left[\prod_{s=0}^{t} m_s (X_t) \right]$

Stochastic Discount Factors



Estimation Procedure

- VAR parameters (c, B, and Σ) are estimated by maximum likelihood

- Risk parameters (λ_0 and Λ_1) can be estimated by minimizing the sum of the squared differences between the fitted yields of the term structure model and historical zero coupon yields.

$$\min_{\{\lambda_0,\Lambda_1\}} \sum_{t=1}^{T}\sum_{n=1}^{N}\left(\hat{y}_t^{(n)} - y_t^{(n)}\right)^2$$

where $\hat{y}_t^{(n)} = -\frac{A_n}{n} - \frac{B_n'}{n} z_t$

and A_n and B_n can be solved recursively

$$A_n = -\delta_0 + A_{n-1} + B_{n-1}'\left(c - \Sigma\lambda_0\right) + \frac{1}{2} B_{n-1}'\Sigma\Sigma' B_{n-1}$$

$$B_n = -\delta_1 + \left(B - \Sigma\Lambda_1\right)' B_{n-1}$$

Non-Negative Equity Guarantee in RM

- For a fixed termination time *t*

$$NN_t = \max\left(L_t - H_t, 0\right)$$

- For random termination time

$$NN = \sum_{t=0}^{\omega-x-1} E\left[\left(\prod_{s=0}^{t} m_s\right)_t p_x q_{x+t} \max\left(L_t - H_t, 0\right)\right]$$

- Cash flow analysis

$$RM = \sum_{t=0}^{\omega-x-1} {}_t p_x q_{x+t} e^{-r_t t}\left[\min\left(L_t, H_t\right) - L_0 e^{ct}\right]$$

Lease for Life in HR

- For a fixed termination time *T*

$$LL_0 = \sum_{t=0}^{T} E\left[\left(\prod_{s=0}^{t} m_s\right) H_t g_t\right]$$

- For random termination time

$$LL = \sum_{t=0}^{\omega-x-1} E\left[\left(\prod_{s=0}^{t} m_s\right)_t p_x H_t g_t\right]$$

- Cash flow analysis

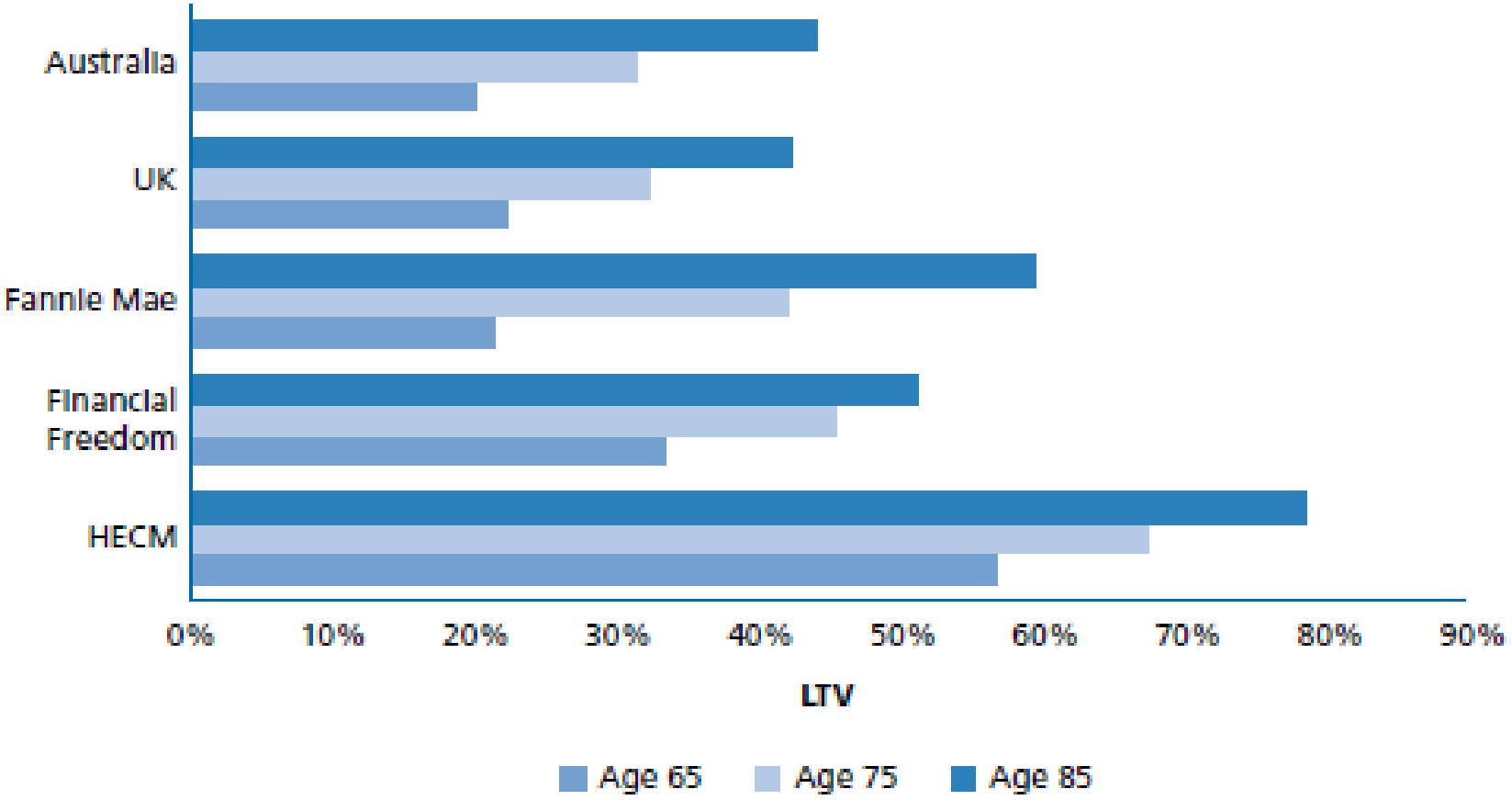
$$HR = \sum_{t=0}^{\omega-x-1} {}_t p_x q_{x+t} e^{-r_t t}\left[H_t - \left(H_0 - LL\right)e^{ct}\right]$$

NN and LL

Age	H0	LTV/Acq	Reverse Mortgage			Home Reversion	
			NN	Premium	EPV(RM)	LL	EPV(HR)
65	480,000	64%	19,947	0.5465%	86,352	5,015	20,444
65	540,000	64%	22,440	0.5465%	97,146	5,642	23,000
65	600,000	64%	24,933	0.5465%	107,940	6,269	25,556
75	480,000	70%	18,086	0.6792%	61,996	7,837	25,422
75	540,000	70%	20,346	0.6792%	69,746	8,817	28,600
75	600,000	70%	22,607	0.6792%	77,495	9,797	31,778
85	480,000	76%	16,637	1.042%	40,568	11,024	23,861
85	540,000	76%	18,717	1.042%	45,639	12,402	26,844
85	600,000	76%	20,797	1.042%	50,710	13,780	29,827

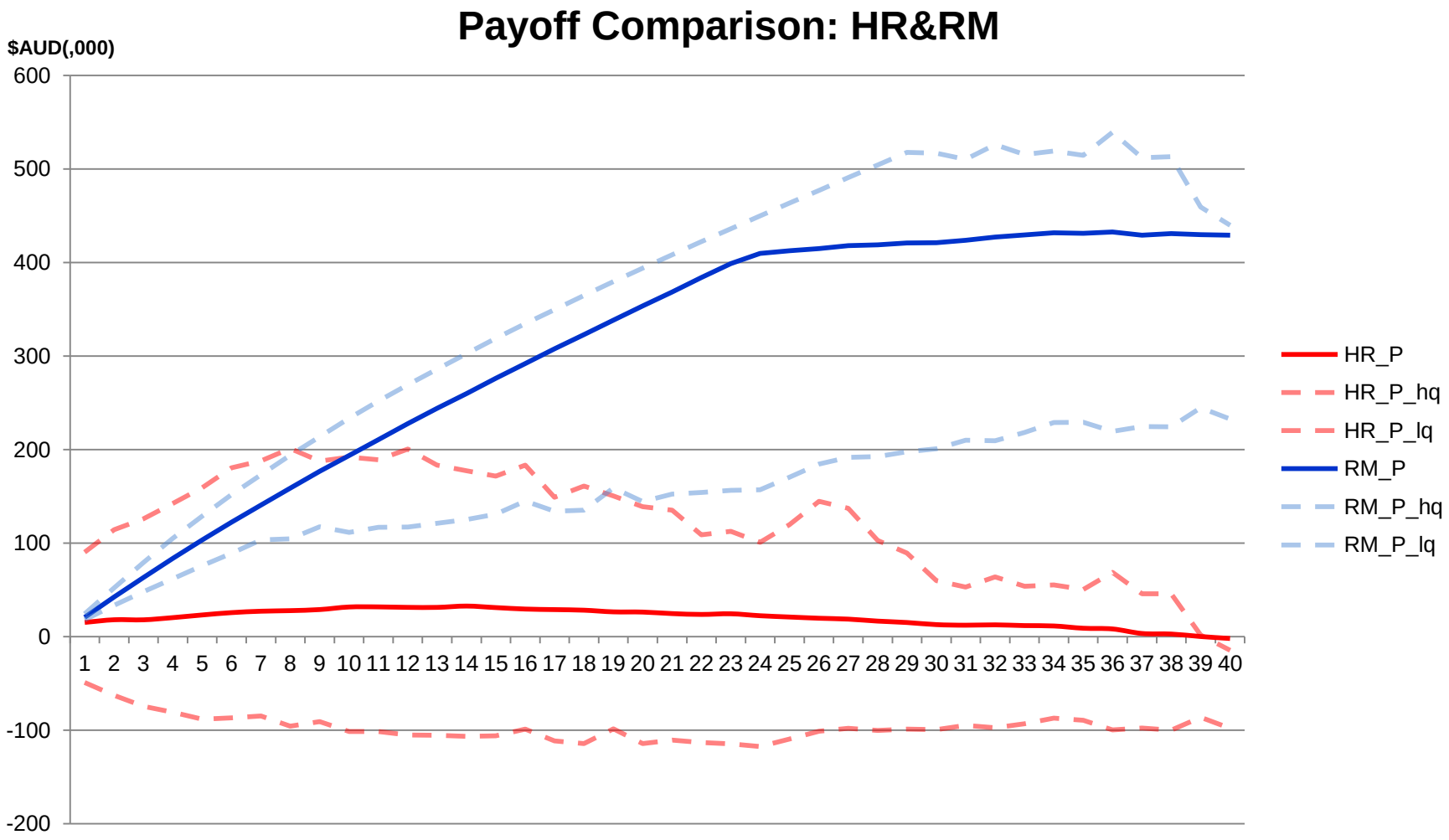
LTV

Equity release LTVs
Across products and countries

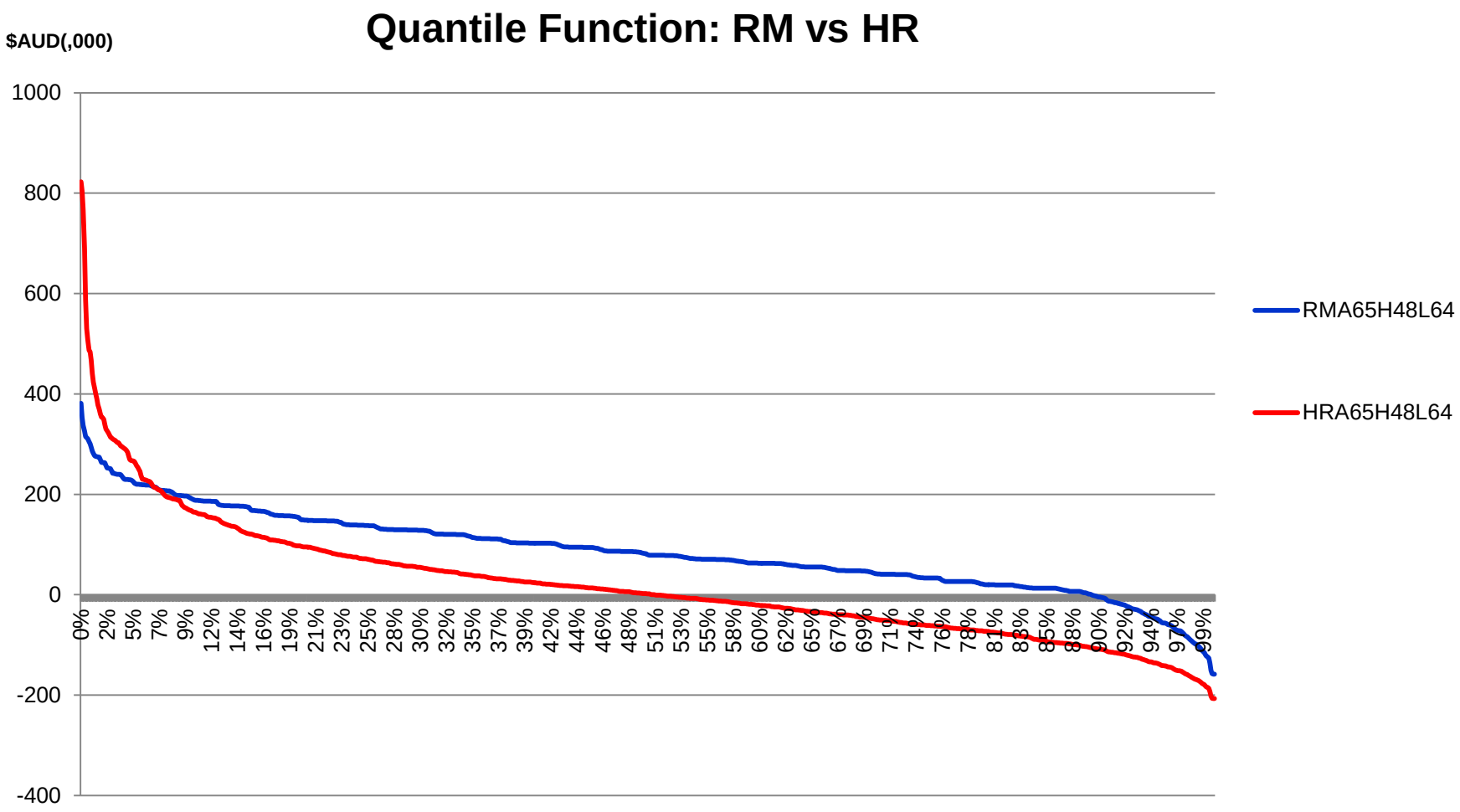


Source: HUD, FF mortgage calculator, Datamonitor

Payoff Comparison



Quantile Function



Risk Measures

Reverse Mortgage						
	VaR 95%	**VaR 99%**	**VaR 99.5%**	**CVaR 95%**	**CVaR 99%**	**CVaR 99.5%**
A65H48L64	-49.12	-113.30	-126.23	-88.11	-134.51	-149.18
A65H54L64	-55.26	-127.46	-142.01	-99.12	-151.32	-167.83
A65H60L64	-61.40	-141.62	-157.79	-110.14	-168.13	-186.48
A75H48L70	-43.07	-112.87	-128.19	-85.36	-137.80	-159.35
A75H54L70	-48.45	-126.98	-144.21	-96.03	-155.03	-179.26
A75H60L70	-53.83	-141.09	-160.24	-106.69	-172.26	-199.18
A85H48L76	-29.68	-89.94	-118.16	-64.63	-120.82	-141.05
A85H54L76	-33.39	-101.19	-132.93	-72.71	-135.92	-158.68
A85H60L76	-37.10	-112.43	-147.70	-80.79	-151.02	-176.32
Home Reversion						
	VaR 95%	**VaR 99%**	**VaR 99.5%**	**CVaR 95%**	**CVaR 99%**	**CVaR 99.5%**
A65H48L64	-137.02	-178.09	-186.37	-161.97	-191.66	-201.05
A65H54L64	-154.14	-200.35	-209.66	-182.21	-215.62	-226.18
A65H60L64	-171.27	-222.61	-232.96	-202.46	-239.58	-251.32
A75H48L70	-123.11	-171.97	-182.70	-152.71	-189.43	-204.50
A75H54L70	-138.50	-193.47	-205.53	-171.80	-213.10	-230.07
A75H60L70	-153.89	-214.96	-228.37	-190.89	-236.78	-255.63
A85H48L76	-97.19	-140.96	-155.19	-122.44	-161.31	-176.83
A85H54L76	-109.33	-158.58	-174.58	-137.75	-181.47	-198.93
A85H60L76	-121.48	-176.20	-193.98	-153.05	-201.63	-221.03

Conclusions

- Comparison between RM and HR
  - RM: accumulation of debt over the life of the contract
  - HR: debt-free.

  - RM: senior homeowners bear various risks, including longevity risk, interest rate risk and property value risk
  - HR: these risks are remitted to the provider with the transfer of the title.

  - RM: providers want house price to rise, while homeowners do not care
  - HR: The interests of investors and consumers are aligned: both want the value of the home to rise

- Consumers may prefer home reversion product, but providers bear higher risk and need more stringent capital requirement.