Selection and Moral Hazard in the Reverse Mortgage Market

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Abstract

This paper explains why selection in the US reverse mortgage market to date has been advantageous rather than adverse. Reverse mortgages let "house rich, cash poor" older homeowners transfer wealth from the wealthy period after their home is sold to the impoverished period before. Near absence of demand seems to contradict life cycle consumption theory and has been blamed in part on large up-front fees. These fees, in turn, are justified by adverse selection and moral hazard concerns related to length of stay in the home. In fact, reverse mortgage loan histories and the *American Housing Survey* reveal that single women who are reverse mortgage borrowers depart from their homes at a rate almost 50 percent *greater* than observably similar non-participating homeowners. This surprising fact appears to arise from the phenomenon that the types of people who wish to take equity out of their homes through reverse mortgage borrowing are also likely to take out the remaining home equity by selling their homes. This mechanism is similar to the heterogeneity in risk aversion proposed by de Meza and Webb (2001) to rationalize advantageous selection in insurance markets. Further results suggest that future declines in price appreciation may generate sufficient moral hazard as to undermine the advantageous selection seen to date.

1 Introduction

Home equity is the dominant form of wealth for older Americans, particularly widows. Based on the 2001 *Survey of Consumer Finances*, Aizcorbe, Kennickell and Moore (2003) show that 76 percent of household heads 75 or over owned a home, with a median value of $92,500. Median net wealth among these households was $151,400. Just 11% of these households owed any mortgage debt. Among the majority of older single women in the 2000 *AHEAD* survey who own homes, the median ratio of home value to total assets was 79%.

Not only does home equity represent the majority of wealth for older Americans, but it is wealth that frequently goes unspent. Sheiner and Weil (1992) report an annual mobility rate of approximately 4% among older single women based on the Panel Study of Income Dynamics.[1]. Combined with mortality rates, this suggests that approximately 50% of recent retirees will die in their current home. This is consistent with the AARP survey finding, cited by Venti and Wise (2000), that 89% of surveyed Americans over 55 reported that they wanted to remain in their current residence as long as possible.

In a life-cycle model, the desire for a smooth consumption trajectory implies that a transfer of money from the wealthy period after a home is sold to the cash-poor period before increases welfare, absent extremely strong bequest motives or complementarities between non-housing and housing consumption.[2] In fact, low interest rates and rising home values have contributed to a recent increase in the volume of home equity borrowing among the elderly.[3] Home equity loans with growing balances can serve the purpose of transferring money from after to before sale or death. However, such loans provide little liquidity for older homeowners unable to pledge much non-pension income towards repayment because of enforced minimum income to loan amount tests.[4]

Reverse mortgages, unlike standard home equity loans, require borrowers to make only a single, "balloon" payment at the time of move out or death (although full or partial pre-payment is also allowed). These loans are also typically made without recourse to borrower financial assets.[5] Hence underwriting is based only on age and

[1] Similarly low mobility rates are found on inspection of the Survey of Income and Program Participation and in the AHEAD survey of the elderly (see Venti and Wise (2000)).

[2] Artle and Varaiya (1978) prove such a gain in a specialized setting with deterministic mobility and no bequest motive. Mayer (1994) and Kutty (1998) suggest that a large number of retirees could move out of poverty if they took on reverse mortgages.

[3] See, for example, Bayot (2004).

[4] Borrowers may simply not state income in loan contracts, but this involves steep increases in the interest rate, on the order of 2%.

[5] In an extreme version of a "shared appreciation" reverse mortgage, the lender takes title the home when the borrower moves or dies.

collateral and not at all on income or non-housing assets. Figure 1 illustrates the workings of a stylized reverse mortgage for an older homeowner who is alive at present and may live zero or one additional periods. Conditional on living for one additional period, this consumer might move or remain in their home. M_1 denotes an initial reverse mortgage amount paid to a reverse mortgagor by a lender. If the borrower moves or dies, the borrower (or their estate) owes principal plus interest on M_1 plus a financed origination fee F. Should the borrower remain in the home and live in the second period, they borrow M_2. M_2 can be a negative number if the borrower wishes to prepay some portion of the loan balance. After the borrower's death, the estate owes accumulated principal and interest on M_1, F and M_2.

Absence of recourse and borrowers' freedom to determine the date of exit from the home give rise to concerns of adverse selection and moral hazard. This design feature gives rise to concerns of adverse selection and moral hazard. The potential for adverse selection in the reverse mortgage industry is well illustrated by the case of famed Frenchwoman Jeanne Calmet who lived to the age of 121 and her reverse mortgagee Andre-Francois Raffray.[6] More generally, the rate of price appreciation (π in Figure 1) is likely to be smaller than the opporunity cost of funds for lenders. Depending on maximal loan amounts, borrowers who remain in their homes for a long time may thus enjoy a long effectively interest free period of default, in which the bank is, by construction, unable to evict. "Adverse selection" thus arises if consumers expecting an unusually long life or low mobility enter into reverse mortgages at a rate disproportionate to their share of the population. Adverse selection is more severe if, in expectation, the rate of mobility among reverse mortagors is positively correlated with house price appreciation.

Reverse mortgage design might invite two dimensions of moral hazard. The first, mentioned by Caplin (2002) and modeled by Miceli and Sirmans (1994) and Shiller and Weiss (2000), is that a mortgagor facing default has no incentive to maintain property values. The second moral hazard issue is that by giving funds to an older homeowner, life in the home is made relatively more attractive than life after moving or death, and so the act of giving a borrower a reverse mortgage may extend the borrower's stay in the home beyond the optimal length for an otherwise identical non-mortgagor.

This paper explains that neither adverse selection nor moral hazard is guaranteed by the structure of the reverse mortgage industry. In fact, Figures 2 and 3 demonstrate that, to date, reverse mortgage borrowers in the US have moved out of their homes, whether due to death or voluntary mobility, at a rate that far exceeds the rate of demographically similar non-borrowers. These figures and supplementary hazard estimates

[6] As reported by the Associated Press on August 5, 1997, Calmet sold her apartment forward to Raffray in her eighties, in what turned out to be a disastrous arrangement for Raffray and his heirs. The french word for the arrangement is "viager."

are discussed in detail below.

Figure 1 shows that a reverse mortgage is essentially an insurance contract, where the insured risk is the act of staying for a long time in a home that experiences weak or negative appreciation. As in a standard insurance contract, money is transferred from a low marginal utility state (after the gains from sale have been realized) to a high marginal utility state (before the gains have been realized and when liquid assets are typically small). Because of the borrower's limited liability, there is also a transfer from after-sale states of nature with high appreciation rates to after-sale states of nature with low appreciation rates.[7]

de Meza and Webb (2001) argue that when actuarially unfair pricing renders full coverage undesirable, insurance markets may feature advantageous, rather than adverse, selection. For example, they cite evidence that UK credit card holders who purchase insurance against lost cards are less likely to lose their credit cards. Finkelstein and McGarry (2003) find that older individuals who purchase long term medical care insurance are less likely to wind up in long term carre than non-purchasers. In both cases, the proposed rationale is that more risk averse consumers are likely both to seek insurance and to behave in a way that avoids the insured event. Cohen and Einav (2004) find complicated selection effects relating both to underlying probability of accidents and to risk aversion in the Israeli auto insurance market.

The relatively rapid exit from homes on the part of reverse mortgagors may be explained similarly. Reverse mortgage borrowers are likely, by revealed preference, to have a greater gap between marginal utility before moving and marginal utility after moving (or in death) than those who find reverse mortgages unattractive. The reallocation of wealth allowed by a reverse mortgage may be insufficient to fully reduce this marginal utility gap. Just as the insured can act to reduce the probability of accidents through careful behavior, so reverse mortgagors can act to reduce the length of the high marginal utility state by moving relatively quickly.

Section 2 of this paper outlines the structure of the dominant reverse mortgage product in the United States, the Home Equity Conversion Mortgage (HECM). Section 3 lays out a stylized model of the relationships among health status, optimal move date and reverse mortgage take up. The model does not deliver closed form results, but inspection of the first order condition for an optimal move suggests that advantageous selection of the type described by de Meza and Webb (2001) is likely to operate in the reverse mortgage market, at least when house price appreciation is as strong as it has been over the life of most reverse mortgages. Numerical examples presented in

[7]The second insurance characteristic could be replicated by purchasing short positions in local housing price indices, as proposed, e.g. by Shiller and Weiss (2000). There has been even less demand for such contracts than for reverse mortgages, perhaps suggesting that the pre-move vs. post-move consumption smoothing is more likely to be of interest to seniors.

the Appendix suggest that both moral hazard and advantageous selection are likely to operate in this market. Given the large number of individual characteristics that govern optimal consumption, mobility and home equity behavior, the numerical examples are not meant to capture reality so much as to illustrate the likelihood that moral hazard would arise and the possibility of advantageous selection in this market.

Empirically, we find in Section 4 that selection on the observable characteristics of age, income, wealth, property value and historical price appreciation rates follow from theoretical considerations. However, advantageous selection on observables explains only a small part of the large difference in mobility rates between reverse mortgage borrowers and the rest of the population. These results suggest that advantageous selection to date has occurred, but largely on unobservable dimensions such as risk aversion, discounting or health status.

The theory is further confirmed in that mobility among reverse mortgage borrowers is sharply reduced in states that have featured historically very low house price appreciation rates. This fact is predictable because in these states, default is feasible and hence borrowers may seek to exploit the implicit free stay in homes offered by the reverse mortgage. This predictable difference across states suggests that a future slowdown in appreciation rates might undo the advantageous selection observed to date.

This paper largely ignores moral hazard issues related to home maintenance. In modelling, we allow borrowers to have private information concerning the rate of price appreciation, but do not consider the effects of reverse mortgage borrowing on maintenance. Neglect of maintenance moral hazard can be justified in three ways. First, home maintenance among the elderly is quite low on average, even in the near absence of debt.[8] Second, inspection of Figure 1 demonstrates that unless the borrower anticipates default, the presence of reverse mortgage debt should encourage, rather than discourage, home maintenance. A liquidity constrained mortgagor should be more, rather than less willing to make investments that are realized only after sale after borrowing money from the post-sale period. Third, data on realized appreciation and maintenance are not readily available, and even if it were, it would be very difficult to attribute a causal role to under-maintenance.[9] A stochastic model of maintenance by a risk averse homeowner is presented in ongoing research.[10]

Strategic behavior on the part of lenders is not considered in this paper. To date, pricing in the home equity conversion market has been driven largely by federal regulations and potential losses to the actual issuers of reverse mortgages are small due to

[8]Davidoff (2004) finds under-investment in home maintenance on the part of older homeowners as well as average appreciation rates of three percent less per additional year of ownership by a household head over 75, controlling for metropolitan area and the specific years of occupancy.

[9]See, for example, Harding, Rosenthal and Sirmans (2003).

[10]See Welke (2004).

federal loan guarantees. As an illustration of the absence of strategic supply behavior, the actuarial model used by FHA to estimate income and payouts from its insurance of HECMs assumes a constant termination rate that is independent of interest rates or price appreciation.[11]. As such, we take the pricing and credit limits of reverse mortgages as exogenously given.[12]

2 The Home Equity Conversion Mortgage

The modern reverse mortgage industry dates to 1961 in the US and the early part of 20th Century in Europe. In the late 1980s, the US Department of Housing and Urban Development ("HUD") devised a Home Equity Conversion Mortgage ("HECM") program. HECM is currently the dominant reverse mortgage product in the US. The program works roughly as follows.[13]

Borrowers must be homeowners with very little or zero outstanding mortgage debt. HECMs are originated by banks, sometimes through mortgage brokers. The banks and brokers earn upfront fees and the banks typically retain servicing rights. These lenders typically sell the cash flow rights associated with the loans to Fannie Mae, a for-profit mortgage company whose bond holders have an "implicit guarantee" of repayment from the federal government. The loan cash flows themselves are insured by the Federal Housing Agency (FHA) against default. In exchange for providing any difference between property value and accumulated loan balance, FHA receives 2 percent of the property value at the time of loan closing and assesses a charge of $\frac{1}{24}$ of one percent of the outstanding loan balance each month. To date, Fannie Mae has held these loans in its portfolio rather than securitizing them.

HECM borrowers are obliged to make property tax payments and to perform minimal maintenance. The maintenance requirements are widely deemed enforceable only before closing because of the considerable legal difficulty in evicting an elderly mortgagor for failing to make sufficient repairs to their home. Otherwise, no payments are due until all mortgagors (a borrower and a spouse if one exists) have moved out of the home, dead or alive. There is no recourse to the lender for payments outside of the value of the home in the event that the resale value is below the outstanding loan balance.

Borrowers can receive payments in several forms. They may receive a single lump sum payment, a line of credit with an increasing maximum outstanding balance, monthly payments that last for a fixed period (term payments), or monthly payments

[11] See Rodda, Herbert and Lam (2000)

[12] Expansion of the home equity conversion industry beyond its currently small size would presumably affect housing prices and interest rates, considerations we ignore.

[13] Much of the discussion below comes from Rodda et al. (2000).

that last as long as the borrower lives in the home (tenure payments). Borrowers may receive payments in a combination of any of these forms. The line of credit is by far the most popular option (and it includes lump sum payments as a subset).

Because interest rates are likely to exceed the rate of house price inflation, loan-to-value ratios are smaller than available on conventional home equity loans, increase with age and decrease with the interest rate. For example, an 80 year old single homeowner could obtain a loan-to-value of approximately two-thirds of property value as of August, 2004. A 65 year old single homeowner could obtain an actuarially reduced value of approximately one-half of property value.

The interest rate on HECM loans may be fixed or adjustable, but almost all existing loan rates are adjustable as Fannie Mae will only purchase adjustable rate mortgages under HECM. The spread over the one-year treasury rate is typically near 1.5 percent. Closing costs on the 77,007 loans issued through 2003 vary considerably.[14] The median ratio of closing cost to property value is 6.8 percent. These closing costs, which may be financed, are large relative to conventional loans, particularly relative to home equity lines of credit which feature closing costs of zero in some cases. No payments are due until the borrower moves or dies.

Weakness of demand has led to the exit of many originators,[15] but as discussed above, the potential size of the market is huge. Indeed, Mayer (1994) estimates that the HECM product should be welfare-enhancing attractive to at least six million older households, so that something like one percent of the potential market has taken on reverse mortgage debt. The numerical exercises discussed below suggest that the potential market is, indeed, large.

The small size of the reverse mortgage market is blamed in part on the very large fees. A lower upfront fee combined with smaller loan amounts to render default highly unlikely seems like a natural way to encourage demand, but loan size appears anecdotally to be an important factor in consumer demand. Part, but not all, of the large fees are attributable to the 2 percent insurance fee charged by the FHA. This guarantee fee is more than ten times as large as the fees charged by Fannie Mae to insure repayment of conventional mortgages.[16] To date, FHA has been able to assemble a large reserve

[14]The R^2 from a regression of closing cost on maximum loan amount is just .0008 and the coefficient on maximum loan amount has the wrong sign.

[15]Other problems have plagued the industry. Some reverse mortgages were designed with shared appreciation features. Some reverse mortgagors under such "SAM" arrangements died within one or two years of origination but enjoyed large capital gains, so that the payments received relative to the debt owed were very small. This has led to legal conflicts. Perhaps for this reason, Fannie Mae does not purchase shared appreciation mortgages. There appears to be some belief in the industry that a vicious cycle of absence of demand leading to difficulty in establishing actuarial estimates, leading to high borrowing costs leading to absence of demand.

[16]In 2000, Fannie Mae reported an average guaranty fee of .2 percent, but this is on mortgage size, not

against future defaults because of rising asset values and rapid mobility of borrowers. However, there is uncertainty about what will happen to actuarial performance if appreciation weakens. Hence, it is not entirely obvious that the two percent guarantee fee should be reduced, given prevailing credit limit rules. Providing the market with a better understanding of the nature of selection and moral hazard in the market may thus be critical to expansion.

3 A Model of Mobility, Mortality and Reverse Mortgage Take Up

While a complete actuarial model of the reverse mortgage market is beyond our present scope, it is clear that mobility and appreciation rates are critical determinants of market viability. To see this, denote initial home value H, loan amount L, risk adjusted discount rate r and constant and deterministic net appreciation g. Assume that the entire allowable loan balance at date 0 is withdrawn immediately and that FHA charges no fixed fee in exchange for its guarantee of full HECM repayment. The FHA would then lose money through its guaranty program if the borrower moves past the date $t = \frac{ln(H)-ln(L)}{r-g}$.

In this section we take the details of the HECM program described above as given and we ask under what conditions borrowers are likely to exhibit greater mobility than non-borrowers. Holding the evolution of asset prices constant and assuming that fees are greater than or equal to fixed loan costs, selection is advantageous from an actuarial perspective if mobility is greater among borrowers. Given the program details, we consider "mobility" to include moves to different private homes, moves to assisted living or nursing homes or moves to live with relatives as well as death.

To determine whether mobility among HECM borrowers should exceed population mobility, we consider the lifetime utility maximization problem for a retired homeowner, observed at age a. We ask whether the retiree will find it optimal to move at some date T prior to the date of death A and whether the retiree will consider reverse mortgage debt attractive. We also ask whether the act of taking on reverse mortgage debt is likely to speed or delay mobility, conditional on characteristics. Unambiguous predictions are not available even in a rather simplified setting. Some parameterized numerical optimization problems are thus presented as well.

home value.

3.1 Optimal Mobility With and Without Reverse Mortgage Debt

For simplicity, we consider single retirees both in modelling and estimation of relative mobility among borrowers and non-borrowers. In practice, approximately 60% of HECM borrowers are single, and most of these are single females. To focus on asymmetric information and given the complexity and unexplored nature of the problem, we assume that the borrower knows with certainty the date of death A, the constant rates of interest r and house price appreciation net of fixed maintenance, g. The interest rate assumption is not too severe of an approximation in the sense that HECM debt is adjustable, so that refinancing strategies are not salient to the analysis. The reverse mortgage debt grows at the constant rate $r_M > r$ in addition to draws from the line of credit.

In the absence of mortgage debt, moving generates a large and immediate positive cash flow. If the homeowner had been unwilling or unable to treat home equity as liquid wealth, this windfall allows the rate of consumption of other goods to increase, as discussed in Artle and Varaiya (1978). We denote consumption of a composite non-housing numeraire by c.

Waiting an additional period to move when there is no mortgage debt has three financial effects. First, there is an additional period of capital gain or loss prior to sale, discounted by the interest rate. Second, the price of housing consumed (either purchased or rented) after the move increases by the rate of growth g. Assuming housing demand is price inelastic, this will tend to reduce marginal utility after the move. Third, the purchase (or rental) of post-move housing is deferred, generating an interest savings. With a deterministic date of death A (or an upper bound on the support of A), it is clear from these considerations that for purely financial purposes, a move before death must be optimal.

Moving, however, generates direct changes to utility as well as the financial effects listed above. First, it is clear from observation that moving involves a considerable and possibly time dependent psychic disruption cost, which we denote $\mu_0(t)$.[17] Second, after the move, the act of having moved may generate utility gains or costs through moving perhaps closer to family or medical attention and improved maintenance conditions, but out of a familiar environment. We denote such costs or benefits $\mu_1(t)$. Moving also allows a consumer to reoptimize housing consumption, from the level before the move H_a to the optimal subsequent level H_T. For house rich - asset poor elderly widows, this reoptimization should in theory generate considerable gains. Theoretically, concavity of the utility function should also imply that asset rich - house poor widows should find immediate reoptimization through trade-up in housing attractive (e.g. moving to

[17]We ignore maintenance and selling costs.

Palm Beach upon retirement).

The existence of reverse mortgage debt affects the analysis of the optimal move date. If, at the optimal move date, the borrower is in default on the reverse mortgage, then the only financial effect of waiting to move is to save the user cost of the new housing unit for some time. The first two financial effects alluded to above disappear, because the entire proceeds from the home, and no more, go to the lender. If the loan is not in default at the optimal move date, then waiting to move generates both the price and interest rate related effects discussed above as well as an additional period of interest paid on the reverse mortgage.

An older homeowner must compare taking on reverse mortgage debt both to taking on no debt and to taking on a home equity line of credit. Home equity lines feature higher interest rates than the reverse mortgage, but we assume zero fixed fee. In the absence of a reverse mortgage, the interest rate on savings r is thus greater than r_M for negative savings and infinite above some limit on allowable debt under a home equity line. A home equity loan is likely to be relatively more attractive to retirees with large income, since the maximum loan amount available under a home equity loan is an increasing function of non-annuitized income. This ranking is complicated by the possibility that increased income will lead to a lengthened stay in the home, rendering the HECM's high fee and low interest rate more attractive.

With these considerations in mind, denoting lifetime utility by U, instantaneous felicity by u, denoting the choice of reverse mortgage debt to take on in each period by $m(t)$, assuming that a single level of housing H_T is chosen after any move, and assuming that utility is intertemporally separable and consistent, the utility maximization problem can be written:[18]

$$\max_{\{m(t)\},\{c(t)\},T,H_T} U = \int_a^T u(c(t), H_a)e^{-\delta t}dt - \mu_0(T) + \int_T^A (u(c(t), H_T)e^{-\delta t} + \mu_1(t))dt. \quad (1)$$

The optimization over mortgage draws, consumption, move date and housing after moving are subject to the following constraints:

$$M(a) = F(\bar{M}); \quad s(a) = s_a; \quad (2)$$

$$M(t) \leq \bar{M}e^{t-a}. \quad (3)$$

The first equation in (2) states that the initial mortgage balance is either zero or the size of the fee required to open a reverse mortgage line of credit with upper limit $\bar{M}$. F is difficult to estimate as there has been considerable heterogeneity in reverse mortgage fees to date. As discussed above, this is a large amount and may be increasing in the

[18]This form of a utility function assumes away a bequest motive. The presence and functional form of bequest motives are matters of empirical controversy. Assuming that bequest size is a superior good, we would expect the desirability of reverse mortgages to decrease all the more in wealth and income.

value of the home as well as in $\bar{M}$; there is, however, a considerable fixed component. Equation (3) recognizes the bound on draws out of the allowable reverse mortgage balance.

The laws of motion for savings and reverse mortgage debt are given in equations (4) through (7). These laws reflect the jump in cash savings at the time the home is sold and the assumption there is no collateral to allow for reverse mortgage borrowing after the move. We assume that savings must be weakly positive at death whether or not there is a bequest motive. f represents the rental cost per unit of housing price, $m(t)$ is the withdrawal from a reverse mortgage line of credit and $M(t)$ the reverse mortgage balance at time t.

$$\dot{s}(t) = \tilde{r}(s(t) - M(t), y(t), HP(t)) \times s(t) + y + m(t) - c(t); \tag{4}$$

$$\dot{M}(t) = m(t) + r_M M(t) \ \forall t < T; \tag{5}$$

$$\dot{s}(T) = \max(0, H_a P_a e^{g(T-a)} - M(T)); \tag{6}$$

$$\dot{s}(t) = rs(t) + y(t) + m(t) - c(t) - H_T f P_a e^{g(t-a)} \ \forall t > T. \tag{7}$$

The notation $\tilde{r}$ in equation (4) acknowledge the role of home equity borrowing and the larger interest rates faced by borrowers with low income and low collateral. $y(t)$ is exogenous income at date t.

An optimal move at date T must therefore satisfy the following first order condition:[19]

$$\frac{\partial U}{\partial T} = -\mu_0'(T) - \mu_1(T) + u(c(T-), H_a) - u(c(T+), H_T) \tag{8}$$
$$+\pi_s(T+) I_{H_a P_a e^{g(T-a)} > M(T)}((g - r) H_a P_a e^{g(T-a)} - (r_M - r) M(T))$$
$$+\pi_s(T-)\dot{s}(T-) - \pi_s(T+)\dot{s}(T+) = 0.$$

In (8), $\pi_s(t)$ represents the shadow value of an additional dollar of savings s at date t, $T-$ denotes the moment before the move and $T+$ the moment after. M_T is the amount of reverse mortgage debt owed at time T.

The first order condition can be interpreted by considering the three lines separately. The first line represents the change in the level of utility induced by waiting an additional moment to move. If housing consumption is unchanged and if the homeowner were not liquidity constrained at T, then the only consideration is the effect of the "psychic" costs and benefits of moving μ_0 and μ_1. For a liquidity constrained homeowner, utility is most likely greater before the move.

The second line of first order condition (8) represents the capital gains and mortgage interest effects of waiting to move. As discussed above, these effects are operative only if any reverse mortgage debt owed is not in default. Note that the shadow value of an

[19] The optimality condition is discussed in, e.g., Léonard and Van Long (1992).

extra dollar of reverse mortgage debt at time T is either $-\pi_s(T+)$ or, if the loan is in default, zero.

The third line of (8) represents the possibility that scarce resources are stretched thinner before or after the move. Absent substantial mortgage debt, we would expect the shadow value of savings to be greater before moving and the rate of dissavings greater. This might not be the case if the felicity function were non-separable between housing and other consumption. The effect of rising prices on rental and other expenditures after moving is subsumed in the expression $-\pi_s(T+)\dot{s}(T+)$.

There is no guarantee that an optimal move date less than A exists. This fact is seen empirically in the large number of retirees who die without moving. Further, it is possible that an extremum of utility in T could reflect a minimum rather than a maximum.

3.2 Numerical Welfare Effects

In the Appendix, we detail parameterized solutions to the control problem stated above. We focus on a particular, parsimonious formulation of the utility function that simply drops housing as an argument. Hence all consumers would move immediately if not for the direct utility costs of moving. We consider the problem of a single woman at age 75 who may or may not take on reverse mortgage debt. This woman chooses numeraire consumption and the date at which she moves subject to maximize the utility function 1 As parameterized, absent financial considerations, the optimal move would occur when $\mu_1 - \mu_0'$ equals zero; this time is selected to be 10 years, approximating a 50 percent probability of a move before death. The reverse mortgage program details match important characteristics of HECM.

We find considerable welfare gains associated with reverse mortgage take-up for a broad swath of consumers. For a retiree with \$2,000 in wealth and \$10,000 in annual income, we find that the opportunity to take on a reverse mortgage is equivalent to being given a lump sum between \$10,000 and \$30,000 in a world where reverse mortgages are unavailable. The value, denoted "CV" in Figure 7, depends greatly on the rate of house price appreciation.[20] In some cases, we find even larger gains to high wealth and high income consumers, but, not surprisingly, these do not extend to high demand for reverse mortgages in the cross section.[21]

[20] In the parameterization we use, a higher appreciation environment the mortgage is more valuable because it is desirable to stay longer at home with appreciating prices.

[21] Our simulations assume that the retiree has a take-it-or-leave it option to take on a reverse mortgage. Realistically, a consumer would spend down financial wealth before taking on the interest obligation of the reverse mortgage if there is any probability of moving before retirement. We only observe assets among mortgagors at the time of loan closing, so that we do not know if individuals spent down significant wealth before taking on the HECM. Simulations that allowed for stochastic health shocks, thereby providing a basis

Reverse mortgagors do not value the proceeds from the loan dollar for dollar despite the fact that they never move. This is because the mortgagors would have moved absent the reverse mortgage and enjoyed the proceeds from sale.

These results underscore the puzzling absence of demand for reverse mortgages. While negative valuations can be attained in other numerical parameterizations, such parameterizations yield implausibly rapid exits from homeownership.

3.3 Moral Hazard

Lenders might worry that issuing reverse mortgage debt will impel borrowers to extend their stays at home so long as to ensure default. Indeed, part of the public justification for federal involvement in the HECM program is to enable older homeowners to remain in their homes longer than they would be able to otherwise (see Blacker (1998)). This is amounts to moral hazard in that a very long stay in the home is an insured event that the lender hopes is not incited by the reverse mortgage contract.

We define "moral hazard" as follows:

Definition 1 ***Moral hazard*** *is operative if, conditional on consumer characteristics, an increase in reverse mortgage debt increases the optimal date of exit from home T.*

Intuitively, based on implicit differentiation, we would expect the derivative of optimal move date with respect to exogenously increased reverse mortgage borrowing capacity, $\frac{dT}{d\bar{M}}$, to have the same sign as the cross partial $\frac{\partial^2 U}{\partial T \partial \bar{M}}$. This cannot be proved rigorously without very strong assumptions, however, because the flexibility of the consumption trajectory and housing consumption after moving imply that the negativity of $\frac{\partial^2 U}{\partial T^2}$ is not sufficient to give the result.

We have not identified a tractable way to identify analytically the effect of reverse mortgage debt on move date, but inspection of the first order condition is revealing. Assuming that the reverse mortgage is not prepaid (empirically, almost none are fully prepaid), the presence of reverse mortgage debt increases the first and last lines of equation (8). This is because an infusion of cash before the move and the attendant outflow after increase the level of utility before moving and reduce the level after. The marginal value of cash before the move must therefore weakly fall relative to the value after by concavity of indirect utility in wealth. Numerical examples reported below justify the intuitive fear of moral hazard.

That reverse mortgage debt could fail to induce a longer stay follows from the interest rate spread $r_M > r$. This spread implies that reverse mortgage debt engenders an added financial cost to waiting to move that increases in the loan balance, itself

for exogenous moves demonstrated that gains were considerably larger for lower wealth and lower income retirees.

increasing with time. If the liquidity constraint before moving is weak or non-existent, then there is likely no effect of the reverse mortgage on relative utility and marginal utility, so the only effect is to induce an earlier move. Of course, if there is no liquidity constraint prior to any planned move, the reverse mortgage is welfare destructive unless either default is planned or the consumer does not plan to move prior to death.

3.3.1 Numerical Examples of Moral Hazard

As parameterized, our numerical examples generate extreme moral hazard. Figures 6 and 8 show that reverse mortgagors always remain in their homes until death, despite the associated medical inconvenience. Non-mortgagors exit within zero to 13 years of first observation.

3.4 Selection

The example of Mme. Calmet suggests that adverse selection might arise in the reverse mortgage market, just as Finkelstein and Poterba (2004) show exists in the U.K. annuities market. We define adverse selection as follows:

Definition 2 ***Adverse (advantageous) selection*** *occurs if the benefit from reverse mortgage take-up is positively (negatively) correlated with optimal move date, conditional on reverse mortgage status.*

Thus moral hazard implies that giving a particular individual a reverse mortgage impels them to stay longer in their home. Adverse selection implies that the people who take up reverse mortgages have characteristics that render a long stay at home desirable with or without reverse mortgage debt available. It is not obvious what form a mathematical definition would take, but again, inspection of the first order condition (8) is instructive.

In the absence of a bequest motive, any individual who is certain to remain in their home until death, even with no reverse mortgage, will find reverse mortgage debt attractive. Indeed, the value of the reverse mortgage to such an individual is identical to the present value of optimal loan withdrawals. This calculation follows because home equity has no value to such an individual.[22] Because the value of the opportunity to take on reverse mortgage debt must be weakly less than the present value of maximum allowable proceeds, no one can value the reverse mortgage more than individuals who are certain to remain in their homes up to death. This consideration implies that adverse selection is possible. More generally, individuals who choose to move earlier,

[22] A similar idea has been presented with respect to the valuation of annuities. See Bernheim (1987) and Davidoff, Brown and Diamond (2003).

all else equal, should have a smaller marginal utility of money before moving relative to after moving (as indicated in the third line of equation (8). This should lead again to a positive correlation between reverse mortgage demand and length of stay, since the direction of cash transfers implied by reverse mortgages appeal to individuals with large marginal utilities before moving relative to after moving.

Advantageous selection is plausible because the same forces that render an early move attractive may tend to render reverse mortgage debt attractive. The considerations above that lead to adverse selection take the optimal move date T as exogenous.Consider the factors that contribute to mobility holding the direct utility costs and benefits of moving μ_0 and μ_1 as well as the schedule of mortgage debt outstanding in t constant. Individuals who wish to move earlier have a larger difference between at least one of (a) utility after moving and utility before moving, and (b) marginal utility before moving and marginal utility after moving.[23] Individuals with a higher marginal utility of wealth before moving relative to after moving should find reverse mortgage debt more attractive, again because reverse mortgages transfer wealth from the period after moving to the period before.[24]

A number of characteristics, both observable and unobservable, should lead both to relatively high marginal utility before moving and to earlier mobility, thereby feeding advantageous selection. Low wealth, low income, high home value and old age should all contribute to relatively high utility before moving and are empirically observable. A high discount rate should lead at any time t to a low weight on the relatively distant post-move period and hence high marginal utility of wealth before. Likewise, a utility function that is more concave over non-housing consumption should increase marginal utility in the period before home equity is fully cashed out. A weak bequest motive would have similar effects as a high discount rate assuming the bequest entered lifetime utility additively.

Unobserved heterogeneity in health status in the population is likely to generate selection effects, but with indeterminate sign. The growth of the income stream $y(t)$ is likely correlated with health status. Hence individuals likely to move for health reasons are likely also to face dwindling resources. Health-induced mobility should lead to adverse selection if it is forecastable and if moves always occur before the onset of medical

[23]The differences (a) and (b) can be ranked differently between individuals because the level of housing before moving is not chosen optimally and because there may be complementarities between housing and the consumption good).

[24]It is not obvious how to define the concept of "reverse mortgage debt is attractive." The effect on maximized utility of a small amount of reverse mortgage debt is negative if a move is ever optimal due to the large fixed cost. One might consider evaluating the effect of the shadow value of the constraint that reverse mortgage debt not exceed some positive amount on mobility to estimate adverse selection, but we have not found a way to capture this shadow value in an analytically useful expression.

expenditures. However, the connection between ill health and diminished financial resources would generate a correlation between ill health status and high marginal utility before moving. It is thus not at all clear what the effect of variation in health status should be on the sign of selection. Similarly, early mortality, holding the disutility of moving constant, tends to render the reverse mortgage more attractive by increasing the marginal utility of expenditures before moving relative to after moving. This follows because a move is less likely if death is to occur earlier and because conditional on a move, the short horizon before death reduces marginal utility of wealth.[25]

3.4.1 Numerical Selection

We consider selection along three dimensions in the numerical examples presented in the Appendix; housing wealth, non-housing wealth and price appreciation. With respect to housing wealth, we find strongly advantageous selection. High housing wealth is associated in Figures 8 and 9 with both increased valuation of the reverse mortgage and with more rapid exit from homeownership.

Selection on the dimension of wealth is more complicated. With rates of price appreciation less than the interest rate, lifetime wealth decreases in the date of moving. Hence lower wealth households are incited to move earlier than higher wealth households. In these settings, wealthier households value the reverse mortgage more than lower wealth households in dollars. However, as a fraction of wealth, the reverse mortgage is more attractive to lower wealth households. When appreciation exceeds the interest rate, there is a weaker financial incentive to move and poorer households value the reverse mortgage more than wealthier households even in dollar terms. In all cases, the date of move is a normal good, so selection on wealth appears to be positive. Finally, it must be noted that in practice we will (and do) typically observe reverse mortgage take-up only after other asset wealth has been very nearly exhausted because of the high rate of interest on HECM loans and the possibility that the fixed fee might be avoided if an earlier move becomes necessary. In our calculations, we assume for simplicity that reverse mortgage choice is a take-it-or-leave-it matter so that wealthy homeowners may find the proposition unrealistically attractive. Empirically, it would be difficult to discriminate between poor homeowners and once-wealthy homeowners who had spent their resources in anticipation of reverse mortgage take-up.

3.5 Appreciation, Moral Hazard and Selection

The strength and direction of moral hazard and selection effects are likely to depend on the rate of price appreciation. We see this in that our numerical results on selection

[25] The effect might go the other way in the presence of a strong bequest motive due to the large fixed cost associated with reverse mortgage take up.

change with increasing appreciation. Strong price appreciation makes selling later attractive through a "substitution" effect, assuming that future housing consumption H_T is not too much larger than present housing H_a. However, strong appreciation also increases the value of the home and hence reduces marginal utility after sale, rendering an early move optimal through an "income" effect. Hence there is an ambiguous effect of appreciation on optimal move date, holding reverse mortgage debt constant. Holding move date constant, appreciation increases the appeal of reverse mortgage debt again by reducing post-move marginal utility.

Very weak price appreciation should enhance the moral hazard effect. If it is possible to remain in the home for a long period of default on the reverse mortgage, then the second line of the derivative (8) may disappear for most candidate move dates, so that remaining at home is costless to a reverse mortgagor. By contrast, non-mortgagors experience capital losses when they wait to move, regardless of the date.

Similar considerations suggest that weak or negative price appreciation may push the direction of selection to adversity. To the extent that a long stay in the home is planned under default, the reverse mortgage becomes less of a transfer from the period after the move and to the period before the move and becomes more of a transfer from the bank to the borrower. Hence, the appeal of a reverse mortgage likely has more to do with planned stay and less to do with relative marginal utilities in a low appreciation environment. As we saw above, this renders adverse selection more likely.

4 Empirical Tests of Selection and Moral Hazard in the Reverse Mortgage Market

In this section, we ask to what extent available data support the theoretical and numerical discussion in Section 3. To date, HECM reverse mortgagors have exited homes at a strikingly rapid rate, as illustrated in Figures 2 and 3. However, this rapid rate of exit from homeownership is consistent both with (a) advantageous selection and with (b) adverse selection combined with the opposite of moral hazard. We thus ask in this section if the data are consistent with the simultaneous presence of moral hazard and advantageous selection. We ask further if the data support the intuition that sufficiently weak price appreciation undermines the effect of advantageous selection and leads to augmented moral hazard.

To determine whether advantageous selection appears to have a role in the relative mobility rates, we extend the comparison of survival and hazard rates between single women reverse mortgage borrowers and single women homeowners in the *American Housing Survey* (AHS) to include covariates. Single women only are selected to avoid intra-family dynamics in interpretation.[26] We ask first whether the observable variables that predict participation in the HECM program also predict rapid mobility out of homes, noting that there is no systematic attempt in the HECM program to screen in or out individuals likely to move quickly on any dimension other than age. To obtain an idea of the importance of selection on observable characteristics, we ask whether any observed advantageous selection explains away a large fraction of the difference in observed mobility rates among borrowers and non-borrowers. In particular, we estimate the effect of HECM participation on a hazard rate out of homeownership by merging all single women homeowners in a proprietary HECM data set with all single women homeowners in the AHS. We then ask whether the estimated coefficient on having come from the HECM data set falls in the presence of observable covariates.

If moral hazard is a concern in the reverse mortgage market, it appears from Section 3 that mobility rates in HECM should be lower relative to mobility rates of non-borrowers where default is a possibility. For most HECM borrowers (the median in our data set enrolled in 1999), regional price appreciation has been large enough to render default unlikely in the foreseeable future. However, home price appreciation has varied considerably by region. Since 1999, OFHEO repeat sales data show that state-level annual price appreciation has varied from a low of two percent per year in Utah to a high of 14 percent per year in Washington, DC.[27] We thus test the condition on moral hazard by asking whether the effect of HECM participation is weaker in markets with extremely low average price appreciation. We also ask selection is weaker in the extremely low appreciation states.

We thus estimate equations of the form:

$$S(t,i) = \exp(-\theta t), \tag{9}$$

$$\theta = x_i \beta \tag{10}$$

where $S(t,i)$ is the estimated probability that individual i remains in their home up to or past time t. x_i denotes a vector of covariates, including an indicator for participation in the HECM program. In this way, we can test for selection on observables by testing for a statistical difference between the coefficients on HECM participation with and without covariates. Variables x that are associated with β coefficients less than one are associated with longer periods remaining at home and variables associated with coefficients greater than one are associated with shorter stays.

The covariates are observed only once, but we allow age to vary with time over the course of analysis. Parameters are estimated in Stata through maximum likelihood.

[26]The rapidity of tenure termination among HECM borrowers extends to couples and single men.

[27]The plausibility of default in low appreciation states is bolstered by the result in Davidoff (2004) that appreciation rates among the elderly are approximately three percent less per year among the elderly than among other homeowners.

The exponential parameterization of the hazard is used in most estimates for reasons discussed below. The results are qualitatively similar under lognormal or Weibull paramterizations. Results are presented with one observation per individual per year, but similar results are obtained with each individual considered a single observation and with age held constant; age is the only covariate that changes with time. Wealth, income and home values in the year of first observation are deflated to 1985 levels based on the US national CPI for non-housing goods.

For many of the homeowners under consideration, there is no exit from the home between the time of first observation and last possible observation, in late 2001 for the American Housing Survey homeowners and late 2003 for the reverse mortgage sample.

Given the complexity of the optimization that gives rise to an optimal move date, there is not much reason to think that the functional form for the hazard given in (10) will be correctly specified. This relates to the "common support" problem discussed by Heckman, Ichimura and Todd (1997). For example, the β coefficients on characteristics are likely to be different for mortgagors and non-mortgagors. Frailty estimates using either the inverse gaussian or gamma distributions indicate that hazard estimates among the HECM sample are biased by unobserved heterogeneity, but the null of no heterogeneity is not rejected among the non-mortgagor AHS data. Further, as discussed below, many variables are mismeasured.

Taking these issues into account, something akin to a "propensity score" approach is presented as an alternative means of testing the extent to which advantageous selection based on observable covariates drives the observed differences in mobility. In particular, we estimate a probit for participation in HECM of the form:

$$\Pr(HECM_i = 1) = \Phi(z_i \gamma). \tag{11}$$

Here $HECM_i$ indicates that an individual is a HECM mortgagor as opposed to an AHS homeowner and presumed non-mortgagor. z_i is a vector of demographic characteristics (mostly the same as x, but excluding HECM). We then estimate equations of the form (10) confined to the HECM dataset and to the AHS dataset. The hazard estimate confined to the AHS with the predicted value for participation included as the sole right hand side variable allows us to measure the effect of predicted HECM participation among non-borrowers without assuming that covariates affect borrowers and non-borrowers in the same way.

As it turns out, we find clearly advantageous selection on observables, but not enough to explain the gap in mobility between borrowers and non-borrowers. We therefore seek to determine whether the data is consistent with our predictions concerning moral hazard to rule out the possibility that the opposite of moral hazard operates to augment the gap in mobility generated by advantageous selection on observables.

To test whether very low appreciation adds to moral hazard, we include interactions between HECM participation and indicators for low rates of return in the x variables in equations of the form (10), returning to a pooling of HECM mortgagors and AHS non-mortgagors. We expect that the difference between mobility rates of similar HECM borrowers and non-borrowers will be smaller in very low appreciation environments. Due to functional form uncertainty, we define "very low appreciation" rates in different ways, checking for consistency of results. We also examine the effects of predicted HECM participation separately in low appreciation states in each of the AHS and HECM samples.

4.1 Data

Estimation is undertaken using two distinct data sets. The first is from the US Department of Housing and Urban Development (HUD) and contains loan information on all 77,007 HECM loans originated between the program's inception in 1989 and the start of this project in mid-2003. We observe the date of loan closing and the date of loan termination (if any), either through death or voluntary mobility. We also observe income, financial assets, home equity, appraised property value and outstanding debt on the home if any. The income data appears to be of poor quality and likely excludes pension and social security income, given the large number of zero (distinct from missing) values assigned. Borrower's age is also known. For the most part, the reason for loan termination is not reported. Among the loans for which the reason for termination is reported, the large majority are either death or moving. Only approximately 2% of loans report prepayment without a move. This is not surprising given the very little financial wealth reported by borrowers. Unfortunately, while we observe the maximal credit limit at the time of loan closing, we do not observe the extent to which credit has been used.

A comparison group of single women homeowners is found in the AHS, a bienniel panel survey of over 55,000 US homes. Since 1985, the same set of homes has been surveyed, with occasional additions. We confine ourselves to single women over age 62 (and hence eligble for HECM participation). We observe mobility through 2001. In this data set, we can consider the start of a spell of homeownership to be the year and month of a first interview with a single woman homeowner. As in the HECM data set, income, age, property value (the owner's estimate) and an indicator for financial assets in excess of $20,000 are available. Termination of a spell of homeownership is identified by noting the first date, if any, at which the home is occupied by a different household or individual. The AHS identifies metropolitan area, from which a state can be imputed.[28]

[28]State is assigned as the state in which the central city of a metropolitan area is located. Most observations of single women homeowners in the AHS are non-metropolitan, so we check for consistency of results when

Combining the HECM and AHS data, we can compare truncated lengths of stay between borrowers and non-borrowers, under the assumption that HECM participation rates are so low (less than one-tenth of one percent nationally, and closer to zero at the start of the AHS panel) that the AHS women are all non-borrowers. We observe the length of completed states and a lower bound on length of not yet completed stays in both data sets and can thus estimate equation (10) with and without some covariates common to both datasets.

A natural concern in comparing mobility rates between two different data sets is that the AHS data might under- or over-report the rate at which older women exit from homeownership due to imperfect data collection.[29] To address this concern, we estimate mortality and mobility rates in three different data sets and ask whether the AHS appears consistent with other data sets populated almost entirely by non-reverse mortgagees. Table 1 compares mobility and mortality rates over two year periods across these data sets. The AHEAD survey of older women is an outlier for its low imputed mobility rates among single women homeowners. The AHS features a combined mortality plus mobility rate that is slightly higher than the implied mortality plus mobility from the Berkeley Mortality Database and the SIPP mobility survey of 1996. The AHS combined termination rate is overstated yet more if we consider that mortality rates are typically lower among homeowners than renters, as suggested by comparing the AHEAD mortality rates from 1993 to 1995 to those in the general population (mortality is nonlinear, so the comparison is imperfect). It appears that, if anything, the AHS overstates the speed of implicit loan termination. Hence we should not see bias towards low rates of exit from homeownership among reverse mortgagors. Further, since some people move before dying over a two year period, the sum of mobility plus mortality should overstate the implicit exit rate from homeownership.

Data from the AHEAD survey is in agreement with our theoretical intuitions concerning the role of income and wealth in mobility and suggests that the μ_0 and μ_1 terms, changes in which reflect health status, are critical factors in determining mobility. Results are presented in Table 2. This table summarizes results from a probit estimate where the dependent variable is whether an individual moves out or dies between 1993 and 1998. These estimates are based on a survey of 2,317 households headed by an individual over age 70 in 1993. We find that income is associated with a lower probability of moving but that the interviewee-assessed probability of leaving $10,000 to heirs has no effect, nor do non-housing financial assets.

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we do and do not exploit regional variation in the data.

[29]HECM terminations may also be defined differently from AHS terminations.

4.2 Move Out Date and Reverse Mortgage Take Up

Figures 2 and 3 show Kaplan - Meyer survival time and hazard rate estimates based on the AHS and HECM data. A failure date in the AHS data is listed as the earliest date at which a respondent who is not the original single woman occupant reports moving into a home, if this occurs at all.[30] A failure in the HECM data is the date at which the loan terminates, if the loan has terminated as of mid-2003. As noted above, HECM loans appear to terminate only very rarely for reasons other than a move or death We see that single women participating in HECM terminate the loans at a rate far in excess of the combined mobility and mortality rates in the AHS. This is consistent with the preliminary results in Rodda et al. (2000), but inconsistent with fears of moral hazard or adverse selection.

4.2.1 Hazard Estimates in a pooled sample

Table 3 adds to the hazard analysis some covariates that, based on the discussion above, might be expected to affect the date at which loans terminate or at which move out or death occurs. Here HECM is an indicator for participation in the HECM program. Table 5 provides summary statistics. Separate means are provided for each data set. Unfortunately, measures of health status are available in neither the AHS nor the HECM data set. The AHEAD results suggest that these are critically important factors. A plausible advantageous selection story would be that HECM proceeds are used to pay medical expenses which eventually lead to death or departure from the home.

Columns (1) and (2) of Table 3 demonstrate that the presence of covariates does not alter the conclusion that older women participating in HECM leave their homes much more rapidly than do similar women who are not participants. Older single women HECM borrowers move out at a rate approximately 45 percent greater than the rate for older single women in AHS. The difference in mobility remains statistically and economically significant in the presence of covariates, but falls to a difference of 24 percent in estimated hazard rates. Advantageous selection on observables is confirmed by the statistical difference in the estimated effect of HECM participation with and without covariates.[31]

The (unreported) effect of age is predicted by the model; advanced age (and hence a shorter remaining lifetime) renders moving more attractive (and death more likely). The shorter horizon has an ambiguous effect on reverse mortgage demand in theory, but the reverse mortgage borrowers are significantly older than the AHS single women

[30] On average, this date is earlier than the date at which the respondent reports having purchased the home, biasing mobility rates up, not down in AHS.

[31] The difference in estimated coefficients is more than two times larger than the larger standard error.

homeowners over 62. Unfortunately, we do not observe how long HECM borrowers have remained in their homes. We see among the AHS comparison group that having an extra year of tenure at one's home before the year of first observation is associated with a one percent decrease in the hazard rate.

As predicted by the model, we find a consistently positive effect of home value on the hazard out of homeownership in the pooled sample. However, restricting ourselves to non-HECM borrowers, we find that housing value has a small and insignificant effect of increasing the stay at home. We find in Table 5 that the HECM borrowers have dramatically more expensive homes than non-mortgagors. This difference overstates the true difference because the HECM data set is on average newer than AHS and the bulk of originations have been made since the price boom starting in the mid- to late-1990s. These results are somewhat supportive of advantageous selection.

A clearer picture of housing value relates to wealth. We see that despite much larger housing values and a run-up in the stock market, HECM borrowers are much less likely than AHS older woman homeowners to have $20,000 in savings (the discrete figure is all that is available in the AHS data set). Figure 5 and shows the distribution of non-housing assets and the ratio of housing assets to these other assets in the HECM data set and the AHEAD data set, respectively. We see both less wealth and much more concentration of wealth in housing among HECM borrowers. This is hardly surprising given the program details which guarantee that it is a poor idea to take up the reverse mortgage when liquid assets are available. We do not find a significant effect of non-housing wealth in the pooled data or the AHS alone, however, so there is no clear selection story relating to wealth. We do find that in the AHS sample, higher income is associated with significantly reduced mobility out of homeownership, suggestive of advantageous selection.

Notably, we find support for the theoretical and numerical predictions that selection becomes less favorable and moral hazard more severe when appreciation is low. In column (3), we find that while HECM participation in general is associated with 38% more rapid mobility, mobility is diminished by 20% by HECM participation in states with historically low appreciation rates. The variable LOW GAIN indicates that an individual lives in a state with a housing price appreciation rate, as measured by OFHEO, that ranks in the bottom fifth among homeowners in the pooled sample that report their state. The measure of price appreciation is the log difference in the state repeat sale price index between 1975 and 2003. The diminished mobility associated with HECM participation in these states is such that we would predict mobility among borrowers to be just 10 percent more rapid relative to non-borrowers in the low appreciation states.[32] These results apply when LOW GAIN is determined by including only either the bottom 10 percent or bottom 5 percent of state appreciation rates in the

[32]HECM participation is associated with an increase in the hazard rate out of one's home at any date of

sample. At 10 percent, the coefficient on the interaction term is estimated to be .81, almost unchanged, but now significant only at the 10% confidence level. When LOW GAIN is defined at a 5% cutoff for appreciation rates, the coefficient on the interaction falls to .75, and is again just significant at a 10% confidence level. Specification (4) in Table 3 includes borrower covariates and other state characteristics interacted with HECM participation. While significance disappears, the diliatory effect of low appreciation on mobility among borrowers remains and even increases in estimated magnitude.

4.2.2 Predicted HECM participation and mobility in split samples

We do not know from Table 3 is whether the smaller mobility effect of HECM borrowing in low appreciation states results from less advantageous selection in these states or from worsened moral hazard. To get better insight into the nature of selection and moral hazard, we estimate probit equations of the form (11), and then estimate the effect of predicted participation in HECM on the hazard rate of homeownership first in the HECM sample, and then in the AHS sample. This approach avoids the likely identification problem that the effects of covariates on mobility are likely to differ across the samples due to selection and non-linearities. Predicted HECM participation is denoted in Table 4 by $\widehat{HECM}$.

The results of the probit estimation are reported in Table 4. These results can be predicted from inspection of the different sample means for covariates reported in Table 5 between the HECM and AHS samples. We estimate two probits, one that estimates the probability that an individual in the pooled HECM and AHS samples comes from the HECM sample, based on characteristics observable to the bank. The second probit estimate is based only on AHS and HECM borrowers in very low house price appreciation states. In both cases, we find advantageous selection along the dimensions of income and housing value in the sense that income is associated with longer duration in the AHS, and low income is associated with HECM takeup. High housing value, associated with rapid mobility in theory, simulations and the pooled hazard regressions, also strongly predicts HECM participation. Finally, wealth, which is associated with longer durations in theory and simulations, but not in the hazard regressions of Table 3, negatively predicts HECM takeup.

We estimate the participation equation (11) including a polynomial in age. The same polynomial is included as an additional covariate in the hazard estimates of the effect of $\widehat{HECM}$ on mobility because lenders increase available loan proceeds with age,

38%. Participation in HECM in a low appreciation state thus multiplies a survival probability of 1.38 times the survival rate unconditional on participation (but conditional on living in a low appreciation state) by 80%. This yields a hazard that is 10% greater.

so that selection on age should not necessarily be seen as an element of advantageous selection.

The hazard estimates in Table 4 are consistent with the predictions of moral hazard and advantageous selection in the reverse mortgage market, and with the prediction that moral hazard undermines selection when price appreciation is low. We find that across all states, moving from a probability of participating in HECM based on characteristics of zero to a probability of one would be associated with an increase of the hazard rate of 29% among HECM borrowers and 123% among non-borrowers. These results are consistent with the hazard results above of both advantageous selection on observables and a residual effect of either unobservables or the opposite of moral hazard. The mean predicted values for participation ($\widehat{HECM}$) are given in Table 5 as .84 in the AHS sample and .98 in the HECM sample. Absent a reverse mortgage, the HECM borrowers would thus be expected to move approximately $.14 \times 1.23$ or 17 percent more quickly than non-borrowers, as opposed to the 50% difference we observe even given the presence of reverse mortgage debt (which is associated with a much smaller effect of observables on mobility).

The top panel of Figure 4 shows graphically that predicted HECM participation is associated with more rapid mobility. The light colored set of data points shows that the median predicted stay at home for a 65 year old HECM participant with a 40% probability of participation is approximately 15 years. For a woman with a nearly 100% probability of participation, the median stay is approximately 13 years. The effects are much stronger for the AHS sample, where a move from 40% to nearly 100% predicted participation reduces the expected duration from approximately 34 years to approximately 22 years. We see very similar effects for women in the AHS sample.

In states with low appreciation rates, we obtain estimates for HECM participation that are similar to those found for all states. Comparing columns (1) (all states) and (4) (only low appreciation states) of Table 4, we find that income predicts participation less strongly, but home value more strongly. The indicator for having more than \$20,000 in wealth has an almost identical effect across the two samples.

We find also in Table 4 that the characteristics that are associated with HECM participation lead to increased mobility among non-borrowers in LOW GAIN states and all states. A comparison of columns (3) and (6) suggests some weakening of the advantageous selection in the low appreciation states, but we cannot reject that the effects of predicted participation are identical for AHS women between appreciation status. The fact that the coefficient on predicted participation remains positive (albeit insignificant in a very small sample) suggests that adverse selection is not to blame for the low mobility rates for HECM borrowers in these states relative to other states.

The effect of predicted HECM participation on the mobility of HECM borrowers is much less positive in low appreciation states than in all states. We find in column (5) that in low appreciation states the effect of predicted participation is to significantly increase, rather than decrease, the expected length of stay. This result, combined with the fact that borrower characteristics appear to speed mobility conditional on *not* taking up a reverse mortgage, suggests that advantageous selection occurs in all states, but that moral hazard effects drive down the effect of predicted participation because low appreciation weakens the incentive to move in a particularly strong way for cash-poor, house-rich individuals. This is entirely consistent with the theoretical and numerical discussion above.

Comparing the top and bottom panels of Figure 4, we find that HECM borrowers move at a more rapid rate in both appreciation settings. We also see that predicted mobility among HECM borrowers is increasing in predicted participation in high appreciations states, but decreasing in low appreciation states. We also observe from the density of data points in the smaller, low appreciation, sample that the large majority of most older women homeowners, whether borrowers or not, have the low wealth and high housing values characteristic of HECM borrowers, albeit to somewhat varying degrees.

4.2.3 Functional Form, Measurement Error and Unobserved Heterogeneity

We have chosen the exponential functional form the survivor function. This is not because we do not consider duration dependence important, but rather because we do not know when HECM borrowers first moved into their homes. We do allow age to vary by month of the observed spell, so time dependence in the hazard is captured in part. Conditional on age, we find in Table 3 a small but significant effect of the date of first occupancy among AHS borrowers.

As discussed in Lancaster (1990), unobserved heterogeneity can effect time dependent hazard estimation even if the unobservables are uncorrelated with observed covariates. Similarly, the fact that observables do not explain all of the difference in mobility rates between borrowers and the comparison group[33] does not imply that the opposite of moral hazard impels borrowers to move more quickly conditional on characteristics. Rather, we might think that unobserved characteristics would be associated with more advantageous selection than seen in the data. Allowing for unobserved characteristics to have the gamma distribution, we find that the estimated effect of predicted HECM participation on mobility in the AHS sample is unaffected in a Weibull paramaterization. Similarly, the time dependence parameter is indistinguishable from one with or without allowing for unobserved heterogeneity.

We also know that predicted HECM participation and the underlying covariates are

[33]See Table 3, column (2) and Figure 4.

measured with error. This likely attenuates our estimate of the strength of selection. Hence the fact that HECM borrowers move more quickly than non-borrowers, even conditional on observables does not imply that the opposite of moral hazard operates to explain the remaining gap in mobility. Rather, we might expect that with more comprehensive and precise observation of characteristics, we would be able to explain most of the gap. Indeed, the results of section 4.2.2 strongly suggest that moral hazard is operative, such that it is only advantageous selection that affords the rapid mobility seen to date.

5 Conclusion

There appears to be substantial advantageous selection in the US reverse mortgage market to date, at least among the plurality of borrowers who are older women. There is clear selection on observables such as house value, age and price appreciation. However, even controlling for these observables, we find a significant positive correlation between HECM participation and the rate of departure from homes. The model presented in Section 3 and the numerical examples presented in the Appendix make it hard to believe that this relationship is causal in the sense that a HECM loan enables early move out. Rather, it appears that some borrower characteristics, such as health status, access to unreported assets, bequest motives, localized price conditions or an attachment to home equity (perhaps due to some precautionary concerns), are both unobservable and important determinants of reverse mortgage demand that are associated with early move out. This interpretation is supported by the fact that predicted participation in HECM is associated with more rapid mobility among both borrowers and non-borrowers in high appreciation states, but with reduced mobility among borrowers in low appreciation states, where moral hazard is predicted by the theory to undermine advantageous selection. We conclude that, to date, reverse mortgages have enabled longer stays at home, but that the kind of people who want to cash out their housing wealth have turned first to a reverse mortgage and relatively soon thereafter to disposal of the entire asset. The data are also consistent with unobserved factors such as differences in discounting, risk aversion, mortality or health status driving some of the differences in mobility.

A consequence of the evident advantageous selection has been that there have been very few losses paid out of the comparatively large reserves collected by the FHA as insurance against insufficient collateral. Interestingly, the large fixed fee and low interest rate that characterize the HECM program would seem to guarantee long stays among borrowers, since a home equity line of credit (with almost no fixed fee and a higher interest rate) seems to dominate HECM unless the planned stay is very long.

In this way, it seems that reducing the large fees would be justified both by more rapid move outs than expected to date and by likely falling move outs with reduction of the fee. The analysis presented above suggests, however, that a reduced fee might invite participation by homeowners less eager to take out home equity and thus perhaps less likely to move out conditional on a less than 100% loan to value ratio.

It will be interesting to observe whether the favorable selection and relatively minor moral hazard effects observed to date continue in any periods during which interest rates far exceed price appreciation. Some speculate that such a regime is imminent.[34] When default is likely to occur in the sense that loan balance exceeds amount due, a longer stay becomes more attractive with falling prices. Already, we find that HECM borrowers living in states with low historical appreciation are dramatically slower to move out of their homes than HECM borrowers living in other states, and that this phenomenon does not occur among non-borrowers. We find further that advantageous selection appears to operate in these states, leaving enhanced moral hazard with dimished appreciation as the likely culprit.

[34] See for example the UCLA forecast.

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Numerical Examples of Selection and Moral Hazard

In this appendix, we parameterize and conduct comparative statics on the lifetime optimization problem described by equations (1) through (8). We vary initial wealth $s(0)$ and home value H_a, using values meant to capture a reasonable range of homeowners based on the *AHEAD* survey. We could of course vary other characteristics, but choose these two variables to make the discussion manageable.

We consider a 75 year old single woman who will die for certain at age 95. The woman is endowed with an annuity income of $10,000, a personal discount rate of 3% and an instantaneous utility function that takes the value $-\frac{1}{c}$, reflecting a moderate degree of risk aversion over non-housing consumption.[35] The utility function is constant in housing consumption, so we sidestep difficult questions regarding what housing quality means and how marginal utility is affected if one moves into a nursing home or with relatives and how equilibrium housing rents are set.

We consider the optimal move date and consumption trajectory for this potential reverse mortgagor under two sets of circumstances; (a) when she has access to a home equity loan if desired but may not take on reverse mortgage debt and (b) when she may take on reverse mortgage debt but not a home equity loan. We assume that the riskless rate of interest on savings is 3%, matching the personal discount rate. Borrowing absent a reverse mortgage is at a rate that increases up to 6% as debt service grows to a maximum of 40% of income. In case (b), the upper bound on reverse mortgage debt is the typically much larger value of $\frac{5}{7}$ of home value. The reverse mortgage balance accrues interest at a rate of 4.5%. This lower borrowing rate is offset by a large fixed fee of 6.8% of loan proceeds. Annual housing price appreciation π_H varies between -2%, 2% ("baseline" case) and 6%.

The costs and benefits of mobility μ_0 and μ_1 follow a trajectory such that absent financial considerations, the optimal move date would be at age 85, halfway between initial consideration and death, roughly matching the fraction of retirees that are observed to move before death.

Using a grid search, we solve the retired homeowner's problem under both cases and ask by how much $s(0)$ would have to increase (or decrease) with only the HELOC available to provide the same level of maximized utility. We denote this compensating variation by CV.

Figure 6 shows, not surprisingly, that moving before the otherwise optimal date of $t = 10$ is an inferior good. Wealthier homeowners move later than poorer homeowners for growth rates that are historically moderate (two percent per year) or large (six

[35]See, for example, Barsky, Juster, Kimball and Shapiro (1997).

percent per year). With very low appreciation rates (minus two percent per year), an immediate move is optimal regardless of income.[36]

We see also in Figure 6 that the fear of moral hazard is well-founded. At all appreciation rates, the optimal move date is the corner solution of never moving. This generates losses the guarantor (FHA) only in the case of 2% net depreciation per year. However, the borrower is also in default at death when appreciation is at the moderate value of 2% per year.

Figure 7 informs the direction of selection. We find that wealthy homeowners, who are inclined to move later value the reverse mortgage more, in the sense of having a greater CV, than lower wealth homeowners for negative and moderate price appreciation. However, since both types of homeowners obtain an effective gain in wealth that is considerable relative to wealth, and because the slope of the CV in wealth is less than one, it is not clear whether this is adverse or advantageous selection. With large price appreciation at 6%, we obtain clearly advantageous selection, as low wealth individuals obtain a larger CV than high wealth individuals. Selection is advantageous in this case because conditional on reverse mortgage status, the optimal move date increases in wealth.

Figure 8 plots the optimal move date with and without a reverse mortgage against initial wealth for different initial home values, assuming a two percent appreciation rate. Under this parameterization, we continue to find extreme moral hazard in that the reverse mortgage leads all income-house value pairs to remain in the home until death. We also find that absent the reverse mortgage, larger home value leads to more rapid exit from the home. This implies advantageous selection, as we find in Figure 9; larger home values also lead to more rapid exit from the home. These results make sense in light of the discussion in Section 3.

[36] At an income level of $5,000, which is perhaps more representative of reverse mortgage borrowers, moving is implausibly immediate for representative wealth levels, even in the presence of a reverse mortgage. This problem in parameterization reflects the problem of coming up with consistently plausible move dates for fixed values of μ_0 and μ_1.

Figure 1: Reverse mortgage design. Loan balance is repaid by the borrower as late as the date of move out of the home or death. F denotes financed closing costs.

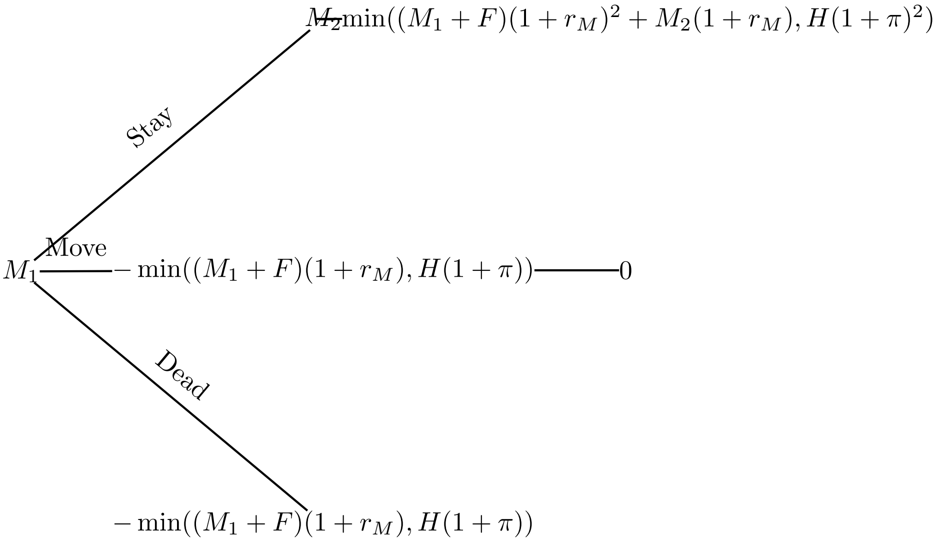
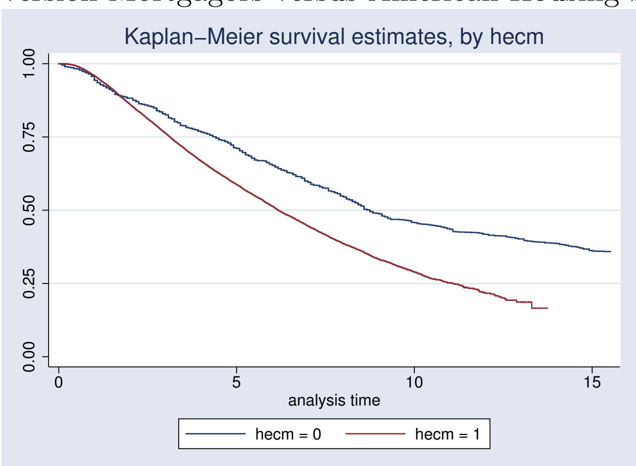
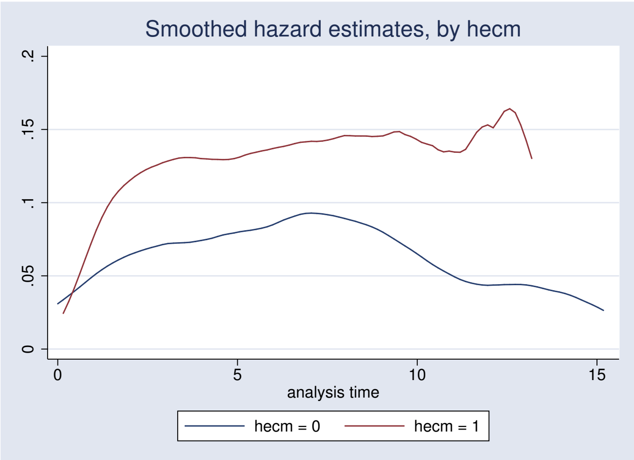


Figure 2: Kaplan-Meyer survival time estimates: Older Single Women Home Equity Conversion Mortgagors versus American Housing Survey



Note: The blue (top) line is estimated time to move or die for single women homeowners over age 62 in the *American Housing Survey*. The red (bottom) line is estimated time to loan termination for single women homeowners participating in the HECM program.

Figure 3: Empirical Hazard out of homeownership: Older Single Women Home Equity Conversion Mortgagors versus American Housing Survey



Note: The blue (bottom) line is estimated time to move or die for single women homeowners over age 62 in the *American Housing Survey*. The red (top) line is estimated time to loan termination for single women homeowners participating in the HECM program.

Table 1: Two-Year Mobility and Mortality Rates among Single Women Homeowners Aged 62 + in Several US Population Surveys

Data	Mortality	Mobility	Mortality or Mobility	Mean Age
AHS 1985-2001			14.2%	73.6
Berkeley Mortality 1993-1995	5.5%			74
SIPP mobility survey 1996		8.0%		76
AHEAD 1993-1995	7.4%			78.8
AHEAD (Venti and Wise (2000))		3.8%		
Berkeley Mortality 1993-1995	7.9%			78

Notes: Berkeley data is for women aged 73 or 77 in 1993 only. Venti and Wise use the entire AHEAD panel.

Table 2: Probit estimates for moving or dying between 1993 and 1998 based on 2,317 AHEAD household heads

Price growth	-.0004
	(.0005)
Bequest10k	-.000267
	(.0009)
Medical Exp./10,000	.136**
	(.002)
Healthprobs	.094
	(.036)
Income	-.074
	(.042)
Houseval	-.064
	(.042)
Fin.wealth	-.002
	.007
Woman?	.197*
	(.08)
Married?	-.1966254*
	(.079)
Num.children	-.004
	(.017)
constant	78.45
	49.78

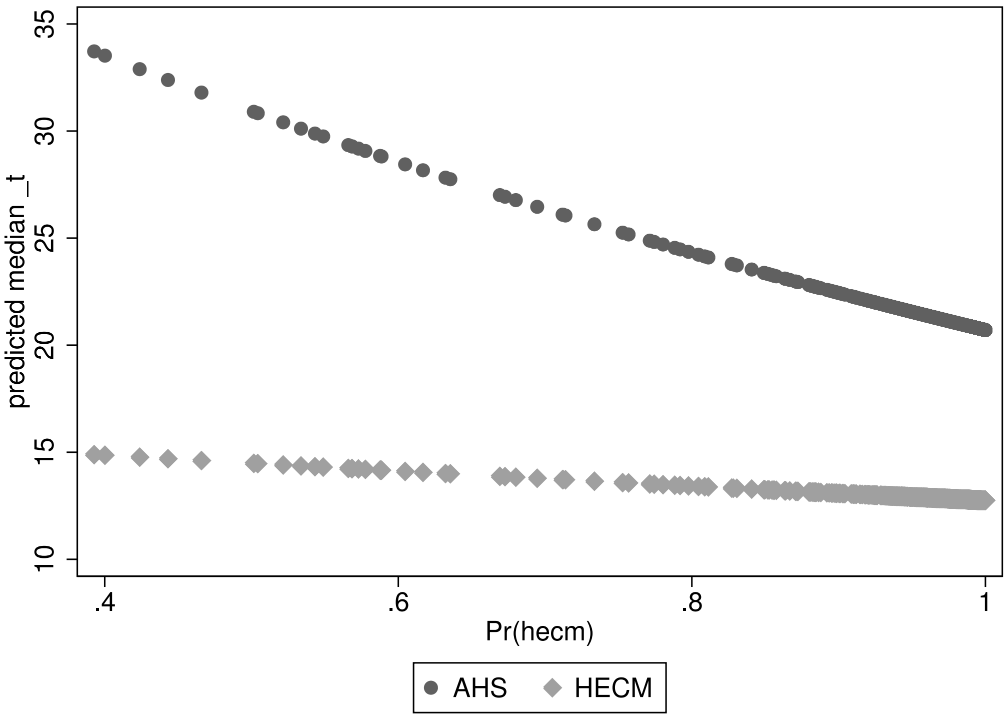
Notes: A fifth order polynomial in mean age among household members is included by not reported. bequest10k asks the probability that the household will leave $10,000 to their children (this estimated probability is typically strikingly low given housing and other assets). healthprobs ranks the severity of any health problems, averaged across household members. Num.children is the number of children (not necessarily living with the household. Price growth is mean annual appreciation estimated from OFHEO based on Census region over the period 1976 to 2003. Medixal Exp. is out of pocket medical expenditures over the past year. All variables are as measured in the initial 1993 survey. All household heads are over age 70. Woman? and Married? are indicators.

Table 3: Regressions of Hazard Rates on HECM Participation and Covariates. Dependent variable is the estimated time-varying hazard rate under the Weibull distribution

	(1)	(2)	(3)	(4)	(5)
HECM	1.45**	1.24**	1.38*	$1.95*10^{-5}$	
	(.052)	(.082)	(.000)	$(10*10^{-4})$	
INV20K		1.01		1.01	1.01
		(.046)		(.045)	(.010)
Income/100,000		1.01*		1.01*	0.45*
		(.007)		(.007)	(.182)
ln Value		1.12**		1.12**	0.923
		(.022)		(.021)	(.042)
Low Return			1.09	1.24	
			(.107)	(.22)	
Return				1.14	
				(.095)	
ln Price				.45	
				(224)	
HECM × Low Return			.80*	.74	
			(.081)	(.131)	
HECM × Return				0.84*	
				(.071)	
HECM × ln Price				2.79*	
				(1.40)	
Tenure					0.995*
Excludes HECM?	No	No	No	No	Yes
Age Polynomial	No	Yes	Yes	Yes	Yes
Subjects Observed	42,271	41,222	41,664	40,932	1,277
State Dummies?	No	Yes	No	No	No

Notes: Z-statistics reported in parentheses - subtract one from the coefficient estimates and divide by the standard error to get something akin in magnitude to a t-ratio. These estimates come from a merge of the cross section of HECM loan performance with the American Housing Survey Panel from 1985 to 2001. State fixed effects are approximated in the sense that the state of residence in AHS is identified through the location of the central city of a metropolitan area. The polynomial in age (at the time of first observation) contains five terms. INV20K denotes non housing assets are worth at least $20,000. ln Price is the log of mean price in the state in which an individual lives. HECM*ln Price interacts an indicator for HECM status with the mean price measure. GAIN measures the total percentage change in the OFHEO state price index from 1976-2003. LOW GAIN indicates that the log total return is less than 3. TENURE is how long prior to the first observation the individual lived in their home.

Figure 4: The relationship between estimated probability of HECM participation and predicted duration of stay at home for HECM borrowers and AHS homeowners aged 65, all states (top panel) and states with OFHEO estimated house price appreciation rates in the bottom 20% of the pooled AHS-HECM sample (bottom panel)



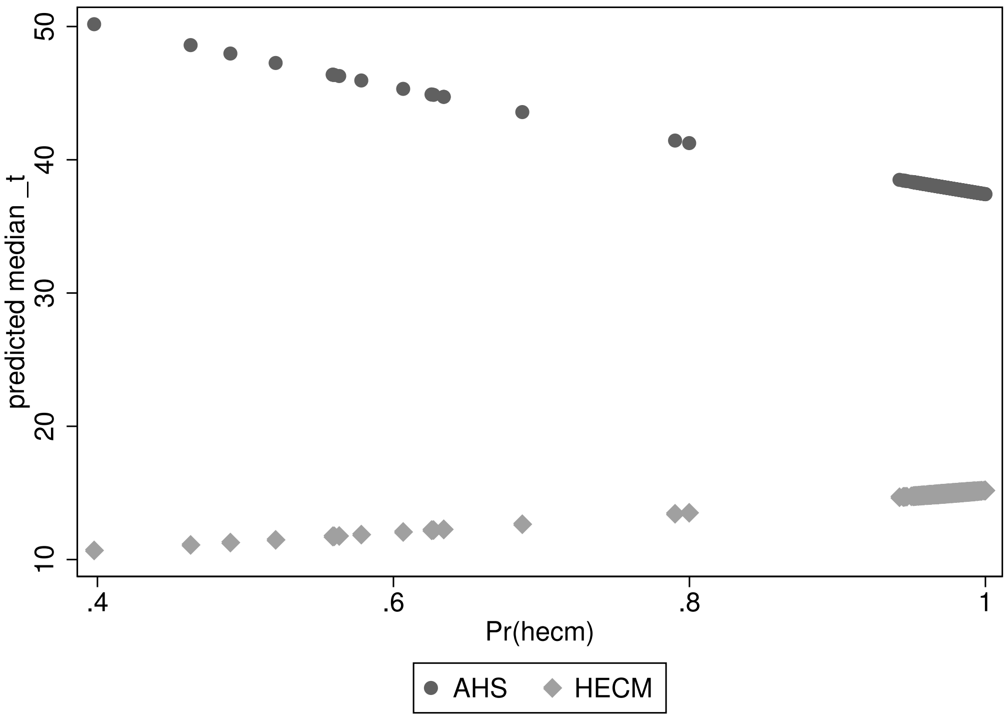


Table 4: Probit Estimates of HECM participation and hazard estimates of the effect of predicted HECM participation on the hazard out of homeownership

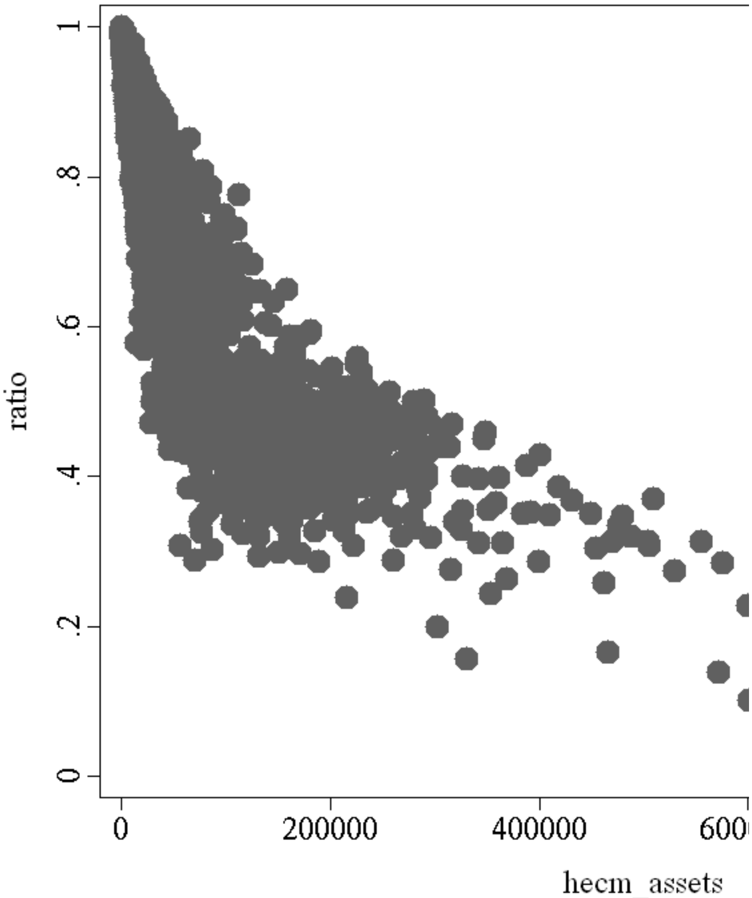
	(1)	(2)	(3)	(4)	(5)	(6)
Dependent	HECM			HECM		
Variable	Particpation	Hazard	Hazard	Participation	Hazard	Hazard
Appreciation Rates	All	All	All	Bottom 20%	Bottom 20%	Bottom 20%
Value/100,000	.86**			.97**		
	(.025)			(.059)		
INV20k	-1.61**			-1.67**		
	(.024)			(.039)		
Income/100,000	-.024**			-0.008		
	(.005)			(.008)		
$\widehat{HECM}$		2.23*	1.29		0.56	1.62
		(.845)	(.275)		(.175)	(.916)
Age Polynomial?	Yes	Yes	Yes	Yes	Yes	Yes
State Dummies?	Yes	No	No	No	No	No
Sample	Pooled	AHS	HECM	Pooled	AHS	HECM
Subjects Observed	38,364	385	38,009	9,742	9,220	522

Notes: Columns (1) and (4) are probit estimates of HECM participation based on the pooled sample of HECM borrowers and the American Housing Survey comparison group. Both data sets are confined to single female homeowners over age 62. Columns (4) through (6) are restricted to the states for which appreciation rates are in the bottom 20% as measured by 1975-2003 appreciation in the OFHEO house price index. $\widehat{HECM}$ in specifications (2) and (3) is based on the estimate from specification (1); in specifications (5) and (6), $\widehat{HECM}$ comes from the constricted sample in specification (4).

Table 5: Summary Statistics for Hazard Regression Covariates

Variable	Obs. HECM	Mean HECM	Obs. AHS	Mean AHS
AGE	41,004	76.2	1,301	72.7
House Value	41,004	144,807	1,301	58,370
Income	41,004	2,841	1,299	12,047
$\frac{\text{House Value}}{\text{Total Assets}}$	40,608	.95	0	.
$\frac{\text{House Value}}{\text{Income}}$	7,416	24.64	1,280	11.66
INV20K	41,004	.02	786	.28
PRICE (state mean)	40,793	148,165	684	142,550
RETURN (state mean)	40,924	5.55	684	2.05
LOWRETURN	41,004	.005	685	.0015
$\widehat{HECM}$	40,793	.98	684	.84

Figure 5: Distribution of total (horizontal axis) and ratio of housing to total assets (vertical) in the HECM (top panel) and AHEAD (bottom panel) data sets



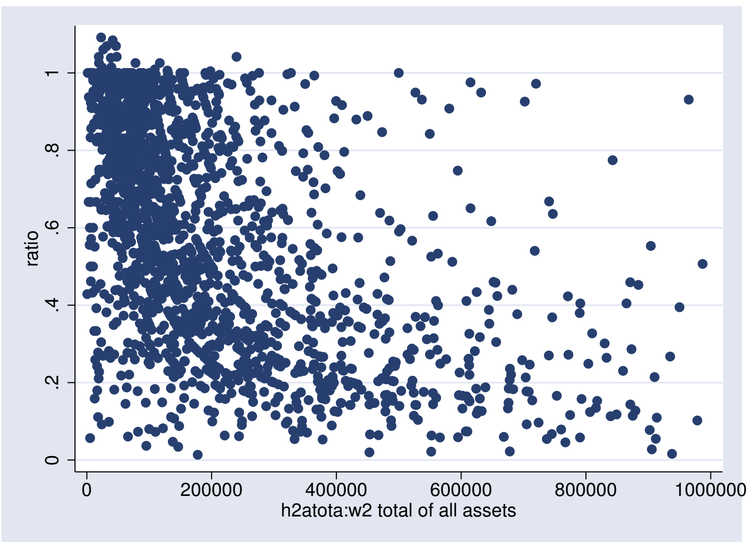
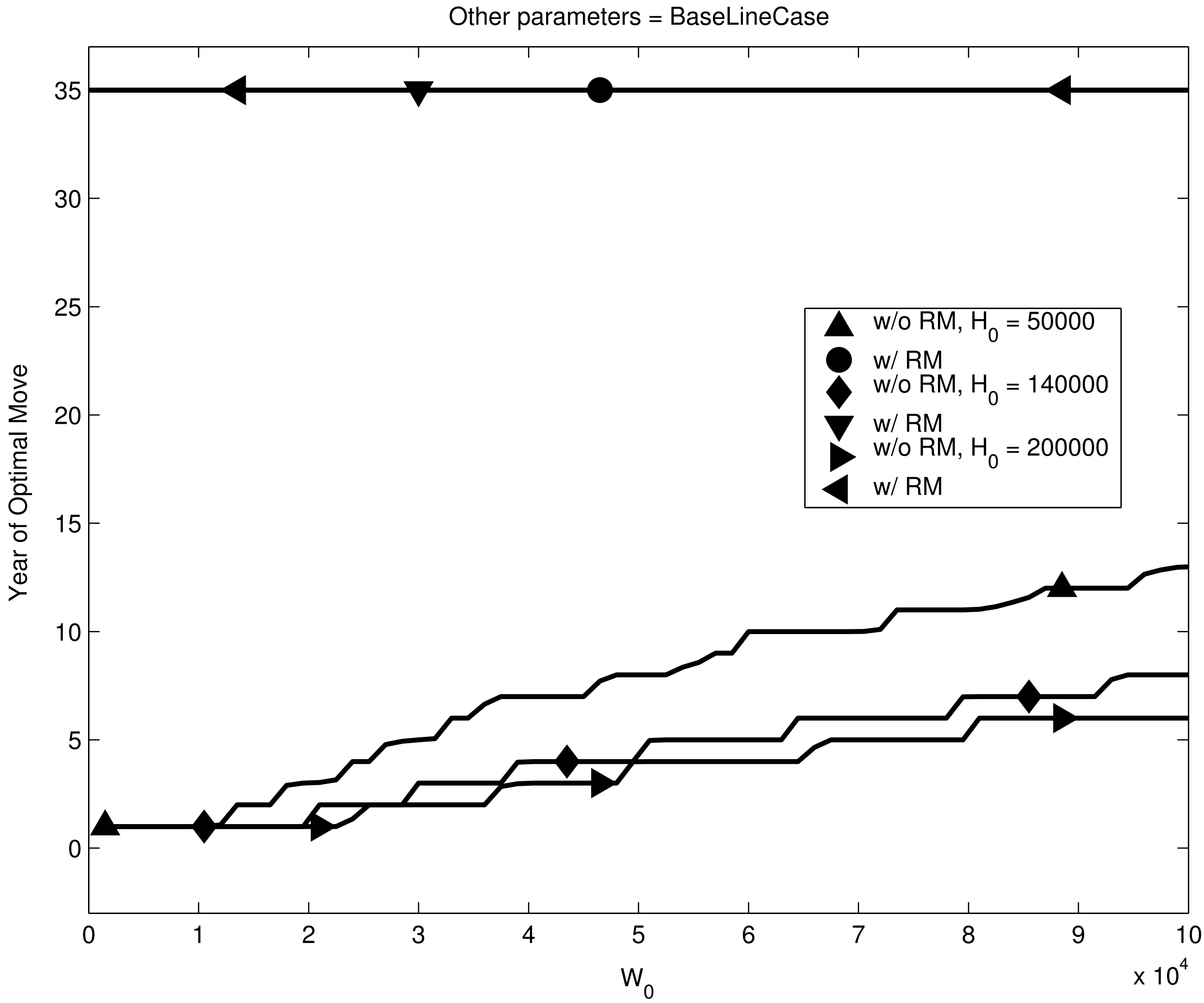
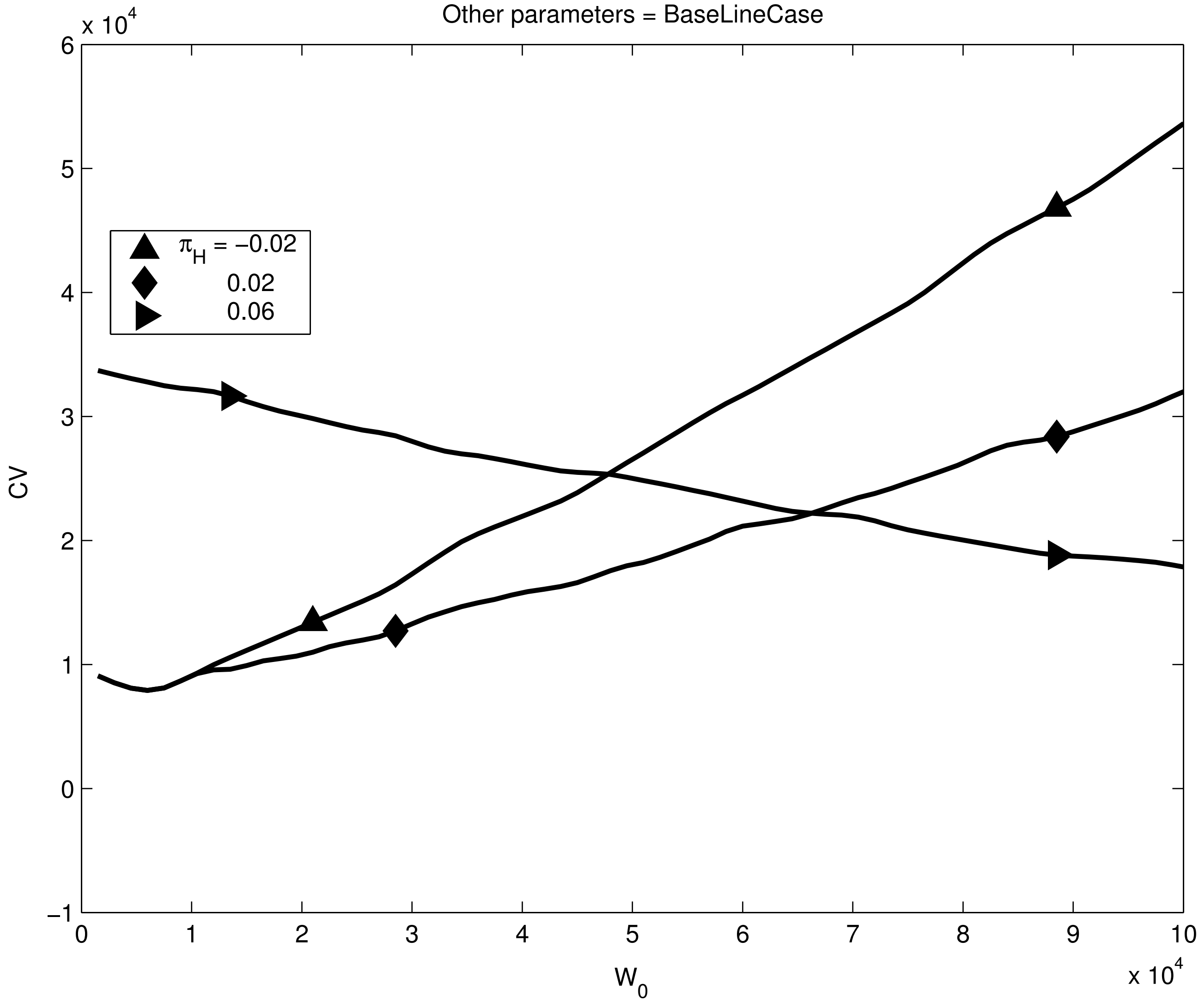


Figure 6: Optimal move date by wealth with varying appreciation rates



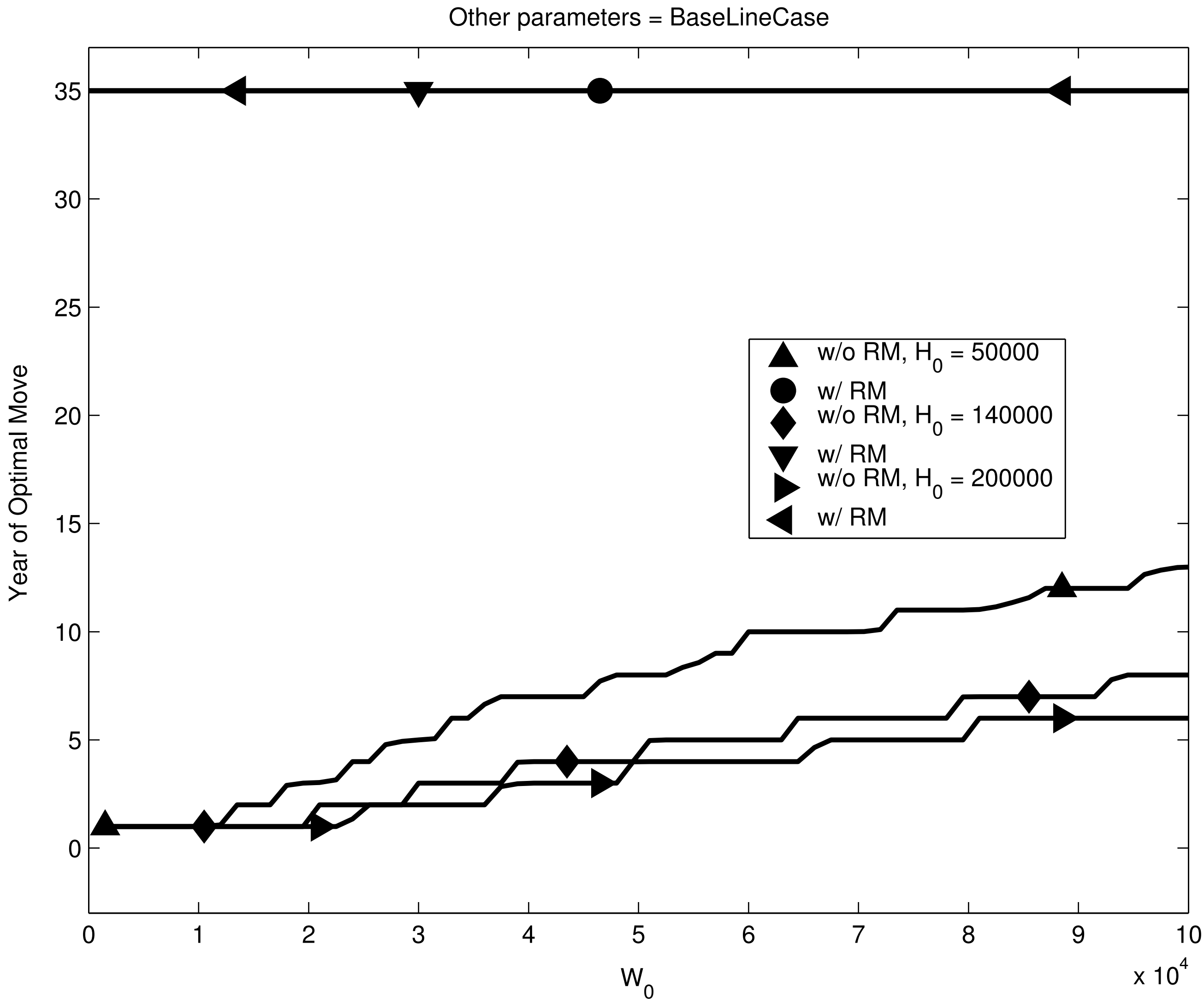
Note that the move at a date past death indicates a corner solution with no move.

Figure 7: Dollar value of the opportunity to take on reverse mortgage debt by wealth with varying appreciation rates



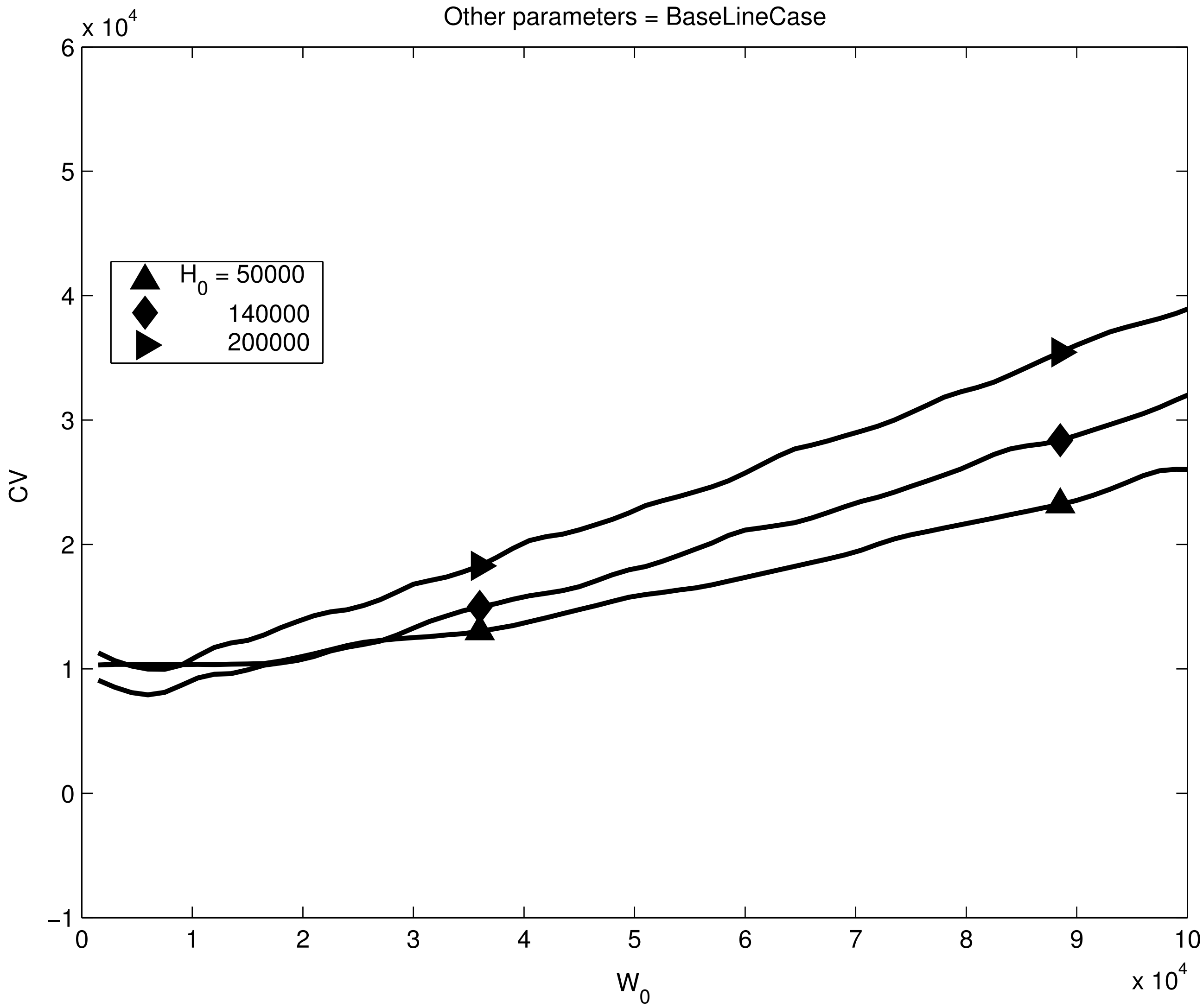
Note that the move at a date past death indicates a corner solution with no move.

Figure 8: Optimal move date by wealth with varying initial housing values (2% appreciation rate).



Note that the move at a date past death indicates a corner solution with no move.

Figure 9: Dollar value of the opportunity to take on reverse mortgage debt by wealth with varying initial house value (2% appreciation rate)



Note that the move at a date past death indicates a corner solution with no move.