Reverse Mortgage Securitizations: Understanding and Gauging the Risks

AUTHOR:

David H. Zhai, Ph. D.
Vice President
Senior Analyst
(212) 553-4635
David.Zhai@moodys.com

CONTACTS:

Linda A. Stesney
Managing Director
(212) 553-3691
Linda.Stesney@moodys.com

Mark Adelson
Managing Director
(212) 553-4454
Mark.Adelson@moodys.com

Investor Liaisons

Vernessa Poole
Asset-Backed Securities and Collateralized Debt Obligations
(212) 553-4796
Vernessa.Poole@moodys.com

Sally Cornejo
All Mortgage Related and Fully Supported Securities
(212) 553-4806
Sally.Cornejo@moodys.com

CONTENTS

SUMMARY

Reverse mortgages provide senior citizens, age 62 and older, with cash payments and possibly a credit line in exchange for the equity in their homes. Although the products have been in the market for some time, their risks are not yet well understood. The market also needs to develop analytic approaches for gauging these risks.

Unlike traditional mortgage pools, the credit risk in a reverse mortgage pool is not driven by potential default of the loans. The main risk factors are the mortality and mobility of the underlying borrowers, and the net liquidation value upon the sale of the underlying properties. This report explains Moody's current approach to analyzing these risks in a reverse mortgage pool.

At the loan-by-loan level, mortality risk is captured by survival probability functions derived from the borrowers' ages and historical mortality experiences recorded by the insurance industry. In particular, the approach takes into consideration the fact that females tend to live longer than males.

The approach also takes a more refined view of the mortality and mobility probabilities of couple co-borrowers. It recognizes that the probability of death of both individuals in the couple is significantly lower than either individual's mortality probability. In addition, it takes into account that marriage tends to increase longevity. A couple's propensity to move out of their home is also different from that of singles due to the interdependence between the individuals in the couple. For market participants, failing to consider the couple effect on mortality and mobility, or using the age of the younger borrower, or using the longer average life expectancy can seriously underestimate the couple's longevity risk, and also bias the mobility analysis.

The rate that seniors leave their homes, known as the move-out rate, is also driven by factors such as age, gender, health, and marital and economic status. Reverse mortgage borrowers are less likely to move out than the general senior population. As a borrower ages, non-health-related mobility risk declines while health-related mobility rate accelerates.

A reverse mortgage borrower tends not to make capital investments in the mortgaged home because of the owner's increasing age and shrinking home equity. Housing market recessions and home price volatility may result in slower-than-expected appreciation or even depreciation of a collateralized property. Consequently, sale proceeds may be insufficient to repay the loan balance. Therefore, price risk analysis places discounts on home appreciation rates and calibrates price volatility according to historical recession experiences.

The timing of occurrence of either a mortality event or a mobility event determines the timing of repayment on a first-to-occur basis. Then the home price model and loan terms determine the amount of repayment. On the pool level, geographic correlation may have a significant impact on risk factors and deal performance.

Reverse mortgages are expected to gradually gain popularity in coming years. But further education and research on analyzing and managing their unique risks are needed for all market participants, including consumers, originators, securitizers, and investors.

REVERSE MORTGAGES

Reverse mortgages, as mentioned, provide senior citizens, age 62 and older, with cash payments and possibly a credit line in exchange for the equity in their homes. These products appeal to house-rich, cash-poor seniors by allowing them to remain in their homes and to use the equity in their houses to supplement their income.

The foreclosure risk in a reverse mortgage is minimal. The homeowner retains full ownership rights, while the lender holds a first lien on the mortgaged property. The lender cannot take away the ownership prior to death or certain move-out events.

A foreclosure can only take place when a borrower fails to meet some common sense requirements, such as paying property taxes, and insuring and properly maintaining the property.

Reverse Mortgages Differ from Traditional Mortgages

A reverse mortgage differs significantly from a traditional mortgage in terms of borrower population, repayment, and servicing. Therefore, a reverse-mortgage-backed securitization in many ways turns upside down the collateral and credit issues that investors are familiar with in a standard mortgage-backed security transaction.

Borrower Population

The borrower population for reverse mortgages is not the general population. Rather, it consists of aging seniors with equity in their homes, but less cash and income to support their health and retirement needs.

Reverse mortgage borrowers form a self-selected population group. They have demonstrated health and financial management ability by financing homes that are essentially free and clear of mortgages at these later stages in their lives. They are planing and funding their future lives by participating in reverse mortgage programs that gradually draw down the equity in their homes over quite long periods.

However, reverse mortgage borrowers have less incentive to make capital investments to maintain, to repair, or to improve their homes. This is because of their age, shortage of cash, and shrinking home equity.

Repayment

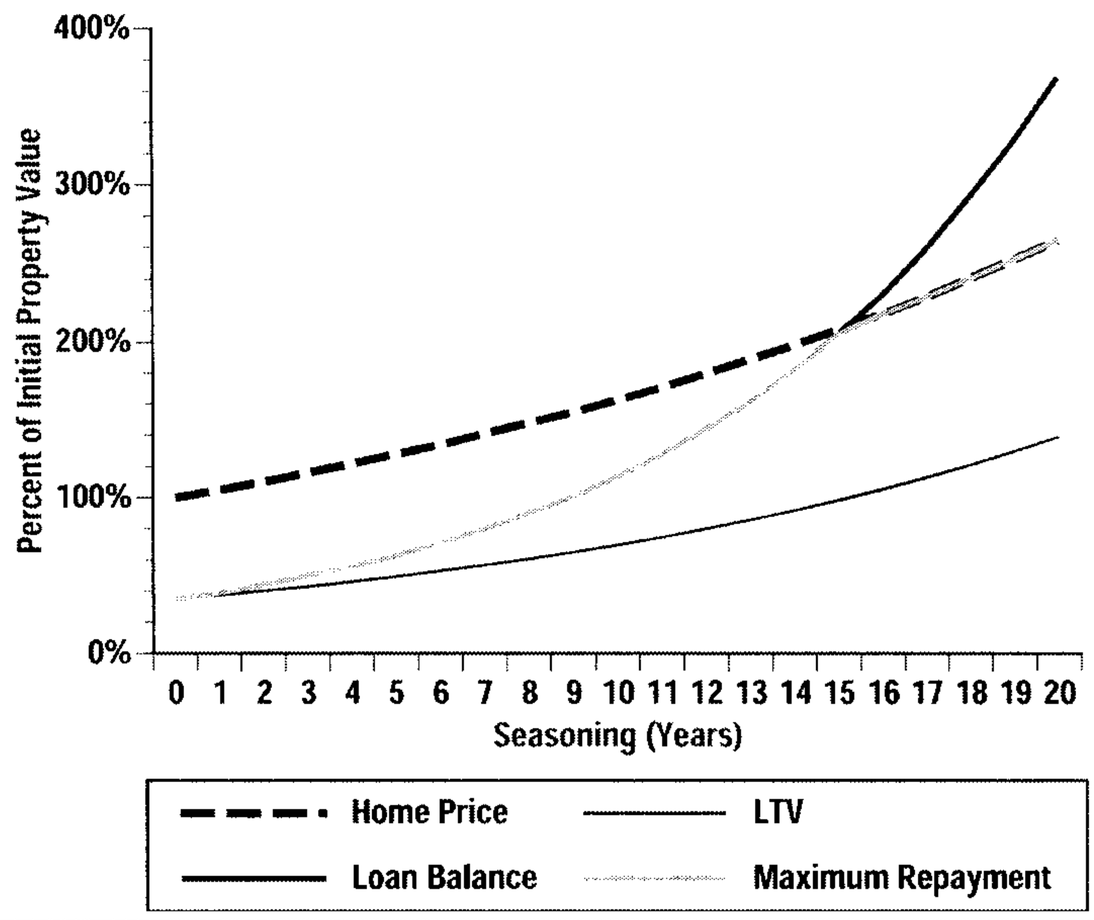
A reverse mortgage distinguishes itself from a traditional mortgage primarily by patterns of repayment and cashflow. These patterns dictate that reverse mortgages have unique credit risks other than default by borrowers.

Unlike traditional home equity loans, a reverse mortgage requires no payments until the borrower permanently leaves the mortgaged home because of death, illness, or other reasons. If a reverse mortgage loan is made to a couple as co-borrowers, repayment does not have to be made until both move out of the home or die.

In a traditional mortgage, the lender disburses the principal amount of the loan up-front to the borrower in one lump sum; the borrower is then obligated to make regular monthly payments. Repayment to the lender of a traditional mortgage depends on both the borrower's credit quality and on the value of the property upon liquidation, if the borrower ultimately defaults.

But with a reverse mortgage, the lender makes lump sum or periodic payments to the borrower. Those payments—and the interest that accrues on those payments—are added together to determine the loan balance at any given time. The lender does not rely on the borrower's credit for repayment, as there is no obligation to make monthly payments.

Figure 1
Even in Appreciating Real Estate Markets Loan Balance Increases Erode LTV
Maximum Repayment = Min (Loan Balance, Home Price)



Repayment of a reverse mortgage depends solely on the net sale proceeds of the property. The repayment is the minimum of the net liquidation value of the property, or the principal and interest on the loan, and possibly a contingency payment.[1] There is no recourse to any other assets of the borrower or to the borrower's estate for shortfalls.

Even in a robust economy where property values are increasing, it is possible the property will sell for less than the amount owed on the loan (i.e., the increased loan balance combined with the shared appreciation fees due at maturity). The longer it takes for the loan to mature, the more likely this scenario is.

The loan repayment amount can be capped by the net liquidation value realized upon the sale of the property if the time to maturity is too long. In this case, the lender may suffer a loss because the cash flow is less than anticipated.

Figure 1 illustrates that there is a time in the future, called the cross-over point, when the loan balance is equal to the net liquidation value. The interest rate is set at 12.5%, the annual home appreciation rate is 5%, the initial LTV is 35%, and there is no liquidation cost. Then the cross-over point is around the 15th year after origination.

Servicing

Reverse mortgages also pose unique servicing challenges. The servicer isn't required to process payments and make collection calls, as it must in traditional mortgage transactions. Instead, it has unique responsibilities, including determining each property's occupancy status (to determine if a maturity event has occurred) and condition, and ensuring that payment of taxes and insurance are current. To protect the collateral, the servicer must also monitor the maintenance by the borrower of the mortgaged property.

Types of Reverse Mortgages

Some representative types of reverse mortgages include:

Term reverse mortgage provides monthly payments for a set period of time, usually three to ten years. The lender will receive the principal, interest, and possibly a share of home appreciation upon the expiration of a fixed term or upon the borrower's death or move-out. The monthly

1 The contingency payment consists of the participation share of home price appreciation and other charges.

payment is determined by the future value of the principal limit, the term, and the compounding rate in a sinking fund formula.

Tenure reverse mortgage provides monthly payments for as long as the borrower lives in the home as a primary residence. The monthly payment is determined the same way as the term loans with the tenure term calculated as 100 for the age of the younger borrower. The lender will receive the principal, interest, and possibly a share of home appreciation upon the borrower's death or move-out or term expiration.

Lifetime reverse mortgage provides cash advances for as long as the borrower lives, whether he or she stays in the home or moves out. An annuity attached to this reverse mortgage enables income to be provided for life.

Line-of-credit reverse mortgage offers borrowers access to a source of money they can use whenever and however they choose. The principal limit is approved based on the borrower's home value, age, origination fee, and percentage of shared appreciation the lender is entitled to. The entire line of credit may be advanced at closing.

Hybrid term/tenure reverse mortgage combines the features of term or tenure plan and line-of-credit plan. It allows the borrower to set aside part of the principal limit at origination to establish a line of credit. The borrower receives the rest of the principal limit in the form of equal monthly payments as long as the term does not expire or the borrower lives in the home.

Fixed payment loan lets a borrower receive an initial advance at origination, followed by fixed, on going monthly payments for a stated period of time. The initial amount of the loan may be used: to purchase a deferred annuity, to refinance an existing mortgage, to cover expenses such as home repair, and to pay off other debts. The deferred annuity becomes effective when the loan matures and continues to pay out as long as the borrowers live, even if they leave their home. A small percentage of fixed payment loans include a line-of-credit feature, which gives the borrower the flexibility to draw upon this amount as needed.

Shared appreciation mortgage (SAM) is originally a European version of a reverse mortgage. It is a zero-coupon loan of a low percentage of the home value. The lender receives the mandatory redemption of the initial advance plus a share of the appreciation of the house when borrowers die or move-out. Borrowers have an option to redeem the loan in full or in part prior to the mandatory maturity on a pro rata basis. For example, the shared appreciation can be three times the original loan-to-value ratio multiplied by the net home appreciation.

Home appreciation loan (HAL) is basically a modification of SAM but targets younger age groups of 45 or over. It is similar to a home equity loan but it does not take away home appreciation earnings or have income qualifications. A borrower with a loan-to-value ratio of 40 to 50 percent could borrow 10 to 20 percent of the home value.

Home equity conversion mortgage (HECM) is a term, or a tenure, or a hybrid loan but with HUD insurance. The lender has the right to assign or put the mortgage to HUD when the outstanding balance is equal to or greater than 98% of the maximum claim amount. The maximum claim amount is the lesser of the appraised property value and the 203(b) limit of the National Housing Act. When the proceeds from the sale of the property are insufficient to pay off the outstanding balance, the lender will file a claim for the difference between the proceeds from the sale and the outstanding balance, up to the maximum claim amount.[2]

Reverse Mortgage Market and Securitization

Reverse mortgage products have been around for some time, although they are still new to the securitization market. Since 1989, in excess of 55,000 reverse mortgages have been originated under both government- and privately-insured programs.

The market consists of jumbo and non-jumbo loans—currently, those below $240,000. Fannie Mae and FHA target the non-jumbo segment and control about 98% of the reverse mortgage

2 See HUD Housing Handbooks, Document Number 4235.1.

market. Their dominance is based on the market they serve and have developed over the last several years. Some well-known mortgage originators, such as Wells Fargo/Norwest, and other specialty lenders originate and sell reverse mortgages to Fannie Mae. Currently there are only a handful of specialty lenders, including Financial Freedom and Unity, generating jumbo reverse mortgages. The volume of jumbo reverse mortgages is very small compared to the non-jumbo sector or to regular mortgages.

Securitization of reverse mortgage loans is in its start-up stage. Investment banks are testing the water as to how to make a reverse mortgage deal executable. There has already been a jumbo transaction launched in US. The market expects the first HECM securitization to come out soon.

Moody's rated the first US reverse mortgage transaction, the SASCO 1999-RM1 deal by Lehman Brothers, in August 1999.[3] Moody's also rated the first European SAM transaction, the Millshaw SAMS deal by Barclays Capital, in April 1999.[4]

RISK FACTORS AND ANALYSIS

In contrast to traditional mortgage pools, a reverse mortgage pool has unusual and less understood risk factors, including mortality, mobility, and price risks. Assessing these risks properly is fundamental when making an underwriting or investment decision on reverse mortgages and related securitization products.

Main Risk Factors are Mortality, Mobility, and Price

Mortality, mobility, and price risks are the main drivers of credit risk for reverse mortgages. This is dictated by the unique characteristics of reverse mortgage cashflows.

Cashflows available to pay investors depend on two fundamental factors:

- The timing of repayment which is triggered by a "maturity event"; and
- The net liquidation value available from the sale of the property to repay the loan.

A *maturity event* occurs primarily when the borrowers no longer occupy the underlying property, either because they die or move out. The *net liquidation value* is the sale price of the property net of sales cost and legal expenses.

The main risk for a reverse mortgage loan, therefore, is the delay of repayment due to a later-than-expected maturity event and the lower-than-expected net liquidation value of the property.

A delay of a maturity event may reduce the present value of the loan to the lender. The later the repayment, the less value the reverse mortgage has to the lender. If borrowers occupy the underlying property longer than expected, the occurrence of a maturity event will be delayed, so will be the repayment of the loan. Even though interest accrues on the loan, the repayment amount may be capped because the amount owed at maturity may exceed the net liquidation value of the property.

A maturity event is triggered mainly by one of the following two action events:

- *Mortality event:* when the borrower or all the co-borrowers die; and
- *Mobility event:* when the borrower or all the co-borrowers permanently move out of the property.

The probability of delay of mortality event is defined as the *mortality risk*, and the probability of delay of mobility event as the *mobility risk*.

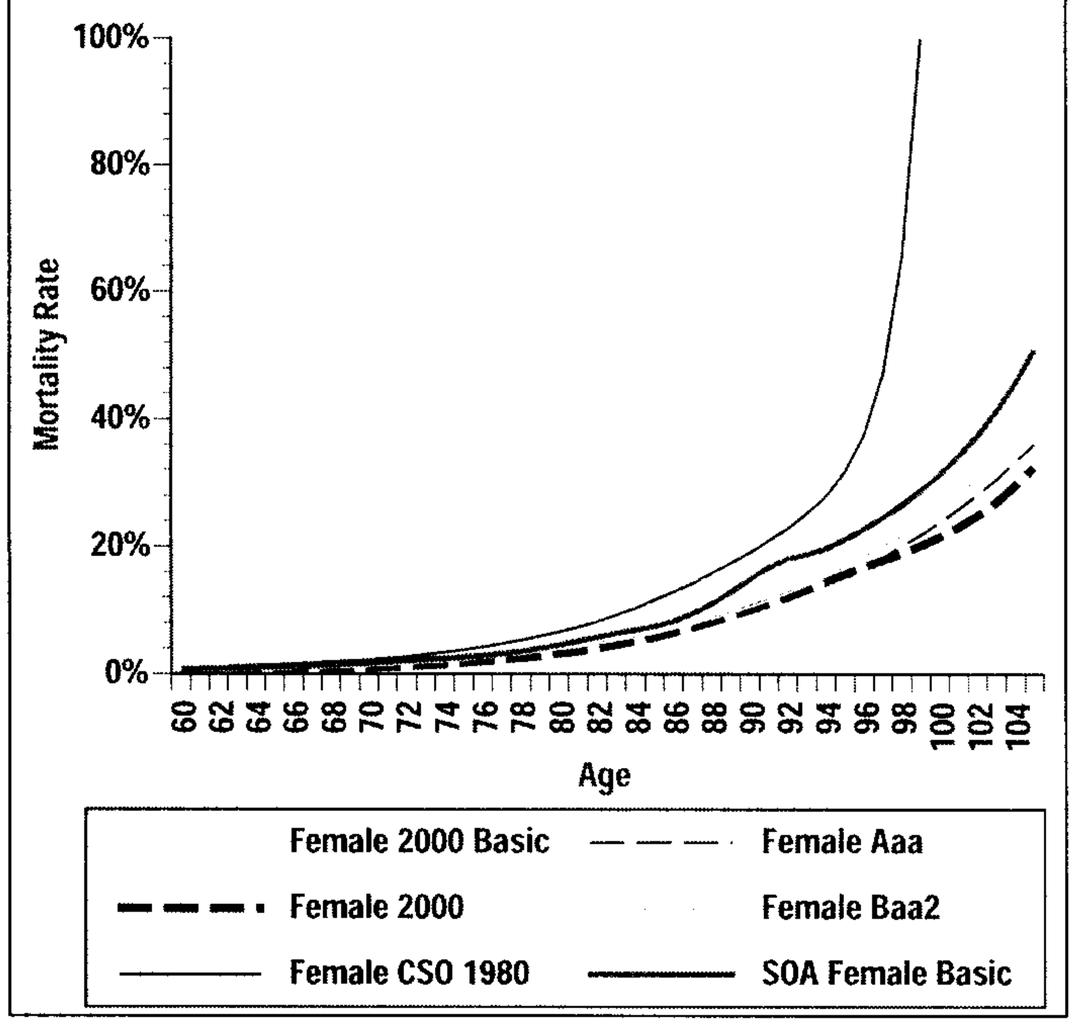
The price realized upon the sale of the property triggered by a maturity event may be less than expected and therefore miss the targeted repayment amount of the loan, causing a loss to the lender. Such a price inadequacy is defined as the *price risk*.

3 See "Structured Asset Securities Corporation, Reverse Mortgage Notes, Series 1999-RM1," *Moody's Investors Service* August 27, 1999. Also see "Reverse Mortgage Securitizations: Moody's September 1999 Teleconference," *Moody's Investors Service* September 17, 1999.
4 See "Millshaw SAMS No.1 Limited, Shared Appreciation Mortgage-Backed Notes Due 2054," *Moody's Investors Service* April 22, 1999.

Figure 2

Mortality Tables and Moody's Representative Scenarios: Female

CSO: Commissioners Standard Ordinary Table
SOA: Society of Actuaries



Analytical Notions

Some notions from statistical survival analysis and actuarial analysis are borrowed to define useful quantities in analyzing risks in reverse mortgages.

For a given time after origination, a *survival function* provides an estimate of the odds that a certain event has not yet taken place. In the case of mortality event, a mortality survival function assesses the probability of an individual or a couple surviving beyond a given time in the future. For example, if at the fifth year, a mortality survival function gives a value of 50%, then it posits that there is a 50% chance the borrower or the couple live longer than five years after they get the reverse mortgage.

A *density function* is the probability density function derived from a survival function. It measures the intensity of occurrence of a specific event at a given time after origination. For example, if a maturity density function at the fifth year is 5%, then it posits that there is a 5% chance that the loan matures during the period ending at the fifth year.

A *hazard rate* approximates the probability of experiencing an event in the next instant or period of time given that the event has not occurred so far. In a mortality case, the hazard rate is interchangeable with the concept of *mortality rate*. For a move-out event and a maturity event, hazard rates are also referred to as *mobility rate* and *maturity rate*, respectively. For example, if a mobility rate at the fifth year is 5%, then it posits that, during the next period of time, 5% of borrowers of given characteristics will move out of their homes.

The density functions of maturity events are used to calculate the cashflow amortization curves of initial principal repayment for each underlying reverse mortgage loan. Based on the terms of a loan, the associated loan balance, home value, and the repayment can be estimated for a given time period. Then the repayment upon maturity and the probability of the maturity event at any given time can be used to form an expected collateral cashflow stream out of a pool consisting of large numbers of similar loans.

GAUGING MORTALITY RISK

Regarding mortality risk, the following tendencies among reverse mortgage borrowers are expected:

- Reverse mortgage borrowers are a self-selected group that tend to live longer than the general population;
- Female borrowers tend to live longer than male borrowers of comparable ages;
- Married borrowers tend to live longer than their single counterparts;
- The joint mortality rate for a couple can be much lower than for each individual; and finally
- Improvements in standards of living, healthcare, and education have reduced US mortality rates steadily since WWII.

Choosing Mortality Tables

The ideal way to model the mortality rate for a reverse mortgage borrower is to conduct a statistical analysis of historical mortality data of reverse mortgage borrowers. Unfortunately, the sources of data seem to be scarce and less credible than traditional mortgage data.

The next-best method is to use the mortality experience of the general population, and of life insurance or annuity policy subscribers. Mortality tables constructed by the life insurance industry and the U.S. Census Bureau are statistical guidelines of historical mortality experience.

The mortality tables and data from the Census Bureau are based on the general population's mortality history. Therefore, they provide ceilings for mortality rates of reverse mortgage borrowers who are expected to live longer than the general senior population.[5]

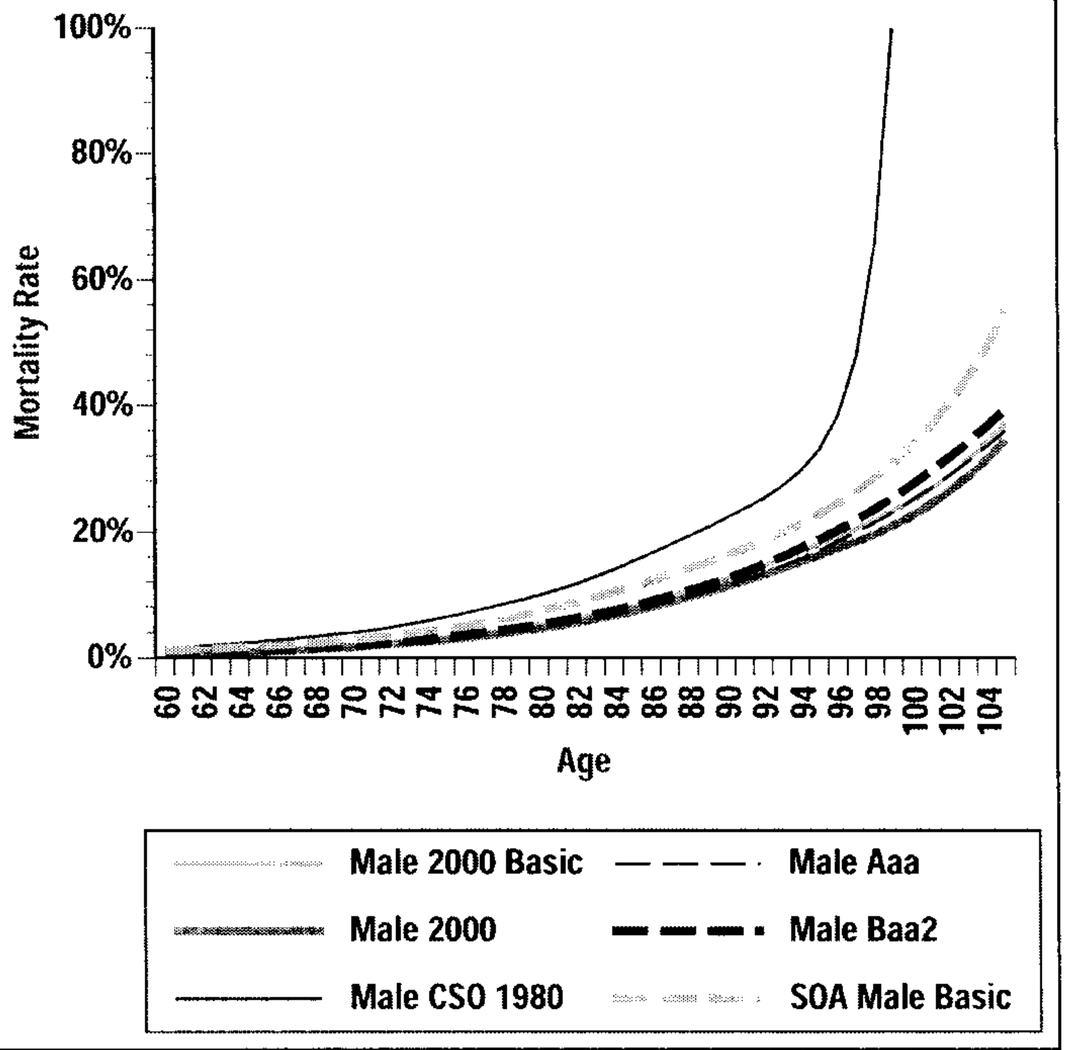
The annuitant mortality tables are designed for annuity subscribers who are expected to live longer than reverse mortgage borrowers. Therefore they provide floors for mortality rates of reverse mortgage borrowers who may not be as self-selected as annuity subscribers.[6]

The most recent mortality tables should be used when gauging mortality risk. Rapid progress of health care could prolong the lives of borrowers or postpone their moving into long-term care facilities. In general, the life expectancy of Americans has increased over time. Older mortality tables, such as the 1983 Basic Mortality Tables, may not capture this marginal longevity risk.

Figure 3

Mortality Tables and Moody's Representative Scenarios: Male

CSO: Commissioners Standard Ordinary Table
SOA: Society of Actuaries



The 1996 US Annuity 2000 Tables are used as the floors for calculating mortality rates, and for deriving the survival model of reverse mortgage borrowers. In particular, the Annuitant 2000 Mortality Tables are used as the floor references for **Aaa** baseline scenarios of mortality, and the Annuitant 2000 Basic Mortality Tables for **Baa2** baseline scenarios.[7]

Understanding that reverse mortgage borrowers may not be as self-selected as annuitant insurance buyers, we accelerated the mortality curves for the older ages. In addition, we assumed all the borrowers will die by the age of 105. *Figures 2* and *3* illustrate some representative mortality-rate curves of females and males for **Aaa** and **Baa2** baseline scenarios.

Factoring Mortality Risk

There are many factors that can affect mortality risk, including age, gender, location, and economic status. Therefore, the mortality rates are adjusted according to these factors on a loan-by-loan basis.

Age is a primary factor for mortality. As expected, older people have higher mortality rates. Consequently, the survival probabilities for older people decline faster than for younger people.

Gender is an important factor driving the mortality rate. Historically, a female tends to live longer than a male of the same age, as indicated by the mortality tables. *Figures 4* and *5* illustrate some representative survival functions and density functions of mortality for males, females and couples of age 65 in a **Baa2** baseline scenario, compared with that of age 80.

5 Reverse mortgage borrowers are self-selected with established financial and health management track records. These borrowers have significant equity in their homes. They opted for a reverse mortgage loan because they expected to live in their homes for a substantial period of time.

6 Similar to a reverse mortgage borrower, an annuity subscriber requires immediate payouts just as a reverse mortgage borrower does. However, annuitant applicants are subjected to medical and lifestyle exams. They are expected to live longer than reverse mortgage borrowers based on the known medical selection effect. In addition, reverse mortgage borrowers are likely house-rich and cash-poor, and may have to use their home equity as the funding vehicle for their immediate health-care needs.

7 Annuitant tables reflect the longer life expectancy for annuitant insurance buyers. The new 2000 tables reflected the systematic increase in life expectancies in the US. The Annuitant 2000 Mortality Tables are used for annuity insurance reserve calculations. The mortality rates in these tables are roughly 10% lower than those in the Annuitant 2000 Basic Mortality Tables. The 10% reduction seems to provide an adequate confidence level for **Aaa** baseline cases against the statistical volatility in the mortality rate for annuitant insurance buyers.

Figure 4

Male, Female, and Couple Mortality Survival Functions in a Representative Baa2 Case

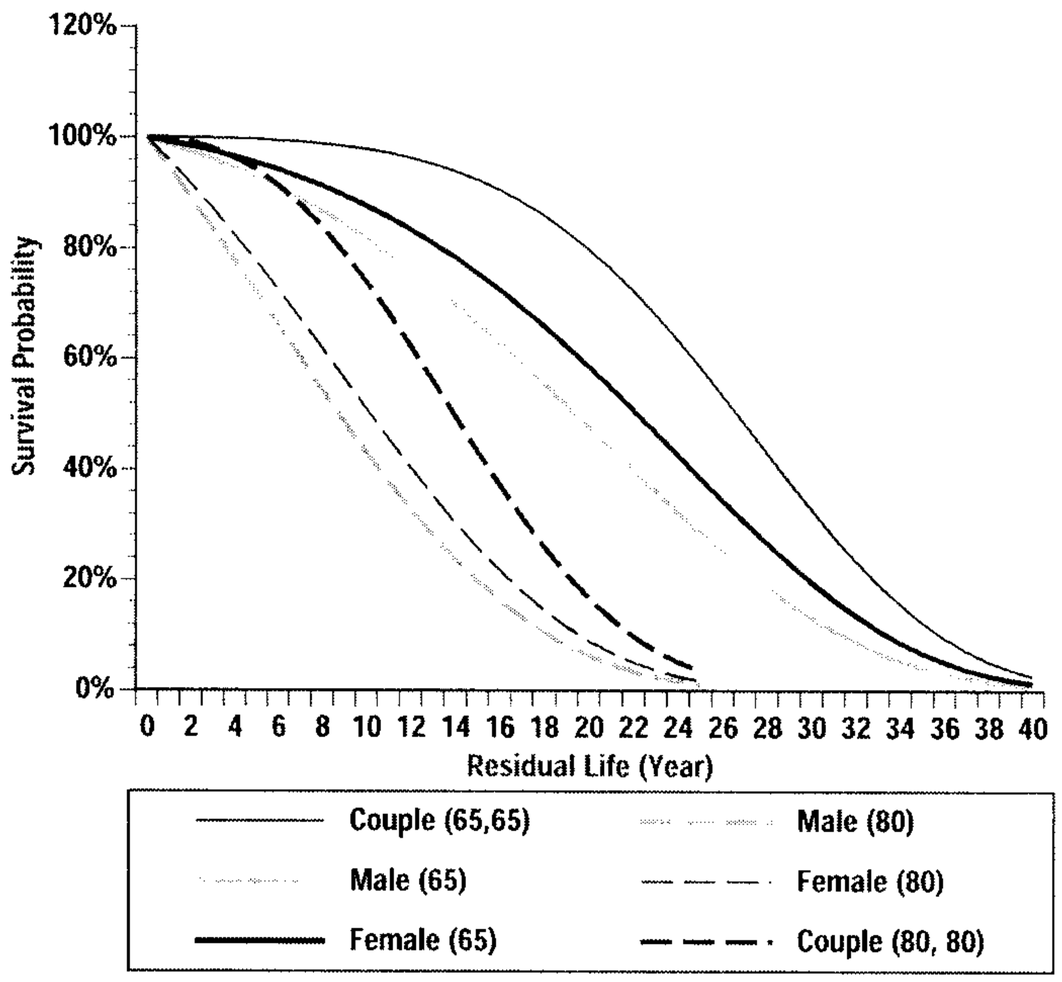
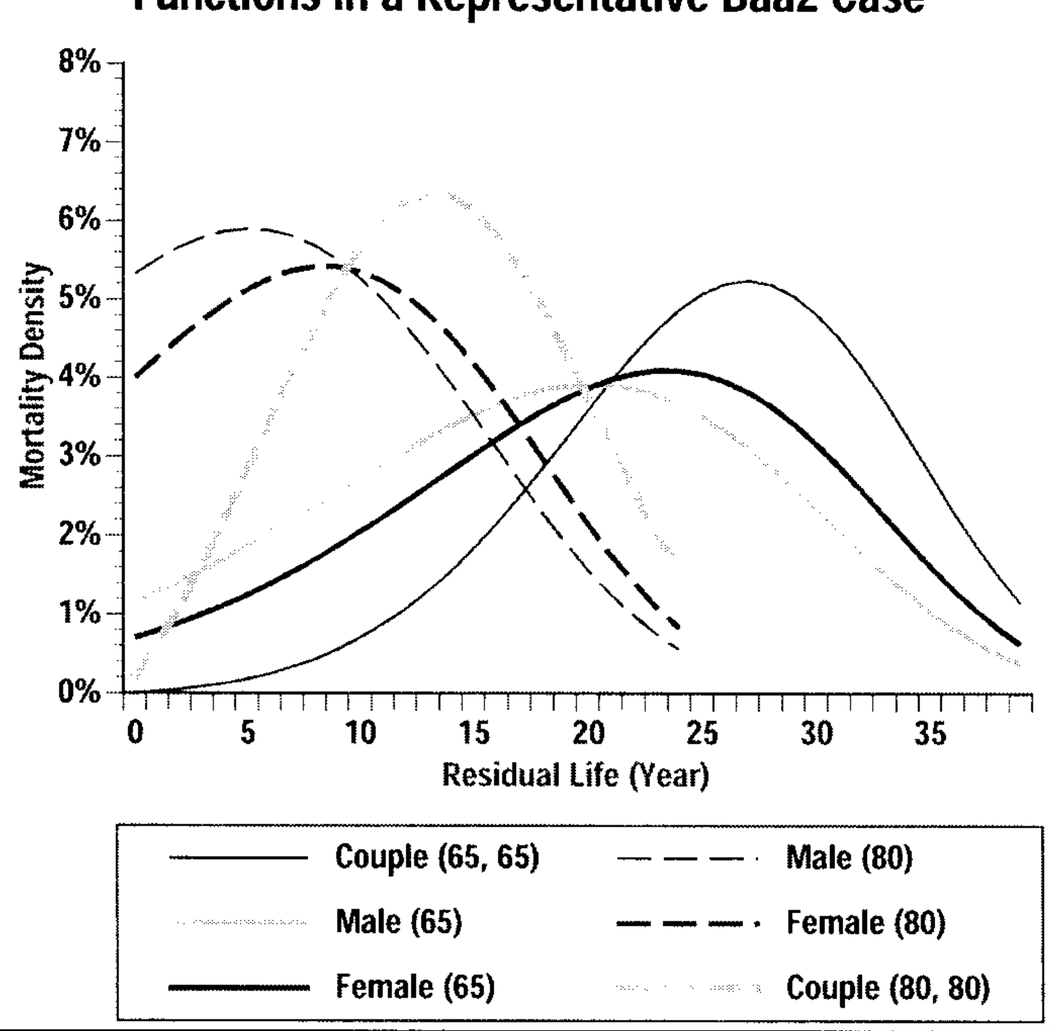


Figure 5

Male, Female, and Couple Mortality Density Functions in a Representative Baa2 Case



Mortality rates can vary and are correlated over geographic regions because of differences in demographics, health-care conditions, and other social and environmental factors.

Mortality rates can also deviate from the national norm for the wealthy and for the poor. A borrower with a higher economic status has much better access to and stronger knowledge about health-care. These variations and correlations should be recognized, especially if more comprehensive mortality data are available by geographic region and economic status.

Medical history, race, and personal habits, such as smoking, may also have significant impact on mortality. However, the practice of qualifying reverse mortgage borrowers based on medical history, medical exams, and race is not viewed as politically correct at this time.

Couple's Joint Mortality Risk

For a couple as co-borrowers, the maturity event of the loan caused by mortality is triggered by the death of the last individual in the couple:

Couple life expectancy = maximum (male life expectancy, female life expectancy)

Therefore, the survival probability of a couple can be significantly higher than the maximum of the survival probabilities of the individuals in the couple. This is because the survival probability for a couple is the survival probability of either individual in the couple, say partner A, plus the probability that the other survives partner A.

In addition, couples tend to live longer than singles due to the "happiness" of marriage. A *frailty factor* is used to calibrate the impact of marriage on individual life expectances for the couple, i.e., discounting the mortality rates for the individuals in the couple.

Given the ages of the couple at origination, the survival and mortality density functions of the couple are calculated over the "residual lives" till the age of 105. *Figures 4* and *5* also illustrate some representative mortality survival and density functions in a **Baa2** baseline case for couples, compared to singles of the same ages.

GAUGING MOBILITY RISK

The second primary risk factor is mobility risk. It is related to the extension of time to maturity of the loan because of a delay in a non-death-related move-out. Mobility risk is a subtle factor, and credible historical data is lacking.

Nonetheless, we may make the following general observations about mobility:

- Reverse mortgage borrowers have a higher desire to remain in their homes than the general senior population;
- Gender seems to be a less significant factor for non-death-related move-out rates;
- Health factors are significant drivers of non-death-related move-outs. For example, some borrowers have to move out their houses to nursing homes even though reverse mortgage borrowers as a group tend to like to remain in their own homes;
- Economic status is a significant factor in mobility. Affluent borrowers seem to move less frequently due to their greater financial options and better health-care knowledge;
- For couples, mutual care may reduce health-related move-outs. However, it seems that a surviving partner is more likely to move out upon the death of the other partner. And a divorce can also cause the sale of a home. Therefore, a couple tend to have higher move-out propensity than their single counterparts.

Patterns of Mobility Rate

There are essentially two main types of non-death-related move-outs:

- Health-related move-outs are caused by the needs of moving into long-term health-care facilities or nursing homes; and
- Non-health-related move-outs or home relocations are caused by marriage, divorce, separation, death of the spouse, disasters, job change, change of financial status, retirement, change from owner to renter, convenience to friends or relatives, and other reasons.

Therefore, we assume that the mobility rate is made up of the health-related mobility rate plus the non-health-related mobility rate.

For the general population in the US, non-health-related mobility rates generally decline as age increases, as indicated by the 1997 American Housing Survey by the U.S. Census Bureau (see *Table 1*). We expect the non-health-related mobility rate for a reverse mortgage borrower to be slightly lower than the national norm.

The health-related mobility rate should be negligible for younger people. But as a person ages, this rate should gradually rise and accelerate at the very late stages of life.

Table 1

Rates of Changing Residence: American Housing Survey 1997, US Census Bureau

Age of Household	Total Occupied Units	Moved in last year	"Move-in" rate(%)
Under 25	5308	3284	61.87
25 to 29	8412	3551	42.21
30 to 34	10384	2763	26.61
35 to 44	23270	4023	17.29
45 to 54	18777	2015	10.73
55 to 64	12431	924	7.43
65 to 74	10997	524	4.76
75 and older	9910	385	3.88

Overall, we expect the general population to have substantial mobility for younger age groups. Then mobility rates decline and eventually level off in the low single digits until age 80. Above 80, mobility rates are expected to increase because of the rising needs for health-related move-outs.

Borrower Mobility Risk

The move-out rates were calibrated based on factors such as age, gender or marital status, health, and economic status. A health adjustment to the mobility rate is assumed to be proportional to the mortality rate to reflect the propensity of that the borrower to move out for health-care reasons. It is added to a non-health-related mobility rate, which is a function of age. For senior reverse mortgage borrowers, baseline mobility rates are capped at 10% and are modeled as follows:

Mobility rate = min(10%, health factor x mortality rate + economic adjustment + non-heath-related rate + static rate)

Figure 6

Representative Annual Mobility Rate Curves

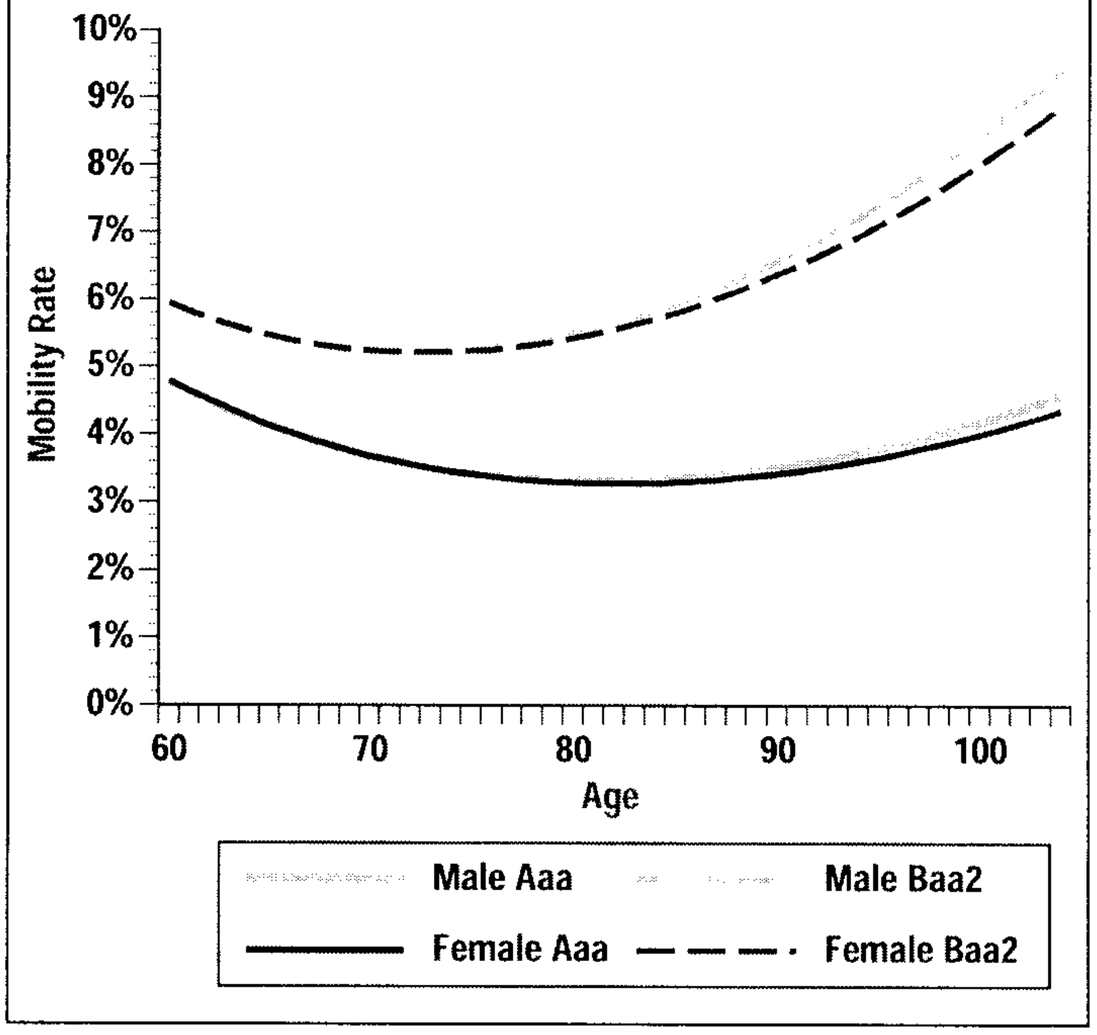
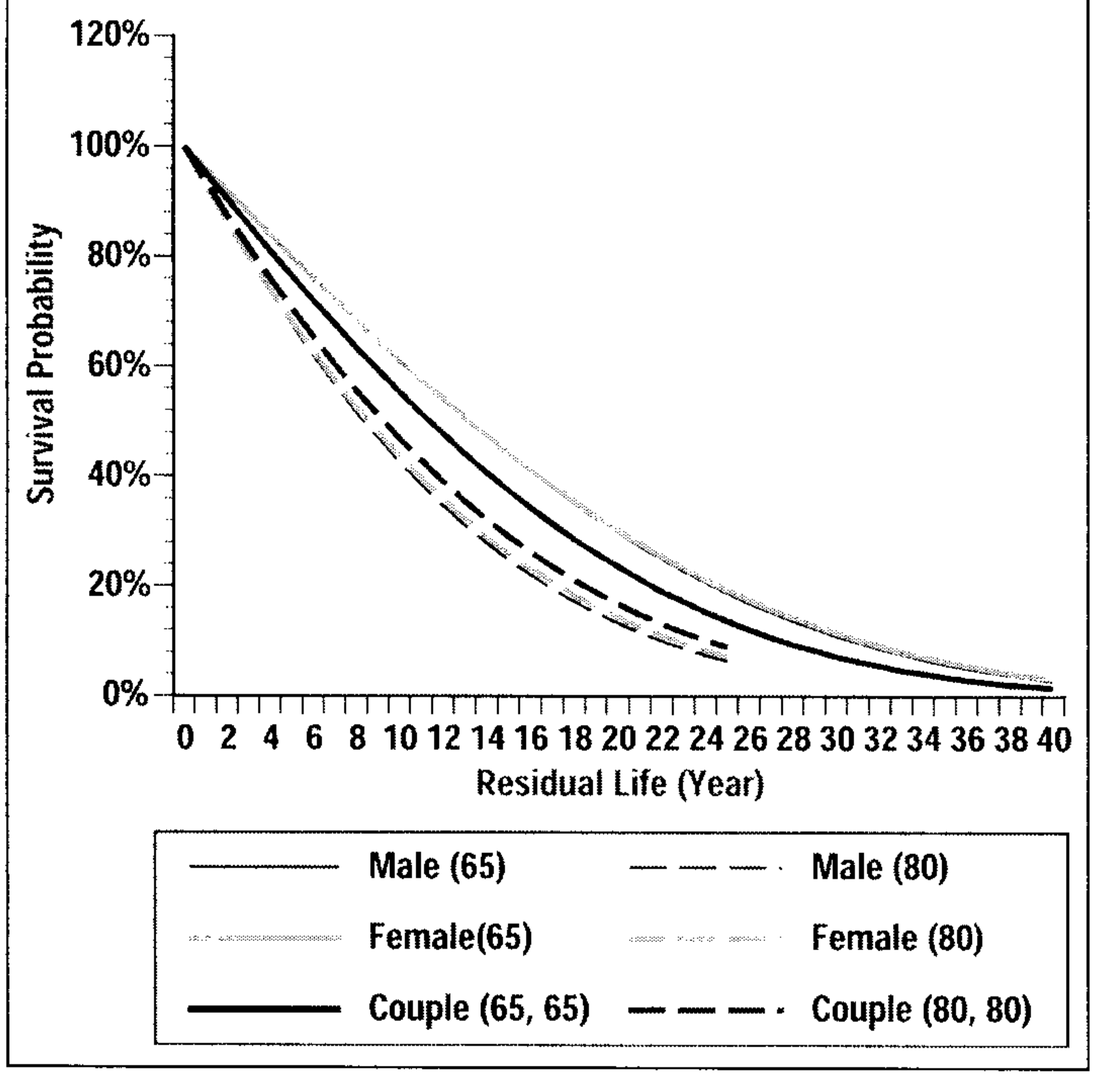


Figure7

Male, Female, and Couple Mobility Survival Functions in a Representative Baa2 Case



Mortality rates are used as a proxy for the health factor. The economic factor for move-out is calibrated by the current value of the property relative to the local median prices and by regional population growth and economic trends. We also assume a static move-out rate across the age group, but may alter that by gender.

Figure 6 illustrates some representative mobility rates for male and female borrowers in **Aaa** and **Baa2** baseline cases.

Couple Co-Borrower Mobility Risk

The joint mobility rates for couples are derived from the first-to-move-out mechanism:

Couple move-out time =
min (male move-out time, female move-out time)

However, the mobility rate of the male in a couple is expected to be less than that of a comparable single male. The same expectation can be applied to females. The discount on the mobility rates for the individuals in the couple, e.g. 50%, is due to the correlation factor of marriage.

Figure 7 illustrates some representative mobility survival functions for the borrower groups of comparable ages in a **Baa2** baseline scenario. *Figure 8* presents the corresponding mobility density functions.

TIMING OF MATURITY EVENT

For a reverse mortgage loan, the mortality event and the mobility event compete to trigger the maturity event. Therefore, the time-to-maturity depends on the joint survival probability of the competing events on a first-to-occur basis.

Under certain mathematical treatments and the following assumption:

Loan maturity time =
min (mortality time, mobility time),

the survival probability or the odds of a reverse mortgage loan can be determined by

Odds of loan survival =
odds of no mortality x odds of no move-out.

Based on the maturity survival function, the maturity density function as well as the expected time to maturity can be determined.

Once the loan matures, there may be a delay before the lender liquidates the property. Based on empirical evidence, an average sales period of several months is added to the time to maturity to calculate the time to repayment:

Average time to repayment = average time to maturity + sales period.

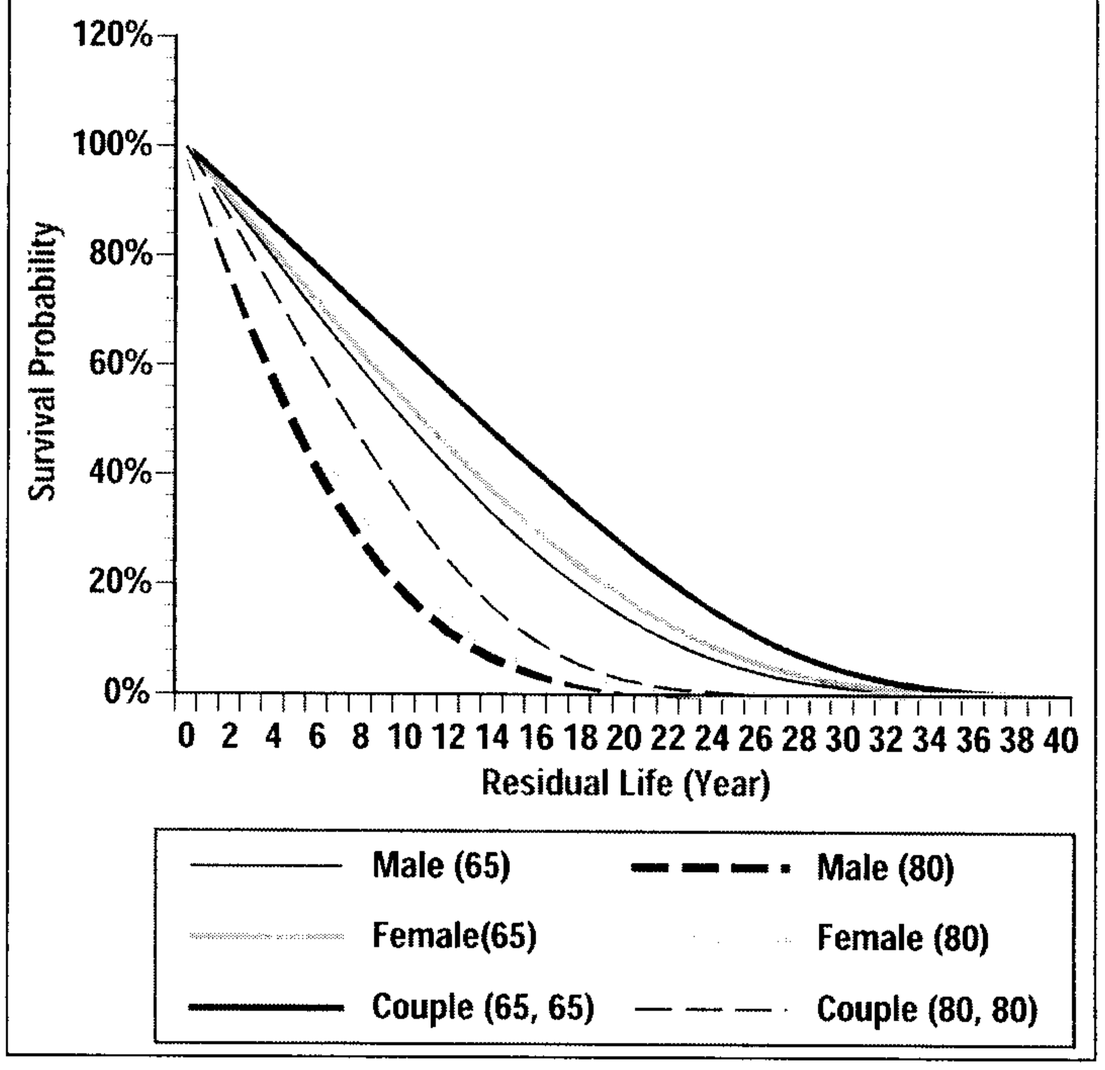
We expect that a male borrower has a shorter expected time-to-repayment than a female borrower of the same age. However, for couple co-borrowers of certain age pairs and economic status, the expected time-to-repayment is not necessarily longer than that of their single counterparts.

In a representative stressed **Aaa** case, for example, a 70-year-old male may be expected to repay in about 12 years, while for a female of age 70 it could be about 13.5 years. However, for a couple both at 70, the joint expected time-to-repayment could be less than 13 years.

Figures 9 and *10* illustrate some representative maturity survival and density functions in a **Baa2** baseline scenario. These flexible parametric functions can be altered to adopt empirical data and qualitative assumptions about the risk factors.

Figure 8

Male, Female, and Couple Mobility Density Functions in a Representative Baa2 Case



GAUGING PRICE RISK

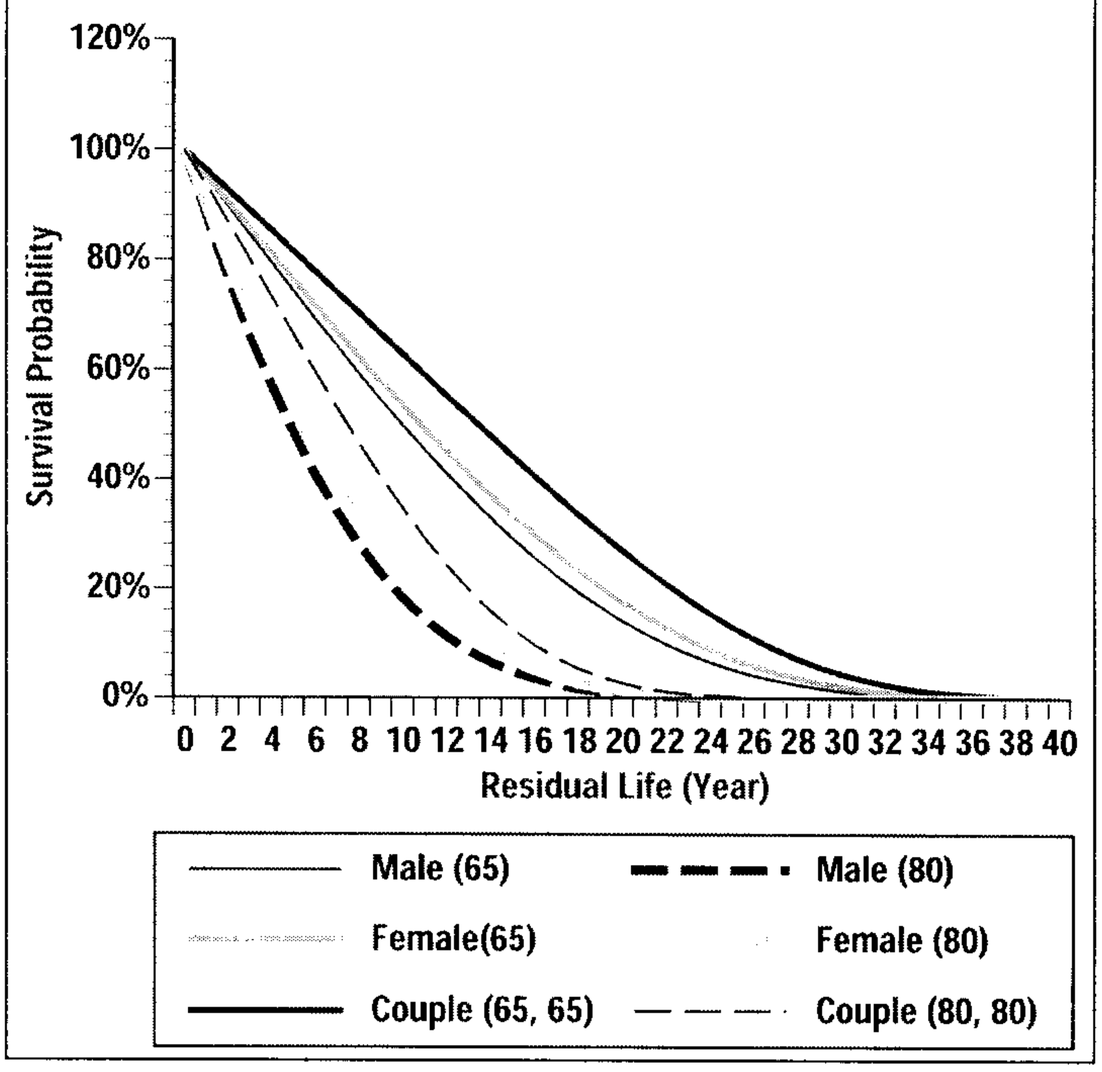
The third primary risk factor is price risk. Even for borrowers with average life expectancies and mobility, because of slower-than-expected appreciation or even depreciation in home price, proceeds from the sale of the home may be insufficient to repay the loan balance due.

It is possible that home prices at the time of a maturity event may be lower than at the time of origination. Although the long-term national average of home price appreciation has been reported around 5% per year (see *Figure 11*), the property value of the homes backing any particular pool of reverse mortgages could depreciate for several reasons:

- A borrower does not perform the necessary repairs to maintain the property;
- The property is located in a neighborhood that has declined in quality;
- There is a national, regional, or local economic downturn;
- An area is hit by natural disaster such as earthquake, tornado or hurricane;
- Elderly homeowners may be less willing than younger homeowners to make capital improvements that increase the value of the home; and
- Reverse mortgage borrowers have much less incentive to modernize, repair, or improve their homes because they are aging seniors with less and less equity in their homes.

Figure 9

Male, Female, and Couple Maturity Survival Functions in a Representative Baa2 Case



Therefore, on average, home price appreciation rates for reverse mortgage borrowers should be lower than the national average. Discounts in sale prices and appreciation rates are incorporated into cashflow analysis.

Figure 10

Male, Female, and Couple Maturity Density Functions in a Representative Baa2 Case

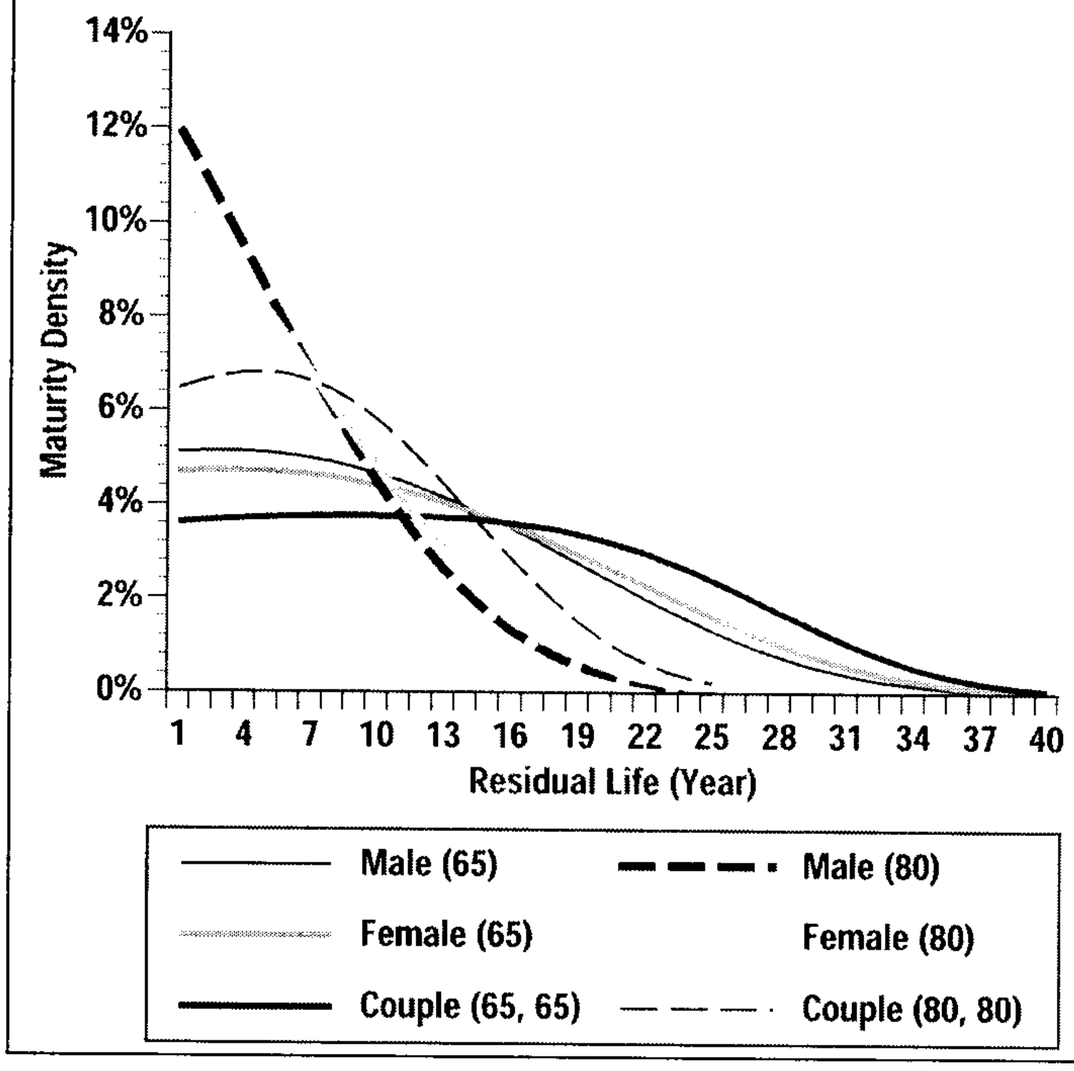
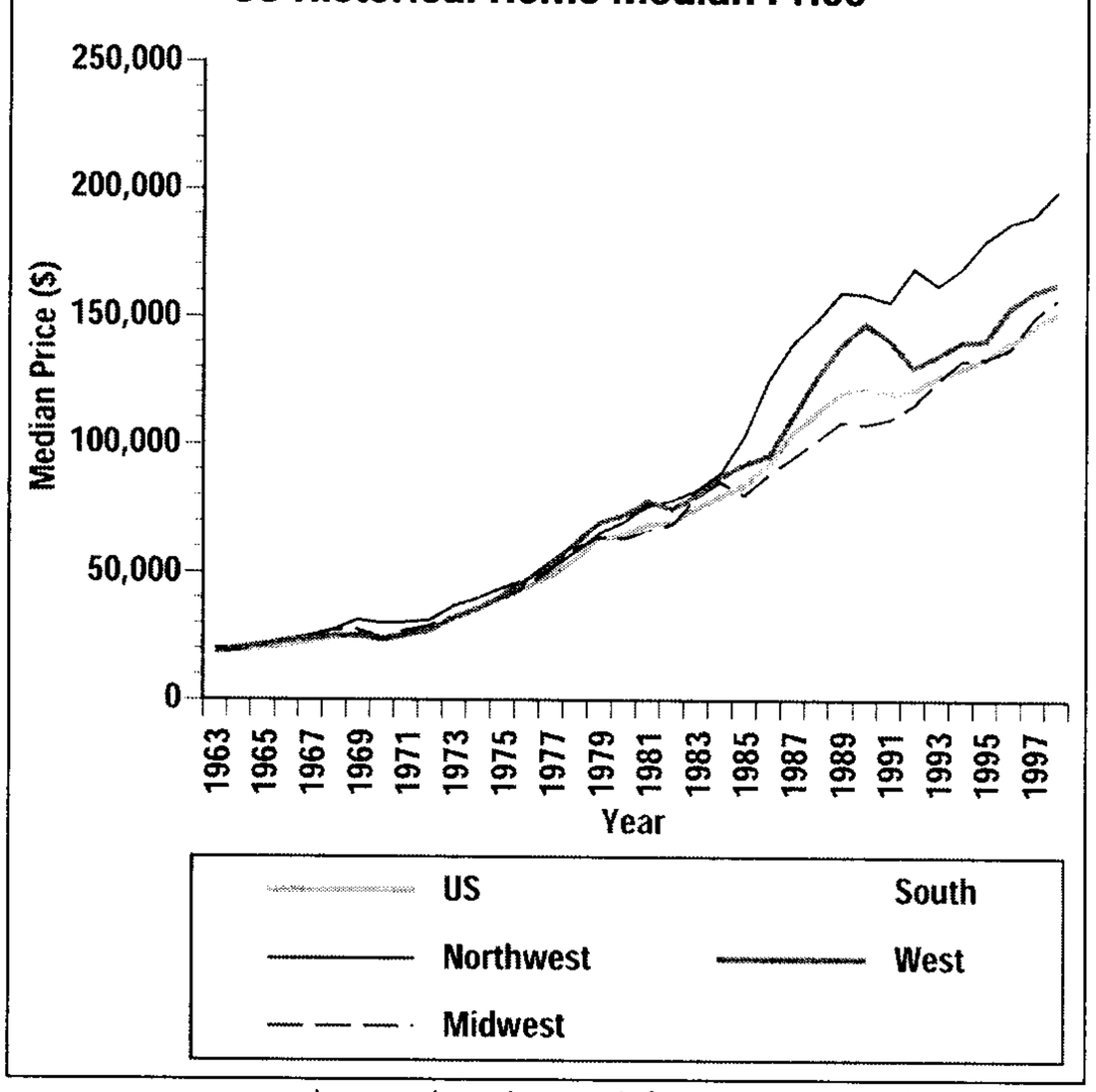


Figure 11

US Historical Home Median Price



However, unseasoned reverse mortgages may suffer less from market value declines than regular unseasoned mortgages. Even with no incentives, senior reverse mortgage borrowers are expected to adequately maintain their homes under reverse mortgage contracts enforced by the servicer. In addition, most reverse mortgages start with lower loan-to-value ratios than traditional mortgages.[8] The loan amounts may take long periods of time to reach the levels of home value where losses may occur. Home prices are expected to rise based on long-term real estate appreciation trends.[9]

On a loan-by-loan basis, the actual loan-level appreciation rate and home price are adjusted according to the unique risks and factors that are also used for traditional mortgages.

As in traditional mortgages, factors such as relative value, location and type of property, in addition to market and economic conditions, should drive home price risk.

Unique risk factors, such as gender, age, health, economic status of the borrower, along with initial LTV and seasoning of the loan as well as servicing quality, are also driving price risk.

For example, older borrowers tend to invest less in home improvement and repairs. More affluent borrowers have more financial capacity to keep their homes well maintained. High-end homes in a given region may be harder to liquidate than a home of average price.

The quality of servicing is crucial to the prevention of home value depreciation. If the servicer does not monitor the occupancy status and condition of a property frequently, the actual repayment can be delayed, or the home value may be reduced significantly.

Volatility in home prices is derived from volatility in annualized one-year home price appreciation rate. Historically, volatility varies across regions or economies, and also over time. For a given loan, volatility in the home price appreciation rate is set according to regional empirical experience.

Rating assumptions on home prices provide guidelines for average home price paths at certain confidence levels and for certain ratings. These assumptions take into consideration average home price rates and volatility, and are formed on a lognormal distribution framework.

8 A typical shared appreciation mortgage (SAM), for example, allows an individual to borrow up to 25% of the home value.
9 For a longer time horizon, annualized home appreciation rates become smoother and converge with the long-term average rates at or above 5% level. In fact, the recent 30-year national long-term annualized rate of regional median price growth is around 6%.

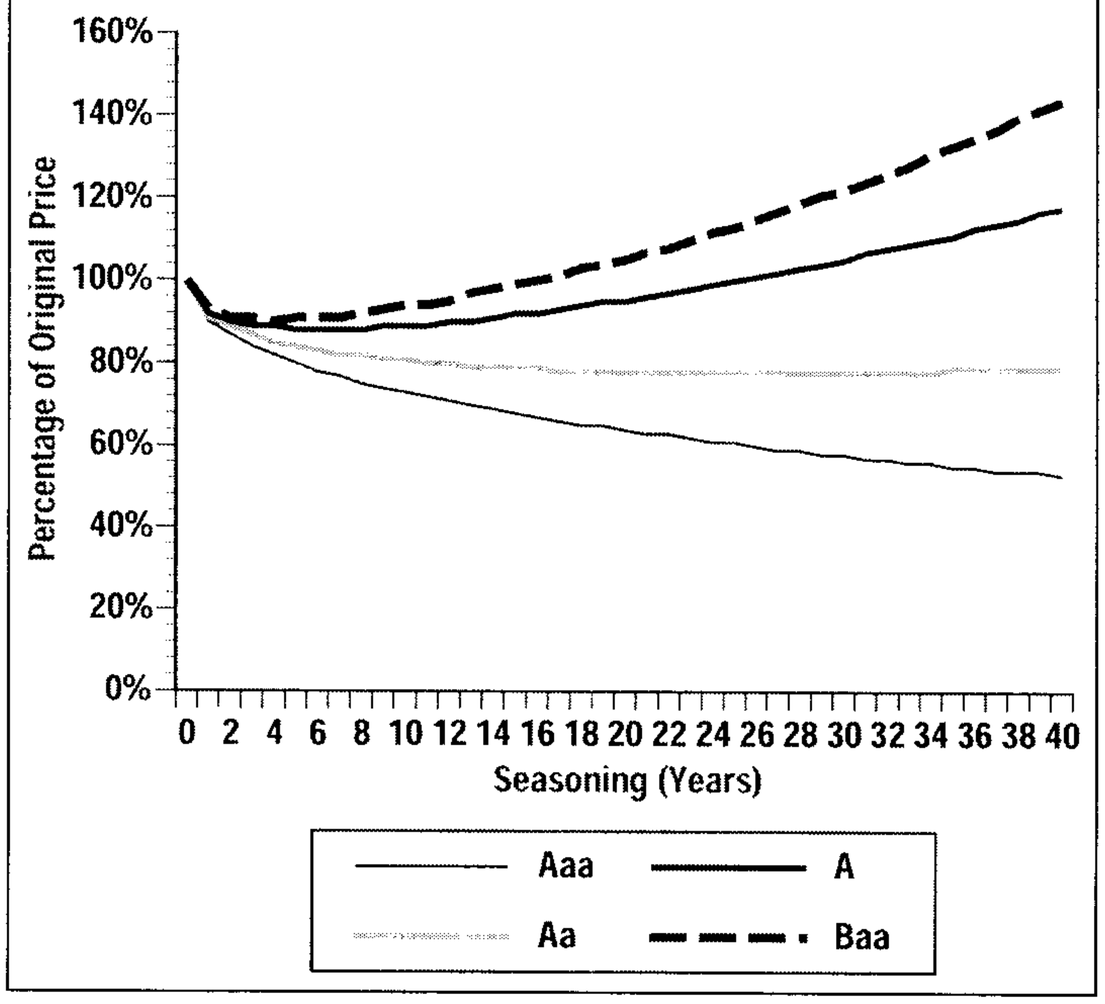
Figure 12 illustrates representative average paths of home prices over seasoning of a generic reverse mortgage loan. In a stressed **Aaa** baseline scenario, we assume the average annual home appreciation rate is 0% with 10% volatility. In a representative **Baa2** case we may assume an average annual appreciation rate of 2.5%.

Both average rates and the volatility of home price appreciation are adjusted according to the current outlook on regional economic and housing-market trends. A long-term above-norm appreciation in the overall housing market may not go on forever, and a short- to mid-term recession is always a possibility. When analyzing a high-LTV seasoned reverse mortgage, more caution should be exercised regarding price risk.

Multiple time series for regional economic factors, such as population growth and employment statistics, are constantly monitored to keep the home price outlook updated. Correlation among regional price movements is also calibrated periodically.

Figure 12

Illustration of Representative Rating Assumptions for Home Price



Geographic diversification adds benefits at the pool level. Less-than-perfect correlation among home prices can be introduced mainly by differences in regional economies, reducing volatility in the overall property value of a reverse mortgage pool.

The net liquidation value is the home price assumption less 10 to 15% for liquidation costs, depending on factors such as location and type of property.

COMMON ERRORS IN ANALYZING RISKS IN REVERSE MORTGAGES

Some market participants are using flawed methods for analyzing risks in reverse mortgages. These flawed methods may potentially lead to serious over- or underestimates of the risks, and to lower returns or even losses for investors in reverse mortgages and reverse mortgage securitizations. Following are a few examples of such analytical errors.

Average Life Expectancy Used to Time Loan Maturity

Some market participants use average life expectancy in determining time to maturity on a loan-by-loan level. Some even assume all the loans in a reverse mortgage pool have an identical average life expectancy. These extremely oversimplified analytical frameworks will mislead the cashflow assessments both on the loan level and on the pool level.

The cashflow mechanism of a reverse mortgage is "non-linear" and "path-dependent." Reverse mortgage loans have different terms and payment methods. The actual cash flow of a loan upon maturity is contingent on home price movement, interest accrual, drawing experience on the line of credit, among other factors.

In addition, the survival probability function, related to the time to maturity, can vary significantly based on differences in risk factors. An average time to maturity will be unlikely to correspond to the average repayment of the loan.

Overlooking Gender and Couple Effects on Mortality Risk

Some market participants ignore the differences in mortality risk between male and female borrowers, and between singles and co-borrowers. Some use the maximum of the survival probabilities of the individuals that make up the couple to model the mortality risk of a couple. In