Repayment Profile of Reverse Mortgages

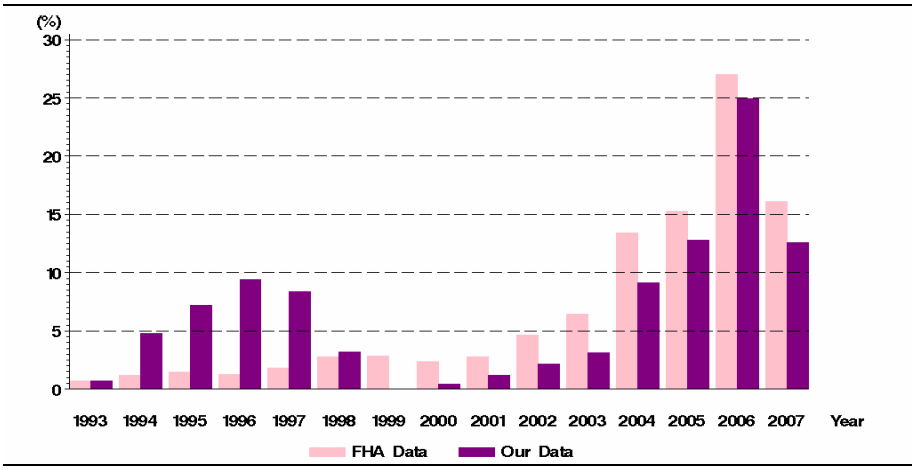
With the virtual shutdown of mortgage origination in Alt-A and subprime sectors, the Street is seeking new asset classes (preferably containing little credit risk), to fulfil their securitization capacity. Reverse mortgages have been identified as one such asset class, and interest in reverse mortgage securitization is growing. Recently, we reviewed the GNMA guideline for securitizing reverse mortgage [*SEE*: "GNMA to Securitize HECM Reverse Mortgages", *Mortgage Strategist*, 8/7/2007], in which we discussed the different cash flow pattern of reverse mortgages from forward mortgages and some securitization challenges. This week, we study the fundamentals in reverse mortgage cash flow—*the time horizon when an "event" occurs and the loan becomes payable.*

Recall that a reverse mortgage loan becomes payable when: *(1)* both primary borrower and secondary borrower, if any, move out of the property; *(2)* both primary and secondary borrower, if any, pass away; or *(3)* the property is no longer properly maintained. For a HECM loan, when the loan balance exceeds 98% of property value, the loan is assigned to FHA and becomes fully paid off from the investor's perspective. Modelling time horizons on these payoff events is crucial in generating cash flows for reverse mortgage pools and pricing them. In this article we investigate repayment risk of reverse mortgage by borrower's age and gender (among most important predictors of repayment risk).

Our Reverse Mortgage Data

The data in our analysis consists of a sample of 10,623 proprietary reverse mortgage loans originated between 1993 and 2007Q1. A comparison of origination volume distribution between our proprietary data and FHA HECM data indicate that our data is skewed to earlier vintages (see Figure 1 below). However, both sets of data confirm a very strong upward trend in recent years' origination volume, as more seniors tap into their home equity to aid retirement.

Figure 1: Origination Distribution Comparison, by Vintage (as of Q1 2007)

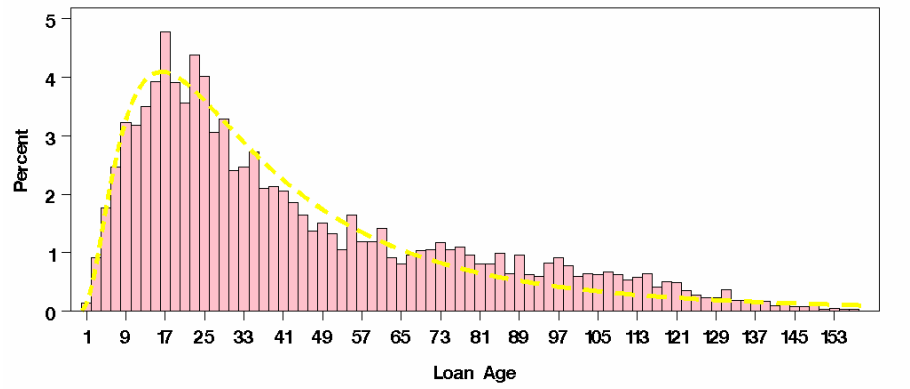


Source: FHA, UBS

In our data, ~73% loans have single borrowers and ~27% have two borrowers. Of single borrowers, ~73% are females. For loans with two borrowers, the majority of ~97% are male+female, with ~2% female+female and ~1% male+male. Among single borrowers, the median age is 79 for females and 78 for males. Among multiple borrowers, the median age is 76 for females and 78 for males. The median age of our proprietary data is higher than that of HECM borrowers (74 years old) reported by a recent HUD study, reflecting that proprietary loans are more attractive to older borrowers.

Of the 10,623 loans, 4,378 have already paid off, and the remaining 6,245 were outstanding as of March 31st, 2007. For paid-off loans, if the death dates of all borrowers are identified, the payoff is considered a *mortality event*, otherwise it is recognized as a *mobility event* (includes all non-death triggered events, such as refinancing, forced foreclosure, moving to a nursing home). Within our definition, 27% of the payable loans were due to mortality, and 73% to mobility. The payoff loan age distribution is illustrated in Figure 2 (below); the mean is 44 months and the median is 33 months.

Figure 2: Distribution—Payoff Loan Age

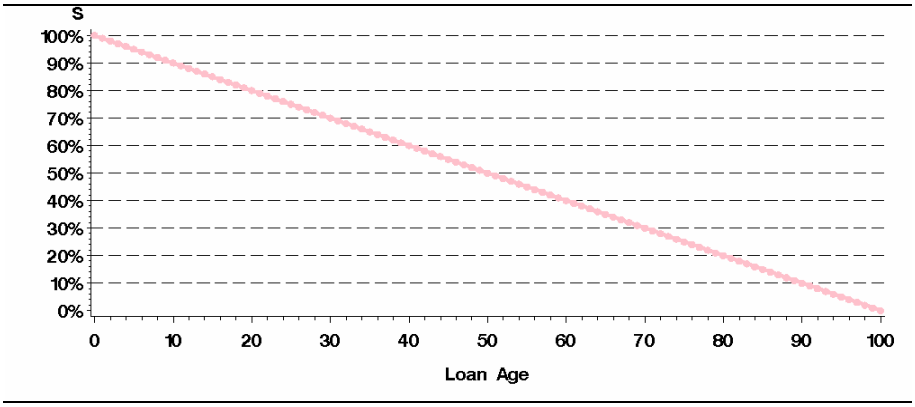


Source: UBS

Survival Curve

The period (in months) between origination of a loan and its payoff date is called the *survival time* of the loan. Although the exact survival time of a loan can not be perfectly predicted at origination, we may form opinions on the survival time. For a hypothetical example, for a loan of a single borrower at age 95, we may believe the probability of a loan being paid within the first month = 1%, within 2 months = 2%, within 3 months = 3% . . . and within 100 months = 100%. The survival probability *S(t)* is 100% at loan origination (t=0) and 0% at loan age >=100. A survival curve visually describes this relationship between survival probability *S(t)* and loan age, as illustrated in Figure 3 (next page). Readers may also understand a survival curve by drawing an analogy to pool factors. For a pool of mortgages, the percentage of outstanding loans is 100% at pool origination. As time elapses, the pool factor monotonically decreases to 0. *The difference between the two is that a survival curve is defined at individual loan level, and probability rather than percentage is adopted as the measure.*

Figure 3: An Example Survival Curve



Source: UBS

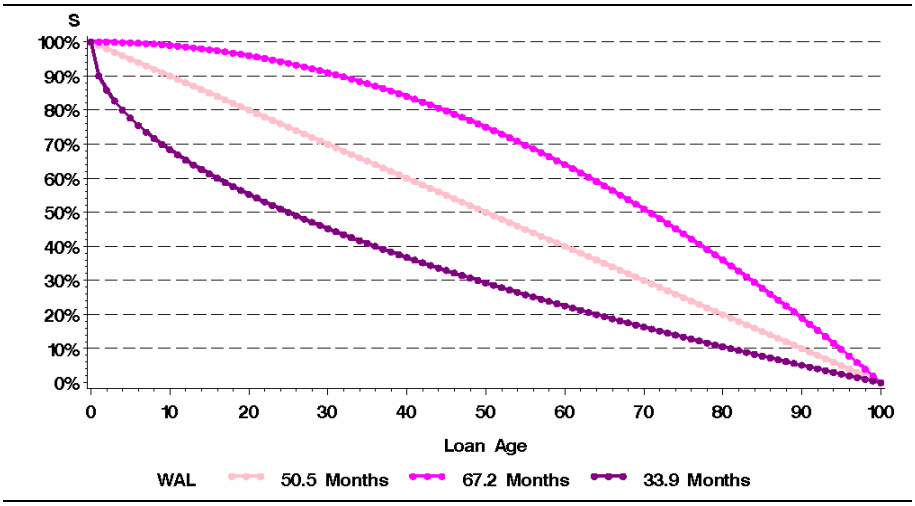
Why do we care about survival curves? Similar to Agency forward mortgage loans - - *Pricing is mainly concerned with basis risk and repayment risk.* A survival curve contains information necessary to forecast repayment speed, the cash flow and weighted average life (WAL) of a reverse mortgage pool, as we demonstrate below.

Because survival probability *S(t)* denotes the chance a loan being paid off *within t months*, the probability that a loan is paid off *at* month *t* is *S(t-1) – S(t)* (the loan survived month *t-1* but not month *t*). The WAL of a loan is calculated as the average time *t*, weighted by the probability that a loan is paid *at* month *t*. Go back to our example survival curve; the probability a loan is paid off at each month is 1% for the first 100 months, and is 0 afterwards. The WAL is:

$$WAL = 1\times 0.01 + 2\times 0.01 + 3\times 0.01 + ... + 100\times 0.01 = 50.5 \text{ Months}$$

Survival curves also visually convey WAL information of reverse mortgage loans. A steeper curve suggests faster repayment speed and shorter WAL. Figure 4 (below) demonstrate 3 hypothetical survival curves and their individual WAL.

Figure 4: Three Hypothetical Survival Curves and Their WALs



Source: UBS

The conversion from a survival curve to a CPR curve is straight forward. CPR (Constant Prepayment Rate) defines the annualized speed of unscheduled principal pay down relative to the outstanding balance. Given survival curve *S(t)*, the expected principal pay down for $1 at month *t* is *S(t-1) – S(t)*, thus SMM can be calculated as,

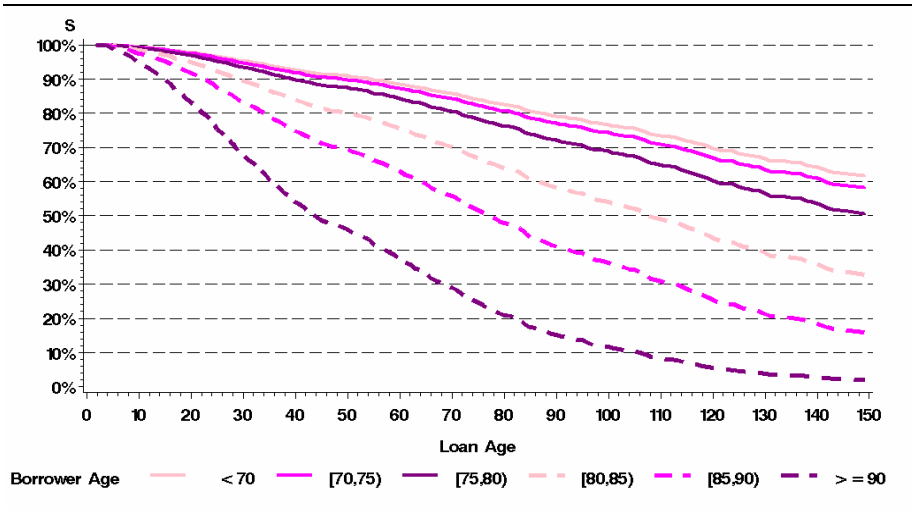
$$SMM = \frac{S(t-1)-S(t)}{S(t-1)} = 1 - \frac{S(t)}{S(t-1)}$$

The conversion from SMM to CPR is the same as forward mortgages.

Borrower's Age

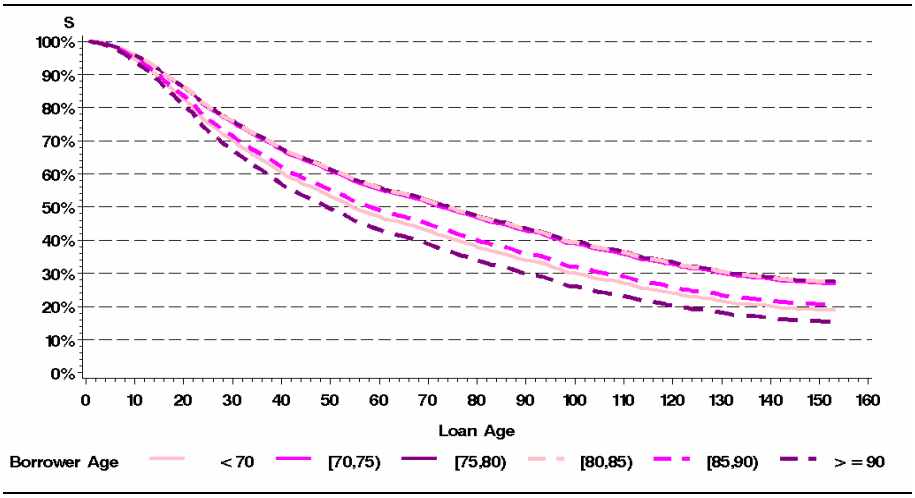
Borrower's age is the single most important driver of repayment risk. It is vital to evaluating both mortality and mobility risks. In our analysis, we divided 7707 loans with single borrowers into 6 groups by borrower's age, and estimated the survival curves. Figures 5-7 (below and next page) show the survival curves across the age groups for mortality, mobility and overall repayment. The results indicate that while mortality risk increases monotonically with borrower's age, mobility risk is greatest for the youngest (<70) and the oldest borrowers (>=90). We suspect most mobility activities among young borrowers are voluntary, such as relocation or property sales, and that most mobility activities among old borrowers are involuntary, such as moving to a nursing home (although the data does not provide sufficient detail to support the hypothesis). Regardless of underlying reason, the barbell mobility risk elevated the repayment risk of age group <70 to approximately the same level as age group (80, 85), as illustrated by Figure 7.

Figure 5: Mortality Survival Curves (by Borrower's Age)



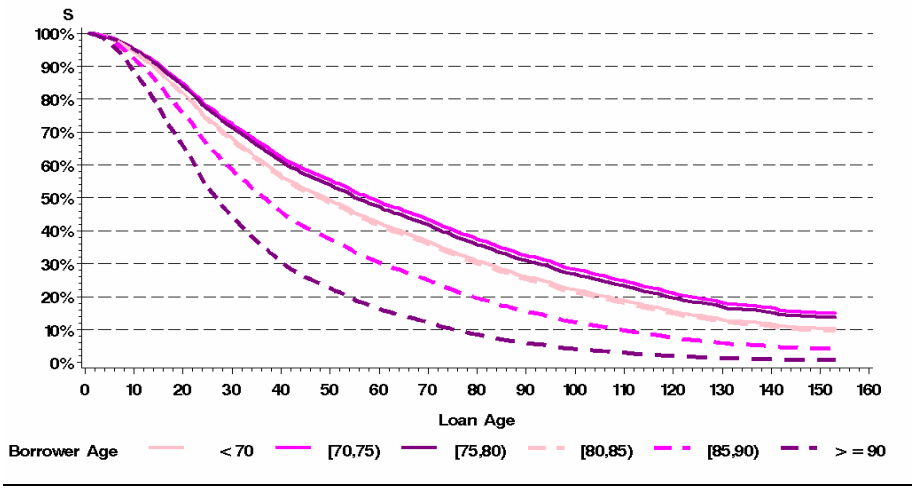
Source: UBS

Figure 6: Mobility Survival Curves (by Borrower's Age)



Source: UBS

Figure 7: Total Survival Curves (by Borrower's Age)



Source: UBS

Table 1 (below) summarizes our findings on the relationship between repayment risk and borrower's age. While the mortality risk of age group >=90 is almost 8X that of age group <70, the overall repayment risk is only 2X as much. This can be interpreted as being due to: *(1)* the relatively high mobility risk of young borrowers, and *(2)* a majority of the paid-off loans were terminated through mobility events. Results suggest WAL is shortest for age group >=90 (35 months) and longest for age group (70, 75) (57 months).

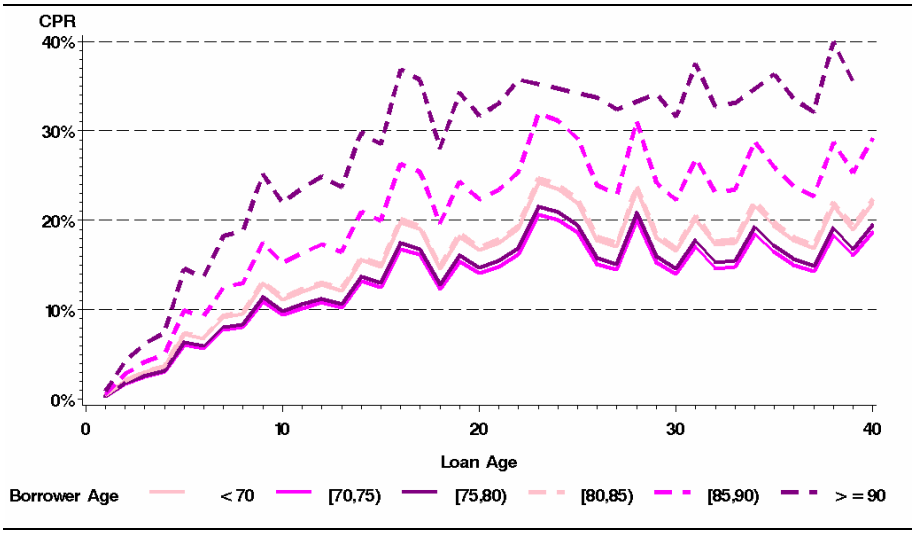
Table 1: Summary—Repayment Risk (by Borrower's Age)

Age Group	Count	Frequency	Mean Age	Mortality Risk	Mobility Risk	Repayment Risk	WAL(Months)
<70	892	12%	66.5	100%	100%	100%	53
[70,75)	1417	18%	72.2	112%	79%	83%	57
[75,80)	1892	25%	77.1	140%	77%	87%	56
[80,85)	1770	23%	81.9	231%	78%	102%	52
[85,90)	1084	14%	86.7	382%	95%	139%	45
>=90	652	8%	93.1	787%	114%	209%	35

Source: UBS

Figure 8 (below) shows the repayment curve in CPR implied by survival curves in Figure 7. For each age group, repayment speed ramps up to a relatively stable level after month 20. The speed is ~20% CPR for borrowers <85 and ~35% CPR for borrowers >90. We consulted our trading desk; aggregated repayment speed is similar to the repayment curve used in deal pricing.

Figure 8: Survival Curve Implied Repayment Speed (by Borrower's Age)

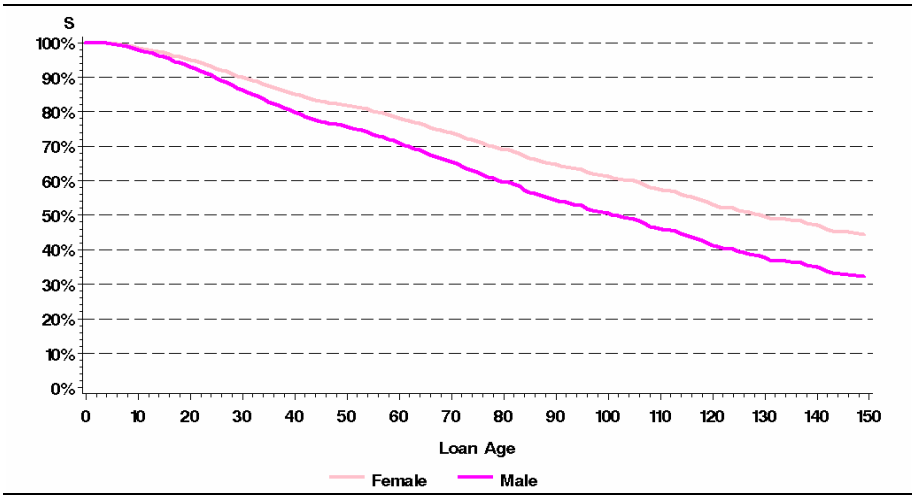


Source: UBS

Borrower's Gender

Borrower's gender also plays an important role in determining repayment risk. Figures 9-11 (below and next page) plot the survival curves of mortality, mobility and repayment risk by gender. Consistent with common knowledge, males have a steeper mortality survival curve than do females, suggesting high mortality hazards. In addition, Figure 9 suggests that male borrowers also have a higher tendency to move out of property than do female borrowers.

Figure 9: Mortality Survival Curve (by Borrower's Gender)

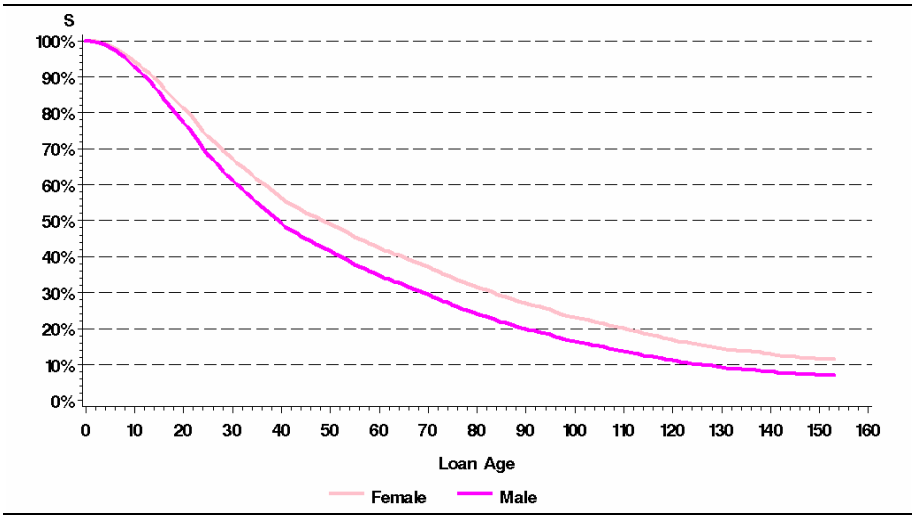


Source: UBS

Figure 10: Mobility Survival Curve (by Borrower's Gender)

Source: UBS

Figure 11: Total Survival Curve (by Borrower's Gender)



Source: UBS

Table 2 (below) summarizes the relationship between repayment risks and borrower's gender. Male borrowers have 40% higher mortality risk, 16% higher mobility risk and 23% higher overall repayment risk than do female borrowers. The expected WAL of a loan is ~52 months for female borrowers (79 years old) and 48 months for male borrowers (78 years old).

Table 2: Summary—Repayment Risk (by Borrower's Gender)

Age Group	Count	Frequency	Mean Age	Mortality Risk	Mobility Risk	Repayment Risk	WAL (Months)
Female	5604	73%	79.2	100%	100%	100%	52
Male	2103	27%	77.6	140%	116%	123%	48

Source: UBS

Figure 12 (next page) shows the repayment speed implied by survival curves by borrower's gender. The chart indicates that male borrowers have marginally higher repayment speed than female borrowers, by ~3% CPR.

Figure 12: Survival Curve Implied Repayment Speed (by Borrower's Gender)

Source: UBS

Conclusion

In this article, we investigated some fundamental questions in reverse mortgage repayment risk. In particular, we have discovered that:

- *Mortality risk increases consistently with age, while mobility risk is greatest among youngest and oldest borrowers. This results in a non-monotonic relationship between overall repayment risk and borrower's age.*
- *Male borrowers have both higher mortality risk and mobility risk than do female borrowers.*
- *Repayment speeds derived from the survival curves in our analysis are consistent with the repayment curve used in deal pricing.*